1985/86
LINEAR ICs

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THOMSON SEMICONDUCTORS
created by the THOMSON Group to meet today's most demanding technological changes.

Formed by combining EFCIS, EUROTECHNIQUE, and SEMICONDUCTEURS ALCATEL with the Discrete Semiconductors and the Bipolar Integrated Circuits Divisions into a single operating entity: THOMSON SEMICONDUCTORS represents a major commitment to the advancement of electronics. It has enabled the THOMSON Group to implement a whole new set of strategies, technologies, production capabilities, technical and commercial services, and to focus on delivering effective answers to the multiple challenges facing today's electronics industry.

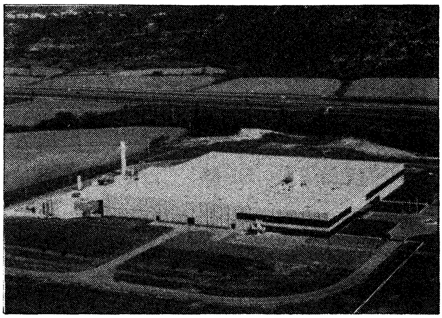
Technological competence: a guarantee

THOMSON SEMICONDUCTORS maintains Research and Development Laboratories in Grenoble, St-Egreve, Tours, Rousset, Aix-en-Provence and Montgomeryville, PA (USA). Together with their Central Laboratories. THOMSON SEMICONDUCTORS conducts highly independent research, and offers its customers the latest advances in technology:

Research activities dedicated to the development of new and improved products are carried out simultaneously in all these laboratories.

Among the more significant developments:
- Improved MOS and bipolar technologies for linear and digital LSI circuits and power circuits.
- New packaging processes to increase miniaturization and improve reliability; e.g. SO, SOT, plastic and ceramic chip-carriers.
- New power circuit packages: TOP 3, ISOTOP, etc.
- Technologies of the future, notably in solid state physics leading to the development of new components in professional, industrial and consumer electronics, as well as the telecommunications and computer aided design fields.

A full 20% of THOMSON SEMICONDUCTORS sales revenues are reinsvested in Research and Development.



MOS circuit plant in Rousset (France)

Industrial power: a solid support

Thousands of people trained to our exacting professional standards, the latest state-of-the-art production and control equipment, product design aided by powerful data processing resources - all these made it possible to produce millions of integrated circuits and discrete components in these THOMSON SEMICONDUCTORS plants last year:

In France

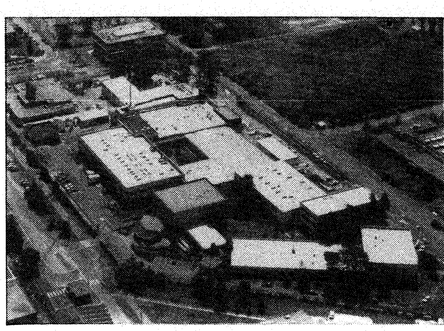
- St-Egreve: bipolar and high reliability integrated circuits: ECL-TTL gate arrays, bipolar custom products.
- Grenoble: MOS circuits & microsystems, CMOS, MOS custom products.
- Rousset: MOS circuits.
- Aix-en-Provence: switching power transistors, rectifiers, zeners.
- Tours: thyristors and triacs, switching power MOS transistors, zeners.
- Alençon: power modules, molding and assembly of semiconductors to perform complex functions, thyristors, triacs, rectifier diodes and zeners.

In United States

- Montgomeryville, PA: RF and microwave power transistors for mobile communications. TV transmission, radar, IFF, DME, and TACAN applications.

In Morocco, Brazil, the Philippines and Singapore

- Assembly and test centers.

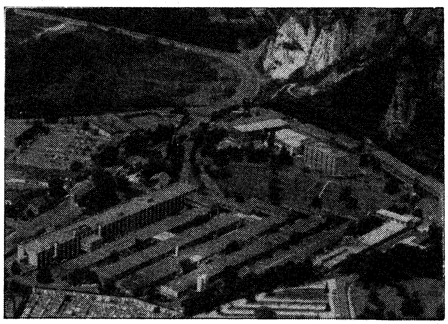


MOS circuit plant in Grenoble (France)

Commercial network: a worlwide service

THOMSON SEMICONDUCTORS has one of the most comprehensive service and technical networks in the world at its disposal, with commercial services operating in Germany, Austria, Belgium, Brazil, Canada, Spain, France, Hong Kong, Ireland, Italy, Japan, Morocco, the Netherlands, Singapore, the United Kingdom, and the United States, in addition to its worldwide distribution network.

THOMSON SEMICONDUCTORS is always at the customer's service, with technical assistance, applications laboratories, software, and development of microcontrollers, gate array networks and custom circuits available to meet their needs.



Bipolar circuits and HI-REL circuit plant in Grenoble (France)

About this data book and how to use it

This THOMSON SEMICONDUCTORS **Linear Data Book** includes data sheets covering most of the industrial and professional Integrated Circuits.
For THOMSON SEMICONDUCTORS first source bipolar products, the Pro-Electron coding is used throughout. Due to a general tendency towards standardization of coding system, THOMSON SEMICONDUCTORS like most leading semiconductor manufacturers, has decided to normalize its coding system in accordance with first source devices.
For the convenience of our customers, a former-to-1st source device equivalence table is given next, followed by a former-to-present package letter code equivalence table.

THOMSON SEMICONDUCTORS BIPOLAR ICs

FORMER TO 1st SOURCE DEVICE EQUIVALENCE TABLE

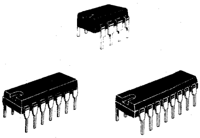
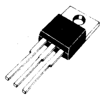
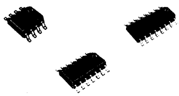
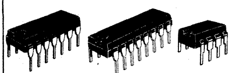
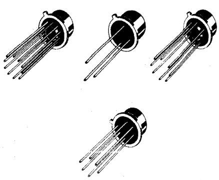
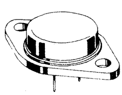
Former device N°	First source device N°	Page
SF.C 2101 A	LM 101 A	63
SF.C 2105	LM 105	349
SF.C 2108	LM 108	73
SF.C 2109	LM 109	357
SF.C 2111	LM 111	303
SF.C 2118	LM 118	87
SF.C 2201 A	LM 201 A	63
SF.C 2205	LM 205	349
SF.C 2208	LM 208	73
SF.C 2209	LM 209	357
SF.C 2211	LM 211	303
SF.C 2218	LM 218	87
SF.C 2301 A	LM 301 A	63
SF.C 2305	LM 305	349
SF.C 2308	LM 308	73
SF.C 2309	LM 309	357
SF.C 2311	LM 311	303
SF.C 2318	LM 318	87
SF.C 2458.C	LM 1458	143
SF.C 2458.M	LM 1558	143
SF.C 2723	UA 723	421
SF.C 2741	UA 741	271
SF.C 2748	UA 748	279
SF.C 2761.C	TAA 761	165
SF.C 2761.T	TAA 765I	165
SF.C 2761.M	TAA 762M	165
SF.C 2776	UA 776	287
SF.C 2805	UA 7805	435,445
SF.C 2806	UA 7806	435,445
SF.C 2808	UA 7808	435,445
SF.C 2812	UA 7812	435,445

Former device N°	First source device N°	Page
SF.C 2815	UA 7815	435,445
SF.C 2818	UA 7818	435,445
SF.C 2824	UA 7824	435,445
TDB 0061	TL 061 C	193
TDB 0062	TL 062 C	201
TDB 0064	TL 064 C	209
TDB 0071	TL 071 C	217
TDB 0072	TL 072 C	225
TDB 0074	TL 074 C	233
TDB 0081	TL 081 C	243
TDB 0082	TL 082 C	251
TDB 0084	TL 084 C	261
TDB 0117	LM 317	365
TDB 0119	LM 319	311
TDB 0123	LM 323	375
TDB 0124	LM 324	99
TDB 0134	LM 334	679
TDB 0135	LM 335	689
TDB 0136	LM 336	699
TDB 0137	LM 337	383
TDB 0139	LM 339	319
TDB 0146	LM 346	111
TDB 0148	LM 348	123
TDB 0149	LM 349	123
TDB 0155	LF 355	35
TDB 0156	LF 356	35
TDB 0157	LF 357	35
TDB 0158	LF 358	35
TDB 0193	LM 393	329

Former device N°	First source device N°	Page
TDB 0555	NE 555 C	707
TDB 0556	NE 556 C	715
TDB 2905	UA 7905	455,463
TDB 2912	UA 7912	455,463
TDB 2915	UA 7915	455,463
TDB 3403	MC 3403	151
TDB 4558	MC 4558 C	159
TDC 0061	TL 061 M	193
TDC 0062	TL 062 M	201
TDC 0064	TL 064 M	209
TDC 0071	TL 071 M	217
TDC 0072	TL 072 M	225
TDC 0074	TL 074 M	233
TDC 0081	TL 081 M	243
TDC 0082	TL 082 M	251
TDC 0084	TL 084 M	261
TDC 0117	LM 117	365
TDC 0119	LM 119	311
TDC 0123	LM 123	375
TDC 0124	LM 124	99
TDC 0134	LM 134	679
TDC 0135	LM 135	689
TDC 0137	LM 137	383
TDC 0139	LM 139	319
TDC 0146	LM 146	111
TDC 0148	LM 148	123
TDC 0149	LM 149	123
TDC 0155	LF 155	35
TDC 0156	LF 156	35
TDC 0157	LF 157	35
TDC 0158	LF 158	35
TDC 0193	LM 193	329
TDC 0555	SE 555 M	707
TDC 0556	SE 556 M	715
TDC 2905	UA 7905	455,463
TDC 2912	UA 7912	455,463
TDC 2915	UA 7915	455,463

Former device N°	First source device N°	Page
TDC 3403	MC 3503	151
TDC 4558	MC 4558 M	159
TDE 0061	TL 061 I	193
TDE 0062	TL 062 I	201
TDE 0064	TL 064 I	209
TDE 0071	TL 071 I	217
TDE 0072	TL 072 I	225
TDE 0074	TL 074 I	233
TDE 0081	TL 081 I	243
TDE 0082	TL 082 I	251
TDE 0084	TL 084 I	261
TDE 0117	LM 217	365
TDE 0119	LM 219	311
TDE 0123	LM 223	375
TDE 0124	LM 224	99
TDE 0134	LM 234	679
TDE 0135	LM 235	689
TDE 0136	LM 236	699
TDE 0137	LM 237	383
TDE 0146	LM 246	111
TDE 0148	LM 248	123
TDE 0149	LM 249	123
TDE 0155	LF 255	35
TDE 0156	LF 256	35
TDE 0157	LF 257	35
TDE 0158	LM 258	131
TDE 0193	LM 293	329
TDF 2901	LM 2901	319
TDF 2902	LM 2902	99
TDF 2903	LM 2903	329
TDF 2904	LM 2904	131
TDF 3302	MC 3302	319
TDF 3403	MC 3303	151

FORMER TO 1st SOURCE
PACKAGE LETTER CODE EQUIVALENCE TABLE

Package description		Package number	Package letter code	
			Former	Present
	Plastic DIL	CB-98 CB-2, CB-79	D E	DP-8 DP
	Plastic TO-220	CB-117	E	SP
	Plastic micropackage	CB-342, CB-359, CB-511	U	FP
	Plastic single-in-line	CB-97	SP	Z
	Cerdip DIL	CB-2, CB-79, CB-98	J or G	DG
	Tricecop (LCC)	CB-705	H	GC
	Metal can	CB-3, CB-7, CB-11 CB-107	Not specified or CM	H
	Steel can	CB-19	R or KM	K

Note : for package dimensions, please refer to chapiter 17 (page 965)

How to select products

For your convenience and in order to facilitate your product selection, this Data Book also contains the following:

— Master Selection Guide listed by product family (pages 11 through 17)
— An Alpha-Numerical Index (pages 19 through 26)
— Detailed Product Selection Guides - classifying products by their main selection criteria - is included at the beginning of the following chapters:

- Chapter 1 - Operational amplifiers
- Chapter 2 - Voltage comparators
- Chapter 3 - Voltage regulators
- Chapter 4 - Autoprotected control
- Chapter 5 - Motor control
- Chapter 6 - Switch Mode Power Supplies & Power Drivers
- Chapter 7 - Proximity detectors
- Chapter 11 - Consumer circuits

Note: A separate CONSUMER DATA BOOK is available giving full information on products outlined in this chapter.

— A Linear cross reference listed by manufacturer (Chapter 19).

- For customers who used to order products under their former device numbers:
  refer to above tables where you will find directly the new device number as well as the page number of the corresponding data sheet.

- For customers who are familiar with currently marketed part numbers:
  an Alpha-Numerical Index is provided in pages 19 through 26 indicating functions and data sheet page numbers.

- For customers who require an alternative second source or desire to switch to THOMSON SEMICONDUCTORS products:
  refer to chapter 19 (Cross reference by manufacturer).

- For new customers:
  A detailed Master Selection Guide is provided in pages 11 through 17 describing the contents of this Data Book listed by product family, and also giving functions and data sheet page numbers. Otherwise, at the beginning of every chapter, a detailed selection guide listing the most important product selection criteria is included for your assistance.

The specification of the devices referred to in this data book may have changed. For up dated information regarding static and dynamic characteristics, please consult the current issue of the relevant data sheet.

CHAPTER 1 - OPERATIONAL AMPLIFIERS

Page

Operational amplifier selection guide 28

SINGLE BIPOLAR OP-AMPs

●**LM11/LM11L** Precision single operational amplifiers/buffers 49
●**LM101A/LM201A/LM301A** Single operational amplifiers 63
●**LM108,A/LM208,A/LM308,A** Precision single operational amplifiers 73
●**LM118/LM218/LM318** Single operational amplifiers 87
●**TAA761/TAA762/TAA765** Open collector output single operational amplifiers 165
TDB2022 Wideband single operational amplifier 175
TDB7910 Power single operational amplifier 185
●**UA741** General-purpose single operational amplifier 271
●**UA748** General-purpose single operational amplifier 279
●**UA776** Programmable single operational amplifier 287

DUAL BIPOLAR OP-AMPs

●**LM158/LM258/LM358/LM2904** Low power dual operational amplifiers 131
●**LM1458/LM1558** Dual operational amplifiers 143
LM2904 Low power dual operational amplifier 131
●**MC4558** Wideband dual operational amplifier 159
●**TE.1033** Dual operational amplifiers for active filter design 189

QUAD BIPOLAR OP-AMPs

●**LM124/LM224/LM324,A/LM2902** Low power quad operational amplifiers 19
●**LM146/LM246/LM346** Programmable quad operational amplifiers 111
●**LM148/LM248/LM348** Differential input quad operational amplifiers 123
LM149/LM249/LM349 Quad operational amplifiers 123
LM2902 Low power quad operational amplifier 99
MC3303/MC3403/MC3503 Low power differential input quad operational amplifiers 151

SINGLE J-FET OP-AMPs

●**LF155,A/LF255,A/LF355,A** Monolithic J-FET input single operational amplifiers 35
●**LF156,A/LF256,A/LF356,A** Monolithic J-FET input single operational amplifiers 35
LF157,A/LF257,A/LF357,A Monolithic J-FET input single operational amplifiers 35
●**TL061/TL061A/TL061B** Low power J-FET input single operational amplifiers 193
●**TL071/TL071A/TL071B** Low noise J-FET input single operational amplifiers 217
●**TL081/TL081A/TL081B** J-FET input single operational amplifiers 243

DUAL J-FET OP-AMPs

●**TL062/TL062A/TL062B** Low power J-FET input dual operational amplifiers 201
●**TL072/TL072A/TL072B** Low noise J-FET input dual operational amplifiers 225
●**TL082/TL082A/TL082B** J-FET input dual operational amplifiers 251

QUAD J-FET OP-AMPs

●**TL064/TL064A/TL064B** Low power J-FET input quad operational amplifiers 209
●**TL074/TL074A/TL074B** Low noise J-FET input quad operational amplifiers 233
●**TL084/TL084A/TL084B** J-FET input quad operational amplifiers 261

● Hi-Rel versions available - See chapter 14

CHAPTER 2 - VOLTAGE COMPARATORS

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Voltage comparator selection guide 301

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● **LM111/LM211/LM311** Voltage comparators 303

DUAL

● **LM119/LM219/LM319** High speed dual comparators 311

● **LM193,A/LM293,A/LM393,A/LM2903** Low power low offset voltage dual comparators ... 329

LM2903 Low power, low offset voltage dual comparator 329

QUAD

● **LM139,A/LM239,A/LM339,A/LM2901/MC3302** Low power low offset voltage quad comparators 319

LM2901 Low power low offset voltage quad comparator 319

MC3302 Low power low offset voltage quad comparator 319

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Voltage regulator selection guide 338

THREE-TERMINAL FIXED REGULATORS

● **LM109/LM209/LM309** Three-terminal 5-V regulators 357

● **LM123/LM223/LM323** Three-terminal 3A-5V positive voltage regulators 375

UA78S00/UA78S00B Series Three-terminal fixed positive voltage regulators 429

● **UA7800/UA7800B Series** Three-terminal fixed positive voltage regulators 435,445

● **UA7900/UA7900B Series** Three-terminal fixed negative voltage regulators 455,463

THREE-TERMINAL ADJUSTABLE REGULATORS

● **LM117/LM217/LM317** Three-terminal adjustable positive voltage regulators 365

● **LM137/LM237/LM337** Three-terminal adjustable negative voltage regulators 383

● **LM138/LM238/LM338** Three-terminal 5-A adjustable voltage regulators 393

MULTI-TERMINAL ADJUSTABLE REGULATORS

L200 Adjustable voltage and current regulator 341

● **LM105/LM205/LM305** Adjustable positive voltage regulators 349

● **UA723/UA723A** Precision adjustable voltage regulators 421

TEA5110 Low drop-out 5-V dual voltage regulator 403

TEA7028 Low drop-out 5-V voltage regulator 409

TEA7034 Low drop-out 5-V voltage regulator 415

CHAPTER 4 - AUTOPROTECTED CONTROL

Autoprotected control selection guide 473

TDE1607 Relay and lamp driver 475

TDE1647/TDE1647A Relay and lamp drivers 475

TDE1737 Relay and lamp driver 487

TDE1747 Relay and lamp driver 475

TDE1767/TDE1767A Relay and lamp drivers 493

TDE1787/TDE1787A Relay and lamp drivers 493

TDE1798 Relay and lamp driver 503

TDE3207 Relay and lamp driver 511

TDF1778 Dual 2-Amp source driver 517

● Hi-Rel versions available - See chapter 14

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MC34060 Pulse width modulation control circuit ... 557
TEA1510 Long cycle zero voltage triac driver for proportional power control ... 569
TEA1511 Zero voltage zero current triac control circuit ... 577
TEA2018A Switch Mode Power Supply control circuit ... 585
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TL494 Pulse width modulation control circuit ... 597
UAA4001 Switch Mode Power Supply control circuit ... 609
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● **TS8306** 6-bit flash A/D converter ... 733
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● **TS8408** Video speed 8-bit video speed voltage output D/A converter ... 743
● **TS85XX** Industrial switched capacitor filter family ... 747
● **UAB1005/UAC1005** High speed 4-bit A/D converters ... 749

● Hi-Rel versions available - See chapter 14

CHAPTER 9 - PLASTIC MICROPACKAGES

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CHAPTER 10 - CHIPS

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J LM101A/J LM301A Single operational amplifiers 773
J LM108,A/J LM308,A Precision single operational amplifiers 775
J LM118/J LM318 Single operational amplifiers 777
J UA741 General-purpose single operational amplifiers 805
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DUAL BIPOLAR OP-AMPs

J LM158/J LM358 Low power dual operational amplifiers 785
J LM1458/J LM1558 Dual operational amplifiers 787
J MC4558 Wideband dual operational amplifier 791

QUAD BIPOLAR OP-AMPs

J LM124/J LM324 Low power quad operational amplifiers 779
J LM146/J LM346 Programmable quad operational amplifiers 781
J LM148/J LM348 Differential input quad operational amplifiers 783
J MC3403/J MC3503 Low power differential input quad operational amplifiers 789

SINGLE J-FET OP-AMPs

J LF155/J LF355 Monolithic J-FET input single operational amplifiers 771
J LF156/ J LF356 Monolithic J-FET input single operational amplifiers 771
J LF157/J LF357 Monolithic J-FET input single operational amplifiers 771
J TL061 Low power J-FET input single operational amplifier 793
J TL081 J-FET input single operational amplifier 799

DUAL J-FET OP-AMPs

J TL062 Low power J-FET input dual operational amplifier 795
J TL082 J-FET input dual operational amplifier 801

QUAD J-FET OP-AMPs

J TL064 Low power J-FET input quad operational amplifier 797
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J LM111/J LM311 Single voltage comparators 811
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J LM105/J LM305 Adjustable positive voltage regulators 821
J LM117/J LM317 Adjustable positive voltage regulators 823
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TEA2031 Parabolic correction .... *
TEA2037 Complete horizontal & vertical deflection (displays) .... *
TEA2116 Vertical power stage (110° screens) .... *
TEA2134 Vertical power stage (90° screens) .... *
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* Available as separate data sheet

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TDA2542	Video I.F. amplifier with demodulator and AFC	Consumer
TDA2593	Color TV horizontal processor	Consumer
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TDA4427	Video I.F. amplifier with AFC	*
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J LM119	High speed dual comparator	813
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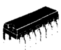
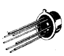
Operational amplifiers

INTERNAL COMPENSATION

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
LML11/LM11L	Precision	●		●			49
LM118/LM218/LM318	Ultra fast				●	Ultra fast	87
TDB2022	Wide band				●	95 MHz	175
TDB7910	Power		●	●		$I_O > 500$ mA	185
UA741	General purpose			●		$I_{IB} < 500$ mA	271
UA776	Programmable	●		●			287

($T_{amb} = +25°C$)

CHARACTERISTIC	SYMBOL	UNIT	LM11 LM11L	LM118 LM218 LM318	TDB2022	TDB7910	UA741	UA776
Supply voltage	$V_{CC(max)}$	V	±20	±20	±18	±18	±18	±18
Input offset voltage	$V_{IO(max)}$	mV	0.6	10	5	6	6	6
Input offset current	$I_{IO(max)}$	nA	0.010	200	1000	200	200	25
Input impedance	$R_{I(min)}$	MΩ	10^5 typ.	0.5	0.05 typ.	0.3	0.3	5 typ.
Input bias current	$I_{IB(max)}$	nA	0.1	500	3000	500	500	50
Slew rate	$S_{VO(typ)}$	V/µs	–	50 min.	50	–	0.5	0.8
Supply voltage rejection ratio	$SV_{R(min)}$	dB	100	65	50	76	76	76
Gain × bandwidth	$GW_{R(typ)}$	MHz	–	15	150 (–10dB)	–	–	–
Short-circuit current	$I_{SC(typ)}$	mA	–	–	–	1000	25	12
Voltage gain	$A_{VD(min)}$	V/mV	100	25	0.9	20	20	50
Input voltage range	$V_{IM(min)}$	V	$V^- +2$ $V^+ -1$	±11.5	–	±12	±12	±10
PACKAGE		**SUFFIX**						
Plastic SO 8		FP		●			●	●
Plastic DIL 8		DP	●	●			●	●
Batwing DIL 16		DP				●		
Cerdip DIL 8		DG		●			●	
Chip carrier		GC		●			●	●
Metal can TO-99		H	●	●	CM		●	●
Page			49	87	175	185	271	287

EXTERNAL COMPENSATION

Part number	Function	Low power < 1 mA	Single supply	Adjustable offset	Bandwidth > 2 MHz	Other charac.	Page
LM101A/LM201A/LM301A	General purpose			●		I_{IB} < 100 nA	63
LM108,A/LM208,A/LM308,A	Precision	●				High gain	73
TAA761/TAA762/TAA765	Open collector						165
UA748	General purpose					I_{IB} < 500 nA	279

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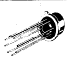
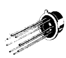
(T_{amb} = + 25°C)

CHARACTERISTIC	SYMBOL	UNIT	LM101A LM201A LM301A	LM108A LM208A LM308A	TAA761 TAA762 TAA765	UA748
Supply voltage	$V_{CC(max)}$	V	± 18	± 18	± 18	± 18
Input offset voltage	$V_{IO(max)}$	mV	7.5	7.5	6	6
Input offset current	$I_{IO(max)}$	nA	50	1	300	200
Input impedance	$R_{I(min)}$	MΩ	0.5	10	0.2 typ.	0.3
Input bias current	$I_{IB(max)}$	nA	250	7	1000	500
Slew rate	$S_{VO(typ)}$	V/µs	0.5	–	9	0.5
Supply voltage rejection ratio	$SV_{R\,(min)}$	dB	70	80	74	76
Short-circuit current	$I_{SC(typ)}$	mA	–	–	–	25
Voltage gain	$A_{VD(min)}$	V/mV	25	25	12	20
Input voltage range	$V_{IM(min)}$	V	± 12	± 14	± 12	± 12
PACKAGE		**SUFFIX**				
Plastic SO 8		FP	●	●		●
Plastic DIL 6/8	 	DP	⑧	⑧	⑥	⑧
Cerdip DIL 8		DG	●	●		●
Chip carrier		GC	●	●		●
Metal can TO-99		H	●	●		●
6-pin metal can		H			●	
Page			63	73	165	279

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
LM158/LM258/LM358/LM2904	Low power	●	●			I_{IB} < 100 nA	131
LM1458/LM1558	General purpose					I_{IB} < 500 nA	143
MC4558	Wide band				●	I_{IB} < 500 nA	159
TE.1033	Active filter design	●			●	I_{IB} < 100 nA	189

(T_{amb} = +25°C)

CHARACTERISTIC	SYMBOL	UNIT	LM158 LM258 LM358	LM1458 LM1558	LM2904	MC4558	TE.1033
Supply voltage	$V_{CC(max)}$	V	±16 or 32	±18	±13 or 26	±18	±18
Input offset voltage	$V_{IO(max)}$	mV	±7	6	±7	6	3
Input offset current	$I_{IO(max)}$	nA	±50	200	±50	200	50
Input impedance	$R_{I(min)}$	MΩ	–	0.2	–	0.3	0.5 typ.
Input bias current	$I_{IB(max)}$	nA	250	500	250	500	200
Slew rate	S_{VO}	V/μs	–	0.8 typ.	–	1 min.	1 typ.
Supply voltage rejection ratio	SV_R (min)	dB	65	76	50	76	86
Gain × bandwidth	$GW_{R(typ)}$	MHz	–	–	–	2	1.5
Voltage gain	$A_{VD(min)}$	V/mV	25	20	–	20	20
Input voltage range	V_{IM}	V	0 to $V^+ - 1.5$	±12 (min)	0 to $V^+ - 1.5$	±12 (min)	±10 (min)
PACKAGE		**SUFFIX**					
Plastic SO 8		FP	●	●	●	●	●
Plastic DIL 8		DP	●	●	●	●	●
Cerdip DIL 8		DG	●	●		●	
Chip carrier		GC	●	●			●
Metal can TO-99		H	●	●		●	
Page			131	143	131	159	189

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
LM124/LM224/LM324,A/LM2902	Low power	●	●			I_{IB} < 100 nA	99
LM146/LM246/LM346	Programmable	●					111
LM148/LM248/LM348	Differential input	●				I_{IB} < 100 nA	123
LM149/LM249/LM349	Differential input	●			●	G > 5	123
MC3303/MC3403/MC3503	Differential input		●			Low distortion	151

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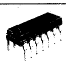
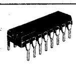
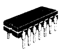
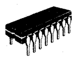
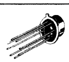
(T_{amb} = +25°C)

CHARACTERISTIC	SYMBOL	UNIT	LM124 LM224 LM324,A	LM146 LM246 LM346	LM148 LM248 LM348	LM149 LM249 LM349	LM2902	MC3303 MC3403 MC3503
Supply voltage	$V_{CC(max)}$	V	±16 or 32	±18	±18	±18	±13 or 26	±18
Input offset voltage	$V_{IO(max)}$	mV	7	6	6	6	7	10
Input offset current	$I_{IO(max)}$	nA	50	100	50	50	50	70
Input impedance	$R_{I(min)}$	MΩ	—	1 typ.	0.8	0.8	—	0.3
Input bias current	$I_{IB(max)}$	nA	250	250	200	200	250	500
Slew rate	$S_{VO(typ)}$	V/µs	—	0.5	0.5	2	—	0.6
Supply voltage rejection ratio	SV_R (min)	dB	65	74	77	77	—	76
Gain × bandwidth	$GW_{R(typ)}$	MHz	—	0.4 min.	1 typ.	4 typ.	—	1 typ.
Short-circuit current	I_{SC}	mA	60 max.	30 max.	25 typ.	25 typ.	60 max.	45 max.
Voltage gain	$A_{VD(min)}$	V/mV	25	50	25	25	—	20
Input voltage range	V_{IM}	V	0 to $V^+ - 1.5$	±13.5 (min)	±12 (min)	±12 (min)	0 to $V^+ - 1.5$	±13 to $V^-_{(min)}$
PACKAGE		**SUFFIX**						
Plastic SO 14-16 		FP	14	16	14	14	14	14
Plastic DIL 14-16 		DP	14	16	14	14	14	14
Cerdip DIL 14-16 		DG	14	16	14	14		14
Chip carrier		GC	●	●	●	●		
Page			99	111	123	123	99	151

SINGLE OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
LF155,A/LF255,A/LF355,A	General purpose			●	2.5 MHz typ	$I_{IB}<200$ pA	35
LF156,A/LF256,A/LF356,A	General purpose			●	5 MHz typ	$I_{IB}<200$ pA	35
LF157,A/LF257,A/LF357,A	General purpose			●	20 MHz typ	$I_{IB}<200$ pA	35
TL061/TL061A/TL061B	Low power	●		●		$I_{CC}<250$ µA	193
TL071/TL071A/TL071B	Low noise			●			217
TL081/TL081A/TL081B	General purpose			●			243

($T_{amb} = +25°C$)

CHARACTERISTIC		SYMBOL	UNIT	LF155,A LF255,A LF355,A	LF156,A LF256,A LF356,A	LF157,A LF257,A LF357,A	TL061 TL061A TL061B	TL071 TL071A TL071B	TL081 TL081A TL081B
Supply voltage		$V_{CC(max)}$	V	±18	±18	±18	±18	±18	±18
Input offset voltage		$V_{IO(max)}$	mV	10	10	10	15	10	15
Input offset current		$I_{IO(max)}$	nA	0.05	0.05	0.05	0.2	0.05	0.2
Input impedance		$R_{I(typ)}$	10^6 MΩ	1	1	1	1	1	1
Input bias current		$I_{IB(max)}$	nA	0.2	0.2	0.2	0.4	0.2	0.4
Slew rate		$S_{VO(typ)}$	V/µs	5	12	50	3.5	13	13
Supply voltage rejection ratio		$SV_{R(min)}$	dB	80	80	80	70	70	70
Gain × bandwidth		$GW_{R(typ)}$	MHz	2.5	4.5	20	1	3	3
Voltage gain		$A_{VD(min)}$	V/mV	25	25	25	3	25	25
Input voltage range		$V_{IM(min)}$	V	±10	±10	±10	±10	±11	±10
PACKAGE			**SUFFIX**						
Plastic SO 8			FP				●	●	●
Plastic DIL 8			DP	●	●	●	●	●	●
Chip carrier			GC	●	●	●			●
Metal can TO-99			H	●	●	●	●	●	●
Page				35	35	35	193	217	243

DUAL OP-AMPs

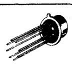
Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
TL062/TL062A/TL062B	Low power	●				$I_{CC} < 250\ \mu A$*	201
TL072/TL072A/TL072B	Low noise				●		225
TL082/TL082A/TL082B	General purpose				●		251

QUAD OP-AMPS

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
TL064/TL064A/TL064B	Low power	●				$I_{CC} < 250\ \mu A$*	209
TL074/TL074A/TL074B	Low noise				●		233
TL084/TL084A/TL084B	General purpose				●		261

* Each amplifier

($T_{amb} = +25°C$)

CHARACTERISTIC	SYMBOL	UNIT	DUAL			QUAD		
			TL062	TL072	TL082	TL064	TL074	TL084
Supply voltage	$V_{CC(max)}$	V	±18	±18	±18	±18	±18	±18
Input offset voltage	$V_{IO(max)}$	mV	15	10	15	15	10	15
Input offset current	$I_{IO(max)}$	nA	0.2	0.05	0.2	0.2	0.05	0.2
Input impedance	$R_{I(typ)}$	10^6 MΩ	1	1	1	1	1	1
Input bias current	$I_{IB(max)}$	nA	0.4	0.2	0.4	0.4	0.2	0.4
Slew rate	$S_{VO(typ)}$	V/µs	3.5	13	13	3.5	13	13
Supply voltage rejection ratio	SVR(min)	dB	70	70	70	70	70	70
Gain × bandwidth	$GW_{R(typ)}$	MHz	1	3	3	1	3	3
Voltage gain	$A_{VD(min)}$	V/mV	3	25	25	3	25	25
Input voltage range	$V_{IM(min)}$	V	±10	±11	±10	±10	±11	±10
PACKAGE		**SUFFIX**						
Plastic SO 8-14		FP	8	8	8	14	14	14
Plastic DIL 8-14		DP	8	8	8	14	14	14
Cerdip DIL 14		DG				●	●	●
20-pin chip carrier		GC			●			●
Metal can TO-99		H	●	●	●			
Page			201	225	251	209	233	261

THOMSON SEMICONDUCTORS

LF155,A/156,A/157,A
LF255/256/257
LF355,A/356,A/357,A

1

J-FET INPUT SINGLE OPERATIONAL AMPLIFIERS

These circuits are monolithic J-FET input operational amplifiers incorporating well matched high voltage J-FETs on the same chip with standard bipolar transistors.

These amplifiers feature low input bias and offset currents, low input offset voltage and input offset voltage drift, coupled with offset adjust which does not degrade drift or common-mode rejection.

The devices are also designed for high slew rate, wide bandwidth, extremely fast settling time, low voltage and current noise and a low I/f noise corner.

- Replace hybrid and module FET op amps. Rugged JFETs allow blow-out free handling compared with MOSFET input devices.
- Excellent for low noise applications using either high or low source impedance very low I/f corner.
- Offset voltage adjust does not degrade drift or common-mode rejection as in most monolithic amplifiers.
- New output stage allows use of large capacitive loads (10 000 pF) without stability problems.
- Internal compensation and large differential input voltage capability.

Typical applications :
- Precision high speed integrators.
- Fast D/A and A/D converters.
- High impedance buffers.
- Wideband, low noise, low drift amplifiers.
- Logarithmic amplifiers.
- Photocell amplifiers.
- Sample and hold circuits.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

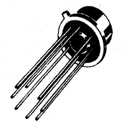
PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		H	DP	GC
LF355,A/LF356,A LF357,A	0°C to + 70°C	•	•	
LF255/LF256 LF257	−25°C to + 85°C	•		
LF155,A/LF156,A LF157,A	−55°C to +125°C	•		•

Examples : LF355ADP, LF155H

J-FET INPUT SINGLE OPERATIONAL AMPLIFIERS

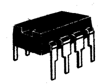
CASES

CB-11



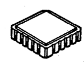
H SUFFIX
METAL CAN

CB-98



DP SUFFIX
PLASTIC PACKAGE

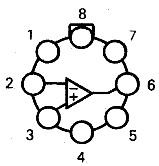
CB-705



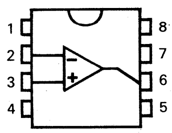
GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS
(Top views)

CB-11

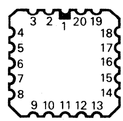


CB-98



1 - Offset null
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Offset null
6 - Output
7 - V_{CC}^+
8 - NC

CB-705



1 - NC
2 - Offset null
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Offset null
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - NC

Réf. 00330

THOMSON SEMICONDUCTORS
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45, av. de l'Europe - 78140 VELIZY - FRANCE
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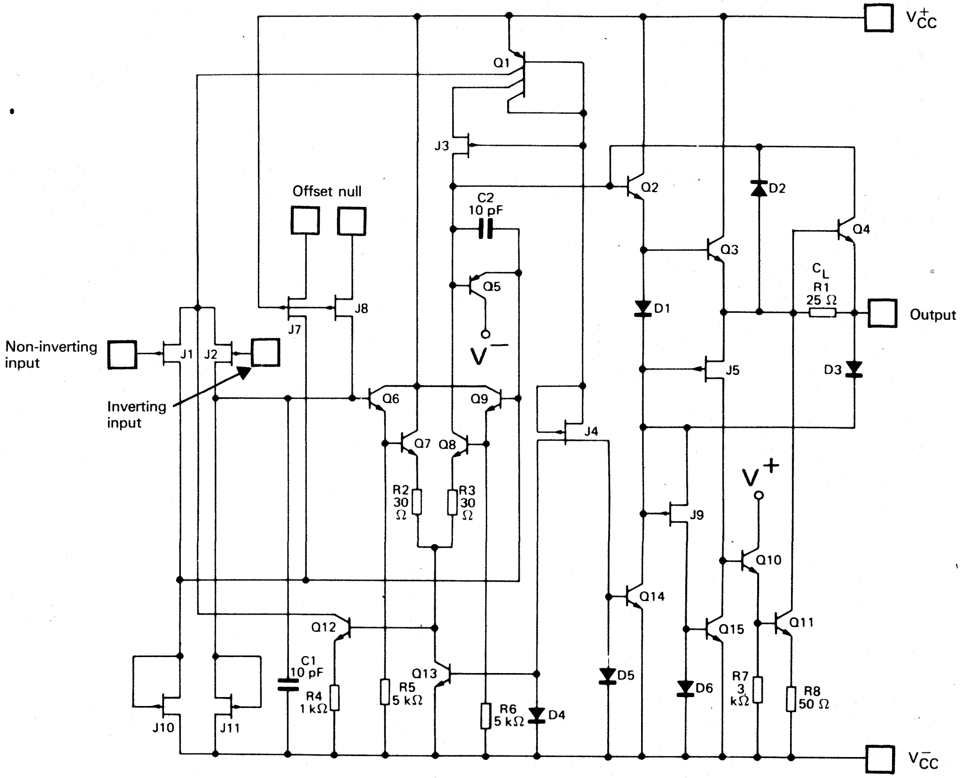
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	LF355,A LF356,A LF357,A	LF255 LF256 LF257	LF155,A LF156,A LF157,A	Unit
Supply voltage	V_{CC}	± 18	± 22	± 22	V
Differential input voltage	V_{ID}	± 30	± 40	± 40	V
Input voltage (Note 2)	V_I	± 16	± 20	± 20	V
Output short-circuit duration	–	Continuous	Continuous	Continuous	–
Power dissipation	P_{tot}	500	570	670	mW
Operating free-air temperature range	T_{oper}	0 to + 70	– 25 to + 85	– 55 to + 125	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	– 65 to + 150	°C

SCHEMATIC DIAGRAM



CASE	Offset null	Inverting input	Non-inverting input	V_{CC}^-	V_{CC}^+	Output	N.C.
CB-11 CB-98	1, 5	2	3	4	7	6	8
CB-705	2, 12	5	7	10	17	15	*

*** CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

LF155, LF156, LF157 : $-55°C \leq T_{amb} \leq +125°C$, $\pm 15\ V \leq V_{CC} \leq \pm 20\ V$ (Note 3)
LF155A, LF156A, LF157A : $-55°C \leq T_{amb} \leq +125°C$, $\pm 15\ V \leq V_{CC} \leq \pm 20\ V$ (Note 3)
LF255, LF256, LF257 : $-25°C \leq T_{amb} \leq +85°C$, $\pm 15\ V \leq V_{CC} \leq \pm 20\ V$ (Note 3)
(Unless otherwise specified)

Characteristic	Symbol	LF155, LF156, LF157 LF255, LF256, LF257			LF155A/156A/157A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}							mV
$T_{amb} = +25°C$		–	3	5	–	1	2	
$T_{min} \leq T_{amb} \leq T_{max}$ LF155, LF156, LF157		–	–	7	–	–	2.5	
LF255, LF256, LF257		–	–	6.5	–	–	–	
Input offset current (Note 5)	I_{IO}							
$T_j = +25°C$		–	3	20	–	3	10	pA
$T_j \leq T_{max}$ LF155, LF156, LF157		–	–	20	–	–	10	nA
LF255, LF256, LF257		–	–	1	–	–	–	
Input bias current (Note 5)	I_{IB}							
$T_j = +25°C$		–	30	100	–	30	50	pA
$T_j \leq T_{max}$ LF155, LF156, LF157		–	–	50	–	–	25	nA
LF255, LF256, LF257		–	–	5	–	–	–	
Large signal voltage gain ($V_{CC} = \pm 15\ V$, $V_{OPP} = \pm 10\ V$, $R_L = 2\ k\Omega$)	A_{VD}							V/mV
$T_{amb} = +25°C$		50	200	–	50	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	–	–	25	–	–	
Supply voltage rejection ratio (Note 6)	SVR	85	100	–	85	100	–	dB
Supply current ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$)	I_{CC}							mA
LF155, LF255		–	2	4	–	2	4	
LF156, LF256		–	5	7	–	5	7	
LF157, LF257		–	5	7	–	5	7	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$) - Note 4	αV_{IO}	–	5	–	–	3	5	µV/°C
Change in average temperature coefficient with V_{IO} adjust $R_S = 50\ \Omega$	$\alpha V_{IO}/V_{IO}$	–	0.5	–	–	0.5	–	µV/°C per mV
Input voltage range ($V_{CC} = \pm 15\ V$)	V_I	±11	+15.1 −12	–	±11	+15.1 −12	–	V
Common-mode rejection ratio	CMR	85	100	–	85	100	–	dB
Output voltage swing ($V_{CC} = \pm 15\ V$)	V_{OPP}							V
$R_L = 10\ k\Omega$		±12	±13	–	±12	±13	–	
$R_L = 2\ k\Omega$		±10	±12	–	±10	±12	–	
Gain-bandwidth product ($V_{CC} = +15\ V$, $T_{amb} = +25°C$)	GB_p							MHz
LF155, LF255		–	2.5	–	–	2.5	–	
LF156, LF256		–	5	–	4	4.5	–	
LF157, LF257		–	20	–	15	20	–	
Slew rate ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$)	S_{VO}							V/µs
$A_V = 1$ LF155, LF255		–	5	–	3	5	–	
LF156, LF256		7.5	12	–	10	12	–	
$A_V = 5$ LF157, LF257		30	50	–	40	50	–	
Input resistance ($T_j = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	Ω
Input capacitance ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$)	C_I	–	3	–	–	3	–	pF
Equivalent input noise voltage ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$, $R_S = 100\ \Omega$)	V_n							$nV/\sqrt{Hz}$
f = 1000 Hz LF155		–	25	–	–	20	–	
LF255		–	20	–	–	–	–	
LF156, LF157		–	12	–	–	15	–	
LF256, LF257		–	15	–	–	–	–	
f = 100 Hz LF155		–	20	–	–	25	–	
LF255		–	25	–	–	–	–	
LF156, LF157		–	12	–	–	15	–	
LF256, LF257		–	15	–	–	–	–	
Equivalent input noise current ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$, f = 100 Hz or f = 1000 Hz)	I_n	–	0.01	–	–	0.01	–	$pA/\sqrt{Hz}$
Settling time ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$) - Note 7	t_s							µs
LF155, LF255		–	4	–	–	4	–	
LF156, LF256 LF157, LF257		–	1.5	–	–	1.5	–	

ELECTRICAL CHARACTERISTICS

LF355, LF356, LF357 : 0°C ≤ T_{amb} ≤ +70°C, V_{CC} = ±15 V
LF355A, LF356A, LF357A : 0°C ≤ T_{amb} ≤ +70°C, ±15 V ≤ V_{CC} ≤ ±18 V (Note 3)
(Unless otherwise specified)

Characteristic	Symbol	LF355, LF356, LF357			LF355A/356A/357A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage (R_S = 50 Ω) T_{amb} = +25°C T_{min} ≤ T_{amb} ≤ T_{max}	V_{IO}	 – –	 3 –	 10 13	 – –	 1 –	 2 2.3	mV
Input offset current (Note 5) T_j = +25°C T_j ≤ +70°C	I_{IO}	 – –	 3 –	 50 2	 – –	 3 –	 10 1	 pA nA
Input bias current (Note 5) T_j = +25°C T_j ≤ +70°C	I_{IB}	 – –	 30 –	 200 8	 – –	 30 –	 50 5	 pA nA
Large signal voltage gain (V_{CC} = ±15 V, V_{OPP} = ±10 V, R_L = 2 kΩ) T_{amb} = +25°C T_{min} ≤ T_{amb} ≤ T_{max}	A_{VD}	 25 15	 200 –	 – –	 50 25	 200 –	 – –	V/mV
Supply voltage rejection ratio (Note 6)	SVR	80	100	–	85	100	–	dB
Supply current (V_{CC} = ±15 V, T_{amb} = +25°C) LF355 LF356, LF357	I_{CC}	 – –	 2 5	 4 10	 – –	 2 5	 4 10	mA
Temperature coefficient of input offset voltage (R_S = 50 Ω) - Note 4	αV_{IO}	–	5	–	–	3	5	μV/°C
Change in average temperature coefficient with V_{IO} adjust R_S = 50 Ω	$\alpha V_{IO}/V_{IO}$	–	0.5	–	–	0.5	–	μV/°C per mV
Input voltage range (V_{CC} = ±15 V)	V_I	±10	+15.1 −12	–	±11	+15.1 −12	–	V
Common-mode rejection ratio	CMR	85	100	–	85	100	–	dB
Output voltage swing (V_{CC} = ±15 V) R_L = 10 kΩ R_L = 2 kΩ	V_{OPP}	 ±12 ±10	 ±13 ±12	 – –	 ±12 ±10	 ±13 ±12	 – –	V
Gain-bandwidth product (V_{CC} = ±15 V, T_{amb} = +25°C) LF355 LF356 LF357	GB_p	 – – –	 2.5 5 20	 – – –	 – 4 15	 2.5 4.5 20	 – – –	MHz
Slew rate (V_{CC} = ±15 V, T_{amb} = +25°C) A_V = 1 LF355 LF356 A_V = 5 LF357	S_{VO}	 – – –	 5 12 50	 – – –	 3 10 40	 5 12 50	 – – –	V/μs
Input resistance (T_j = +25°C)	R_I	–	10^{12}	–	–	10^{12}	–	Ω
Input capacitance (V_{CC} = ±15 V, T_{amb} = +25°C)	C_I	–	3	–	–	3	–	pF
Equivalent input noise voltage (V_{CC} = ±15 V, T_{amb} +25°C, R_S = 100 Ω) f = 1000 Hz LF355 LF356, LF357 f = 100 Hz LF355 LF356, LF357	V_n	 – – – –	 20 12 25 15	 – – – –	 – – – –	 20 12 25 15	 – – – –	nV/√Hz
Equivalent input noise current (V_{CC} = ±15 V, T_{amb} = +25°C, f = 100 Hz or f = 1000 Hz)	I_n	–	0.01	–	–	0.01	–	pA/√Hz
Settling time (V_{CC} = ±15 V, T_{amb} = +25°C) - Note 7 LF355 LF356, LF357	t_s	 – –	 4 1.5	 – –	 – –	 4 1.5	 – –	μs

Note 1 : The CB package must be derated based on a thermal resistance of 150°C/W junction to ambient or 45°C/W juntion to case ; for the DIP package, the device must be derated based on thermal resistance of 175°C/W junction to ambient.

Note 2 : Unless otherwise specified the absolute maximum negative input voltage is equal to the negative power supply voltage.

Note 3 : These specifications apply for $\pm 15\ V \leqslant V_{CC} \leqslant \pm 20\ V$, $-55°C \leqslant T_{amb} \leqslant +125°C$ and $T_{high} = +125°C$ unless otherwise stated for the LF155A, LF156A, LF157A and the LF155, LF156, LF157.
For the LF355, LF356, LF357 these specifications apply for $\pm 15\ V \leqslant V_{CC} \leqslant \pm 20\ V$, $-25°C \leqslant T_{amb} \leqslant +85°C$ and $T_{high} = +85°C$ unless otherwise stated.
For the LF255, LF256, LF257 these specifications apply for $\pm 15\ V \leqslant V_{CC} \leqslant \pm 20\ V$, $0°C \leqslant T_{amb} \leqslant +70°C$ and $T_{high} = +70°C$, and for the LF355, LF356, LF357 these applications apply for $V_{CC} = \pm 15\ V$ and $0°C \leqslant T_{amb} \leqslant +70°C$.
V_{IO}, I_{IB} and I_{OS} are mesured at $V_I = 0$.

Note 4 : The temperature coefficient of the adjusted input offset voltage changes only a small amount (0.5 µV/°C typically) for each mV of adjustment from its original unadjusted value. Common-mode rejection and open loop voltage gain are also unaffected by offset adjustment.

Note 5 : The input bias currents are junction leakage currents which approximately double for every 10°C increase in the junction temperature T_j. Due to limited production test time, the input bias current measured is correlated to junction temperature.
In normal operation the junction temperature rises above the ambient temperature as a result of internal power dissipation, P_{tot}. $T_j = T_{amb} + R_{th(j-a)} \times P_{tot}$ where $R_{th(j-a)}$ is the thermal resistance from junction to ambient. Use of a heatsink is recommended if input currents are to be kept to a minimum.

Note 6 : Supply voltage rejection is measured for both supply magnitudes increasing or decreasing simultaneously, in accordance with common practice.

Note 7 : Settling time is defined here, for a unity gain inverter connection using 2 kΩ resistors for the LF155, LF156 series. It is the time required for the error voltage (the voltage at the inverting input pin on the amplifier) to settle to within 0.01% of its final value from the time a 10 V step input is applied to the inverter. For the LF157 series $A_V = -5$, the feedback resistor from output to input is 2 kΩ and the output step is 10 V.

APPLICATION HINTS

The LF155, LF156, LF157 series are op amps with J-FET input devices. These JFETs have large reverse breakdown voltages from gate to source or drain eliminating the need of clamps across the inputs. Therefore large differential input voltages can easily be accommodated without a large increase of input currents. The maximum differential input voltage is independent of the supply voltage. However, neither of the negative input voltages should be allowed to exceed the negative supply as this will cause large currents to flow which can result in a destroyed unit.

Exceeding the negative common-mode limit on either input will cause a reversal of the phase to the output and force the amplifier output to the corresponding high or low state. Exceeding the negative common-mode limit on both inputs will force the amplifier output to a high state. In neither case does a latch occur since raising the input back within the common-mode range again puts the input stage and thus the amplifier in a normal operating mode.

Exceeding the positive common-mode limit on a single input will not change the phase of the output however, if both inputs exceed the limit, the output of the amplifier will be forced to a high state.

These amplifiers will operate with the common-mode input voltage equal to the positive supply. In fact, the common-mode voltage can exceed the positive supply by approximately 100 mV independent of supply voltage and over the full operating temperature range. The positive supply can therefore be used as a reference on an input as, for example, in a supply current monitor and/or limiter.

Precautions should be taken to ensure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently metalled backwards in a socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Because these amplifiers are JFET rather than MOSFET input op amps they do not require special handling.

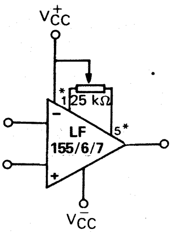
All of the bias currents in these amplifiers are set by FET current sources. The drain currents for the amplifiers are therefore essentially independent of supply voltages.

As with most amplifiers, care should be taken with lead dress, components placement and supply decoupling in order to ensure stability. For example, resistors from the output to an input should be placed with the body close to the input to minimize "pickup" and maximize the frequency of the feedback pole by minimizing the capacitance from the input to ground.

A feedback pole is created when the feedback around any amplifier is resistive. The parallel resistance and capacitance from the input of the device (usually the inverting input) to ac ground set the frequency of the pole. In many instances the frequency of this pole is much greater than the expected 3 dB frequency of the closed loop gain and consequently there is negligible effect on stability margin. However, if the feedback pole is less than approximately six times the expected 3 dB frequency a lead capacitor should be placed from the output to the input of the op amp. The value of that added capacitor should be such that the RC time constant of this capacitor and the resistance it parallels is greater than or equal to the original feedback pole time constant.

TYPICAL CIRCUITS

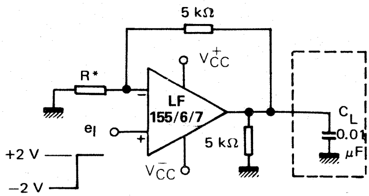
V_{IO} ADJUSTMENT



V_{IO} is adjusted with a 25 kΩ potentiometer. The potentiometer wiper is connected to V_{CC}^{+}

* CB-11, CB-98 pin configuration

DRIVING CAPACITIVE LOADS



R* = 5 kΩ LF155, LF156
R* = 1.25 kΩ LF157

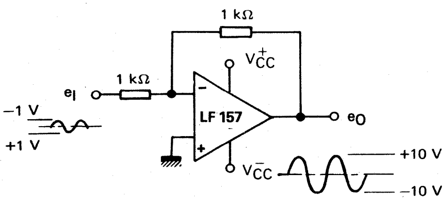
Due to a unique output stage design these amplifiers have the ability to drive large capacitive loads and still maintain stability.

$C_{L(max)} \simeq 0.01\ \mu F$

Overshoot ≤ 20%

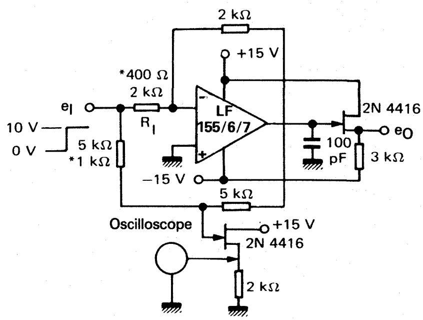
Settling time $(t_S) \simeq 5\ \mu s$

LARGE POWER BW AMPLIFIER



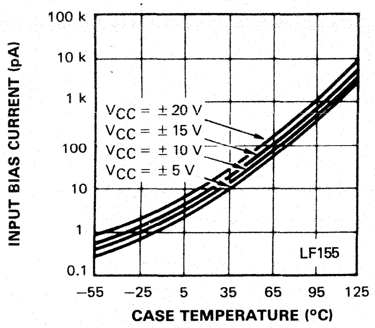
For distortion < 1% and a 20 V_{pp} V_O swing, power bandwidth is : 500 kHz.

SETTLING TIME TEST CIRCUIT

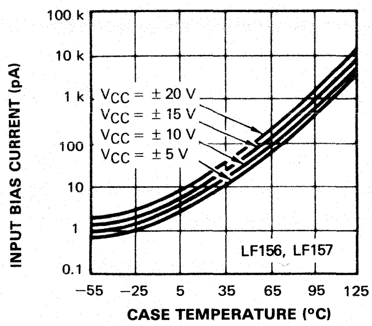


Settling time is tested with the LF155, LF156 connected as unity gain converter $R_I = 2$ kΩ and LF157 connected for $A_V = -5$, $R_I = 0.4$ kΩ.

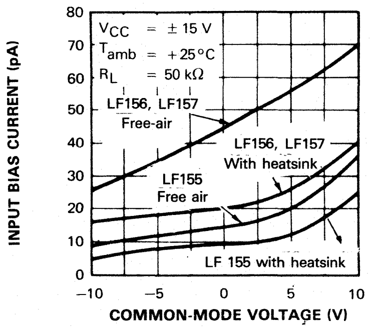
INPUT BIAS CURRENT



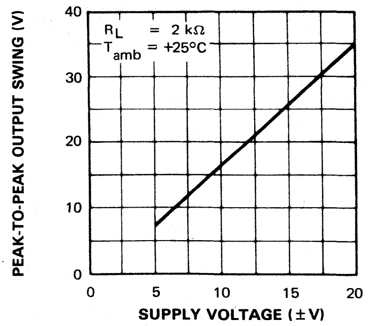
INPUT BIAS CURRENT



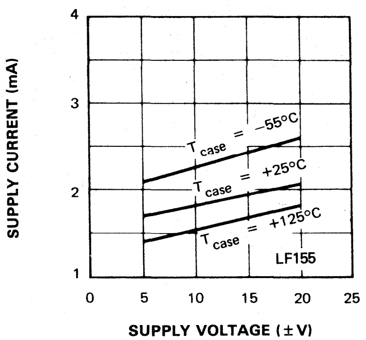
INPUT BIAS CURRENT



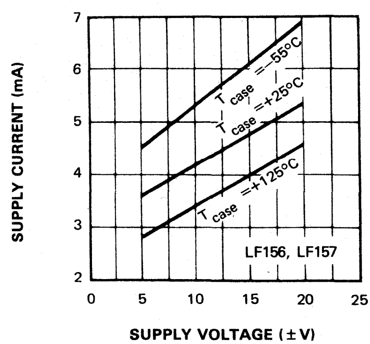
VOLTAGE SWING



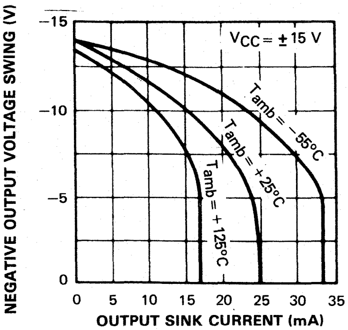
SUPPLY CURRENT



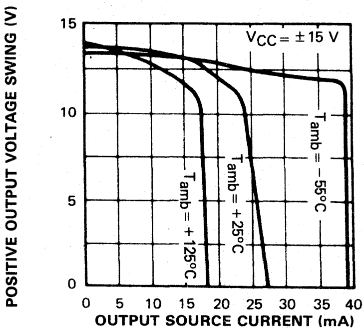
SUPPLY CURRENT



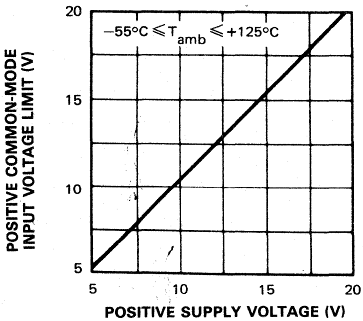
MAXIMUM NEGATIVE CURRENT



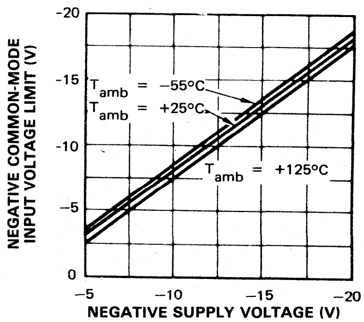
MAXIMUM POSITIVE CURRENT



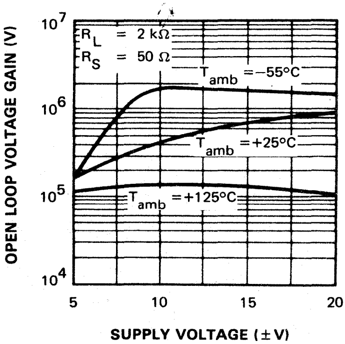
MAXIMUM POSITIVE COMMON-MODE INPUT VOLTAGE



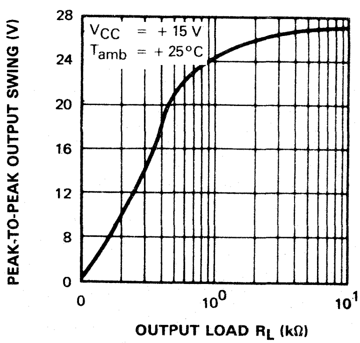
MAXIMUM NEGATIVE COMMON-MODE INPUT VOLTAGE



OPEN LOOP VOLTAGE GAIN

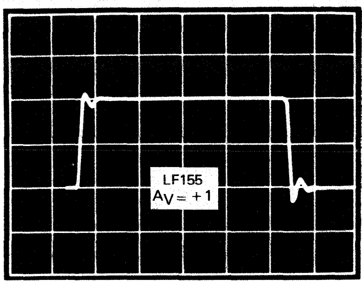


OUTPUT VOLTAGE SWING



SMALL SIGNAL PULSE RESPONSE

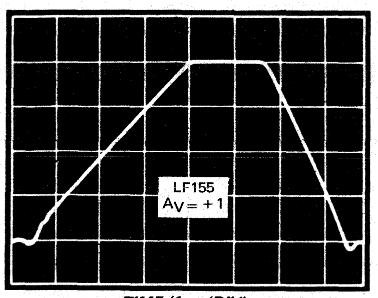
OUTPUT VOLTAGE SWING (50 mV/DIV)



TIME (0.5 μs/DIV)

LARGE SIGNAL PULSE RESPONSE

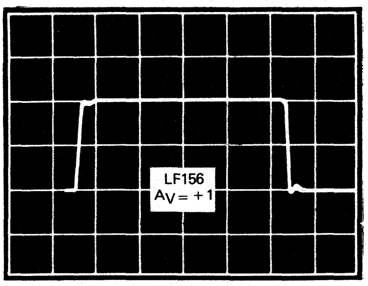
OUTPUT VOLTAGE SWING (5 V/DIV)



TIME (1 μs/DIV)

SMALL SIGNAL PULSE RESPONSE

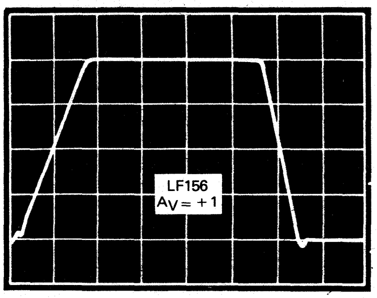
OUTPUT VOLTAGE SWING (50 mV/DIV)



TIME (0.5 μs/DIV)

LARGE SIGNAL PULSE RESPONSE

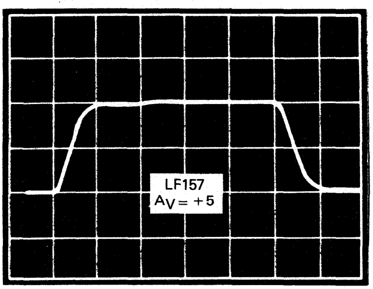
OUTPUT VOLTAGE SWING (5 V/DIV)



TIME (1 μs/DIV)

SMALL SIGNAL PULSE RESPONSE

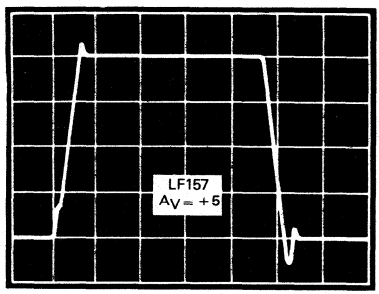
OUTPUT VOLTAGE SWING (50 mV/DIV)



TIME (0.1 μs/DIV)

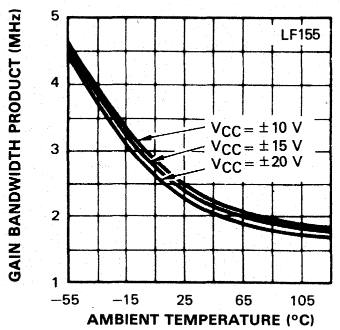
LARGE SIGNAL PULSE RESPONSE

OUTPUT VOLTAGE SWING (5 V/DIV)

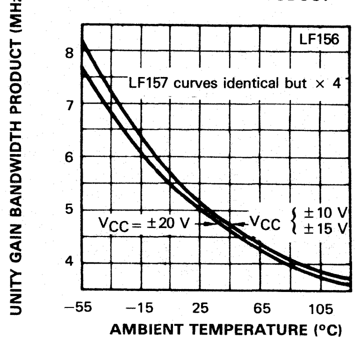


TIME (0.5 μs/DIV)

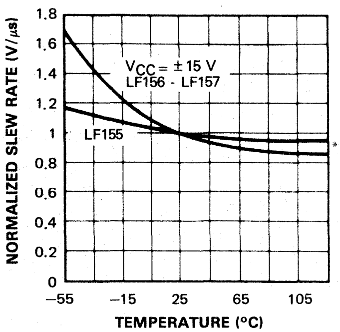
GAIN BANDWIDTH PRODUCT



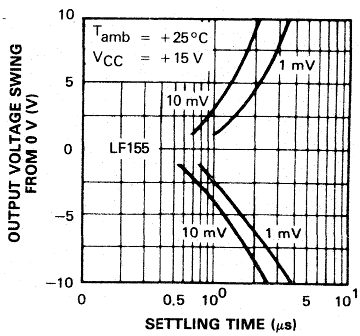
GAIN BANDWIDTH PRODUCT



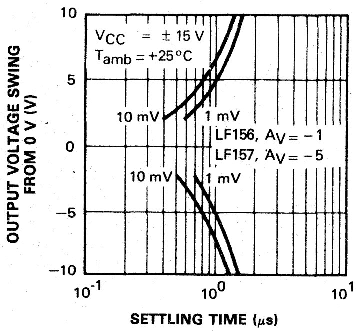
NORMALIZED SLEW RATE



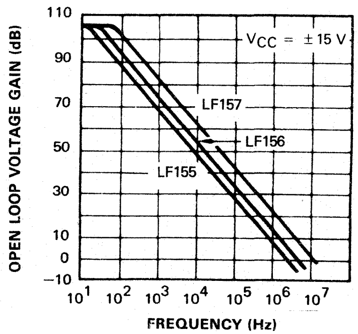
INVERTER SETTLING TIME



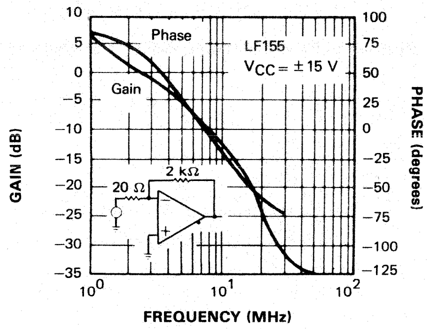
INVERTER SETTLING TIME



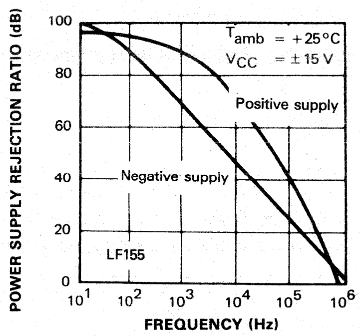
OPEN LOOP FREQUENCY RESPONSE



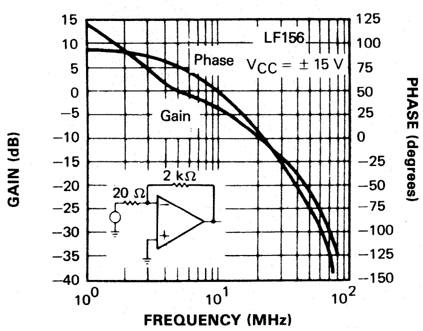
BODE PLOT



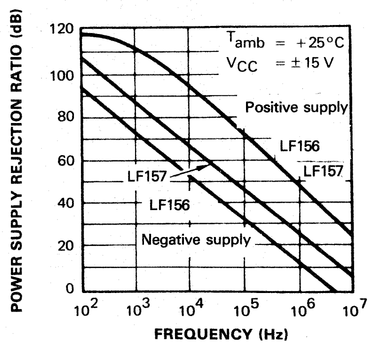
POWER SUPPLY REJECTION RATIO



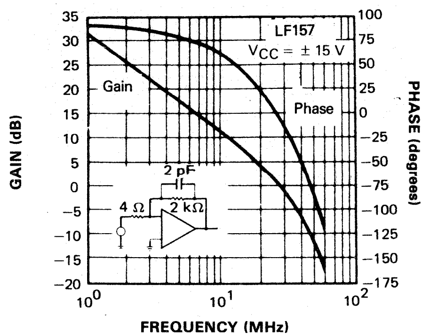
BODE PLOT



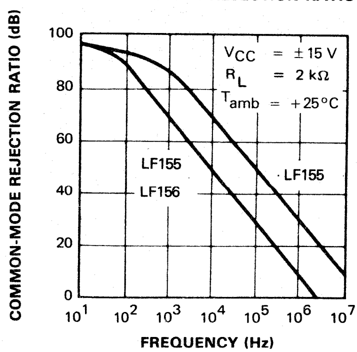
POWER SUPPLY REJECTION RATIO



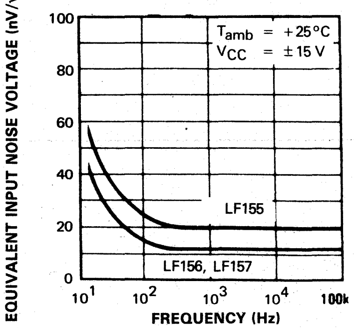
BODE PLOT



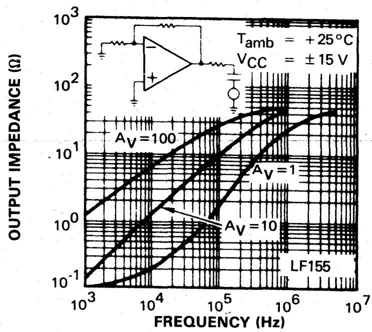
COMMON-MODE REJECTION RATIO



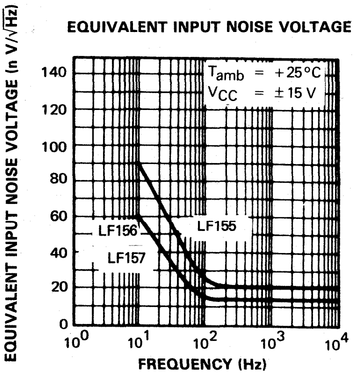
EQUIVALENT INPUT NOISE VOLTAGE (EXPANDED SCALE)



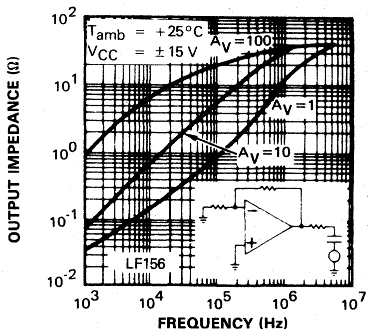
OUTPUT IMPEDANCE



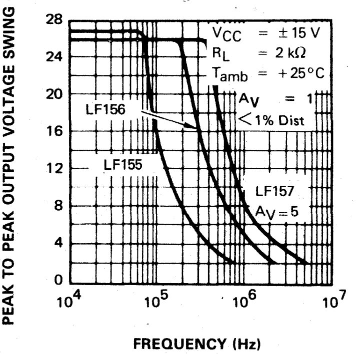
EQUIVALENT INPUT NOISE VOLTAGE



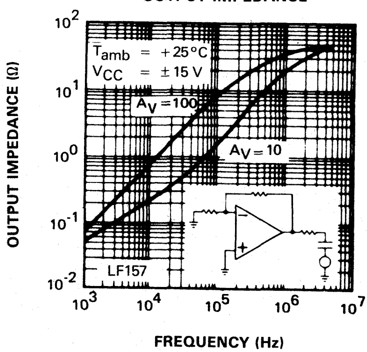
OUTPUT IMPEDANCE

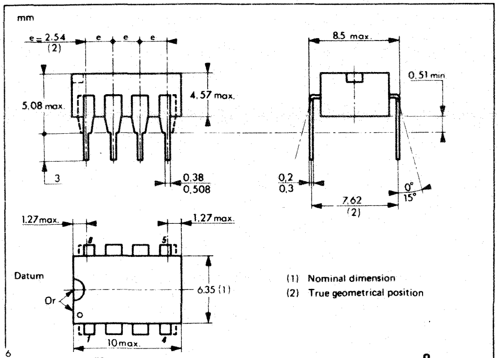


UNDISTORTED OUTPUT VOLTAGE SWING

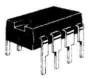


OUTPUT IMPEDANCE



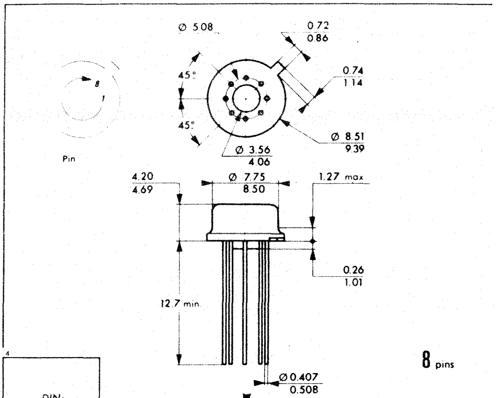


DIN				
A50D			F 116 A	CB-98
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS

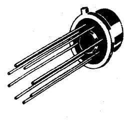


CB-98

DP SUFFIX
PLASTIC PACKAGE

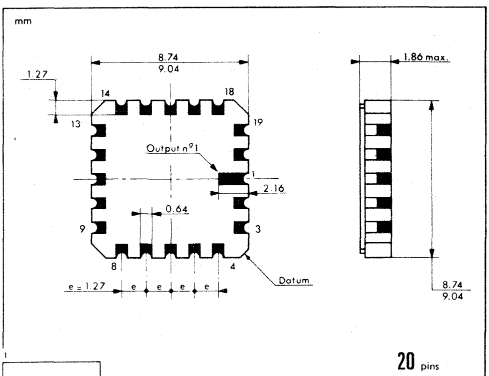


Case : C-23 Base :				
DIN	TO-99	TO-99	F 101	CB-11
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS

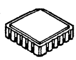


CB-11
(TO-99)

H SUFFIX
METAL CAN



DIN				
MS004 CB		TMS004 CB		CB-705
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS



CB-705

GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

LM11M
LM11C
LM11LC

1

PRECISION SINGLE OP-AMPs / BUFFERS

The LM11 is a precision dc amplifier combining the best features of existing bipolar and FET op amps. It is similar to the LM108A, except that input currents have been reduced by more than a factor of ten. Offset voltage and drift have also been improved.

Compared to FETs, the device provides inherently lower offset voltage and offset voltage drift, along with at least an order of magnitude better long-term stability. Low frequency noise is also somewhat reduced. Bias current is significantly lower even under laboratory conditions, and its low drift makes compensation practical. Offset current is almost unmeasureable. Although not as fast as FETs, it does have a much lower power drain. This low dissipation has the added advantage of eliminating warm up time in critical applications.

Typical characteristics for 25°C (− 55°C to + 125°C) are :
- Offset voltage : 100 μV (200 μV)
- Bias current : 25 pA (65 pA)
- Offset current : 0.5 pA (3 pA)
- Temperature drift : 1 μV/°C
- Long-term stability : 10 μV/year.

The LM11 is internally compensated, but external compensation can be added for improved frequency stability, particularly with capacitive loads. Offset voltage balancing is also provided, with the balance range determined by a low resistance potentiometer.
Otherwise, the device is the electrical equivalent of the LM108A, except that the negative common-mode limit is 0.6 V less, performance is specified down to ± 2.5 V and the guaranteed output drive has been increased to ± 2 mA. The input noise is somewhat higher, but amplifier noise is obscured by resistor noise with higher source resistances.
This monolithic IC has obvious applications as electrometer amplifiers, charge integrators, analog memories, low frequency active filters or for frequency shaping in slow servo loops. It can be substituted for existing circuits to provide improved performance or eliminate trimming operations.
The greater precision can also be used to extend the dynamic range of logarithmic amplifiers, light meters and solid-state particle detectors.
The LM11 is manufactured with standard bipolar processing using super-gain transistors.

ORDERING INFORMATION

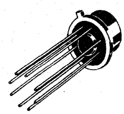
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		DP	H	GC
LM11M	− 55°C to + 125°C		•	•
LM11C	0°C to + 70°C	•	•	
LM11LC*	0°C to + 70°C	•	•	
Examples : LM11MH, LM11CDP				

PRECISION SINGLE OPERATIONAL AMPLIFIERS / BUFFERS

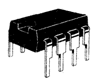
CASES

CB-11 (TO-99)



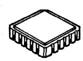
H SUFFIX
METAL CAN

CB-98



DP SUFFIX
PLASTIC PACKAGE

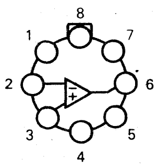
CB-705



GC SUFFIX
TRICECOP (LCC)

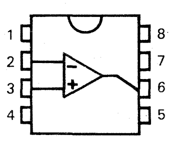
PIN CONFIGURATIONS
(Top views)

CB-11



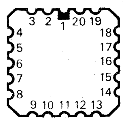
1 - Balance
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Compensation
6 - Output
7 - V_{CC}^+
8 - Balance

CB-98



1 - NC
2 - Balance
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-

CB-705



11 - NC
12 - Compensation
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - Balance

Réf. 00130

MAXIMUM RATINGS

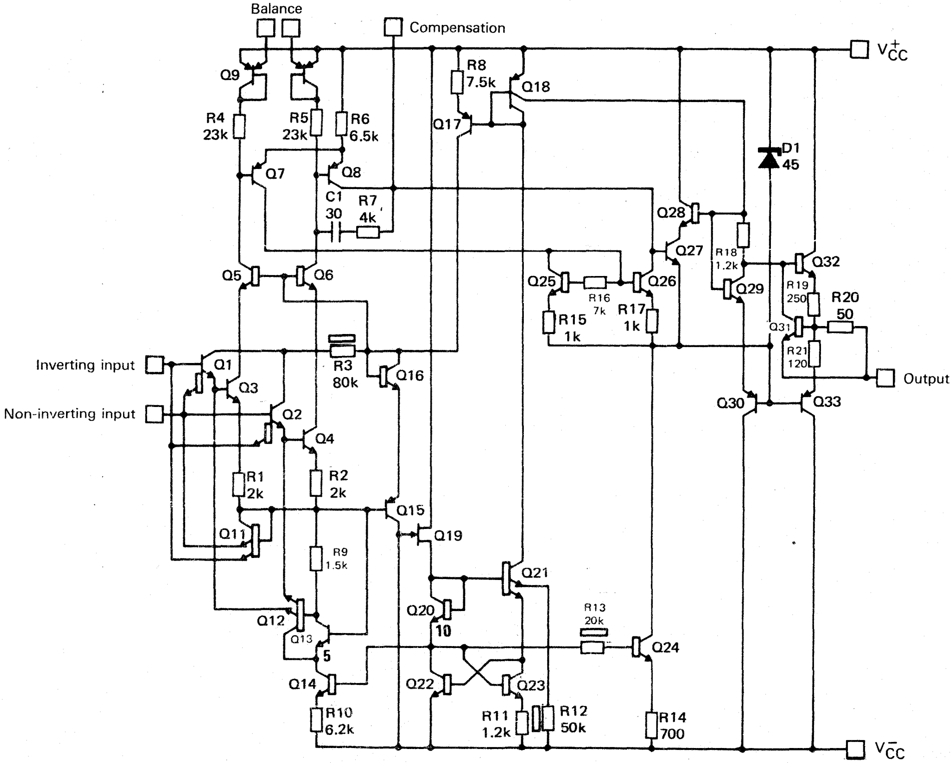
Rating	Symbol	Value	Unit
Total supply voltage	V_{CC}	40	V
Input current (Note 1)	I_I	± 10	mA
Power dissipation (Note 2)	P_{tot}	500	mW
Output short-circuit duration (Note 3)	—	Indefinite	—
Lead temperature (soldering, 10 seconds)	T_{lead}	300	°C
Operating free-air, temperature range LM11M, LM11C, LM11LC	T_j	– 55 to + 125 0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

Note 1 : The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used. In addition, a 2 kΩ minimum resistance in each input is advised to avoid possible latch up initiated by supply reversals.

Note 2 : The maximum operating-junction temperature is + 150°C for the LM11M and 85°C for the LM11C, LC. Devices must be derated based on package thermal resistance (see physical dimensions).

Note 3 : Current limiting protects the output when it is shorted to ground or any voltage less than the supplies. With continuous overloads, package dissipation must be taken into account and heat sinking provided when necessary.

SCHEMATIC DIAGRAM



CASE	Inverting input	Non-inverting input	Output	V_{CC}^-	V_{CC}^+	Balance	Compensation	N.C.
CB-98 CB-11	2	3	6	4	7	1,8	5	—
CB-705	5	7	15	10	17	2,20	12	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $(V_{CC}^- + 2\ V) \leq V_{CM} \leq (V_{CC}^+ - 1\ V)$ and $\pm 2.5\ V \leq V_{CC} \leq \pm 20\ V$
$T_{min} \leq T_j \leq T_{max}$: $(V_{CC}^- + 2.5\ V) \leq V_{CM} \leq (V_{CC}^+ - 1\ V)$ and $\pm 2.5\ V \leq V_{CC} \leq \pm 20\ V$
(Unless otherwise specified)

Characteristic	Symbol	LM11M			LM11C			LM11LC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}										mV
$T_j = +25°C$		–	0.1	0.3	–	0.2	0.6	–	0.5	5	
$T_{min} \leq T_j \leq T_{max}$		–	–	0.6	–	–	0.8	–	–	6	
Input offset current	I_{IO}										pA
$T_j = +25°C$		–	0.5	10	–	1	10	–	4	25	
$T_{min} \leq T_j \leq T_{max}$		–	–	30	–	–	20	–	–	50	
Input bias current	I_{IB}										pA
$T_j = +25°C$		–	25	50	–	40	100	–	70	200	
$T_{min} \leq T_j \leq T_{max}$		–	–	150	–	–	150	–	–	300	
Input resistance	R_I	–	10^{11}	–	–	10^{11}	–	–	10^{11}	–	Ω
Offset voltage drift ($T_{min} \leq T_j \leq T_{max}$)	αV_{IO}	–	1	3	–	2	5	–	3	–	µV/°C
Offset current drift ($T_{min} \leq T_j \leq T_{max}$)	αI_{IO}	–	20	–	–	10	–	–	50	–	pA/°C
Bias current drift ($T_{min} \leq T_j \leq T_{max}$)	αI_{IB}	–	0.5	1.5	–	0.8	3	–	1.4	–	pA/°C
Large signal voltage gain ($V_{CC} = \pm 15\ V$)	A_V										V/mV
$T_j = +25°C$, $V_O = \pm 12\ V$, $I_O = \pm 2\ mA$		100	300	–	100	300	–	25	300	–	
$I_O = \pm 0.5\ mA$		250	1200	–	250	1200	–	50	800	–	
$T_{min} \leq T_j \leq T_{max}$, $V_O = \pm 12\ V$, $I_O = \pm 0.5\ mA$		100	–	–	100	–	–	30	–	–	
$V_O = \pm 11.5\ V$, $I_O = \pm 2\ mA$		50	–	–	50	–	–	15	–	–	
Common-mode rejection ratio ($V_{CC} = \pm 15\ V$)	CMR										dB
$T_j = +25°C$, $-13\ V \leq V_{CM} \leq +14\ V$		110	130	–	110	130	–	96	110	–	
$T_{min} \leq T_j \leq T_{max}$, $-12.5\ V \leq V_{CM} \leq +14\ V$		100	–	–	100	–	–	90	–	–	
Supply voltage rejection ($\pm 2.5 \leq V_{CC} \leq \pm 20\ V$)	SVR										dB
$T_j = +25°C$		100	118	–	100	118	–	84	100	–	
$T_{min} \leq T_j \leq T_{max}$		96	–	–	96	–	–	80	–	–	
Supply current	I_{CC}										mA
$T_j = +25°C$		–	0.3	0.6	–	0.3	0.8	–	0.3	0.8	
$T_{min} \leq T_j \leq T_{max}$		–	–	0.8	–	–	1	–	–	1	
Output short-circuit current ($T_j = +150°C$)	I_{OS}	–	–	±15	–	–	–	–	–	–	mA

APPLICATION HINTS

When working with circuitry capable of resolving pico-ampere level signals, leakage currents in circuitry external to the op amp can significantly degrade performance. High quality insulation is a must (Kel-F and Teflon rate high). Proper cleaning of all insulating surfaces to remove fluxes and other residues is also required. This includes the IC package as well as sockets and printed circuit boards. When operating in high humidity environments or near 0°C, some form of surface coating may be necessary to provide a moisture barrier.

The effects of board leakage can be minimized by encircling the input circuitry with a conductive guard ring operated at a potential close to that of the inputs. For critical applications, dual-in-line packages are available that include input guard pins. With the ceramic package, the floating metal lid is best connected to the guard. This might be accomplished with a dab of conductive paint.

Electrostatic shielding of high impedance circuitry is advisable.

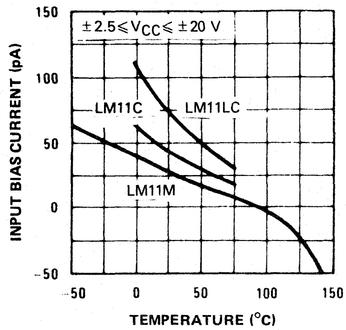
Error voltages can also be generated in the external circuitry. Thermocouples formed between dissimilar metals can cause hundreds of microvolts of error in the presence of temperature gradients. The most troublesome thermocouples are the junction of the IC package and the printed circuit board (35 µV/°C for copper-kovar) and internal resistor connections. Problems can be avoiled by keeping low level circuitry away from heat generating elements. Mounting the IC directly to the PC board while keeping package leads short and the input leads close together also help.

With the LM11 there is a temptation to remove the bias-current-compensation resistor normally used on the non-inverting input of a summing amplifier. Direct connection of the inputs to ground or a low-impedance voltage source is not recommended with supply voltages greater than about 3 V. The potential problem involves reversal of one supply which can cause excessive current in the second supply. Destruction of the IC could results if the output current of the second supply is not limited to about 100 mA or if there is much more than 1 µF bypass on the supply buss.

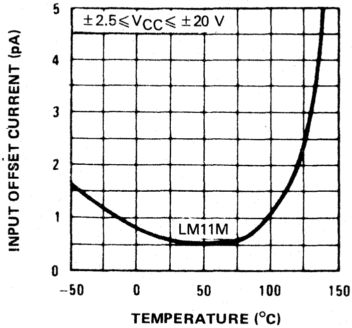
Just disconnecting one supply will generally involve reversal because of loading to the other supply both within the IC and in external circuitry. Although difficulties can be largely avoided by installing clamp diodes across the supply lines on every PC board, a conservative design would include enough resistance in the input lead to limit current to 10 mA if the input lead is pulled to either supply by internal currents. This precaution is by no means limited to the LM11.

TYPICAL CHARACTERISTICS

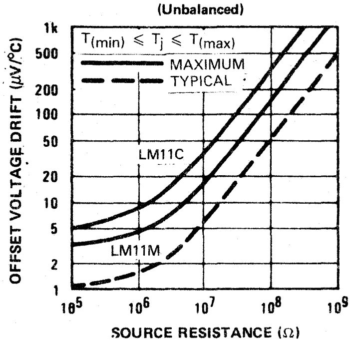
INPUT BIAS CURRENT



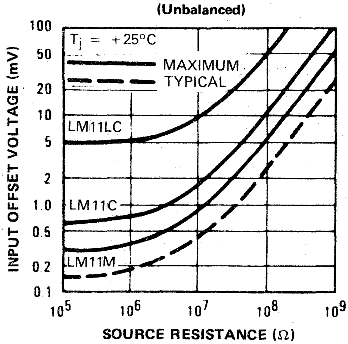
INPUT OFFSET CURRENT



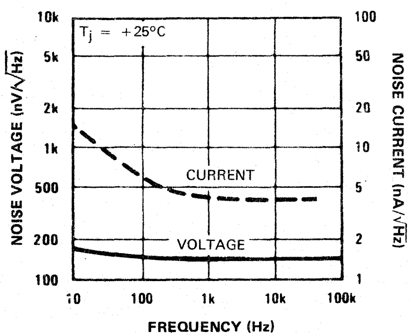
DRIFT : SINGLE SOURCE RESISTOR (Unbalanced)



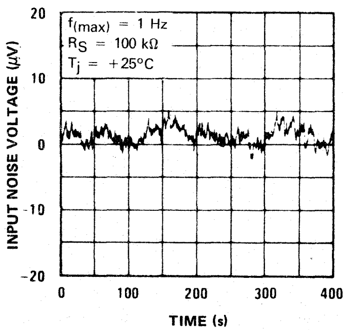
OFFSET : SINGLE SOURCE RESISTOR (Unbalanced)



INPUT NOISE



INPUT NOISE



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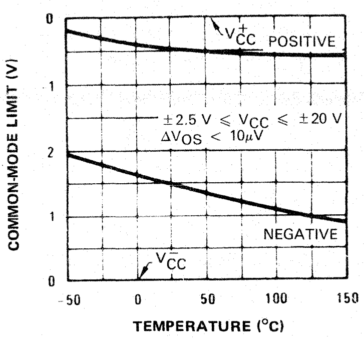
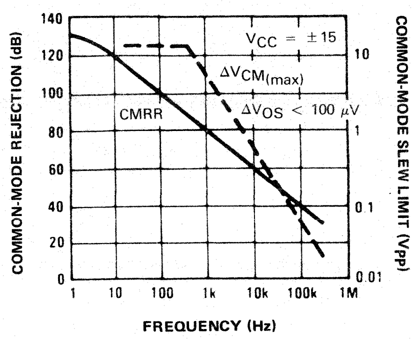
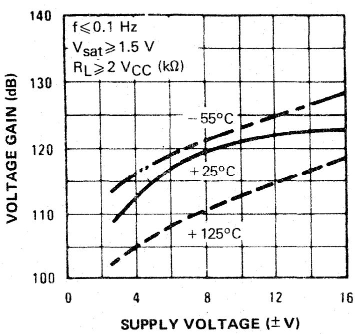
COMMON-MODE LIMITS



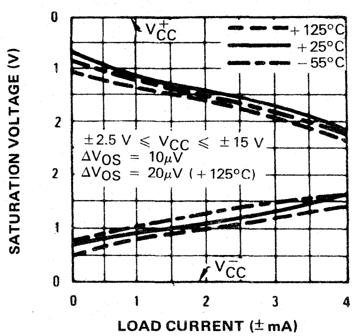
COMMON-MODE REJECTION



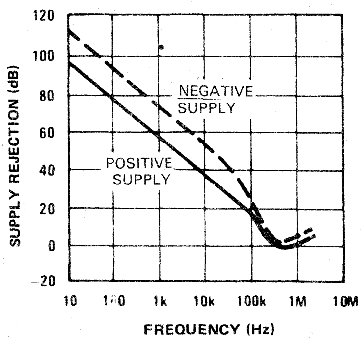
LARGE SIGNAL VOLTAGE GAIN



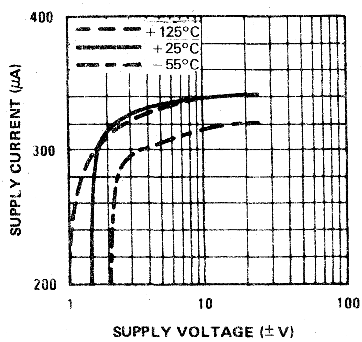
OUTPUT SATURATION THRESHOLD



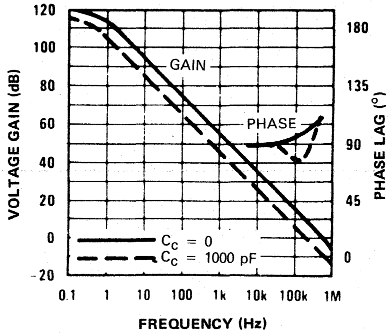
SUPPLY REJECTION



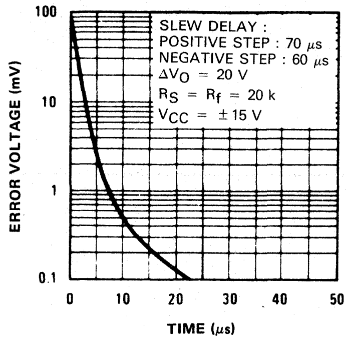
SUPPLY CURRENT



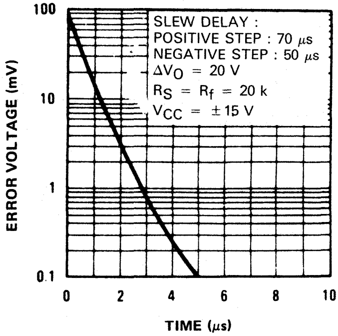
OPEN LOOP RESPONSE



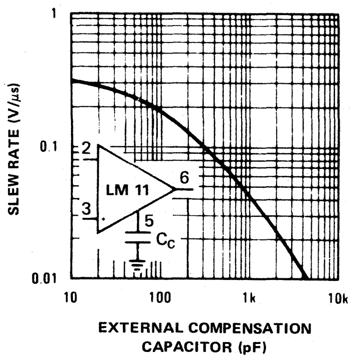
FOLLOWER FINAL SETTLING TIME



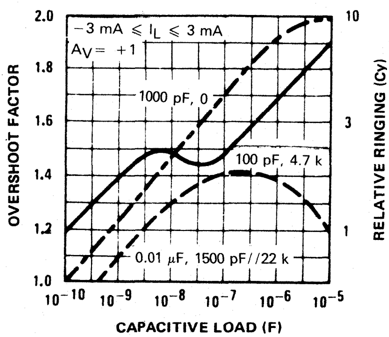
INVERTER FINAL SETTLING TIME



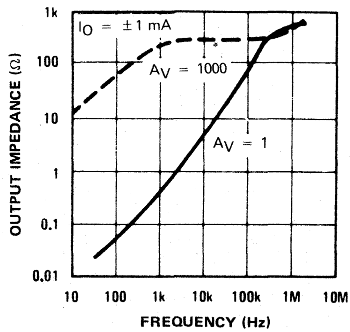
SLEW RATE



STABILITY WITH OVER-COMPENSATION

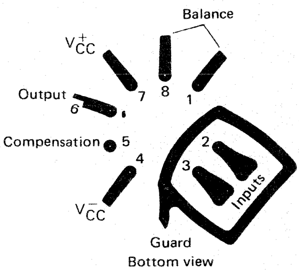


CLOSED LOOP OUTPUT IMPEDANCE

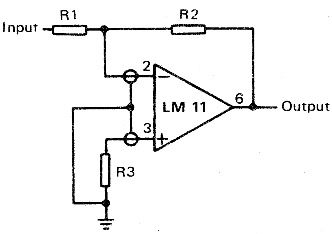


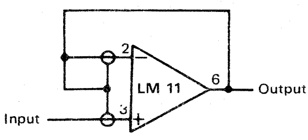
Input guarding

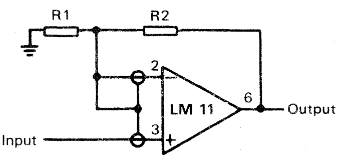
Input guarding can drastically reduce surface leakage. Layout for metal can is shown here. Guarding both sides of board is required. Bulk leakage reduction is less and depends on guard ring width.



Guard ring is connected to low impedance point at same potential as sensitive input leads. Connections for various op amp configurations are shown here.

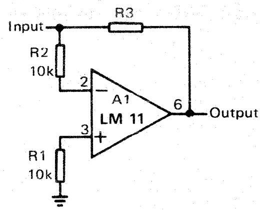




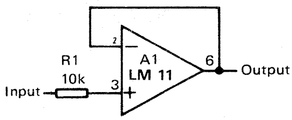


Input protection

Current is limited by R2 even when input is connected to voltage source outside common-mode range. If one supply reverses, current is controlled by R1. These resistors do not affect normal operation.

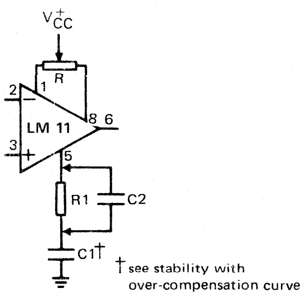


Input resistor controls current when input exceeds supply voltages, when power for op amp is turned off or when output is shorted.



Balancing and over-compensation

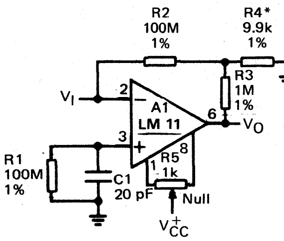
Over-compensation will improve stability with capacitive loading (see curves). Offset voltage adjustment range is determined by balance potentiometer resistance as indicated in the table.



min. adj range	R
± 5 mV	100 kΩ
± 2	10k
± 1	3k
± 0.8	3k
± 0.4	1k

Resistance multiplication

Equivalent feedback resistance is 10 GΩ, but only standard resistors are used. Even though the offset voltage is multiplied by 100, output offset is actually reduced because error is dependent on offset current rather than bias current. Voltage on summing junction is less than 5 mV.

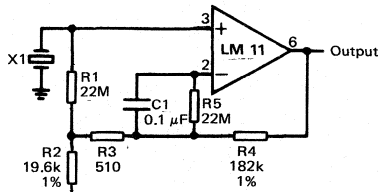


$R_f = R2\ (1 + \frac{R3}{R4})$

R2>>R3//R4

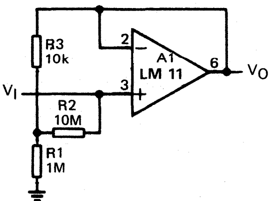
*gain trim

A high-input-impedance ac amplifier for a piezoelectric transducer. Input resistance of 880 MΩ and gain of 10 is obtained.



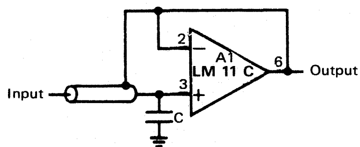
$R_I = R1\ (1 + \frac{R2}{R3})$ $A_V = \frac{R2 + R3 + R4}{R2 + R3}$

Follower input resistance is 1GΩ. With the input open, offset voltage is multiplied by 100, but the added error is not great because the op amp offset is low.

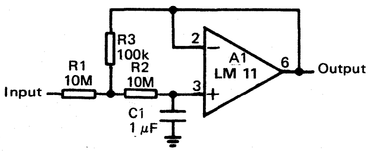


Cable bootstrapping

Bootstrapping input shield for a follower reduces cable capacitance, leakage and spurious voltages from cable flexing. Instability can be avoided with small capacitor on input.



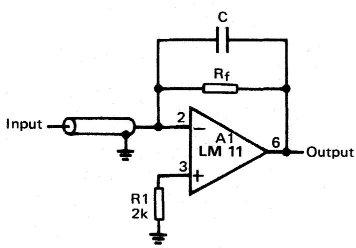
This circuit multiplies RC time constant to 1000 seconds and provides low output impedance.



$\tau = \frac{R1\ C}{R3}\ (R2 + R3)$

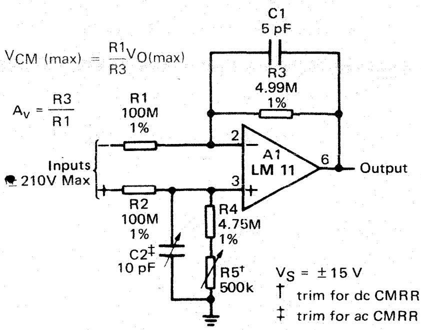
$\Delta V_O = \frac{R1 + R3}{R3}\ (I_B\ R2 + V_{OS})$

With summing amplifier, summing node is at virtual ground so input shield is best grounded. Small feedback capacitor insures stability.

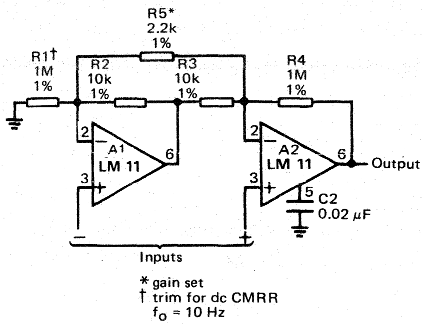


Differential amplifiers

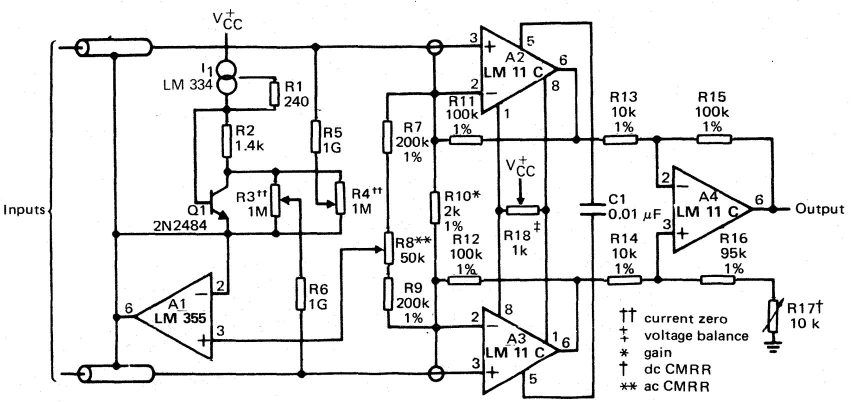
This differential amplifier handles high input voltages. Resistor mismatches and stray capacitors should be balanced out for best common-mode rejection.



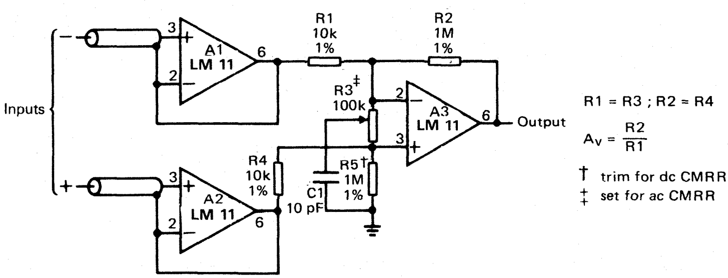
Two op-amp instrumentation amplifier has poor ac common-mode rejection. This can be improved at the expense of differential bandwidth with C2.



High gain differential instrumentation amplifier includes input guarding, cable bootstrapping and bias current compensation. Differential bandwidth is reduced by C1 which also makes common-mode rejection less dependent on matching of input amplifiers.

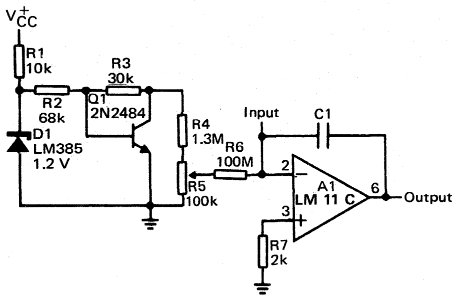


For moderate-gain instrumentation amplifiers, input amplifiers can be connected as followers. This simplifies circuitry, but A3 must also have low drift.

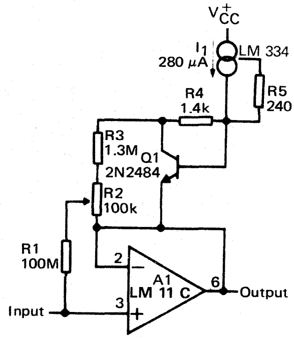


Bias current compensation

Precise bias current compensation for use with unregulated supplies. Reference voltage is available for other circuitry.

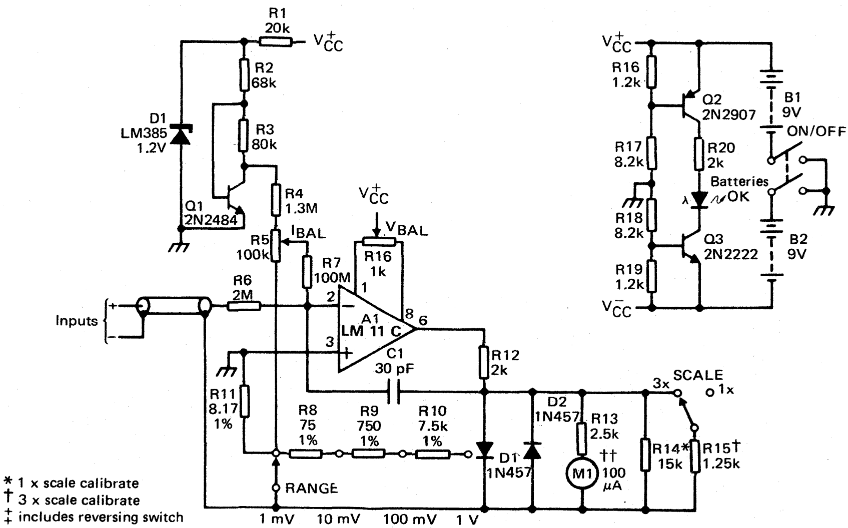


This circuit shows how bias current compensation can be used on a voltage follower.



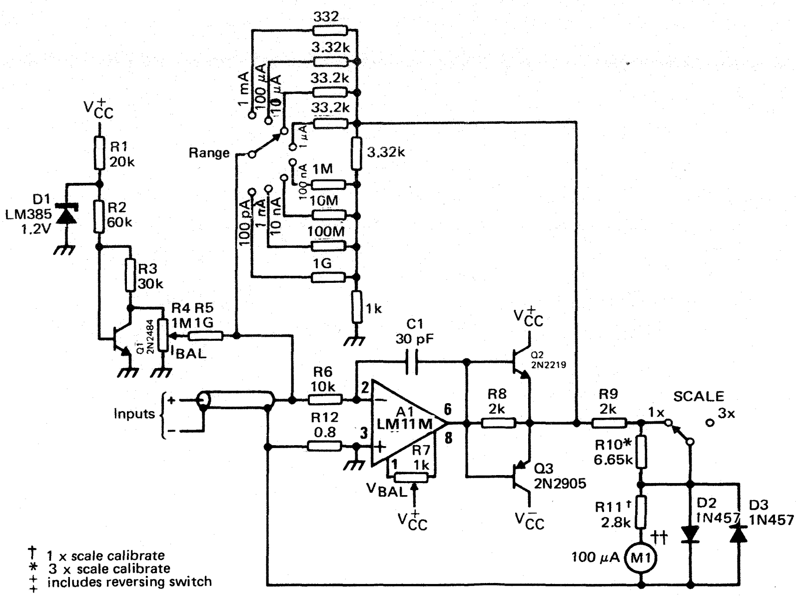
Voltmeter

High input impedance millivoltmeter. Input current is proportional to input voltage, about 10 pA at full scale. Reference could be used to make direct reading linear ohmmeter.



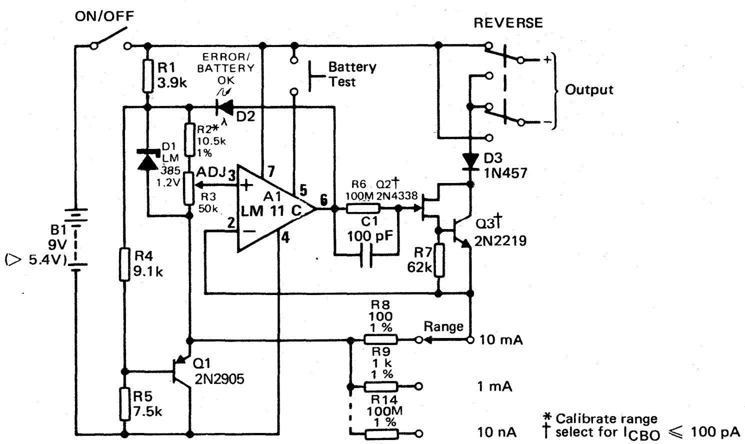
Ammeter

Current meter ranges from 100 pA to 3 mA full scale. Voltage across input is 100 µV at lower ranges rising to 3 mV at 3 mA. Buffers on op amp are to remove ambiguity with high-current overload. Output can also drive DVM or DPM.



Current source

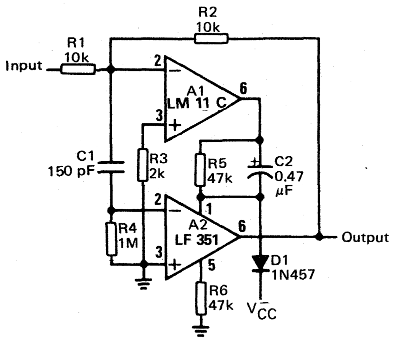
Precision current source has 10 µA to 10 mA ranges with output compliance of 30 V to −5 V. Output current is fully adjustable on each range with a calibrated, ten-turn potentiometer. Error light indicates saturation.

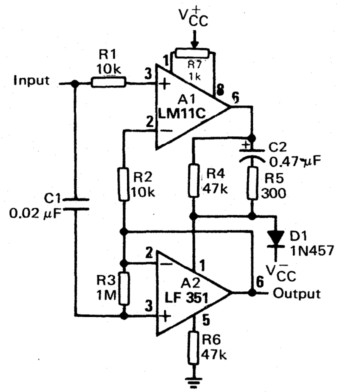


Fast amplifiers

These inverters have bias current and offset voltage of LM 11 along with speed of the FET op amps. Open loop gain is about 140 dB and settling time to 1 mV about 8 µs. Overload-recovery delay can be eliminated by direct coupling the FET amplifier to summing node.

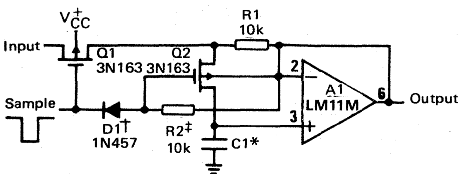
Follower has 10 µs setting to 1 mV, but signal repetition frequency should not exceed 10 kHz if the FET amplifier is ac coupled to input. The circuit does not behave well if common-mode range is exceeded.





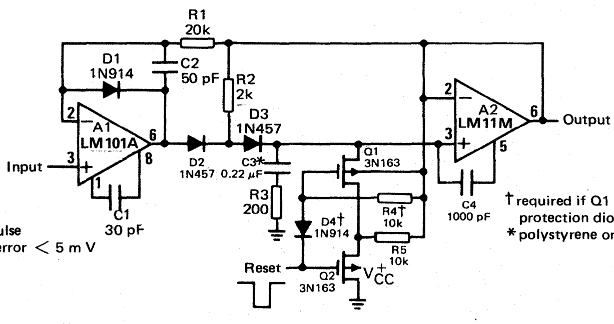
Leakage isolation

Switch leakage in this sample and hold does not reach storage capacitor.



*polystyrene or Teflon
† required if protected-gate switch is used

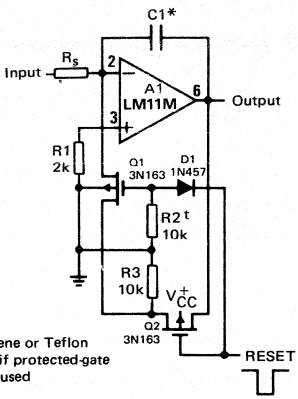
A peak detector designed for extended hold. Leakage currents of peak-detecting diodes and reset switch are absorbed before reaching storage capacitor.



300 µs min single pulse
200 µs min repetitive pulse
300 Hz max sine wave error < 5 m V

† required if Q1 has gate-protection diode
* polystyrene or Teflon

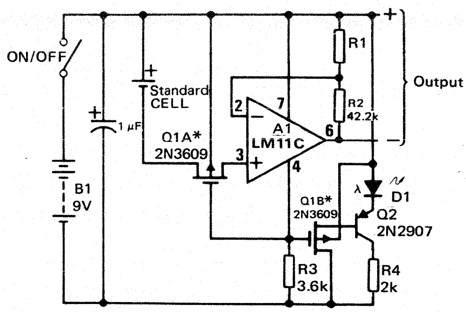
Reset is provided for this integrater and switch leakage is isolated from the summing junction. Greater precision can be provided if bias-current compensation is included.



* polystyrene or Teflon
† required if protected-gate switch is used

Standard-cell buffer

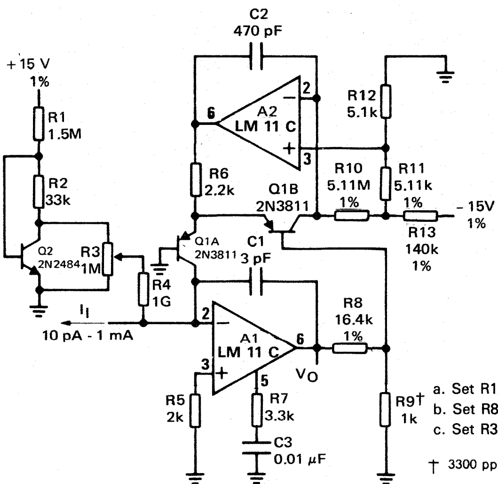
Battery powered buffer amplifier for standard cell has negligible loading and disconnects cell for low supply voltage or overload on output. Indicator diode extinguishes as disconnect circuitry is activated.



*cannot have gate protection diode ; $V_{TH} > V_O$

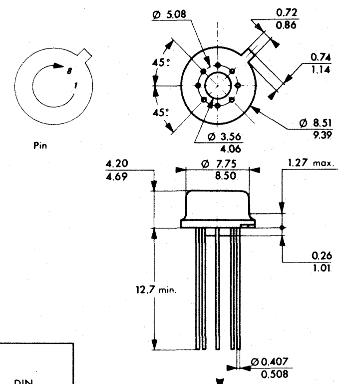
Logarithmic amplifiers

Unusual frequency compensation gives this logarithmic converter a 100 µs time constant from 1 mA down to 100 µA, increasing from 200 µs to 200 ms from 10 nA to 10 pA. Optional bias current compensation can give 10 pA resolution from −55°C to 100°C. Scale factor is 1V/decade and temperature compensated.



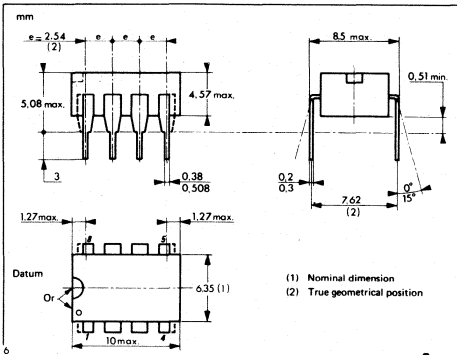
a. Set R11 for $V_O = 0$ at $I_I = 100$ nA
b. Set R8 for $V_O = +3$ V at $I_I = 100$ µA
c. Set R3 for $V_O = -4$ V at $I_I = 10$ pA

† 3300 ppM/°C.



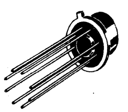
8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

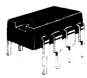


8 pins

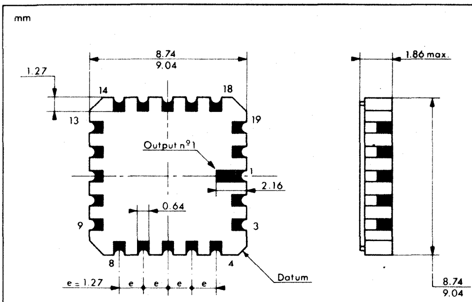
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS



CB-11
(TO-99)
H SUFFIX
METAL CAN

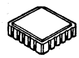


CB-98
DP SUFFIX
PLASTIC PACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM101A LM201A LM301A

1

SINGLE OPERATIONAL AMPLIFIERS

The LM101A is a general-purpose operational amplifier. This amplifier offers many features : supply voltages from ±5 V to ±20 V, low current drain, overload protection on the input and output, no latch-up when the common mode range is exceeded, freedom from oscillations and compensation with a single 30 pF capacitor. It has advantages over internally compensated amplifiers in that the compensation can be tailored to the particular application : slew rates of 10 V/µs and bandwidths of 3.5 MHz can be easily achieved. In addition, the circuit can be used as a comparator with differential inputs up to ±30 V. The output can be clamped at any desired level to make it compatible with logic circuits.

	LM101A LM201A	LM301A
• Input offset voltage	0.7 mV	2 mV
• Input bias current	30 nA	70 nA
• Input offset current	1.5 nA	3 nA
• Slew rate as inverting amplifier	10 V/µs	10 V/µs

ORDERING INFORMATION

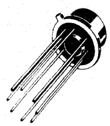
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DP	DG	GC	FP
LM101A	−55°C to +125°C	•		•	•	
LM201A	−25°C to + 85°C	•	•	•		
LM301A	0°C to + 70°C	•	•	•		•
Examples : LM101AH, LM201ADP						

SINGLE OPERATIONAL AMPLIFIERS

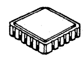
CASES

CB-11 (TO-99)



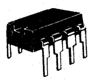
H SUFFIX
METAL CAN

CB-705



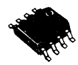
GC SUFFIX
TRICECOP (LCC)

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

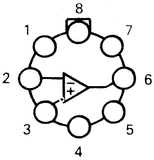
CB-342



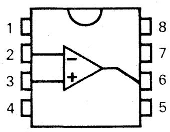
FP SUFFIX
PLASTIC
MICROPACKAGE

PIN ASSIGNMENTS
(Top views)

CB-11

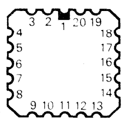


CB-98
CB-342



1 - Balance compensation 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Balance
6 - Output
7 - V_{CC}^+
8 - Compensation 2

CB-705



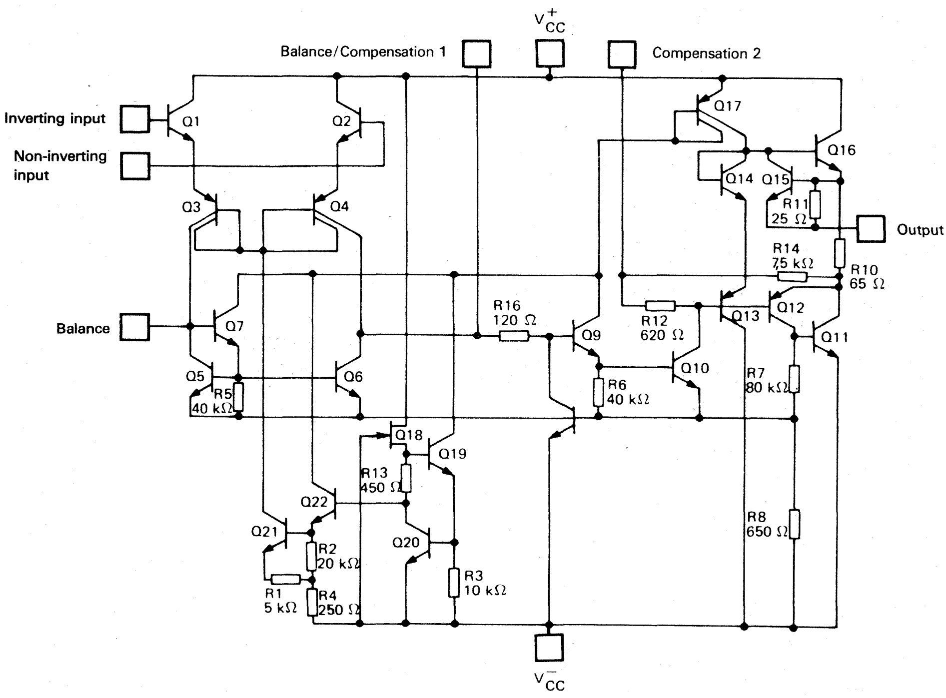
1 - NC
2 - Balance compensation 1
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Balance
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - Compensation 2

Réf. 00335

MAXIMUM RATINGS

Rating	Symbol	Value			Unit
		LM101A	LM201A	LM301A	
Supply voltage	V_{CC}	± 22	± 22	± 18	V
Differential input voltage	V_{ID}	± 30	± 30	± 30	V
Input voltage	V_I	± 15	± 15	± 15	V
Output short-circuit duration	–	Indefinite for T_{amb} = + 70°C		Indefinite for T_{amb} = + 55°C	–
Power dissipation LM101AGC LM301AFP	P_{tot}	500 665 –	500 – –	500 – 300	mV
Operating free-air temperature range	T_{oper}	– 55 to + 125	– 25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	– 65 to + 150	°C

SCHEMATIC DIAGRAM



CASE	Balance/ Comp. 1	Inverting input	Non-inverting input	V_{CC}^-	V_{CC}^+	Output	Balance	Comp. 2
CB-11	1	2	3	4	7	6	5	8
CB-98/CB-342	1	2	3	4	7	6	5	8
CB-705*	2	5	7	10	17	15	12	20

* CB-705 : Other pins not connected.

1

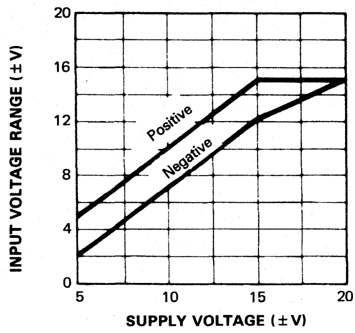
ELECTRICAL CHARACTERISTICS

LM101A : $-55°C \leq T_{amb} \leq +125°C$, $\pm5 V \leq V_{CC} \leq \pm20 V$, $C1 = 30 pF$
LM201A : $-25°C \leq T_{amb} \leq +85°C$, $\pm5 V \leq V_{CC} \leq \pm20 V$, $C1 = 30 pF$
LM301A : $0°C \leq T_{amb} \leq +70°C$, $\pm5 V \leq V_{CC} \leq \pm15 V$, $C1 = 30 pF$
(Unless otherwise specified)

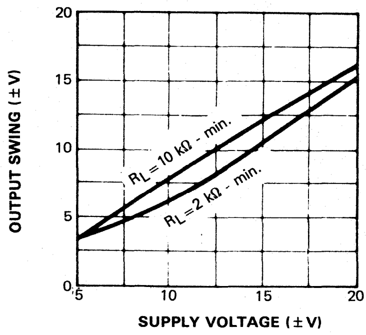
Characteristic	Symbol	LM101A/LM201A			LM301A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50 k\Omega$)	V_{IO}							mV
$T_{max} \leq T_{amb} \leq T_{min}$		–	–	3	–	–	10	
$T_{amb} = +25°C$		–	0.7	2	–	2	7.5	
Input offset current	I_{IO}	–	–	20	–	–	70	nA
$T_{amb} = +25°C$		–	1.5	10	–	3	50	
Input bias current	I_{IB}							nA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	100	–	–	300	
$T_{amb} = +25°C$		–	30	75	–	70	250	
Large signal voltage gain ($V_{CC} = \pm15 V$, $R_L = 2 k\Omega$, $V_O = \pm10 V$)	A_{VD}							V/mV
$T_{max} \leq T_{amb} \leq T_{min}$		25	–	–	15	–	–	
$T_{amb} = +25°C$		50	160	–	25	160	–	
Supply voltage rejection ratio ($R_S = 50 k\Omega$)	SVR	80	96	–	70	96	–	dB
Supply current	I_{CC}^+, I_{CC}^-							mA
$V_{CC} = +20 V$, $T_{amb} = T_{max}$		–	1.2	2.5	–	–	–	
$V_{CC} = +20 V$, $T_{amb} = +25°C$		–	1.8	3	–	–	–	
$V_{CC} = +15 V$, $T_{amb} = +25°C$		–	–	–	–	1.8	3	
Temperature coefficient of input offset voltage	αV_{IO}	–	3	15	–	6	30	µV/°C
Average temperature coefficient of input offset current	αI_{IO}							nA/°C
$+25°C \leq T_{amb} \leq T_{max}$		–	0.01	0.1	–	–	–	
$T_{min} \leq T_{amb} \leq +125°C$		–	0.02	0.2	–	–	–	
$+25°C \leq T_{amb} \leq +70°C$		–	–	–	–	0.03	0.3	
$0°C \leq T_{amb} \leq +25°C$		–	–	–	–	0.02	0.6	
Input voltage range ($V_{CC} = V_{CC(max)}$)	V_I	±15	–	–	±12	–	–	V
Common mode rejection ratio ($R_S \leq 50 k\Omega$)	CMR	80	96	–	70	90	–	dB
Output voltage swing ($V_{CC} = \pm15 V$)	V_{OPP}							V
$R_L = 2 k\Omega$		±10	±13	–	±10	±13	–	
$R_L = 10 k\Omega$		±12	±14	–	±12	±14	–	
Slew rate ($T_{amb} = +25°C$) - Note 1	S_{VO}	–	0.5	–	–	0.5	–	V/µs
Input impedance ($T_{amb} = +25°C$)	Z_I	1.5	4	–	0.5	2	–	MΩ

Note 1 : May be improved up to 10 V/µs in inverting amplifier configuration (see basic diagrams).

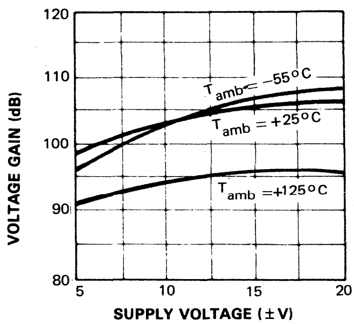
INPUT VOLTAGE RANGE (Note 2)



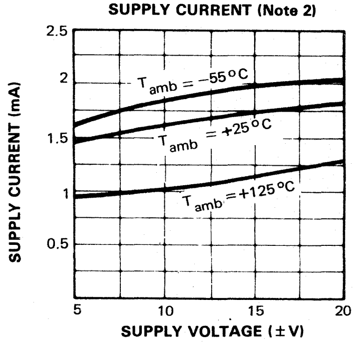
OUTPUT SWING (Note 2)



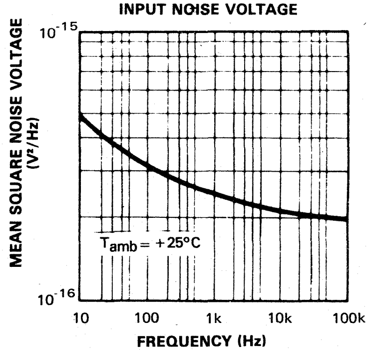
VOLTAGE GAIN (Note 2)



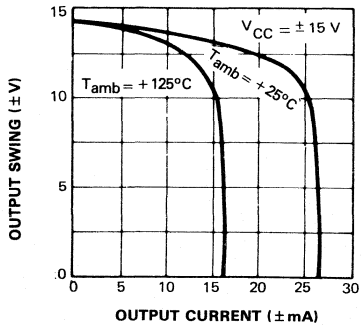
SUPPLY CURRENT (Note 2)



INPUT NOISE VOLTAGE



CURRENT LIMITING



Note 2 :

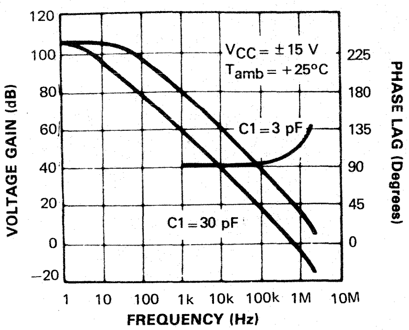
LM101A : $-55°C \leq T_{amb} \leq +125°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$

LM201A : $-25°C \leq T_{amb} \leq +85°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$

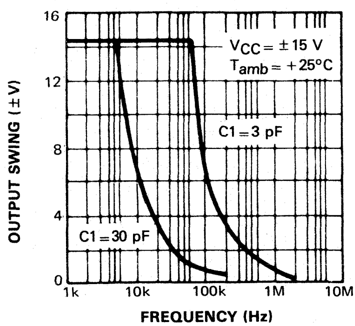
LM301A : $0°C \leq T_{amb} \leq +70°C$, $\pm 5\ V \leq V_{CC} \leq \pm 15\ V$

SINGLE POLE COMPENSATION

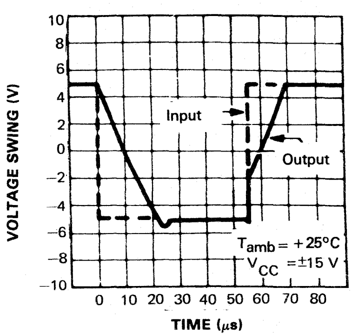
OPEN LOOP FREQUENCY RESPONSE



LARGE SIGNAL FREQUENCY RESPONSE

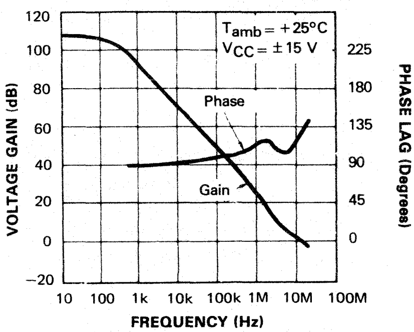


VOLTAGE FOLLOWER PULSE RESPONSE

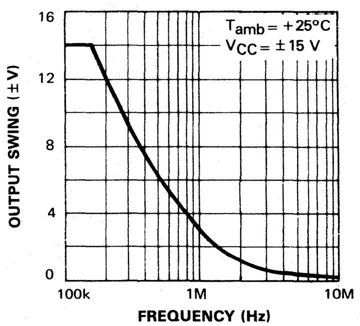


FEED FORWARD COMPENSATION

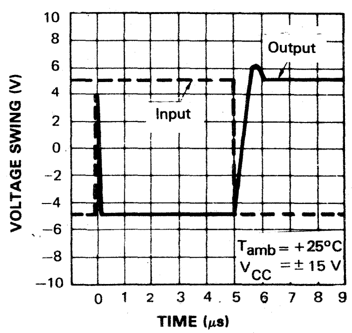
OPEN LOOP FREQUENCY RESPONSE



LARGE SIGNAL FREQUENCY RESPONSE

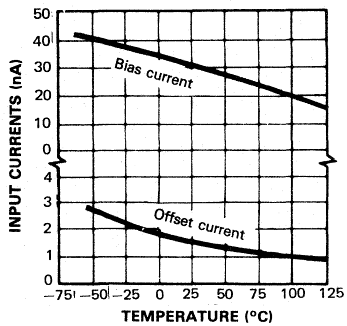


INVERTER PULSE RESPONSE

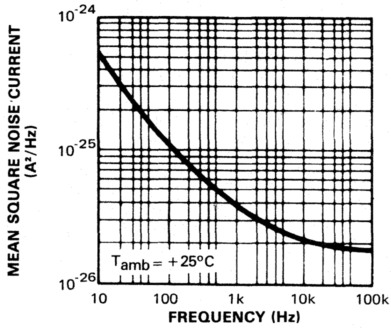


LM101A

INPUT CURRENTS

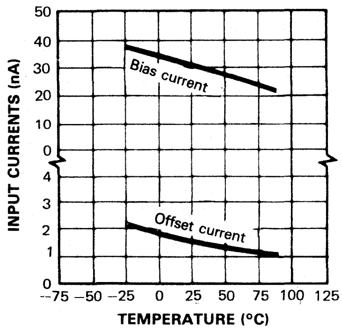


INPUT NOISE CURRENT

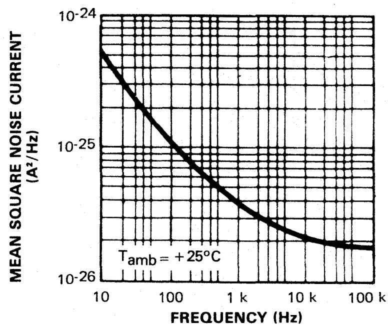


LM201A

INPUT CURRENTS

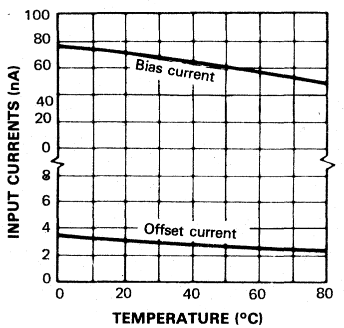


INPUT NOISE CURRENT

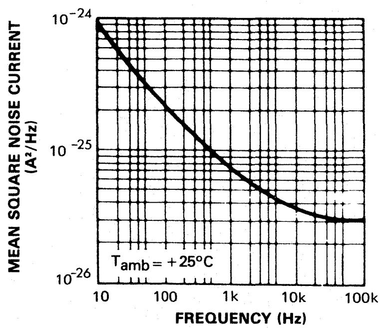


LM301A

INPUT CURRENTS

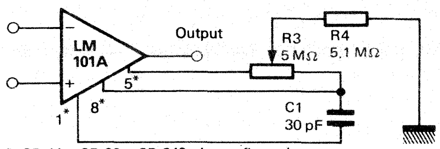


INPUT NOISE CURRENT



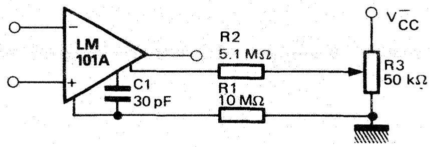
BASIC DIAGRAMS

BALANCING CIRCUIT

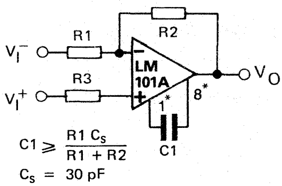


* CB-11 - CB-98 - CB-342 pin-configuration

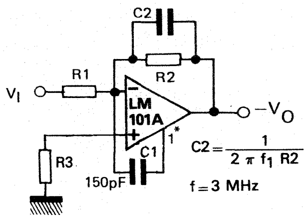
ALTERNATE BALANCING CIRCUIT

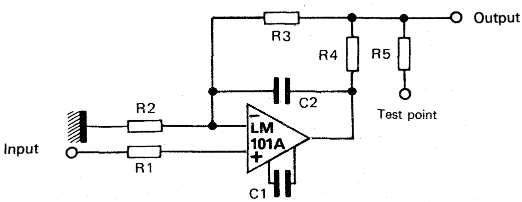


SINGLE POLE COMPENSATION



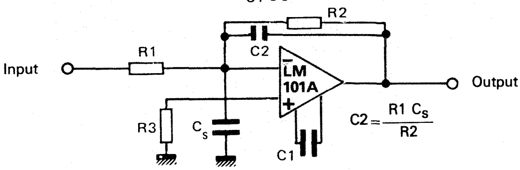
FEEDFORWARD COMPENSATION



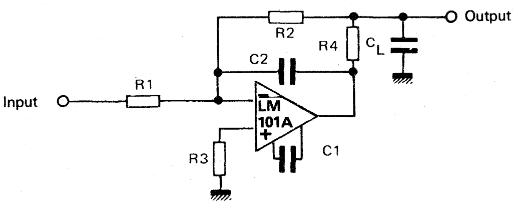


PROTECTING AGAINST GROSS FAULT CONDITIONS

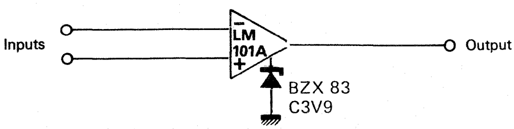
R1 : protects input
R4 : protects output
R5 : protects output. Not needed when R4 is used



COMPENSATING FOR STRAY INPUT CAPACITANCES OR LARGE FEEDBACK RESISTOR



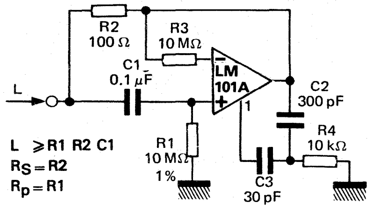
ISOLATING LARGE CAPACITIVE LOADS



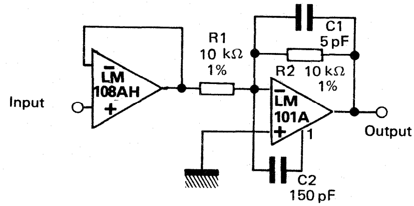
VOLTAGE COMPARATOR FOR DRIVING RTL LOGIC OR HIGH CURRENT DRIVER

TYPICAL APPLICATIONS

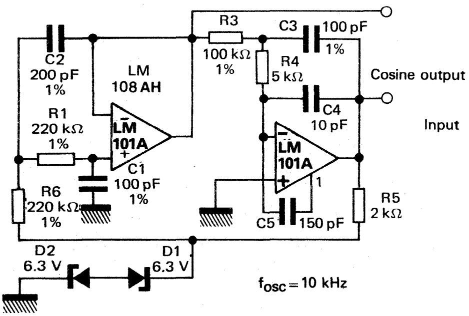
SIMULATED INDUCTOR



FAST INVERTING AMPLIFIER WITH HIGH INPUT IMPEDANCE

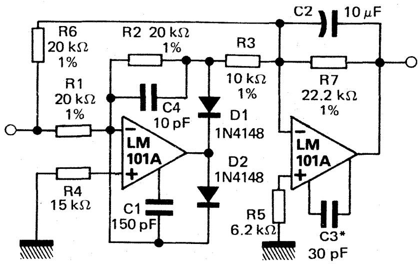


SINE WAVE OSCILLATOR



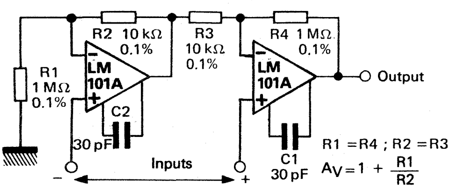
$f_{osc} = 10$ kHz

FAST AC/DC CONVERTER

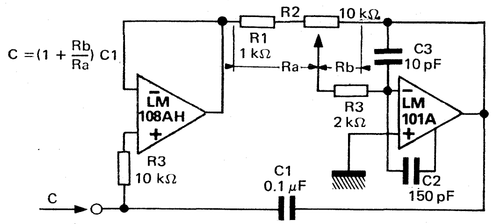


Less than 1% error to 100 kHz

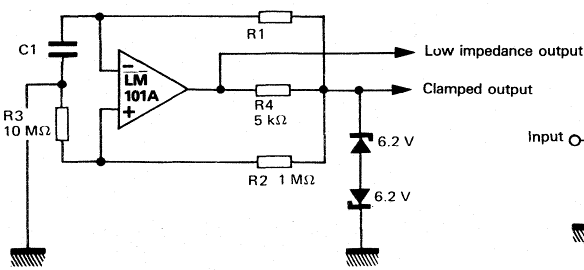
INSTRUMENTATION AMPLIFIER



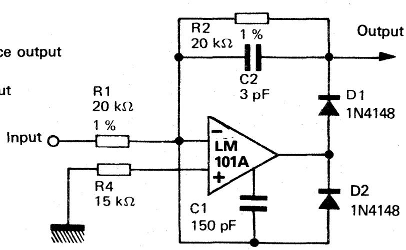
VARIABLE CAPACITANCE MULTIPLIER

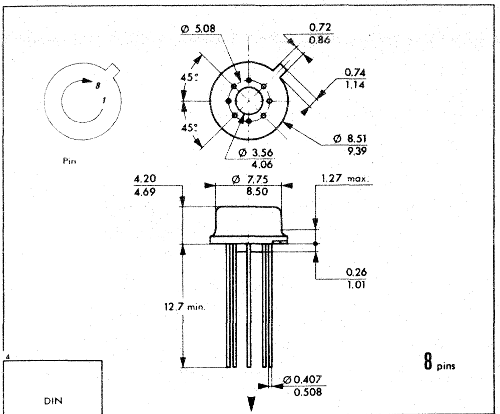


LOW FREQUENCY SQUARE WAVE GENERATOR



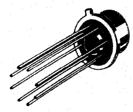
FAST HALF WAVE RECTIFIER



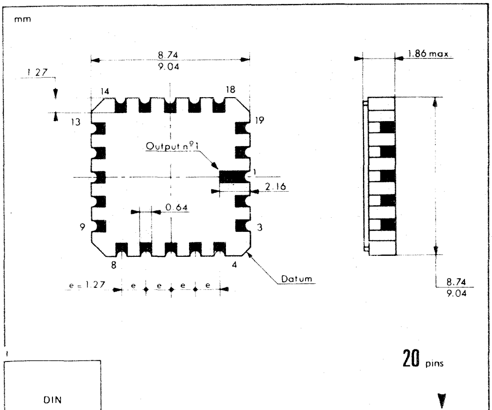


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

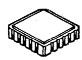


H SUFFIX
METAL CAN

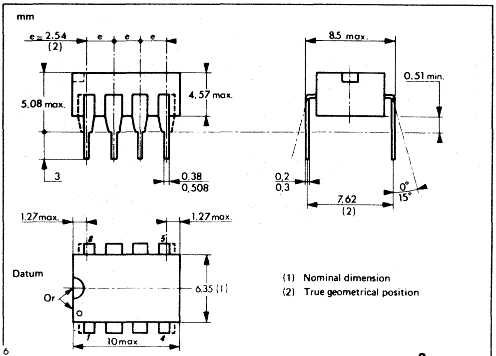


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705

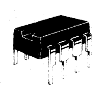


GC SUFFIX
TRICECOP (LCC)

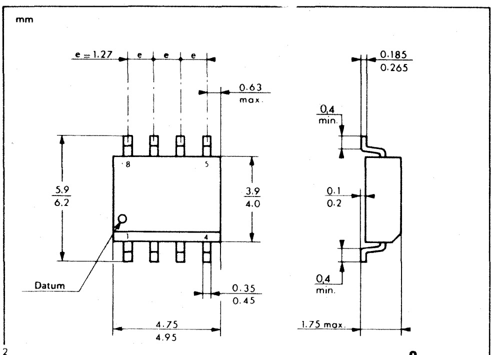


DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98

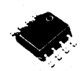


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM108,A
LM208,A
LM308,A

PRECISION SINGLE OP-AMPs

The LM108,A is a precision operational amplifier having specifications a factor ten better than FET amplifiers over a −55°C to +125°C temperature range. Selected units are available with offset voltages less than 1 mV and drifts less than 5µV/°C. This makes it possible to eliminate offset adjustments, in most cases.

The device operates with supply voltages from ±2 V to ±20 V (LM308 : ±2 V to ±15 V) and has sufficient supply rejection to use unregulated supplies. Although the circuit is interchangeable with and uses the same compensation as the LM101A, an alternate compensation scheme can be used to make it particularly insensitive to power supply noise and to make supply bypass capacitors unnecessary.

Outstanding characteristics of LM108A :
- Input offset voltage : 0.5 mV maximum
- Input bias current : 3 nA maximum over full temperature range
- Input offset current : 0.4 nA maximum over full temperature range
- Power supply current : 600 µA maximum
- Guaranteed drift characteristics
- Slew rate of 10 V/µs as inverting amplifier.

ORDERING INFORMATION

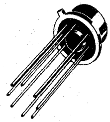
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DG	DP	GC	FP
LM108,A	−55°C to +125°C	•	•		•	
LM208,A	−25°C to + 85°C	•				
LM308,A	0°C to + 70°C	•	•	•		•
Examples : LM108H, LM108AH, LM308DG						

PRECISION SINGLE OPERATIONAL AMPLIFIERS

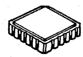
CASES

CB-11
(TO-99)



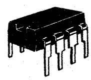
H SUFFIX
METAL CAN

CB-705



GC SUFFIX
TRICECOP (LCC)

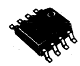
CB-98



DP SUFFIX
PLASTIC PACKAGE

DG SUFFIX
CERDIP PACKAGE

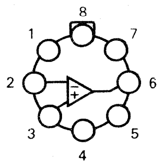
CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

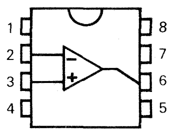
PIN ASSIGNMENTS
(Top views)

CB-11



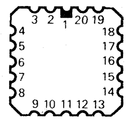
1 - Frequency compensation
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - NC
6 - Output
7 - V_{CC}^+
8 - Frequency compensation

CB-98
CB-342



1 - NC
2 - Frequency compensation
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-

CB-705



11 - NC
12 - NC
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - Frequency compensation

Réf. 00230

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

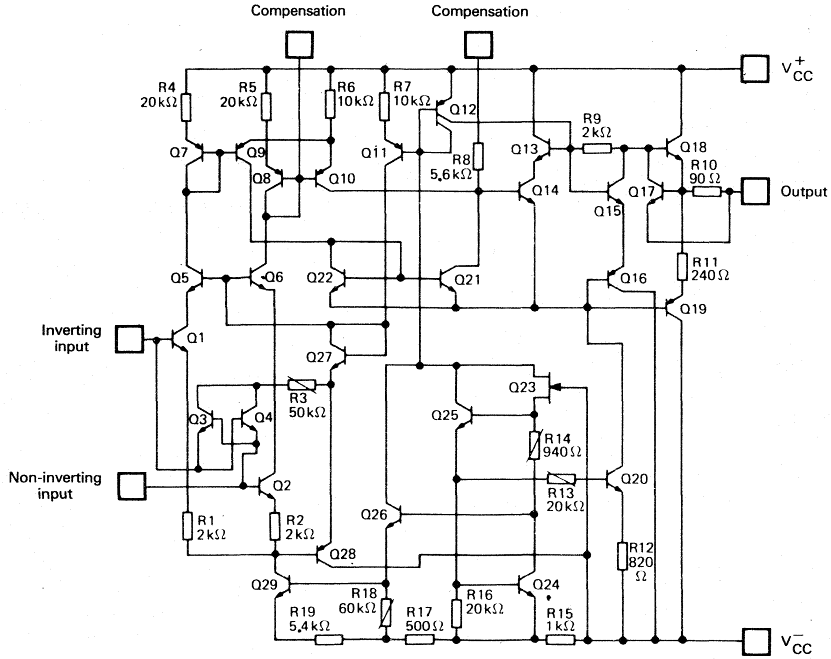
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	LM108,A	LM208,A	LM308,A	Unit
Supply voltage	V_{CC}	± 20	± 20	± 18	V
Input voltage (Note 2)	V_I	± 15	± 15	± 15	V
Input offset current (Note 1)	I_{IO}	± 10	± 10	± 10	mA
Power dissipation LM108GC, LM108AGC	P_{tot}	500 665	500 –	500 –	mW
Output short-circuit duration	–	Indefinite	Indefinite	Indefinite	–
Operating free-air temperature range	T_{oper}	– 55 to + 125	– 25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	– 55 to + 125	°C

Note 1 : The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used.
Note 2 : For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.

SCHEMATIC DIAGRAM



CASE	Frequency Compens.	Inverting input	Non-inverting input	V_{CC}^-	V_{CC}^+	Output	N.C.
CB-11 CB-98 CB-342	1, 8	2	3	4	7	6	5
CB-705	2, 20	5	7	10	17	15	*

* **CB705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

LM108A : $-55°C \leq T_{amb} \leq +125°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$

LM208A : $-25°C \leq T_{amb} \leq +85°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$

LM308A : $0°C \leq T_{amb} \leq +70°C$, $\pm 5\ V \leq V_{CC} \leq \pm 15\ V$

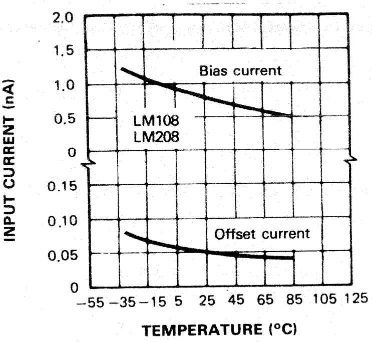
(Unless otherwise specified)

Characteristic	Symbol	LM108A - LM208A			LM308A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}							mV
$T_{amb} = +25°C$		–	0.3	0.5	–	0.3	0.5	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	1	–	–	0.73	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	0.05	0.2	–	0.2	1	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	0.4	–	–	1.5	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	0.8	2	–	1.5	7	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	3	–	–	10	
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L \geq 10$ kΩ, $V_O = \pm 10$ V)	A_{VD}							V/mV
$T_{amb} = +25°C$		80	300	–	80	300	–	
$T_{min} \leq T_{amb} \leq T_{max}$		40	–	–	60	–	–	
Supply voltage rejection ratio	SVR	96	110	–	96	110	–	dB
Supply current	I_{CC}^{+}, I_{CC}^{-}							mA
$T_{amb} = +25°C$		–	0.3	0.6	–	0.3	0.8	
$T_{amb} = T_{max}$		–	0.15	0.4	–	–	–	
Temperature coefficient of input offset voltage	αV_{IO}	–	1	5	–	1	5	µV/°C
Temperature coefficient of input offset current	αI_{IO}	–	0.5	2.5	–	2	10	pA/°C
Input voltage range ($V_{CC} = \pm 15$ V)	V_I	± 13.5	–	–	± 14	–	–	V
Common-mode rejection ratio	CMR	96	110	–	96	110	–	dB
Output voltage swing ($V_{CC} = \pm 15$ V, $R_L = 10$ kΩ)	V_{OPP}	± 13	± 14	–	± 13	± 14	–	V
Input resistance ($T_{amb} = +25°C$)	R_I	30	70	–	10	40	–	MΩ

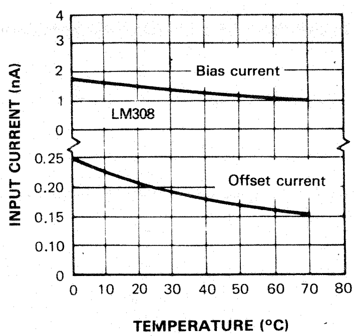
LM108 : $-55°C \leq T_{amb} \leq +125°C$, $\pm5\ V \leq V_{CC} \leq \pm20\ V$
LM208 : $-25°C \leq T_{amb} \leq +85°C$, $\pm5\ V \leq V_{CC} \leq \pm20\ V$
LM308 : $0°C \leq T_{amb} \leq +70°C$, $\pm5\ V \leq V_{CC} \leq \pm15\ V$
(Unless otherwise specified)

Characteristic	Symbol	LM108 - LM208			LM308			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}							mV
$T_{amb} = +25°C$		–	0.7	2	–	2	7.5	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	3	–	–	10	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	0.05	0.2	–	0.2	1	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	0.4	–	–	1.5	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	0.8	2	–	1.5	7	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	3	–	–	10	
Large signal voltage gain ($V_{CC} = \pm15\ V$, $R_L \geq 10\ k\Omega$, $V_O = \pm10\ V$)	A_{VD}							V/mV
$T_{amb} = +25°C$		50	300	–	25	300	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	–	–	15	–	–	
Supply voltage rejection ratio	SVR	80	96	–	80	96	–	dB
Supply current	I_{CC}^+, I_{CC}^-							mA
$T_{amb} = +25°C$		–	0.3	0.6	–	0.3	0.8	
$T_{amb} = T_{max}$		–	0.15	0.4	–	–	–	
Temperature coefficient of input offset voltage	αV_{IO}	–	3	15	–	6	30	µV/°C
Temperature coefficient of input offset current	αI_{IO}	–	0.5	2.5	–	2	10	pA/°C
Input voltage range ($V_{CC} = \pm15\ V$)	V_I	±13.5	–	–	±14	–	–	V
Common-mode rejection ratio	CMR	85	100	–	80	100	–	dB
Output voltage swing ($V_{CC} = \pm15\ V$, $R_L = 10\ k\Omega$)	V_{OPP}	±13	±14	–	±13	±14	–	V
Input resistance ($T_{amb} = +25°C$)	R_I	30	70	–	10	40	–	MΩ

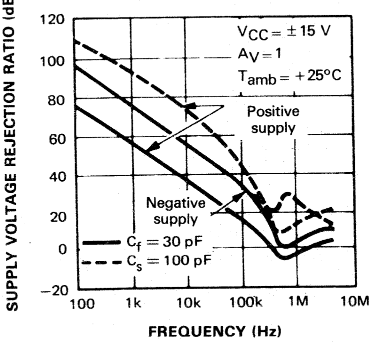
INPUT CURRENTS (Note 3)



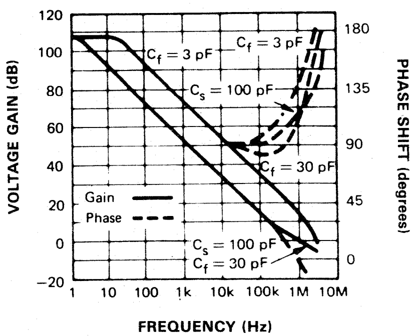
INPUT CURRENTS



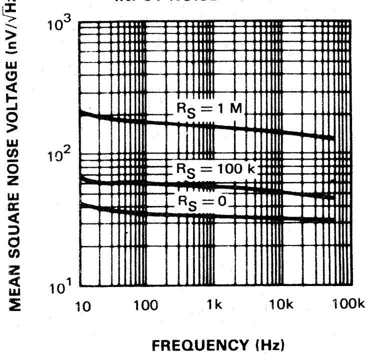
POWER SUPPLY REJECTION RATIO



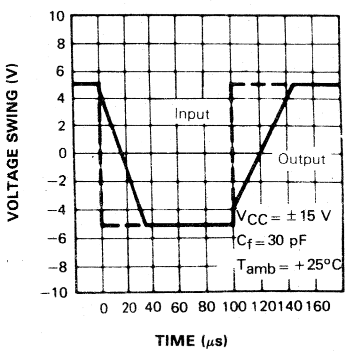
OPEN LOOP FREQUENCY RESPONSE



INPUT NOISE VOLTAGE



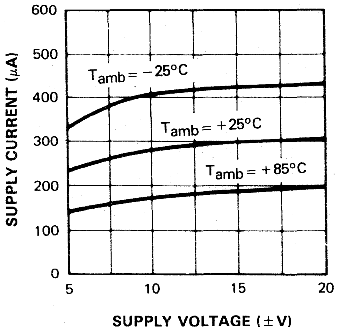
VOLTAGE FOLLOWER PULSE RESPONSE



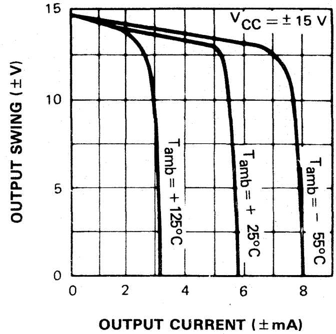
Note 3 : **LM108A** : $-55°C \leqslant T_{amb} \leqslant +125°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$.
LM208A : $-25°C \leqslant T_{amb} \leqslant +85°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$.

LM108A

SUPPLY CURRENT

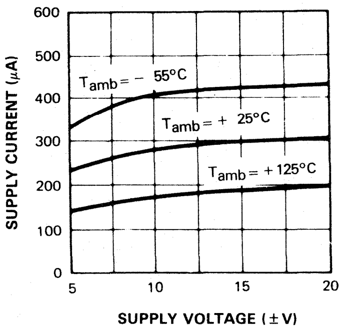


OUTPUT SWING

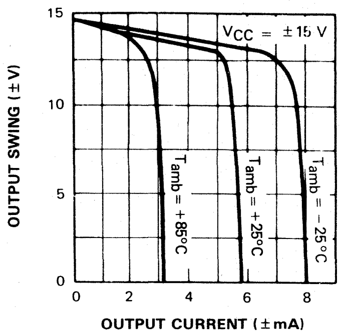


LM208A

SUPPLY CURRENT

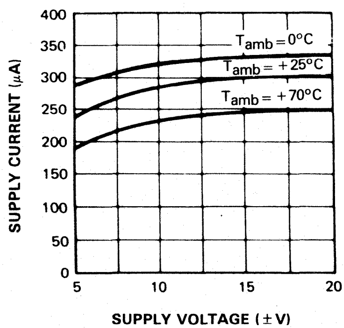


OUTPUT CURRENT

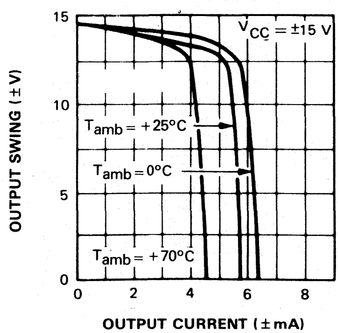


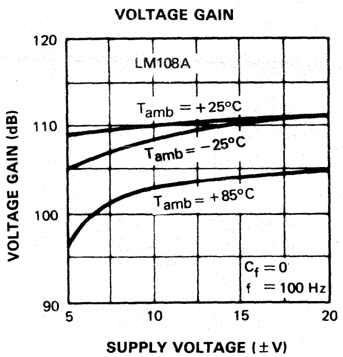
LM308A

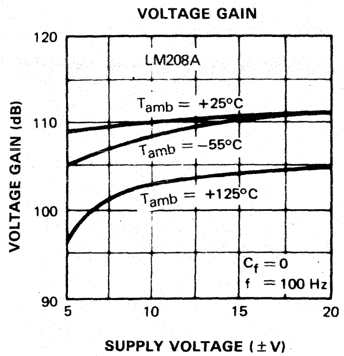
SUPPLY CURRENT

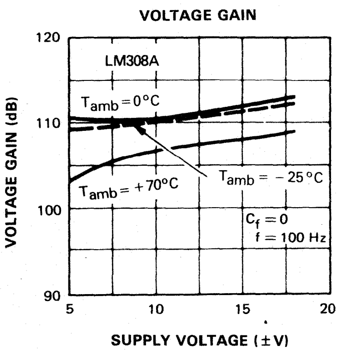


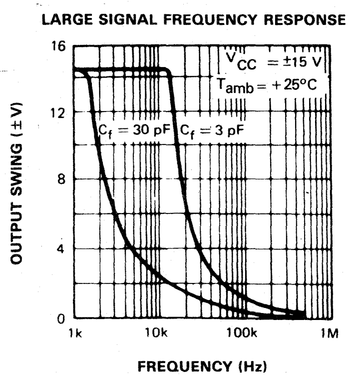
OUTPUT SWING

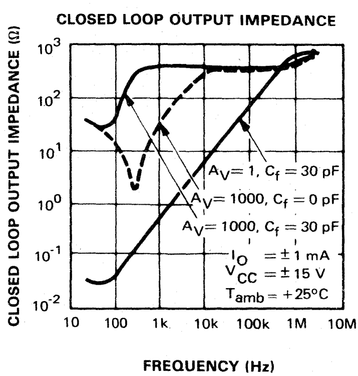



VOLTAGE GAIN
LM108A
Tamb = +25°C
Tamb = −25°C
Tamb = +85°C
Cf = 0
f = 100 Hz
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (± V)
120
110
100
90
5
10
15
20


VOLTAGE GAIN
LM208A
Tamb = +25°C
Tamb = −55°C
Tamb = +125°C
Cf = 0
f = 100 Hz
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (± V)
120
110
100
90
5
10
15
20

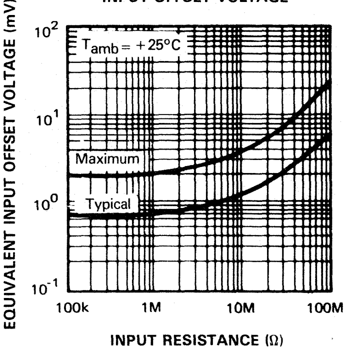

VOLTAGE GAIN
LM308A
Tamb = 0°C
Tamb = +70°C
Tamb = − 25 °C
Cf = 0
f = 100 Hz
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (± V)
120
110
100
90
5
10
15
20


LARGE SIGNAL FREQUENCY RESPONSE
VCC = ±15 V
Tamb = +25°C
Cf = 30 pF
Cf = 3 pF
OUTPUT SWING (± V)
FREQUENCY (Hz)
16
12
8
4
0
1k
10k
100k
1M

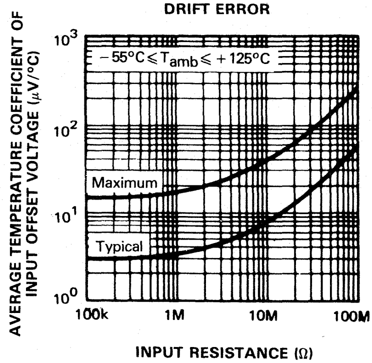

CLOSED LOOP OUTPUT IMPEDANCE
AV = 1, Cf = 30 pF
AV = 1000, Cf = 0 pF
AV = 1000, Cf = 30 pF
IO = ± 1 mA
VCC = ± 15 V
Tamb = +25°C
CLOSED LOOP OUTPUT IMPEDANCE (Ω)
FREQUENCY (Hz)
10^3
10^2
10^1
10^0
10^-1
10^-2
10
100
1k
10k
100k
1M
10M

LM108A

INPUT OFFSET VOLTAGE

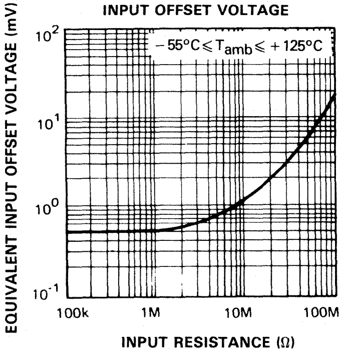


DRIFT ERROR

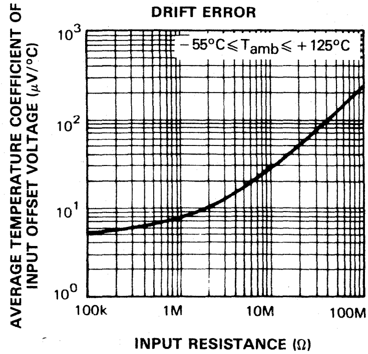


LM108

INPUT OFFSET VOLTAGE

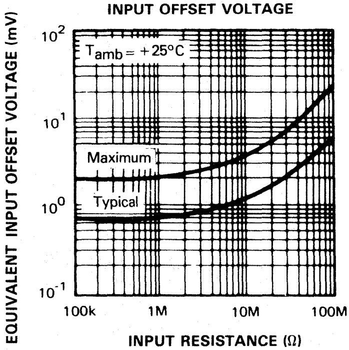


DRIFT ERROR

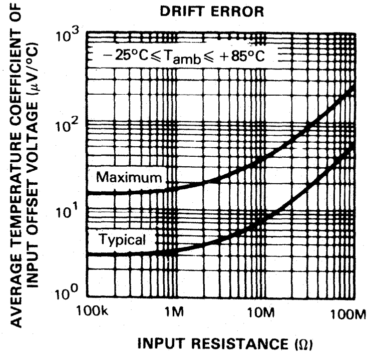


LM208

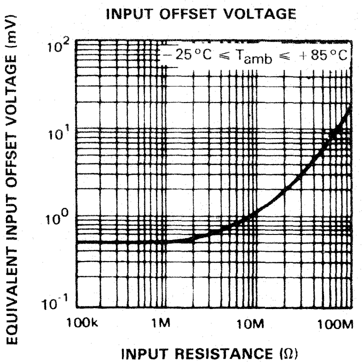
INPUT OFFSET VOLTAGE

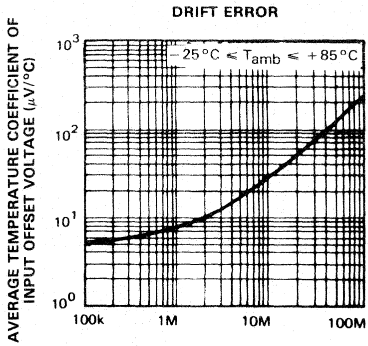


DRIFT ERROR

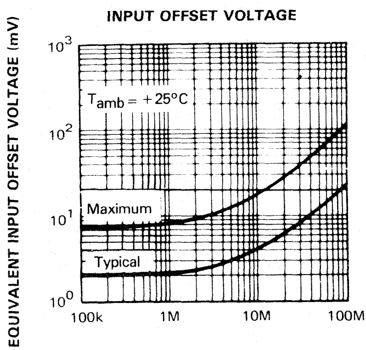


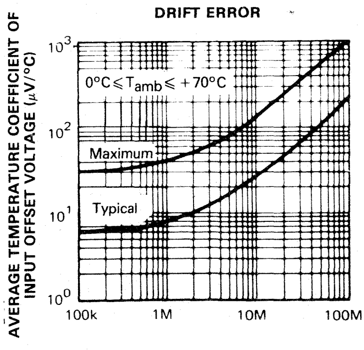
LM208A





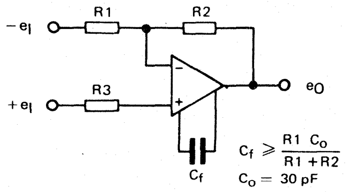
LM308



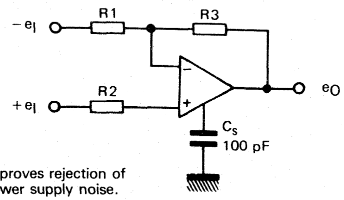


BASIC DIAGRAMS

STANDARD COMPENSATION CIRCUIT



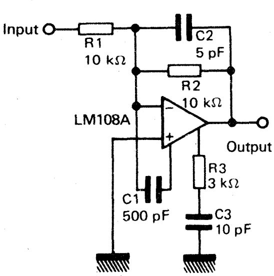
ALTERNATE FREQUENCY COMPENSATION*



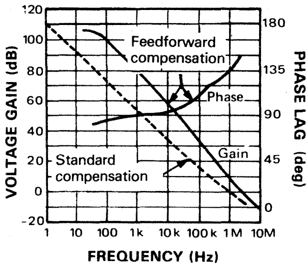
* Improves rejection of power supply noise.

TYPICAL APPLICATIONS

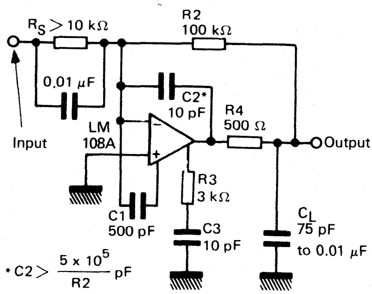
STANDARD FEEDFORWARD



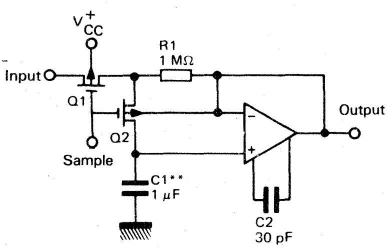
OPEN LOOP VOLTAGE GAIN



FEEDFORWARD COMPENSATION FOR DECOUPLING LOAD CAPACITANCE



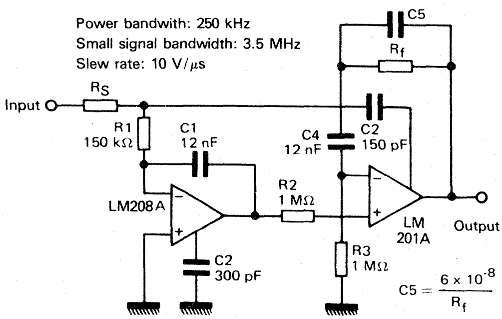
SAMPLE AND HOLD*



* Worst case drift less than 2.5 mV/sec.
** Teflon, polyethylene or polycarbonate dielectric capacitor.

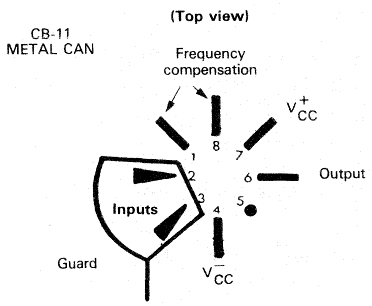
FAST SUMMING AMPLIFIER

Power bandwith: 250 kHz
Small signal bandwidth: 3.5 MHz
Slew rate: 10 V/µs

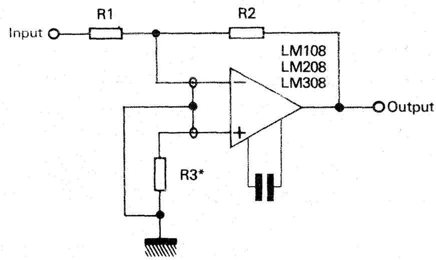


In addition to increasing speed the LM201A raises high and low frequency gain and eliminates thermal feedback.

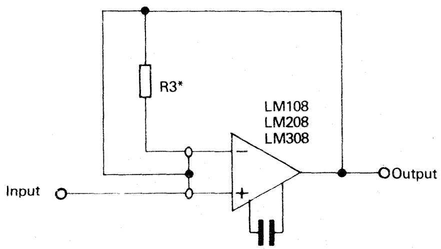
TYPICAL APPLICATIONS (continued)



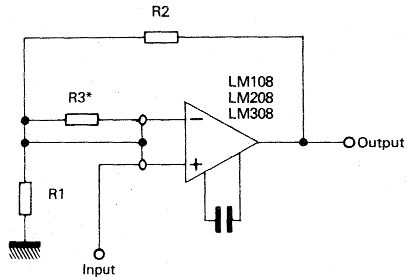
Pin 4 connected to case



INVERTING AMPLIFIER



FOLLOWER AMPLIFIER



NON-INVERTING AMPLIFIER

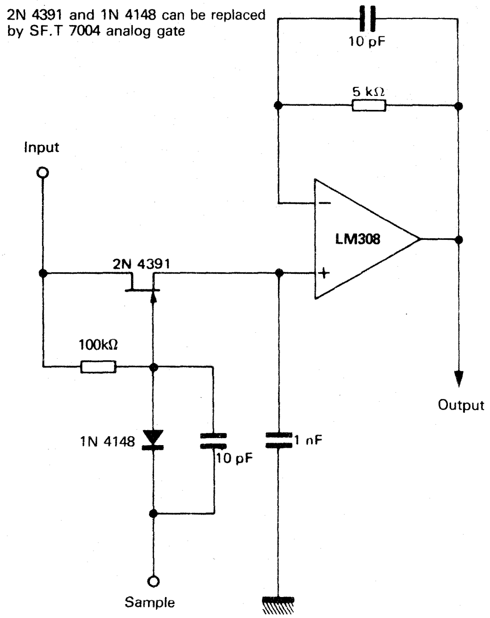
* Used to compensate for large source resistances.

INPUT GUARDING

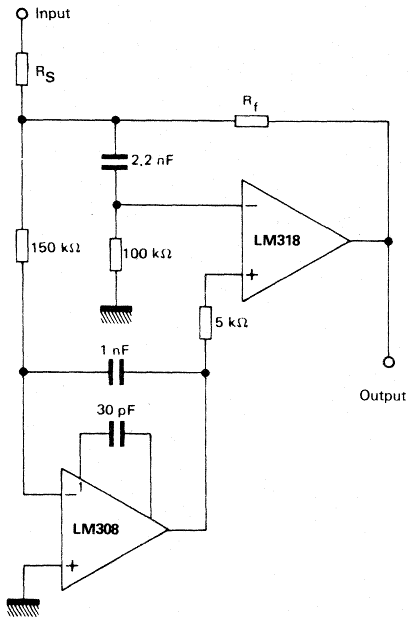
Leakage currents are on the verge of causing trouble at +125°C. The standard pin configuration of most IC op amps has the input pins adjacent to pins wich are the supply potentials. Therefore, it is advisable to employ guarding to reduce the voltage difference between the inputs and adjacent metal runs. A ten-lead pin circle is used, and the leads of the IC are formed so that the holes adjacent to the inputs are vacant when it is inserted in the board. The guard, which is a conductive ring surrounding the inputs, is connected to a low impedance point that is at the same potential as the inputs.

TYPICAL APPLICATION DIAGRAMS

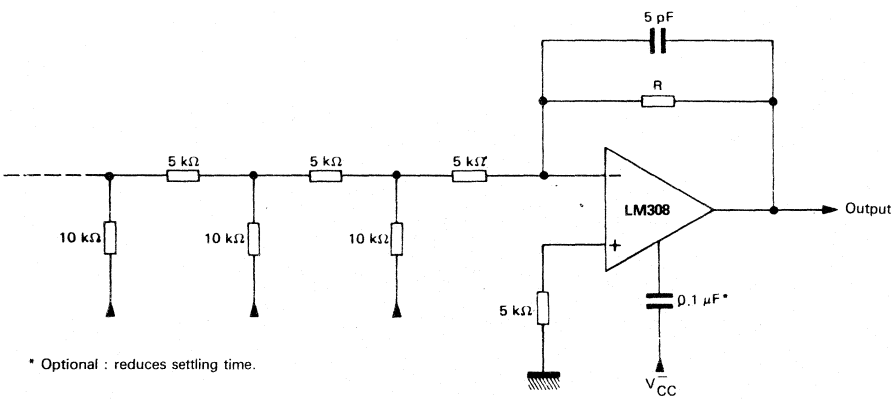
FAST SAMPLE AND HOLD



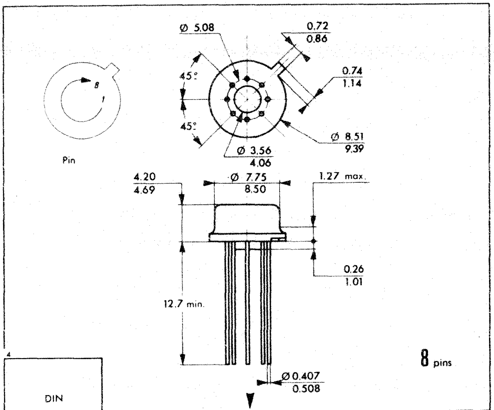
FAST SUMMING AMPLIFIER WITH LOW INPUT CURRENT



D/A CONVERTER USING LADDER NETWORK

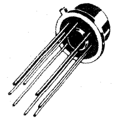


* Optional : reduces settling time.

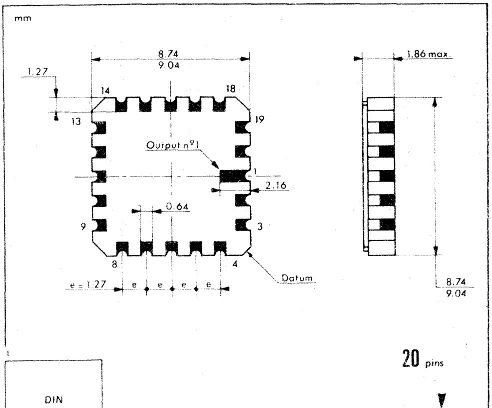


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11

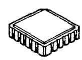


H SUFFIX
METAL CAN

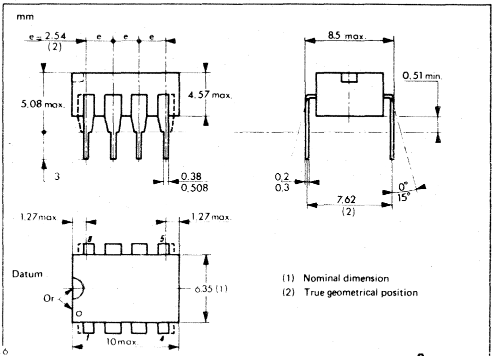


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705



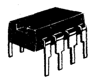
GC SUFFIX
TRICECOP (LCC)



8 pins

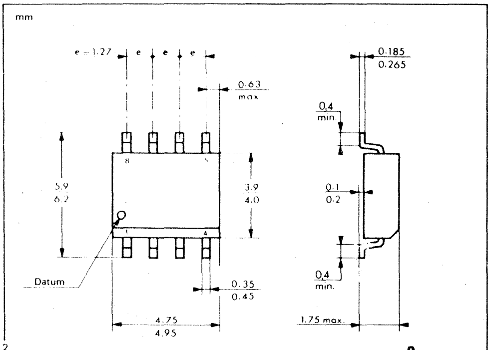
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98



DP SUFFIX
PLASTIC PACKAGE

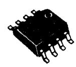
DG SUFFIX
CERDIP PACKAGE



8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM118
LM218
LM318

SINGLE OPERATIONAL AMPLIFIERS

The LM118, LM218 and LM318 are precision high speed operational amplifiers designed for applications requiring wide bandwidth and high slew rate. They feature internal frequency compensation and a factor of ten increase in speed over general purpose devices.

Although, no external frequency compensation components are needed for operation, feedforward compensation may be used to further increase the speed. For inverting applications, feedforward compensation will boost the slew rate to over 150 V/μs and almost double the bandwidth. However, for non-inverting or differential applications feedforward cannot be used.

The high speed and fast settling time of these op amps make them useful in A/D converters, oscillators, active filters, sample and hold circuits, or general purpose amplifiers.

- Input offset voltage : 4 mV max. (military range)
  10 mV max. (industrial range)
- Input bias current : 250 nA max. (military range)
  500 nA max. (industrial range)
- Input offset current : 50 nA max. (military range)
  200 nA max (industrial range)
  Guaranteed over the operating temperature range
- Slew rate of 50 V/μs as inverting amplifier.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

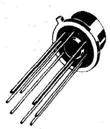
PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DP	DG	GC	FP
LM118	−55°C to +125°C	•		•	•	
LM218	−25°C to + 85°C	•				
LM318	0°C to + 70°C	•	•			•

Example : LM118DG, LM218H

SINGLE OPERATIONAL AMPLIFIERS

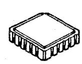
CASES

CB-11



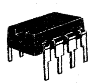
H SUFFIX
METAL CAN

CB-705



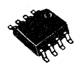
GC SUFFIX
TRICECOP (LCC)

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

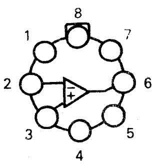
CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

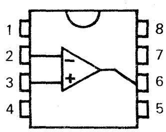
PIN ASSIGNMENTS
(Top views)

CB-11



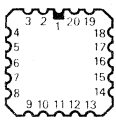
1 - Balance / Compensation 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-

CB-98
CB-342



5 - Balance / Compensation 3
6 - Output
7 - V_{CC}^+
8 - Compensation 2

CB-705



1 - NC
2 - Balance / Compensation 1
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Balance / Compensation 3
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - Compensation 2

Réf. 00235

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

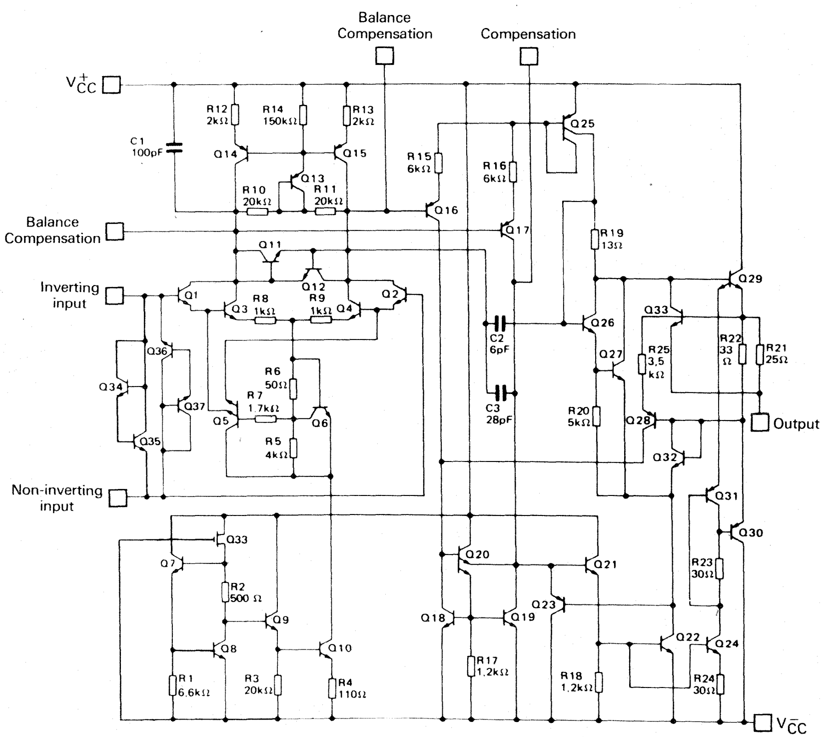
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	LM118	LM218	LM318	Unit
Supply voltage	V_{CC}	±20	±20	±20	V
Input voltage (Note 1)	V_I	±15	±15	±15	V
Differential input current (Note 2)	I_{ID}	±10	±10	±10	mA
Output short-circuit duration	–	Indefinite	Indefinite	Indefinite	–
Power dissipation LM318FP All other versions	P_{tot}	– 500	– 500	300 500	mW
Operating free-air temperature range (Note 3)	T_{oper}	– 55 to + 125	– 25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	– 65 to + 150	°C

Note 1 : For supply voltage less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.
Note 2 : The inputs are shunted with shunt diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used.
Note 3 : $T_{j(max)} = + 150°C$ for all categories.
Devices bonded on a 6 cm × 3 cm × 0.15 cm glass-epoxy substrate with 30 mm² of 35 μm thick copper.

SCHEMATIC DIAGRAM



CASE	Balance Compensation	Inverting input	Non-inverting input	V_{CC}^-	V_{CC}^+	Output	Compensation	N.C.
CB-11/CB-98/CB-342	1, 5	2	3	4	7	6	8	
CB-705	2, 12	5	7	10	17	15	20	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

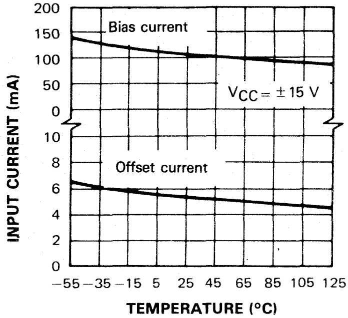
LM118 : $-55°C \leq T_{amb} \leq +125°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$
LM218 : $-25°C \leq T_{amb} \leq +\ 85°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$
LM318 : $0°C \leq T_{amb} \leq +\ 70°C$, $\pm 5\ V \leq V_{CC} \leq \pm 20\ V$
(Unless otherwise specified)

Characteristic	Symbol	LM118			LM218			LM318			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}										mV
$T_{amb} = +25°C$		–	2	4	–	2	4	–	4	10	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	6	–	–	6	–	–	15	
Input offset current	I_{IO}										nA
$T_{amb} = +25°C$		–	6	50	–	6	50	–	30	200	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	100	–	–	100	–	–	300	
Input bias current	I_{IB}										nA
$T_{amb} = +25°C$		–	120	250	–	120	250	–	150	500	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	500	–	–	500	–	–	750	
Large signal voltage gain ($V_{CC} = \pm 15\ V$, $R_L \geq 2\ k\Omega$, $V_O = \pm 10\ V$)	A_{VD}										V/mV
$T_{amb} = +25°C$		50	200	–	50	200	–	25	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	–	–	25	–	–	20	–	–	
Supply voltage rejection ratio	SVR	70	80	–	70	80	–	65	80	–	dB
Supply current	I^+_{CC}, I^-_{CC}										mA
$T_{amb} = +25°C$		–	5	8	–	5	8	–	5	10	
$T_{amb} = T_{max}$		–	4.5	7	–	–	8	–	–	–	
Input voltage range ($V_{CC} = \pm 15\ V$)	V_I	±11.5	–	–	±11.5	–	–	±11.5	–	–	V
Common-mode rejection ratio	CMR	80	100	–	80	100	–	70	100	–	dB
Output voltage swing ($V_{CC} = \pm 15\ V$, $R_L = 2\ k\Omega$)	V_{OPP}	±12	±13	–	±12	±13	–	±12	±13	–	V
Small signal bandwidth ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$)	GW_R	–	15	–	–	15	–	–	15	–	MHz
Slew rate (Note 4) ($V_{CC} = \pm 15\ V$, $T_{amb} = +25°C$, $A_V = 1$)	S_{VO}	50	70	–	50	70	–	50	70	–	V/µs
Input impedance ($T_{amb} = +25°C$)	Z_I	1	3	–	1	3	–	0.5	3	–	MΩ

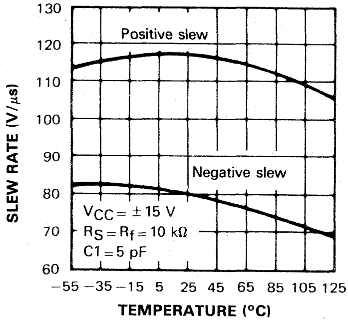
Note 4 : May be improved up to 150 V/µs in inverting amplifier configuration (see typical application).

LM118 - LM218 - LM318

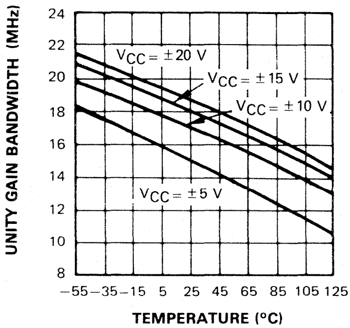
INPUT CURRENT (Note 5)



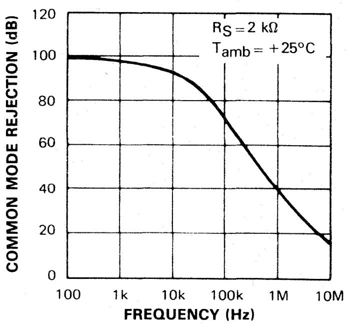
VOLTAGE FOLLOWER SLEW RATE (Note 5)



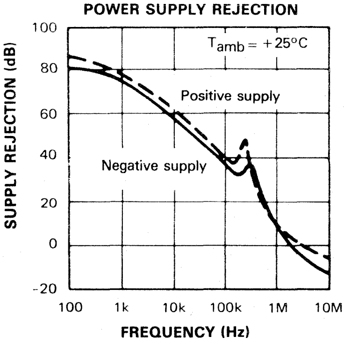
UNITY GAIN BANDWIDTH (GAIN : 1) (Note 5)



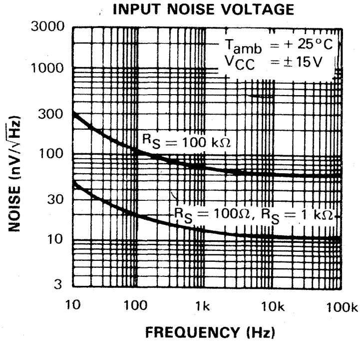
COMMON MODE REJECTION



POWER SUPPLY REJECTION



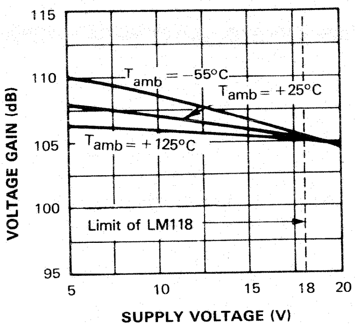
INPUT NOISE VOLTAGE



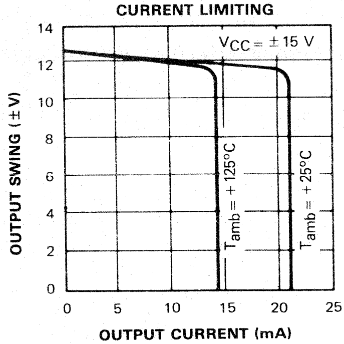
Note 5 : LM118 : $-55°C \leqslant T_{amb} \leqslant +125°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$
LM218 : $-25°C \leqslant T_{amb} \leqslant +85°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$
LM318 : $0°C \leqslant T_{amb} \leqslant +70°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$

LM118

VOLTAGE GAIN

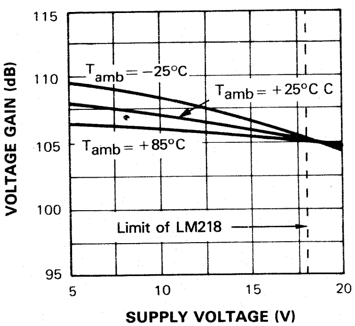


CURRENT LIMITING

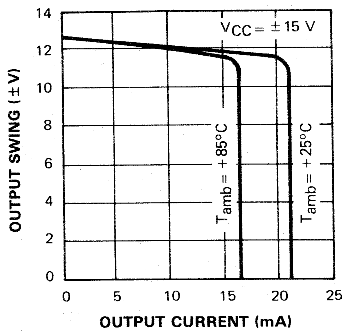


LM218

VOLTAGE GAIN

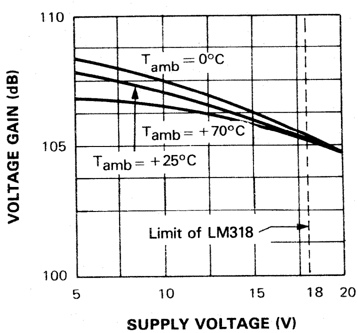


CURRENT LIMITING

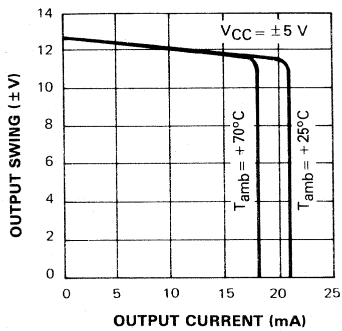


LM318

VOLTAGE GAIN

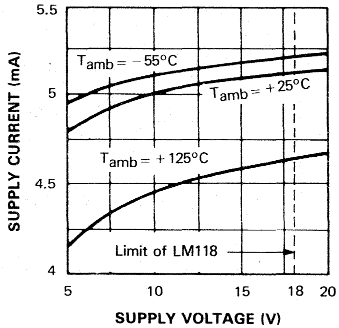


CURRENT LIMITING

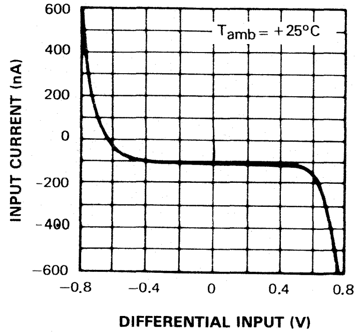


LM118

SUPPLY CURRENT

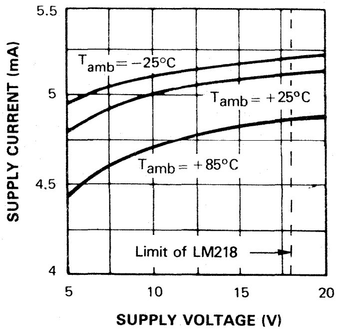


INPUT CURRENT

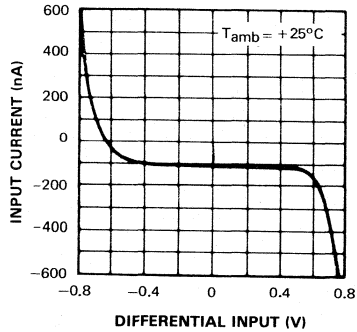


LM218

SUPPLY CURRENT

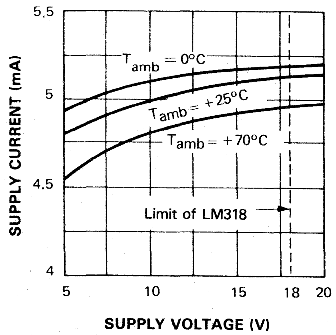


INPUT CURRENT

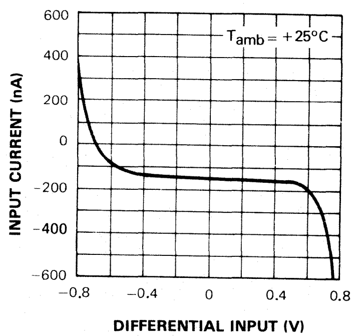


LM318

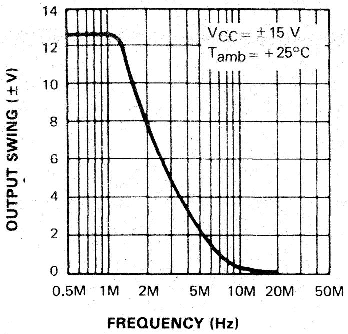
SUPPLY CURRENT



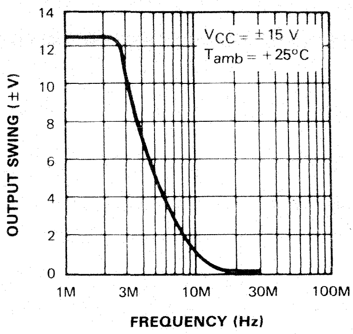
INPUT CURRENT



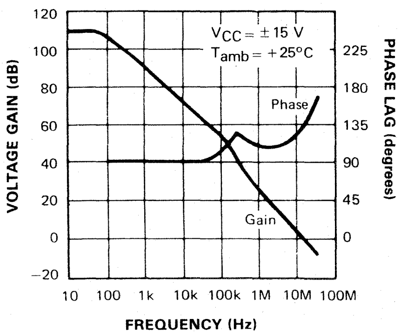
LARGE SIGNAL FREQUENCY RESPONSE



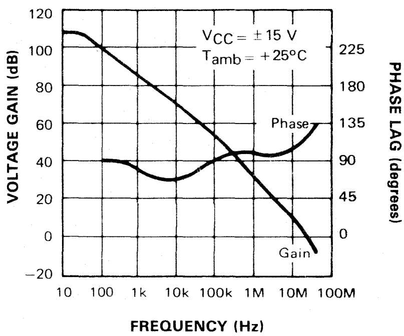
LARGE SIGNAL FREQUENCY RESPONSE*



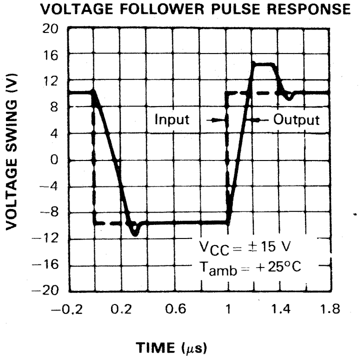
OPEN LOOP FREQUENCY RESPONSE



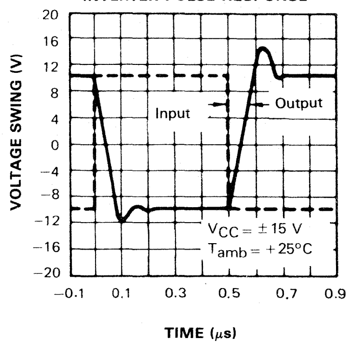
OPEN LOOP FREQUENCY RESPONSE*



VOLTAGE FOLLOWER PULSE RESPONSE

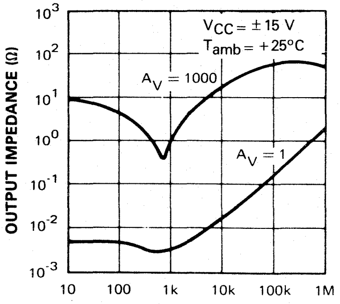


INVERTER PULSE RESPONSE*

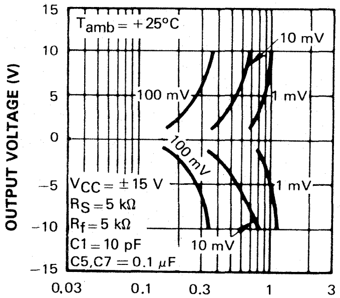


* With feedforward compensation

CLOSED LOOP OUTPUT IMPEDANCE

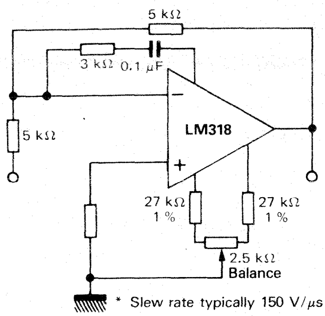


INVERTER SETTLING TIME



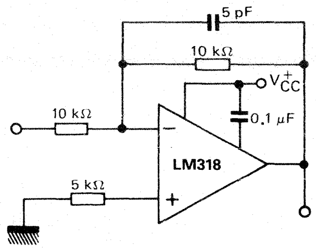
BASIC DIAGRAMS

FEEDFORWARD COMPENSATION FOR GREATER INVERTING SLEW RATE*



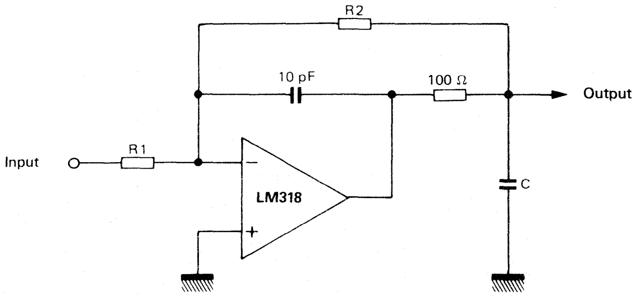
* Slew rate typically 150 V/µs

COMPENSATION FOR MINIMUM SETTLING TIME*

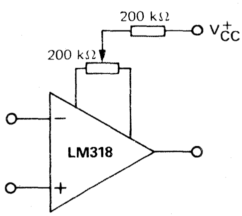


* Slew and settling time to 0.1% for a 10 V step change is 800 ns

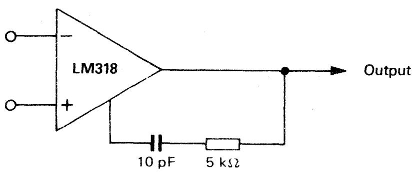
ISOLATING LARGE CAPACITIVE LOADS



OFFSET BALANCING



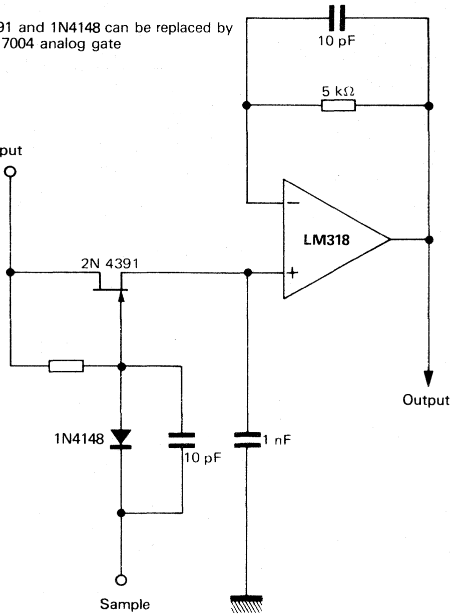
OVERCOMPENSATION



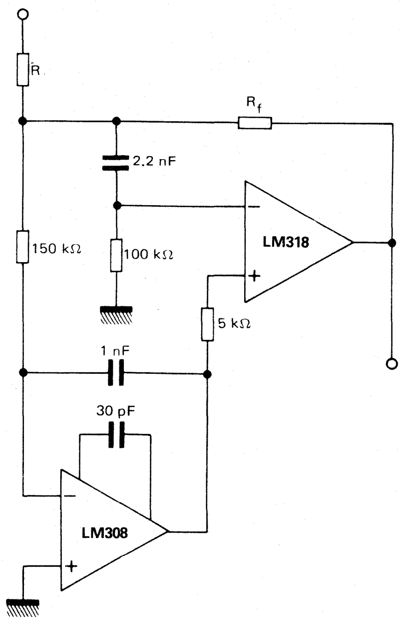
TYPICAL APPLICATION DIAGRAMS

FAST SAMPLE AND HOLD

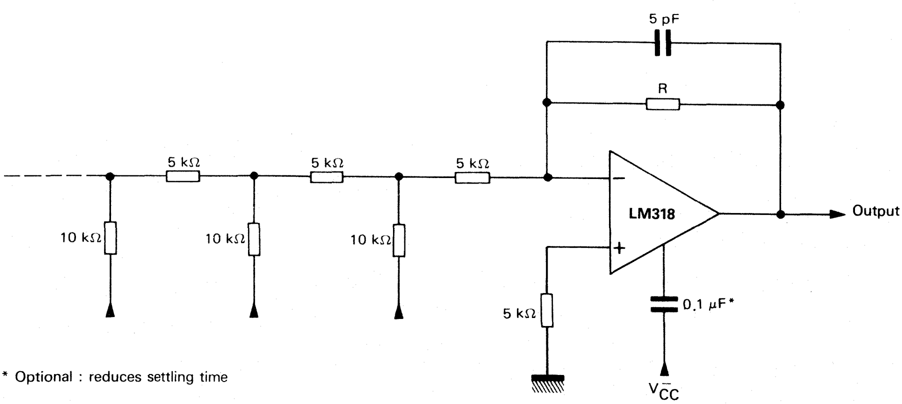
2N 4391 and 1N4148 can be replaced by SF. T 7004 analog gate



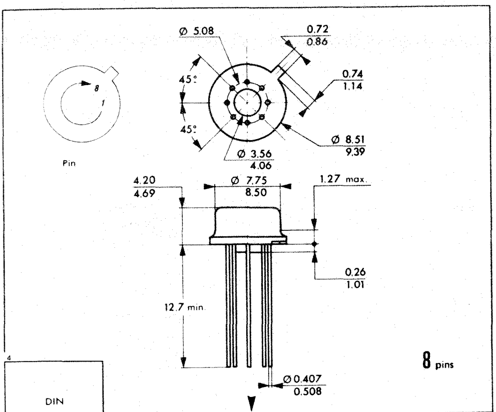
FAST SUMMING AMPLIFIER WITH LOW INPUT CURRENT



D/A CONVERTER USING LADDER NETWORK

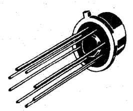


* Optional : reduces settling time

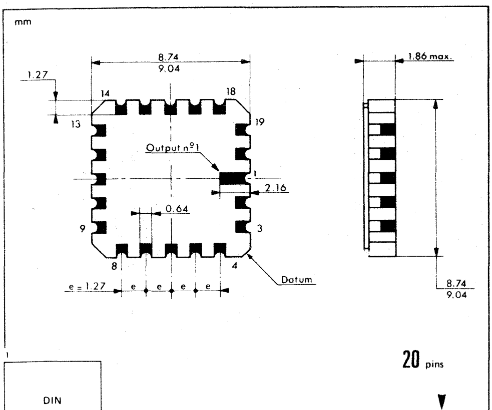


Case : Base : C-23 CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

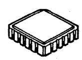


H SUFFIX
METAL CAN

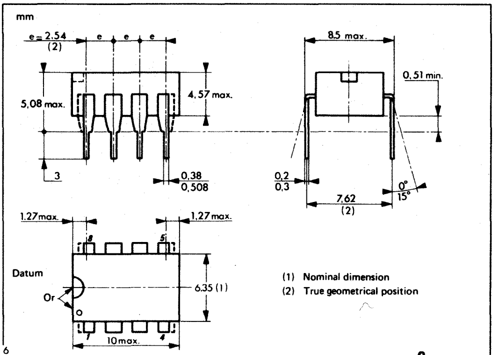


MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705

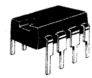


GC SUFFIX
TRICECOP (LCC)

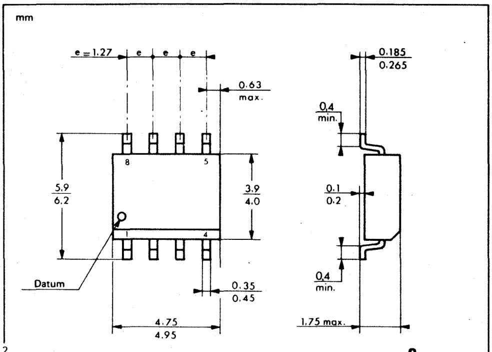


DIN				
A50D			F 116A	CB-98
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS

CB-98

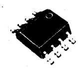


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



DIN	SO8			
				CB-342
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM124 LM224 LM324,A LM2902

LOW POWER QUAD OPERATIONAL AMPLIFIERS

These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

- Large voltage gain : 100 dB.
- Very low supply current drain : 800 μA.
- Low input bias current : 45 nA.
- Low input offset voltage : 2 mV.
- Low input offset current : 5 nA.

Wide power supply range :

- Single supply : +3 V to +30 V.
- Dual supplies for LM124 : ±1.5 V to ±15 V.
- Single supply for LM2902 : +3 V to +26 V.

ORDERING INFORMATION

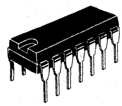
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	GC	FP
LM124	−55°C to +125°C		•	•	
LM224	−25°C to + 85°C	•	•		
LM324, A	0°C to + 70°C	•	•		•
LM2902	−40°C to + 85°C	•			•
Examples : LM124DG, LM124GC, LM224DP					

LOW POWER QUAD OPERATIONAL AMPLIFIERS

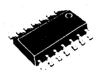
CASES

CB-2



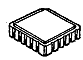
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511



FP SUFFIX
PLASTIC
MICROPACKAGE

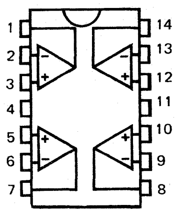
CB-705



GC SUFFIX
TRICECOP (LCC)

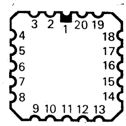
PIN ASSIGNMENTS
(Top views)

CB-2
CB-511



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

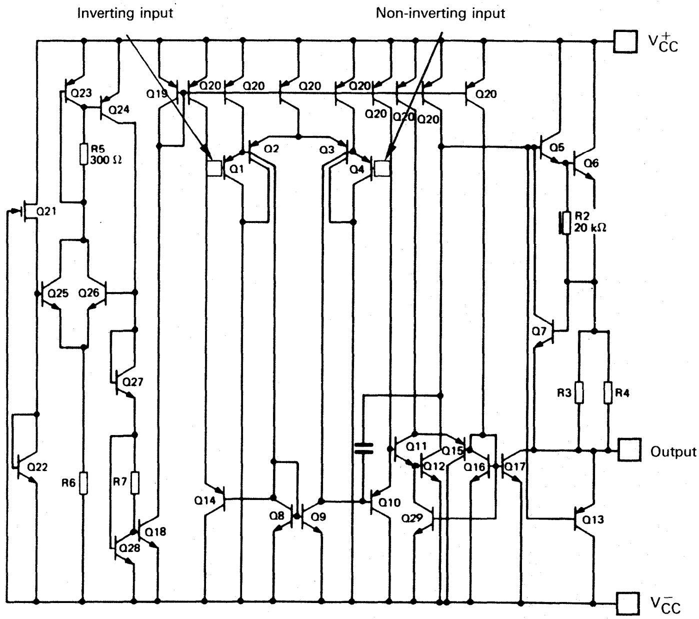
Réf. 00305

MAXIMUM RATINGS

Rating	Symbol	LM124	LM224	LM324,A	LM2902	Unit
Supply voltage	V_{CC}	± 16 or 32	± 16 or 32	± 16 or 32	± 13 or 26	V
Differential input voltage	V_{ID}	32	32	32	26	V
Input voltage (Note 7)	V_I	− 0.3 to + 32	− 0.3 to + 32	− 0.3 to + 32	− 0.3 to + 26	V
Output short circuit duration (V_{CC} = ± 15 V, T_{amb} = + 25°C)	—	Indefinite for all amplifiers				—
Power dissipation (Note 1) LM124GC LM324FP, AFP/LM2902FP	P_{tot}	500 665 —	500 — —	500 — 400	500 — 400	mW
Operating free-air temperature range	T_{oper}	− 55 to + 125	− 25 to + 85	0 to + 70	− 40 to + 85	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

Input current for $V_I \leqslant -0.3$, V_{OL} : 50 mA
See notes page 4
Devices bonded on a 6 cm × 3 cm × 0.15 cm glass epoxy substrate with 30 mm^2 of 35 μm thick copper.

SCHEMATIC DIAGRAM



CASE	Inverting inputs	Non-inverting inputs	V_{CC}^-	V_{CC}^+	Outputs	N.C.
CB-2/CB-511	2, 6, 9, 13	3, 5, 10, 12	11	4	1, 7, 8, 14	
CB-705	3, 9, 13, 19	4, 8, 14, 18	16	6	1, 2, 12, 20	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

$V_{CC}^{+} = +5$ V, $V_{CC}^{-} = GND$
LM124 : $-55°C \leq T_{amb} \leq +125°C$
LM224 : $-25°C \leq T_{amb} \leq +85°C$
LM324,A : $0°C \leq T_{amb} \leq +70°C$
LM2902 : $-40°C \leq T_{amb} \leq +85°C$
(Unless otherwise specified)

Characteristic	Symbol	LM124, LM224			LM324,A/LM2902			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}							mV
$R_S = 0\ \Omega$, $T_{amb} = +25°C$ - (Note 4)		—	2	5	—	2	7	
LM324A		—	—	—	—	2	3	
$R_S = 0\ \Omega$ - (Note 4)		—	—	7	—	—	9	
LM324A		—	—	—	—	—	5	
LM2902		—	—	—	—	—	10	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		—	3	30	—	5	50	
LM324A		—	—	—	—	5	30	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	100	—	—	150	
LM324A		—	—	—	—	—	75	
LM2902		—	—	—	—	—	200	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$ - (Note 3)		—	45	100	—	45	250	
LM324A		—	—	—	—	45	100	
$T_{min} \leq T_{amb} \leq T_{max}$		—	40	300	—	40	500	
LM324A		—	—	—	—	40	200	
Large signal voltage gain ($V_{CC} = \pm 15$ V)	A_{VD}							V/mV
$T_{amb} = +25°C$		50	100	—	25	100	—	
LM2902		—	—	—	—	100	—	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L = 2\ k\Omega$		25	—	—	15	—	—	
Supply voltage rejection ratio ($T_{amb} = +25°C$)	SVR	65	100	—	65	100	—	dB
LM2902		—	—	—	—	100	—	
Supply current ($R_L = \infty$ for all amplifiers)	I_{CC}^{+}, I_{CC}^{-}							mA
$T_{amb} = +25°C$		—	0.7	1.2	—	0.8	1.2	
$V_{CC}^{+} = +30$ V		—	1.5	3	—	1.5	3	
$T_{min} \leq T_{amb} \leq T_{max}$		—	0.8	1.2	—	0.8	1.2	
$V_{CC}^{+} = +30$ V (except for LM2902)		—	1.5	3	—	1.5	3	
Temperature coefficient of input offset voltage ($R_S = 0\ \Omega$)	αV_{IO}	—	7	—	—	7	—	µV/°C
LM324A		—	—	—	—	7	30	
Temperature coefficient of input offset current	αI_{IO}	—	10	—	—	10	—	pA/°C
LM324A		—	—	—	—	10	300	
Input voltage range ($V_{CC}^{+} = +30$ V*) - Note 5	V_I							V
$T_{amb} = +25°C$		0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	
$T_{min} \leq T_{amb} \leq T_{max}$		0	—	$V_{CC}^{+} - 2$	0	—	$V_{CC}^{+} - 2$	
Common-mode rejection ratio	CMR	70	85	—	65	70	—	dB
LM324A		—	—	—	65	85	—	
LM2902		—	—	—	50	70	—	
Output short-circuit current ($T_{amb} = +25°C$)	I_{OS}	—	40	60	—	40	60	mA
Output current ($V_{CC}^{+} = +15$ V, $V_I^{+} = +1$ V, $V_I^{-} = 0$ V)	I_O							mA
$T_{amb} = +25°C$		20	40	—	20	40	—	
$T_{min} \leq T_{amb} \leq T_{max}$		10	20	—	10	20	—	
Output current sink ($V_I^{+} = 0$ V, $V_I^{-} = +1$ V)	$I_{O(sink)}$							mA
$V_{CC}^{+} = +15$ V, $T_{amb} = +25°C$		10	20	—	10	20	—	
$V_O = +200$ mV, $T_{amb} = +25°C$		0.012	0.05	—	0.012	0.05	—	
$V_{CC}^{+} = +15$ V, $T_{min} \leq T_{amb} \leq T_{max}$		5	8	—	5	8	—	
Output voltage swing	V_{OPP}							V
$V_{CC}^{+} = +5$ V, $T_{amb} = +25°C$, $R_L \geq 2\ k\Omega$ ($R_L \geq 10\ k\Omega$ for LM2902)		0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	
High level output voltage ($V_{CC}^{+} = +30$ V)*	V_{OH}							V
$R_L = 2\ k\Omega$		26	—	—	26	—	—	
LM2902		—	—	—	22	—	—	
$R_L = 10\ k\Omega$		27	28	—	27	28	—	
LM2902		—	—	—	23	24	—	
Low level output voltage ($R_L \leq 10\ k\Omega$)	V_{OL}	—	5	20	—	5	20	mV
LM2902		—	—	—	—	5	100	
Amplifier to amplifier coupling	—							dB
$1\ kHz \leq f \leq 20\ kHz$, $T_{amb} = +25°C$ - (Note 6)		—	−120	—	—	−120	—	

* $V_{CC}^{+} = +26$ V for LM2902

Note 1 : $R_{th(j-a)} = 175°C/W$, T_j max = +125°C (LM324) for $T_{case} = +25°C$
T_j max = +150°C (LM124, 224, 2902) for $T_{case} = +50°C$
* $R_{th(j-a)} = 250°C/W$, T_j max = +125°C (LM324FP, LM2902FP) for $T_{case} = +25°C$
The dissipation is the total of all four amplifiers.

Note 2 : Short-circuits from the output to V_{CC}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}^+. At values of supply voltage in excess of +15 V, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

Note 3 : The direction of the output current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

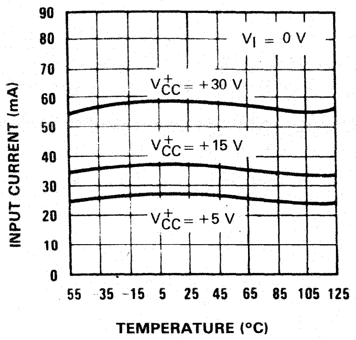
Note 4 : $V_O = +1.4$ V, $R_S = 0\ \Omega$, $+5\ V \leqslant V_{CC}^+ \leqslant +30$ V, $V_{CC}^- =$ Ground, $0 \leqslant V_I \leqslant (V_{CC}^+ - 1.5\ V)$.

Note 5 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC}^+ - 1.5$ V, but either or both inputs can go to +32 V without damage.

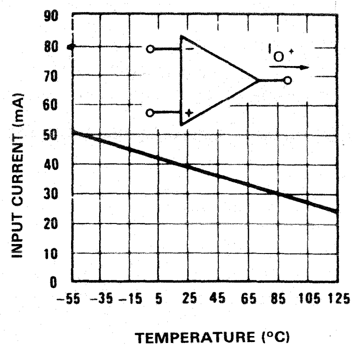
Note 6 : Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitive coupling increases at higher frequencies.

Note 7 : This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V_{CC}^+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than $-0.3\ V_{DC}$.

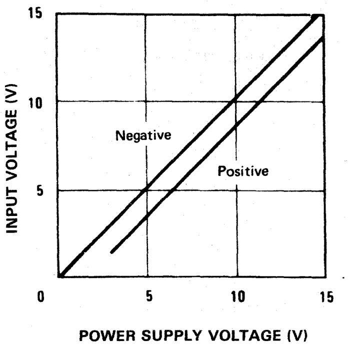
INPUT CURRENT (Note 8)



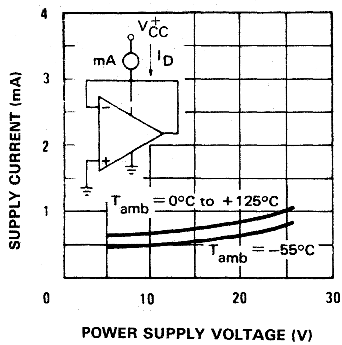
CURRENT LIMITING (Note 8)



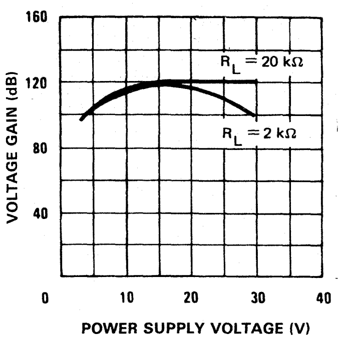
INPUT VOLTAGE RANGE



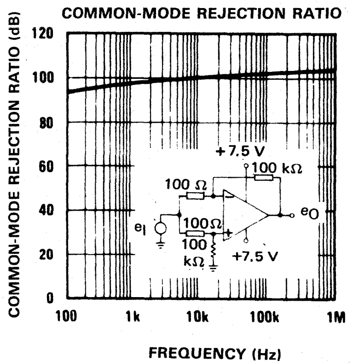
SUPPLY CURRENT



VOLTAGE GAIN

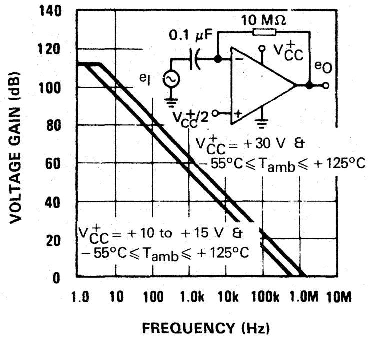


COMMON-MODE REJECTION RATIO

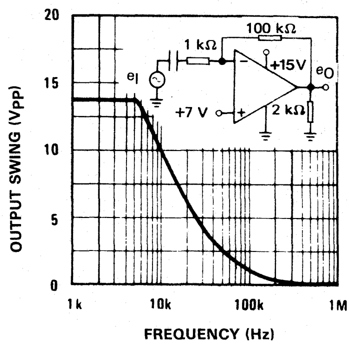


Note 8 : LM124 : $-55°C \leqslant T_{amb} \leqslant +125°C$
LM224 : $-25°C \leqslant T_{amb} \leqslant +85°C$
LM324,A : $0°C \leqslant T_{amb} \leqslant +70°C$
LM2902 : $-40°C \leqslant T_{amb} \leqslant +85°C$

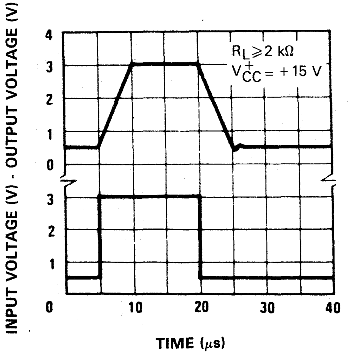
OPEN LOOP FREQUENCY RESPONSE



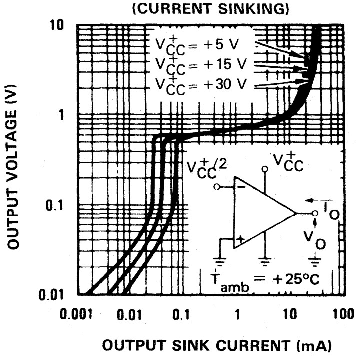
LARGE SIGNAL FREQUENCY RESPONSE



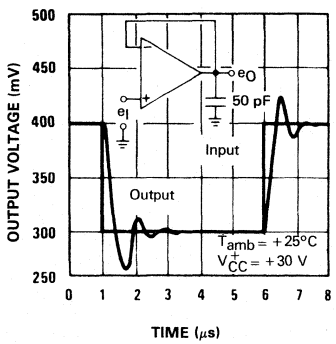
VOLTAGE FOLLOWER PULSE RESPONSE



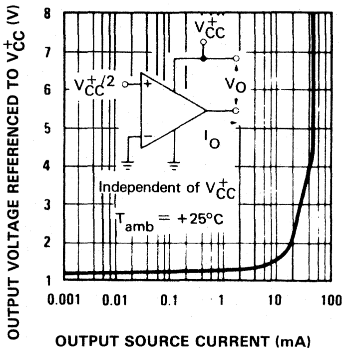
OUTPUT CHARACTERISTICS
(CURRENT SINKING)

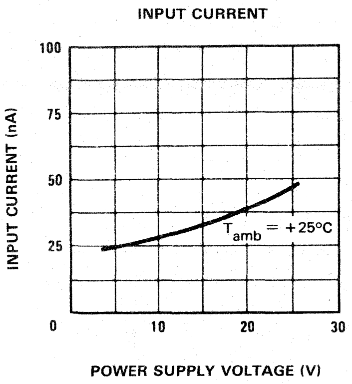


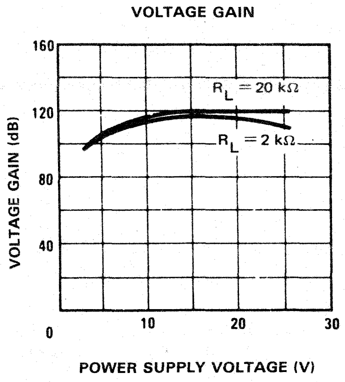
VOLTAGE FOLLOWER PULSE RESPONSE
(SMALL SIGNAL)



OUTPUT CHARACTERISTICS
(CURRENT SOURCING)

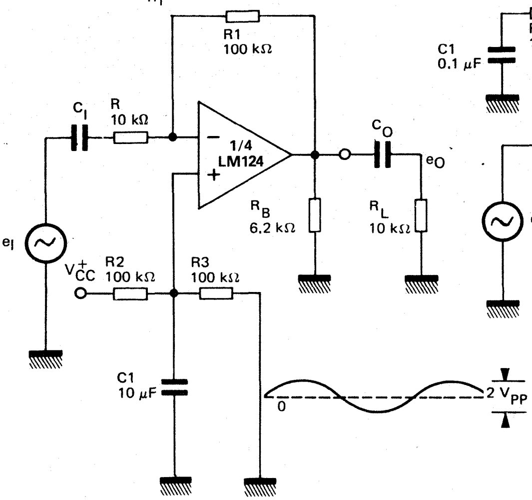



INPUT CURRENT
100
75
50
25
0
INPUT CURRENT (nA)
T_{amb} = +25°C
10
20
30
POWER SUPPLY VOLTAGE (V)


VOLTAGE GAIN
160
120
80
40
0
VOLTAGE GAIN (dB)
R_L = 20 kΩ
R_L = 2 kΩ
10
20
30
POWER SUPPLY VOLTAGE (V)

TYPICAL SINGLE - SUPPLY APPLICATIONS

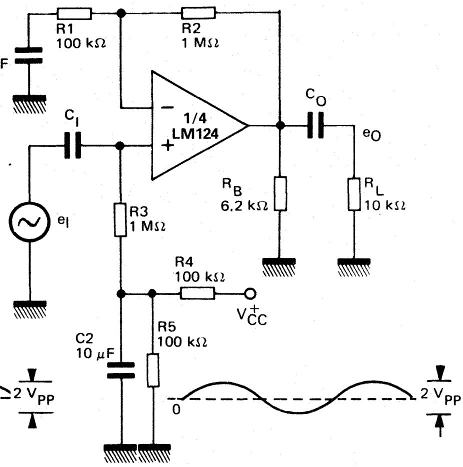
$A_V = \frac{-R}{R_1}$ (As shown $A_V = -10$)



AC COUPLED INVERTING AMPLIFIER

$A_V = 1 + \frac{R2}{R1}$

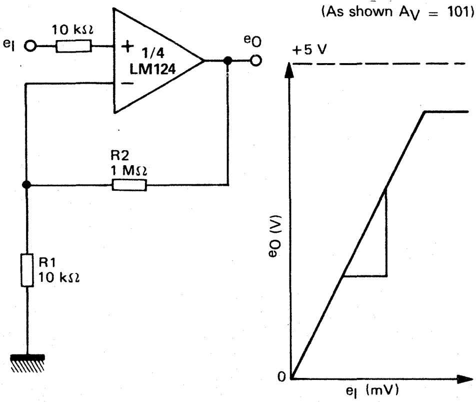
(As shown $A_V = 11$)



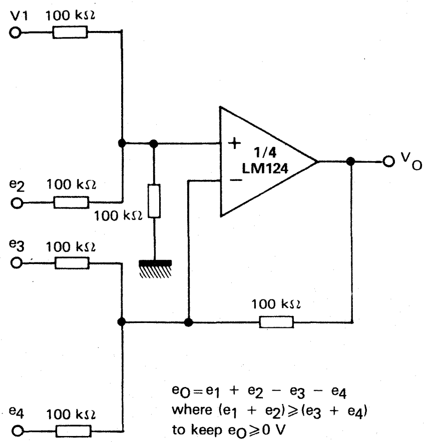
AC COUPLED NON-INVERTING AMPLIFIER

$A_V = 1 + \frac{R_2}{R_1}$

(As shown $A_V = 101$)



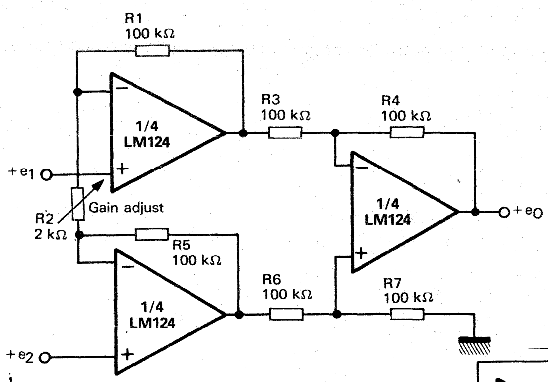
NON-INVERTING DC GAIN



DC SUMMING AMPLIFIER

TYPICAL SINGLE SUPPLY APPLICATIONS (continued)

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER

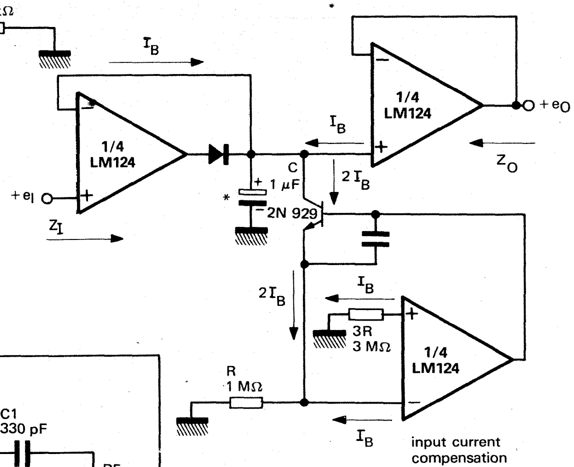


If $R_1 = R_5$ and $R_3 = R_4 = R_6 = R_7$

$$e_O = \left(1 + \frac{2R_1}{R_2}\right)(e_2 - e_1)$$

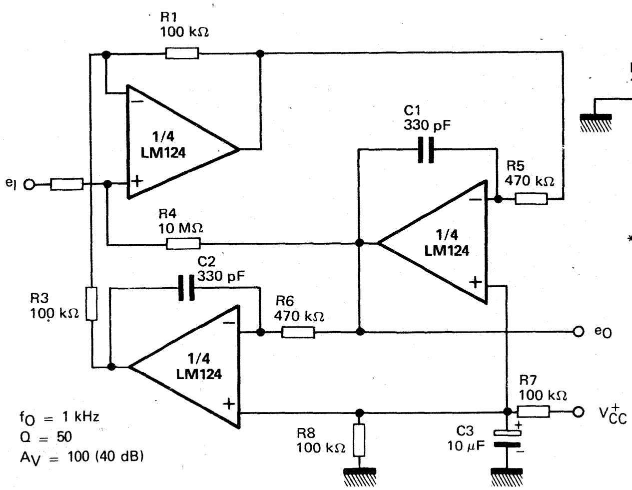
As shown $e_O = 101\ (e_2 - e_1)$

LOW DRIFT PEAK DETECTOR



* Polycarbonate or polyethylene

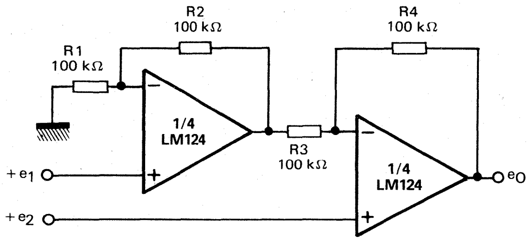
ACTIVE BANDPASS FILTER



f_O = 1 kHz
Q = 50
A_V = 100 (40 dB)

TYPICAL SINGLE - SUPPLY APPLICATIONS (continued)

HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER

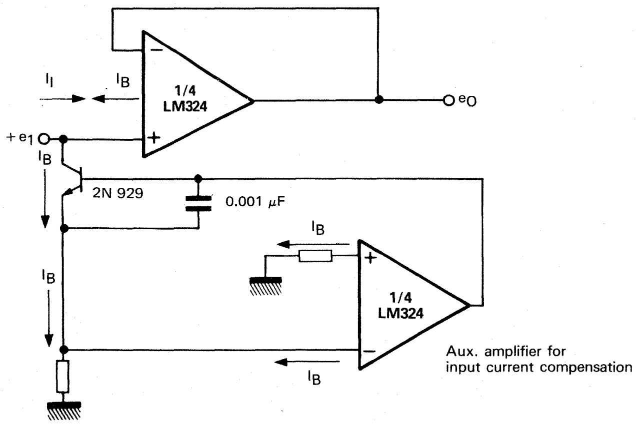


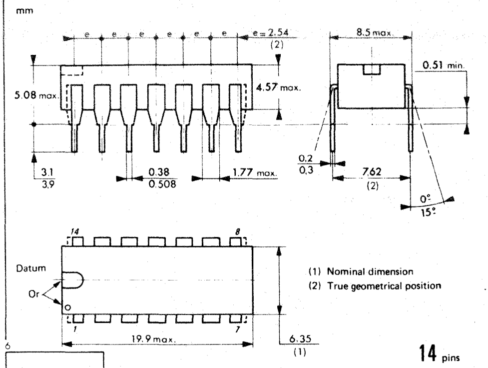
For $\frac{R_1}{R_2} = \frac{R_4}{R_3}$ (CMRR depends on this resistor ratio match)

$$e_O = \left(1 + \frac{R_4}{R_3}\right)(e_2 - e_1)$$

As shown $e_O = 2\,(e_2 - e_1)$

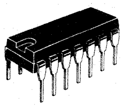
USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



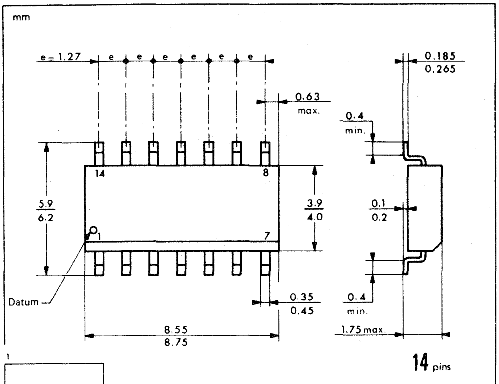


DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

CB-2

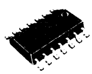


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



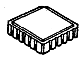
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS

CB-511

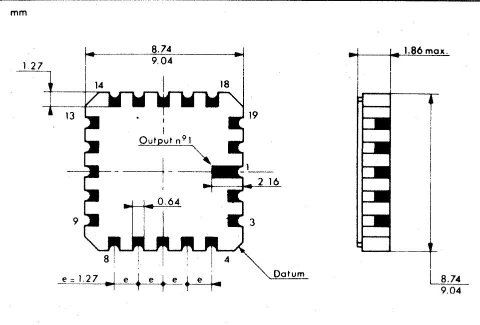


FP SUFFIX
PLASTIC MICROPACKAGE

CB-705



GC SUFFIX
TRICECOP (LCC)



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM146
LM246
LM346

PROGRAMMABLE QUAD OPERATIONAL AMPLIFIERS

The LM346 consists of four independent, high gain, internally compensated, low power programmable amplifiers. Two external resistors (R_{set}) allow the user to program the gain-bandwith product, slew rate, supply current, input bias current, input offset current and input noise. For example the user can trade-off supply current for bandwidth or optimize noise figure for a given source resistance. In a similar way other amplifier characteristics can be tailored to the application.

Except for the two programming pins at the end of the package the LM346 pin out is the same as the LM324 and LM348.

PROGRAMMING EQUATIONS :
Total supply current = 1.4 mA (I_{set} = 10 μA)
Gain-bandwith product = 1 MHz (I_{set} = 10 μA)
Slew rate = 0.4 V/μs (I_{set} = 10 μA)
Input bias current ≃ 50 nA (I_{set} = 10 μA)
I_{set} = current into pin 8 and pin 9 (see schematic diagram)

$$I_{set} = \frac{V_{CC}^{+} - V_{CC}^{-} - 0.6V}{R_{set}}$$

- Programmable electrical characteristics.
- Battery powered operation.
- Low supply current (350 μA/amplifier).
- Gain-bandwidth product : 1 MHz.
- Large dc voltage gain : 120 dB.
- Low noise voltage : 28 nV/√Hz.
- Wide power supply range : ±1.5 V to ±22 V.
- Classe AB output stage. No cross-over distortion.
- Overload protection for inputs and outputs.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

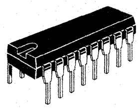
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	GC
LM146	−55°C to +125°C		•		•
LM246	−25°C to + 85°C	•	•		
LM346	0°C to + 70°C	•	•	•	

Examples : LM146DG, LM246DP

PROGRAMMABLE QUAD OPERATIONAL AMPLIFIERS

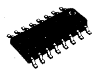
CASES

CB-79



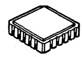
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-359



FP SUFFIX
PLASTIC
MICROPACKAGE

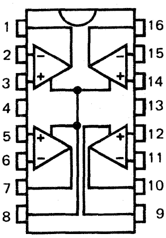
CB-705



GC SUFFIX
TRICECOP (LCC)

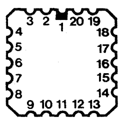
PIN ASSIGNMENTS
(Top views)

CB-79 and CB-359



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Set
9 - Set
10 - Output 3
11 - Inverting input 3
12 - Non-inverting input 3
13 - V_{CC}^{-}
14 - Non-inverting input 4
15 - Inverting input 4
16 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - V_{CC}^{+}
6 - NC
7 - Non-inverting input 2
8 - Inverting input 2
9 - Output 2
10 - Set 1, 2, 4
11 - NC
12 - Set 3
13 - Output 3
14 - Inverting input 3
15 - Non-inverting input 3
16 - NC
17 - V_{CC}^{-}
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00220

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

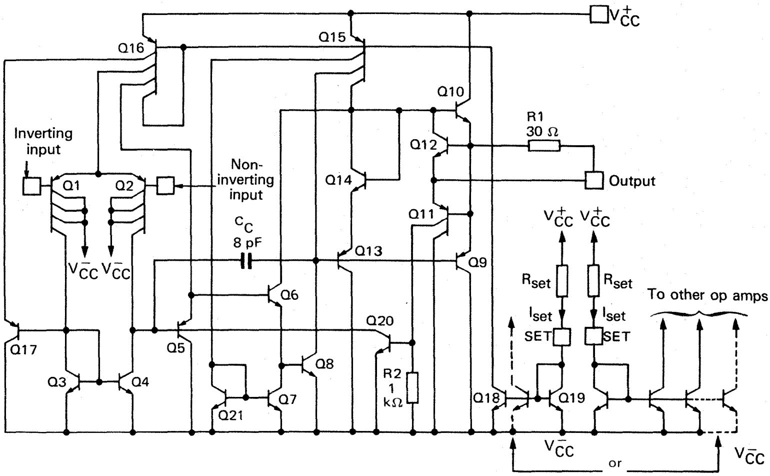
MAXIMUM RATINGS

Rating	Symbol	LM146	LM246	LM346	Unit
Supply voltage	V_{CC}	±22	±18	±18	V
Input voltage (Note 1)	V_I	±15	±15	±15	V
Differential input voltage	V_{ID}	±30	±30	±30	V
Output short-circuit duration (Note 2)	–	Indefinite	Indefinite	Indefinite	–
Power dissipation GC suffix DG suffix	P_{tot}	– 665 900	500 – –	500 – 900	mW
Operating free-air temperature range	T_{oper}	–55 to +125	–25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	–65 to +150	–65 to +150	–65 to +150	°C

Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

Note 2 : Any of the amplifier outputs can be shorted to ground indefinitly ; however more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

SCHEMATIC DIAGRAM (1/4 LM146)



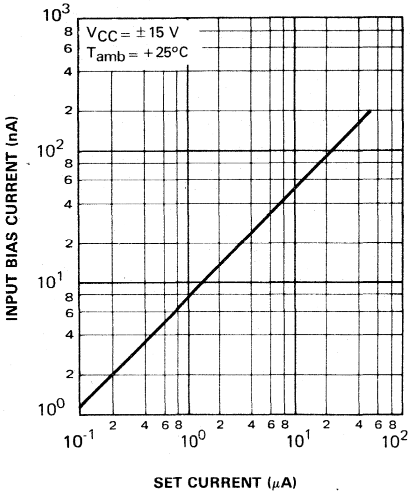
CASE	Inverting inputs	Non-inverting inputs	V_{CC}^-	V_{CC}^+	Outputs	SET	N.C.
CB-79/CB-359	3, 5, 12, 14	2, 6, 11, 15	13	4	1, 7, 10, 16	8, 9	–
CB-705	3, 8, 14, 19	4, 7, 15, 18	17	5	2, 9, 13, 20	10, 12	*

* **CB-705 :** Other pins are not connected.

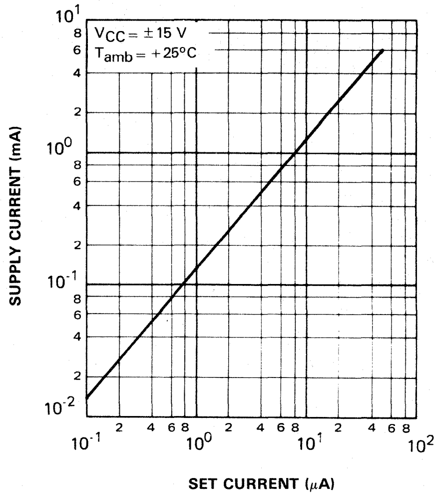
ELECTRICAL CHARACTERISTICS
LM146 : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V, $I_{set} = 10\mu A$
LM246 : $-\ \ 0°C \leq T_{amb} \leq +\ \ 70°C$, $V_{CC} = \pm 15$ V, $I_{set} = 10\mu A$
LM346 : $-25°C \leq T_{amb} \leq +\ \ 85°C$, $V_{CC} = \pm 15$ V, $I_{set} = 10\mu A$
(Unless otherwise specified)

Characteristic	Symbol	LM146			LM246, LM346			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leq 50\ \Omega$)	V_{IO}							mV
$T_{amb} = +25°C$		–	0.5	5	–	0.5	6	
$T_{min} \leq T_{amb} \leq T_{max}$		–	0.5	6	–	0.5	7.5	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	2	20	–	2	100	
$T_{min} \leq T_{amb} \leq T_{max}$		–	2	25	–	2	100	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	50	100	–	50	250	
$T_{min} \leq T_{amb} \leq T_{max}$		–	50	100	–	50	250	
Large signal voltage gain ($\Delta V_O = \pm 10$ V, $R_L = 10\ k\Omega$)	A_{VD}							V/mV
$T_{amb} = +25°C$		100	1000	–	50	1000	–	
$T_{min} \leq T_{amb} \leq T_{max}$		50	1000	–	25	1000	–	
Supply voltage rejection ratio	SVR							dB
$R_S \leq 10\ k\Omega$, $T_{amb} = +25°C$		80	100	–	74	100	–	
$R_S \leq 50\ \Omega$, $T_{min} \leq T_{amb} \leq T_{max}$		76	100	–	74	100	–	
Supply current	I_{CC}							mA
$T_{amb} = +25°C$		–	1.4	2	–	1.4	2.5	
$T_{min} \leq T_{amb} \leq T_{max}$		–	1.5	2	–	1.5	2.5	
Input voltage range	V_I							V
$T_{amb} = +25°C$		±13.5	±14	–	±13.5	±14	–	
$T_{min} \leq T_{amb} \leq T_{max}$		±13.5	±14	–	±13.5	±14	–	
Common-mode rejection ratio	CMR							dB
$R_S \leq 10\ k\Omega$, $T_{amb} = +25°C$		80	100	–	70	100	–	
$R_S \leq 50\ \Omega$, $T_{min} \leq T_{amb} \leq T_{max}$		70	100	–	70	100	–	
Output short-circuit current ($T_{amb} = +25°C$)	I_{OS}	5	20	30	5	20	30	mA
Output voltage swing ($R_L \geq 10\ k\Omega$)	V_{OPP}							V
$T_{amb} = +25°C$		±12	±14	–	±12	±14	–	
$T_{min} \leq T_{amb} \leq T_{max}$		±12	±14	–	±12	±14	–	
Gain-bandwidth product ($T_{amb} = +25°C$)	GBp	0.8	1.2	–	0.5	1.2	–	MHz
Slew rate ($T_{amb} = +25°C$)	S_{VO}	–	0.4	–	–	0.4	–	V/µs
Equivalent input noise voltage (f = 1 kHz, $T_{amb} = +25°C$)	V_n	–	28	–	–	28	–	$nV/\sqrt{Hz}$
Input resistance ($T_{amb} = +25°C$)	R_I	–	1	–	–	1	–	MΩ
Input capacitance ($T_{amb} = +25°C$)	C_I	–	2	–	–	2	–	pF
Channel separation ($\Delta V_O = 0V$ to $+12$ V, $R_L \geq 10\ k\Omega$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	dB
Phase margin ($C_L = 100$ pF, $T_{amb} = +25°C$)	φM	–	60	–	–	60	–	Degree

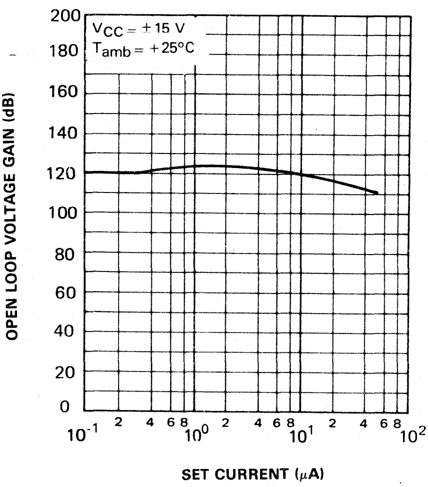
INPUT BIAS CURRENT vs I_{set}



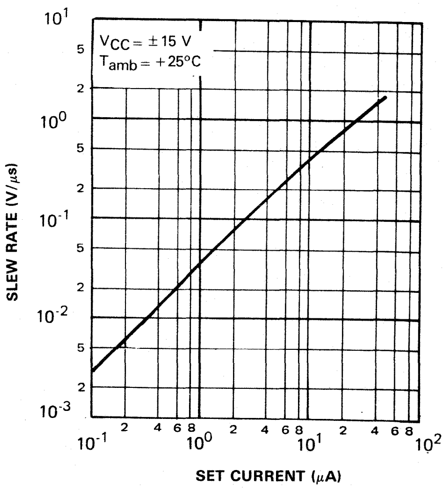
SUPPLY CURRENT vs I_{set}



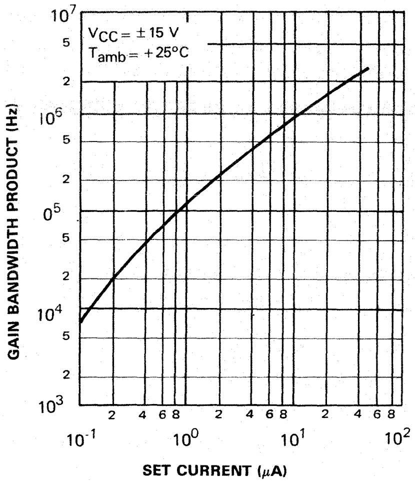
OPEN LOOP VOLTAGE GAIN vs I_{set}



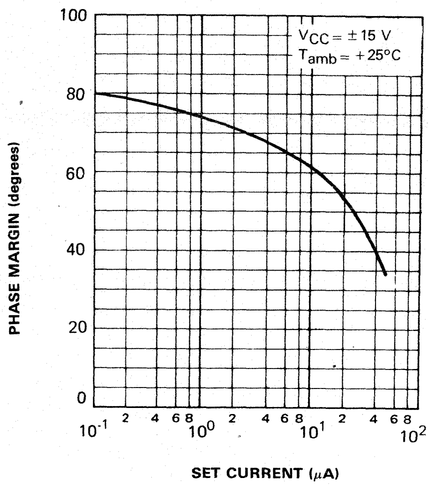
SLEW RATE vs I_{set}



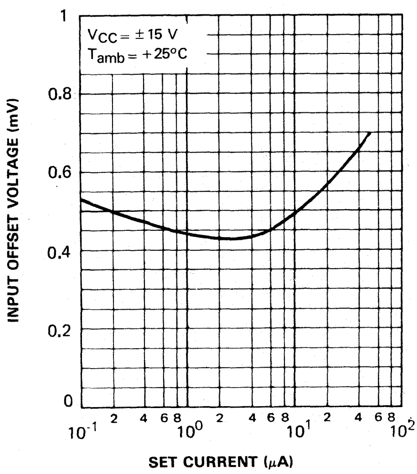
GAIN BANDWIDTH PRODUCT vs I_{set}



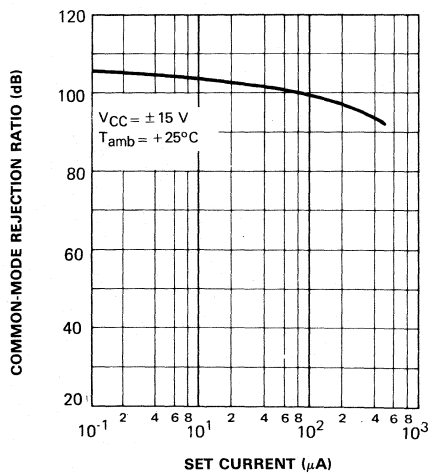
PHASE MARGIN vs I_{set}



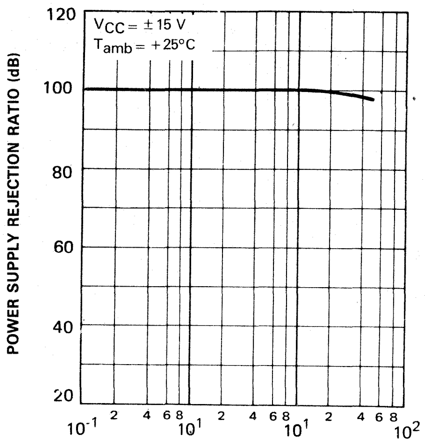
INPUT OFFSET VOLTAGE vs I_{set}



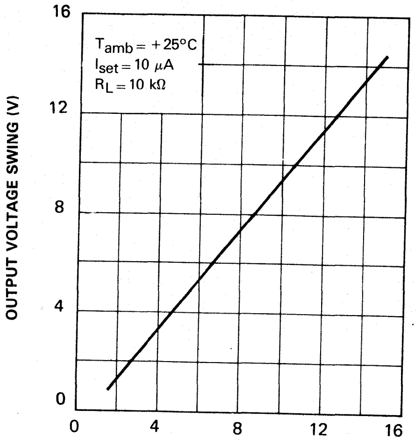
COMMON-MODE REJECTION RATIO vs I_{set}



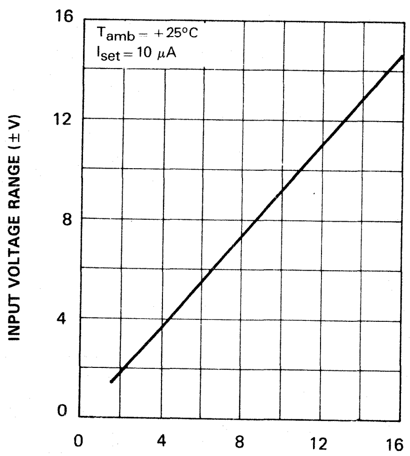
POWER SUPPLY REJECTION RATIO vs I_{set}



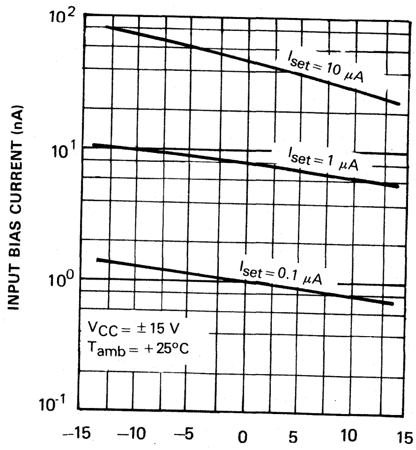
OUTPUT VOLTAGE SWING



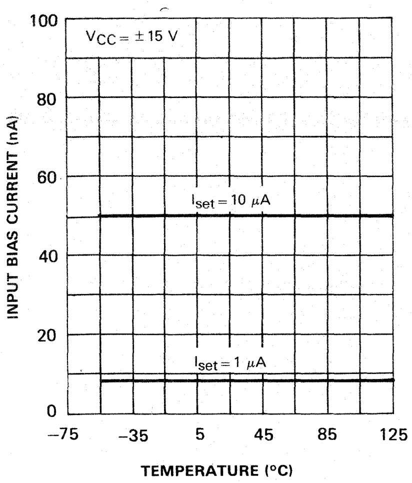
INPUT VOLTAGE RANGE



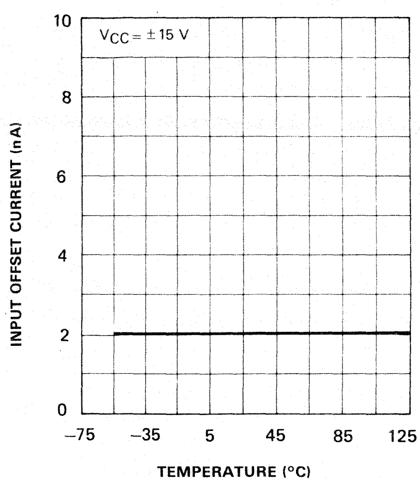
INPUT BIAS CURRENT



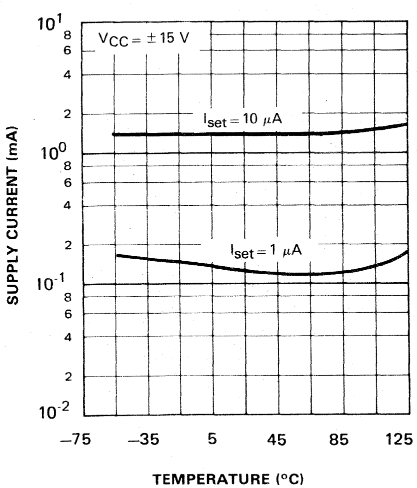
INPUT BIAS CURRENT vs TEMPERATURE



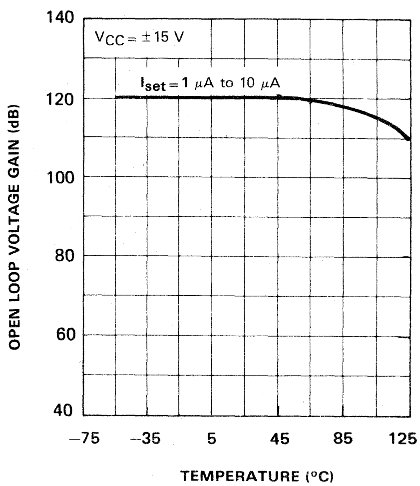
INPUT OFFSET CURRENT vs TEMPERATURE



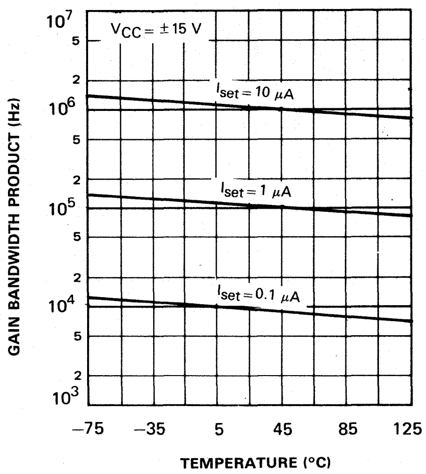
SUPPLY CURRENT vs TEMPERATURE



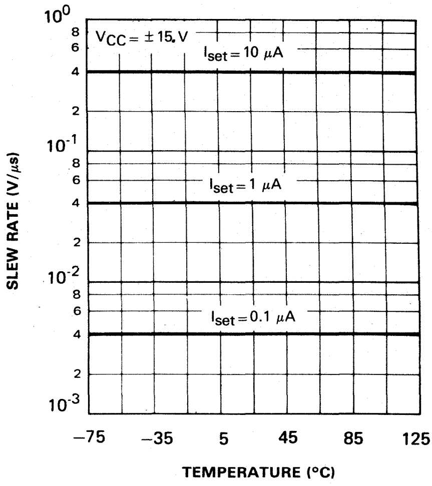
OPEN LOOP VOLTAGE GAIN vs TEMPERATURE



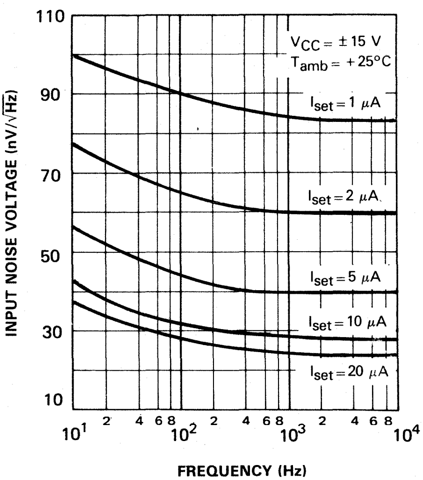
GAIN BANDWIDTH PRODUCT vs TEMPERATURE



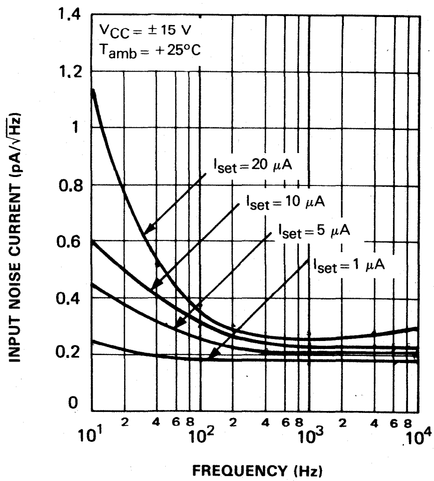
SLEW RATE vs TEMPERATURE



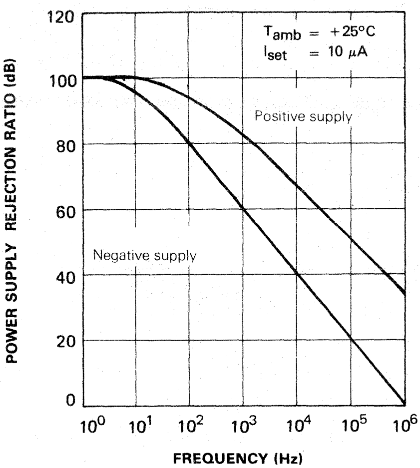
INPUT NOISE VOLTAGE vs FREQUENCY



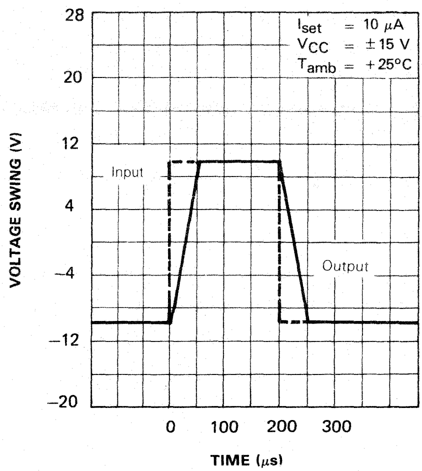
INPUT NOISE CURRENT vs FREQUENCY



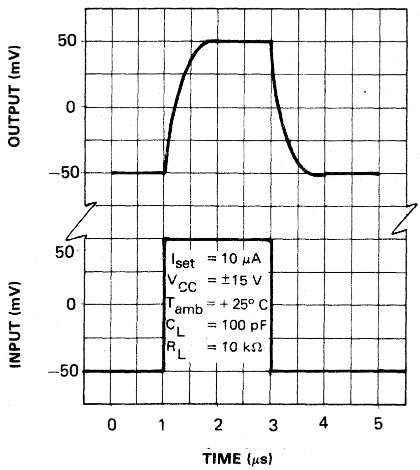
POWER SUPPLY REJECTION RATIO



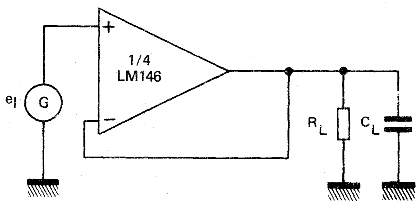
VOLTAGE FOLLOWER PULSE RESPONSE

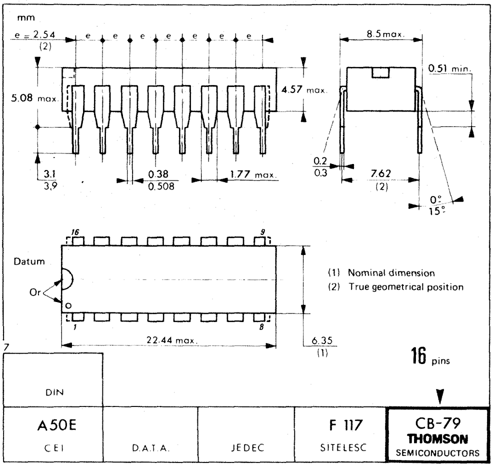


VOLTAGE FOLLOWER TRANSIENT RESPONSE

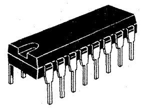


TRANSIENT RESPONSE TEST CIRCUIT

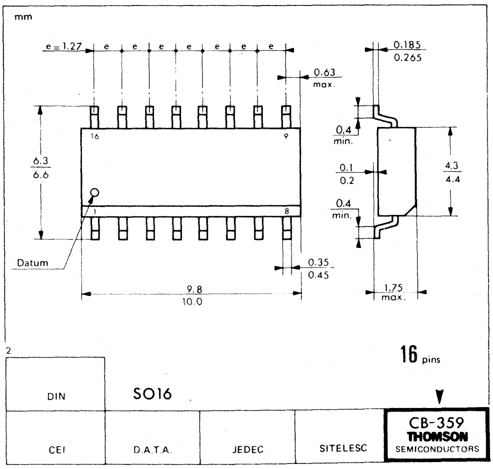




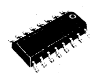
CB-79



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

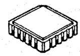


CB-359

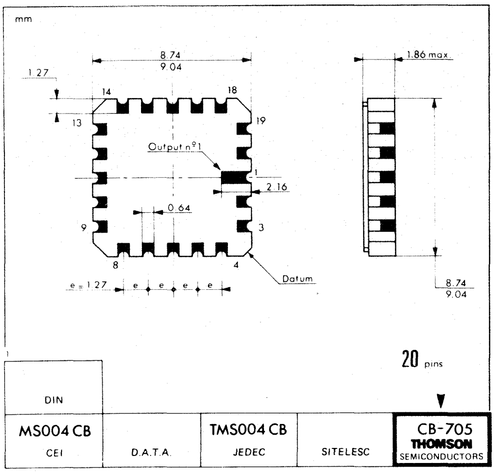


FP SUFFIX
PLASTIC MICROPACKAGE

CB-705



GC SUFFIX
TRICECOP (LCC)



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

LM148/248/348
LM149/249/349

DIFFERENTIAL INPUT QUAD OP-AMPs

The LM148 consists of four independent, high gain internally compensated, low power operational amplifiers which have been designed to provide functional characteristics identical to those of the familiar UA741 operational amplifier. In addition the total supply current for all four amplifiers is comparable to the supply current of a single UA741 type op amp. Other features include input offset currents and input bias current which are much less than those of a standard UA741. Also, excellent isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling.

The LM149 series has the same features as the LM148 plus a gain bandwidth product of 4 MHz at a gain of 5 or greater.

The LM148 can be used anywhere multiple UA741 type amplifiers are being used and in applications where amplifier matching or high packing density is required.

- Low supply current : 0.6 mA/amplifier.
- Class AB output stage : no crossover distortion.
- Pin compatible with LM124.
- Low input offset voltage : 1 mV.
- Low input offset current : 4 nA.
- Low input bias current : 30 nA.
- Gain bandwidth product : 1 MHz.
- High degree of isolation between amplifiers : 120 dB.
- Overload protection for inputs and outputs.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

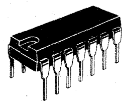
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	GC	FP
LM148	−55°C to +125°C		•	•	
LM248	−25°C to + 85°C	•		•	
LM348	0°C to 70°C	•	•		•
LM149	−55°C to +125°C		•	•	
LM249	−25°C to + 85°C	•		•	
LM349	0°C to + 70°C	•	•		•

Examples : LM148DG, LM349FP

DIFFERENTIAL INPUT QUAD OPERATIONAL AMPLIFIERS

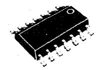
CASES

CB-2 (TO-116)



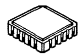
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

CB-705

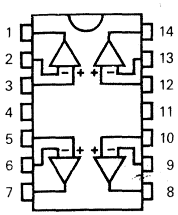


GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS

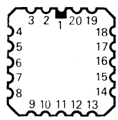
(Top views)

CB-2 CB-511



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00245

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 - Telex : 204780 F

THOMSON COMPONENTS

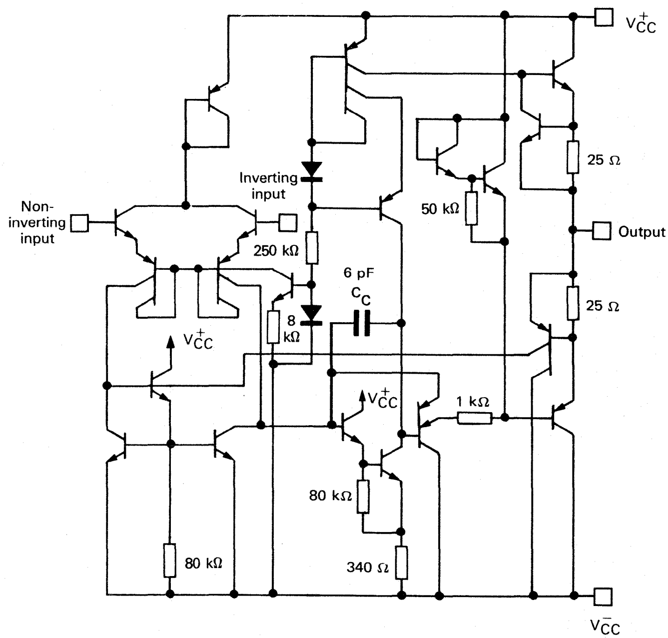
MAXIMUM RATINGS

Rating	Symbol	LM148, LM149	LM248, LM249	LM348, LM349	Unit
Supply voltage	V_{CC}	±22	±18	±18	V
Differential input voltage	V_{ID}	±44	±36	±36	V
Input voltage	V_I	±22	±18	±18	V
Power dissipation (Note 1)	P_{tot}	500	500	500	mW
Output short-circuit duration (Note 2)	–	Indefinite	Indefinite	Indefinite	–
Operating free-air temperature range	T_{oper}	–55 to +125	–25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	–65 to +150	–55 to +150	–55 to +150	°C

Note 1 : For supply voltage less than maximum value, the absolute maximum input voltage is equal to the supply voltage.

Note 2 : Any of the amplifier outputs can be shorted to ground indefinitely ; however, more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

SCHEMATIC DIAGRAM



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^+	V_{CC}^-	N.C.
CB-2, CB-511	1, 7, 8, 14	2, 6, 9, 13	3, 5, 10, 12	4	11	–
CB-705	1, 2, 12, 20	3, 9, 13, 19	4, 8, 14, 18	6	16	*

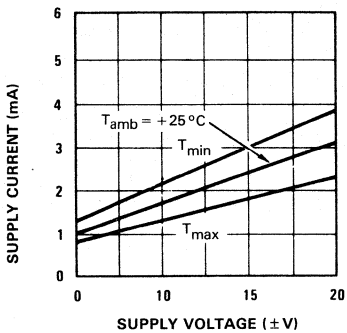
• **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

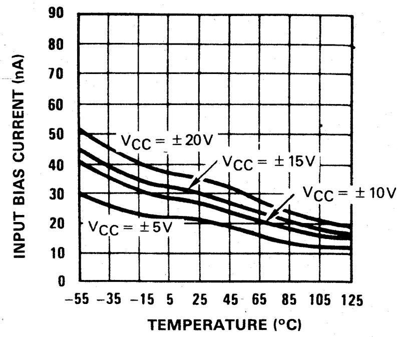
LM148/LM149 : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
LM348/LM349 : $0°C \leqslant T_{amb} \leqslant +70°C$, $V_{CC} = \pm 15$ V
LM248/LM249 : $-25°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

Characteristic	Symbol	LM148 - LM149			LM248 - LM249 LM348 - LM349			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}							mV
$T_{amb} = +25°C$		–	1	5	–	1	6	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	6	–	–	7.5	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	4	25	–	4	50	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	75	–	–	100	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	30	100	–	30	200	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	325	–	–	400	
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geqslant 2$ kΩ)	A_{VD}							V/mW
$T_{amb} = +25°C$		50	160	–	25	160	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		25	–	–	15	–	–	
Supply current (4 amplifiers) - ($T_{amb} = +25°C$)	I_{CC}	–	2.4	3.6	–	2.4	4.5	mA
Input voltage range	V_I	± 12	–	–	± 12	–	–	V
Short-circuit output current	I_{OS}	–	25	–	–	25	–	mA
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	77	96	–	77	96	–	dB
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Input resistance ($T_{amb} = +25°C$)	R_I	0.8	2.5	–	0.8	2.5	–	MΩ
Output voltage swing	V_{OPP}							V
$R_L = 2$ kΩ		± 10	± 12	–	± 10	± 12	–	
$R_L = 10$ kΩ		± 12	± 13	–	± 12	± 13	–	
Slew rate ($T_{amb} = +25°C$)	S_{VO}							V/µs
$A_V = 1$ LM148		–	0.5	–	–	0.5	–	
$A_V = 5$ LM149		–	2	–	–	2	–	
Chanel separation (1 Hz ≤ f ≤ 20 kHz, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	– 120	–	–	– 120	–	dB
Gain-bandwidth product ($T_{amb} = +25°C$)	GBp							MHz
$A_V = 1$ LM148		–	1	–	–	1	–	
$A_V = 5$ LM149		–	4	–	–	4	–	
Phase margin ($T_{amb} = +25°C$)	φ_M							Degrees
$A_V = 1$ LM148		–	60	–	–	60	–	
$A_V = 5$ LM149		–	60	–	–	60	–	

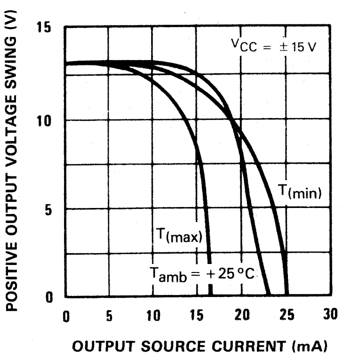
SUPPLY CURRENT



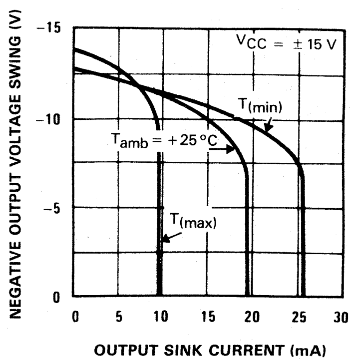
INPUT BIAS CURRENT



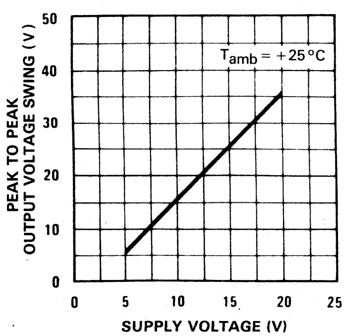
POSITIVE CURRENT LIMIT



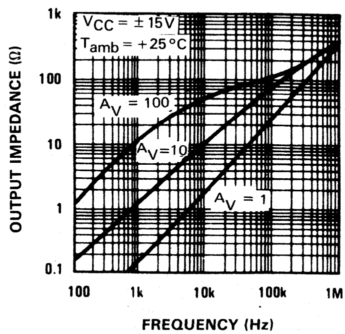
NEGATIVE CURRENT LIMIT



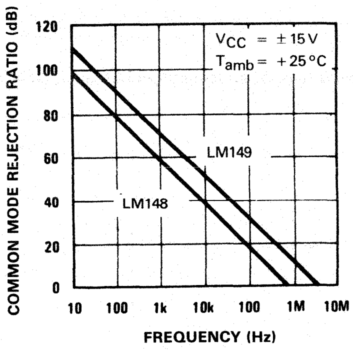
OUTPUT VOLTAGE SWING



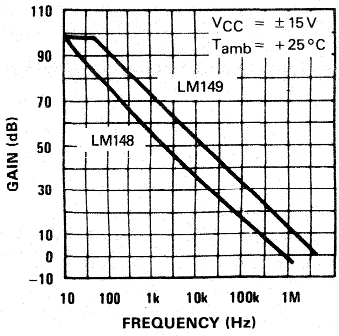
OUTPUT IMPEDANCE



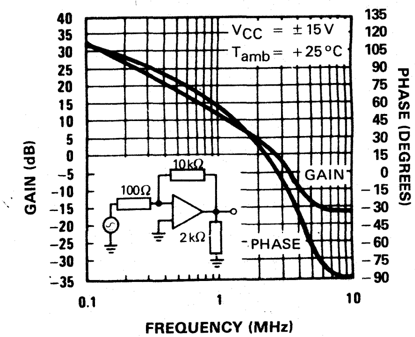
COMMON-MODE REJECTION RATIO



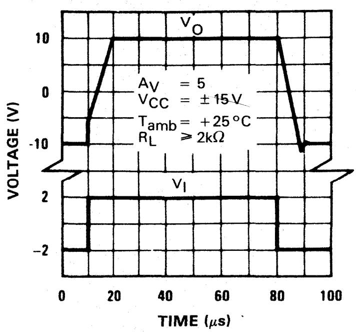
OPEN LOOP FREQUENCY RESPONSE



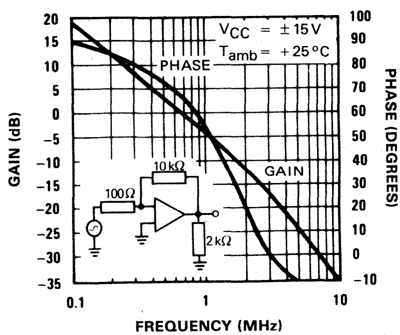
BODE PLOT (LM149)



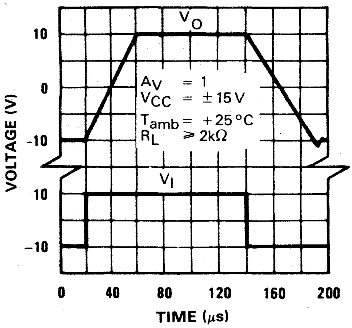
LARGE SIGNAL PULSE RESPONSE (LM149)



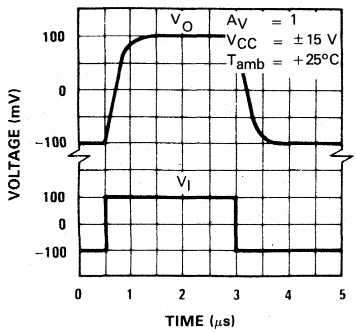
BODE PLOT (LM148)



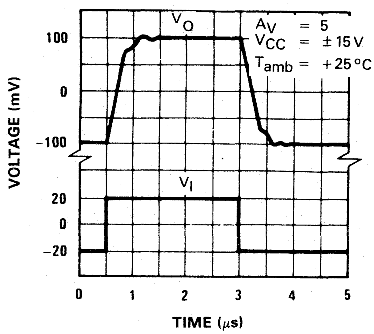
LARGE SIGNAL PULSE RESPONSE (LM148)



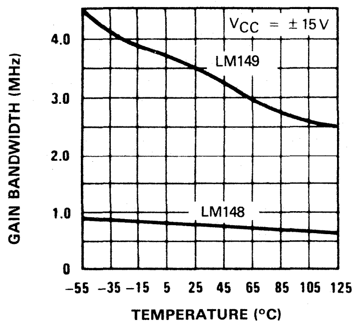
SMALL SIGNAL PULSE RESPONSE (LM148)



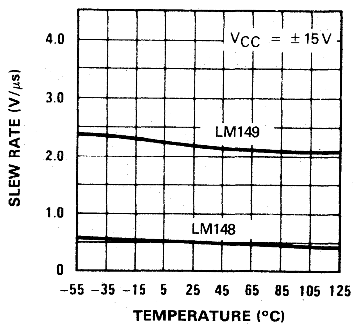
SMALL SIGNAL PULSE RESPONSE (LM149)



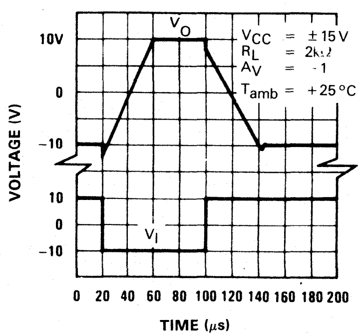
GAIN BANDWIDTH



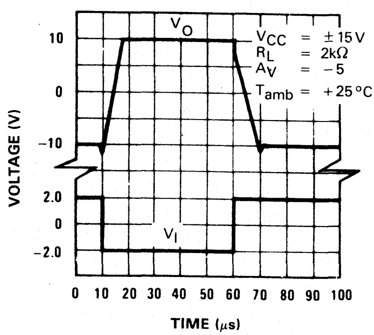
SLEW RATE



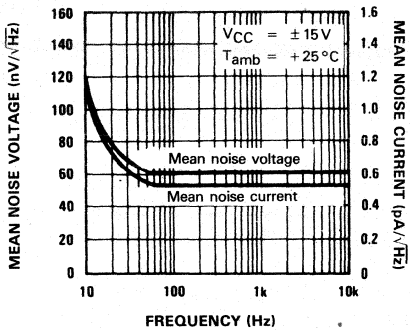
INVERTING LARGE SIGNAL PULSE RESPONSE (LM148)



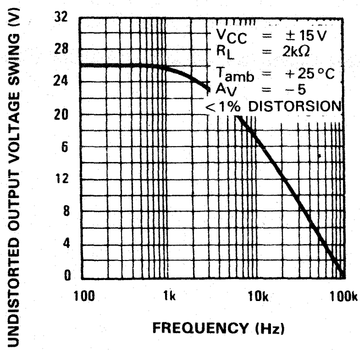
INVERTING LARGE SIGNAL PULSE RESPONSE (LM149)



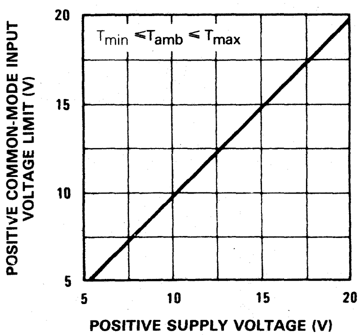
INPUT NOISE VOLTAGE AND NOISE CURRENT



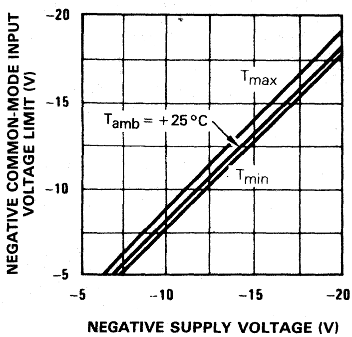
UNDISTORTED OUTPUT VOLTAGE SWING



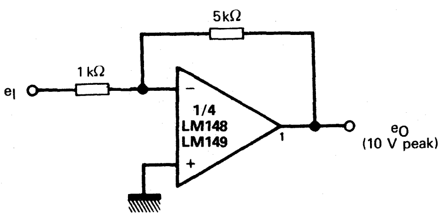
POSITIVE COMMON-MODE INPUT VOLTAGE LIMIT

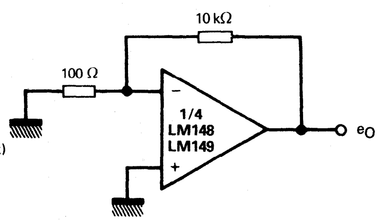


NEGATIVE COMMON-MODE INPUT VOLTAGE LIMIT



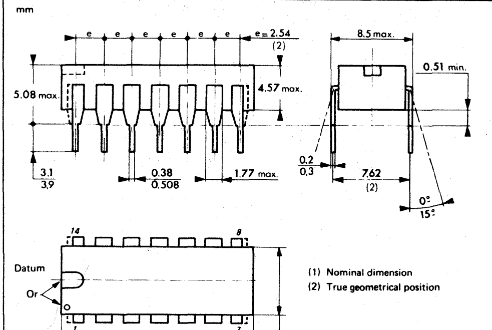
TEST CIRCUITS



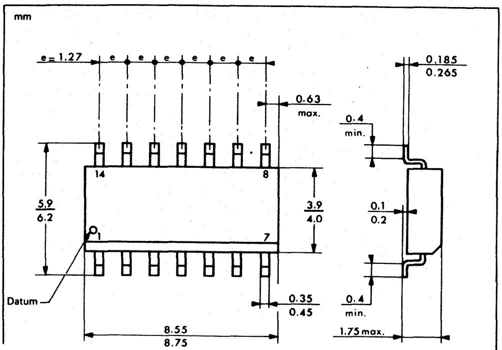


$$\text{Crosstalk} = -20 \log \frac{e_O}{101 \times e_O} \text{ (dB)}$$

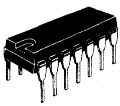
$V_{CC} = \pm 15$ V



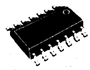
DIN		▼		
A50B	TO-116	TO-116	F 105	CB-2
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS



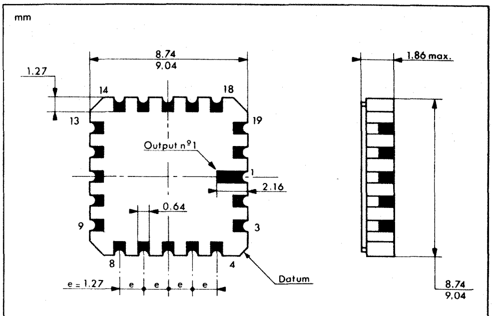
DIN	SO14			▼
				CB-511
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS



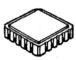
CB-2
(TO-116)
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				▼
MS004 CB		TMS004 CB		CB-705
CEI	D.A.T.A.	JEDEC	SITELESC	THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM158 LM258 LM358 LM2904

LOW POWER DUAL OPERATIONAL AMPLIFIERS

These circuits consist of two independent, high gain, internally frequency compensated which were designed specifically to operate from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, these circuits can be directly operated off the standard +5 V power supply voltage which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The gain-bandwidth product is temperature compensated.

The input bias current is temperature compensated.

- Internally frequency compensated.
- Large dc voltage gain : 100 dB.
- Wide bandwidth (unity gain) : 1 MHz (temperature compensated).
- Very low supply current drain (500 µA) — essentially independent of supply voltage (1 mW/op-amp at +5 V).
- Low input bias current : 45 nA (temperature compensated).
- Low input offset voltage : 2 mV.
- Low input offset current : 5 nA.
- Input common-mode voltage range includes ground.
- Differential input voltage range equal to the power supply voltage.
- Large output voltage swing 0 V to (V_{CC} − 1,5 V).

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

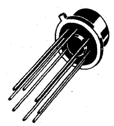
PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DP	DG	GC	FP
LM158	− 55°C to + 125°C	•		•	•	
LM258	− 25°C to + 85°C	•	•	•		
LM358	0°C to + 70°C	•	•	•		•
LM2904	− 40°C to + 85°C		•			•

Example : LM158H, LM258DP, LM2904FP

LOW POWER DUAL OPERATIONAL AMPLIFIERS

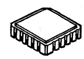
CASES

CB-11 (TO-99)



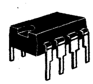
H SUFFIX METAL CAN

CB-705



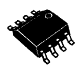
GC SUFFIX TRICECOP (LCC)

CB-98



DP SUFFIX PLASTIC PACKAGE
DG SUFFIX CERDIP PACKAGE

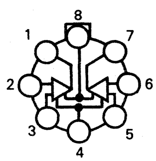
CB-342



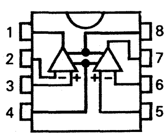
FP SUFFIX PLASTIC MICROPACKAGE

PIN ASSIGNMENTS
(Top views)

CB-11

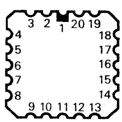


CB-98 CB-342



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - Ground
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}

CB-705



1 - NC
2 - Output 1
3 - NC
4 - NC
5 - Inverting input 1
6 - NC
7 - Non-inverting input 1
8 - NC
9 - NC
10 - Ground
11 - NC
12 - Non-inverting input 2
13 - NC
14 - NC
15 - Inverting input 2
16 - NC
17 - Output 2
18 - NC
19 - NC
20 - V_{CC}

Réf. 00210

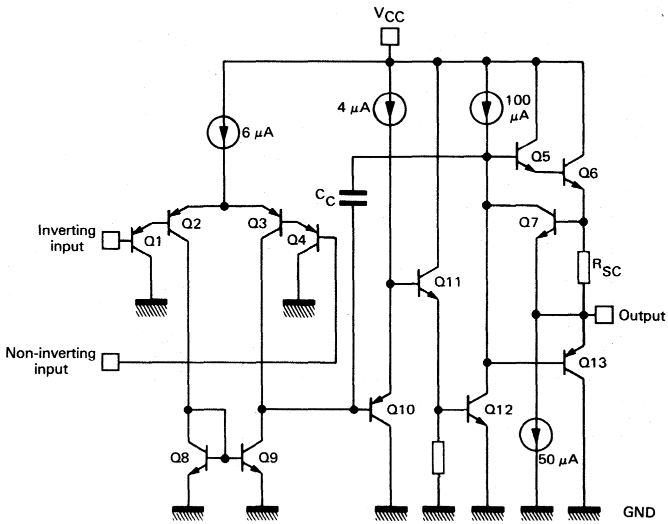
THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	LM158	LM258	LM358 LM2904	Unit
Supply voltage LM2904	V_{CC}	+32 —	+32 —	+32 +26	V
Input voltage LM2904	V_I	−0.3 to +32 —	−0.3 to +32 —	−0.3 to +32 −0.3 to +26	V
Differential input voltage LM2904	V_{ID}	+32 —	+32 —	+32 +26	V
Output short-circuit duration (Note 2)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation LM158GC	P_{tot}	500 665	500 —	500 —	mW
Input current (Note 1)	I_{ID}	50	50	50	mA
Operating free-air temperature range LM2904	T_{oper}	−55 to +125 —	−25 to +85 —	0 to +70 −40 to +85	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C

SCHEMATIC DIAGRAM



- Single supply 3 V to 30 V
- Dual supplies ±1.5 V to ±15 V

} for LM158, LM258, LM358

- Single supply 3 V to 26 V
- Dual supplies ±1.5 V to ±13 V

} for LM2904

CASE	Inverting inputs	Non-inverting inputs	GND	V_{CC}	Outputs	N.C.
CB-11/CB-98/CB-342	2 - 6	3 - 5	4	8	1 - 7	
CB-705	5 - 15	7 - 12	10	20	2 - 17	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS (Note 3)

LM158 : $-55°C \leqslant T_{amb} \leqslant +125°C$
LM258 : $-25°C \leqslant T_{amb} \leqslant +85°C$
LM358 : $0°C \leqslant T_{amb} \leqslant +70°C$
LM2904 : $-40°C \leqslant T_{amb} \leqslant +85°C$
(Unless otherwise specified)

Characteristic	Symbol	LM158, LM258			LM358, LM2904			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage (Note 4)	V_{IO}							mV
$T_{amb} = +25°C$		–	±2	±5	–	±2	±7	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	±7	–	–	±9	
LM2904		–	–	–	–	–	±10	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	±3	±30	–	±5	±50	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	±100	–	–	±150	
LM2904		–	–	–	–	–	±200	
Input bias current	I_{IB}^{+}, I_{IB}^{-}							nA
$T_{amb} = +25°C$ (Note 5)		–	45	150	–	45	250	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	40	300	–	40	500	
Large signal voltage gain($V_{CC} = +15$ V, $R_L \geqslant 2$ kΩ, $T_{amb} = +25°C$)	A_{VD}	50	100	–	25	100	–	V/mV
LM2904		–	–	–	–	100	–	
Supply voltage rejection ratio ($T_{amb} = +25°C$)	SVR	65	100	–	65	100	–	dB
LM2904		–	–	–	50	100	–	
Supply currents ($R_L = \infty$)	I_{CC}^{+}, I_{CC}^{-}							mA
$T_{amb} = +25°C$, $V_{CC} = +5$ V		–	0.7	1.2	–	0.7	1.2	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $V_{CC} = +30$ V		–	1	2	–	1	2	
$V_{CC} = +26$ V LM2904		–	–	–	–	1	2	
Temperature coefficient of input offset voltage	αV_{IO}	–	7	–	–	7	–	μV/°C
Average temperature coefficient of input offset current	αI_{IO}	–	10	–	–	10	–	pA/°C
Input voltage range	V_I							V
$T_{amb} = +25°C$, $V_{CC} = +30$ V (Note 7)		0	–	V_{CC} −1.5	0	–	V_{CC} −1.5	
$V_{CC} = +26$ V LM2904		0	–	V_{CC} −1.5	0	–	V_{CC} −1.5	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $V_{CC} = +30$ V (Note 7)		0	–	V_{CC} −2	0	–	V_{CC} −2	
$V_{CC} = +26$ V LM2904		0	–	V_{CC} −2	0	–	V_{CC} −2	
Common-mode rejection ratio ($T_{amb} = +25°C$)	CMR	70	85	–	65	70	–	dB
LM2904		–	–	–	50	70	–	
Output short-circuit current ($T_{amb} = +25°C$)-Note 2	I_{OS}	–	40	60	–	40	60	mA
Output current ($V_{CC} = +15$ V, $T_{amb} = +25°C$, $V_I^{+} = +1$ V, $V_I^{-} = 0$ V)	I_O	20	40	–	20	40	–	mA
Output current sink ($T_{amb} = +25°C$, $V_I^{-} = -1$ V, $V_I^{+} = 0$ V)	I_O (sink)							
$V_{CC} = +15$ V		10	20	–	10	20	–	mA
$V_O = +0.2$ V		12	50	–	12	50	–	μA
Output voltage swing ($T_{amb} = +25°C$)	V_{OPP}							V
$R_L = 2$ kΩ		0	–	V_{CC} −1.5	0	–	V_{CC} −1.5	
$R_L \geqslant 10$ kΩ LM2904		0	–	V_{CC} −1.5	0	–	V_{CC} −1.5	
Channel separation 1 kHz $\leqslant f \leqslant$ 20 kHz, $T_{amb} = +25°C$ (Note 6)	V_{O1}/V_{O2}	–	−120	–	–	−120	–	dB

Note 1 : This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative.
This is not destructive and normal output will set up again for input voltage higher than −0.3 V

2 : Short-circuits from the output to V_{CC} can cause excessive heating if $V_{CC} > 15$ V. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.

3 : These specifications apply for $-55°C \leqslant T_{amb} \leqslant +125°C$ for LM158, $-25°C \leqslant T_{amb} \leqslant +85°C$ for LM258 and $-40°C \leqslant T_{amb} \leqslant +85°C$ for LM 2904. $V_{CC} = +5$ V, V_{CC}^{-} = Ground, unless otherwise specified.

Note 4 : $V_O \approx 1.4$ V, $R_S = 0$; 5 V $\leqslant V_{CC} \leqslant$ 30 V, $0 \leqslant V_I \leqslant V_{CC} - 1.5$ V for LM158
$V_O \approx 1.4$ V, $R_S = 0$; 5 V $\leqslant V_{CC} \leqslant$ 26 V, $0 \leqslant V_I \leqslant V_{CC} - 1.5$ V for LM2904

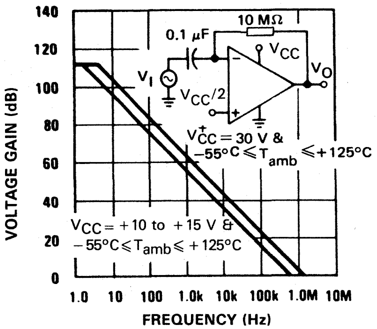
5 : The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

6 : Due to proximity of external components insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequences.

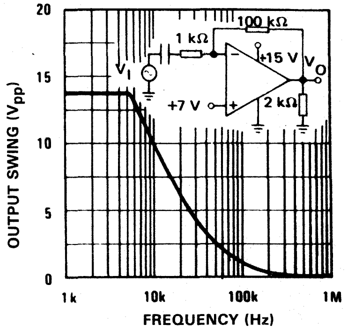
7 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC} - 1.5$ V. But either or both inputs can go to + 32 V without damage. (+ 26 V for LM2904).

8 : These specifications apply for 0°C $\leqslant T_{amb} \leqslant$ + 70°C, V_{CC} = + 5 V unless otherwise specified.

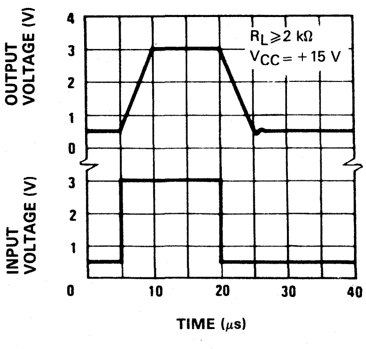
OPEN LOOP FREQUENCY RESPONSE (Note 3)



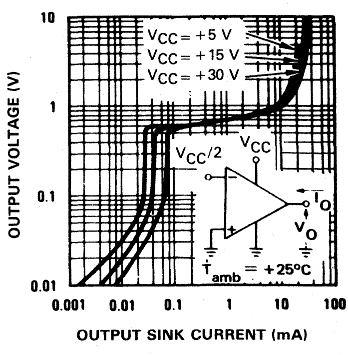
LARGE SIGNAL FREQUENCY RESPONSE



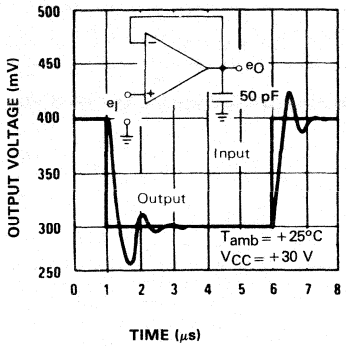
VOLTAGE FOLLOWER PULSE RESPONSE



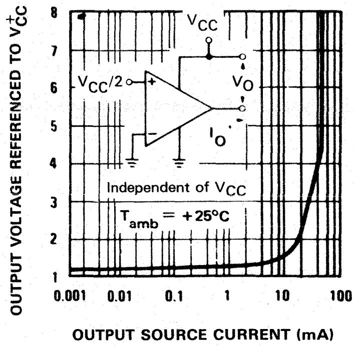
OUTPUT CHARACTERISTICS



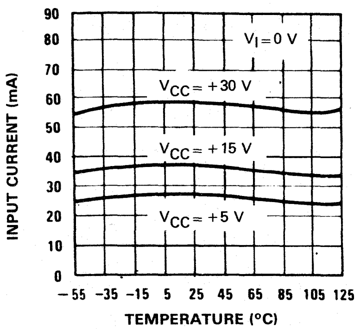
VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



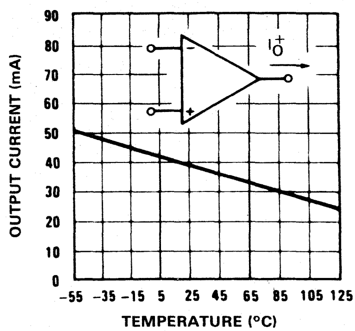
OUTPUT CHARACTERISTICS



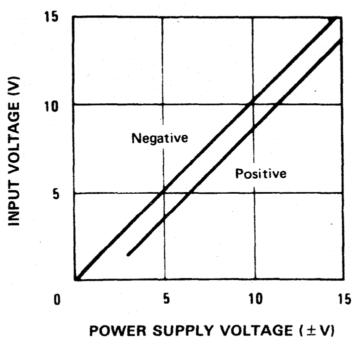
INPUT CURRENT (Note 1)



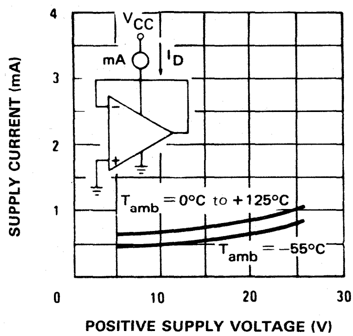
CURRENT LIMITING (Note 1)



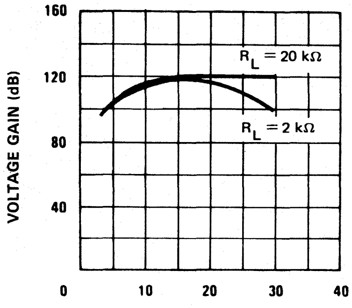
INPUT VOLTAGE RANGE



SUPPLY CURRENT

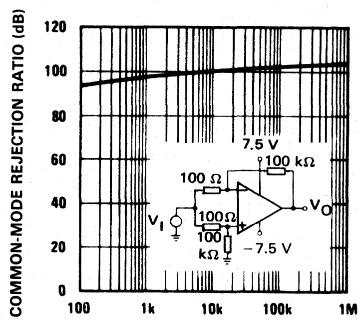


VOLTAGE GAIN



POSITIVE SUPPLY VOLTAGE (V)

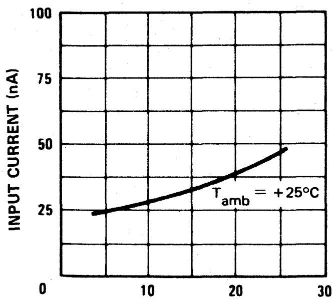
COMMON-MODE REJECTION RATIO



FREQUENCY (Hz)

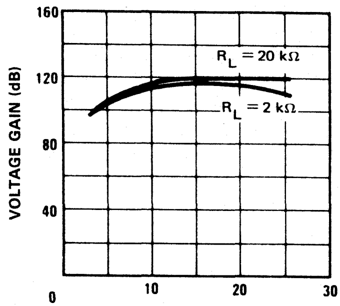
Note 9 : LM158 : $-55°C \leqslant T_{amb} \leqslant +125°C$
LM258 : $-25°C \leqslant T_{amb} \leqslant +85°C$
LM358 : $0°C \leqslant T_{amb} \leqslant +70°C$
LM2904 : $-40°C \leqslant T_{amb} \leqslant +85°C$

INPUT CURRENT



POSITIVE SUPPLY VOLTAGE (V)

VOLTAGE GAIN

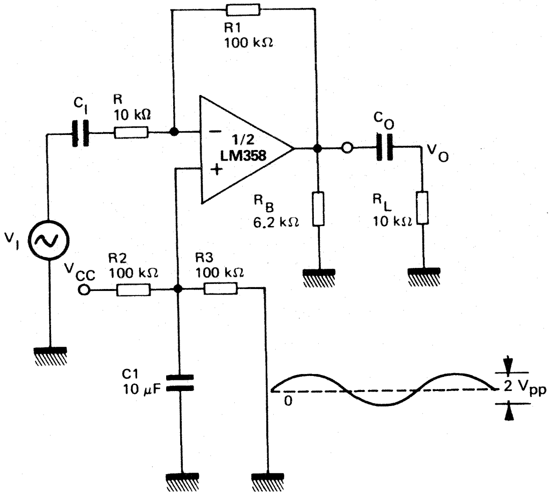


POSITIVE SUPPLY VOLTAGE (V)

TYPICAL APPLICATIONS (SINGLE SUPPLY VOLTAGE) $V_{CC} = +5\ V_{DC}$

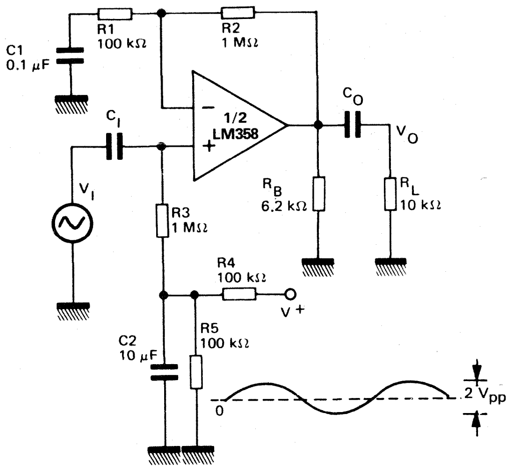
AC COUPLED INVERTING AMPLIFIER

$$A_V = \frac{-R1}{R} \text{ (As shown } A_V = -10)$$



AC COUPLED NON INVERTING AMPLIFIER

$$\text{Gain} = 1 + \frac{R2}{R1} \text{ (As shown, Gain = 11)}$$

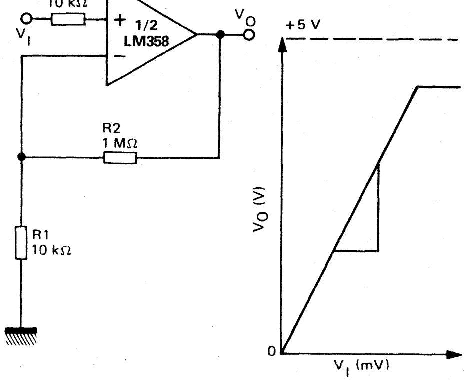


TYPICAL APPLICATIONS (Continued)

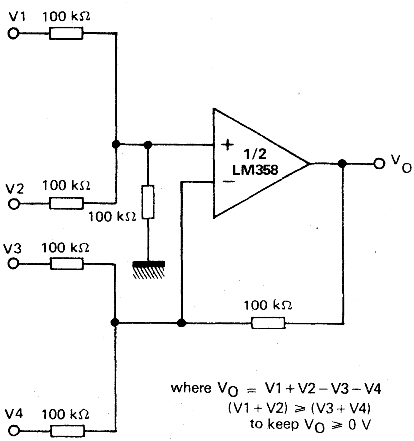
NON-INVERTING DC AMPLIFIER

$A_V = 1 + \frac{R2}{R1}$

$A_V = 101$ (As shown)



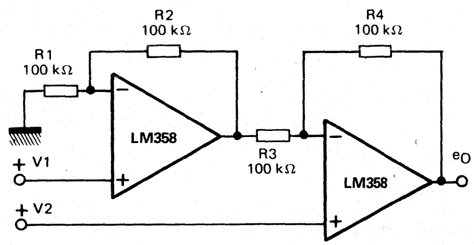
DC SUMMING AMPLIFIER



where $V_O = V1 + V2 - V3 - V4$
$(V1 + V2) \geq (V3 + V4)$
to keep $V_O \geq 0$ V

TYPICAL APPLICATIONS (SINGLE SUPPLY VOLTAGE) (Continued)

HIGH INPUT IMPEDANCE, DC DIFFERENTIAL AMPLIFIER

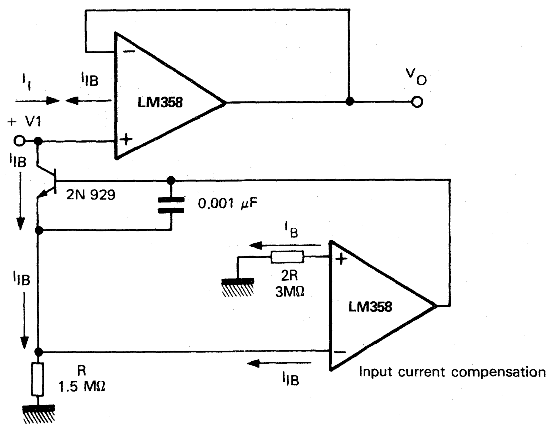


for $\frac{R1}{R2} = \frac{R4}{R3}$ (CMRR depends on this resistor ratio match)

$V_O = (1 + \frac{R4}{R3})\ (V2 - V1)$

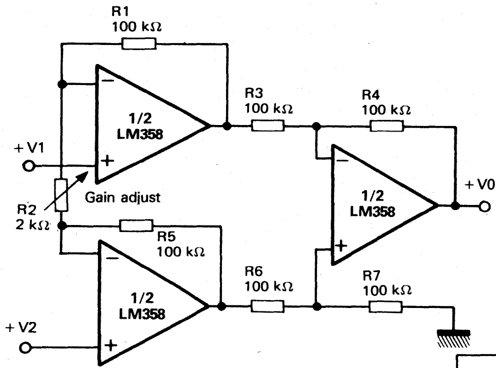
As shown : $V_O = 2(V2 - V1)$

USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



TYPICAL APPLICATIONS (Continued)

HIGH INPUT Z ADJUSTABLE-GAIN DC INSTRUMENTATION AMPLIFIER

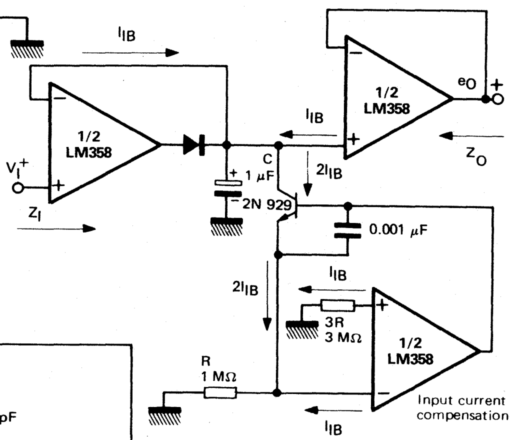


If R1 = R5 and R3 = R4 = R6 = R7

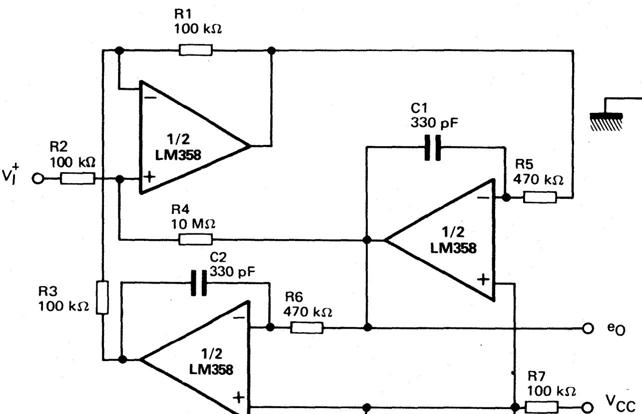
$$V_O = \left(1 + \frac{2\,R1}{R2}\right)(V2 - V1)$$

As shown : $V_O = 101\ (V2 - V1)$

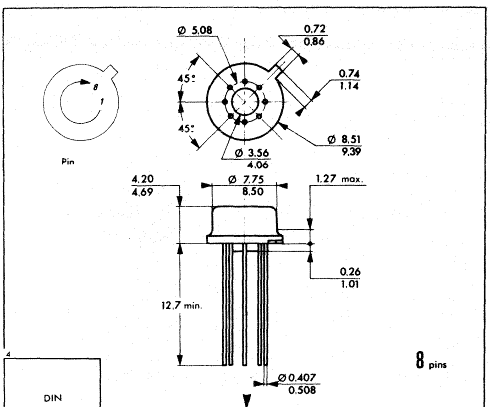
LOW DRIFT PEAK DETECTOR



ACTIVE BAND-PASS FILTER

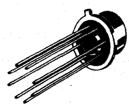


f_O = 1 kHz
Q = 50
A_V = 100 (40 dB)

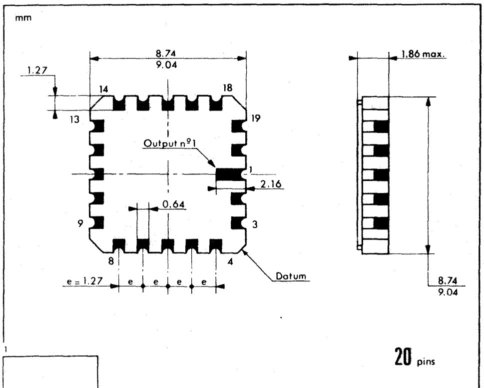


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

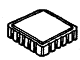


H SUFFIX
METAL CAN

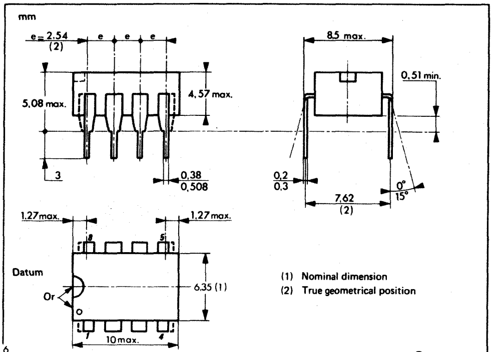


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705



GC SUFFIX
TRICECOP (LCC)

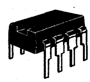


6

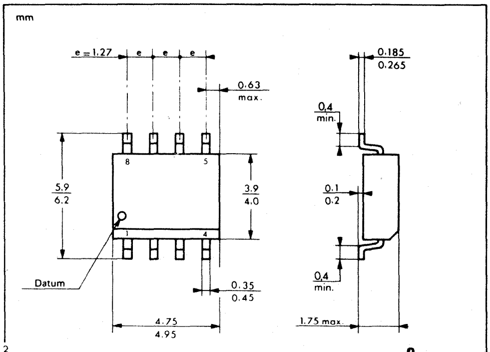
8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

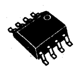


2

8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM1458
LM1558

DUAL OPERATIONAL AMPLIFIERS

The LM1458 is a high performance monolithic dual operational amplifier constructed on a single silicon chip. It is intended for a wide range of analog applications.

- Summing amplifer
- Voltage follower
- Integrator
- Active filter
- Function generator

The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feed back applications. The internal compensation network (6 dB/octave) insures stability in closed loop applications.

- low power consumption
- large input voltage range
- no latch-up
- high gain
- short-circuit protection
- no frequency compensation required.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

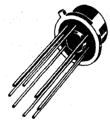
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		H	DP	GC	FP
LM1458	0°C to + 70°C	•	•		•
LM1558	−55°C to +125°C	•		•	

Examples : LM1458H, LM1558GC

DUAL OPERATIONAL AMPLIFIERS

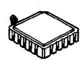
CASES

CB-11 (TO-99)



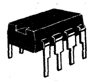
H SUFFIX
METAL CAN

CB-705



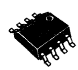
GC SUFFIX
TRICECOP (LCC)

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

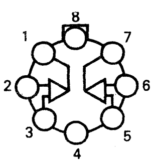
CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

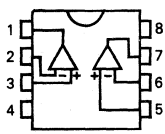
PIN ASSIGNMENTS
(Top views)

CB-11



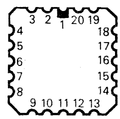
1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^-

CB-98
CB-342



5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

CB-705



1 - NC
2 - Output 1
3 - NC
4 - NC
5 - Inverting input 1
6 - NC
7 - Non-inverting input 1
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Non-inverting input 2
13 - NC
14 - NC
15 - Inverting input 2
16 - NC
17 - Output 2
18 - NC
19 - NC
20 - V_{CC}^+

Réf. 00225

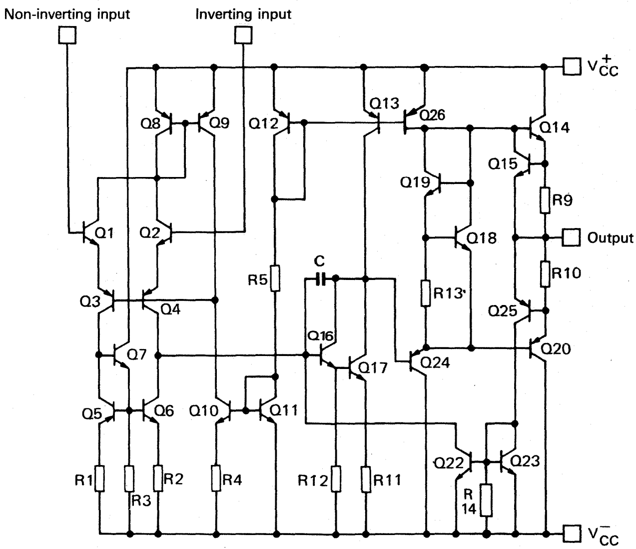
THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Supply voltage	 LM1458 LM1558	V_{CC}	 ±18 ±22	V
Input voltage		V_I	±15	V
Differential input voltage		V_{ID}	±30	V
Output short-circuit duration		—	Indefinite	—
Power dissipation	 LM1458H, LM1558H LM1458DP LM1458FP LM1558GC	P_{tot}	 680 500 300 665	mW
Operating free-air temperature range	 LM1558 LM1458	T_{oper}	 −55 to +125 0 to + 70	°C
Storage temperature range	 LM1558H, GC/LM1458H LM1458DP and FP	T_{stg}	 −65 to +150 −55 to +125	°C

SCHEMATIC DIAGRAM (1/2 LM1458, LM1558)



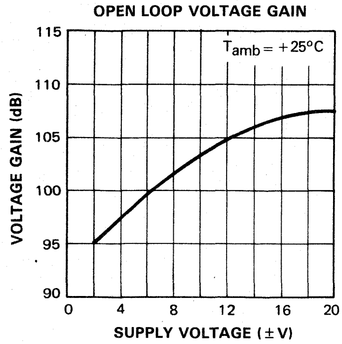
CASE	Outputs	Non-inverting inputs	Inverting inputs	V_{CC}^+	V_{CC}^-
CB-98	1-7	3-5	2-6	8	4
CB-11	1-7	3-5	2-6	8	4
CB-342	1-7	3-5	2-6	8	4
CB-705*	2-17	7-12	5-15	20	10

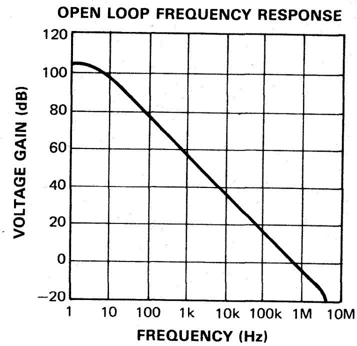
* **CB-705** : Other pins not connected

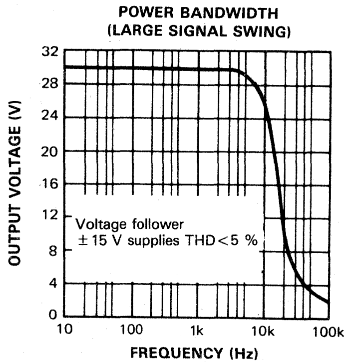
ELECTRICAL CHARACTERISTICS

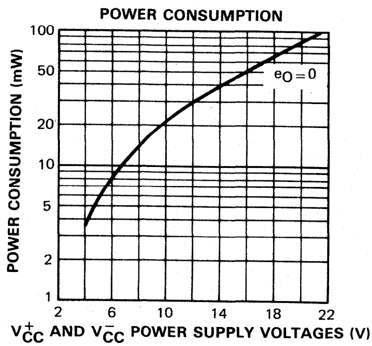
LM1458 : $0°C \leq T_{amb} \leq +70°C$, $V_{CC} = \pm 15$ V
LM1558 : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

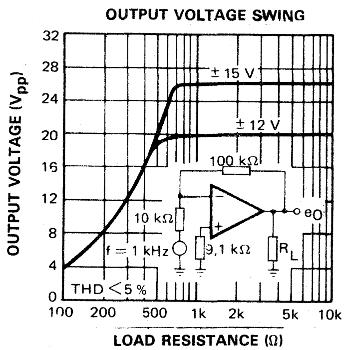
Characteristic	Symbol	LM1558			LM1458			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leq 10$ kΩ) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	V_{IO}	 – –	 1 –	 5 6	 – –	 1 –	 6 7.5	mW
Input offset current $T_{amb} = +25°C$ $T_{amb} = T_{min}$ $T_{amb} = T_{max}$	I_{IO}	 – – –	 20 – –	 200 500 200	 – – –	 20 – –	 200 – 300	nA
Input bias current $T_{amb} = +25°C$ $T_{amb} = T_{min}$ $T_{amb} = T_{max}$	I_{IB}	 – – –	 80 – –	 500 1500 1500	 – – –	 80 – –	 500 800 800	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geq 2$ kΩ) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	A_{VD}	 50 25	 200 –	 – –	 20 15	 200 –	 – –	V/mV
Supply voltage rejection ratio ($R_S \leq 10$ kΩ)	SVR	–	30	150	–	30	150	μV/V
Supply current ($T_{amb} = +25°C$) - Note 1	I_{CC}^{+}, I_{CC}^{-}	–	2.3	5	–	2.3	5.6	mA
Input voltage range	V_I	± 12	± 13	–	± 12	± 13	–	V
Common mode rejection ratio ($R_S \leq 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output voltage swing $R_L \geq 10$ kΩ $R_L \geq 2$ kΩ	V_{OPP}	 ± 12 ± 10	 ± 14 ± 13	 – –	 ± 12 ± 10	 ± 14 ± 13	 – –	V
Rise time ($V_I = \pm 20$ mV, $C_L \leq 100$ pF, $R_L = 2$ kΩ $T_{amb} = +25°C$, Unity gain)	t_r	–	0.3	–	–	0.3	–	μs
Overshoot factor ($V_I = +20$ mV, $C_L \leq 100$ pF, $R_L = 2$ kΩ, $T_{amb} = +25°C$, Unity gain)	K_{OV}	–	5	–	–	5	–	%
Input resistance ($T_{amb} = +25°C$)	R_I	0.3	2	–	0.3	2	–	MΩ
Output resistance ($V_O = 0$, $T_{amb} = +25°C$)	R_O	–	75	–	–	75	–	Ω
Slew rate ($R_L \geq 2$ kΩ, $T_{amb} = +25°C$, Unity gain)	S_{VO}	–	0.8	–	–	0.8	–	V/μs
Output short-circuit current ($T_{amb} = +25°C$)	I_{OS}	–	± 20	–	–	± 20	–	mA
Common-mode input impedance (f = 20 Hz, $T_{amb} = +25°C$)	Z_{ic}	–	200	–	–	200	–	MΩ
Input capacitance ($T_{amb} = +25°C$)	C_I	–	1.4	–	–	1.4	–	pF
Equivalent (input) noise voltage ($A_{VD} = 100$, $R_S = 0$, f = 1 kHz, BW = 1 Hz, $T_{amb} = +25°C$)	V_n	–	45	–	–	45	–	nV_{rms}
Large signal bandwidth ($R_L = 2$ kΩ, $V_O \geq \pm 10$ V, $A_{VD} = 1$, THD ≤ 5%, $T_{amb} = +25°C$)	B_{OM}	–	14	–	–	14	–	kHz
Unity gain bandwidth ($T_{amb} = +25°C$)	B	–	1	–	–	1	–	MHz
Phase margin ($A_V = 1$, $T_{amb} = +25°C$)	φ_M	–	65	–	–	65	–	Degree
Gain margin ($T_{amb} = +25°C$)	A_M	–	11	–	–	11	–	dB

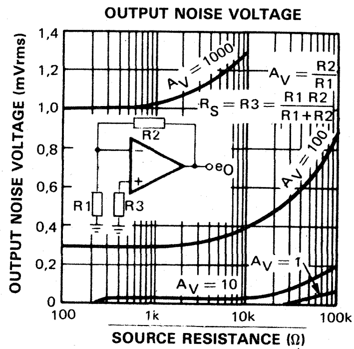

OPEN LOOP VOLTAGE GAIN
Tamb = +25°C
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (±V)

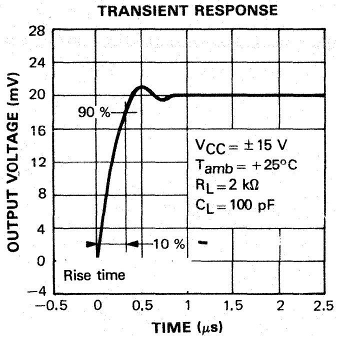

OPEN LOOP FREQUENCY RESPONSE
VOLTAGE GAIN (dB)
FREQUENCY (Hz)

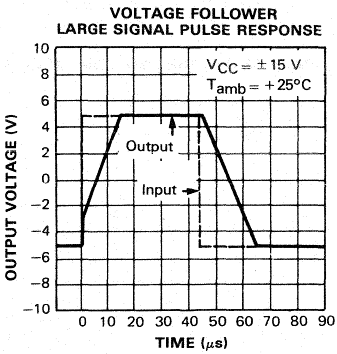

POWER BANDWIDTH
(LARGE SIGNAL SWING)
Voltage follower
± 15 V supplies THD<5 %
OUTPUT VOLTAGE (V)
FREQUENCY (Hz)

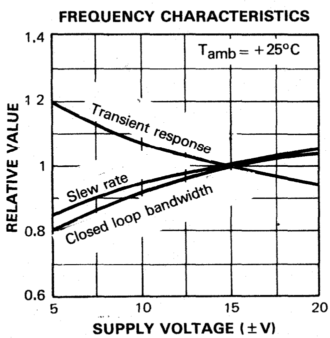

POWER CONSUMPTION
eO = 0
POWER CONSUMPTION (mW)
V+CC AND V−CC POWER SUPPLY VOLTAGES (V)

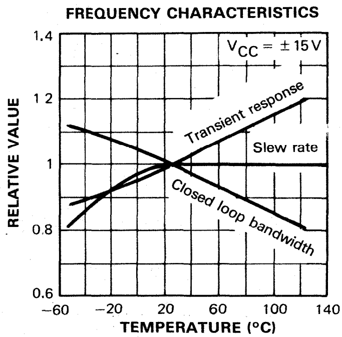

OUTPUT VOLTAGE SWING
± 15 V
± 12 V
100 kΩ
10 kΩ
f = 1 kHz
9,1 kΩ
RL
eO
THD < 5 %
OUTPUT VOLTAGE (Vpp)
LOAD RESISTANCE (Ω)


OUTPUT NOISE VOLTAGE
AV = 1000
AV = R2/R1
RS = R3 = R1 R2/(R1 + R2)
R2
R1
R3
eO
AV = 100
AV = 1
AV = 10
OUTPUT NOISE VOLTAGE (mVrms)
SOURCE RESISTANCE (Ω)


TRANSIENT RESPONSE
OUTPUT VOLTAGE (mV)
TIME (μs)
90 %
10 %
Rise time
VCC = ±15 V
Tamb = +25°C
RL = 2 kΩ
CL = 100 pF

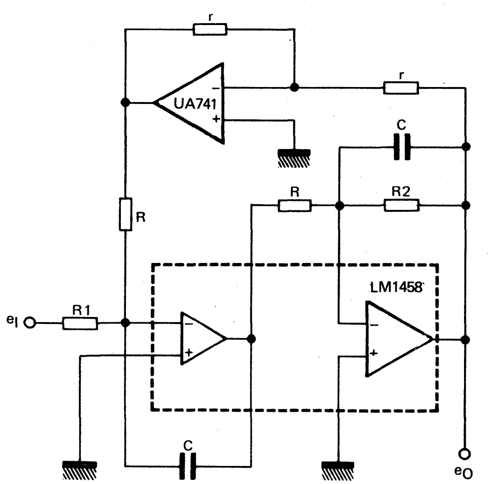

VOLTAGE FOLLOWER
LARGE SIGNAL PULSE RESPONSE
OUTPUT VOLTAGE (V)
TIME (μs)
VCC = ±15 V
Tamb = +25°C
Output
Input


FREQUENCY CHARACTERISTICS
RELATIVE VALUE
SUPPLY VOLTAGE (±V)
Tamb = +25°C
Transient response
Slew rate
Closed loop bandwidth


FREQUENCY CHARACTERISTICS
RELATIVE VALUE
TEMPERATURE (°C)
VCC = ±15V
Transient response
Slew rate
Closed loop bandwidth

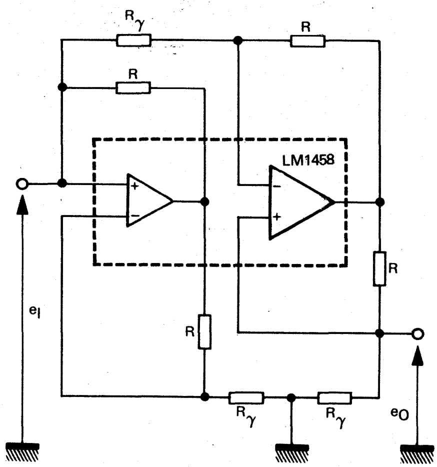
TYPICAL APPLICATIONS

LOW-PASS FILTER



$\omega_O = \frac{1}{RC}$ $\xi = \frac{1}{2}\frac{R}{R2}$ $A_V = \frac{R}{R1}$

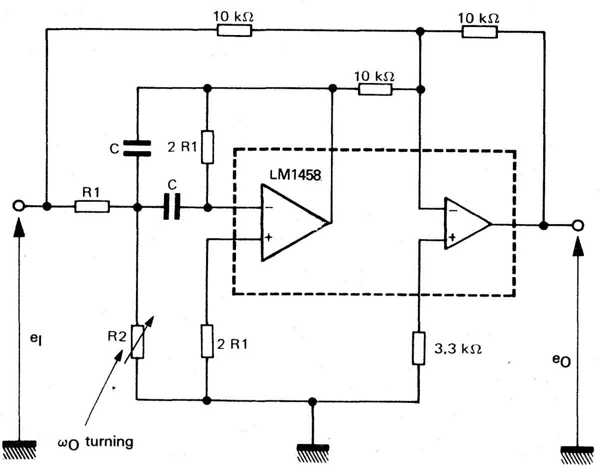
GYRATOR



R_γ = Gyration resistance ($\geqslant$ 1.5 kΩ)

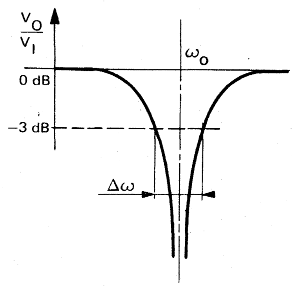
$0.1\ R_\gamma \leqslant R \leqslant 0.5\ R_\gamma$

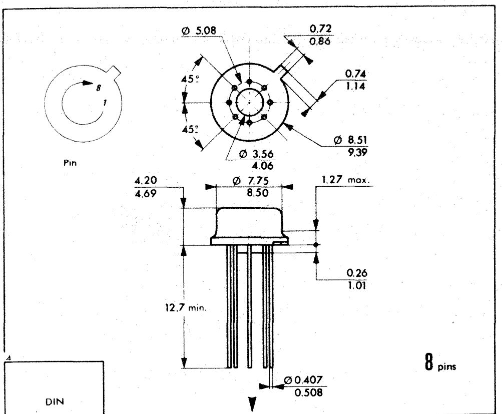
TUNABLE NOTCH FILTER



$$\omega_o = \frac{1}{C\sqrt{2\,R1\,\frac{R1\ R2}{R1+R2}}}$$

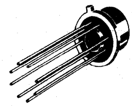
$$\Delta\omega = \frac{1}{CR1} \text{ (Bandwidth notched)}$$



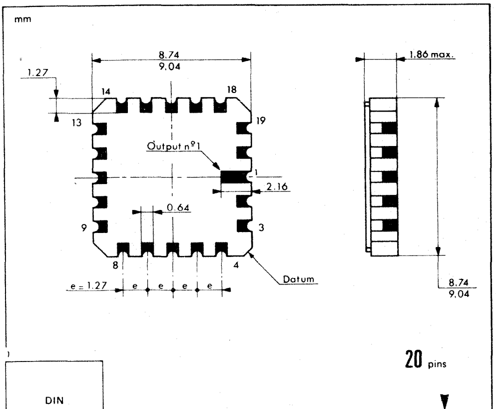


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

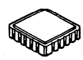


H SUFFIX
METAL CAN

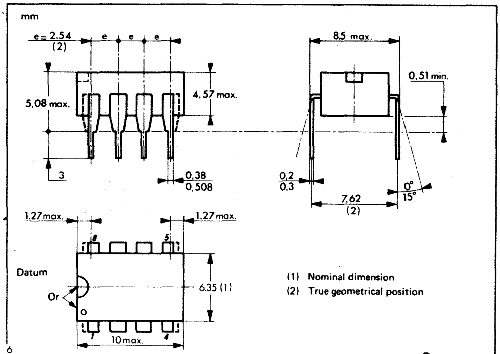


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705



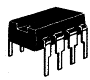
GC SUFFIX
TRICECOP (LCC)



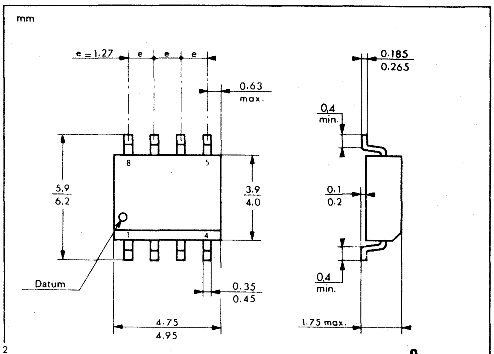
8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98



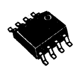
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

MC3303
MC3403
MC3503

LOW POWER DIFFERENTIAL INPUT QUAD OP-AMPs

The MC3403 is a low-cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular UA741. However the MC3403, has several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 volts or as high as 36 volts with quiescent currents about one third of those associated with the UA741 (on a per amplifier basis). The common-mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

- Short-circuit protected outputs.
- Class AB output stage for minimal crossover distortion.
- Single supply operation : +3 V to +36 V.
- Dual supplies : ±1.5 V to ±18 V.
- Low input bias current : 500 nA max.
- Internally compensated.
- Similar performance to popular UA741DP8.

ORDERING INFORMATION

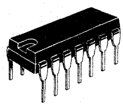
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DG	DP	FP	GC
MC3503	−55°C to +125°C	•			•
MC3403	0°C to + 70°C	•	•	•	
MC3303	−40°C to + 85°C		•		
Examples : MC3503DG, MC3403DP					

LOW POWER DIFFERENTIAL INPUT QUAD OPERATIONAL AMPLIFIERS

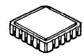
CASES

CB-2



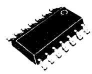
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-705



GC SUFFIX
TRICECOP (LCC)

CB-511

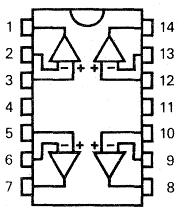


FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENTS

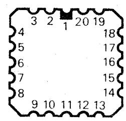
(Top views)

CB-2
CB-511



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00260

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

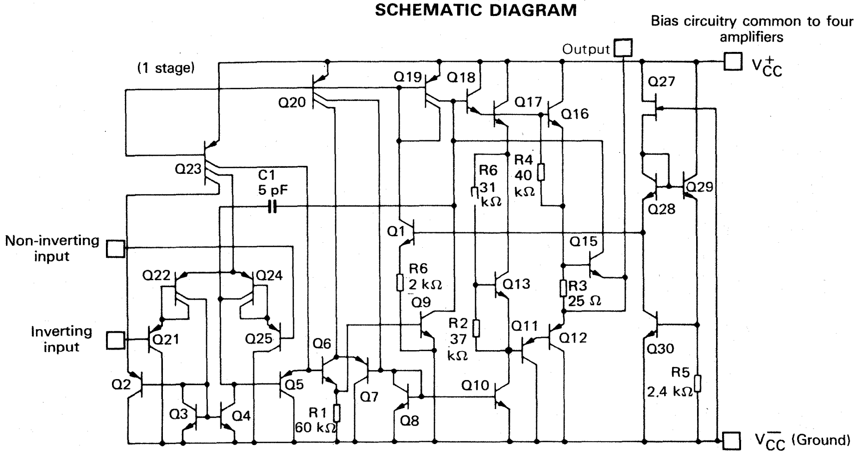
MAXIMUM RATINGS

Rating	Symbol	MC3503	MC3403	MC3303	Unit
Supply voltage	V_{CC}	±18	±18	±18	V
Differential input voltage	V_{ID}	±36	±36	±36	V
Input voltage (Note 1)	V_I	±18	±18	±18	V
Output short-circuit duration (Note 2)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation	P_{tot}	500	500	500	mW
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	−40 to + 85	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C

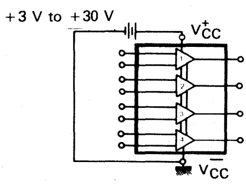
Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

Note 2 : Any of the amplifier outputs can be shorted to ground indefinitely ; however more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

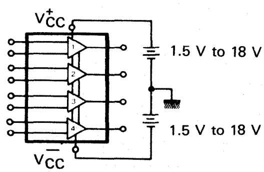
SCHEMATIC DIAGRAM



SINGLE SUPPLY



DUAL SUPPLIES



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^{-}	V_{CC}^{+}	N.C.
CB-2/CB-511	1, 7, 8, 14	2, 6, 9, 13	3, 5, 10, 12	11	4	
CB-705	1, 2, 12, 20	3, 9, 13, 19	4, 8, 14, 18	16	6	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = +15 V, V_{CC}^{-} = −15 V for **MC3503, MC3403**
V_{CC}^{+} = +14 V, V_{CC}^{-} = Ground for **MC3303**
MC3403 : 0°C ≤ T_{amb} ≤ + 70°C
MC3303 : −40°C ≤ T_{amb} ≤ + 85°C
MC3503 : −55°C ≤ T_{amb} ≤ +125°C
T_{amb} = +25°C
(Unless otherwise specified)

Characteristic	Symbol	MC3503, MC3303			MC3403			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	5	–	2	10	mV
MC3303		–	2	8	–	–	–	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	6	–	–	12	
MC3303		–	–	10	–	–	–	
Input offset current	I_{IO}	–	30	50	–	30	70	nA
MC3303		–	30	75	–	–	–	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	200	–	–	200	
MC3303		–	–	250	–	–	–	
Input bias current	I_{IB}	–	−200	−500	–	−200	−500	nA
$T_{min} \leq T_{amb} \leq T_{max}$		–	−300	−1500	–	–	−800	
MC3303		–	–	−1000	–	–	–	
Large signal open loop voltage gain (T_{amb} = +25°C, V_O = ±10 V, R_L = 2 kΩ)	A_{VD}	50	200	–	20	200	–	V/mV
MC3303		20	200	–	–	–	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	300	–	15	–	–	
MC3303		15	–	–	–	–	–	
Positive supply rejection ratio	SVR^{+}	–	30	150	–	30	150	µV/V
Negative supply rejection ratio(except MC3303)	SVR^{-}	–	30	150	–	30	150	µV/V
Supply current (V_O = 0 V, R_L = ∞)	I_{CC}	–	2.8	4	–	2.8	7	mA
MC3303		–	2.8	7	–	–	–	
Average temperature coefficient of input offset voltage ($T_{min} \leq T_{amb} \leq T_{max}$)	αV_{IO}	–	10	–	–	10	–	µV/°C
Average temperature coefficient of input offset curent ($T_{min} \leq T_{amb} \leq T_{max}$)	αI_{IO}	–	50	–	–	50	–	pA/°C
Input common-mode voltage range (to V_{CC}^{-})	V_I	+13	+13.5	–	+13	+13.5	–	V
MC3303		+12	+12.5	–	–	–	–	
Common-mode rejection ratio	CMR	70	90	–	70	90	–	dB
Individual output short-circuit current (Note 1)	I_{OS}	±10	±30	±45	±10	±20	±45	mA
Small signal bandwidth (A_V = 1, R_L = 10 kΩ, V_O = 50 mV)	GW_R	–	1	–	–	1	–	MHz
Power bandwidth (A_V = 1, R_L = 2 kΩ, V_O = 20 V_{pp}, THD = 5%)	BW_p	–	9	–	–	9	–	kHz
Slew rate (A_V = 1, V_I = −10 V to +10 V)	S_{VO}	–	0.6	–	–	0.6	–	V/µs
Rise time (A_V = 1, R_L = 10 kΩ, V_O = 50 mV)	t_r	–	0.35	–	–	0.35	–	µs
Fall time (A_V = 1, R_L = 10 kΩ, V_O = 50 mV)	t_f	–	0.35	–	–	0.35	–	µs
Overshoot factor (A_V = 1, R_L = 10 kΩ, V_O = +50 mV)	K_{OV}	–	20	–	–	20	–	%
Input impedance (f = 20 Hz)	Z_I	0.3	1	–	0.3	1	–	MΩ
Output impedance (f = 20 Hz)	Z_O	–	75	–	–	75	–	Ω
Phase margin (A_V = 1, R_L = 2 kΩ, C_L = 200 pF)	φM	–	60	–	–	60	–	Degree
Crossover distortion (e_I = 30 mVPP, e_O = 2 VPP, f = 10 kHz)	D	–	1	–	–	1	–	%
Output voltage range	V_O							V
R_L = 10 kΩ, T_{amb} = +25°C		±12	±13.5	–	±12	±13.5	–	
MC3303		±12	±12.5	–	–	–	–	
R_L = 2 kΩ, T_{amb} = +25°C		±10	±13	–	±10	±13	–	
MC3303		±10	±12	–	–	–	–	
R_L = 2 kΩ, $T_{min} \leq T_{amb} \leq T_{max}$		±10	–	–	±10	–	–	

Note 1 : Not to exceed maximum package power dissipation.

ELECTRICAL CHARACTERISTICS (continued)
$V_{CC}^{+} = +5$ V, V_{CC}^{-} = Ground, $T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	MC3503, MC3303			MC3403			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	5	–	2	10	mV
MC3303		–	2.5	10	–	–	–	
Input offset current	I_{IO}	–	30	50	–	30	50	nA
MC3303		–	–	75	–	–	–	
Input bias current	I_{IB}	–	– 200	– 500	–	– 200	– 500	nA
MC3303		–	–	– 500	–	–	–	
Large signal open loop voltage gain ($R_L = 2$ kΩ)	A_{VD}	10	200	–	10	200	–	V/mV
Power supply rejection ratio	SVR	–	–	150	–	–	150	μV/V
Supply current	I_{CC}	–	2.5	4	–	2.5	7	mA
MC3303		–	2.5	7	–	–	–	
Output voltage range ($R_L = 10$ kΩ) - Note 2	V_O							V
$V_{CC}^{+} = +5$ V		3.3	3.5	–	3.3	3.5	–	
$+5\text{ V} \leq V_{CC}^{+} \leq +30$ V		$V_{CC}^{+}-1.7$	$V_{CC}^{+}-1.5$	–	$V_{CC}^{+}-1.7$	$V_{CC}^{+}-1.5$	–	
Channel separation (f = 1 kHz to 20 kHz)	V_{O1}/V_{O2}	–	– 120	–	–	– 120	–	dB

Note 2 : Output will swing to ground.

CIRCUIT DESCRIPTION

The MC3403 is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance a smaller compensation capacitor (only 5 pF) can be employed, thus saving chip area.

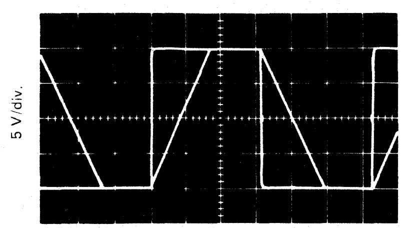
The transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input common-mode range can include the negative supply of ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter.

The second stage consists of a standard current source load amplifier stage. The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operations. This is possible because class AB operation is utilized.

Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

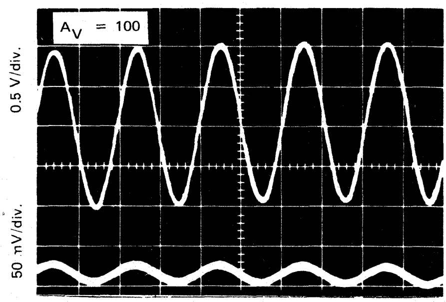
TYPICAL PERFORMANCE CURVES

INVERTER PULSE RESPONSE



20 μs/div.

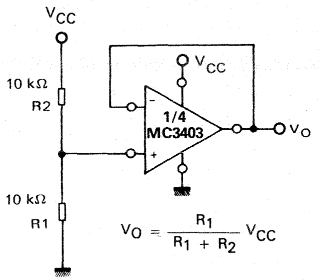
SINEWAVE RESPONSE



Note class AB output stage produces 50 μs/div distortionless sinewave

APPLICATION INFORMATION

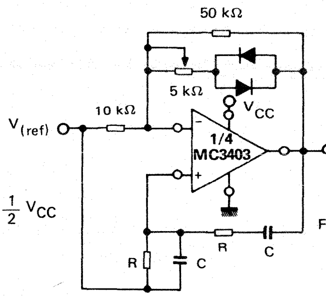
VOLTAGE REFERENCE



$$V_O = \frac{R_1}{R_1 + R_2} V_{CC}$$

$$V_O = \frac{1}{2} V_{CC}$$

WIEN BRIDGE OSCILLATOR

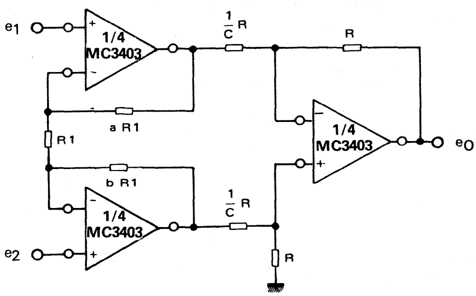


$$V_{(ref)} = \frac{1}{2} V_{CC}$$

$$f_O = \frac{1}{2\pi RC}$$

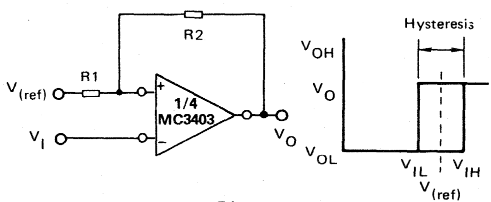
For $f_O = 1$ kHz
$R = 16$ kΩ
$C = 0.01$ μF

HIGH IMPEDANCE DIFFERENTIAL AMPLIFIER



$$e_O = C\,(1 + a + b)\,(e_2 - e_1)$$

COMPARATOR WITH HYSTERESIS

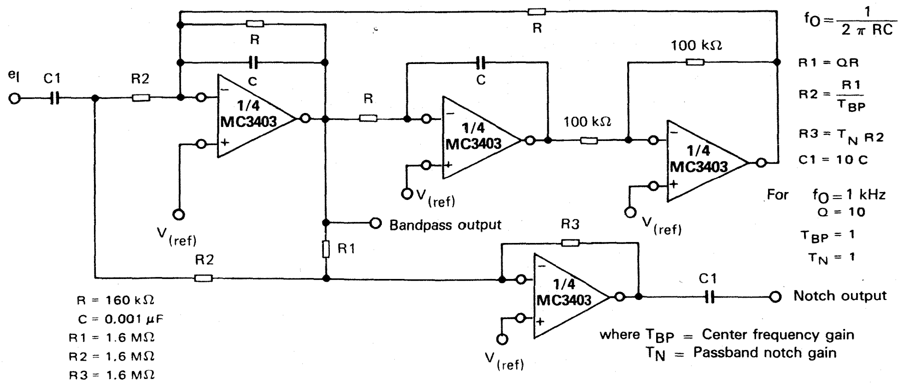


$$V_{IL} = \frac{R1}{R1 + R2} \left[V_{OL} - V_{(ref)}\right] + V_{(ref)}$$

$$V_{IH} = \frac{R1}{R1 + R2} \left[V_{OH} - V_{(ref)}\right] + V_{(ref)}$$

$$H = \frac{R1}{R1 + R2} (V_{OH} - V_{OL})$$

BI-QUAD FILTER



$$V_{(ref)} = \frac{1}{2} V_{CC}$$

$$f_O = \frac{1}{2\pi RC}$$

$R1 = QR$

$R2 = \frac{R1}{T_{BP}}$

$R3 = T_N\, R2$

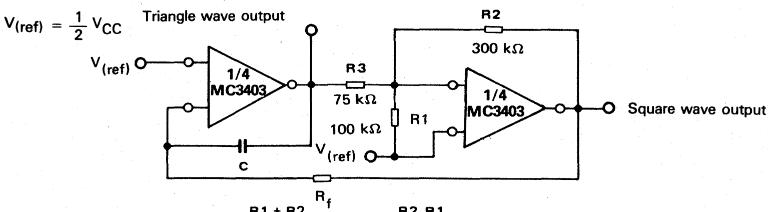
$C1 = 10\,C$

For $f_O = 1$ kHz
$Q = 10$
$T_{BP} = 1$
$T_N = 1$

R = 160 kΩ
C = 0.001 μF
R1 = 1.6 MΩ
R2 = 1.6 MΩ
R3 = 1.6 MΩ

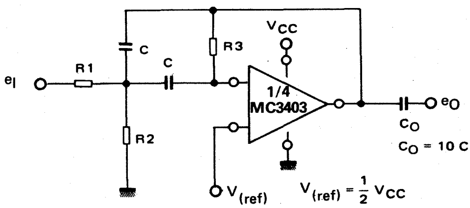
where T_{BP} = Center frequency gain
T_N = Passband notch gain

FUNCTION GENERATOR



$$f = \frac{R1 + R2}{4\,CR_f\,R1} \quad \text{if} \quad R3 = \frac{R2\,R1}{R2 + R1}$$

MULTIPLE FEEDBACK BANDPASS FILTER



Given f_O = Center frequency choose values f_O, C then : $R3 = \frac{Q}{\pi f_O C}$
$A_{(f_O)}$ = Gain at center frequency

$$R1 = \frac{R3}{2A\,(f_O)}$$

$$R2 = \frac{R1\;R5}{4Q^2\,R1 - R5}$$

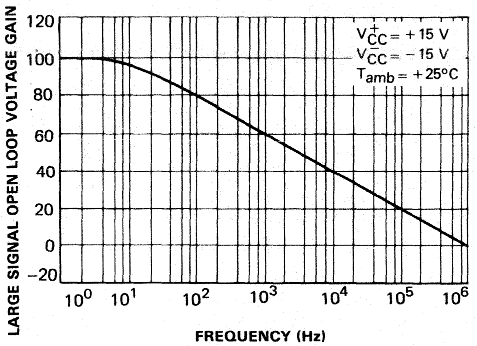
For less than 10% error operational amplifiers

$\frac{Q_O f_O}{BW} < 0.1$ where f_O and BW are expressed in Hz

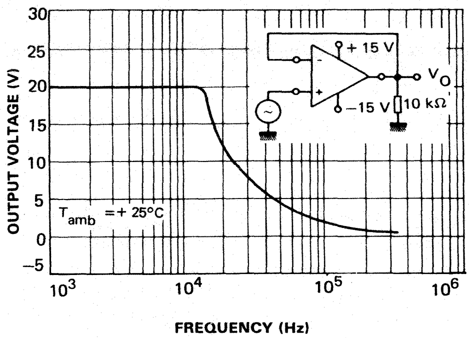
If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

TYPICAL PERFORMANCE CURVES

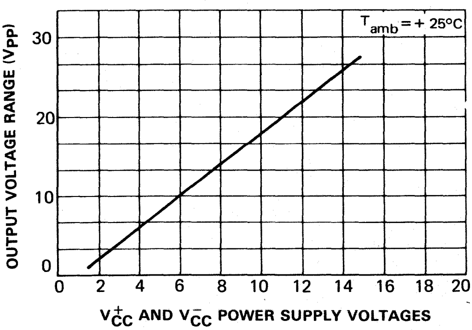
OPEN LOOP FREQUENCY RESPONSE



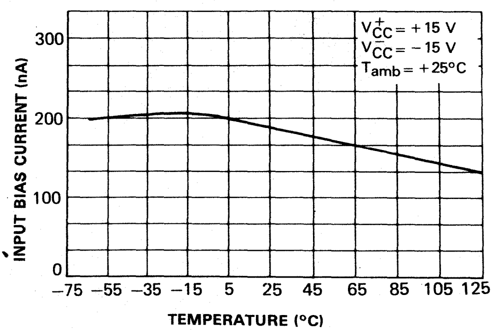
POWER BANDWIDTH



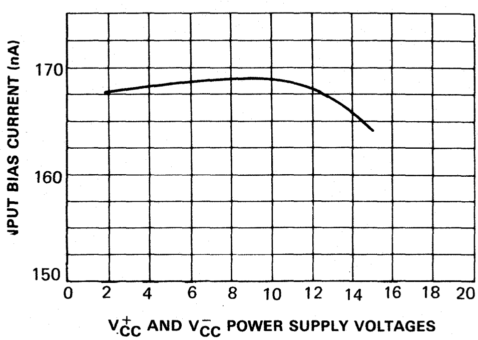
OUTPUT SWING VERSUS SUPPLY VOLTAGE

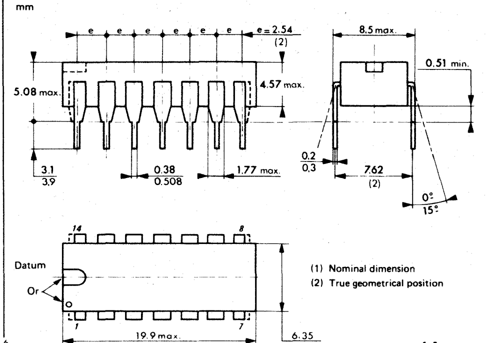


INPUT BIAS CURRENT VERSUS TEMPERATURE



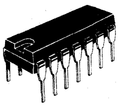
INPUT BIAS CURRENT VERSUS SUPPLY VOLTAGE



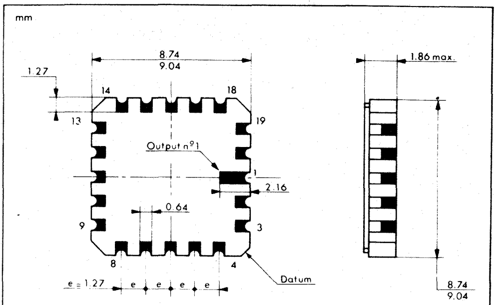


14 pins

DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

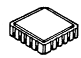


CB-2
(TO-116)
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

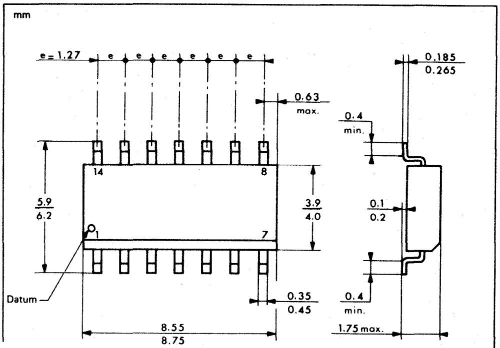


20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

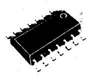


CB-705
GC SUFFIX
TRICECOP (LCC)



14 pins

DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

WIDEBAND DUAL OPERATIONAL AMPLIFIERS

The MC4558 is a high performance monolithic dual operational amplifier constructed on a single silicon chip.

The circuit combines all the outstanding features of the LM1458 and, in addition, possesses three times the unity gain bandwidth of the industry standard.

- f_T min guaranteed 2.5 MHz.
- Internally compensated.
- Short-circuit protection.
- Gain and phase match between amplifiers.
- Low power consumption.
- Pin to pin compatible with LM1458/LM358.

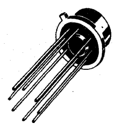
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE H	DP	DG	FP
MC4558C	0°C to + 70°C	•	•	•	•
MC4558I	– 25°C to + 85°C	•	•	•	
MC4558M	– 55°C to + 125°C	•		•	
Example : MC4558CDP, MC4558MH					

WIDEBAND DUAL OPERATIONAL AMPLIFIERS

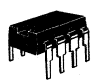
CASES

CB-11 (TO-99)



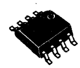
H SUFFIX
METAL CAN

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

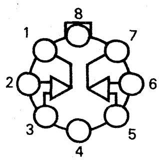
CB-342



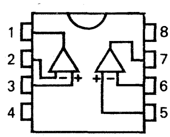
FP SUFFIX
PLASTIC
MICROPACKAGE

PIN ASSIGNMENTS

(Top views)



CB-11 (TO-99)



CB-98
CB-342

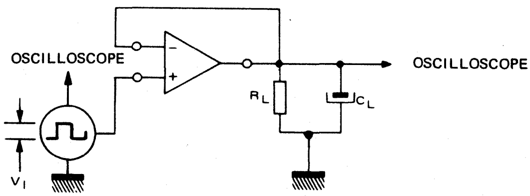
1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^-
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

Réf. 00260

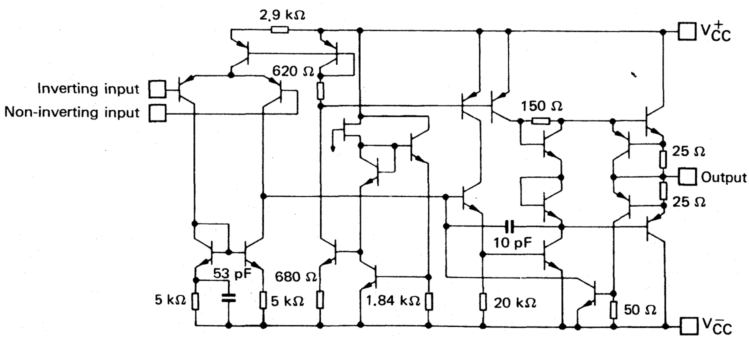
MAXIMUM RATINGS

Rating		Symbol	MC4558C, I	MC4558M	Unit
Supply voltage		V_{CC}	±18	±22	V
Input voltage		V_I	±15	±15	V
Differential input voltage		V_{ID}	±30	±30	V
Power dissipation	MC4558CH All other versions	P_{tot}	680 500	680 –	mV
Output short-circuit duration		–	Indefinite	Indefinite	–
Operating free-air temperature range	MC4558C MC4558I MC4558M	T_{oper}	0 to + 70 – 25 to + 85 –	– – – 55 to + 125	°C
Storage temperature range	MC4558CH All other versions	T_{stg}	– 65 to + 150 – 55 to + 125	– – 55 to + 150	°C

TRANSIENT RESPONSE TEST CIRCUIT



SCHEMATIC DIAGRAM (1/2 MC4558)



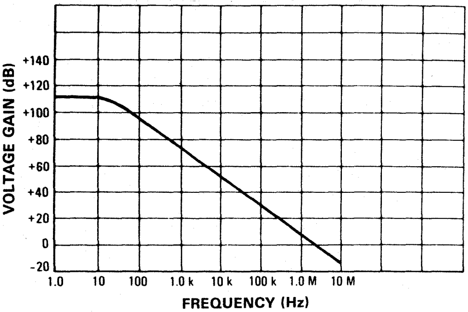
CASE	Inverting inputs	Non-inverting inputs	V_{CC}^-	V_{CC}^+	Outputs
CB-11 CB-98 CB-342	2,6	3,5	4	8	1,7

ELECTRICAL CHARACTERISTICS

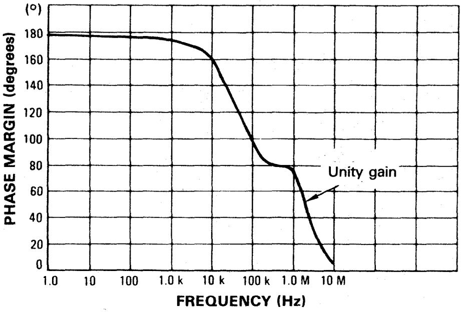
$V_{CC}^{+} = +15$ V $V_{CC}^{-} = -15$ V
MC4558C : $0°C \leqslant T_{amb} \leqslant +70°C$
MC4558I : $-25°C \leqslant T_{amb} \leqslant +85°C$
MC4558M : $-55°C \leqslant T_{amb} \leqslant +125°C$
(Unless otherwise specified)

Characteristic	Symbol	MC4558C,I			MC4558M			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}							mV
$T_{amb} = +25°C$		–	2	6	–	1	5	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	7.5	–	1	6	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	20	200	–	20	200	
$T_{amb} = T_{max}$		–	–	–	–	7	200	
$T_{amb} = T_{min}$		–	–	–	–	85	500	
$T_{amb} = 0$ to $+70°C$		–	–	300	–	–	–	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	80	500	–	80	500	
$T_{amb} = T_{max}$		–	–	–	–	30	500	
$T_{amb} = T_{min}$		–	–	–	–	300	1500	
$T_{amb} = 0$ to $+70°C$		–	–	800	–	–	–	
Large signal voltage gain ($V_O = \pm 10$ V, $R_L = 2$ kΩ)	A_{VD}							V/mV
$T_{amb} = +25°C$		20	200	–	50	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	25	–	–	
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR							μV/V
$T_{amb} = +25°C$		–	30	150	–	30	150	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	–	–	30	150	
Supply current (Both amplifiers)	I_{CC}^{+}, I_{CC}^{-}							mA
$T_{amb} = +25°C$		–	2.3	5.6	–	2.3	5	
$T_{amb} = T_{max}$		–	–	5	–	–	4.5	
$T_{amb} = T_{min}$		–	–	6.7	–	–	6	
Power consumption (Both amplifiers)	P_D							mW
$T_{amb} = +25°C$		–	70	170	–	70	150	
$T_{amb} = T_{max}$		–	–	150	–	–	135	
$T_{amb} = T_{min}$		–	–	200	–	–	180	
Input voltage range	V_I							V
$T_{amb} = +25°C$		±12	±13	–	±12	±13	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	–	±12	±13	–	
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR							dB
$T_{amb} = +25°C$		70	90	–	70	90	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	–	70	90	–	
Output short-circuit current ($T_{amb} = +25°C$)	I_{OS}	10	20	40	10	20	40	mA
Output voltage swing	V_{OPP}							V
$T_{amb} = +25°C$, $R_L \geqslant 10$ kΩ		±12	±14	–	±12	±14	–	
$R_L \geqslant 2$ kΩ		±10	±13	–	±10	±13	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10$ kΩ		±12	±14	–	±12	±14	–	
$R_L \geqslant 2$ kΩ		±10	±13	–	±10	±13	–	
Slew rate ($V_I = +20$ mV, $R_L \geqslant 2$ kΩ, $C_L \leqslant 100$ pF, $T_{amb} = +25°C$)	S_{VO}	1	1.6	–	1.5	1.6	–	V/μs
Rise time ($V_I = +20$ mV, $R_L \geqslant 2$ kΩ, $C_L \leqslant 100$ pF, $T_{amb} = +25°C$)	t_r	–	0.3	–	–	0.3	–	μs
Overshoot ($V_I = +20$ mV, $R_L \geqslant 2$ kΩ, $C_L \leqslant 100$ pF, $T_{amb} = +25°C$)	K_{OV}	–	15	–	–	15	–	%
Input resistance ($T_{amb} = +25°C$)	R_I	0.3	2	–	0.3	2	–	MΩ
Input capacitance ($T_{amb} = +25°C$)	C_I	–	1.4	–	–	1.4	–	pF
Output resistance ($T_{amb} = +25°C$)	R_O	–	75	–	–	75	–	Ω
Unity gain bandwidth ($T_{amb} = +25°C$)	B	2	2.8	–	2.5	2.8	–	MHz

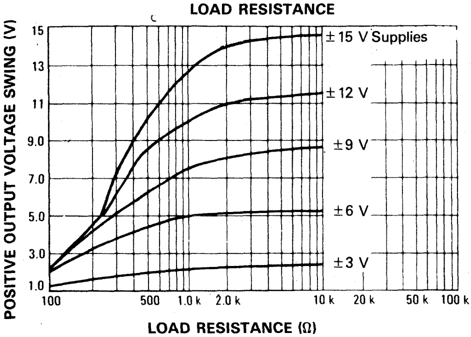
OPEN LOOP FREQUENCY RESPONSE



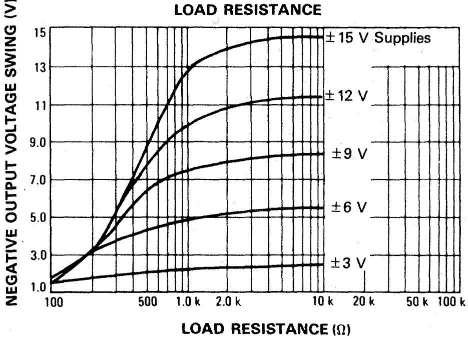
PHASE MARGIN VERSUS FREQUENCY



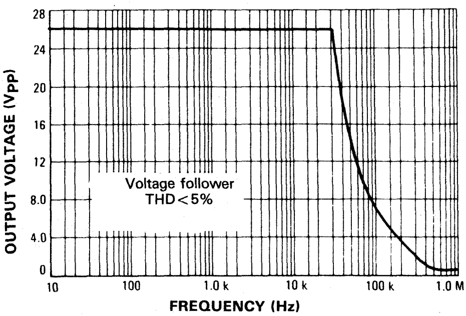
POSITIVE OUTPUT VOLTAGE SWING VERSUS LOAD RESISTANCE

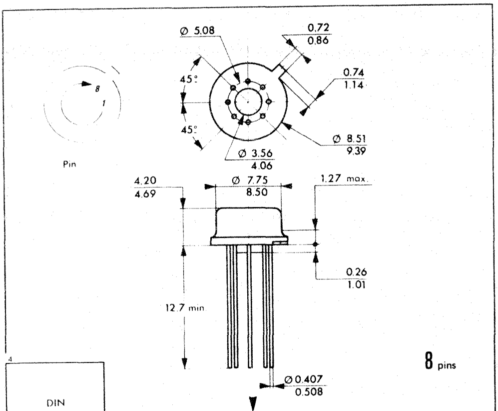


NEGATIVE OUTPUT VOLTAGE SWING VERSUS LOAD RESISTANCE



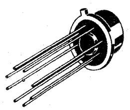
POWER BANDWIDTH
(Large signal swing versus frequency)



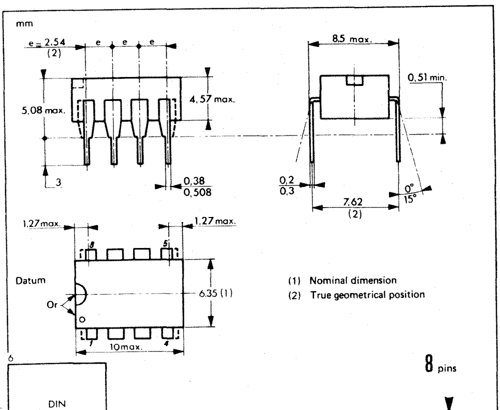


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

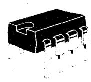


H SUFFIX
METAL CAN



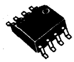
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98

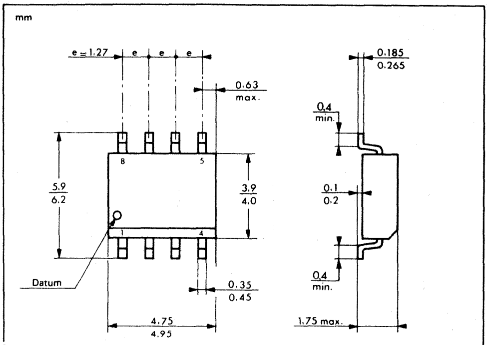


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE



DIN	SO8			8 pins
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TAA761C
TAA762M
TAA765I

OPEN COLLECTOR OUTPUT SINGLE OP-AMPs

These circuits are general purpose operational amplifiers built on a single silicon chip. They provide high voltage gain and an excellent temperature stability.

Frequency compensation is obtained with a single 50 pF capacitor. The amplifier is built with an input protection ; the principal advantage is the possibility to deliver an output current of 70 mA.

The TAA761 is specified over a large supply voltage range : ± 1.5 V to ± 18 V.
The TAA861 is specified over a large supply voltage range : ± 2 V to ± 10 V.

- High input impedance.
- High voltage gain.
- Open collector output.
- Output current : 70 mA.
- Supply voltage range : ± 2 V to ± 10 V (TAA861),
  ± 1.5 V to ± 18 V (TAA761).

ORDERING INFORMATION

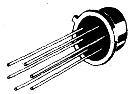
PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		H	DP
TAA761C	0°C to + 70°C	•	•
TAA762M	− 55°C to + 125°C	•	
TAA765I	− 25°C to + 85°C	•	•

Examples : TAA761CH, TAA765IDP

OPEN COLLECTOR OUTPUT SINGLE OPERATIONAL AMPLIFIERS

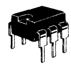
CASES

CB-107



H SUFFIX
METAL CAN

CB-116

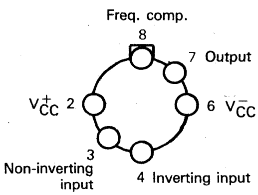


DP SUFFIX
PLASTIC PACKAGE

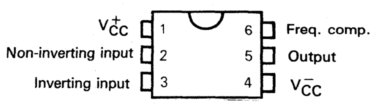
PIN ASSIGNMENTS

(Top views)

CB-107



CB-116



réf. 00320

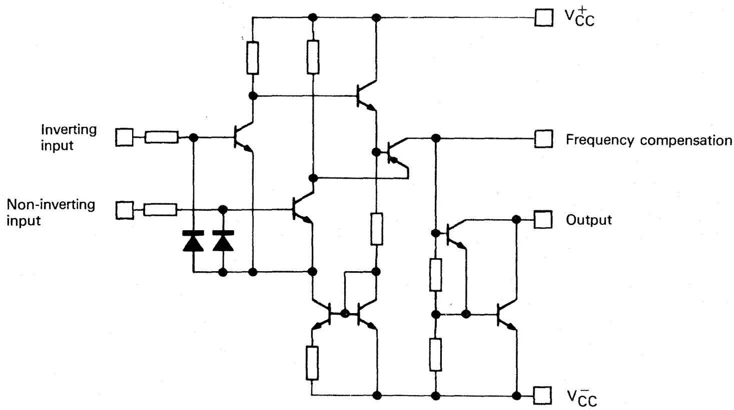
THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TAA762M	TAA765I	TAA761C	Unit
Supply voltage	V_{CC}	± 18	± 18	± 18	V
Differential input voltage	V_{ID}	± 1.5	± 1.5	± 1.5	V
Input voltage	V_I	$\pm V_{CC}$	$\pm V_{CC}$	$\pm V_{CC}$	V
Input offset current	I_{IO}	70	70	70	mA
Power dissipation	P_{tot}	500	500	500	mW
Operating free-air temperature range	T_{oper}	– 55 to + 125	– 25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	– 65 to + 150	°C
Junction temperature	T_j	+ 150	+ 150	+ 150	°C

SCHEMATIC DIAGRAM



CASE	Inverting input	Non-inverting input	V_{CC}^{-}	V_{CC}^{+}	Output	Frequency compensation
CB-116	3	2	4	1	5	6
CB-107	4	3	6	2	7	8

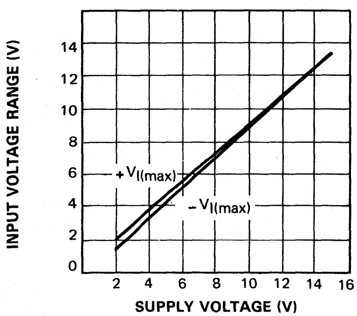
ELECTRICAL CHARACTERISTICS

TAA762M : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
TAA765I : $-25°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC} = \pm 15$ V
TAA761C : $0°C \leqslant T_{amb} \leqslant +70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

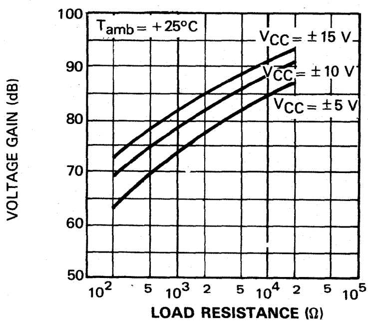
Characteristic	Symbol	TAA762M			TAA765I, TAA761C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 60\ \Omega$)	V_{IO}							mV
$T_{amb} = +25°C$, $R_L = 2$ kΩ		–	–	4	–	–	6	
$V_{CC} = \pm 5$ V		–	–	4	–	–	6	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	6	–	–	–	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$, $R_L = 2$ kΩ		–	50	100	–	80	300	
$V_{CC} = \pm 5$ V		–	–	70	–	–	300	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	300	–	–	–	
Input bias current	I_{IB}							μA
$T_{amb} = +25°C$		–	0.3	0.7	–	0.5	1	
$V_{CC} = \pm 5$ V		–	–	0.6	–	–	1	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	1	–	–	–	
Large signal voltage gain ($T_{amb} = +25°C$)	A_{VD}							dB
$R_L = 2$ kΩ, f = 1 kHz		85	87	–	81.5	85	–	
$R_L = 10$ kΩ, f = 1 kHz		–	92	–	–	90	–	
$R_L = 2$ kΩ, f = 1 MHz		–	43	–	–	43	–	
$R_L = 2$ kΩ, $V_{CC} = \pm 5$ V, f = 1 kHz		70	–	–	70	–	–	
Supply voltage rejection ratio	SVR	–	25	200	–	25	200	μV/V
Positive supply current	I_{CC}							mA
$T_{amb} = +25°C$		–	1.8	2.5	–	1.8	2.5	
$V_{CC} = \pm 5$ V		–	0.7	–	–	0.7	–	
Power consumption ($T_{amb} = +25°C$, $R_L = 2$ kΩ, $V_O \simeq 0$)	P_D	–	170	180	–	170	190	mW
Temperature coefficient of input offset voltage ($R_S = 60\ \Omega$)	αV_{IO}	–	6	25	–	6	–	μV/°C
Average temperature coefficient of input offset current ($R_S = 60\ \Omega$)	αI_{IO}	–	0.3	1.5	–	0.3	–	nA/°C
Input voltage range ($R_L = 2$ kΩ)	V_I	±12	±13.5	–	±12	±13.5	–	V
Common-mode rejection ratio ($T_{amb} = +25°C$, $R_L = 2$ kΩ)	CMR	70	81	–	65	79	–	dB
Output leakage current ($T_{amb} = +25°C$, $V_O = +15$ V)	I_{OH}	–	1	10	–	1	10	μA
Output voltage swing	V_{OPP}							V
$T_{amb} = +25°C$, $R_L = 2$ kΩ		14.9	–	−14	14.9	–	−14	
$R_L = 620\ \Omega$		14.9	–	−12.5	14.9	–	−12	
$V_{CC} = \pm 5$ V, $R_L = 2$ kΩ		4.9	–	−4	4.9	–	−4	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L = 2$ kΩ		14.8	–	−14	14.8	–	−14	
$R_L = 620\ \Omega$		14.8	–	−12	14.8	–	−12	
$V_{CC} = \pm 5$ V, $R_L = 2$ kΩ		4.8	–	−4	4.8	–	−4	
$T_{amb} = +25°C$, $R_L = 2$ kΩ, f = 100 kHz		–	±10	–	–	±10	–	
Slew rate	S_{VO}	–	9	–	–	9	–	V/μs
Equivalent input noise voltage according to DIN45405 standards	V_n	–	3	–	–	3	–	μV
Input resistance ($T_{amb} = +25°C$, f = 1 kHz)	R_I	–	200	–	–	200	–	kΩ

TAA762M - TAA765I

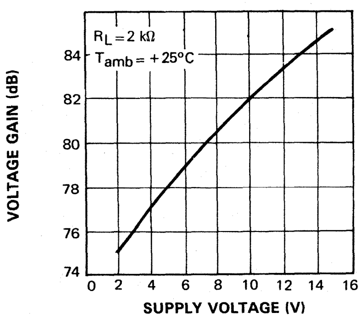
INPUT VOLTAGE RANGE (Note 1)



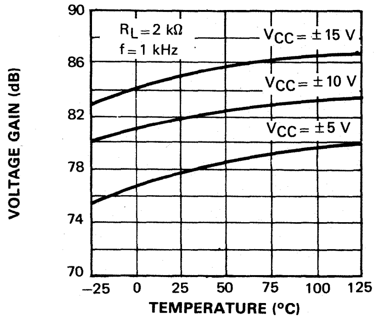
VOLTAGE GAIN



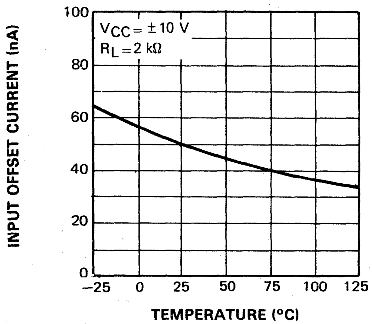
VOLTAGE GAIN (Note 1)



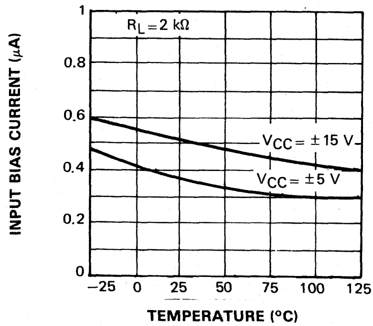
VOLTAGE GAIN



INPUT OFFSET CURRENT (Note 1)



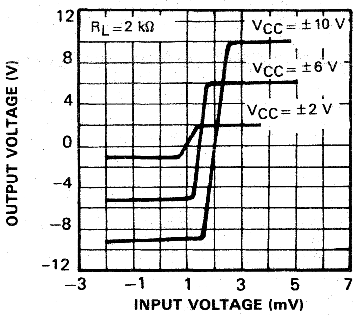
INPUT BIAS CURRENT



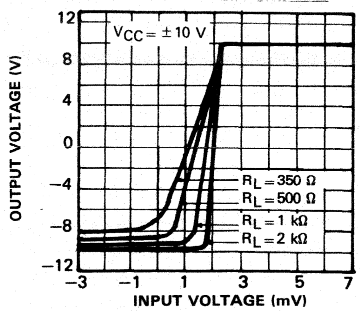
Note 1 : TAA762M : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V
TAA 765I : $-25°C \leq T_{amb} \leq +85°C$, $V_{CC} = \pm 15$ V
TAA761C : $0°C \leq T_{amb} \leq +70°C$, $V_{CC} = \pm 15$ V

TAA761C

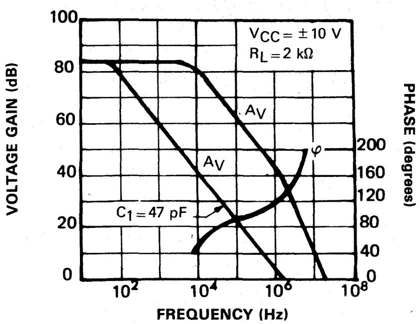
TRANSFER FUNCTION



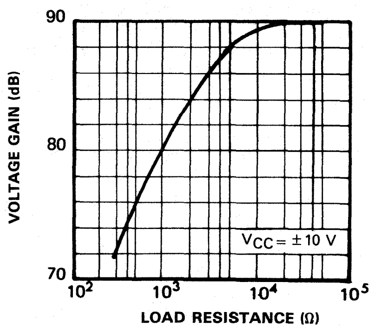
TRANSFER FUNCTION



OPEN LOOP FREQUENCY RESPONSE

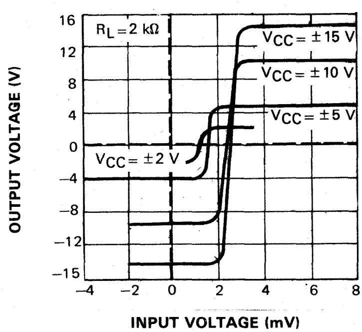


VOLTAGE GAIN

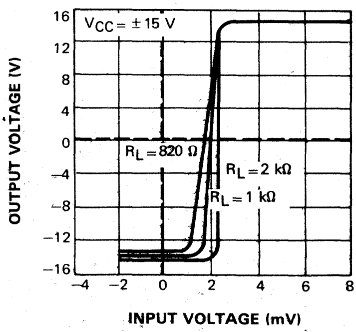


TAA762M - TAA765I

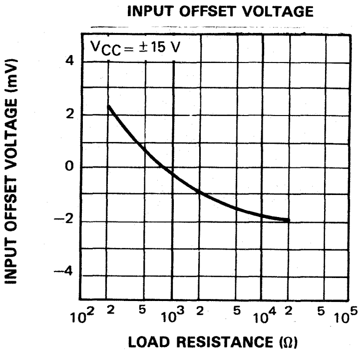
TRANSFER FUNCTION

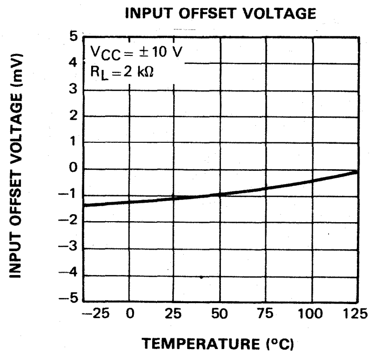


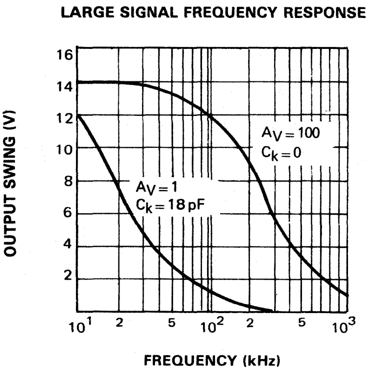
TRANSFER FUNCTION

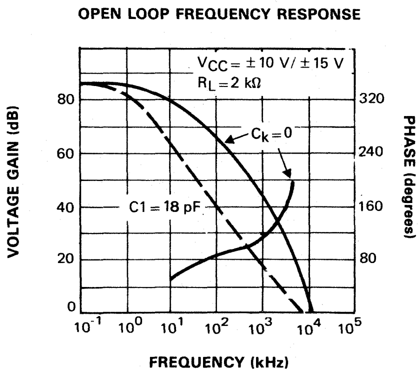


TAA762M - TAA765I



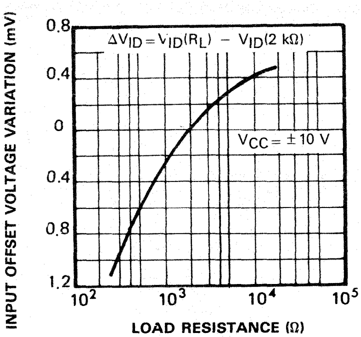




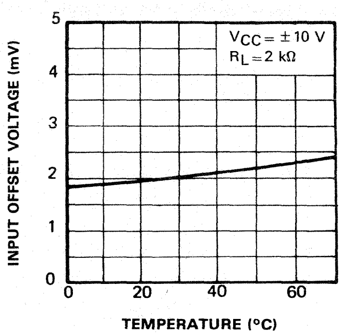


TAA761C

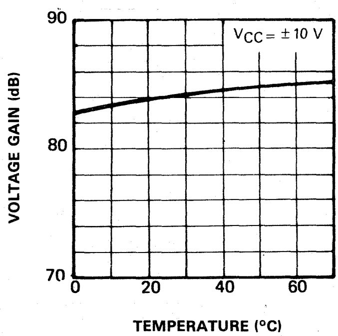
INPUT OFFSET VOLTAGE VARIATION



INPUT OFFSET VOLTAGE

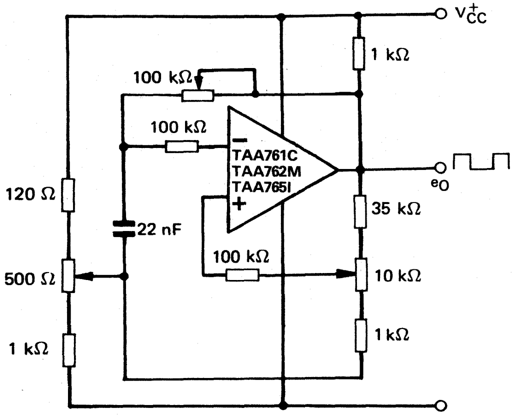


VOLTAGE GAIN

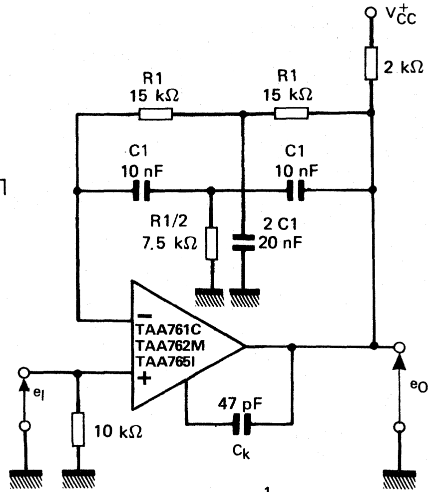


TYPICAL APPLICATIONS

PULSE GENERATOR

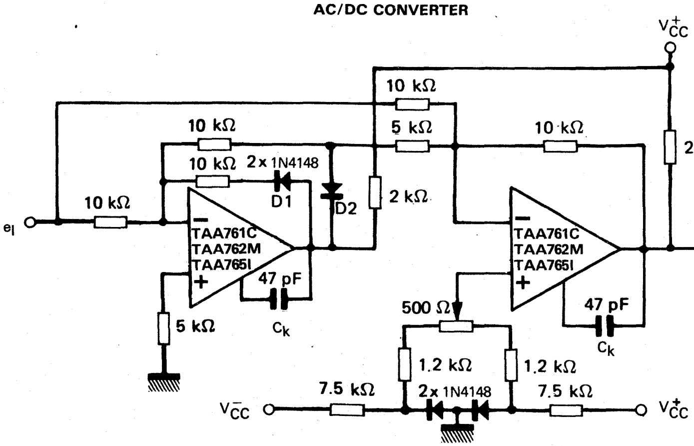


SELECTIVE AMPLIFIER

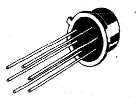


$$f_O = \frac{1}{2\pi R1\, C1}$$

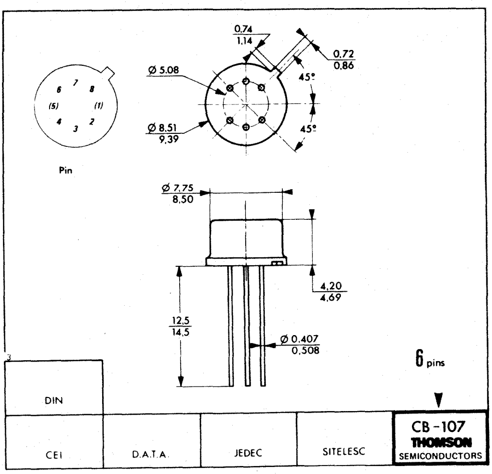
AC/DC CONVERTER



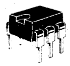
CB-107



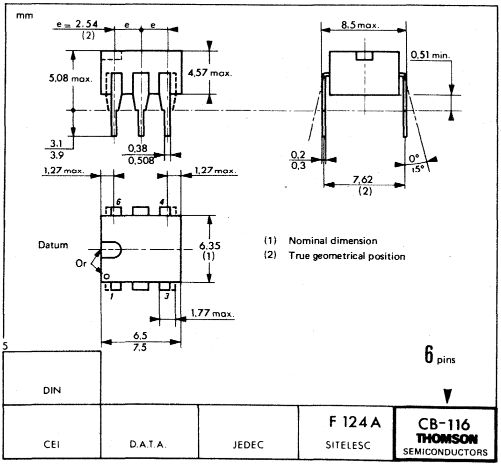
H SUFFIX
METAL CAN



CB-116



DP SUFFIX
PLASTIC PACKAGE



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

WIDEBAND SINGLE OPERATIONAL AMPLIFIER

The TDB2022-CM is a wideband monolithic operational amplifier. Its outstanding characteristics such as 150 MHz gain-bandwidth product and 50 V/µs slew rate make it particularly suitable for use as video frequency amplifier in TV signal processing applications.

The performances of the integrated video frequency amplifiers have been enhanced.

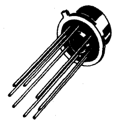
Operation from ± 15 V supplies.
3 dB noise figure.
Closed loop gain and phase irregularities with large input signals are minimized.

This circuit has been developed in co-operation with "Télé Diffusion de France".

- Input offset voltage : 5 mV max.
- Input bias current : 3 µA max.
- Input offset current : 1 µA max.
- Gain-bandwidth product : 95 MHz minimum.
- Slew rate : 40 V/µs min.
- Output short circuit current limited for indefinite duration.

WIDEBAND SINGLE OPERATIONAL AMPLIFIER

CASE CB-11



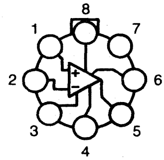
CM SUFFIX
METAL CAN

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
		CM
TDB2022	0°C to +70°C	•
Example : TDB2022CM		

PIN ASSIGNMENT

(Top view)



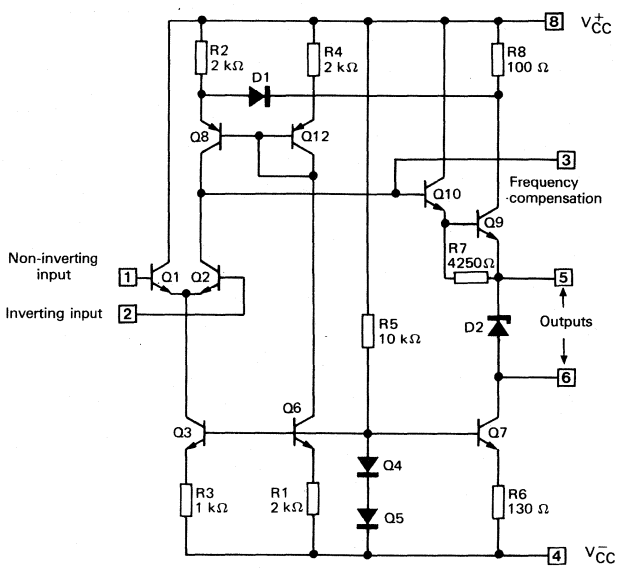
1 - Non-inverting input
2 - Inverting input
3 - Frequency compensation
4 - V_{CC}^-
5 - Output
6 - Output
7 - NC
8 - V_{CC}^+

Réf. 00300

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	± 18	V
Input voltage	V_I	± 10	V
Differential input voltage	V_{ID}	5	V
Output short-circuit duration	–	Indefinite	–
Power dissipation	P_{tot}	500	mW
Operating free-air temperature range	T_{oper}	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

SCHEMATIC DIAGRAM



CASE	V_{CC}^-	V_{CC}^+	Inverting input	Non-inverting input	Frequency compensation	Outputs	N.C.
CB-11	4	8	2	1	3	6, 5	7

ELECTRICAL CHARACTERISTICS

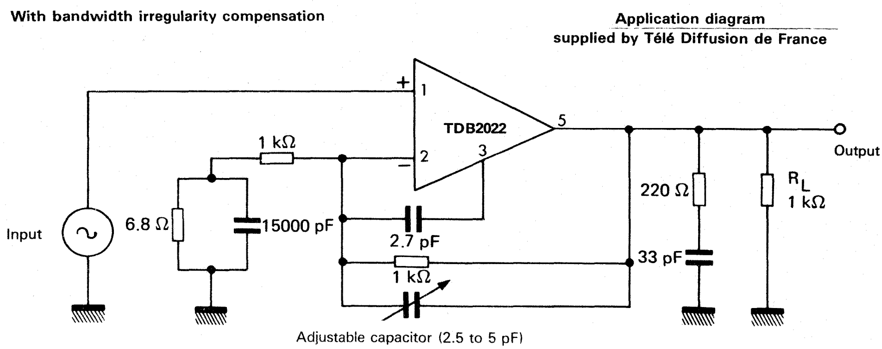
$T_{amb} = +25°C$
$V_{CC}^{+} = +12\ V$
$V_{CC}^{-} = -12\ V$
(Unless otherwise specified)

Characteristic	Symbol	Value			Unit
		Min	Typ	Max	
Input offset voltage ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	V_{IO}	—	2.8	5	mV
Input offset current ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	I_{IO}	—	0.18	1	μA
Input bias current ($R_S = 1\ k\Omega$, $R_L = 100\ k\Omega$)	I_{IB}	—	1.5	3	μA
Differential mode voltage gain ($R_S = 100\ \Omega$, $R_L = 1\ k\Omega$, $f = 10\ kHz$) - Fig. 7	A_{VD}	900	1500	—	V/mV
Supply voltage V_{CC}^{+} rejection ratio ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	SVR^{+}	50	65	—	dB
Supply voltage V_{CC}^{-} rejection ratio ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	SVR^{-}	80	92	—	dB
Supply currents ($R_S = 1\ k\Omega$, $R_L = 100\ k\Omega$)	I_{CC}^{+}, I_{CC}^{-}	—	8	10	mA
Temperature coefficient of input offset voltage ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	αV_{IO}	—	3	20	μV/°C
Common-mode rejection ratio ($R_S = 2\ k\Omega$, $R_L = 100\ k\Omega$)	CMR	80	87	—	dB
Slew rate ($R_L = 1\ k\Omega$) $A_V = +2$ (Figs. 1, 2, 3) $A_V = +6$ (Figs. 5, 6)	S_{VO}	 — —	 50 60	 — —	V/μs
Output(5) current Sourcing current Sinking current	 $I_{05\ (source)}$ $I_{05\ (sink)}$	 — —	 10 3.5	 — —	mA
Output voltage swing ($A_V = +6$, $f = 4.43\ MHz$, $R_L = 1\ k\Omega$) - Note 2 - Fig. 5	V_{OPP}	—	4	—	V
Output voltage swing Output 5 : $R_S = 1\ k\Omega$ $R_L = 100\ k\Omega$ Output 6 : $R_S = 1\ k\Omega$ $R_L = 100\ k\Omega$	 $V_{OPP(5)}$ $V_{OPP(6)}$		 +3.2 −8.6 +1.0 −1.7		V
Output impedance ($R_S = 100\ \Omega$, $f = 50\ kHz$) - Output 5	$Z_{O(5)}$	—	40	—	Ω
Differential input impedance ($R_S = 1\ k\Omega$, $R_L = 100\ k\Omega$)	$Z_{id(1)}$ $Z_{id(2)}$	— —	50 10	— —	kΩ
Input capacitance	C_I	—	5	—	pF
Transition frequency $R_S = 100\ \Omega$, $R_L = 1\ k\Omega$, $f = 10\ MHz$, inverting amplifier $A_V = -10$ - Figs. 7, 8.	f_T	 95	 150	 —	MHz
Noise figure (Center frequency : 10 kHz)	F	—	1.5	3	dB
Equivalent input noise voltage (Bandwidth : 200 Hz)	v_n	—	3.3	—	nV/√Hz
Equivalent input noise current (Figs. 9, 10)	i_n	—	1.1	—	pA/√Hz

Note 1 : Output voltage swing V_{OPP} is maximum allowable output amplitude peak to peak. 2nd or 3rd harmonic ratio less than −40 dB.

TYPICAL APPLICATIONS

FIGURE 1 : NON-INVERTING AMPLIFIER ($A_V = +2$)



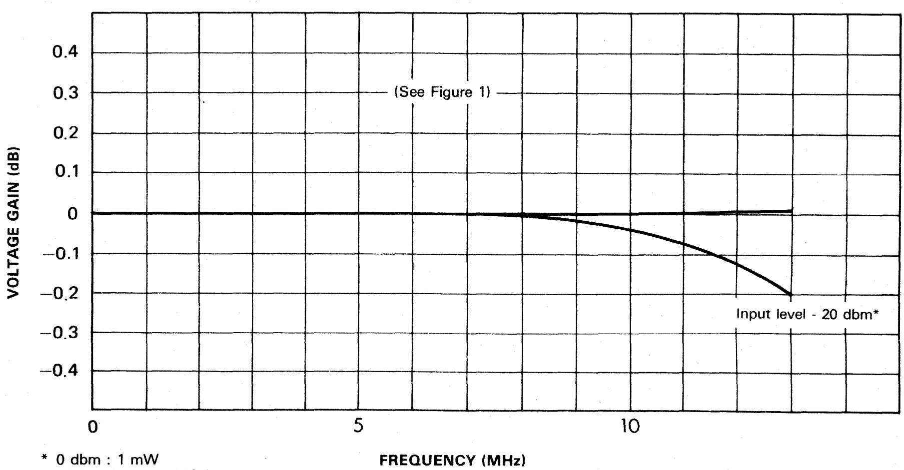
Input signal : −0.7 V to +0.7 V

Differential gain : 0.25% (0.02 dB)

Differential phase shift : 0.1 degree

Slew rate : 50 V/μs

FIGURE 2 : VOLTAGE GAIN VERSUS FREQUENCY OF NON-INVERTING AMPLIFIER ($A_V = +2$)



* 0 dbm : 1 mW
with resistance of 50 Ω

TYPICAL APPLICATIONS (continued)

FIGURE 3 : SLEW RATE

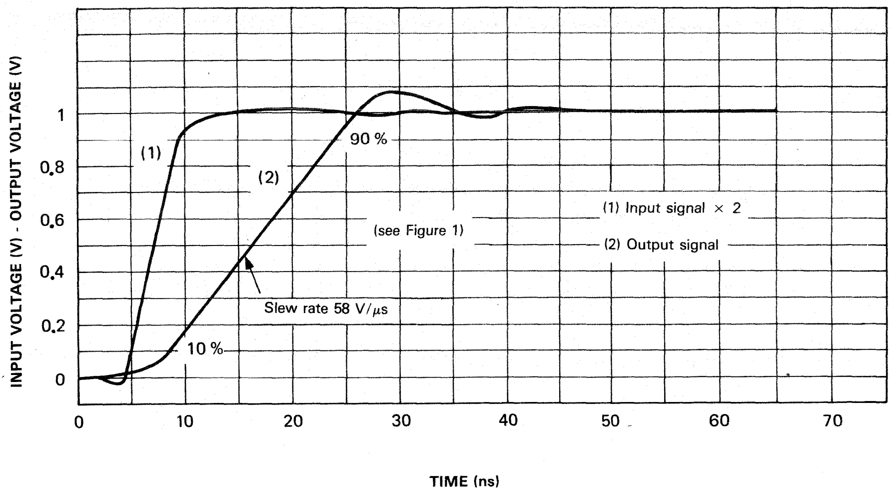
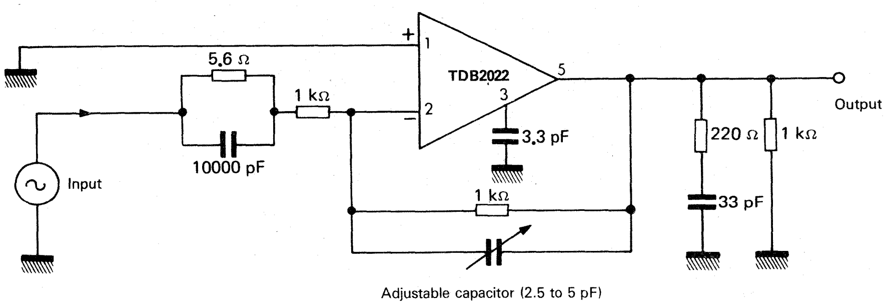


FIGURE 4 : INVERTING AMPLIFIER ($A_V = -1$)

With bandwidth irregularity compensation

Application diagram supplied by Télé Diffusion de France



Input signal : −0.7 V to +0.7 V
Differential gain : 0.25% (0.02 dB)

Differential phase shift : 0.1 degree
Slew rate : 40 V/µs

TYPICAL APPLICATIONS (continued)

FIGURE 5 : NON-INVERTING AMPLIFIER ($A_V = +6$)

Without bandwidth compensation

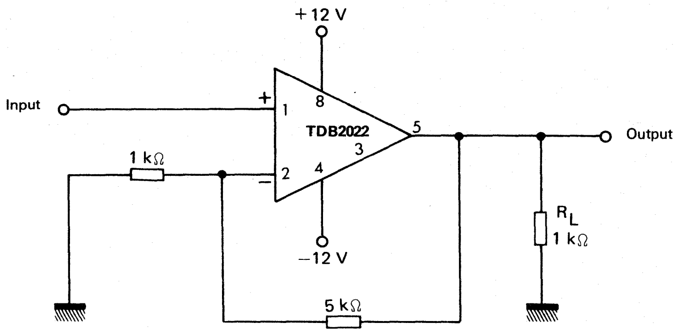
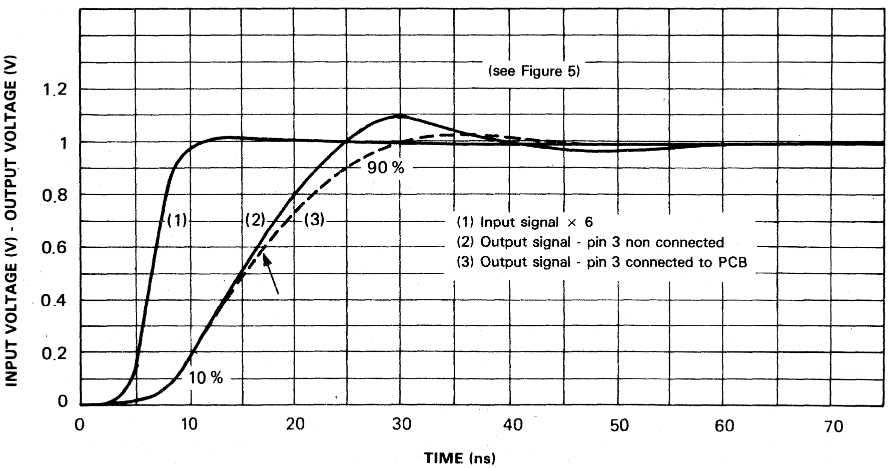


FIGURE 6 : MEASUREMENT OF SLEW RATE



TYPICAL APPLICATIONS (continued)

FIGURE 7 : INVERTING AMPLIFIER ($A_V = -10$)

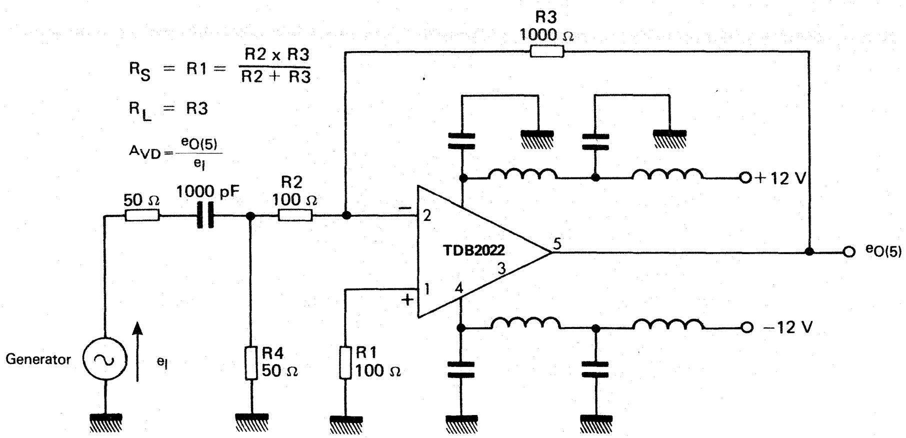
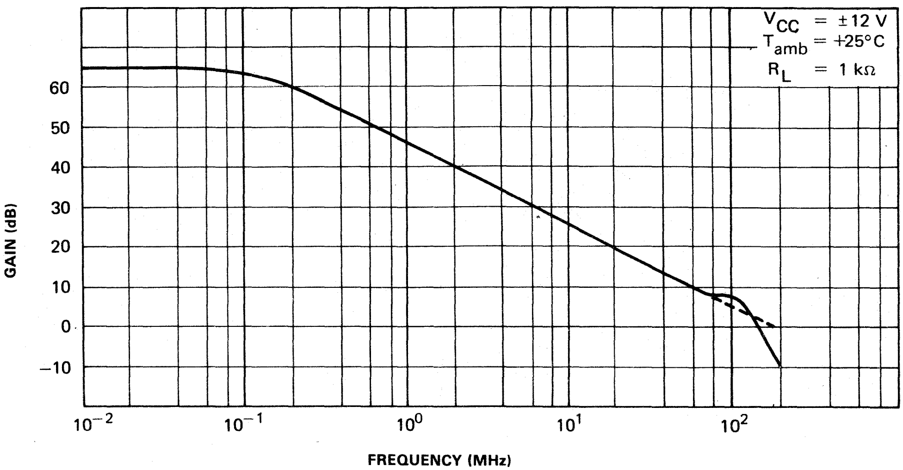


FIGURE 8 : GAIN VERSUS FREQUENCY - OPEN LOOP



TYPICAL APPLICATIONS (continued)

FIGURE 9 : NOISE FIGURE TEST CIRCUIT

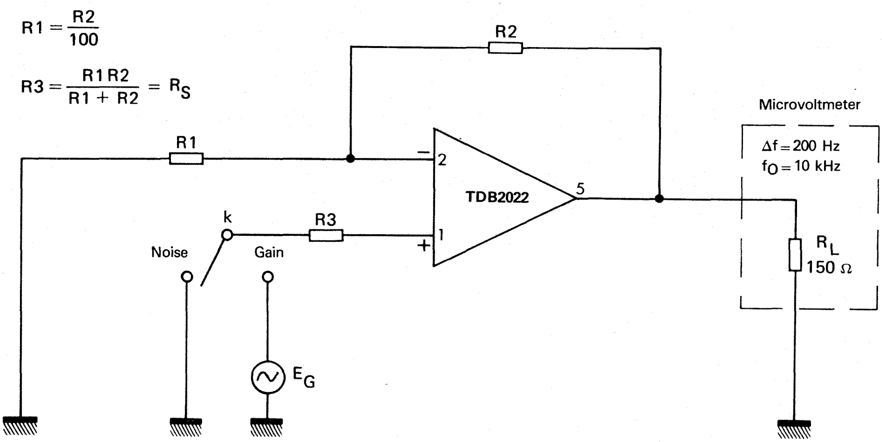
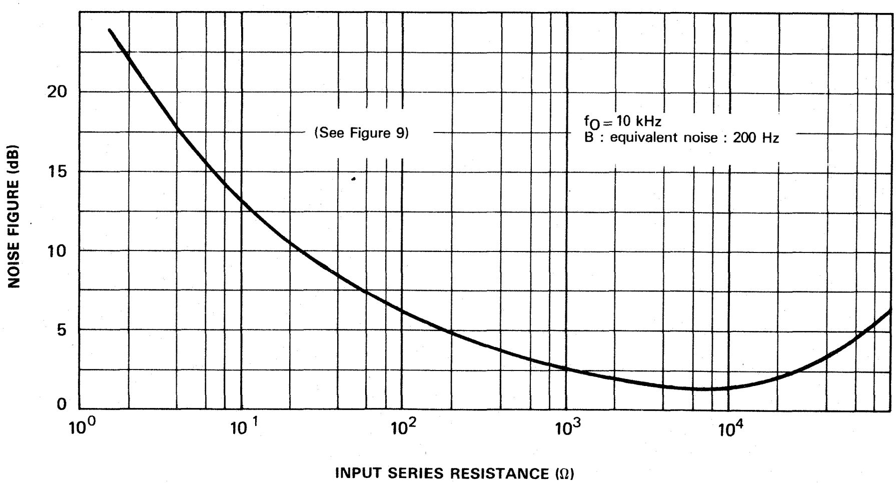
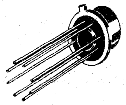


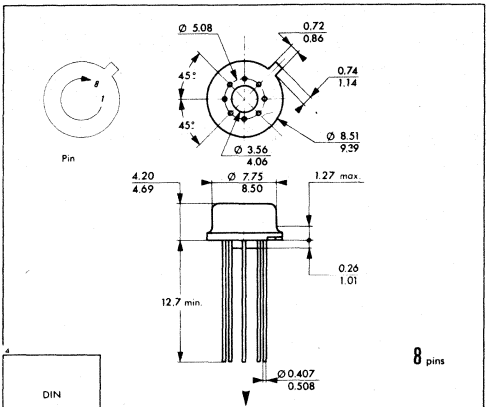
FIGURE 10 : NOISE FIGURE



CB-11
(TO-99)



CM SUFFIX
METAL CAN



Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TDB7910

POWER SINGLE OPERATIONAL AMPLIFIER

The TDB7910 is an internally compensated medium power operational amplifier intended for use in those applications requiring load currents of several hundred milliamperes. Applications include servo amplifiers, driver interfaces, precision power comparators and motor speed control.

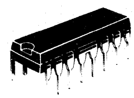
The amplifier is designed to operate from a single or dual power supplies and the input common-mode range includes the negative supply if balance inputs are tied to the negative supply.

The TDB7910 is thermal overload and short-circuit protected.

- Output current up to 500 mA
- Offset voltage null capability
- Short-circuit protection
- Thermal overload protection
- Plastic package for easy assembly

POWER SINGLE OPERATIONAL AMPLIFIER

CASE CB-502



DP SUFFIX
PLASTIC PACKAGE

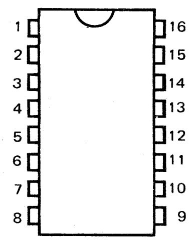
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE DP
TDB7910	0°C to +70°C	•
Example : TDB7910DP		

PIN ASSIGNMENT

(Top view)

CB-502



1 - V_{CC}^-
2 - V_{CC}^-
3 - NC
4 - V_{CC}^-
5 - V_{CC}^-
6 - Output
7 - V_{CC}^+
8 - Current limiting
9 - Compensation
10 - Non-inverting input
11 - Inverting input
12 - V_{CC}^-
13 - V_{CC}^-
14 - Balance
15 - Balance
16 - Compensation

Ref. 00835

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

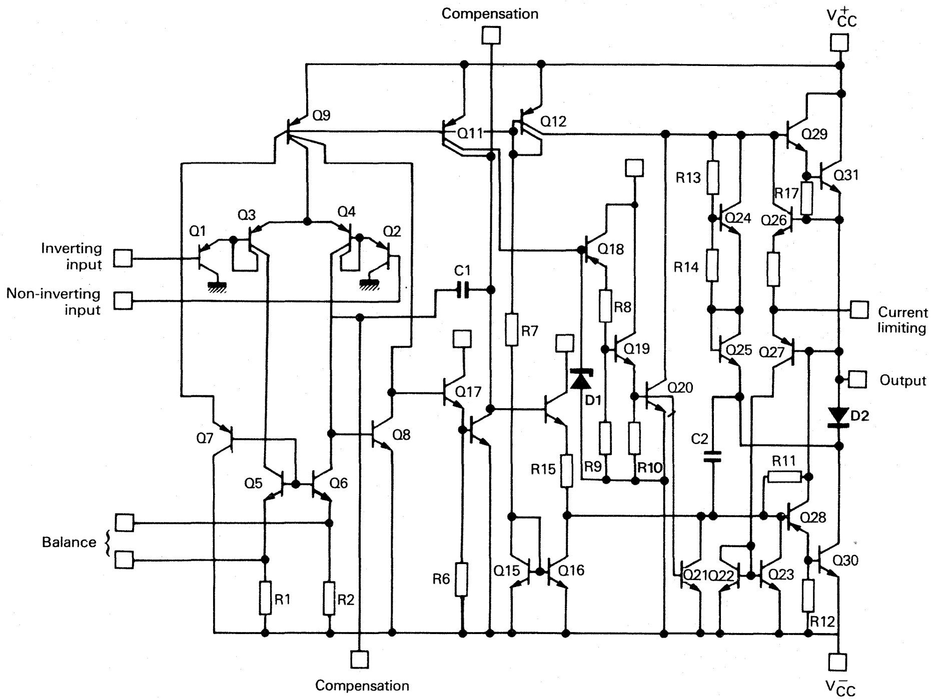
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	± 18	V
Input voltage	V_I	± 15	V
Differential input voltage	V_{ID}	± 30	V
Output current*	I_O	0.75	A
Power dissipation	P_{tot}	15	W
Operating free-air temperature range	T_{oper}	0 to + 70	°C
Storage temperature range	T_{stg}	– 55 to + 70	°C

* Under short-circuit conditions, the safe operating area and dc power dissipation limitations must be observed

SCHEMATIC DIAGRAM



CASE	V_{CC}^-	NC	V_{CC}^+	Output	Current limiting	Compensation	Non-inverting input	Inverting input	Balance
CB-502	1, 2 4, 5 12, 13	3	7	6	8	9, 16	10	11	14, 15

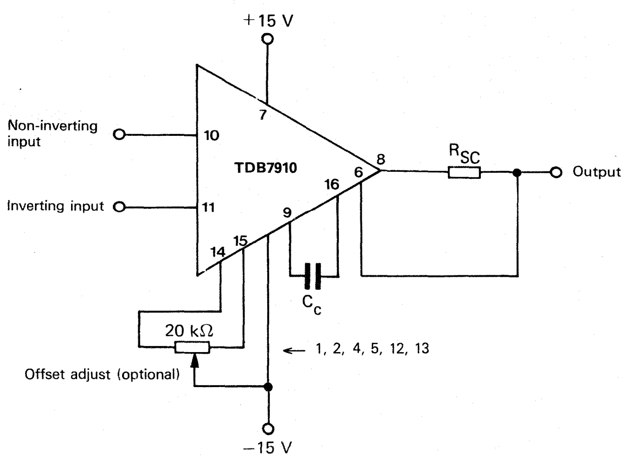
2.4

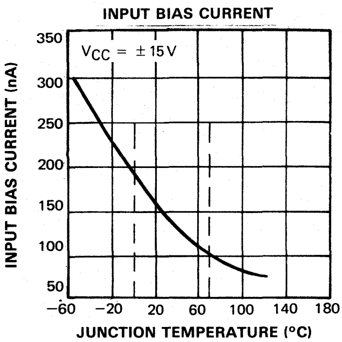
ELECTRICAL CHARACTERISTICS

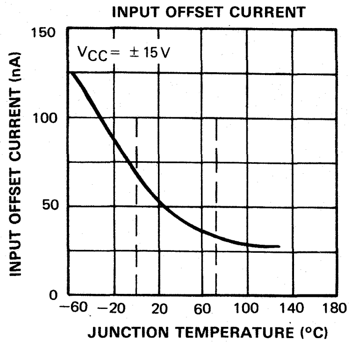
TDB7910 : 0°C $\leqslant T_{amb} \leqslant$ +70°C, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

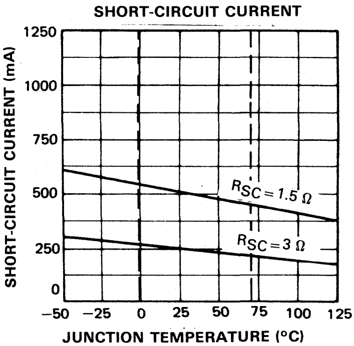
Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}				mV
$T_{amb} = +25°C$		–	2	6	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	7.5	
Input offset current	I_{IO}				nA
$T_{amb} = +25°C$		–	20	200	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	300	
Input bias current	I_{IB}				nA
$T_{amb} = +25°C$		–	80	500	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	800	
Large signal voltage gain ($R_L = 47$ Ω)	A_{VD}				V/mV
$T_{amb} = +25°C$		20	–	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	
Supply currents (no signal)	I_{CC}^+, I_{CC}^-				mA
$T_{amb} = +25°C$		–	–	20	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	25	
Input voltage range	V_I	± 12	± 13	–	V
Output circuit current ($T_{amb} = +25°C$)	I_{OS}				A
$R_{SC} = 0.7$ Ω		–	1	–	
$R_{SC} = 1.5$ Ω		–	0.5	–	
Supply voltage rejection ratio	SVR	–	–	150	µV/V
Common-mode rejection ratio	CMR	70	–	–	dB
Input impedance ($T_{amb} = +25°C$)	Z_I	0.3	1	–	MΩ
Output voltage swing ($R_{SC} = 0$, $R_L = 47$ Ω)	V_{OPP}				V
$T_j = +25°C$		± 11.5	± 12.5	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		± 10	–	–	
Offset voltage adjustment range	V_{IOR}	–	± 15	–	mV
Slew rate ($R_L = 47$ Ω, $T_{amb} = +25°C$, $C_C = 100$ pF, $A_V = 1$	SVO	–	0.3	–	V/µs
Small signal bandwidth ($C_C = 0$, $T_{amb} = +25°C$)	GW_R	–	1	–	MHz

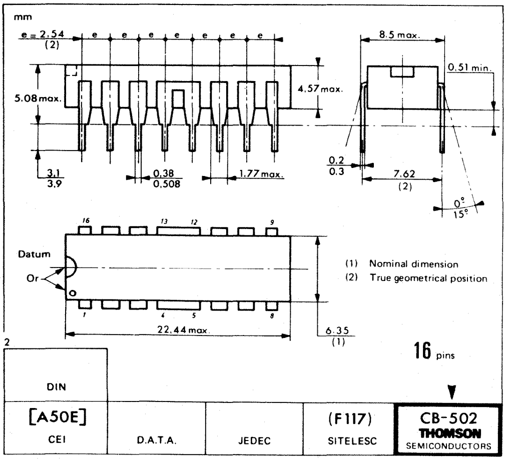
BASIC DIAGRAM



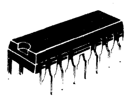








CB-2



DP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TEB1033
TEF1033
TEC1033

ADVANCE INFORMATION

DUAL OPERATIONAL AMPLIFIERS

The TE●1033 are high performance dual-operational amplifiers intented for active filter applications. The internal phase compensation allows stable operation as voltage follower in spite of their high gain-bandwidth products.

The circuits present very stable electrical characteristics over the entire supply voltage range.

- Single or split supply operation
- Low distorsion ratio
- Low noise
- Very low supply current
- Low input offset current
- Low input offset voltage
- Large common-mode range
- High gain
- High ouptut current
- High gain-bandwidth product

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

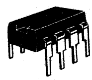
PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		DP	FP	GC
TEB1033	0°C to + 70°C	●	●	
TEF1033	−40°C to + 85°C		●	
TEC1033	−55°C to +125°C			●

Examples : TEB1033DP, TEC1033GC

DUAL OPERATIONAL AMPLIFIERS

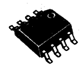
CASES

CB-98



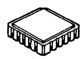
DP SUFFIX
PLASTIC PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

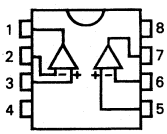
CB-705



GC SUFFIX
TRICECOP (LCC)

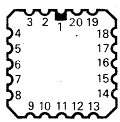
PIN ASSIGNMENTS

(Top views)



CB-98
CB-342

1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{-}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^{+}



CB-705

1 - NC
2 - Output 1
3 - NC
4 - NC
5 - Inverting input 1
6 - NC
7 - Non-inverting input 1
8 - NC
9 - NC
10 - V_{CC}^{-}
11 - NC
12 - Non-inverting input 2
13 - NC
14 - NC
15 - Inverting input 2
16 - NC
17 - Output 2
18 - NC
19 - NC
20 - V_{CC}^{+}

THOMSON SEMICONDUCTORS
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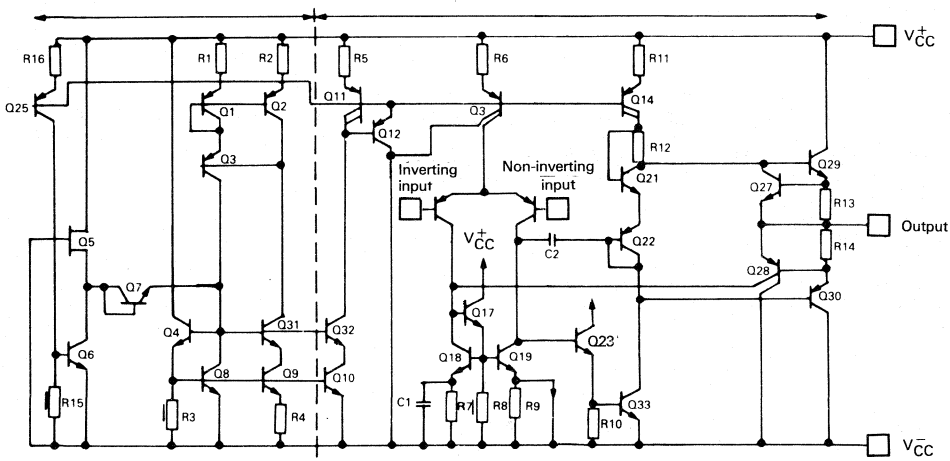
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	± 18	V
Input voltage	V_I	$\pm V_{CC}$	V
Differential input voltage	V_{ID}	$\pm (V_{CC} - 1)$	V
Power dissipation TEB1033FP, TEF1033 FP TEB1033DP TEB1033GC	P_{tot}	 400 665 665	mW
Operating free-air temperature range TEB1033 TEF1033 TEC1033	T_{oper}	 0 to + 70 – 40 to + 85 – 55 to + 125	°C
Storage temperature range	T_{stg}	– 55 to + 150	°C

SCHEMATIC DIAGRAM
(1/2 TEB1033)



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^{+}	V_{CC}^{-}	N.C.
CB-98 **CB-342**	1, 7	2, 6	3, 5	8	4	
CB-705	2, 17	5, 15	7, 12	20	10	*

* **CB705** : Other pins are not connected

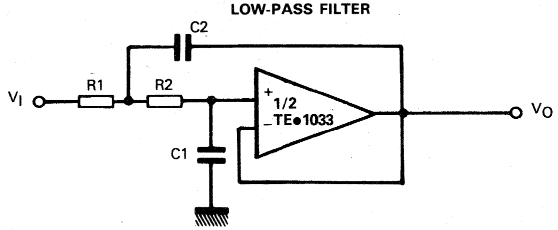
ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$
(Unless otherwise specified)

Characteristics	Symbol	Min	Typ	Max	Unit
Input offset voltage ($R_S \leq 10$ kΩ) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$, $R_S \leq 10$ kΩ	V_{IO}	 — —	 0.3 —	 3 5	mV
Input offset voltage drift ($R_S = 10$ kΩ, $T_{min} \leq T_{amb} \leq T_{max}$)	ΔV_{IO}	—	5	—	µV/°C
Input offset current $T_{min} \leq T_{amb} \leq T_{max}$	I_{IO}	— —	10 —	50 100	nA
Input offset current drift ($T_{min} \leq T_{amb} \leq T_{max}$)	ΔI_{IO}	—	0.1	—	nA/°C
Input bias current $T_{min} \leq T_{amb} \leq T_{max}$	I_{IB}	— —	50 —	200 500	nA
Large signal open loop voltage gain ($R_L = 2$ kΩ, $T_{min} \leq T_{amb} \leq T_{max}$)	A_{VD}	86	100	—	dB
Supply voltage rejection ratio ($V_I = +1$ V, f = 100 Hz, $T_{min} \leq T_{amb} \leq T_{max}$)	SVR	86	—	—	dB
Supply current	I_{CC}	—	1	1.5	mA
Common-mode rejection ($V_I = +10$ V, $T_{min} \leq T_{amb} \leq T_{max}$)	CMR	86	—	—	dB
Short-circuit output current	I_{OS}	—	23	—	mA
Output voltage swing $R_L = 2$ kΩ, $V_{CC} = \pm 15$ V $V_{CC} = \pm 4$ V $R_L = 600$ Ω, $V_{CC} = \pm 6$ V	V_{OPP}	 ±13 — ±4.6	 — ±3 —	 — — —	V
Input resistance (f = 1 kHz)	R_I	—	0.5	—	MΩ
Gain-bandwidth product (f = 20 kHz)	GB_p	1.5	2.5	—	MHz
Slew rate ($R_L = 2$ kΩ, unity gain)	S_{VO}	—	1	—	V/µs
Total input noise voltage (f = 1 kHz) $R_S = 50$ Ω $R_S = 1$ kΩ $R_S = 10$ kΩ	V_n	 — — —	 10 12 20	 — — —	nV/√Hz
Distortion ($A_V = 20$ dB, $R_L = 2$ kΩ, $V_O = 2$ V_{pp}, f = 1 kHz)	D	—	0.03	0.1	%
Large signal voltage swing ($R_L = 10$ kΩ, f = 10 kHz)	V_{OPP}	—	28	—	V_{pp}
Channel separation (f = 1 kHz)	V_{O1}/V_{O2}	—	120	—	dB

TYPICAL APPLICATION

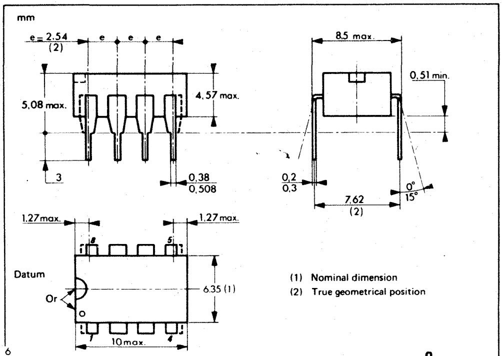
LOW-PASS FILTER



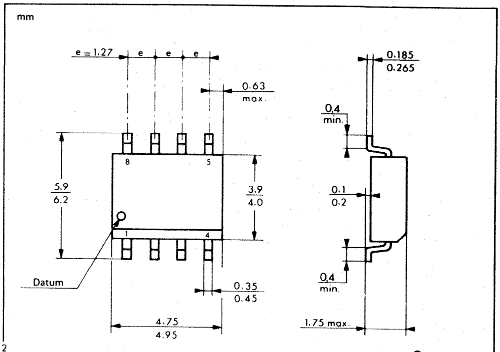
$$\frac{V_O}{V_I} = \frac{1}{1 + 2\xi \frac{S}{\omega_c} + \frac{S^2}{\omega_c^2}}$$

$\omega_c = 2\pi f_c$, with f_c = cutt-off frequency

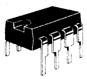
ξ = damping factor



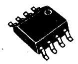
DIN				
A50D			F 116 A	CB-98 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	



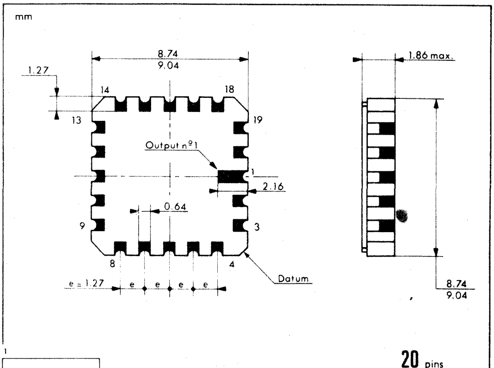
DIN	SO8			
				CB-342 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	



CB-98
DP SUFFIX
PLASTIC PACKAGE

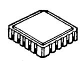


CB-342
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
MS004 CB		TMS004 CB		CB-705 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	

CB-705



GC SUFFIX
TRICECOP (LCC)

This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL061
TL061A
TL061B

LOW POWER J-FET INPUT SINGLE OP-AMP

The TL061, TL061A and TL061B are high speed J-FET input single operational amplifier family. Each of these J-FET input operational amplifiers incorporates well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

- Very low power consumption
- Wide common-mode and differential voltage ranges
- Low input bias and offset currents
- Typical supply current : 200 μA
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate : 3.5 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

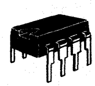
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	FP	H	GC
TL061M	−55°C to +125°C			•	•
TL061I	−25°C to + 85°C	•			
TL061C	0°C to + 70°C	•	•		
TL061AC	0°C to + 70°C	•			
TL061BC	0°C to + 70°C	•			

Examples : TL061MH, TL061IDP

LOW POWER J-FET INPUT SINGLE OP-AMP

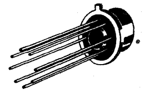
CASES

CB-98



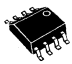
DP SUFFIX
PLASTIC PACKAGE

CB-11



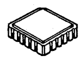
H SUFFIX
METAL CAN

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

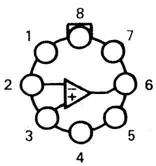
CB-705



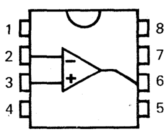
GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS
(Top views)

CB-11

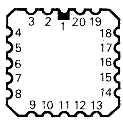


CB-98
CB-342



1 - Balance
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^{-}
5 - Balance
6 - Output
7 - V_{CC}^{+}
8 - NC

CB-705



1 - NC
2 - Balance
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^{-}
11 - NC
12 - Balance
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^{+}
18 - NC
19 - NC
20 - NC

Réf. 00280

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TL061M	TL061I	TL061C	Unit
Supply voltage (Note 1)	V_{CC}	± 18	± 18	± 18	V
Differential input voltage (Note 2)	V_{ID}	± 30	± 30	± 30	V
Input voltage (Note 3)	V_I	± 15	± 15	± 15	V
Output short-circuit duration (Note 4)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation (Note 5)	P_{tot}	680	680	680	mW
Operating free-air, temperature range	T_{oper}	− 55 to + 125	− 25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

* Devices bonded on a 6 cm × 0.15 cm glass epoxy substrate with 30 mm² of 35 μm thick copper.

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

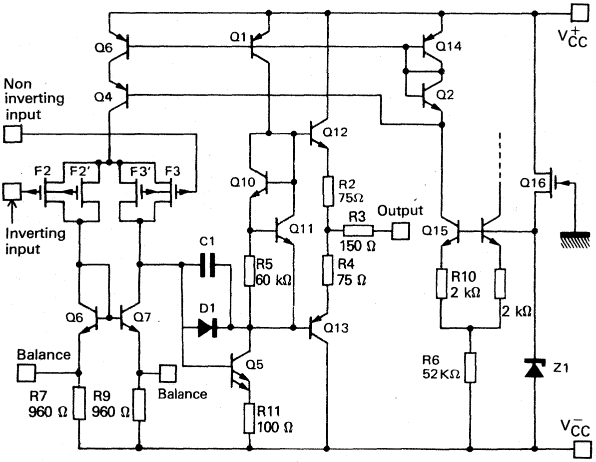
Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceed.

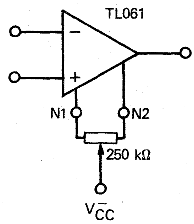
Note 5 : For operation above + 25°C free-air temperature, refer to dissipation derating table.

SCHEMATIC DIAGRAM



INPUT OFFSET VOLTAGE

NULL CIRCUITS



CASE	Balance	Inverting input	Non-inverting input	V_{CC}^-	V_{CC}^+	Output	N.C
CB-98 CB-342 CB-11	1, 5	2	3	4	7	6	8
CB-705	2, 12	5	7	10	17	15	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL061M : $-55°C \leq T_{amb} \leq +125°C$
TL061I : $-25°C \leq T_{amb} \leq +85°C$
TL061C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL061M			TL061I			TL061C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}										mV
$T_{amb} = +25°C$, $R_S = 50\ \Omega$		–	3	6	–	3	6	–	5	15	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_S = 50\ \Omega$		–	–	9	–	–	9	–	–	20	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	100	–	5	100	–	5	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	20	–	–	10	–	–	5	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	400	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	50	–	–	20	–	–	10	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	±11	±12	–	±11.5	±12	–	±10	±11	–	V
Output voltage swing :	V_{OPP}										V
$R_L = 10\ k\Omega$, $T_{amb} = +25°C$		20	27	–	20	27	–	20	27	–	
$R_L \geq 10\ k\Omega$, $T_{min} \leq T_{amb} \leq T_{max}$		20	–	–	20	–	–	20	–	–	
Large signal voltage gain	A_{VD}										V/mV
$T_{amb} = +25°C$, $R_I \geq 10\ k\Omega$, $V_O = \pm 10$ V		4	6	–	4	6	–	3	6	–	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V		4	–	–	4	–	–	3	–	–	
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10\ k\Omega$)	GW_R	–	1	–	–	1	–	–	1	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ration ($R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$		80	95	–	80	95	–	70	95	–	
Supply current ($T_{amb} = +25°C$, no load, no signal)	I_{CC}	–	200	250	–	200	250	–	200	250	μA
Total power consumption (each amplifier)	P_D										mW
$T_{amb} = +25°C$, no load, no signal		–	6	7.5	–	6	7.5	–	6	7.5	

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	TL061M			TL061I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	S_{VO}	2	3.5	–	–	3.5	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	t_r	–	0.2	–	–	0.2	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage ($R_S = 100\ \Omega$; f = 1 kHz)	V_n	–	42	–	–	42	–	nV/√Hz

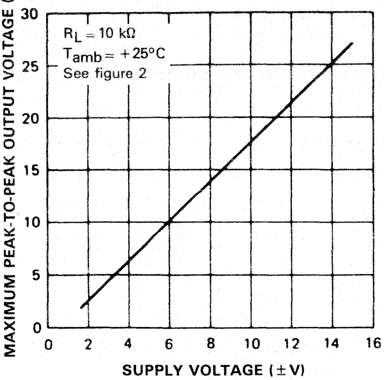
ELECTRICAL CHARACTERISTICS
TL061C : $0°C \leqslant T_{amb} \leqslant +70°C$
$V_{CC} = \pm 15$ V
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL061C			TL061AC			TL061BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}										mV
$T_{amb} = +25°C$, $R_S = 50\ \Omega$		–	3	15	–	3	6	–	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_S = 50\ \Omega$		–	–	20	–	–	7.5	–	–	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	200	–	5	100	–	5	100	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	5	–	–	3	–	–	3	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	400	–	30	200	–	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	10	–	–	7	–	–	7	nA
Input common-mode voltage range	V_I	±10	±11	–	±11.5	±12	–	±11.5	±12	–	V
Output voltage swing :	V_{OPP}										V
$R_L = 10$ kΩ, $T_{amb} = +25°C$		20	27	–	20	27	–	20	27	–	
$R_L \geqslant 10$ kΩ, $T_{min} \leqslant T_{amb} \leqslant T_{max}$		20	–	–	20	–	–	20	–	–	
Large signal voltage gain	A_{VD}										V/mV
$T_{amb} = +25°C$, $R_I \geqslant 10$ kΩ, $V_O = \pm 10$ V		3	6	–	4	6	–	4	6	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		3	–	–	4	–	–	4	–	–	
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10$ kΩ)	GW_R	–	1	–	–	1	–	–	1	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ration ($R_S \geqslant 10$ kΩ ; $T_{amb} = +25°C$)	CMR	70	76	–	80	86	–	80	86	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geqslant 10$ kΩ ; $T_{amb} = +25°C$		70	95	–	80	95	–	80	95	–	
Supply current ($T_{amb} = +25°C$, no load, no signal)	I_{CC}	–	200	250	–	200	250	–	200	250	μA
Total power consumption (each amplifier)	P_D										mW
$T_{amb} = +25°C$, no load, no signal		–	6	7.5	–	6	7.5	–	6	7.5	

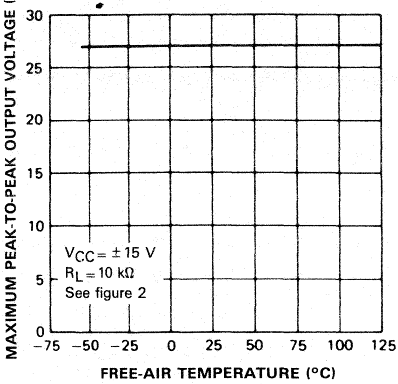
* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

TYPICAL CHARACTERISTICS

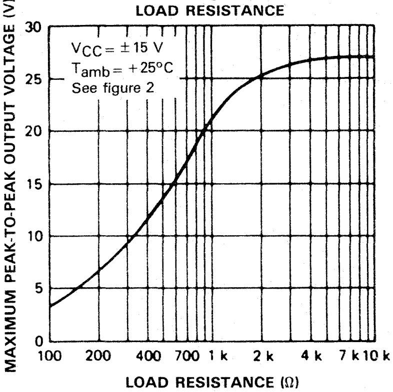
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE



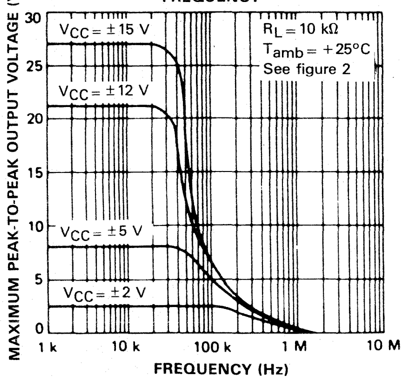
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE



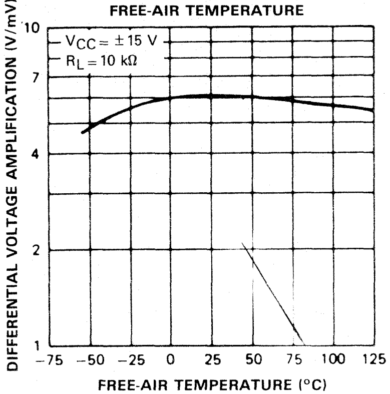
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE



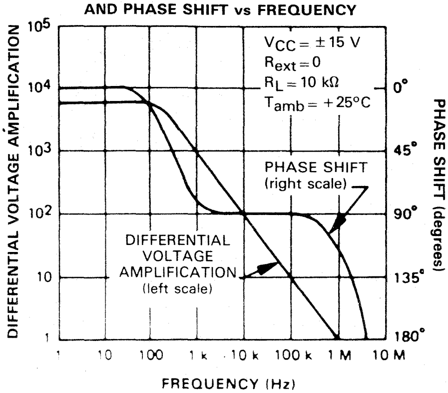
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY



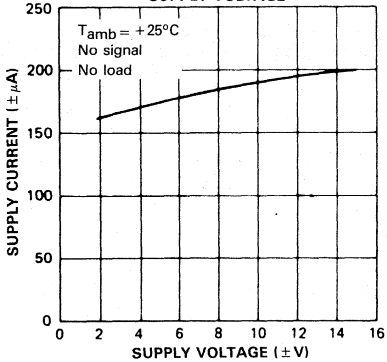
DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE



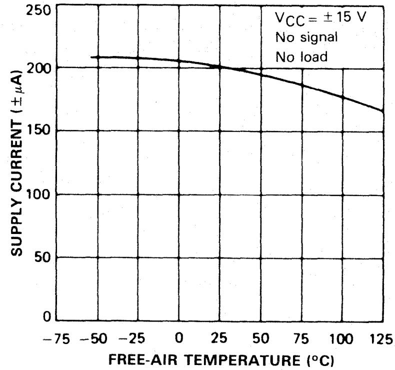
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY



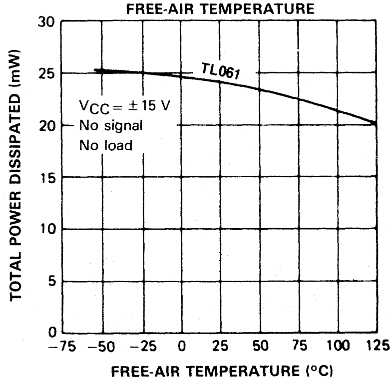
SUPPLY CURRENT PER AMPLIFIER
vs
SUPPLY VOLTAGE



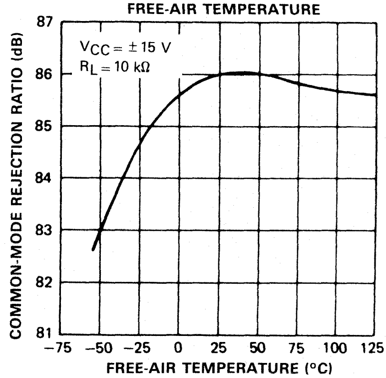
SUPPLY CURRENT PER AMPLIFIER
vs
FREE-AIR TEMPERATURE



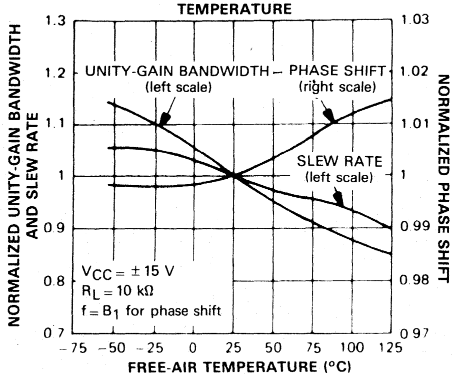
TOTAL POWER DISSIPATED
vs
FREE-AIR TEMPERATURE



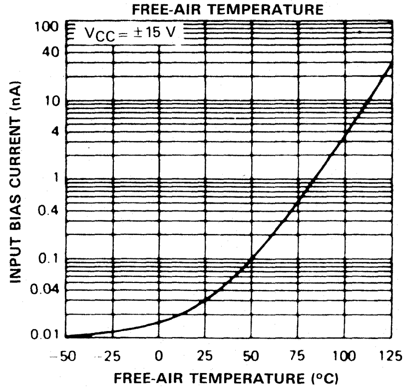
COMMON-MODE REJECTION RATIO
vs
FREE-AIR TEMPERATURE

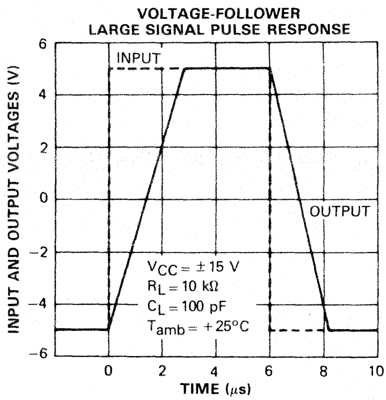


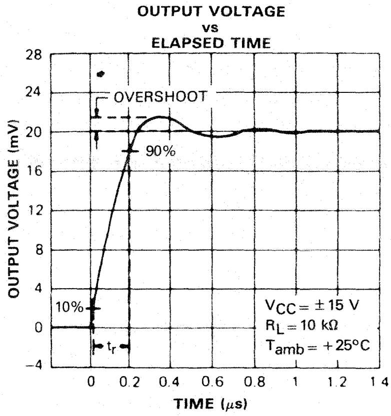
NORMALIZED UNITY-GAIN BANDWIDTH
SLEW RATE, AND PHASE SHIFT
vs
TEMPERATURE

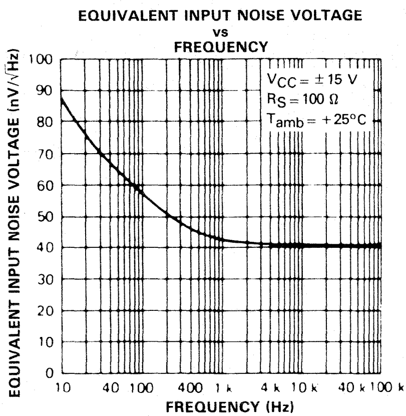


INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE









PARAMETER, MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

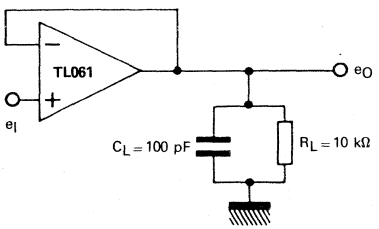
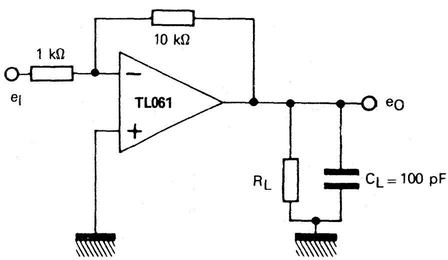
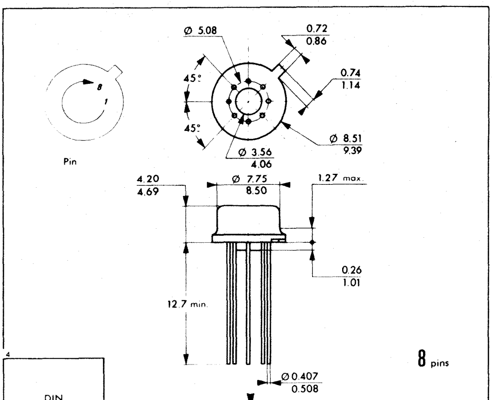


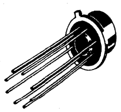
Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



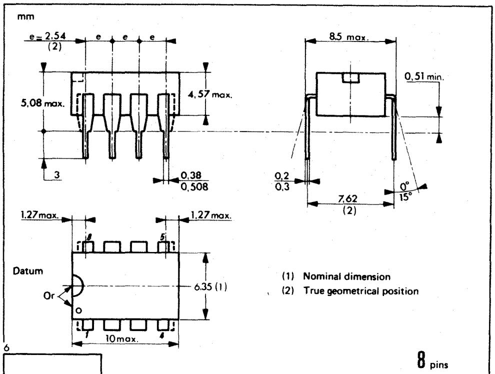


8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

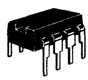


CB-11
H SUFFIX
METAL CAN

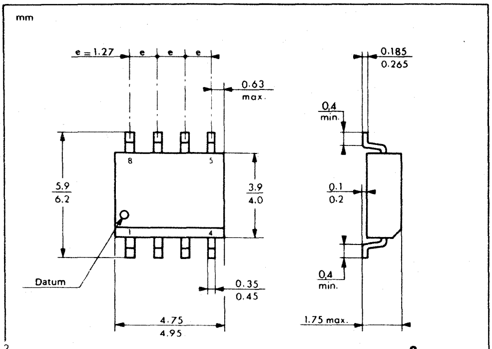


8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

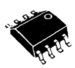


CB-98
DP SUFFIX
PLASTIC PACKAGE

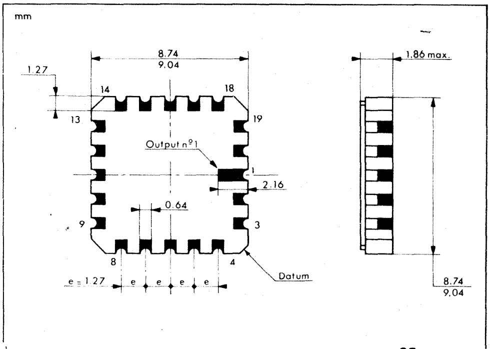


8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

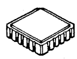


CB-342
FP SUFFIX
PLASTIC MICROPACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL062
TL062A
TL062B

LOW POWER J-FET INPUT DUAL OP-AMPs

The TL062, TL062A and TL062B are high speed quad J-FET input operational amplifier family. Each of these J-FET input operational amplifiers incorporates well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rate, low input bias and offset currents, and low offset voltage temperature coefficient.

- Very low power consumption.
- Wide common-mode and differential voltage ranges.
- Low input bias and offset currents.
- Typical supply current : 200 μA.
- Output-short circuit protection.
- High input impedance J-FET input stage.
- Internal frequency compensation.
- Latch up free operation.
- High slew rate : 3.5 V/μs (typ.)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

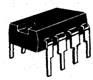
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	H	FP	GC
TL062M	−55°C to +125°C		•		•
TL062I	−25°C to + 85°C	•			
TL062C	0°C to + 70°C	•		•	
TL062AC	0°C to + 70°C	•			
TL062BC	0°C to + 70°C	•			

Examples : TL062MH, TL062IDP

LOW POWER J-FET INPUT DUAL OP-AMPs

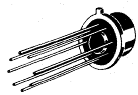
CASES

CB-98



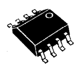
DP SUFFIX
PLASTIC PACKAGE

CB-11



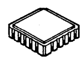
H SUFFIX
METAL CAN

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

CB-705

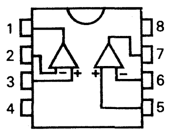


GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS

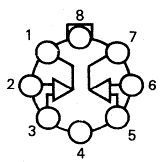
(Top views)

CB-98
CB-342



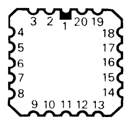
1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^-

CB-11



5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

CB-705



1 - NC
2 - Output 1
3 - NC
4 - NC
5 - Inverting input 1
6 - NC
7 - Non-inverting input 1
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Non-inverting input 2
13 - NC
14 - NC
15 - Inverting input 2
16 - NC
17 - Output 2
18 - NC
19 - NC
20 - V_{CC}^+

Réf. 00325

THOMSON SEMICONDUCTORS
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Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating		Symbol	Value			Unit
			TL062M	TL062I	TL062C	
Supply voltage	(Note 1)	V_{CC}	± 18	± 18	± 18	V
Power dissipation	(Note 5)	P_{tot}	680	680	680	mW
Differential input voltage	(Note 2)	V_{ID}	± 30	± 30	± 30	V
Input voltage	(Note 3)	V_I	± 15	± 15	± 15	V
Output short-circuit duration	(Note 4)	—	Indefinite	Indefinite	Indefinite	—
Operating free-air temperature range		T_{oper}	− 55 to + 125	− 25 to + 85	0 to + 70	°C
Storage temperature range		T_{stg}	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

* Devices bonded on a 6 cm × 3 cm × 0.15 cm glass epoxy substrate with 30 mm² of 35 µm thick copper.

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

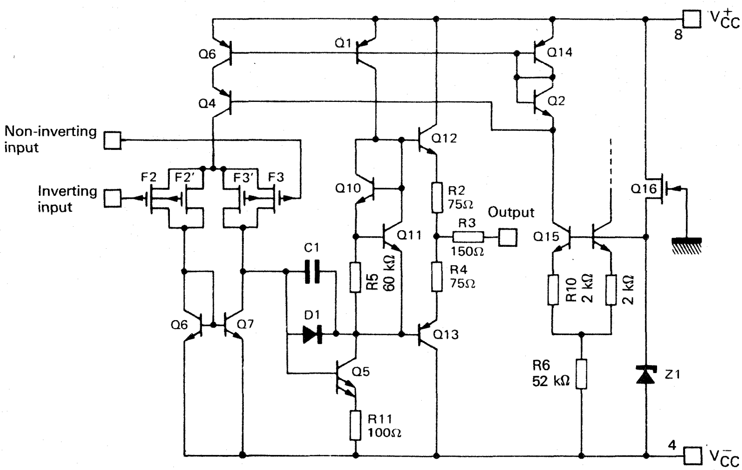
Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

Note 5 : For operation above + 25°C free-air temperature, refer to dissipation derating table.

SCHEMATIC DIAGRAM 1/2 TL062



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^{-}	V_{CC}^{+}	N.C.
CB-98/CB-11/CB-342	1, 7	2, 6	3, 5	4	8	—
CB-705	2, 17	5, 15	7, 12	10	20	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL062M : $-55°C \leqslant T_{amb} \leqslant +125°C$
TL062I : $-25°C \leqslant T_{amb} \leqslant +85°C$
TL062C : $0°C \leqslant T_{amb} \leqslant +70°C$
$V_{CC} = \pm 15$ V
All characteristics are specified under open-loop conditions unless otherwise specified

Characteristic	Symbol	TL062M			TL062I			TL062C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_{IO}	 – –	 3 –	 6 15	 – –	 3 –	 6 9	 – –	 3 –	 15 20	mV
Temperature coefficient of input offset voltage $R_S = 50\ \Omega$	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current* $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IO}	 – –	 5 –	 100 20	 – –	 5 –	 100 10	 – –	 5 –	 200 5	 pA nA
Input bias current* $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IB}	 – –	 30 –	 200 50	 – –	 30 –	 200 20	 – –	 30 –	 400 10	 pA nA
Input common-mode voltage range $T_{amb} = +25°C$	V_I	± 11	± 12	–	± 11.5	± 12	–	± 10	± 11	–	V
Output voltage swing $T_{amb} = +25°C$, $R_L = 10$ kΩ $T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10$ kΩ	V_{OPP}	 20 20	 27 –	 – –	 20 20	 27 –	 – –	 20 20	 27 –	 – –	V
Large signal voltage gain ($R_L \geqslant 10$ kΩ, $V_O = \pm 10$ V) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	A_{VD}	 4 4	 6 –	 – –	 4 4	 6 –	 – –	 3 3	 6 –	 – –	V/mV
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10$ kΩ)	GW_R	–	1	–	–	1	–	–	1	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio $R_S \leqslant 10$ kΩ, $T_{amb} = +25°C$	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) $R_S \leqslant 10$ kΩ, $T_{amb} = +25°C$	SVR	80	95	–	80	95	–	70	95	–	dB
Supply current (per amplifier) $T_{amb} = +25°C$, no load, no signal	I_{CC}	–	200	250	–	200	250	–	200	250	μA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB
Total power consumption (each amplifier) No load, no signal $T_{amb} = +25°C$	P_D	–	6	7.5	–	6	7.5	–	6	7.5	mW

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL062M			TL062I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V, $R_L = 10$ kΩ, $C_L = 100$ pF, $A_V = 1$)	S_{VO}	2	3.5	–	–	3.5	–	V/μs
Rise time (See figure 1) ($e_I = 20$ mV, $R_L = 10$ kΩ, $C_L = 100$ pF, $A_V = 1$)	t_r	–	0.2	–	–	0.2	–	μs
Overshoot factor (See figure 1) ($e_I = 20$ mV, $R_L = 10$ kΩ, $C_L = 100$ pF, $A_V = 1$ V)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage ($R_S = 100\ \Omega$, f = 1 kHz)	V_n	–	42	–	–	42	–	nV/$\sqrt{Hz}$

ELECTRICAL CHARACTERISTICS

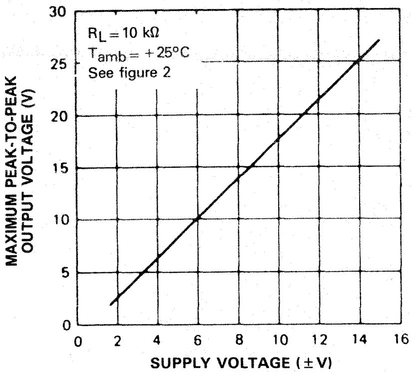
TL062C : $0°C \leqslant T_{amb} \leqslant +70°C$
$V_{CC} = \pm 15$ V
All characteristics are specified under open-loop conditions unless otherwise specified

Characteristic	Symbol	TL062C			TL062AC			TL062BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_{IO}	 — —	 3 —	 15 20	 — —	 3 —	 6 7.5	 — —	 2 —	 3 5	mV
Temperature coefficient of input offset voltage $R_S = 50\ \Omega$	αV_{IO}	—	10	—	—	10	—	—	10	—	$\mu V/°C$
Input offset current* $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IO}	 — —	 5 —	 200 5	 — —	 5 —	 100 3	 — —	 5 —	 100 3	 pA nA
Input bias current* $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IB}	 — —	 30 —	 400 10	 — —	 30 —	 200 7	 — —	 30 —	 200 7	 pA nA
Input common-mode voltage range $T_{amb} = +25°C$	V_I	±10	±11	—	±11.5	±12	—	±11.5	±12	—	V
Output voltage swing $T_{amb} = +25°C$, $R_L = 10\ k\Omega$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10\ k\Omega$	V_{OPP}	 20 20	 27 —	 — —	 20 20	 27 —	 — —	 20 20	 27 —	 — —	V
Large signal voltage gain ($R_L \geqslant 10\ k\Omega$, $V_O = \pm 10$ V) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	A_{VD}	 3 3	 6 —	 — —	 4 4	 6 —	 — —	 4 4	 6 —	 — —	V/mV
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10\ k\Omega$)	GW_R	—	1	—	—	1	—	—	1	—	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	—	10^{12}	—	—	10^{12}	—	—	10^{12}	—	Ω
Common-mode rejection ratio $R_S \leqslant 10\ k\Omega$, $T_{amb} = +25°C$	CMR	70	76	—	80	86	—	80	86	—	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) $R_S \leqslant 10\ k\Omega$, $T_{amb} = +25°C$	SVR	70	95	—	80	95	—	80	95	—	dB
Supply current (per amplifier) $T_{amb} = +25°C$, no load, no signal	I_{CC}	—	200	250	—	200	250	—	200	250	μA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	—	120	—	—	120	—	—	120	—	dB
Total power consumption (each amplifier) No load - no signal $T_{amb} = +25°C$	P_D	—	6	7.5	—	6	7.5	—	6	7.5	mW

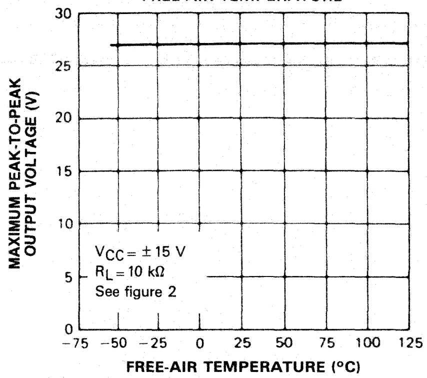
* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

TYPICAL CHARACTERISTICS

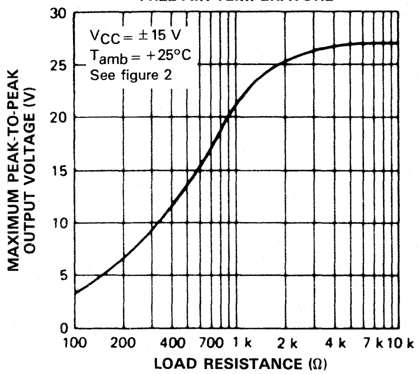
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE



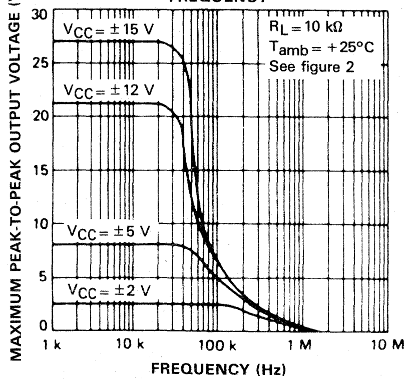
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE



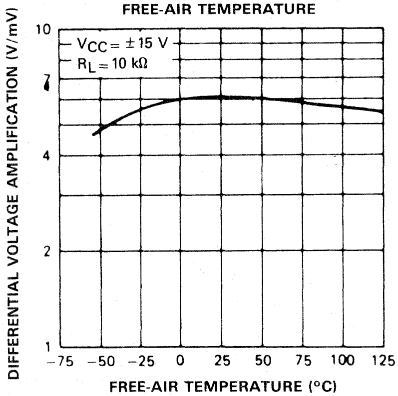
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE



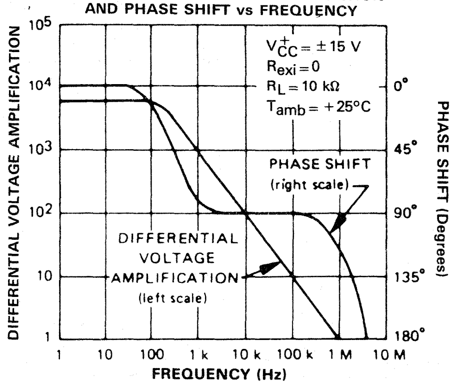
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY



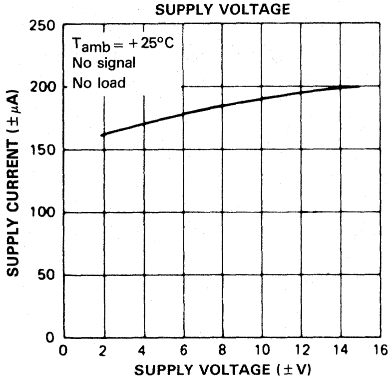
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE



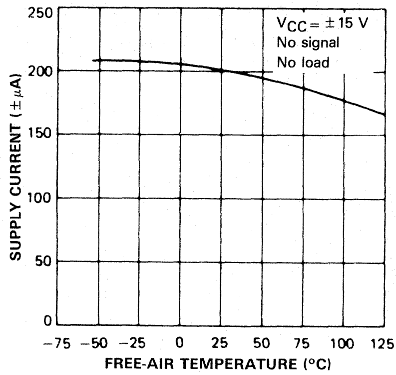
LARGE SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
AND PHASE SHIFT vs FREQUENCY



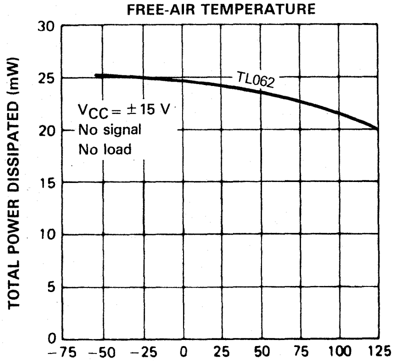
SUPPLY CURRENT PER AMPLIFIER vs SUPPLY VOLTAGE



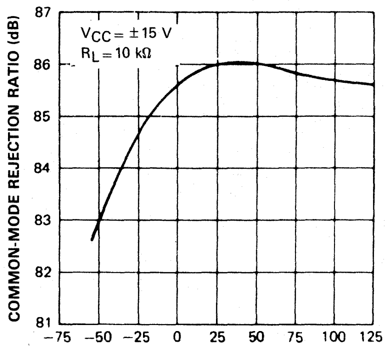
SUPPLY CURRENT PER AMPLIFIER vs FREE-AIR TEMPERATURE



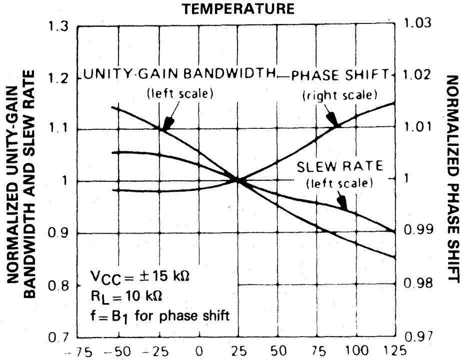
TOTAL POWER DISSIPATED vs FREE-AIR TEMPERATURE



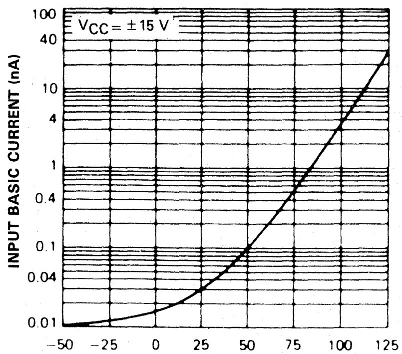
COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE



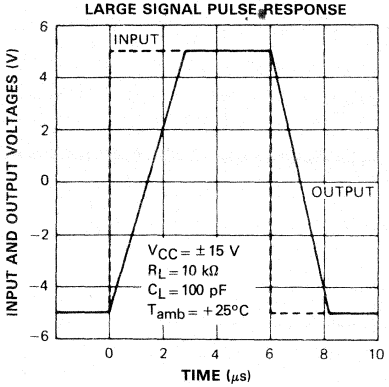
NORMALIZED UNITY-GAIN BANDWIDTH SLEW RATE, AND PHASE SHIFT vs TEMPERATURE



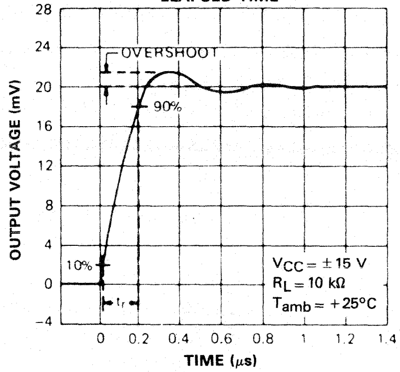
INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE



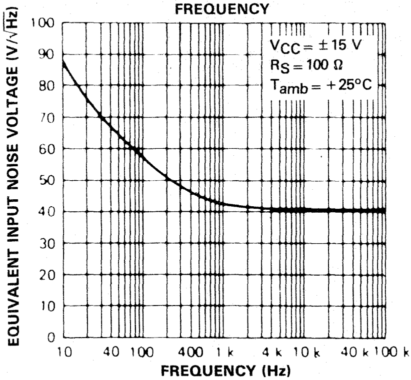
VOLTAGE-FOLLOWER LARGE SIGNAL PULSE RESPONSE



OUTPUT VOLTAGE vs ELAPSED TIME



EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY



PARAMETER MEASUREMENT TEST CIRCUITS

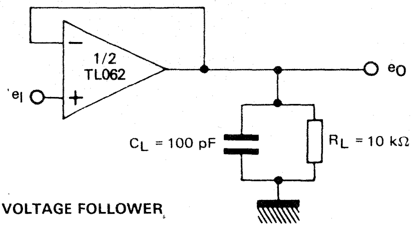


Fig. 1 : VOLTAGE FOLLOWER

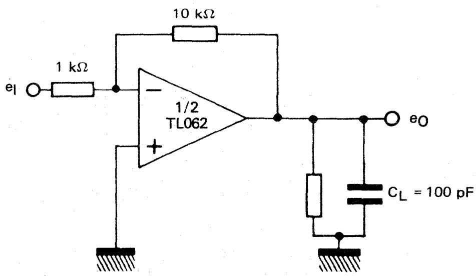
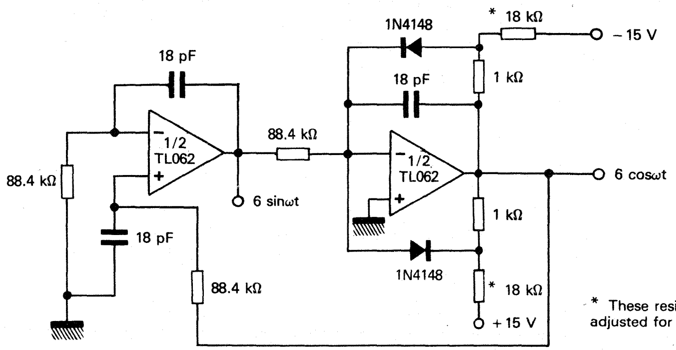


Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER

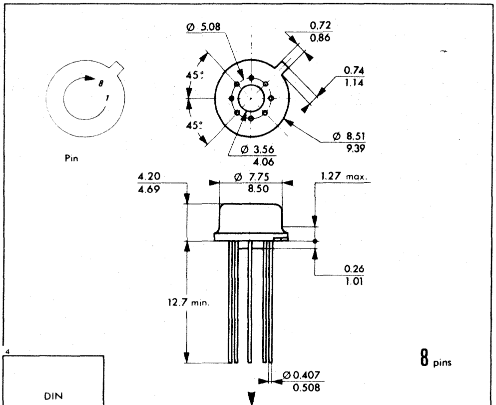
TYPICAL APPLICATION

QUADRATURE OSCILLATOR



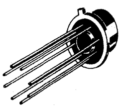
* These resistor values may be adjusted for a symmetrical output

7 8



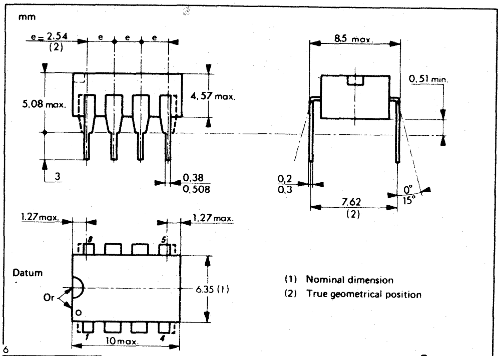
8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



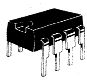
CB-11

H SUFFIX
METAL CAN



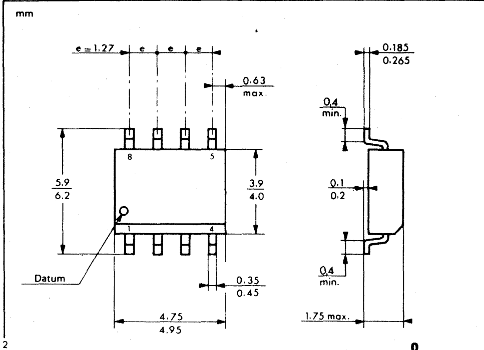
8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS



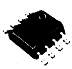
CB-98

DP SUFFIX
PLASTIC PACKAGE



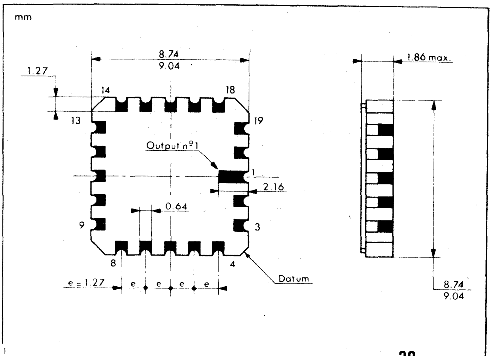
8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS



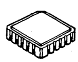
CB-342

FP SUFFIX
PLASTIC
MICROPACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705

GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL064
TL064A
TL064B

LOW POWER J-FET INPUT QUAD OP-AMPs

The TL064, TL064A and TL064B are high speed quad J-FET input operational amplifier family. Each of these J-FET input operational amplifiers incorporates well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias current and offset currents, and low offset voltage temperature coefficient.

- Very Low power consumption
- Wide common-mode and differential voltage ranges
- Low input bias and offset currents
- Typical supply current : 200 μA
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate : 3.5 V/μs (typ).

ORDERING INFORMATION

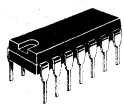
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	GC
TL064M	– 55°C to + 125°C		•		•
TL064I	– 25°C to + 85°C	•			
TL064C	0°C to + 70°C	•		•	
TL064AC	0°C to + 70°C	•			
TL064BC	0°C to + 70°C	•			
Examples : TL064MDG, TL064IDP					

LOW POWER J-FET INPUT QUAD OP-AMPs

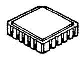
CASES

CB-2



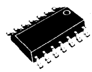
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-705



GC SUFFIX
TRICECOP (LCC)

CB-511

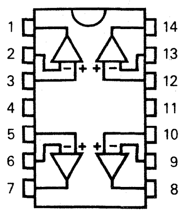


FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENTS

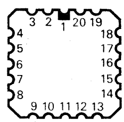
(Top views)

CB-2
CB-511



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00310

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TL061M	TL061I	TL061C	Unit
Supply voltage (Note 1)	V_{CC}	±18	±18	±18	V
Differential input voltage (Note 2)	V_{ID}	±30	±30	±30	V
Input voltage (Note 3)	V_I	±15	±15	±15	V
Output short-circuit duration (Note 4)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation (Note 5)	P_{tot}	680	680	680	mW
Operating free-air, temperature range	T_{oper}	−55 to +125	−25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C

* Devices bonded on a 6 cm × 0.15 cm glass epoxy substrate with 30 mm² of 35 μm thick copper.

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

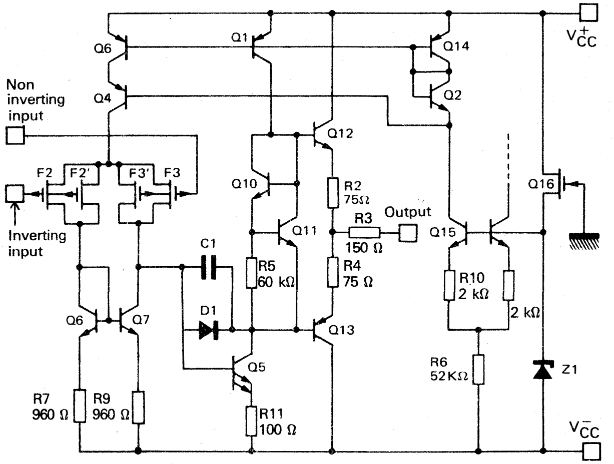
Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

Note 5 : For operation above +25°C free-air temperature, refer to dissipation derating table.

SCHEMATIC DIAGRAM



1/4 TL064

CASE	V_{CC}^{-}	V_{CC}^{+}	Outputs	Non-inverting inputs	Inverting inputs	N.C.
CB-2 CB-511	11	4	1, 7, 8, 14	3, 5, 10, 12	2, 6, 9, 13	—
CB-705	16	6	2, 10, 12, 20	4, 8, 14, 18	3, 9, 13, 19	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL064M : $-55°C \leq T_{amb} \leq +125°C$
TL064I : $-25°C \leq T_{amb} \leq +85°C$
TL064C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL064M			TL064I			TL064C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	V_{IO}	 – –	 3 –	 6 15	 – –	 3 –	 6 9	 – –	 3 –	 15 20	mV
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	µV/°C
Input offset current* $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	I_{IO}	 – –	 5 –	 100 20	 – –	 5 –	 100 10	 – –	 5 –	 200 5	 pA nA
Input bias current* $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	I_{IB}	 – –	 30 –	 200 50	 – –	 30 –	 200 20	 – –	 30 –	 400 10	 pA nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	±11	±12	–	±11.5	±12	–	±10	±11	–	V
Output voltage swing $R_L = 10\ k\Omega$, $T_{amb} = +25°C$ $R_L \geq 10\ k\Omega$, $T_{min} \leq T_{amb} \leq T_{max}$	V_{OPP}	 20 20	 27 –	 – –	 20 20	 27 –	 – –	 20 20	 27 –	 – –	V
Large signal voltage gain ($R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	A_{VD}	 4 4	 6 –	 – –	 4 4	 6 –	 – –	 3 3	 6 –	 – –	V/mV
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10\ k\Omega$)	GW_R	–	1	–	–	1	–	–	1	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \leq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) $R_S \leq 10\ k\Omega$; $T_{amb} = +25°C$	SVR	 80	 95	 –	 80	 95	 –	 70	 95	 –	dB
Supply current (per amplifier) $T_{amb} = +25°C$, no load, no signal	I_{CC}	 –	 200	 250	 –	 200	 250	 –	 200	 250	µA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB
Total power consumption (each amplifier) $T_{amb} = +25°C$, no load, no signal	P_D	 –	 6	 7.5	 –	 6	 7.5	 –	 6	 7.5	mW

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL064M			TL064I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	S_{VO}	2	3.5	–	–	3.5	–	V/µs
Rise time ($e_I = 20$ mV ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	t_r	–	0.2	–	–	0.2	–	µs
Overshoot factor ($e_I = 20$ mV ; $R_L = 10\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	K_{OV}	 –	 10	 –	 –	 10	 –	%
Equivalent input noise voltage ($R_S = 100\ \Omega$; f = 1 kHz)	V_n	–	42	–	–	42	–	nV/√Hz

ELECTRICAL CHARACTERISTICS

TL064C : $0°C \leqslant T_{amb} \leqslant +70°C$

$V_{CC} = \pm 15$ V

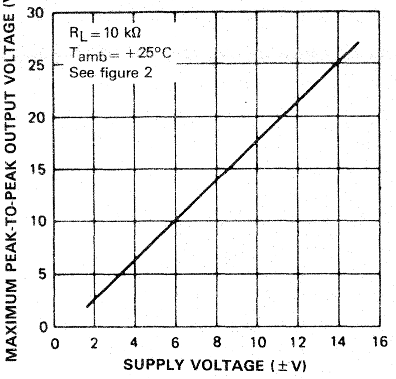
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL064C			TL064AC			TL064BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		—	3	15	—	3	6	—	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	20	—	—	7.5	—	—	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	—	10	—	—	10	—	—	10	—	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		—	5	200	—	5	100	—	5	100	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	5	—	—	3	—	—	3	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		—	30	400	—	30	200	—	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	10	—	—	7	—	—	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	± 10	± 11	—	±11.5	± 12	—	±11.5	± 12	—	V
Output voltage swing	V_{OPP}										V
$R_L = 10\ k\Omega$, $T_{amb} = +25°C$		20	27	—	20	27	—	20	27	—	
$R_L \geqslant 10\ k\Omega$, $T_{min} \leqslant T_{amb} \leqslant T_{max}$		20	—	—	20	—	—	20	—	—	
Large signal voltage gain ($R_L \geqslant 10\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		3	6	—	4	6	—	4	6	—	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		3	—	—	4	—	—	4	—	—	
Small signal bandwidth ($T_{amb} = +25°C$, $R_L = 10\ k\Omega$)	GW_R	—	1	—	—	1	—	—	1	—	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	—	10^{12}	—	—	10^{12}	—	—	10^{12}	—	Ω
Common-mode rejection ratio ($R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	70	76	—	80	86	—	80	86	—	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$		70	95	—	80	95	—	80	95	—	
Supply current (per amplifier)	I_{CC}										μA
$T_{amb} = +25°C$, no load, no signal		—	200	250	—	200	250	—	200	250	
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	—	120	—	—	120	—	—	120	—	dB
Total power consumption (each amplifier)	P_D										mW
$T_{amb} = +25°C$, no load, no signal		—	6	7.5	—	6	7.5	—	6	7.5	

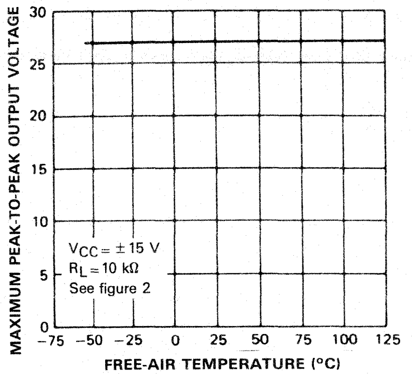
* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

TYPICAL CHARACTERISTICS

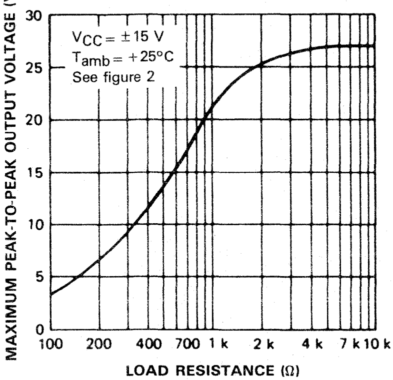
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE



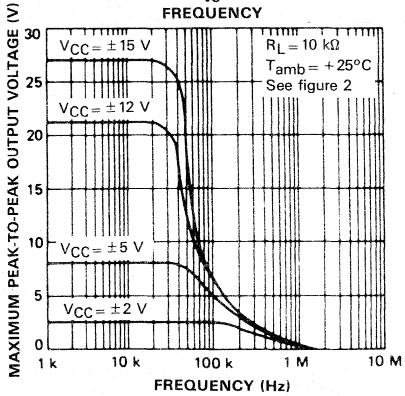
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE



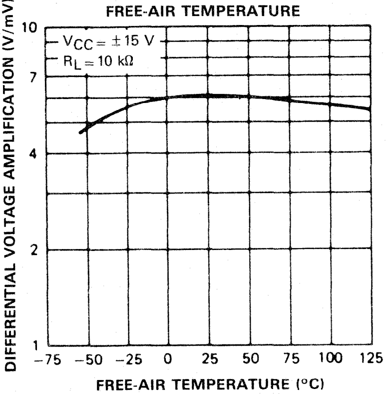
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
LOAD RESISTANCE



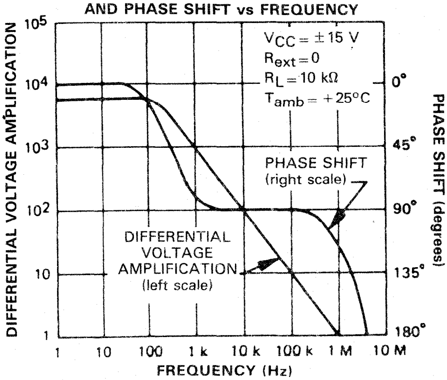
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY



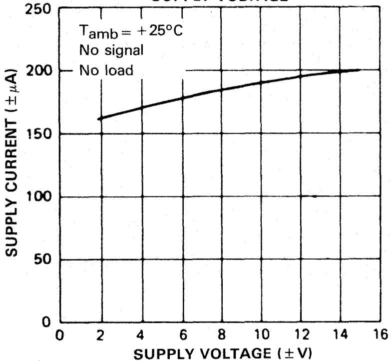
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE



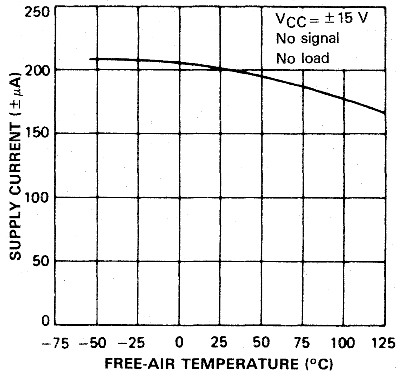
LARGE SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
AND PHASE SHIFT vs FREQUENCY



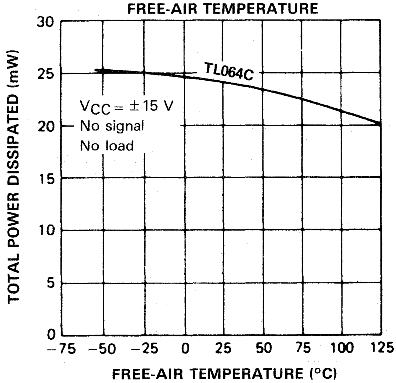
SUPPLY CURRENT PER AMPLIFIER
vs
SUPPLY VOLTAGE



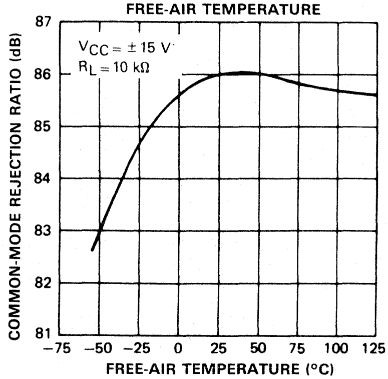
SUPPLY CURRENT PER AMPLIFIER
vs
FREE-AIR TEMPERATURE



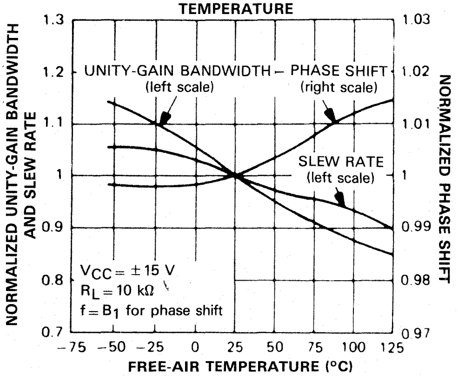
TOTAL POWER DISSIPATED
vs
FREE-AIR TEMPERATURE



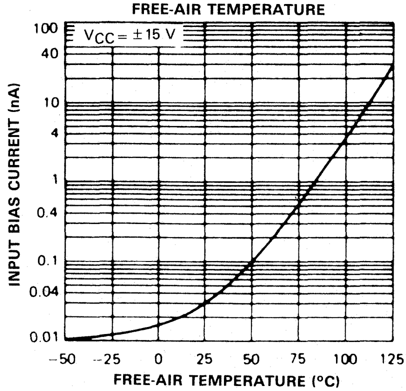
COMMON-MODE REJECTION RATIO
vs
FREE-AIR TEMPERATURE



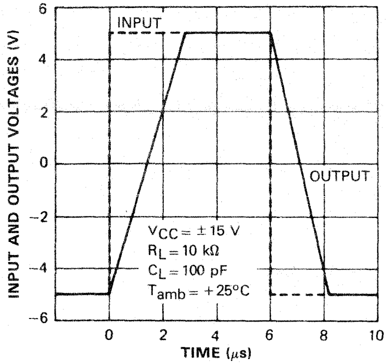
NORMALIZED UNITY-GAIN BANDWIDTH
SLEW RATE, AND PHASE SHIFT
vs
TEMPERATURE



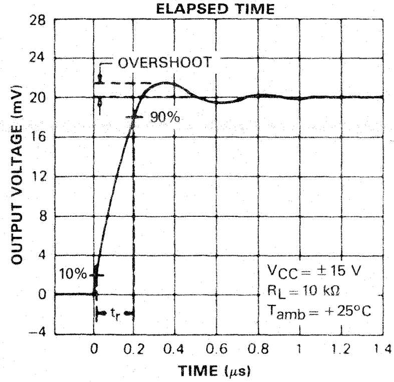
INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE



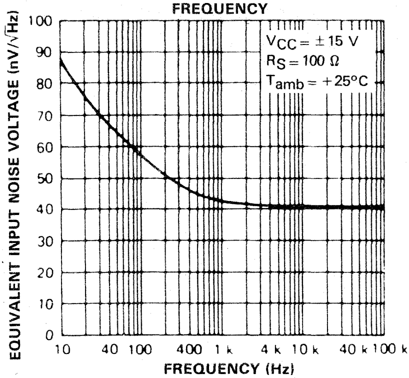
VOLTAGE-FOLLOWER LARGE SIGNAL PULSE RESPONSE



OUTPUT VOLTAGE vs ELAPSED TIME



EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY



PARAMETER, MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

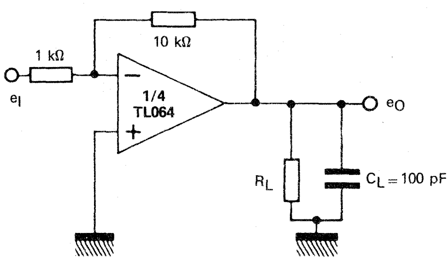
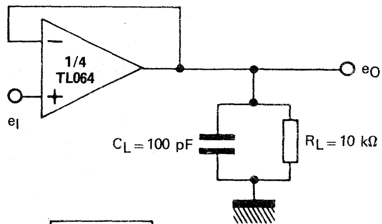
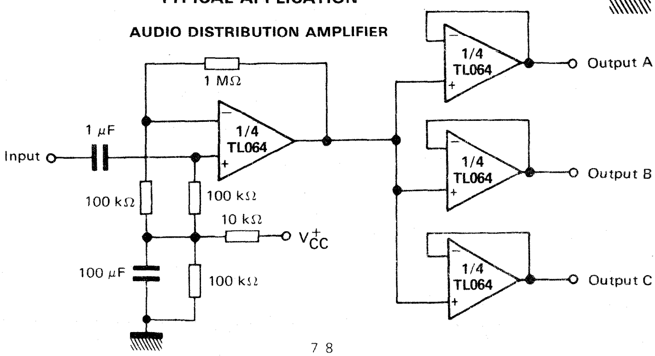


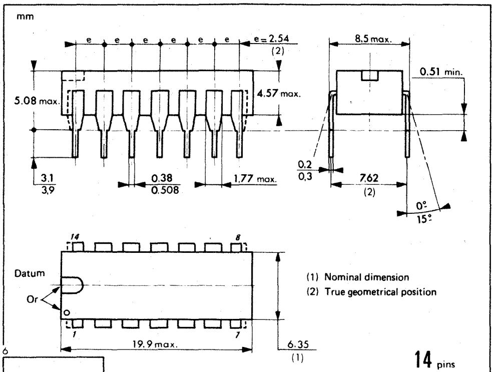
Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



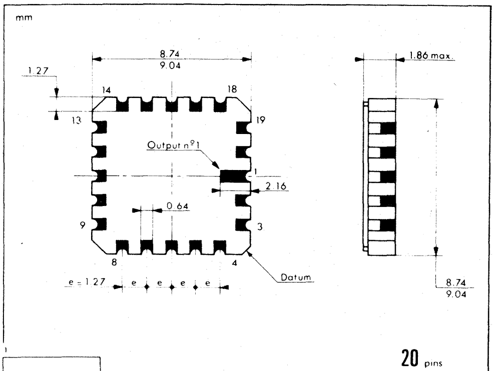
TYPICAL APPLICATION

AUDIO DISTRIBUTION AMPLIFIER

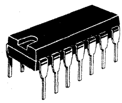




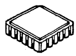
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	**CB-2** **THOMSON** SEMICONDUCTORS



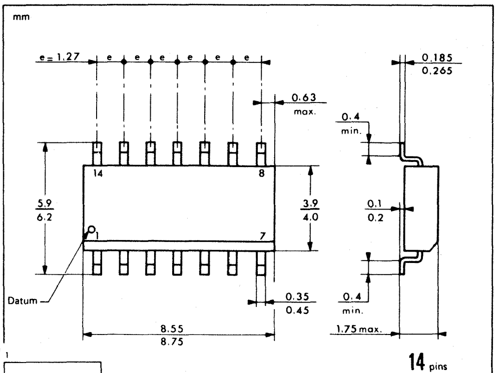
DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	**CB-705** **THOMSON** SEMICONDUCTORS



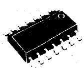
CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



CB-705
GC SUFFIX
TRICECOP (LCC)



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	**CB-511** **THOMSON** SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL071
TL071A
TL071B

LOW NOISE J-FET INPUT SINGLE OP-AMPs

The TL071, TL071A and TL071B are high speed J-FET input operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rate, low input bias and, offset current, and low voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Low noise $V_n = 18\ nV/\sqrt{Hz}$(typ)
- Output short-circuit protection
- High input impedance J-FET input stage
- Low harmonic distortion : 0.01% (typ)
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

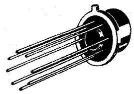
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	H	FP	GC
TL071M	−55°C to +125°C		•		•
TL071I	−25°C to + 85°C	•			
TL071C	0°C to + 70°C	•		•	
TL071AC	0°C to + 70°C	•			
TL071BC	0°C to + 70°C	•			

Examples : TL071MH, TL071IDP

LOW NOISE J-FET INPUT SINGLE OP-AMPs

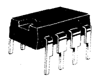
CASES

CB-11



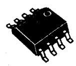
H SUFFIX
METAL CAN

CB-98



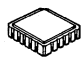
DP SUFFIX
PLASTIC PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

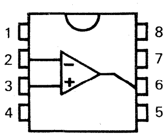
CB-705



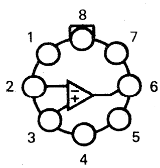
GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS
(Top views)

CB-98
CB-342

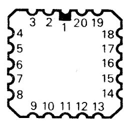


CB-11



1 - Offset null
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Offset null
6 - Output
7 - V_{CC}^+
8 - NC

CB-705



1 - NC
2 - Offset null
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Offset null
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - NC

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TL071M	TL071I	TL071C	Unit
Supply voltage (Note 1)	V_{CC}	± 18	± 18	± 18	V
Differential input voltage (Note 2)	V_{ID}	± 30	± 30	± 30	V
Input voltage (Note 3)	V_I	± 15	± 15	± 15	V
Output short-circuit duration (Note 4)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation	P_{tot}	680	680	680	mW
Operating free-air temperature range	T_{oper}	− 55 to + 125	− 25 to + 85	0 to + 70	°C

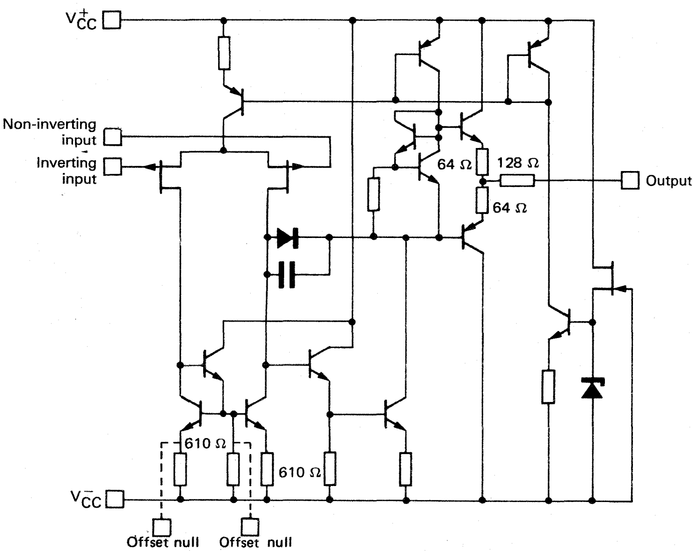
Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

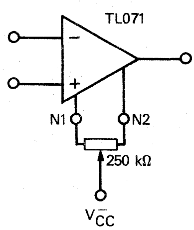
Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC DIAGRAM



INPUT OFFSET VOLTAGE NULL CIRCUIT



CASE	Offset null	Inverting input	Non-inverting input	V_{CC}^{-}	V_{CC}^{+}	Output	N.C
CB-98, CB-342 CB-11	1, 5	2	3	4	7	6	8
CB-705	2, 12	5	7	10	17	15	*

* **CB-705** : Other pins are not conected

ELECTRICAL CHARACTERISTICS

TL071M : $-55°C \leqslant T_{amb} \leqslant +125°C$
TL071I : $-25°C \leqslant T_{amb} \leqslant +85°C$
TL071C : $0°C \leqslant T_{amb} \leqslant +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL071M			TL071I			TL071C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	3	10	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	9	–	–	9	–	–	13	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	50	–	5	50	–	5	50	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	20	–	–	10	–	–	2	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	50	–	–	20	–	–	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geqslant 2\ k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		35	200	–	50	200	–	25	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		20	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$		80	86	–	80	86	–	70	76	–	
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.5	–	1.4	2.5	–	1.4	2.5	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL071M			TL071I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	S_{VO}	10	13	–	–	13	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	t_r	–	0.1	–	–	0.1	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage	V_n							
f = 1 kHz, $R_S = 100\ \Omega$		–	18	–	–	18	–	$nV/\sqrt{Hz}$
f = 10 Hz to 10 kHz		–	4	–	–	4	–	μV
Equivalent input noise current ($R_S = 100\ \Omega$, f = 1 kHz)	I_n	–	0.01	–	–	0.01	–	$pA/\sqrt{Hz}$
Total harmonic distortion								
($V_{O(rms)} = 10$ V, $R_S = 1\ k\Omega$, $R_L \geqslant 2\ k\Omega$, f = 1 kHz)	THD	–	0.01	–	–	0.01	–	%

ELECTRICAL CHARACTERISTICS

TL071C : 0°C ⩽ T_{amb} ⩽ +70°C

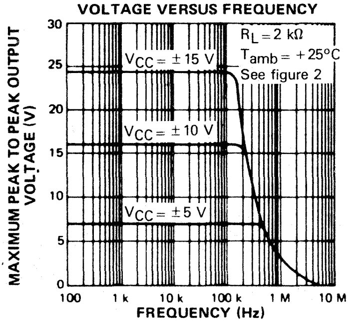
V_{CC} = ± 15 V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

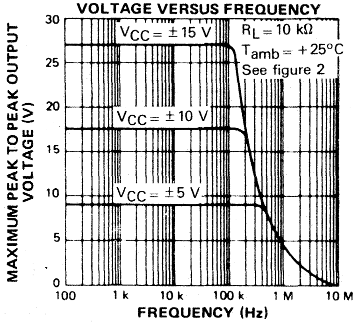
Characteristic	Symbol	TL071C			TL071AC			TL071BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage (R_S = 50 Ω)	V_{IO}										mV
T_{amb} = +25°C		–	3	10	–	3	6	–	2	3	
T_{min} ⩽ T_{amb} ⩽ T_{max}		–	–	13	–	–	7.5	–	–	5	
Temperature coefficient of input offset voltage (R_S = 50 Ω)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
T_{amb} = +25°C		–	5	50	–	5	50	–	5	50	pA
T_{min} ⩽ T_{amb} ⩽ T_{max}		–	–	2	–	–	2	–	–	2	nA
Input bias current*	I_{IB}										
T_{amb} = +25°C		–	30	200	–	30	200	–	30	200	pA
T_{min} ⩽ T_{amb} ⩽ T_{max}		–	–	7	–	–	7	–	–	7	nA
Input common-mode voltage range (T_{amb} = +25°C)	V_I	± 10	± 11	–	± 11	± 12	–	± 11	± 12	–	V
Output voltage swing	V_{OPP}										V
T_{amb} = +25°C, R_L = 10 kΩ		24	27	–	24	27	–	24	27	–	
T_{min} ⩽ T_{amb} ⩽ T_{max}, R_L ⩾ 10 kΩ		24	–	–	24	–	–	24	–	–	
R_L ⩾ 2 kΩ		20	24	–	20	24	–	20	24	–	
Large signal voltage gain (R_L ⩾ 2 kΩ, V_O = ± 10 V)	A_{VD}										V/mV
T_{amb} = +25°C		25	200	–	50	200	–	50	200	–	
T_{min} ⩽ T_{amb} ⩽ T_{max}		15	–	–	25	–	–	25	–	–	
Small signal bandwidth (T_{amb} = +25°C)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance (T_{amb} = +25°C)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio (R_S ⩽ 10 kΩ ; T_{amb} = +25°C)	CMR	70	76	–	80	86	–	80	86	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
R_S ⩽ 10 kΩ ; T_{amb} = +25°C		70	76	–	80	86	–	80	86	–	
Supply current (per amplifier) (T_{amb} = +25°C)	I_{CC}	–	1.4	2.5	–	1.4	2.5	–	1.4	2.5	mA

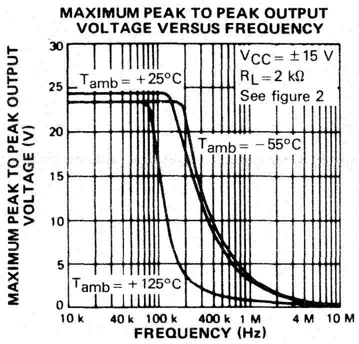
* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

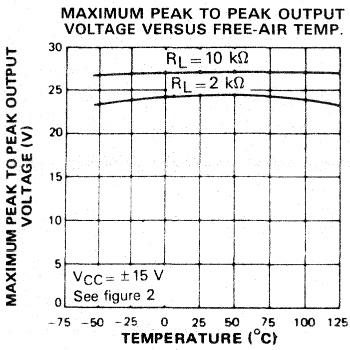
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY

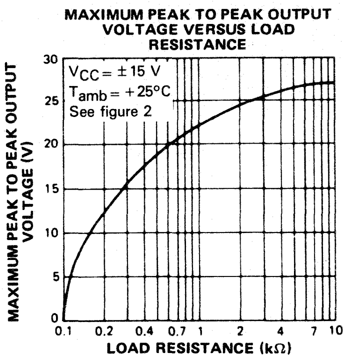


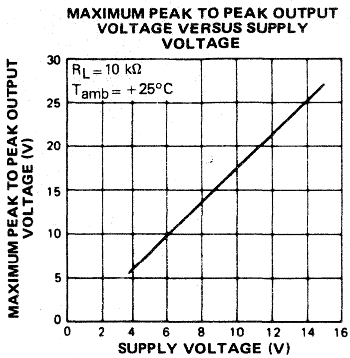
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY

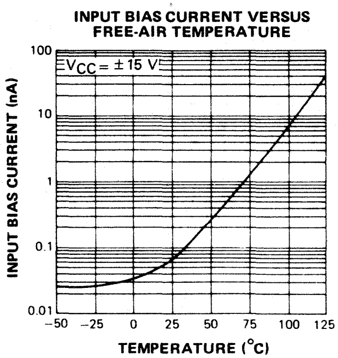


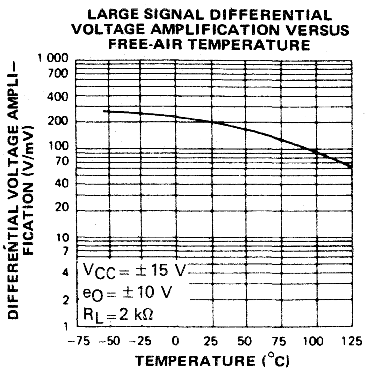

MAXIMUM PEAK TO PEAK OUTPUT
VOLTAGE VERSUS FREQUENCY
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE (V)
FREQUENCY (Hz)
$V_{CC} = \pm 15$ V
$R_L = 2$ kΩ
See figure 2
$T_{amb} = +25°C$
$T_{amb} = -55°C$
$T_{amb} = +125°C$
0
5
10
15
20
25
30
10 k
40 k
100 k
400 k
1 M
4 M
10 M


MAXIMUM PEAK TO PEAK OUTPUT
VOLTAGE VERSUS FREE-AIR TEMP.
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE (V)
TEMPERATURE (°C)
$R_L = 10$ kΩ
$R_L = 2$ kΩ
$V_{CC} = \pm 15$ V
See figure 2
0
5
10
15
20
25
30
–75
–50
–25
0
25
50
75
100
125

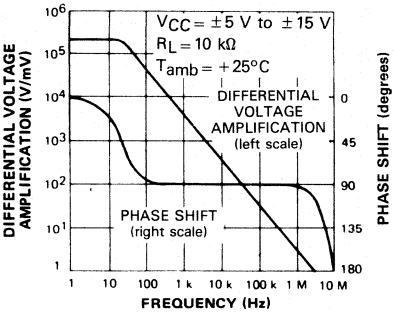

MAXIMUM PEAK TO PEAK OUTPUT
VOLTAGE VERSUS LOAD
RESISTANCE
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE (V)
LOAD RESISTANCE (kΩ)
$V_{CC} = \pm 15$ V
$T_{amb} = +25°C$
See figure 2
0
5
10
15
20
25
30
0.1
0.2
0.4
0.7
1
2
4
7
10


MAXIMUM PEAK TO PEAK OUTPUT
VOLTAGE VERSUS SUPPLY
VOLTAGE
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE (V)
SUPPLY VOLTAGE (V)
$R_L = 10$ kΩ
$T_{amb} = +25°C$
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
16

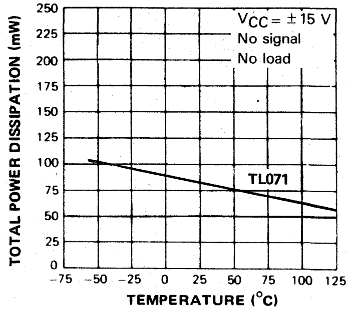

INPUT BIAS CURRENT VERSUS
FREE-AIR TEMPERATURE
INPUT BIAS CURRENT (nA)
TEMPERATURE (°C)
$V_{CC} = \pm 15$ V
0.01
0.1
1
10
100
–50
–25
0
25
50
75
100
125


LARGE SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION VERSUS
FREE-AIR TEMPERATURE
DIFFERENTIAL VOLTAGE AMPLIFICATION (V/mV)
TEMPERATURE (°C)
$V_{CC} = \pm 15$ V
$e_O = \pm 10$ V
$R_L = 2$ kΩ
1
2
4
7
10
20
40
70
100
200
400
700
1 000
–75
–50
–25
0
25
50
75
100
125

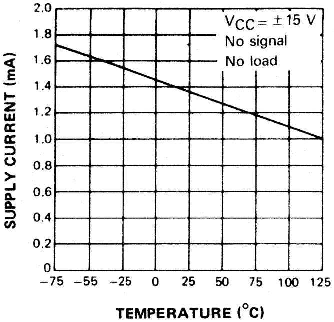
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VERSUS FREQUENCY



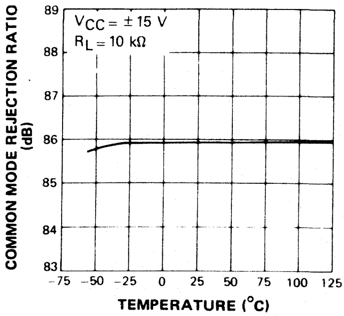
TOTAL POWER DISSIPATION VERSUS FREE-AIR TEMPERATURE



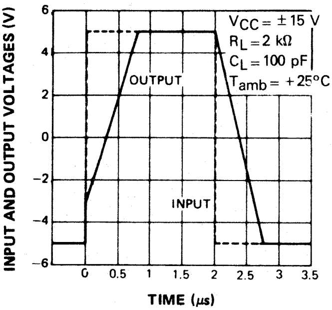
SUPPLY CURRENT PER AMPLIFIER VERSUS FREE-AIR TEMPERATURE



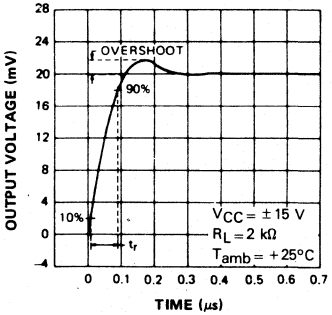
COMMON MODE REJECTION RATIO VERSUS FREE-AIR TEMPERATURE



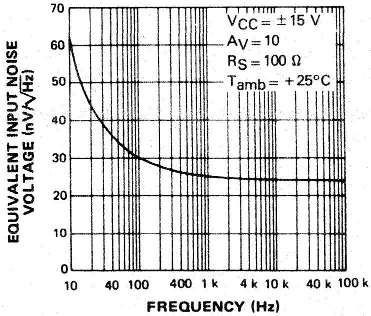
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



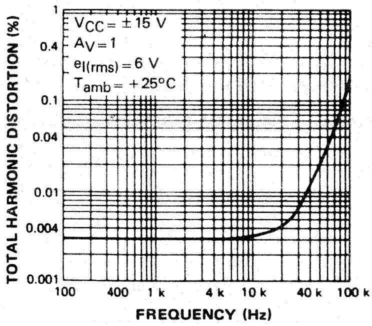
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY

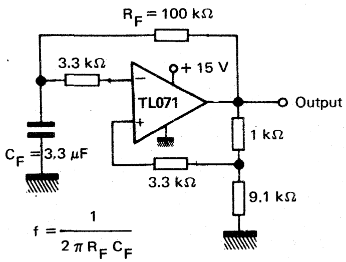


TOTAL HARMONIC DISTORTION VERSUS FREQUENCY

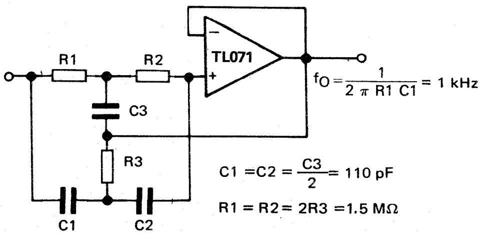


TYPICAL APPLICATIONS

(0.5 Hz) SQUARE WAVE OSCILLATOR



HIGH Q NOTCH FILTER



PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

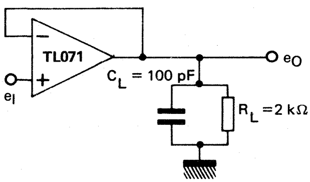
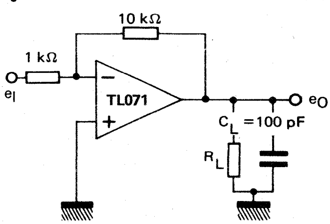
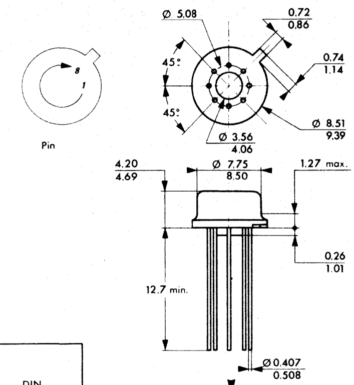


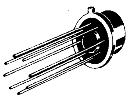
Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



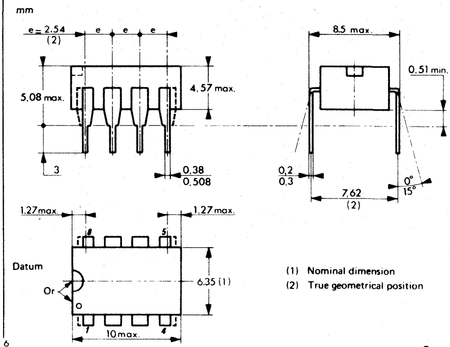


8 pins

DIN				
Case : C-23 Base :	TO-99	TO-99	F 101	CB-11 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS

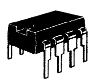


CB-11
H SUFFIX
METAL CAN

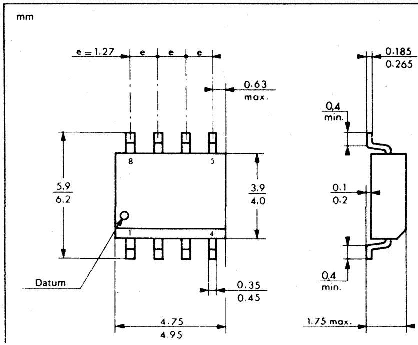


8 pins

DIN				
A50D			F 116 A	CB-98 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS



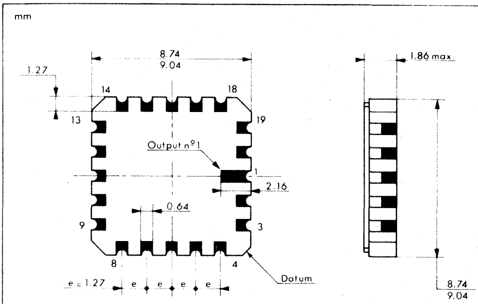
CB-98
DP SUFFIX
PLASTIC PACKAGE



8 pins

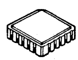
DIN	SO8			
				CB-342 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS

CB-342
FP SUFFIX
PLASTIC
MICROPACKAGE



20 pins

DIN				
MS004 CB		TMS004 CB		CB-705 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages

THOMSON SEMICONDUCTORS

TL072
TL072A
TL072B

LOW NOISE J-FET INPUT DUAL OP-AMPs

The TL072, TL072A and TL072B are high speed J-FET input dual operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a single monolithic integrated circuit.

The devices feature high slew rate, low input bias and offset currents and low offset voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Low noise $V_n = 18\ nV/\sqrt{Hz}$(typ)
- Output short-circuit protection
- High input impedance J-FET input stage
- Low harmonic distortion : 0.01% (typ)
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

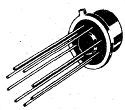
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	H	FP	GC
TL072M	− 55°C to + 125°C		•		•
TL072I	− 25°C to + 85°C	•			
TL072C	0°C to + 70°C	•		•	
TL072AC	0°C to + 70°C	•			
TL072BC	0°C to + 70°C	•			

Examples : TL072MH, TL072IDP

LOW NOISE J-FET INPUT DUAL OP-AMPs

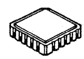
CASES

CB-11



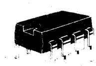
H SUFFIX
METAL CAN

CB-705



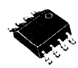
GC SUFFIX
TRICECOP (LCC)

CB-98



DP SUFFIX
PLASTIC PACKAGE

CB-342

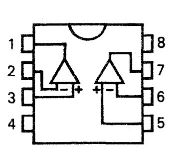


FP SUFFIX
PLASTIC MICROPACKAGE

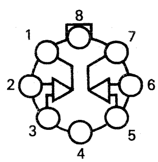
PIN ASSIGNMENTS

(Top views)

CB-98, CB-342

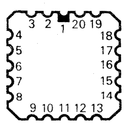


CB-11



1 - Output
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Non-inverting input
6 - Inverting input
7 - Output
8 - V_{CC}^+

CB-705



1 - NC
2 - Output
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Non-inverting input
13 - NC
14 - NC
15 - Inverting input
16 - NC
17 - Output
18 - NC
19 - NC
20 - V_{CC}^+

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TL072M	TL072I	TL072C	Unit
Supply voltage (Note 1)	V_{CC}	±18	±18	±18	V
Differential input voltage (Note 2)	V_{ID}	±30	±30	±30	V
Input voltage (Note 3)	V_I	±15	±15	±15	V
Output short-circuit duration (Note 4)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation	P_{tot}	680	680	680	mW
Operating free-air temperature range	T_{oper}	−55 to +125	−25 to + 85	0 to + 70	°C

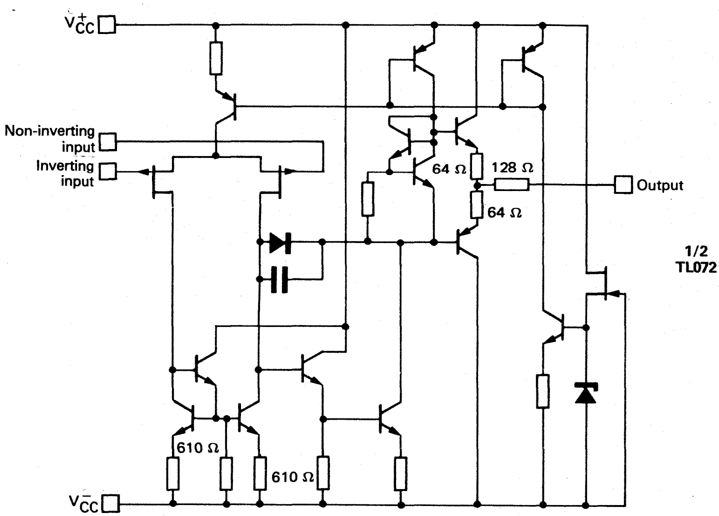
Note 1 : All voltage values, except differential voltage , are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC DIAGRAM



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^-	V_{CC}^+	N.C.
CB-98, CB-342 CB-11	1, 7	2, 6	3, 5	4	8	—
CB-705	2, 17	5, 15	7, 12	10	20	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL072M : $-55°C \leq T_{amb} \leq +125°C$
TL072I : $-25°C \leq T_{amb} \leq +85°C$
TL072C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL072M			TL072I			TL072C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	3	10	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	9	–	–	9	–	–	13	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	$\mu V/°C$
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	50	–	5	50	–	5	50	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	20	–	–	10	–	–	2	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	50	–	–	20	–	–	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_{ICM}	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geq 2\ k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		35	200	–	50	200	–	25	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		20	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \leq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leq 10\ k\Omega$; $T_{amb} = +25°C$		80	86	–	80	86	–	70	76	–	
Supply current (per amplifier) $T_{amb} = +25°C$	I_{CC}	–	1.4	2.5	–	1.4	2.5	–	1.4	2.5	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL072M			TL072I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	S_{VO}	10	13	–	–	13	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	t_r	–	0.1	–	–	0.1	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage	V_n							
$f = 1$ kHz, $R_S = 100\ \Omega$		–	18	–	–	18	–	$nV/\sqrt{Hz}$
$f = 10$ Hz to 10 kHz		–	4	–	–	4	–	μV
Equivalent input noise current ($R_S = 100\ \Omega$, $f = 1$ kHz)	I_n	–	0.01	–	–	0.01	–	$pA/\sqrt{Hz}$
Total harmonic distorsion								
($V_{O(rms)} = 10$ V, $R_S = 1\ k\Omega$, $R_L \geq 2\ k\Omega$, $f = 1$ kHz)	THD	–	0.01	–	–	0.01	–	%

ELECTRICAL CHARACTERISTICS

TL072C : $0°C \leqslant T_{amb} \leqslant +70°C$

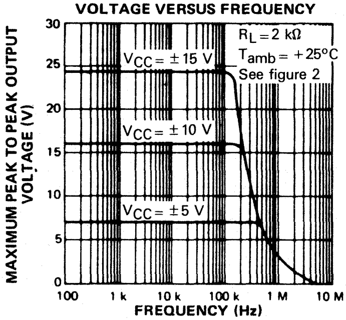
$V_{CC} = \pm 15$ V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

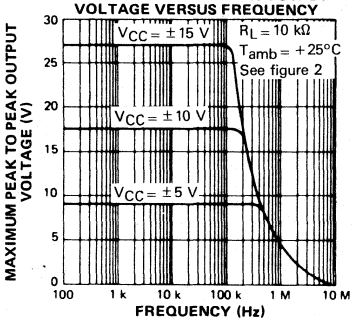
Characteristic	Symbol	TL072C			TL072AC			TL072BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		—	3	10	—	3	6	—	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	13	—	—	7.5	—	—	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	—	10	—	—	10	—	—	10	—	$\mu V/°C$
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		—	5	50	—	5	50	—	5	50	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	2	—	—	2	—	—	2	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		—	30	200	—	30	200	—	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	7	—	—	7	—	—	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_{ICM}	±10	±11	—	±11	±12	—	±11	±12	—	V
Output voltage swing	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	—	24	27	—	24	27	—	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10\ k\Omega$		24	—	—	24	—	—	24	—	—	
$R_L \geqslant 2\ k\Omega$		20	24	—	20	24	—	20	24	—	
Large signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		25	200	—	50	200	—	50	200	—	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	—	—	25	—	—	25	—	—	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	—	3	—	—	3	—	—	3	—	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	—	10^{12}	—	—	10^{12}	—	—	10^{12}	—	Ω
Common-mode rejection ratio ($R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	70	76	—	80	86	—	80	86	—	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$		70	76	—	80	86	—	80	86	—	
Supply current (per amplifier) $T_{amb} = +25°C$	I_{CC}	—	1.4	2.5	—	1.4	2.5	—	1.4	2.5	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	—	120	—	—	120	—	—	120	—	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

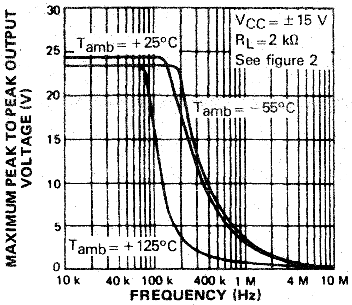
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



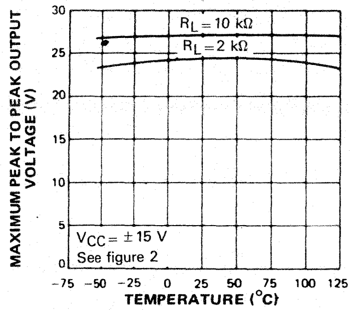
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



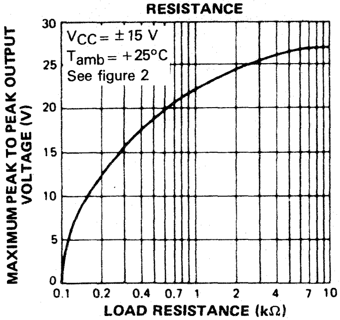
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



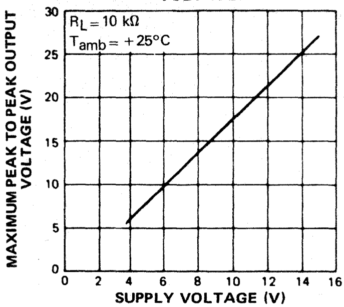
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREE-AIR TEMP.



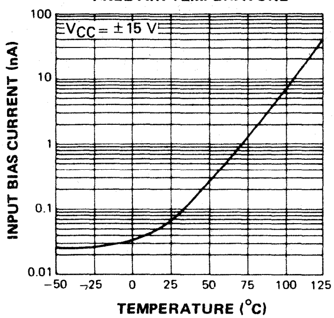
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS LOAD RESISTANCE



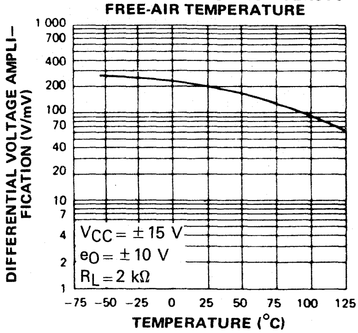
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS SUPPLY VOLTAGE



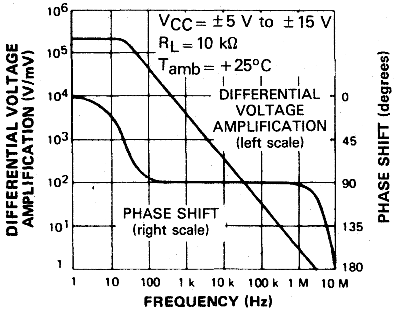
INPUT BIAS CURRENT VERSUS FREE-AIR TEMPERATURE



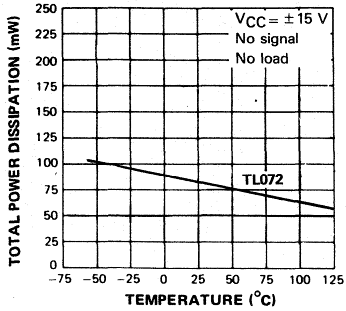
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VERSUS FREE-AIR TEMPERATURE



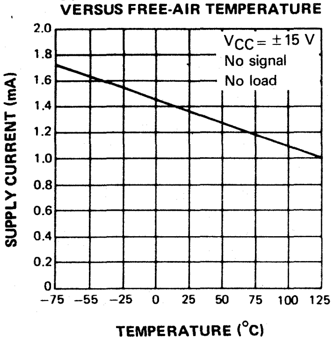
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VERSUS FREQUENCY



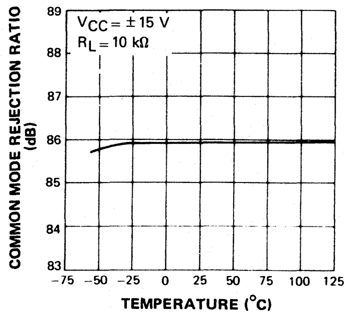
TOTAL POWER DISSIPATION VERSUS FREE-AIR TEMPERATURE



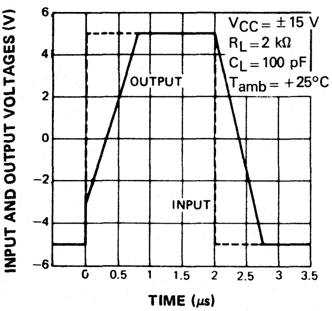
SUPPLY CURRENT PER AMPLIFIER VERSUS FREE-AIR TEMPERATURE



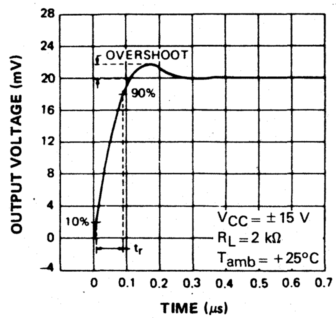
COMMON MODE REJECTION RATIO VERSUS FREE-AIR TEMPERATURE



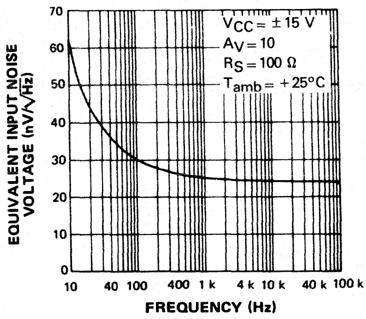
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



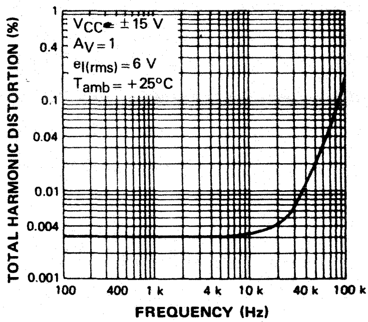
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY

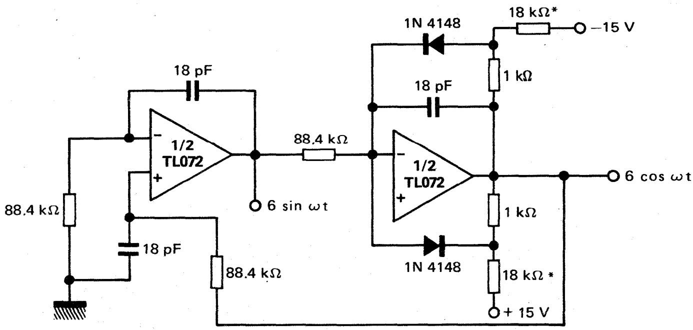


TOTAL HARMONIC DISTORTION VERSUS FREQUENCY



TYPICAL APPLICATION

QUADRATURE OSCILLATOR



* These resistor values may be adjusted for a symmetrical output.

PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

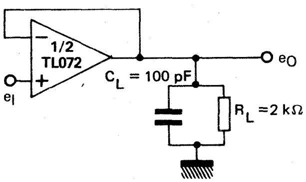
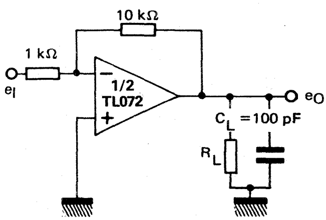
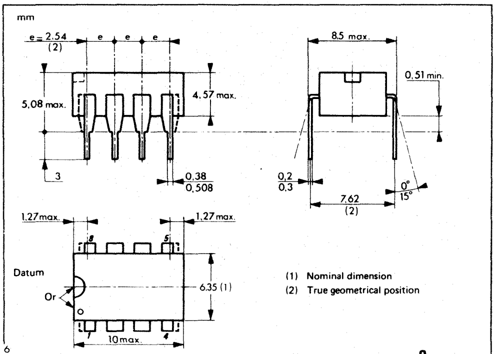


Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER

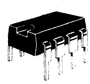


7 8



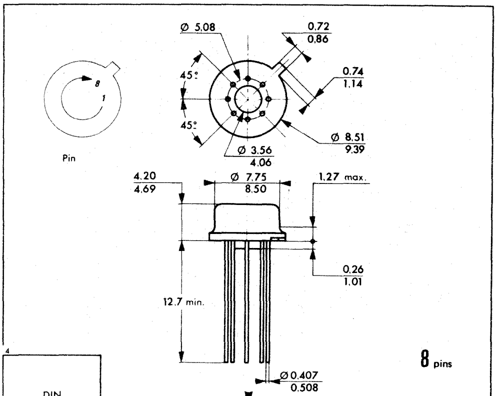
8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS



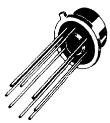
CB-98

DP SUFFIX
PLASTIC PACKAGE



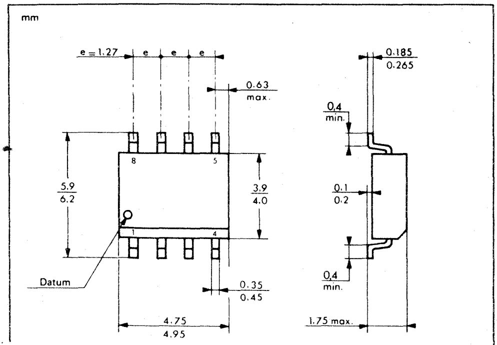
8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



CB-11

H SUFFIX
METAL CAN

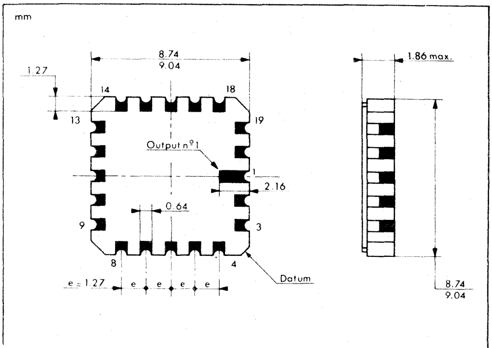


8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

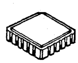
CB-342

FP SUFFIX
PLASTIC
MICROPACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705

GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL074
TL074A
TL074B

LOW NOISE J-FET INPUT QUAD OP-AMPs

The TL074, TL074A and TL074B are high speed J-FET input quad operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Low noise $V_n = 18\ nV/\sqrt{Hz}$(typ)
- Output short-circuit protection
- High input impedance J-FET input stage
- Low harmonic distortion : 0.01% (typ)
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

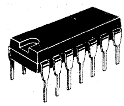
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	GC
TL074M	−55°C to +125°C		●		●
TL074I	−25°C to + 85°C	●			
TL074C	0°C to + 70°C	●		●	
TL074AC	0°C to + 70°C	●			
TL074BC	0°C to + 70°C	●			

Examples : TL074MDG, TL074IDP

LOW NOISE J-FET INPUT QUAD OP-AMPs

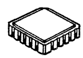
CASES

CB-2



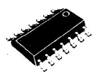
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-705



GC SUFFIX
TRICECOP (LCC)

CB-511

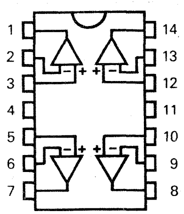


FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENTS

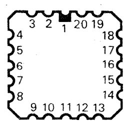
(Top views)

CB-2
CB-511



1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00820

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TL074M	TL074I	TL074C	Unit
Supply voltage (Note 1)	V_{CC}	± 18	± 18	± 18	V
Differential input voltage (Note 2)	V_{ID}	±30	±30	±30	V
Input voltage (Note 3)	V_I	± 15	± 15	± 15	V
Output short-circuit duration (Note 4)	—	Indefinite	Indefinite	Indefinite	—
Power dissipation	P_{tot}	680	680	680	mW
Operating free-air temperature range	T_{oper}	– 55 to + 125	– 25 to + 85	0 to + 70	°C

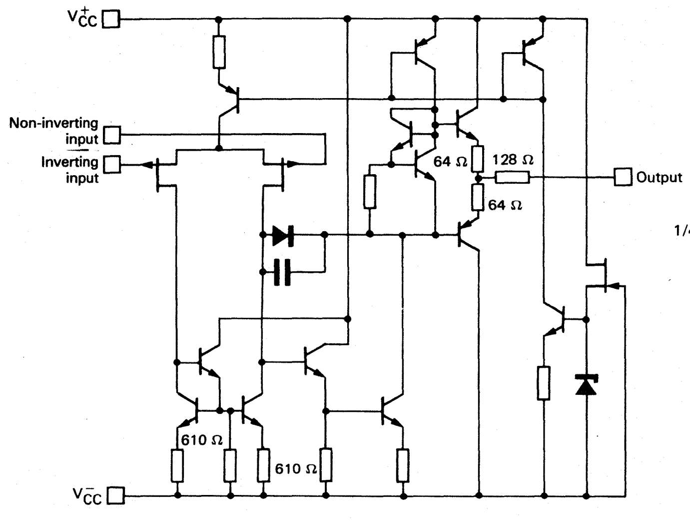
Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC DIAGRAM



1/4 TL074

CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^-	V_{CC}^+	N.C.
CB-2, CB-511	1, 7, 8, 14	2, 6, 9, 13	3, 5, 10, 12	11	4	—
CB-705	2, 10, 12, 20	3, 9, 13, 19	4, 8, 14, 18	16	6	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS
TL074M : $-55°C \leq T_{amb} \leq +125°C$
TL074I : $-25°C \leq T_{amb} \leq +85°C$
TL074C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL074M			TL074I			TL074C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	3	10	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	9	–	–	9	–	–	13	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	µV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	50	–	5	50	–	5	50	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	20	–	–	10	–	–	2	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	50	–	–	20	–	–	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10$ kΩ		24	27	–	24	27	–	24	27	–	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10$ kΩ		24	–	–	24	–	–	24	–	–	
$R_L \geq 2$ kΩ		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geq 2$ kΩ, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		35	200	–	50	200	–	25	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		20	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \leq 10$ kΩ ; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leq 10$ kΩ ; $T_{amb} = +25°C$		80	86	–	80	86	–	70	76	–	
Supply current (per amplifier) $T_{amb} = +25°C$	I_{CC}	–	1.4	2.5	–	1.4	2.5	–	1.4	2.5	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS
$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL074M			TL074I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2$ kΩ ; $C_L = 100$ pF ; $A_V = 1$)	S_{VO}	10	13	–	–	13	–	V/µs
Rise time ($e_I = 20$ mV ; $R_L = 2$ kΩ ; $C_L = 100$ pF ; $A_V = 1$)	t_r	–	0.1	–	–	0.1	–	µs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2$ kΩ ; $C_L = 100$ pF ; $A_V = 1$)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage	V_n							
f = 1 kHz, $R_S = 100\ \Omega$		–	18	–	–	18	–	nV/√Hz
f = 10 Hz to 10 kHz		–	4	–	–	4	–	µV
Equivalent input noise current ($R_S = 100\ \Omega$, f = 1 kHz)	I_n	–	0.01	–	–	0.01	–	pA/√Hz
Total harmonic distorsion ($V_{O(rms)} = 10$ V, $R_S = 1$ kΩ, $R_L \geq 2$ kΩ, f = 1 kHz)	THD	–	0.01	–	–	0.01	–	%

ELECTRICAL CHARACTERISTICS

TL074C : $0°C \leqslant T_{amb} \leqslant +70°C$

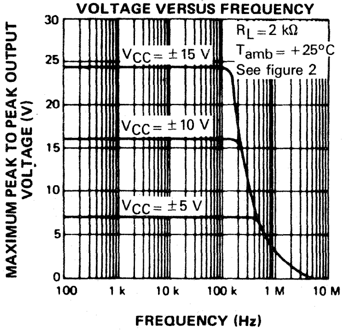
$V_{CC} = \pm 15$ V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

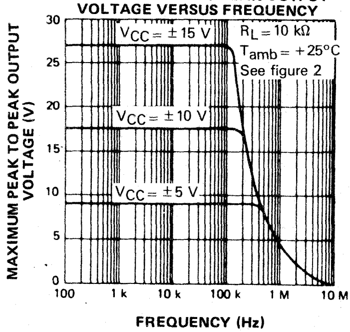
Characteristic	Symbol	TL074C			TL074AC			TL074BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	10	–	3	6	–	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	13	–	–	7.5	–	–	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	50	–	5	50	–	5	50	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	2	–	–	2	–	–	2	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	7	–	–	7	–	–	7	nA
Input common-mode voltage range ($T_{amb} = +25°C$)	V_I	±10	±11	–	±11	±12	–	±11	±12	–	V
Output voltage swing	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R \geqslant 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geqslant 2 k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		25	200	–	50	200	–	25	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	25	–	–	25	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	70	76	–	80	86	–	80	86	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \leqslant 10\ k\Omega$; $T_{amb} = +25°C$		70	76	–	80	86	–	80	86	–	
Supply current (per amplifier) $T_{amb} = +25°C$	I_{CC}	–	1.4	2.5	–	1.4	2.5	–	1.4	2.5	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

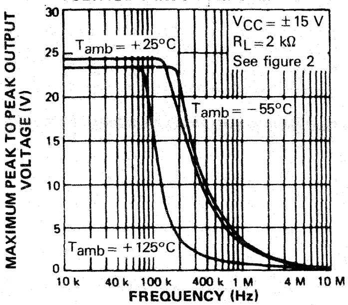
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



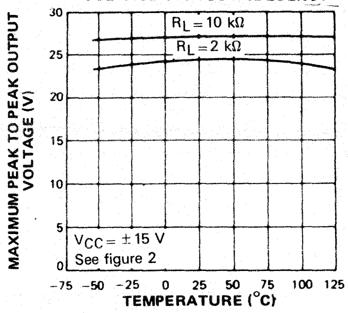
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



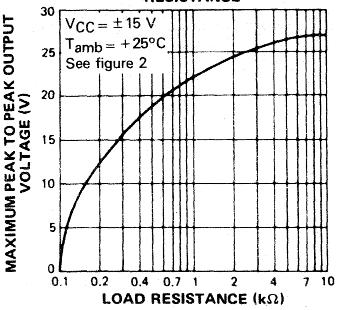
MAXIMUM PEAK TO PEAK OUPUT VOLTAGE VERSUS FREE-AIR TEMP.



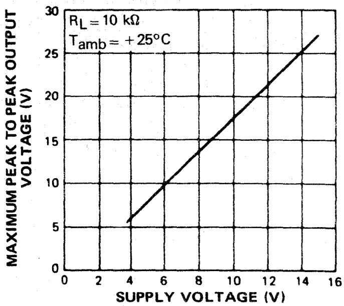
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



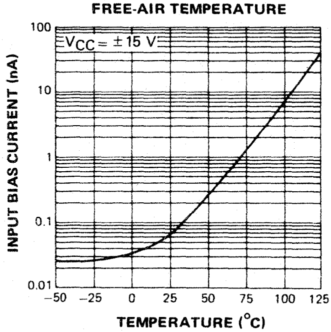
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS LOAD RESISTANCE



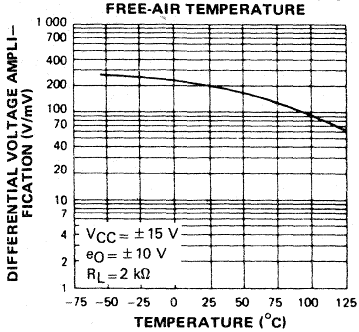
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS SUPPLY VOLTAGE



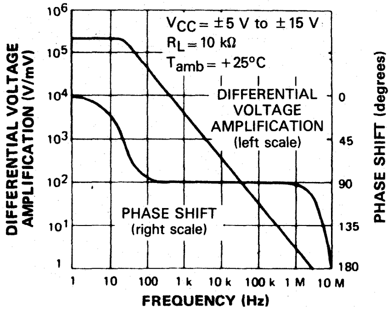
INPUT BIAS CURRENT VERSUS FREE-AIR TEMPERATURE



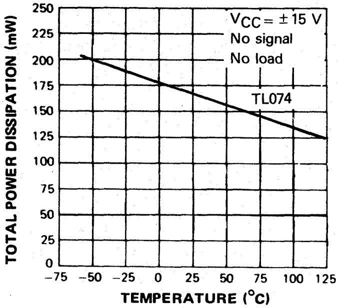
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VERSUS FREE-AIR TEMPERATURE



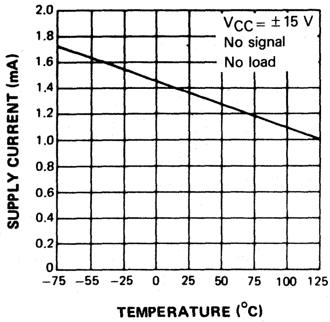
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VERSUS FREQUENCY



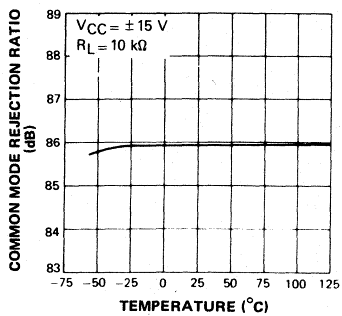
TOTAL POWER DISSIPATION VERSUS FREE-AIR TEMPERATURE



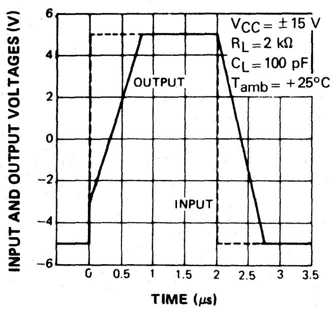
SUPPLY CURRENT PER AMPLIFIER VERSUS FREE-AIR TEMPERATURE



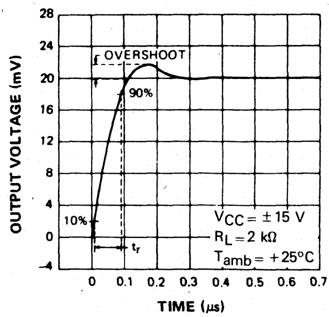
COMMON MODE REJECTION RATIO VERSUS FREE-AIR TEMPERATURE



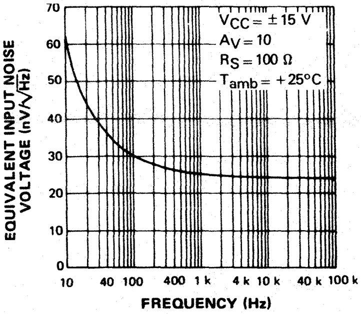
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



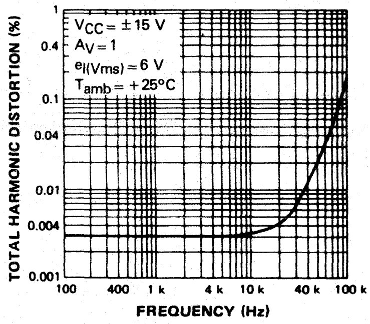
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY



TOTAL HARMONIC DISTORTION VERSUS FREQUENCY



PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

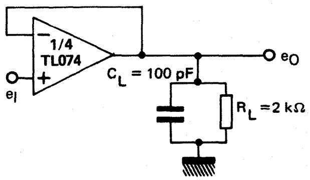
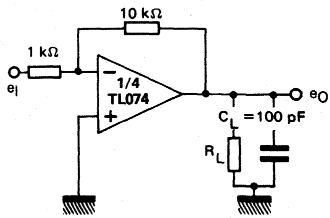


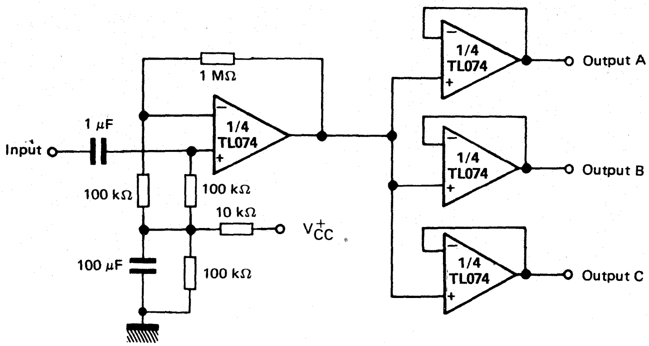
Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



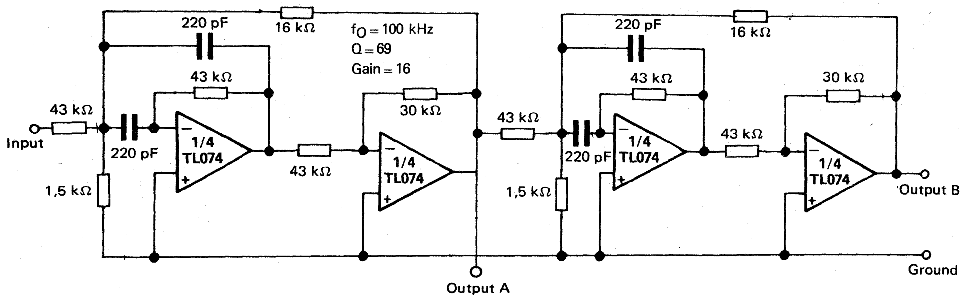
TYPICAL APPLICATIONS

AUDIO DISTRIBUTION AMPLIFIER

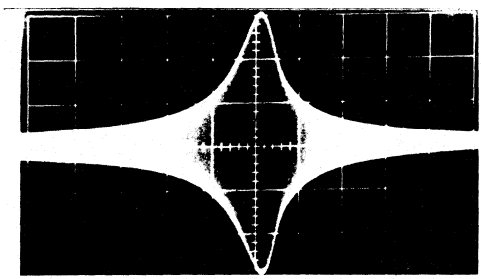
$f_O = 100$ kHz



POSITIVE FEEDBACK BANDPASS-FILTER



OUTPUT A

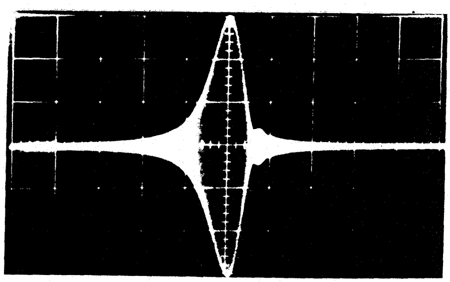


2 kHz/div

SECOND ORDER BANDPASS FILTER

$f_O = 100$ kHz ; Q = 69 ; Gain = 16

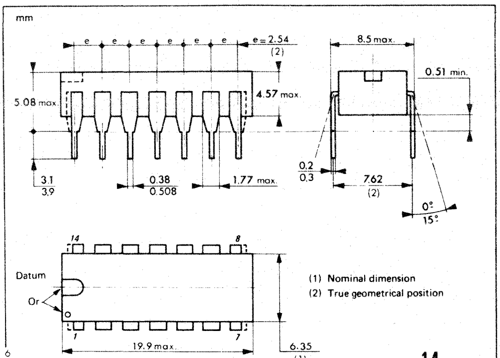
OUTPUT B



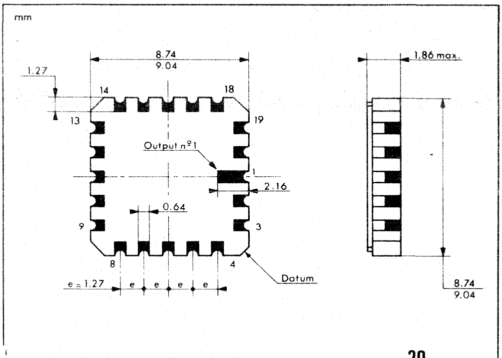
2 kHz/div

CASCADED BANDPASS FILTER

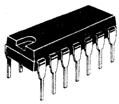
$f_O = 100$ kHz ; Q = 30 ; Gain = 4



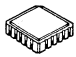
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



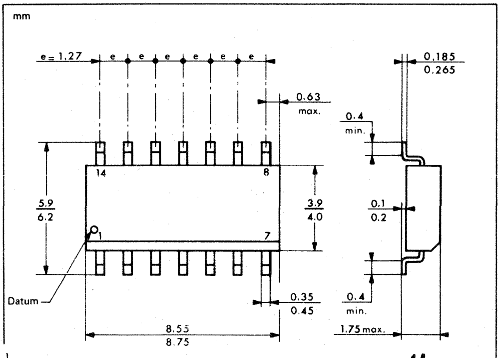
DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



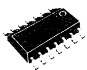
CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



CB-705
GC SUFFIX
TRICECOP (LCC)



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TL081
TL081A
TL081B

J-FET INPUT SINGLE OP-AMPs

The TL081, TL081A and TL081C are high speed J-FET input single operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

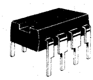
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	H	FP	GC
TL081M	− 55°C to + 125°C		●		●
TL081I	− 25°C to + 85°C	●			
TL081C	0°C to + 70°C	●		●	
TL081AC	0°C to + 70°C	●			
TL081BC	0°C to + 70°C	●			

Examples : TL081MGC, TL081CFP, TL081IDP

J-FET INPUT SINGLE OP-AMPs

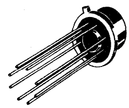
CASES

CB-98



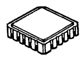
DP SUFFIX
PLASTIC PACKAGE

CB-11



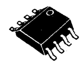
H SUFFIX
METAL CAN

CB-705



GC SUFFIX
TRICECOP (LCC)

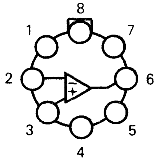
CB-342



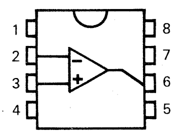
FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENTS
(Top views)

CB-11

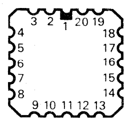


CB-98
CB-342



1 - Balance
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Balance
6 - Output
7 - V_{CC}^+
8 - NC

CB-705



1 - NC
2 - Balance
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Balance
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - NC

Réf. 00315

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage (Note 1)	V_{CC}	± 18	V
Differential input voltage (Note 2)	V_{ID}	±30	V
Input voltage (Note 3)	V_I	± 15	V
Duration of output short-circuit (Note 4)	Unlimited	Unlimited	Unlimited
Power dissipation	P_{tot}	680	mW
Operating temperature range TL081C,AC,BC TL081I TL081M	T_{oper}	 0 to + 70 −25 to + 85 −55 to +125	°C

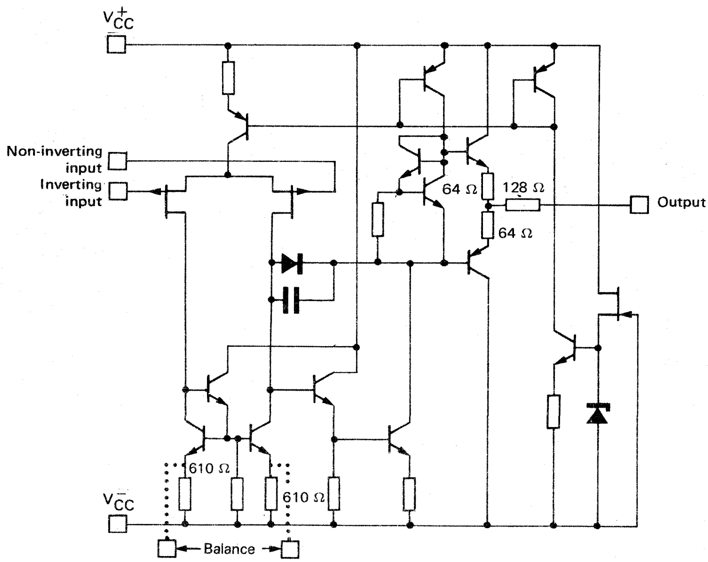
Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

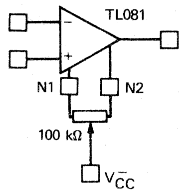
Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC DIAGRAM



INPUT OFFSET VOLTAGE NULL CIRCUITS



CASE	Balance	Inverting input	Non-inverting input	Output	V_{CC}^{+}	V_{CC}^{-}	N.C.
CB-98 CB-342 CB-11	1, 5	2	3	6	7	4	8
CB-705	2, 12	5	7	15	17	10	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL081M : $-55°C \leqslant T_{amb} \leqslant +125°C$
TL081I : $-25°C \leqslant T_{amb} \leqslant +85°C$
TL081C : $0°C \leqslant T_{amb} \leqslant +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL081M			TL081I			TL081C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	5	15	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	9	–	–	9	–	–	20	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	100	–	5	100	–	5	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	20	–	–	10	–	–	5	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	400	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	50	–	–	20	–	–	10	nA
Input common-mode voltage range	V_I	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geqslant 2\ k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		50	200	–	50	200	–	25	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		25	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \geqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geqslant 10\ k\Omega$; $T_{amb} = +25°C$		80	86	–	80	86	–	70	76	–	
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.8	–	1.4	2.8	–	1.4	2.8	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL081M			TL081I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	S_{VO}	8	13	–	–	13	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	t_r	–	0.1	–	–	0.1	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage ($R_S = 100\ \Omega$; f = 1 kHz)	V_n	–	25	–	–	25	–	nV/$\sqrt{Hz}$

ELECTRICAL CHARACTERISTICS

TL081C : $0°C \leqslant T_{amb} \leqslant +70°C$

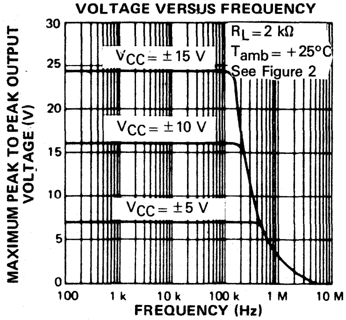
$V_{CC} = \pm 15$ V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

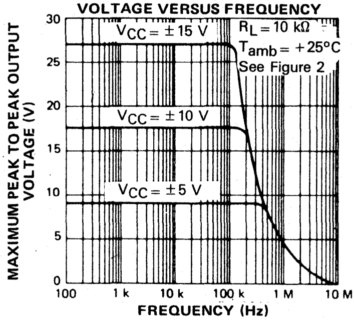
Characteristic	Symbol	TL081C			TL081AC			TL081BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	5	15	–	3	6	–	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	20	–	–	7.5	–	–	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	$\mu V/°C$
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	200	–	5	100	–	5	100	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	5	–	–	3	–	–	3	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	400	–	30	200	–	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	10	–	–	7	–	–	7	nA
Input common-mode voltage range	V_I	± 10	± 11	–	± 11	± 12	–	± 11	± 12	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geqslant 2\ k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		25	200	–	50	200	–	50	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	25	–	–	25	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \geqslant 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	70	76	–	80	86	–	80	86	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geqslant 10\ k\Omega$; $T_{amb} = +25°C$		70	76	–	80	86	–	80	86	–	
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.8	–	1.4	2.8	–	1.4	2.8	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

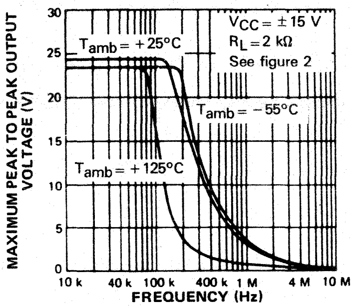
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



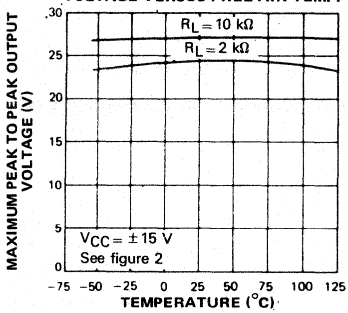
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



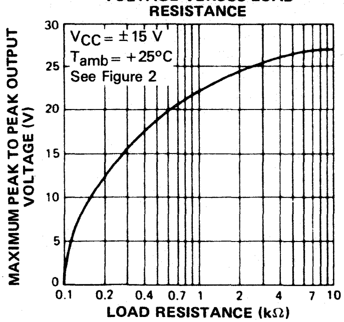
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



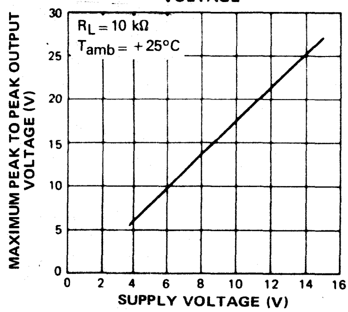
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREE-AIR TEMP.



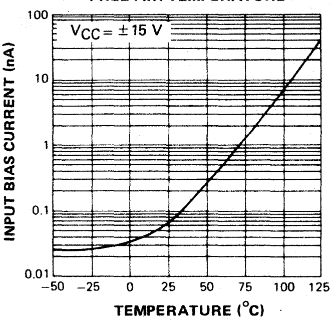
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS LOAD RESISTANCE



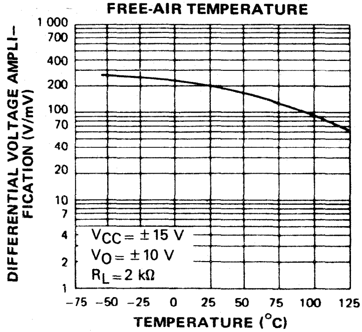
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS SUPPLY VOLTAGE



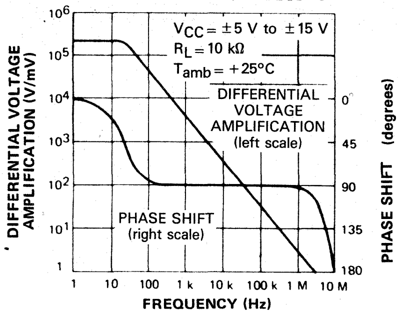
INPUT BIAS CURRENT VERSUS FREE-AIR TEMPERATURE



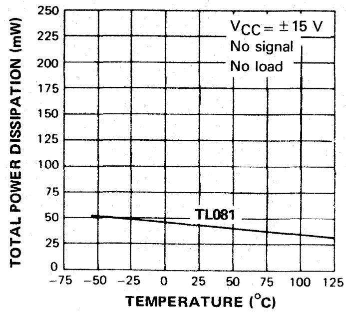
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VERSUS FREE-AIR TEMPERATURE



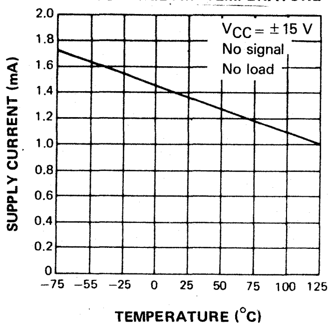
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VERSUS FREQUENCY



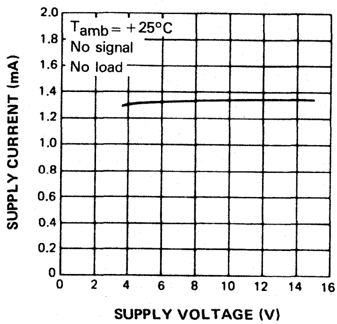
TOTAL POWER DISSIPATION VERSUS FREE-AIR TEMPERATURE



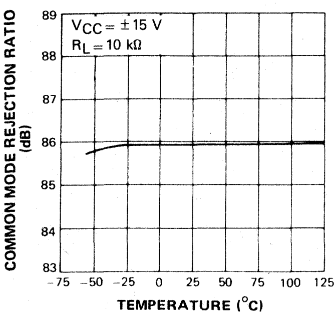
SUPPLY CURRENT PER AMPLIFIER VERSUS FREE-AIR TEMPERATURE



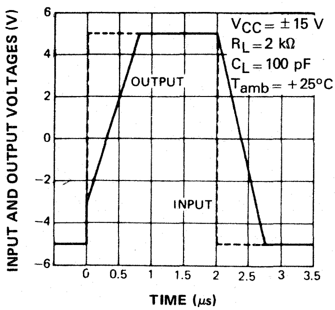
SUPPLY CURRENT PER AMPLIFIER VERSUS SUPPLY VOLTAGE



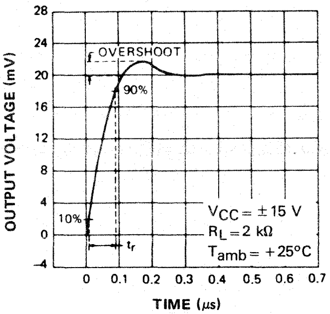
COMMON MODE REJECTION RATIO VERSUS FREE-AIR TEMPERATURE



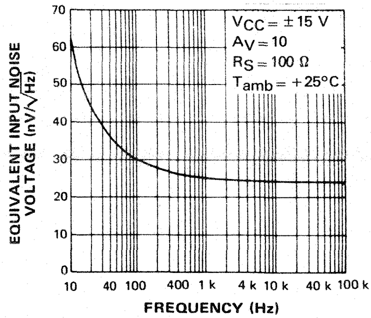
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



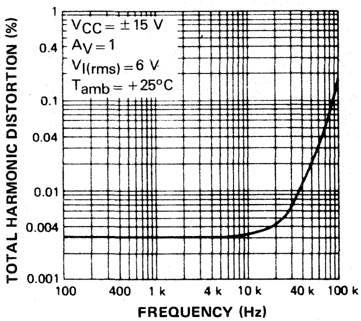
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY

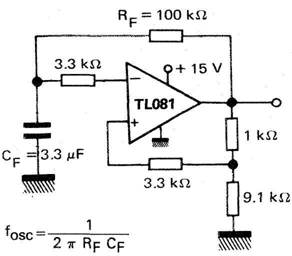


TOTAL HARMONIC DISTORTION VERSUS FREQUENCY

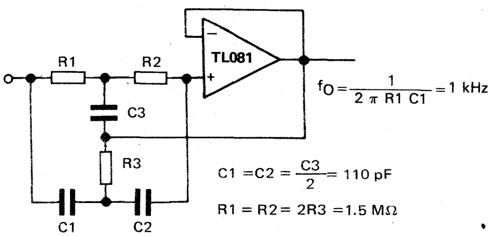


TYPICAL APPLICATIONS

(0.5 Hz) SQUARE WAVE OSCILLATOR



HIGH Q NOTCH FILTER



PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

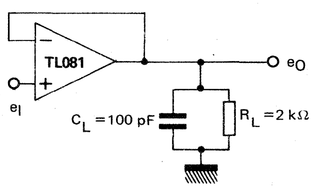
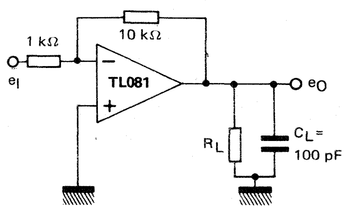
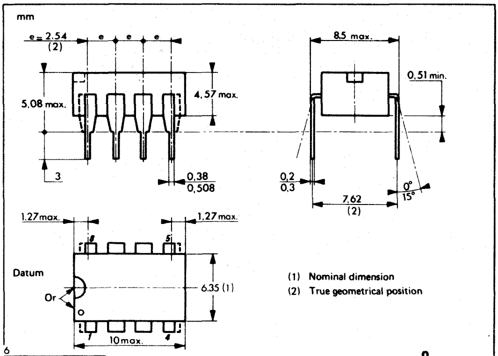
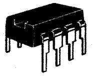


Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER

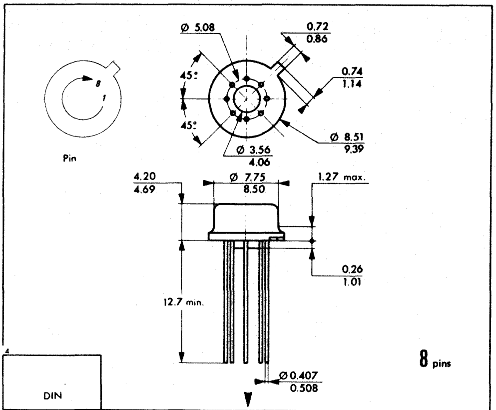




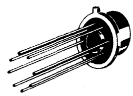
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS



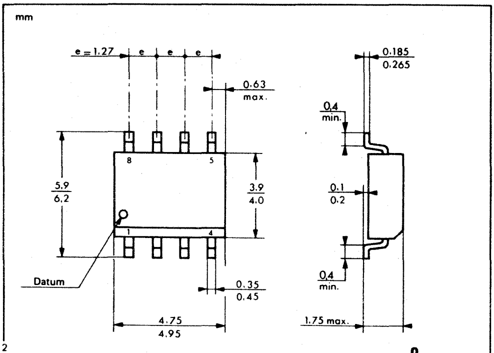
CB-98
DP SUFFIX
PLASTIC PACKAGE



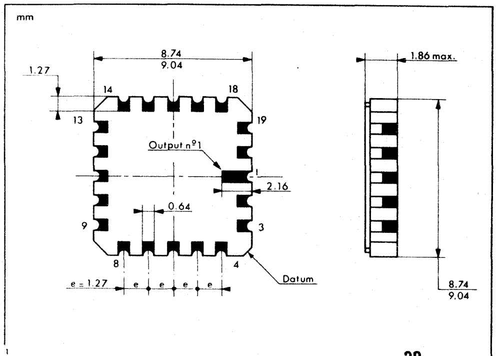
DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



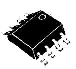
CB-11
H SUFFIX
METAL CAN



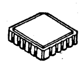
DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS



DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-342
FP SUFFIX
PLASTIC MICROPACKAGE



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL082
TL082A
TL082B

J-FET INPUT DUAL OP-AMPs

The TL082, TL082A and TL082B are high speed J-FET input dual operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

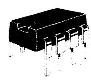
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	H	FP	GC
TL082M	– 55°C to + 125°C		●		●
TL082I	– 25°C to + 85°C	●			
TL082C	0°C to + 70°C	●		●	
TL082AC	0°C to + 70°C	●			
TL082BC	0°C to + 70°C	●			

Examples : TL082CFP, TL082MGC, TL082IDP

J-FET INPUT DUAL OP-AMPs

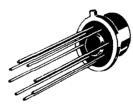
CASES

CB-98



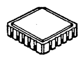
DP SUFFIX
PLASTIC PACKAGE

CB-11



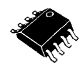
H SUFFIX
METAL CAN

CB-705



GC SUFFIX
TRICECOP (LCC)

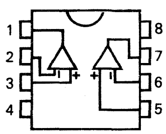
CB-342



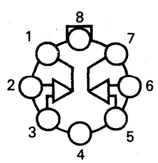
FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENTS
(Top views)

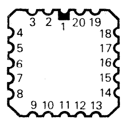
CB-98
CB-342



CB-11



CB-705



1 - Output (1)
2 - Inverting input (1)
3 - Non-inverting input (1)
4 - V_{CC}^{-}
5 - Non-inverting input (2)
6 - Inverting input (2)
7 - Output (2)
8 - V_{CC}^{+}

1 - NC
2 - Output (1)
3 - NC
4 - NC
5 - Inverting input (1)
6 - NC
7 - Non-inverting input (1)
8 - NC
9 - NC
10 - V_{CC}^{-}
11 - NC
12 - Non-inverting input (2)
13 - NC
14 - NC
15 - Inverting input (2)
16 - NC
17 - Output (2)
18 - NC
19 - NC
20 - V_{CC}^{+}

Réf. 00825

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON
COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage (Note 1)	V_{CC}	± 18	V
Differential input voltage (Note 2)	V_{ID}	± 30	V
Input voltage (Note 3)	V_I	± 15	V
Duration of output short-circuit (Note 4)	–	Unlimited	–
Power dissipation	P_{tot}	680	mW
Operating temperature range TL082C,AC,BC TL082I TL082M	T_{oper}	 0 to + 70 – 25 to + 85 – 55 to + 125	°C

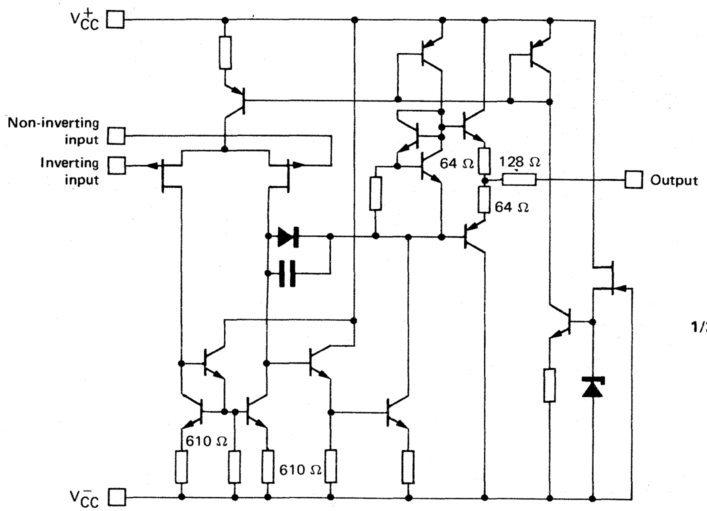
Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC DIAGRAM



1/2 TL082

CASE	Outputs	Non-inverting inputs	Inverting inputs	V_{CC}^-	V_{CC}^+	N.C.
CB-98 CB-342 CB-11	1, 7	3, 5	2, 6	4	8	–
CB-705	2, 17	7, 12	5, 15	10	20	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL082M : $-55°C \leq T_{amb} \leq +125°C$
TL082I : $-25°C \leq T_{amb} \leq +85°C$
TL082C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL082M			TL082I			TL082C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	5	15	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	9	–	–	9	–	–	20	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	100	–	5	100	–	5	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	20	–	–	10	–	–	5	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	400	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	50	–	–	20	–	–	10	nA
Input common-mode voltage range	V_I	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geq 2\ k\Omega$		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		50	200	–	50	200	–	25	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) $R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$	SVR	80	86	–	80	86	–	70	76	–	dB
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.8	–	1.4	2.8	–	1.4	2.8	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL082M			TL082I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	S_{VO}	8	13	–	–	13	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	t_r	–	0.1	–	–	0.1	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage ($R_S = 100\ \Omega$; f = 1 kHz)	V_n	–	25	–	–	25	–	nV/$\sqrt{Hz}$

ELECTRICAL CHARACTERISTICS

TL082C : $0°C \leq T_{amb} \leq +70°C$

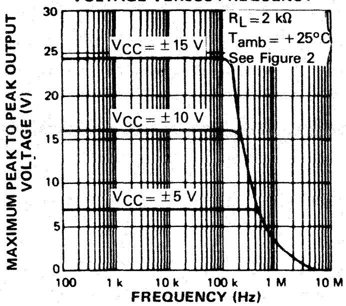
$V_{CC} = \pm 15$ V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

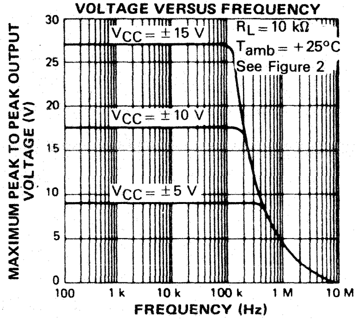
Characteristic	Symbol	TL082C			TL082AC			TL082BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		—	5	15	—	3	6	—	2	3	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	20	—	—	7.5	—	—	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	—	10	—	—	10	—	—	10	—	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		—	5	200	—	5	100	—	5	100	pA
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	5	—	—	3	—	—	3	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		—	30	400	—	30	200	—	30	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	10	—	—	7	—	—	7	nA
Input common-mode voltage range	V_I	±10	±11	—	±11	±12	—	±11	±12	—	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	—	24	27	—	24	27	—	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10\ k\Omega$		24	—	—	24	—	—	24	—	—	
$R_L \geq 2\ k\Omega$		20	24	—	20	24	—	20	24	—	
Large signal voltage gain ($R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		25	200	—	50	200	—	50	200	—	
$T_{min} \leq T_{amb} \leq T_{max}$		15	—	—	25	—	—	25	—	—	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	—	3	—	—	3	—	—	3	—	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	—	10^{12}	—	—	10^{12}	—	—	10^{12}	—	Ω
Common-mode rejection ratio ($R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	70	76	—	80	86	—	80	86	—	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$		70	76	—	80	86	—	80	86	—	
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	—	1.4	2.8	—	1.4	2.8	—	1.4	2.8	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	—	120	—	—	120	—	—	120	—	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

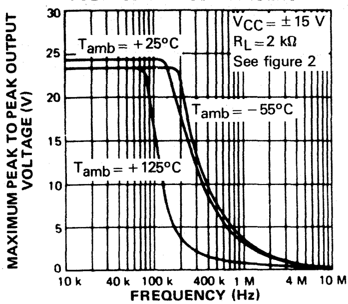
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



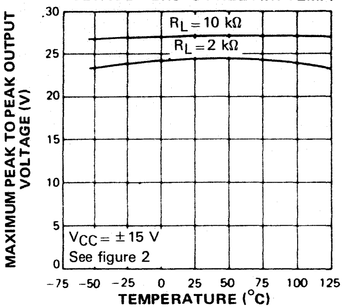
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



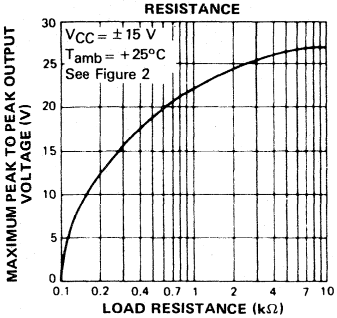
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



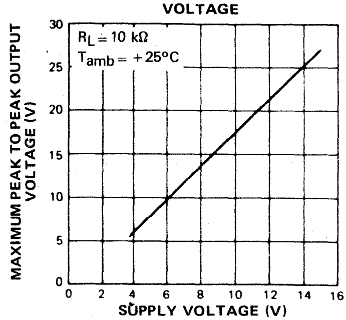
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREE-AIR TEMP.

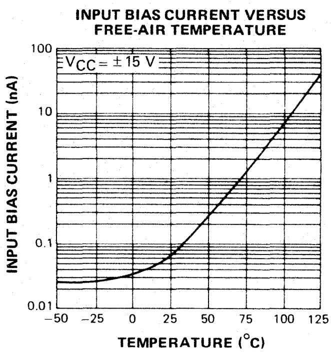


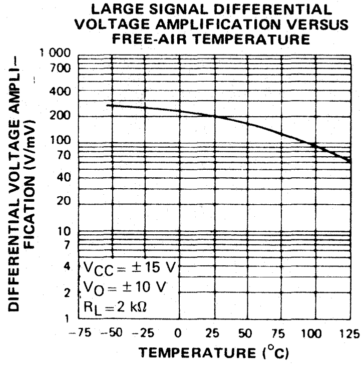
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS LOAD RESISTANCE

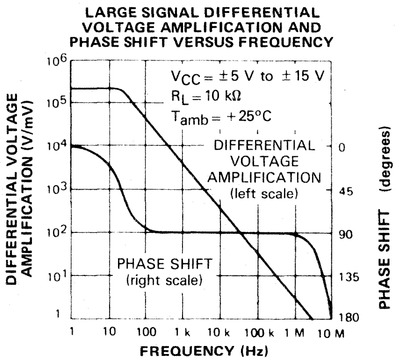


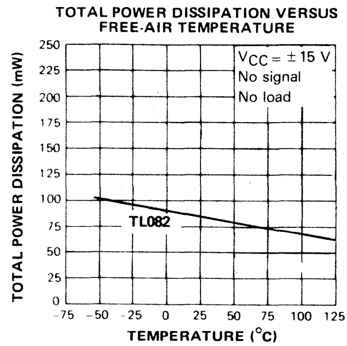
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS SUPPLY VOLTAGE

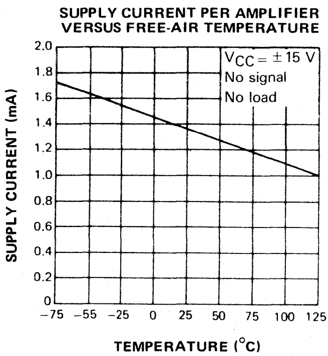


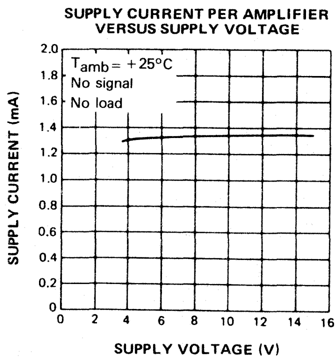

INPUT BIAS CURRENT VERSUS
FREE-AIR TEMPERATURE
VCC = ± 15 V
INPUT BIAS CURRENT (nA)
TEMPERATURE (°C)


LARGE SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION VERSUS
FREE-AIR TEMPERATURE
DIFFERENTIAL VOLTAGE AMPLIFICATION (V/mV)
VCC = ± 15 V
VO = ± 10 V
RL = 2 kΩ
TEMPERATURE (°C)

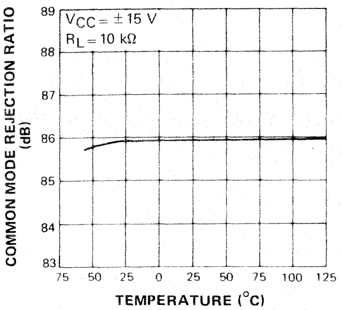

LARGE SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION AND
PHASE SHIFT VERSUS FREQUENCY
VCC = ±5 V to ±15 V
RL = 10 kΩ
Tamb = +25°C
DIFFERENTIAL
VOLTAGE
AMPLIFICATION
(left scale)
PHASE SHIFT
(right scale)
DIFFERENTIAL VOLTAGE AMPLIFICATION (V/mV)
PHASE SHIFT (degrees)
FREQUENCY (Hz)


TOTAL POWER DISSIPATION VERSUS
FREE-AIR TEMPERATURE
VCC = ± 15 V
No signal
No load
TL082
TOTAL POWER DISSIPATION (mW)
TEMPERATURE (°C)

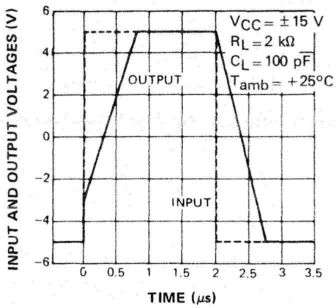

SUPPLY CURRENT PER AMPLIFIER
VERSUS FREE-AIR TEMPERATURE
VCC = ± 15 V
No signal
No load
SUPPLY CURRENT (mA)
TEMPERATURE (°C)


SUPPLY CURRENT PER AMPLIFIER
VERSUS SUPPLY VOLTAGE
Tamb = +25°C
No signal
No load
SUPPLY CURRENT (mA)
SUPPLY VOLTAGE (V)

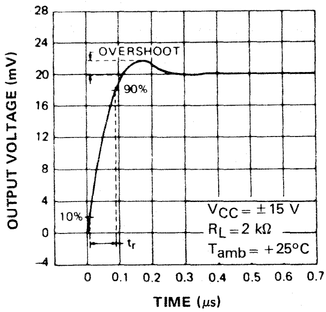
COMMON MODE REJECTION RATIO VERSUS FREE-AIR TEMPERATURE



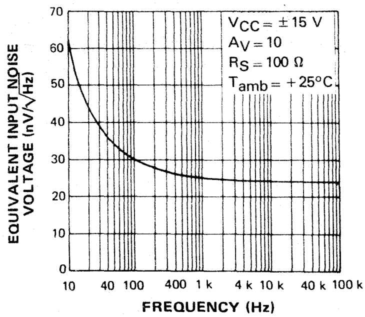
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



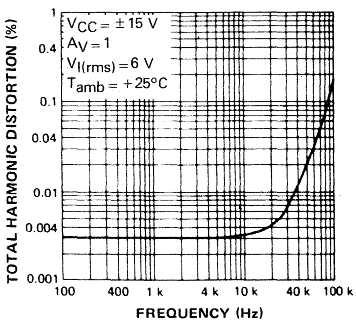
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY

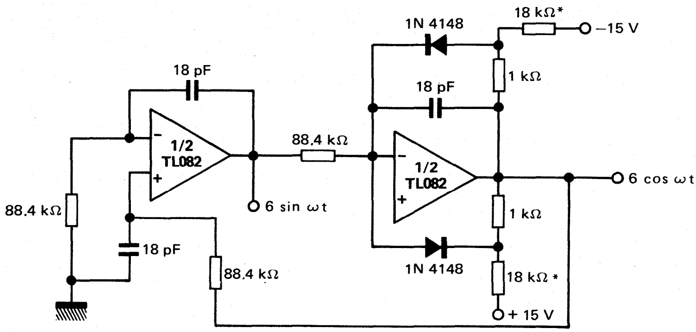


TOTAL HARMONIC DISTORTION VERSUS FREQUENCY



TYPICAL APPLICATION

QUADRATURE OSCILLATOR



* These resistor values may be adjusted for a symmetrical output.

PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

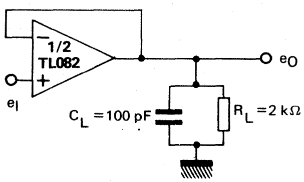
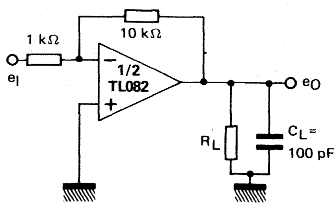
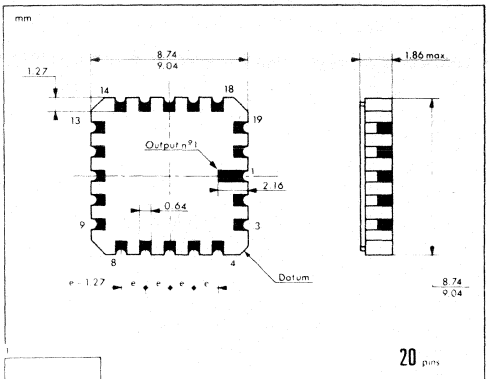


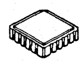
Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



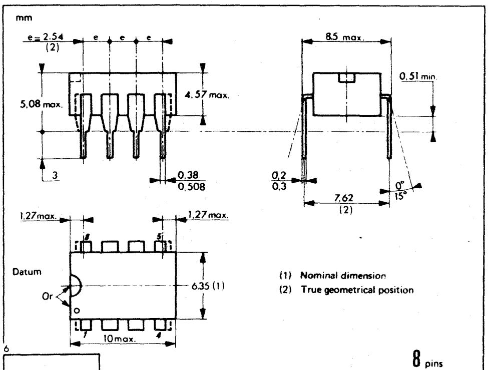


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705

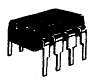


GC SUFFIX
TRICECOP (LCC)

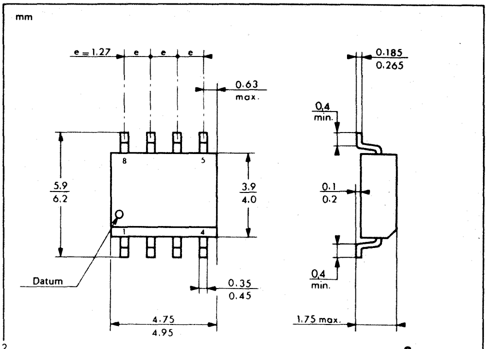


DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98

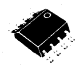


DP SUFFIX
PLASTIC PACKAGE

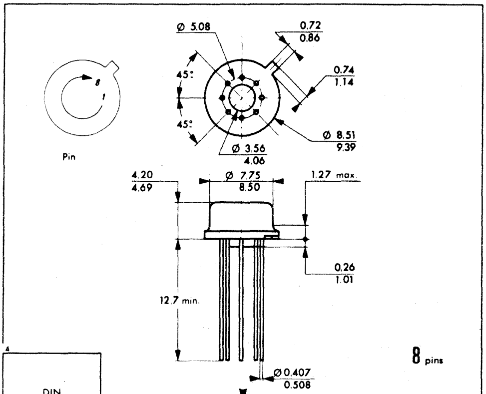


DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342

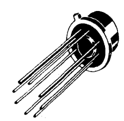


FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11



H SUFFIX
METAL CAN

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL084
TL084A
TL084B

J-FET INPUT QUAD OP-AMPs

The TL084, TL084A and TL084B are high speed J-FET input quad operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.

- Low power consumption
- Wide common-mode and differential voltage range
- Low input bias and offset current
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate : 13 V/μs (typ)

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

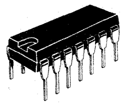
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	GC
TL084M	– 55°C to + 125°C		•		•
TL084I	– 25°C to + 85°C	•			
TL084C	0°C to + 70°C	•		•	
TL084AC	0°C to + 70°C	•			
TL084BC	0°C to + 70°C	•			

Examples : TL084MGC, TL084IDP, TL084CFP

J-FET INPUT QUAD OP-AMPs

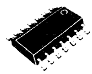
CASES

CB-2



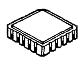
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

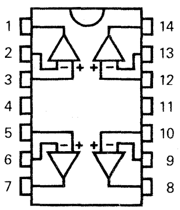
CB-705



GC SUFFIX
TRICECOP (LCC)

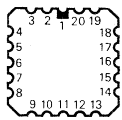
PIN ASSIGNMENTS
(Top views)

CB-2
CB-511



1 - Output (1)
2 - Inverting input (1)
3 - Non-inverting input (1)
4 - V_{CC}^{+}
5 - Non-inverting input (2)
6 - Inverting input (2)
7 - Output (2)
8 - Output (3)
9 - Inverting input (3)
10 - Non-inverting input (3)
11 - V_{CC}^{-}
12 - Non-inverting input (4)
13 - Inverting input (4)
14 - Output (4)

CB-705



1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

Réf. 00830

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage (Note 1)	V_{CC}	± 18	V
Differential input voltage (Note 2)	V_{ID}	± 30	V
Input voltage (Note 3)	V_I	± 15	V
Duration of output short-circuit (Note 4)	–	Unlimited	–
Power dissipation	P_{tot}	680	mW
Operating temperature range TL084C,AC,BC TL084I TL084M	T_{oper}	 0 to + 70 – 25 to + 85 – 55 to + 125	°C

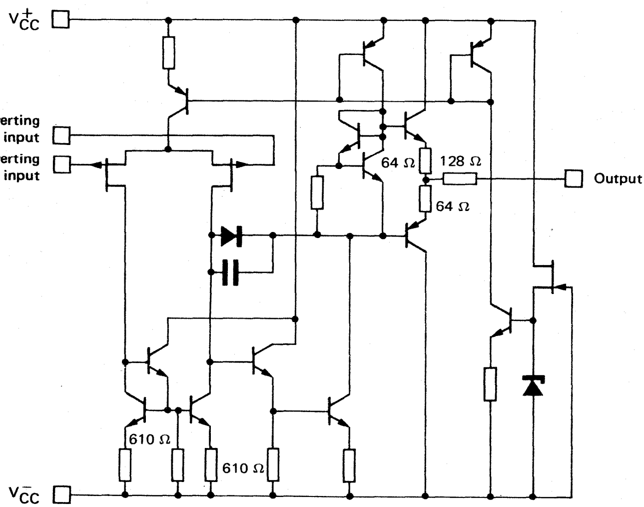
Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

Note 4 : The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SCHEMATIC (each amplifier)



1/4 TL084

CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^+	V_{CC}^-	N.C.
CB-2 CB-511	1, 7, 14, 8	2, 6, 13, 9	3, 5, 12, 10	4	11	–
CB-705	2, 10, 12, 20	3, 9, 13, 19	4, 8, 14, 18	6	16	*

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

TL084M : $-55°C \leq T_{amb} \leq +125°C$
TL084I : $-25°C \leq T_{amb} \leq +85°C$
TL084C : $0°C \leq T_{amb} \leq +70°C$
$V_{CC} = \pm 15$ V
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	TL084M			TL084I			TL084C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	3	6	–	3	6	–	5	15	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	9	–	–	9	–	–	20	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	100	–	5	100	–	5	200	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	20	–	–	10	–	–	5	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	200	–	30	200	–	30	400	pA
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	50	–	–	20	–	–	10	nA
Input common-mode voltage range	V_I	±11	±12	–	±11	±12	–	±10	±11	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10\ k\Omega$		24	27	–	24	27	–	24	27	–	
$T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 10\ k\Omega$		24	–	–	24	–	–	24	–	–	
$R_L \geq 2\ k\Omega$		20	24	–	20	24	–	20	24		
Large signal voltage gain ($R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		50	200	–	50	200	–	25	200	–	
$T_{min} \leq T_{amb} \leq T_{max}$		25	–	–	25	–	–	15	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$)	CMR	80	86	–	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) $R_S \geq 10\ k\Omega$; $T_{amb} = +25°C$	SVR	80	86	–	80	86	–	70	76	–	dB
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.8	–	1.4	2.8	–	1.4	2.8	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 15$ V, $T_{amb} = +25°C$

Characteristic	Symbol	TL084M			TL084I,C			Unit
		Min	Typ	Max	Min	Typ	Max	
Slew rate ($e_I = 10$ V ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	S_{VO}	8	13	–	–	13	–	V/μs
Rise time ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	t_r	–	0.1	–	–	0.1	–	μs
Overshoot factor ($e_I = 20$ mV ; $R_L = 2\ k\Omega$; $C_L = 100$ pF ; $A_V = 1$) (See Fig. 1)	K_{OV}	–	10	–	–	10	–	%
Equivalent input noise voltage ($R_S = 100\ \Omega$; f = 1 kHz)	V_n	–	25	–	–	25	–	nV/√Hz

ELECTRICAL CHARACTERISTICS

TL084C : $0°C \leqslant T_{amb} \leqslant +70°C$

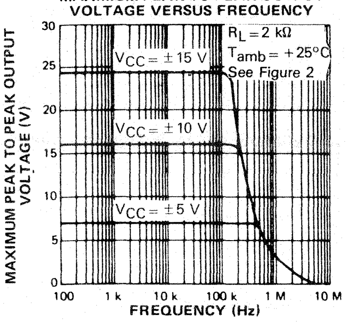
$V_{CC} = \pm 15$ V

Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

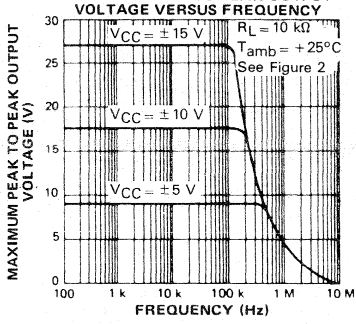
Characteristic	Symbol	TL084C			TL084AC			TL084BC			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}										mV
$T_{amb} = +25°C$		–	5	15	–	3	6	–	2	3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	20	–	–	7.5	–	–	5	
Temperature coefficient of input offset voltage ($R_S = 50\ \Omega$)	αV_{IO}	–	10	–	–	10	–	–	10	–	μV/°C
Input offset current*	I_{IO}										
$T_{amb} = +25°C$		–	5	200	–	5	100	–	5	100	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	5	–	–	3	–	–	3	nA
Input bias current*	I_{IB}										
$T_{amb} = +25°C$		–	30	400	–	30	200	–	30	200	pA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	10	–	–	7	–	–	7	nA
Input common-mode voltage range	V_I	±10	±11	–	±11	±12	–	±11	±12	–	V
Output voltage swing :	V_{OPP}										V
$T_{amb} = +25°C$, $R_L = 10$ kΩ		24	27	–	24	27	–	24	27	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 10$ kΩ		24	–	–	24	–	–	24	–	–	
$R_L \geqslant 2$ kΩ		20	24	–	20	24	–	20	24	–	
Large signal voltage gain ($R_L \geqslant 2$ kΩ, $V_O = \pm 10$ V)	A_{VD}										V/mV
$T_{amb} = +25°C$		25	200	–	50	200	–	50	200	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	25	–	–	25	–	–	
Small signal bandwidth ($T_{amb} = +25°C$)	GW_R	–	3	–	–	3	–	–	3	–	MHz
Input resistance ($T_{amb} = +25°C$)	R_I	–	10^{12}	–	–	10^{12}	–	–	10^{12}	–	Ω
Common-mode rejection ratio ($R_S \geqslant 10$ kΩ ; $T_{amb} = +25°C$)	CMR	70	76	–	80	86	–	80	86	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	SVR										dB
$R_S \geqslant 10$ kΩ ; $T_{amb} = +25°C$		70	76	–	80	86	–	80	86	–	
Supply current (per amplifier) ($T_{amb} = +25°C$)	I_{CC}	–	1.4	2.8	–	1.4	2.8	–	1.4	2.8	mA
Channel separation ($A_{VD} = 100$, $T_{amb} = +25°C$)	V_{O1}/V_{O2}	–	120	–	–	120	–	–	120	–	dB

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

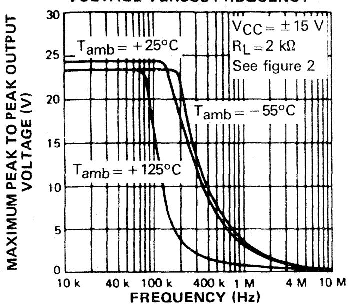
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



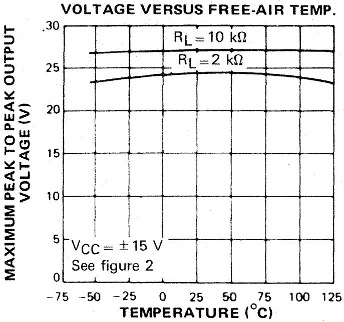
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



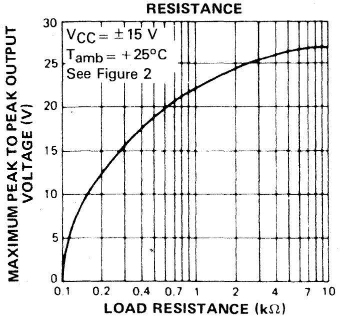
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREQUENCY



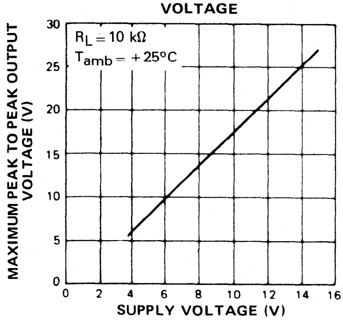
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS FREE-AIR TEMP.



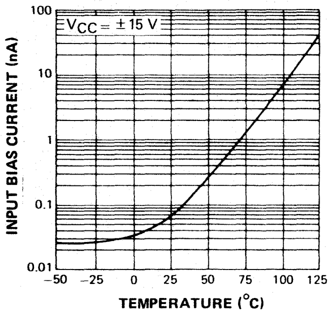
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS LOAD RESISTANCE



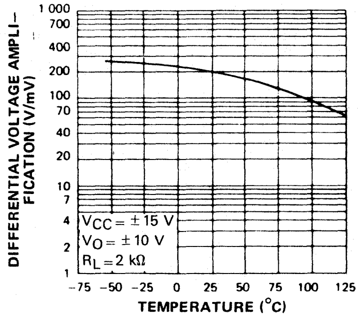
MAXIMUM PEAK TO PEAK OUTPUT VOLTAGE VERSUS SUPPLY VOLTAGE



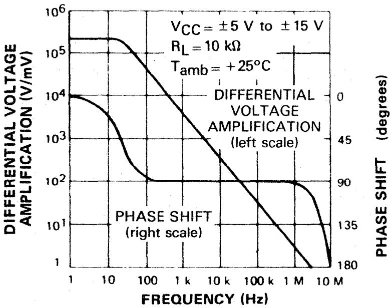
INPUT BIAS CURRENT VERSUS FREE-AIR TEMPERATURE



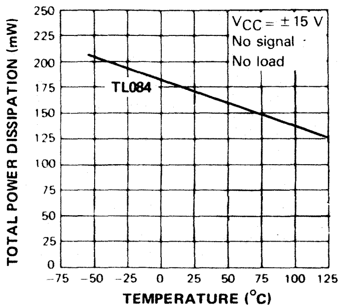
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VERSUS FREE-AIR TEMPERATURE



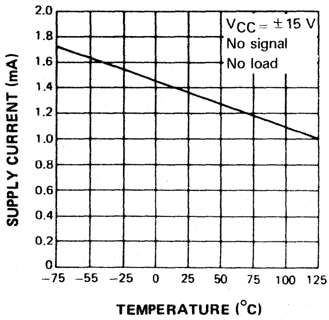
LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VERSUS FREQUENCY



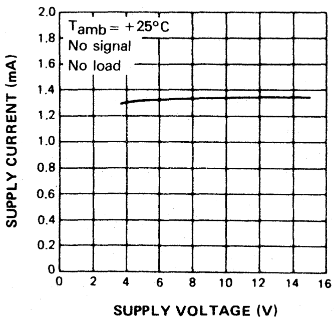
TOTAL POWER DISSIPATION VERSUS FREE-AIR TEMPERATURE



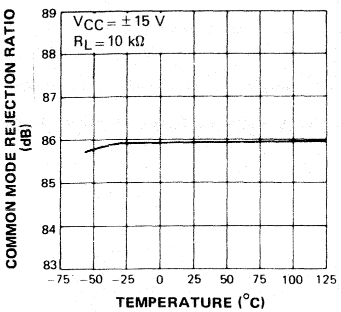
SUPPLY CURRENT PER AMPLIFIER VERSUS FREE-AIR TEMPERATURE



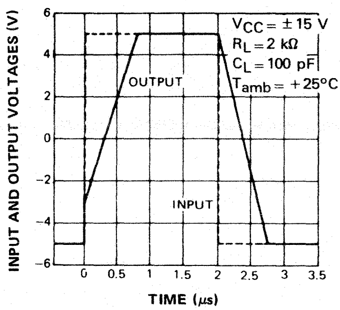
SUPPLY CURRENT PER AMPLIFIER VERSUS SUPPLY VOLTAGE



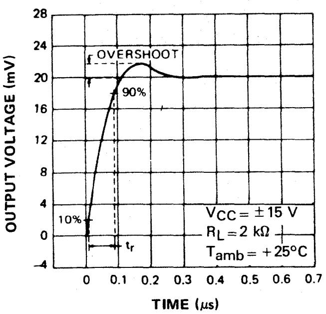
COMMON MODE REJECTION RATIO
VERSUS FREE-AIR TEMPERATURE



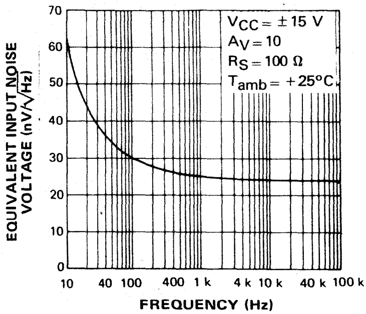
VOLTAGE FOLLOWER LARGE
SIGNAL PULSE RESPONSE



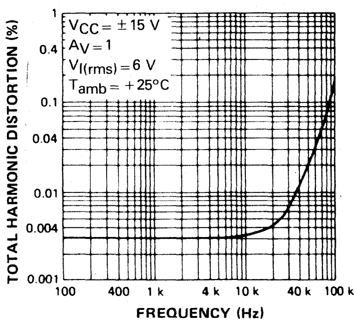
OUTPUT VOLTAGE VERSUS TIME



EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY



TOTAL HARMONIC DISTORTION
VERSUS FREQUENCY



PARAMETER MEASUREMENT INFORMATION

Fig. 1 : VOLTAGE FOLLOWER

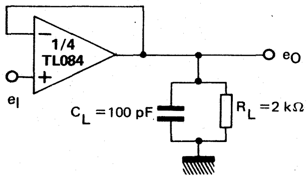
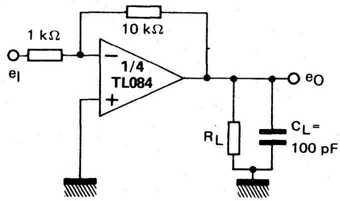
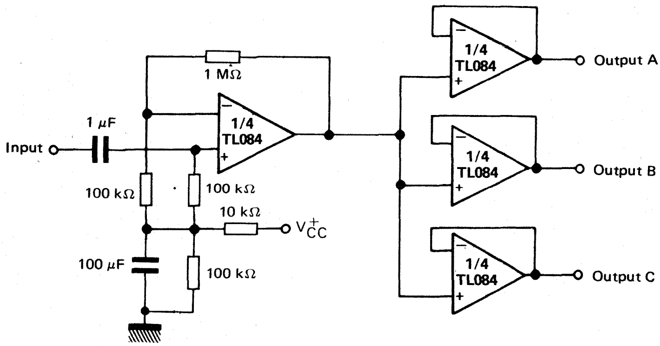


Fig. 2 : GAIN-OF-10 INVERTING AMPLIFIER



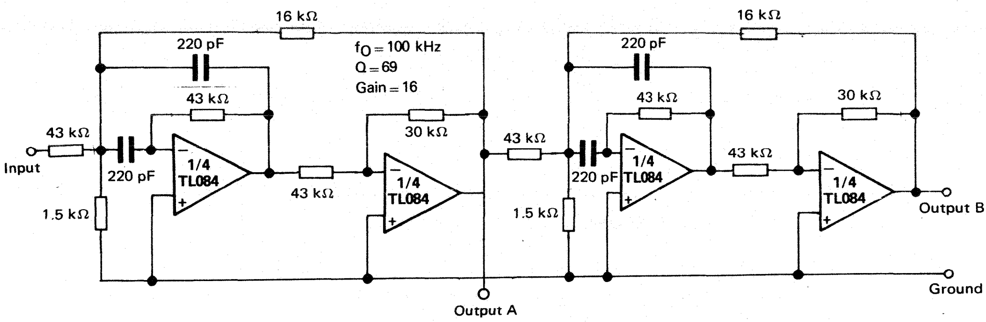
AUDIO DISTRIBUTION AMPLIFIER

$f_O = 100$ kHz

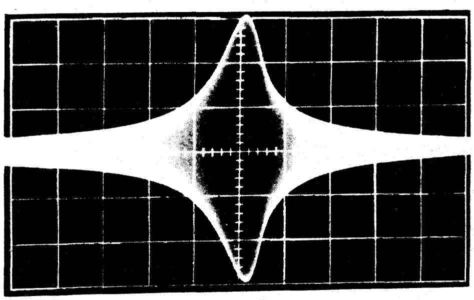


TYPICAL APPLICATION

POSITIVE FEEDBACK BANDPASS FILTER



OUTPUT A

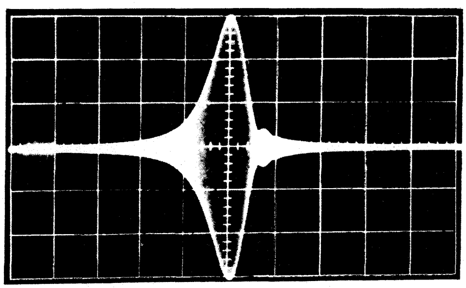


2 kHz/div

SECOND ORDER BANDPASS FILTER

f_O = 100 kHz ; Q = 30 ; Gain = 4

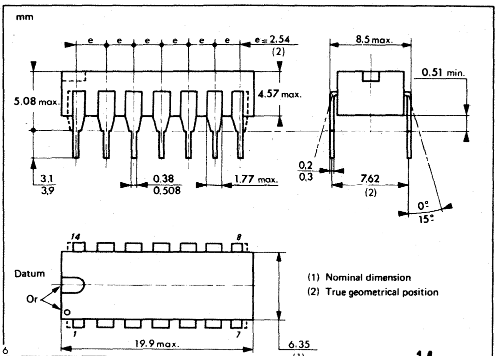
OUTPUT B



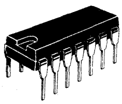
2 kHz/div.

CASCADED BANDPASS FILTER

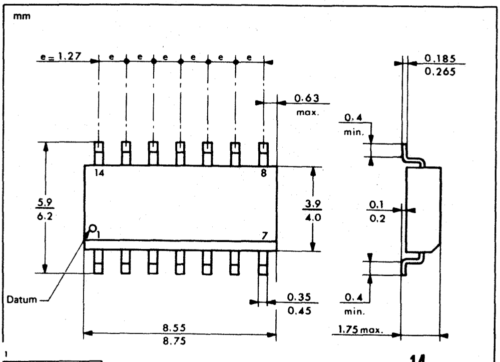
f_O = 100 kHz ; Q = 69 ; Gain = 16



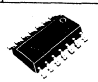
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



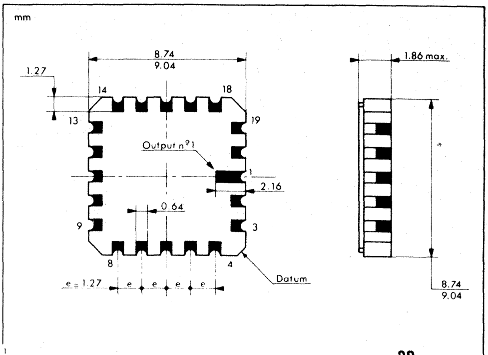
CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



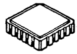
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA741

GENERAL-PURPOSE SINGLE OP-AMPs

The UA741 is a high performance monolithic operational amplifier constructed on a single silicon chip. It is intended for a wide range of analog applications.

- Summing amplifier.
- Voltage follower.
- Integrator.
- Active filter.
- Function generator.

The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feedback applications. The internal compensation network (6 dB/octave) insures stability in closed loop applications.

- Large input voltage range.
- No latch-up.
- High gain.
- Short-circuit protection.
- No frequency compensation required.
- Same pin configuration as the UA709.

ORDERING INFORMATION

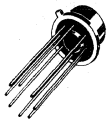
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE					
		H	DG	GC	DP 8	DP 14	FP
UA741C	0°C to + 70°C	•	•		•	•	•
UA741I	−25°C to + 85°C	•			•	•	
UA741M	−55°C to +125°C	•	•	•			
Examples : UA741CDP8, UA741IH							

GENERAL-PURPOSE SINGLE OP-AMPs

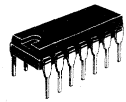
CASES

CB-11 (TO-99)



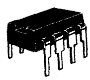
H SUFFIX METAL CAN

CB-2 (TO-116)



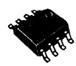
DP SUFFIX PLASTIC PACKAGE

CB-98



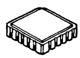
DP SUFFIX PLASTIC PACKAGE
DG SUFFIX CERDIP PACKAGE

CB-342



FP SUFFIX PLASTIC MICROPACKAGE

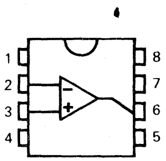
CB-705



GC SUFFIX TRICECOP (LCC)

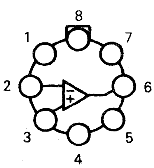
PIN ASSIGNMENTS (Top views)

CB-98 / CB-342

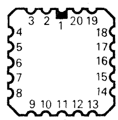


1 - Offset null
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Offset null
6 - Output
7 - V_{CC}^+
8 - NC

CB-11

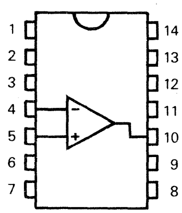


CB-705



1 - NC
2 - Offset null
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Offset null
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - NC

CB-2



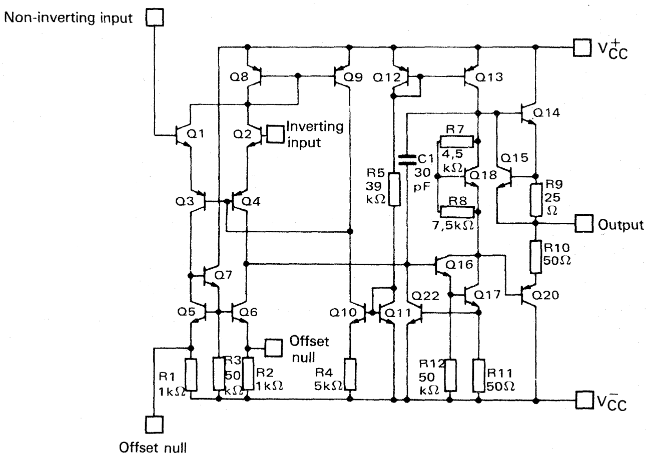
1 - NC
2 - NC
3 - Offset null
4 - Inverting input
5 - Non-inverting input
6 - V_{CC}^-
7 - NC
8 - NC
9 - Offset null
10 - Output
11 - V_{CC}^+
12 - NC
13 - NC
14 - NC

Réf. 00215

MAXIMUM RATINGS

Rating		Symbol	UA741M	UA741I	UA741C	Unit
Supply voltage		V_{CC}	±22	±18	±18	V
Differential input voltage		V_{ID}	±30	±30	±30	V
Input voltage range		V_I	±15	±15	±15	V
Output short-circuit duration		–	Indefinite	Indefinite	Indefinite	–
Power dissipation	GC suffix FP, DG suffix	P_{tot}	500 665	500 –	500 220	mW
Operating free-air temperature range		T_{oper}	–55 to +125	–25 to +85	0 to +70	°C
Storage temperature range	H suffix FP suffix	T_{stg}	–65 to +150 –	–65 to +150 –	–55 to +125 –65 to +150	°C

SCHEMATIC DIAGRAM



CASE	Offset null	Inverting input	Non-inverting input	V_{CC}^{-}	V_{CC}^{+}	Output	N.C.
CB-11/CB-98/CB-342	1, 5	2	3	4	7	6	8
CB-2	3, 9	4	5	6	11	10	*
CB-705	2, 12	5	7	10	17	15	*

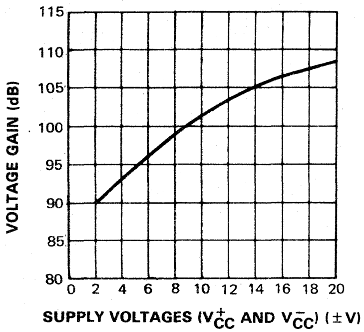
* **CB-2, CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

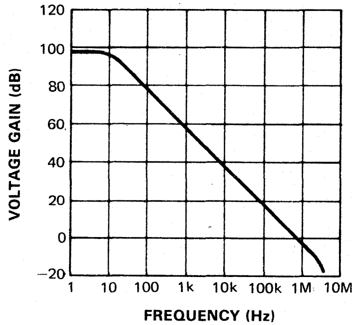
UA741M : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
UA741I : $-25°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC} = \pm 15$ V
UA741C : $0°C \leqslant T_{amb} \leqslant +70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

Characteristic	Symbol	UA741M			UA741I, C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_{IO}	 – –	 1 –	 5 6	 – –	 2 –	 6 7.5	mV
Input offset current $T_{amb} = +25°C$ $T_{amb} = T_{max}$ $T_{amb} = T_{min}$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IO}	 – – – –	 20 – – –	 200 200 500 –	 – – – –	 20 – – –	 200 – – 300	nA
Input bias current $T_{amb} = +25°C$ $T_{amb} = T_{max}$ $T_{amb} = T_{min}$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IB}	 – – – –	 80 – – –	 500 500 1500 –	 – – – –	 80 – – –	 500 – – 800	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geqslant 2$ kΩ) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	A_{VD}	 50 25	 200 –	 – –	 20 15	 200 –	 – –	V/mV
Supply voltage rejection ratio ($T_{amb} = +25°C$, $R_S \leqslant 10$ kΩ)	SVR	–	30	150	–	30	150	μV/V
Supply current ($T_{amb} = +25°C$)	I_{CC}^{+}, I_{CC}^{-}	–	1.7	2.8	–	1.7	2.8	mA
Supply current $T_{amb} = T_{max}$ $T_{amb} = T_{min}$	I_{CC}	 – –	 – –	 2.5 3.3	 – –	 – –	 – –	mA
Input voltage range ($T_{amb} = +25°C$)	V_I	± 12	± 13	–	± 12	± 13	–	V
Common-mode rejection ratio ($T_{amb} = +25°C$, $R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output short-circuit current ($T_{amb} = +25°C$)	I_{OS}	–	25	–	–	25	–	mA
Output voltage swing $R_L \geqslant 10$ kΩ $R_L \geqslant 2$ kΩ	V_{OPP}	 ± 12 ± 10	 ± 14 ± 13	 – –	 ± 12 ± 10	 ± 14 ± 13	 – –	V
Slew rate ($T_{amb} = +25°C$, $R_L \geqslant 2$ kΩ, Unity gain)	S_{VO}	–	0.5	–	–	0.5	–	V/μs
Voltage follower rise time ($T_{amb} = +25°C$, $V_I = +20$ mV, $C_L \leqslant 100$ pF, $R_L = 2$ kΩ, Unity gain)	t_r	–	0.3	–	–	0.3	–	μs
Voltage follower overshoot factor ($T_{amb} = +25°C$, $V_I = +20$ mV, $C_L \leqslant 100$ pF, $R_L = 2$ kΩ)	K_{OV}	–	5	–	–	5	–	%
Input resistance ($T_{amb} = +25°C$)	R_I	0.3	2	–	0.3	2	–	mΩ

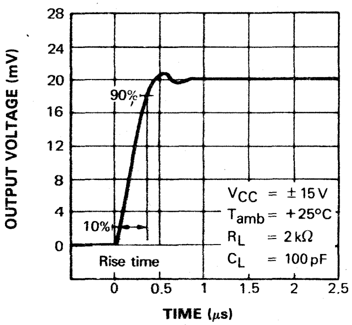
OPEN LOOP VOLTAGE GAIN (Typ.)



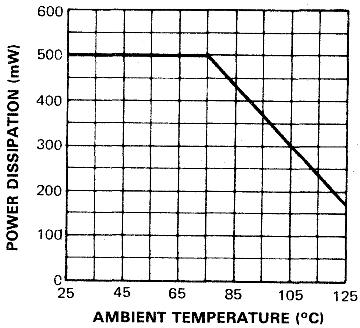
OPEN LOOP FREQUENCY RESPONSE (Typ.)



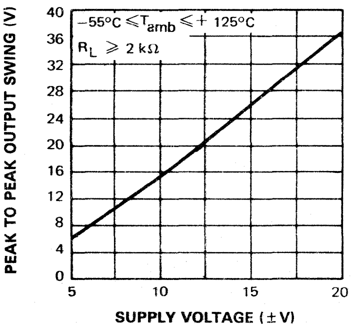
TRANSIENT RESPONSE (Typ.)



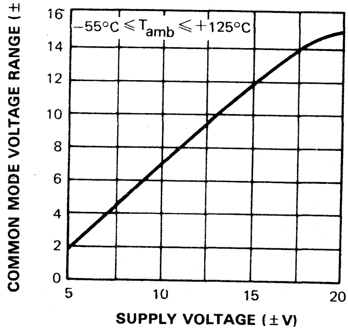
ABSOLUTE MAXIMUM POWER DISSIPATION



OUTPUT VOLTAGE SWING (Note 1)

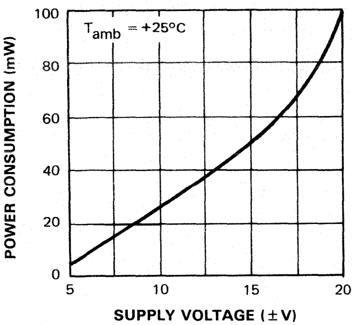


INPUT COMMON MODE VOLTAGE RANGE (Note 1)

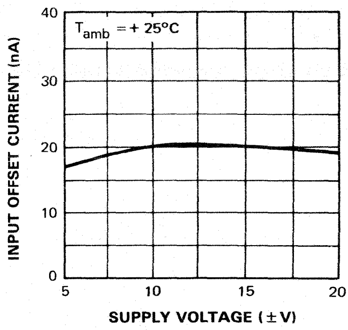


Note 1 : **UA741M** : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V
UA741I : $-25°C \leq T_{amb} \leq +85°C$, $V_{CC} = \pm 15$ V
UA741C : $0°C \leq T_{amb} \leq +70°C$, $V_{CC} = \pm 15$ V

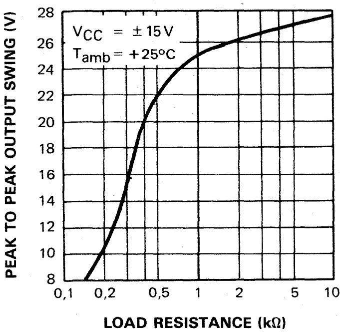
POWER CONSUMPTION



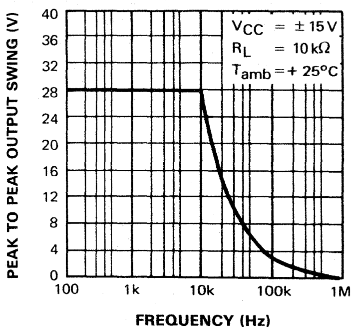
INPUT OFFSET CURRENT



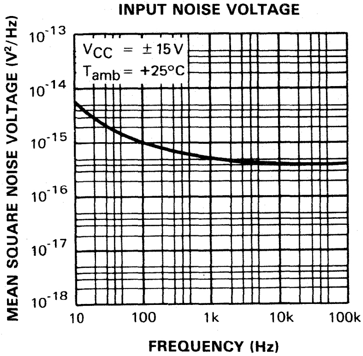
OUTPUT VOLTAGE SWING



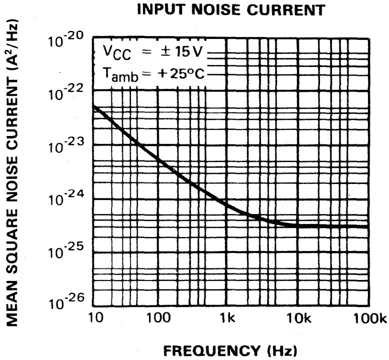
OUTPUT VOLTAGE SWING



INPUT NOISE VOLTAGE



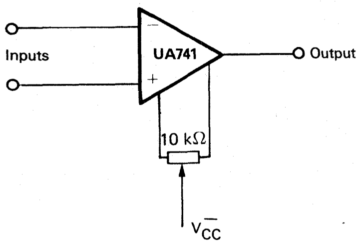
INPUT NOISE CURRENT



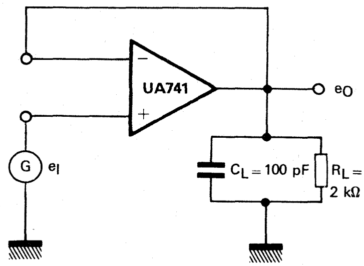
MEASUREMENT DIAGRAMS

VOLTAGE OFFSET NULL CIRCUIT

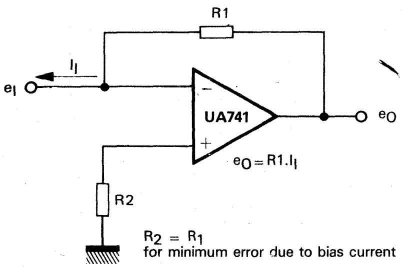
CB-11, CB-98, CB-342



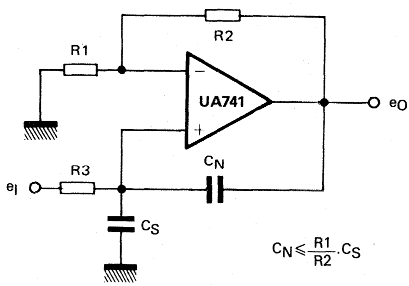
TRANSIENT RESPONSE TEST CIRCUIT



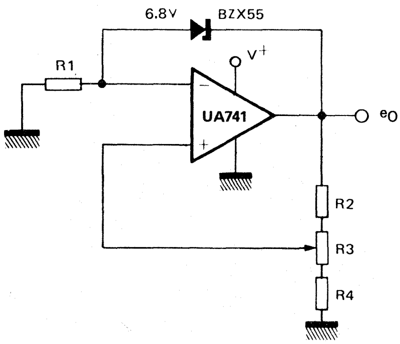
CURRENT TO VOLTAGE CONVERTER



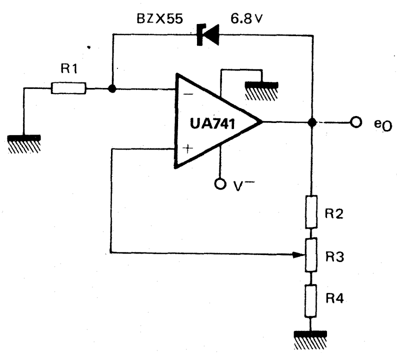
NEUTRALIZING INPUT CAPACITANCE TO OPTIMIZE RESPONSE TIME

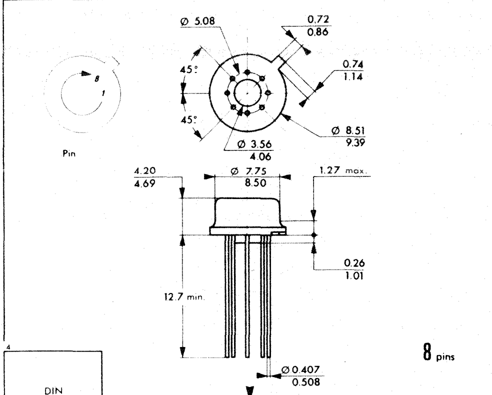


POSITIVE VOLTAGE REFERENCE

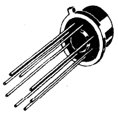


NEGATIVE VOLTAGE REFERENCE

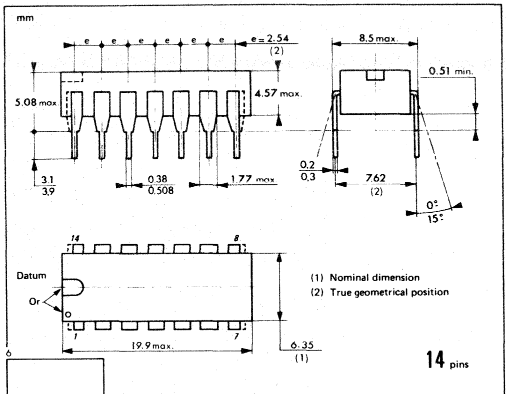




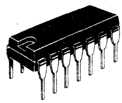
DIN				
Case : Base : C-23 CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



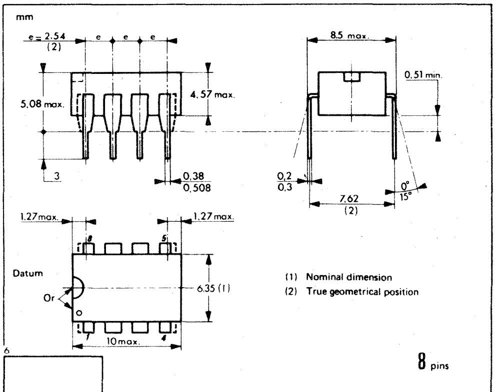
CB-11
H SUFFIX
METAL CAN



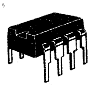
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



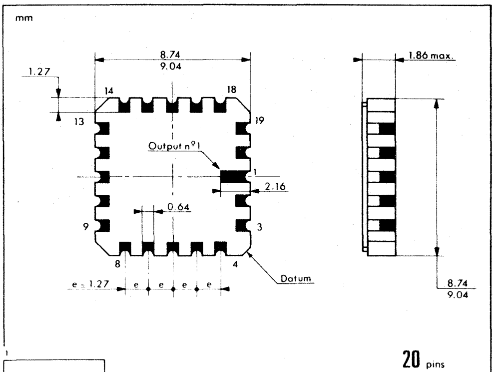
CB-2
DP SUFFIX
PLASTIC PACKAGE



DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

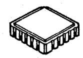


CB-98
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

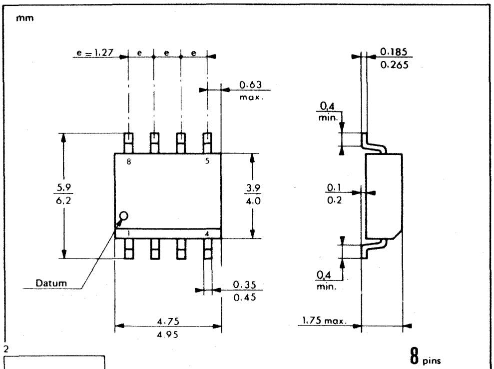


DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705

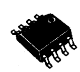


GC SUFFIX
TRICECOP (LCC)



DIN SO8				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA748

GENERAL PURPOSE SINGLE OP-AMPs

The UA748 is a general-purpose operational amplifier built on a single silicon chip. The resulting close match and tight thermal coupling gives low offsets and temperature drift as well as fast recovery from thermal transients.

- Short-circuit protection.
- Offset voltage null capability.
- Large common-mode and differential voltage ranges.
- Low power consumption.
- No latch-up.

The unity-gain compensation specified makes the circuit stable for all feedback configurations, even with capacitive loads. However, it is possible to optimize compensation for best high frequency performance at any gain. As a comparator the output can be clamped at any desired level to make it compatible with logic circuits. Further, the low power dissipation permits high voltage operation and simplifies packaging in full-temperature range sytems.

- Frequency compensation with a single 30 pF capacitor.
- Operation from ±5 V to ±15 V.
- Low power consumption : 50 mW at ±15 V.
- Continuous short-circuit protection.
- Operation as a comparator with differential inputs as high as ±30 V.
- No latch-up when common-mode range is exceeded.
- Same pin configuration as the LM101A.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

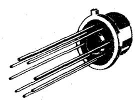
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		H	DP	GC	FP
UA748C	0°C to + 70°C	•	•		•
UA748M	−55°C to +125°C	•		•	

Examples : UA748CH, UA748MGC

GENERAL PURPOSE SINGLE OP-AMPs

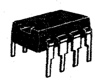
CASES

CB-11



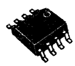
H SUFFIX
METAL CAN

CB-98



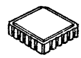
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

CB-705

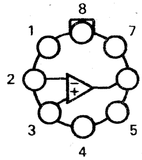


GC SUFFIX
TRICECOP (LCC)

PIN ASSIGNMENTS

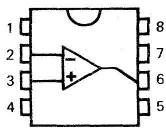
(Top views)

CB-11



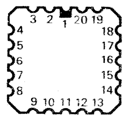
1 - Offset null
frequency compensation
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-

CB-98
CB-342



5 - Offset null
6 - Output
7 - V_{CC}^+
8 - Frequency compensation

CB-705



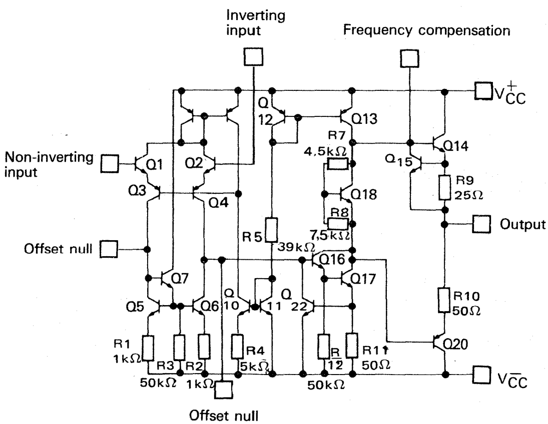
1 - NC
2 - Offset null
frequency compensation
3 - NC
4 - NC
5 - Inverting input
6 - NC
7 - Non-inverting input
8 - NC
9 - NC
10 - V_{CC}^-
11 - NC
12 - Offset null
13 - NC
14 - NC
15 - Output
16 - NC
17 - V_{CC}^+
18 - NC
19 - NC
20 - Frequency
compensation

Réf. 00340

MAXIMUM RATINGS

Rating	Symbol	UA748C	UA748M	Unit
Supply voltage	V_{CC}	± 18	± 22	V
Differential input voltage	V_{ID}	± 30	± 30	V
Input voltage	V_I	± 15	± 15	V
Output short-circuit duration	—	Indefinite	Indefinite	—
Power dissipation UA748GC	P_{tot}	500 665	500 —	mW
Operating free-air temperature range	T_{oper}	0 to + 70	− 55 to + 125	°C
Storage temperature range CB-11 CB-98, CB-342	T_{stg}	 − 65 to + 150 − 55 to + 125	 − 65 to + 150 − 55 to + 125	°C

SCHEMATIC DIAGRAM



CASE	Offset null	Non-inverting input	Inverting input	V_{CC}^-	V_{CC}^+	Output	Frequency Comp.	Off. null Freq. comp.	N.C.
CB-11/CB-98 CB-342	5	3	2	4	7	6	8	1	–
CB-705*	12	7	5	10	17	15	20	2	*

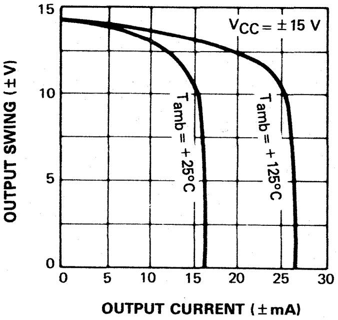
* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

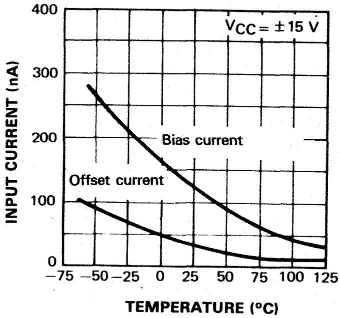
$V_{CC} = \pm 15$ V, C1 = 30 pF
UA748M : $-55°C \leqslant T_{amb} \leqslant +125°C$
UA748C : $0°C \leqslant T_{amb} \leqslant +70°C$
(Unless otherwise specified)

Characteristic	Symbol	UA748C			UA748M			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}							mV
$T_{amb} = +25°C$		–	2	6	–	1	5	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	7.5	–	–	6	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		–	20	200	–	20	200	
$T_{amb} = +125°C$		–	–	–	–	–	200	
$T_{amb} = -55°C$		–	–	–	–	–	500	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	300	–	–	–	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	80	500	–	80	500	
$T_{amb} = +125°C$		–	–	–	–	–	500	
$T_{amb} = -55°C$		–	–	–	–	–	1500	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	800	–	–	–	
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L \geqslant 2$ kΩ, $V_O = \pm 10$ V)	A_{VD}							V/mV
$T_{amb} = +25°C$		20	150	–	50	150	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		15	–	–	25	–	–	
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	–	30	150	–	30	150	µV/V
Supply current	I_{CC}^+, I_{CC}^-							mA
$T_{amb} = +25°C$		–	1.9	2.8	–	1.8	2.8	
$T_{amb} = +125°C$		–	–	–	–	1.2	2.5	
$T_{amb} = -55°C$		–	–	–	–	1.9	3.3	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	2	3.3	–	–	–	
Input voltage range	V_I	±12	±13	–	±12	–	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output voltage swing	V_{OPP}							V
$R_L \geqslant 10$ kΩ		±12	±14	–	±12	±14	–	
$R_L \geqslant 2$ kΩ		±10	±13	–	±10	±13	–	
Slew rate ($T_{amb} = +25°C$, $R_L \geqslant 2$ kΩ, Unity gain)	S_{VO}	–	0.5	–	–	0.5	–	V/µs
Rise time ($e_I = +20$ mV, $C_L \leqslant 100$ pF, $R_L = 2$ kΩ, $T_{amb} = +25°C$, Unity gain)	t_r	–	0.3	–	–	0.3	–	µs
Overshoot factor ($e_I = +20$ mV, $C_L \leqslant 100$ pF, $R_L = 2$ kΩ, $T_{amb} = +25°C$, Unity gain)	K_{OV}	–	5	–	–	5	–	%
Output resistance ($T_{amb} = +25°C$)	R_O	–	75	–	–	75	–	Ω
Input resistance ($T_{amb} = +25°C$)	R_I	0.3	2	–	0.3	2	–	MΩ

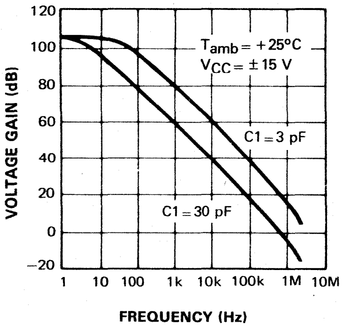
CURRENT LIMITING



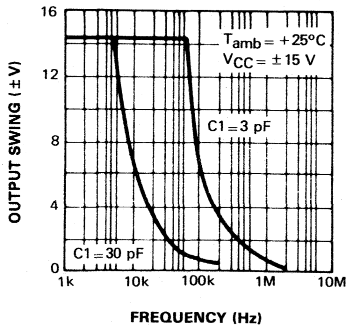
INPUT CURRENT



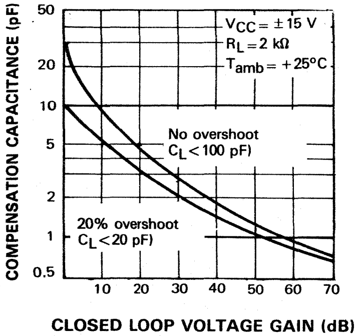
OPEN LOOP FREQUENCY RESPONSE



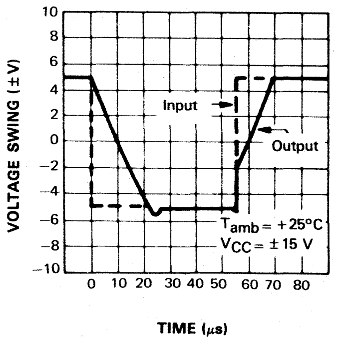
LARGE SIGNAL FREQUENCY RESPONSE

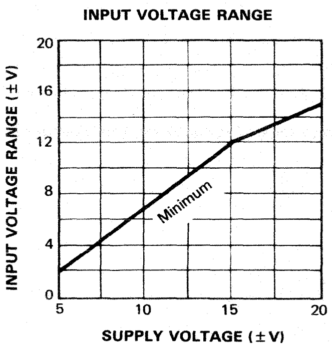


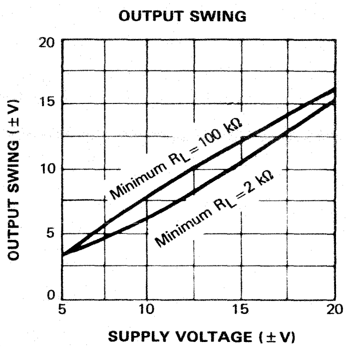
FREQUENCY COMPENSATION

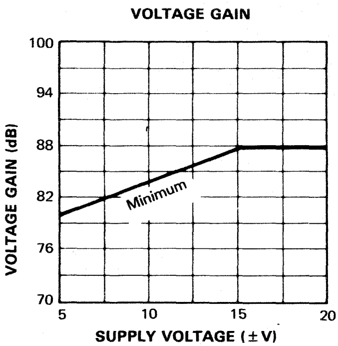


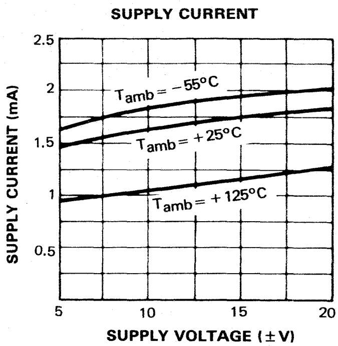
VOLTAGE FOLLOWER PULSE RESPONSE

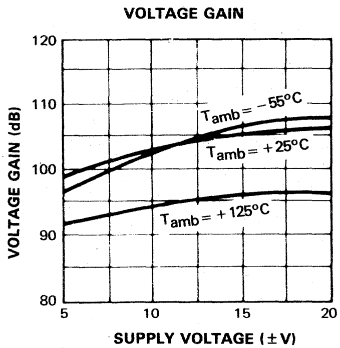


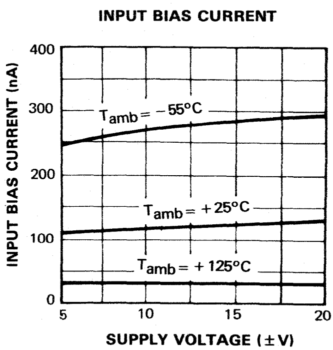

INPUT VOLTAGE RANGE
INPUT VOLTAGE RANGE (± V)
SUPPLY VOLTAGE (± V)
Minimum
0
4
8
12
16
20
5
10
15
20


OUTPUT SWING
OUTPUT SWING (± V)
SUPPLY VOLTAGE (± V)
Minimum RL = 100 kΩ
Minimum RL = 2 kΩ
0
5
10
15
20
5
10
15
20


VOLTAGE GAIN
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (± V)
Minimum
70
76
82
88
94
100
5
10
15
20

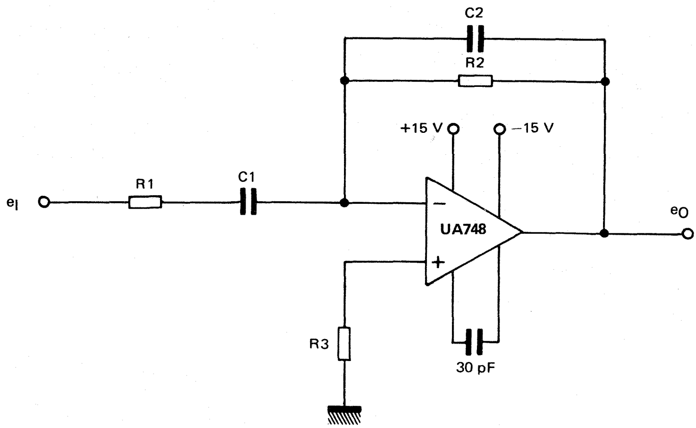

SUPPLY CURRENT
SUPPLY CURRENT (mA)
SUPPLY VOLTAGE (± V)
Tamb = −55°C
Tamb = +25°C
Tamb = +125°C
0.5
1
1.5
2
2.5
5
10
15
20


VOLTAGE GAIN
VOLTAGE GAIN (dB)
SUPPLY VOLTAGE (± V)
Tamb = −55°C
Tamb = +25°C
Tamb = +125°C
80
90
100
110
120
5
10
15
20

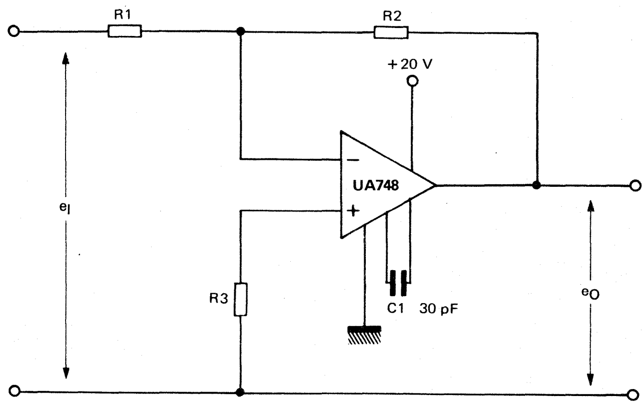

INPUT BIAS CURRENT
INPUT BIAS CURRENT (nA)
SUPPLY VOLTAGE (± V)
Tamb = −55°C
Tamb = +25°C
Tamb = +125°C
0
100
200
300
400
5
10
15
20

TYPICAL APPLICATIONS

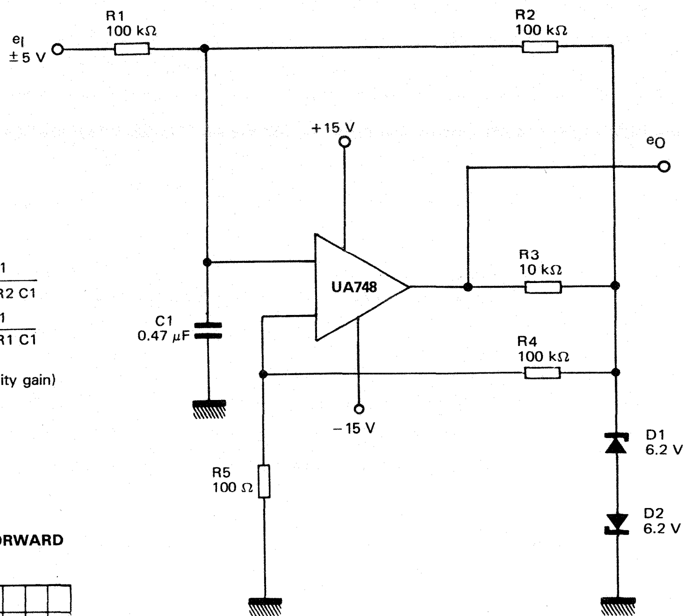
PRACTICAL DIFFERENTIATOR



SINGLE SUPPLY OPERATION



PULSE WIDTH MODULATOR

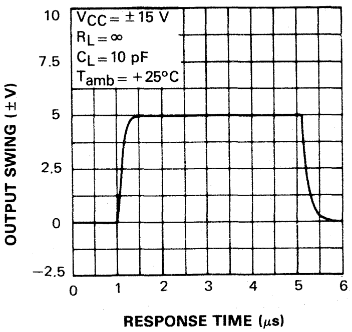


$$f_c = \frac{1}{2\pi\ R2\ C1}$$

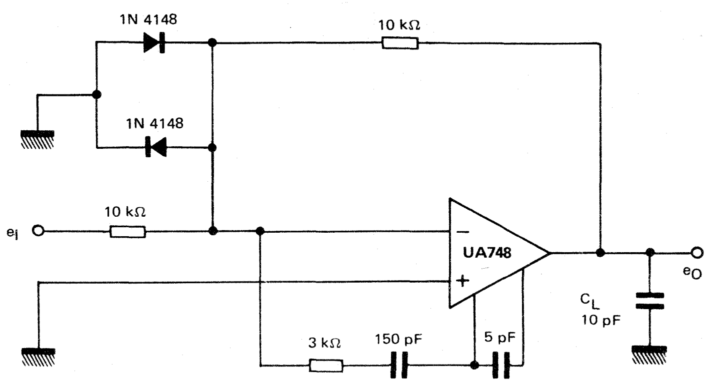
$$f_n = \frac{1}{2\pi\ R1\ C1}$$

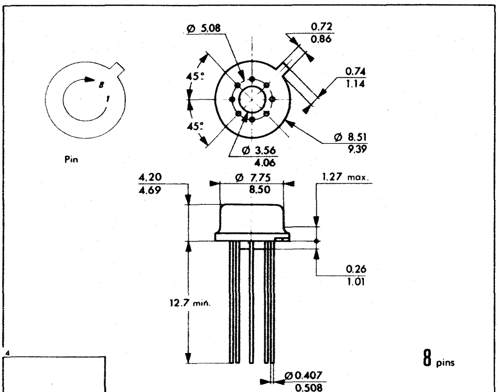
$f_c < f_n$ (unity gain)

LARGE SIGNAL FEED-FORWARD TRANSIENT RESPONSE

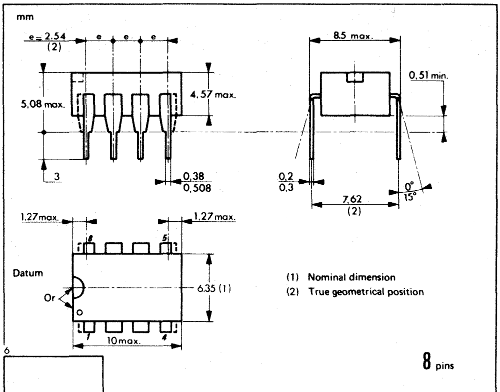


FEED-FORWARD COMPENSATION

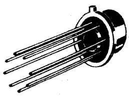




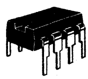
DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



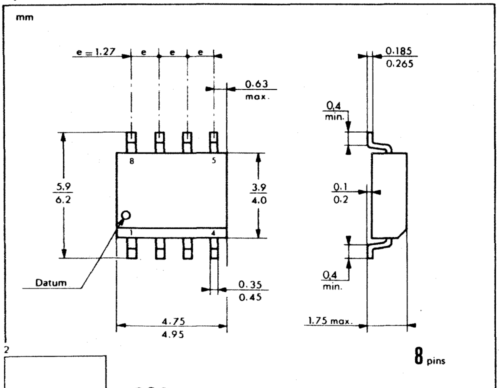
DIN				
A50D CEI	D.A.T.A	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS



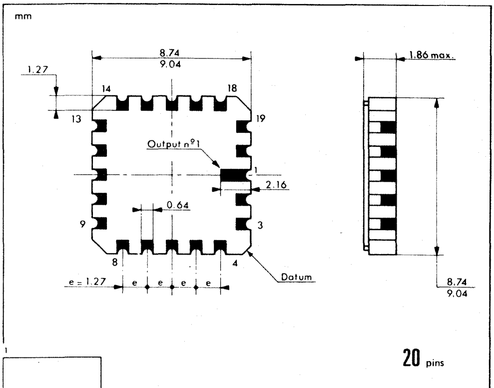
CB-11
H SUFFIX
METAL CAN



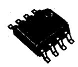
CB-98
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



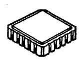
DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS



DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-342
FP SUFFIX
PLASTIC
MICROPACKAGE



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

PROGRAMMABLE SINGLE OP-AMPs

The UA776 programmable operational amplifier is characterized by high input impedance, low supply currents and low input noise over a wide range of operating supply voltages.

Coupled with programmable electrical characteristics it is an extremely versatile amplifier for use in high accuracy, low power consumption analog applications.

Input noise voltage and current, power consumption, and input current can be optimized by a single resistor or current source that sets the chip quiescent current for nano-watt power consumption or for characteristics similar to the UA741.

Internal frequency compensation, absence of latch up, high slew rate and short-circuit protection assure ease of use in long time integrators, active filters, and sample and hold circuits.

- Micropower operation.
- No frequency compensation required.
- Wide programming range.
- High slew rate.
- Short-circuit protection.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

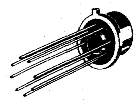
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		H	DP	GC	FP
UA776C	0°C to + 70°C	●	●		●
UA776M	−55°C to +125°C	●		●	

Examples : UA776CH, UA776CDP, UA776CFP

PROGRAMMABLE SINGLE OP-AMPs

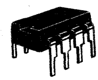
CASES

CB-11 (TO-99)



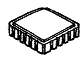
H SUFFIX METAL CAN

CB-98



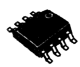
DP SUFFIX PLASTIC PACKAGE

CB-705



GC SUFFIX TRICECOP (LCC)

CB-342

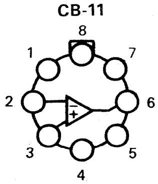


FP SUFFIX PLASTIC MICROPACKAGE

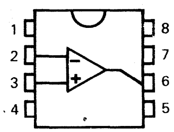
PIN ASSIGNMENTS

(Top views)

CB-11

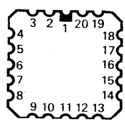


CB-98
CB-342



1 - Offset null
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^{-}
5 - Offset null
6 - Output
7 - V_{CC}^{+}
8 - I_{set}

CB-705



1 - NC	11 - NC
2 - Offset null	12 - Offset null
3 - NC	13 - NC
4 - NC	14 - NC
5 - Inverting input	15 - Output
6 - NC	16 - NC
7 - Non-inverting input	17 - V_{CC}^{+}
8 - NC	18 - NC
9 - NC	19 - NC
10 - V_{CC}^{-}	20 - I_{set}

Réf. 00290

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

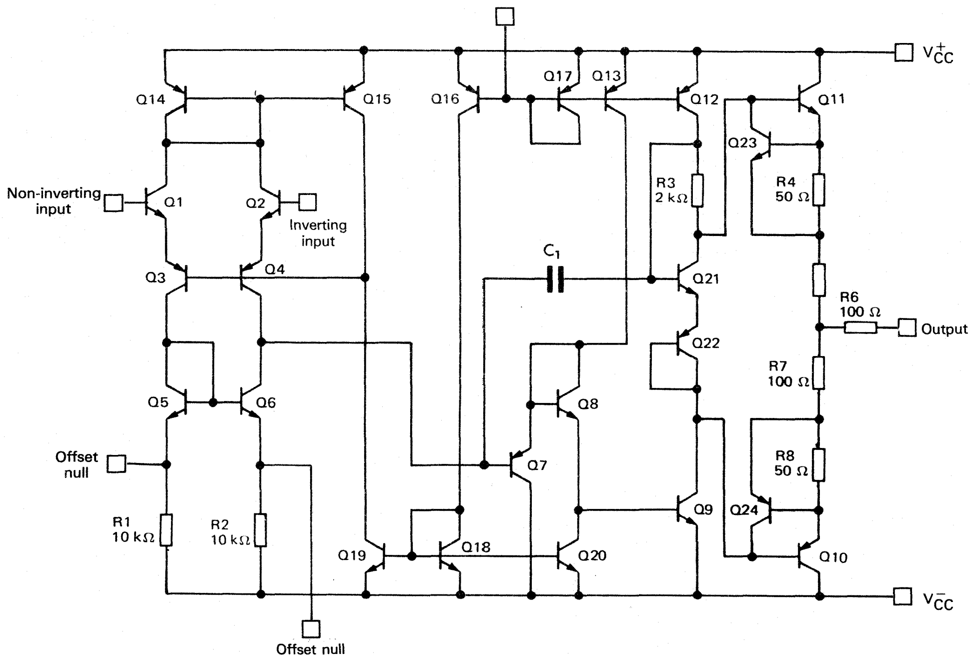
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	UA776M	UA776C	Unit
Supply voltage	V_{CC}	± 18	± 18	V
Differential input voltage	V_{ID}	± 30	± 30	V
Input voltage (Note 1)	V_I	± 15	± 15	V
Output short-circuit duration (Note 2)	—	Indefinite	Indefinite	—
Power dissipation UA776GC UA776CH	P_{tot}	500 665 —	310 — 500	mW
Operating free-air temperature range	T_{oper}	− 55 to + 125	0 to + 70	°C
Storage temperature range UA776CH	T_{stg}	− 65 to + 150 —	− 55 to + 125 − 65 to + 150	°C

Note 1 : For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.
Note 2 : Short-circuit may be to ground or either supply. Rating applies to + 125°C package temperature serial M or + 75°C serial C ambient temperature for $I_{set} \leqslant 30\ \mu A$.
Devices bonded on a 6 cm × 3 cm × 0.15 cm glass-epoxy substrate with 30 mm² of 35 μm thick copper.

SCHEMATIC DIAGRAM



CASE	Offset null	Inverting input	Non-inverting input	Output	V_{CC}^{-}	V_{CC}^{+}	I_{set}
CB-11/CB-98 CB-342	1, 5	2	3	6	4	7	8
CB-705*	2, 12	5	7	15	10	17	20

* **CB-705** : Other pins are not connected

ELECTRICAL CHARACTERISTICS

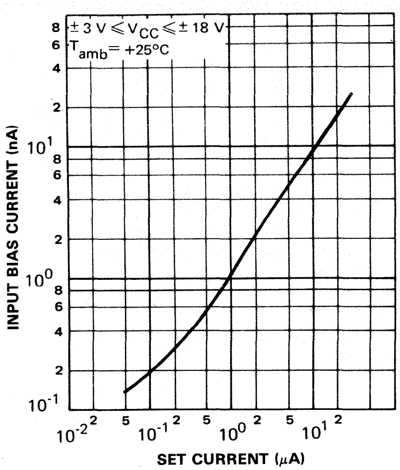
UA776M : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
UA776C : $-\ 0°C \leqslant T_{amb} \leqslant +\ 70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

Characteristic		Symbol	$I_{set} = 1.5\ \mu A$ Min	Typ	Max	$I_{set} = 15\ \mu A$ Min	Typ	Max	Unit
Input offset voltage		V_{IO}							mV
$T_{amb} = +25°C$	UA776M		–	2	5	–	2	5	
	UA776C		–	2	6	–	2	6	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$	UA776M		–	–	6	–	–	6	
	UA776C		–	–	7.5	–	–	7.5	
Input offset current		I_{IO}							nA
$T_{amb} = +25°C$	UA776M		–	0.7	3	–	2	15	
	UA776C		–	0.7	6	–	2	25	
$T_{amb} = T_{max}$	UA776M		–	–	5	–	–	15	
	UA776C		–	–	6	–	–	25	
$T_{amb} = T_{min}$			–	–	10	–	–	40	
Input bias current		I_{IB}							nA
$T_{amb} = +25°C$	UA776M		–	2	7.5	–	15	50	
	UA776C		–	2	10	–	15	50	
$T_{amb} = T_{max}$	UA776M		–	–	7.5	–	–	50	
	UA776C		–	–	10	–	–	50	
$T_{amb} = T_{min}$	UA776M		–	–	20	–	–	120	
	UA776C		–	–	20	–	–	100	
Large signal voltage gain ($V_O = \pm 10$ V)		A_{VD}							V/V
$T_{amb} = +25°C$, $R_L \geqslant 5$ kΩ	UA776M		–	–	–	10^5	4.10^5	–	
	UA776C		–	–	–	5.10^4	4.10^5	–	
$T_{amb} = +25°C$, $R_L \geqslant 75$ kΩ	UA776M		2.10^5	4.10^5	–	–	–	–	
	UA776C		5.10^4	4.10^5	–	–	–	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 75$ kΩ	UA776M		10^5	–	–	$7.5.10^4$	–	–	
	UA776C		5.10^4	–	–	5.10^4	–	–	
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)		SVR							µV/V
	UA776M		–	25	150	–	25	150	
	UA776C		–	25	200	–	25	200	
Supply current		I_{CC}							µA
$T_{amb} = +25°C$	UA776M		–	20	25	–	160	180	
	UA776C		–	20	30	–	160	190	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$	UA776M		–	–	30	–	–	200	
	UA776C		–	–	35	–	–	200	
Power consumption		P_D							mW
$T_{amb} = +25°C$	UA776M		–	–	0.75	–	–	5.4	
	UA776C		–	–	0.9	–	–	5.7	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$	UA776M		–	–	30	–	–	200	
	UA776C		–	–	35	–	–	200	
Input voltage range		V_I	±10	–	–	±10	–	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)		CMR	70	90	–	70	90	–	dB
Output short-circuit current		I_{OS}	–	3	–	–	12	–	mA
Output voltage swing		V_{OPP}							V
$T_{amb} = +25°C$, $R_L \geqslant 5$ kΩ			–	–	–	±10	±13	–	
$R_L \geqslant 75$ kΩ			±12	±14	–	–	–	–	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 75$ kΩ			±10	–	–	±10	–	–	
Offset voltage adjustement range ($T_{amb} = +25°C$)		V_{IOR}	–	9	–	–	18	–	mV
Slew rate ($R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		S_{VO}	–	0.1	–	–	0.8	–	V/µs
Rise time ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		t_r	–	1.6	–	–	0.35	–	µs
Input resistance ($T_{amb} = +25°C$)		R_I	–	50	–	–	5	–	MΩ
Output resistance ($T_{amb} = +25°C$)		R_O	–	5	–	–	1	–	kΩ
Overshoot factor ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		K_{OV}	–	0	–	–	10	–	%
Differential input capacitance ($T_{amb} = +25°C$)		C_{ID}	–	2	–	–	2	–	pF

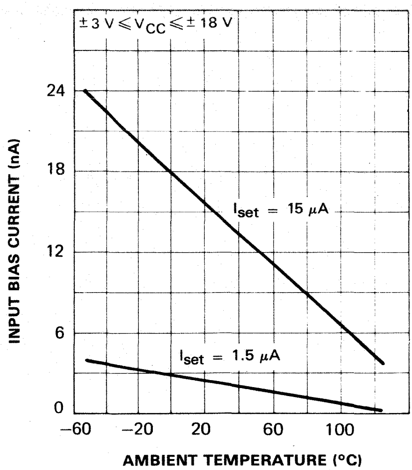
ELECTRICAL CHARACTERISTICS (continued)
UA776M : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 3$ V
UA776C : $-$ $0°C \leqslant T_{amb} \leqslant +$ $70°C$, $V_{CC} = \pm 3$ V
(Unless otherwise specified)

Characteristic		Symbol	$I_{set} = 1.5$ µA			$I_{set} = 15$ µA			Unit
			Min	Typ	Max	Min	Typ	Max	
Input offset voltage		V_{IO}							mV
$T_{amb} = +25°C$	UA776M		—	2	5	—	2	5	
	UA776C		—	2	6	—	2	6	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$	UA776M		—	—	6	—	—	6	
	UA776C		—	—	7.5	—	—	7.5	
Input offset current		I_{IO}							nA
$T_{amb} = +25°C$	UA776M		—	0.7	3	—	2	15	
	UA776C		—	0.7	6	—	2	25	
$T_{amb} = T_{max}$	UA776M		—	—	5	—	—	15	
	UA776C		—	—	6	—	—	25	
$T_{amb} = T_{min}$			—	—	10	—	—	40	
Input bias current		I_{IB}							nA
$T_{amb} = +25°C$	UA776M		—	2	7.5	—	15	50	
	UA776C		—	2	10	—	15	50	
$T_{amb} = T_{max}$	UA776M		—	—	7.5	—	—	50	
	UA776C		—	—	10	—	—	50	
$T_{amb} = T_{min}$	UA776M		—	—	20	—	—	120	
	UA776C		—	—	20	—	—	100	
Large signal voltage gain ($V_O = \pm 1$ V)		A_{VD}							V/V
$T_{amb} = +25°C$, $R_L \geqslant 5$ kΩ	UA776M		—	—	—	5.10^{4}	2.10^{5}	—	
	UA776C		—	—	—	$2.5.10^{4}$	2.10^{5}	—	
$R_L \geqslant 75$ kΩ	UA776M		5.10^{4}	2.10^{5}	—	—	—	—	
	UA776C		$2.5.10^{4}$	2.10^{5}	—	—	—	—	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $R_L \geqslant 5$ kΩ			—	—	—	$2.5.10^{4}$	—	—	
$R_L \geqslant 75$ kΩ			$2.5.10^{4}$	—	—	—	—	—	
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)		SVR							µV/V
	UA776M		—	25	150	—	25	150	
	UA776C		—	25	200	—	25	200	
Supply current		I_{CC}							µA
$T_{amb} = +25°C$	UA776M		—	13	20	—	130	160	
	UA776C		—	13	20	—	130	170	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$			—	—	25	—	—	180	
Power consumption		P_D							µW
$T_{amb} = +25°C$	UA776M		—	78	120	—	780	960	
	UA776C		—	78	120	—	780	1020	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$	UA776M		—	—	150	—	—	1080	
	UA776C		—	—	150	—	—	1080	
Input voltage range		V_I	±1	—	—	±1	—	—	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)		CMR	70	86	—	70	86	—	dB
Output short-circuit current ($T_{amb} = +25°C$)		I_{OS}	—	3	—	—	5	—	mA
Output voltage swing		V_{OPP}							V
$R_L \geqslant 5$ kΩ	UA776C		—	—	—	±2	+2.1	—	
	UA776M		—	—	—	±1.9	±2.1	—	
$R_L \geqslant 75$ kΩ			±2	±2.4	—	±2	±2.4	—	
Offset voltage adjustement range ($T_{amb} = +25°C$)		V_{IOR}	—	9	—	—	18	—	mV
Slew rate ($R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		S_{VO}	—	0.03	—	—	0.35	—	V/µs
Rise time ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		t_r	—	3	—	—	0.6	—	µs
Input resistance ($T_{amb} = +25°C$)		R_I	—	50	—	—	5	—	MΩ
Output resistance ($T_{amb} = +25°C$)		R_O	—	5	—	—	1	—	kΩ
Overshoot factor ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geqslant 5$ kΩ, $T_{amb} = +25°C$)		K_{OV}	—	0	—	—	5	—	%
Differential input capacitance ($T_{amb} = +25°C$)		C_{ID}	—	2	—	—	2	—	pF

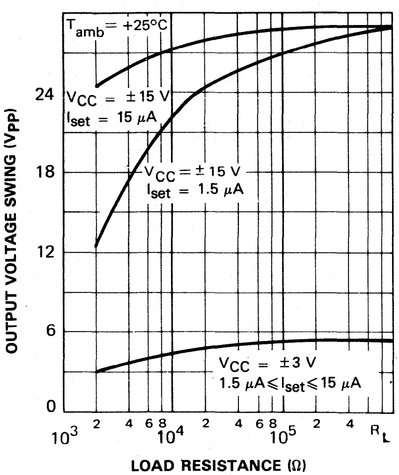
INPUT BIAS CURRENT



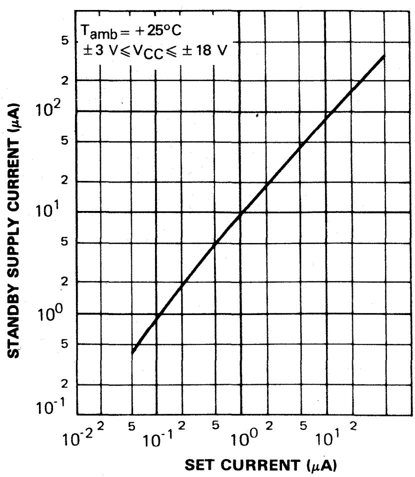
INPUT BIAS CURRENT



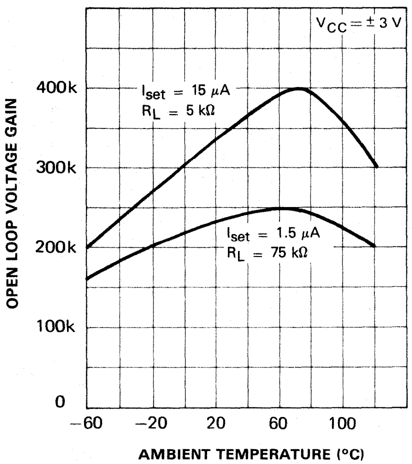
OUTPUT VOLTAGE SWING



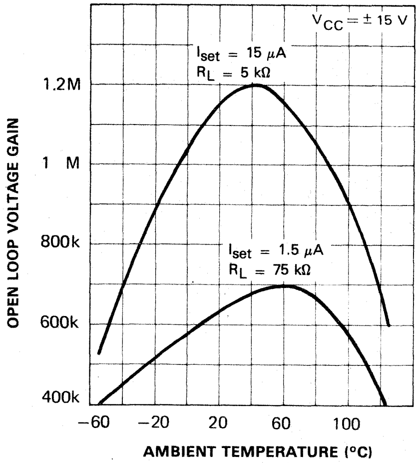
STANDBY SUPPLY CURRENT VERSUS SET CURRENT



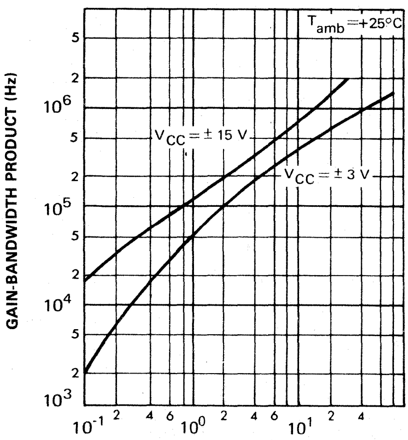
OPEN LOOP VOLTAGE GAIN



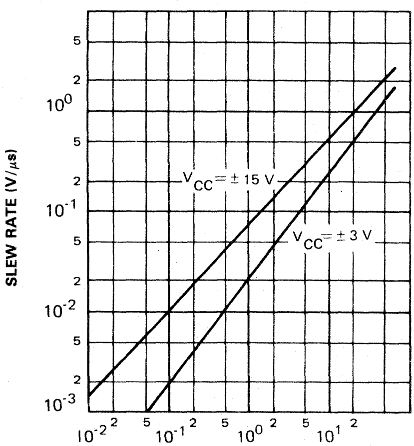
OPEN LOOP VOLTAGE GAIN



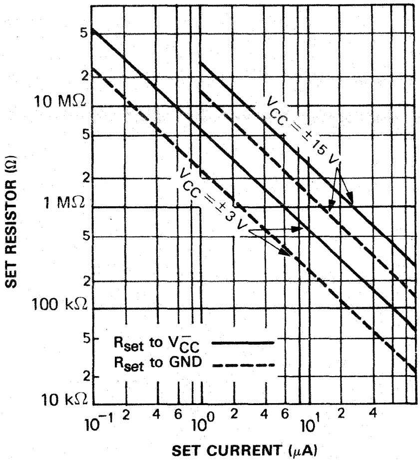
GAIN-BANDWIDTH



SLEW RATE



SET RESISTOR vs SET CURRENT



I_{set} EQUATIONS

$$I_{set} = \frac{V_{CC}^+ - 0.7 - V_{CC}^-}{R_{set}}$$

when R_{set} is connected to V_{CC}^-.

$$I_{set} = \frac{V_{CC}^+ - 0.7}{R_{set}}$$

when R_{set} is connected to ground.

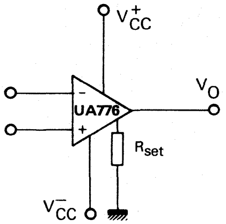
QUIESCENT CURRENT SETTING RESISTOR (I_{set} to V_{CC}^-)

V_{CC}	I_{set}	
	1.5 μA	15 μA
± 1.5 V	1.7 MΩ	170 kΩ
± 3 V	3.6 MΩ	360 kΩ
± 6 V	7.5 MΩ	750 kΩ
± 15 V	20 MΩ	2 MΩ

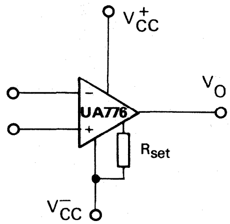
Note : The UA776 may be operated with R_{set} connected to ground or V_{CC}^-.

BIASING CIRCUITS

RESISTOR BIASING

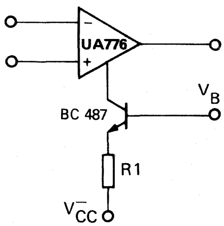


R_{set} connected to ground.

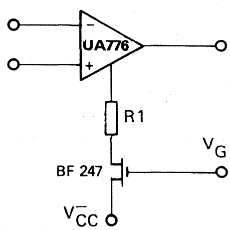


R_{set} connected to V_{CC}^-.
Recommended for : $V_{CC} \leq \pm 6$ V

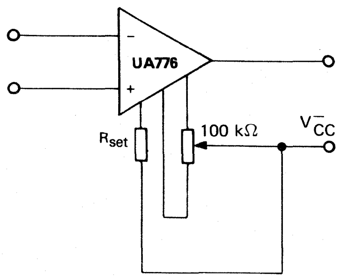
TRANSISTOR CURRENT SOURCE BIASING



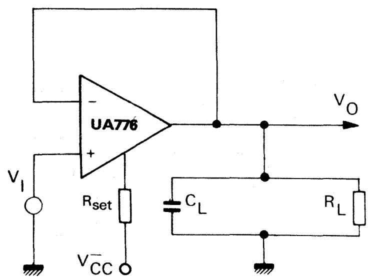
FET CURRENT SOURCE BIASING



VOLTAGE OFFSET NULL CIRCUIT

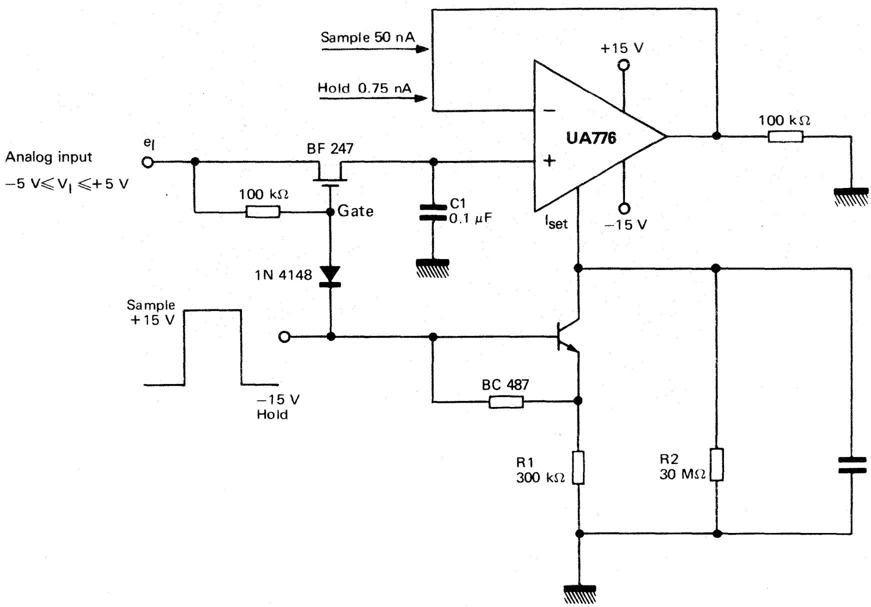


TRANSIENT RESPONSE TIME TEST CIRCUIT

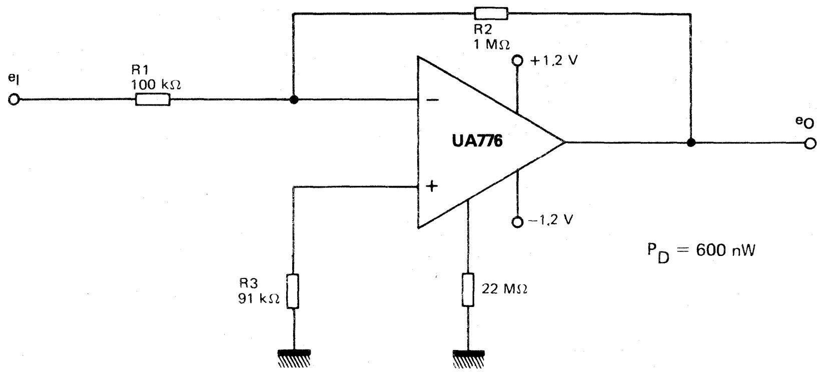


TYPICAL APPLICATIONS

HIGH ACCURACY SAMPLE AND HOLD

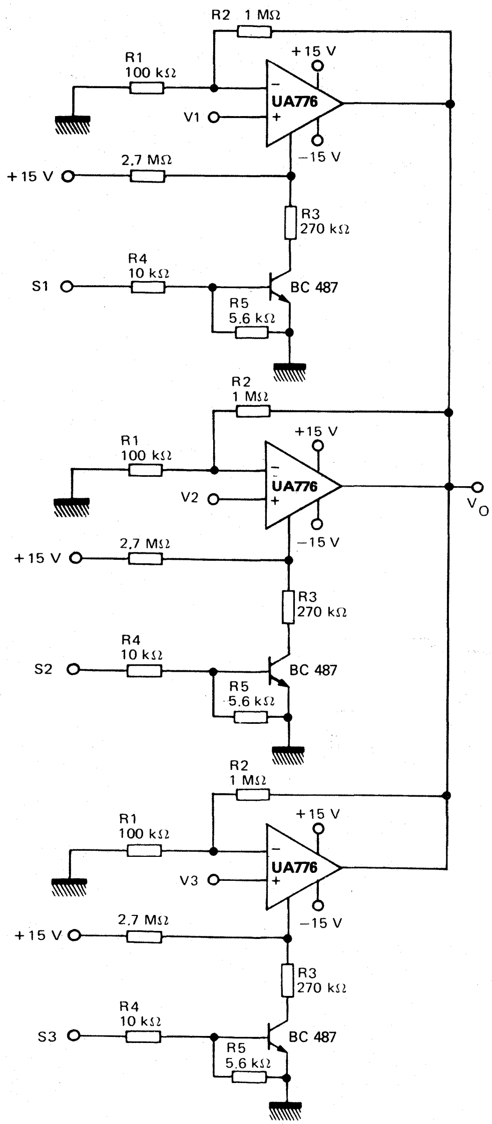


NANO-WATT AMPLIFIER

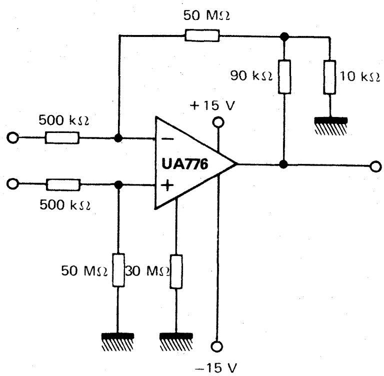


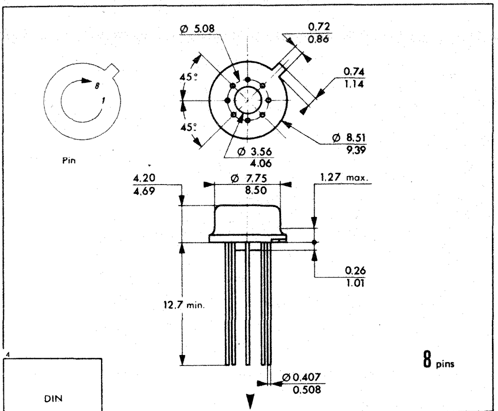
TYPICAL APPLICATIONS (continued)

MULTIPLEXING AND SIGNAL CONDITIONING WITHOUT FETs



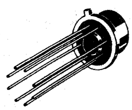
HIGH INPUT IMPEDANCE AMPLIFIER



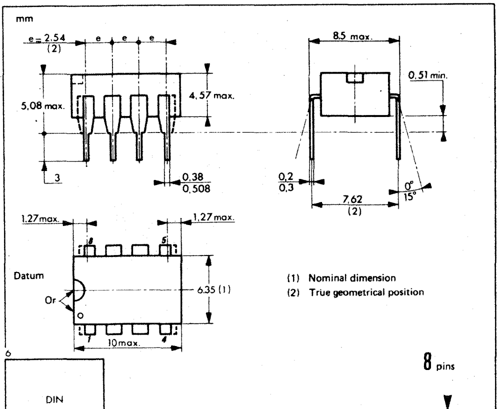


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

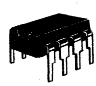


H SUFFIX
METAL CAN



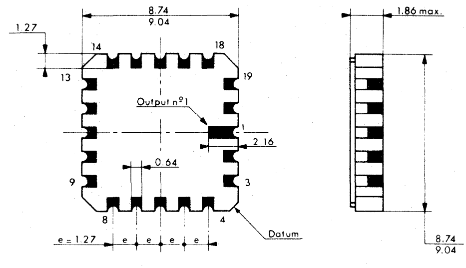
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

mm

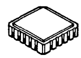


1

20 pins

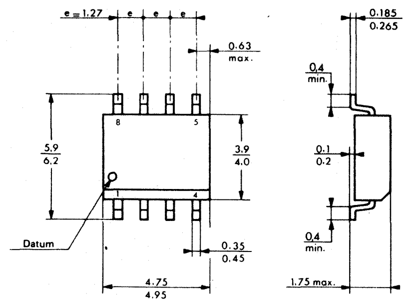
DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS

CB-705



GC SUFFIX
TRICECOP (LCC)

mm

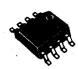


2

8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

2

Voltage comparators

SINGLE VOLTAGE COMPARATOR

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
LM111/LM211/LM311	Voltage comparator			●	●	303

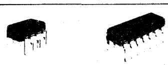
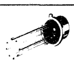
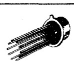
DUAL VOLTAGE COMPARATORS

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
LM119/LM219/LM319	High speed dual comparator			●		311
LM193,A/LM293,A/LM393,A LM2903	Single supply low power, low offset	●	●			329

QUAD VOLTAGE COMPARATORS

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
LM139,A/LM239,A/LM339,A LM2051/MC3302	Single supply low power, low offset	●	●			319

($T_{amb} = +25°C$)

CHARACTERISTIC	SYMBOL	UNIT	SINGLE LM111 LM211 LM311	DUAL LM119 LM219 LM319	DUAL LM193,A LM293,A LM393,A	DUAL LM2903	QUAD LM139,A LM239,A LM339,A	QUAD LM2051	QUAD LM3302
Supply voltage	$V_{CC(max)}$	V	36	36	±18 or 36	±18 or 36	±18 or 36	±18 or 36	±14 or 28
Input offset voltage	$V_{IO(max)}$	mV	7.5	8	±5	±7	±5	±7	±20
Input bias current	$I_{IB(max)}$	nA	250	1000	250	250	250	250	500
Input offset current	$I_{IO(max)}$	nA	50	200	±50	±50	±50	±50	±100
Voltage gain	$A_{VD(typ)}$	V/mV	200	40	200	100	200	100	30
Low level output voltage	$V_{OL(max)}$	V	1.5	1.5	0.4	0.4	0.4	0.4	0.5
Reponse time	$t_{r(typ)}$	µs	0.2	0.08	1.3	1.5	1.3	1.3	1.3
PACKAGE		**SUFFIX**							
Plastic SO 8-14		FP	8	14	8	8	14	14	
Plastic DIL 8-14		DP	8	14	8	8	14	14	14
Cerdip DIL 8-14		DG	8	14			14		
20-pin chip carrier		GC					●		
Metal can TO-99		H	●		●				
Metal can TO-100		H		●					
Page			303	311	329	329	319	319	319

THOMSON SEMICONDUCTORS

LM111 LM211 LM311

VOLTAGE COMPARATORS

The LM111, LM211 and LM311 are voltage comparators that have extremely low input currents.

They are also designed to operate over a wide range of supply voltages : from standard ± 15 V operational amplifier supplies down to the single + 5 V supply used for IC logic.

Their output is compatible with RTL-DTL and TTL as well as MOS circuits and can switch voltages up to + 50 V at output currents as high as 50 mA.

- Maximum input current : 150 nA.
- Maximum offset current : 20 nA.
- Differential input voltage range : ± 30 V.
- Power consumption : 135 mW at ± 15 V.
- Supply voltage : + 5 V to ± 15 V.
- Output current : 50 mA.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

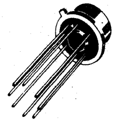
PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DP	DG	FP	GC
LM111	− 55°C to + 125°C	•		•		•
LM211	− 25°C to + 85°C	•				
LM311	0°C to + 70°C	•	•	•	•	

Examples : LM111H, LM111DG

VOLTAGE COMPARATORS

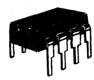
CASES

CB-11 (TO-99)



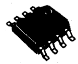
H SUFFIX METAL CAN

CB-98



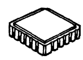
DP SUFFIX PLASTIC PACKAGE
DG SUFFIX CERDIP PACKAGE

CB-342



FP SUFFIX PLASTIC MICROPACKAGE

CB-705



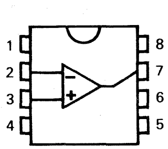
GC SUFFIX TRICECOP (LCC)

2

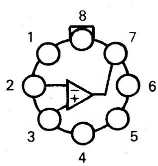
PIN ASSIGNMENTS

(Top views)

CB-98 CB-342

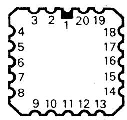


CB-11



1 - Ground
2 - Non-inverting input
3 - Inverting input
4 - V_{CC}^{-}
5 - Balance
6 - Strobe/balance
7 - Output
8 - V_{CC}^{+}

CB-705



1 - NC
2 - Ground
3 - NC
4 - NC
5 - Non-inverting input
6 - NC
7 - Inverting input
8 - NC
9 - NC
10 - V_{CC}^{-}
11 - NC
12 - Balance
13 - NC
14 - NC
15 - Balance/Strobe
16 - NC
17 - Output
18 - NC
19 - NC
20 - V_{CC}^{+}

Réf. 00265

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

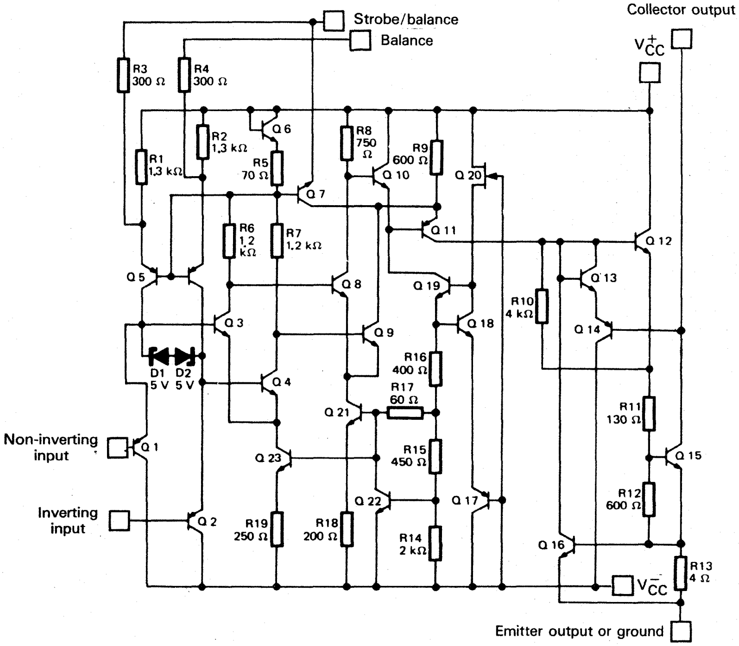
Rating	Symbol	LM111	LM211	LM311	Unit
Supply voltage	V_{CC}	36	36	36	V
Differential input voltage	V_{ID}	±30	±30	±30	V
Input voltage - (Note 1)	V_I	±15	±15	±15	V
Power dissipation LM311FP Other versions	P_{tot}	 — 500	 — 500	 300 500	mW
Operating free-air temperature range	T_{oper}	−55 to +125	−25 to + 85	0 to +70	°C
Storage temperature range LM311H Other versions	T_{stg}	 — −65 to +150	 — −65 to +150	 −65 to +150 −55 to +125	°C
Ground to negative supply voltage	$V_{(1-4)}$	30	30	30	V
Output to negative supply voltage	$V_{(7-4)}$	50	50	40	V

Output short-circuit duration : 10 s
Voltage at strobe pin : V_{CC}^{+} −5 V

Maximum junction temperature **LM111** : +150°C
LM211 : +100°C
LM311 : +100°C

Note 1 : This rating applies for ±15 V supplies. The positive input voltage limit is 30 V above the negative. The negative input voltage limit is equal to the negative supply voltage or 30 V below the positive supply, whichever is less.

SCHEMATIC DIAGRAM



CASE	GND	Non-inverting input	Inverting input	V_{CC}^{-}	Balance	Strobe/ balance	Output	V_{CC}^{+}	N.C.
CB-11 **CB-98** **CB-342**	1	2	3	4	5	6	7	8	—
CB-705	2	5	7	10	12	15	17	20	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

LM111 : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
LM211 : $-25°C \leqslant T_{amb} \leqslant +\ 85°C$, $V_{CC} = \pm 15$ V (Note 2)
LM311 : $0°C \leqslant T_{amb} \leqslant +\ 70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

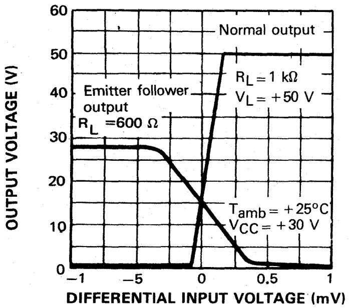
Characteristic	Symbol	LM111/LM211			LM311			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 50\ k\Omega$) - (Note 3)	V_{IO}							mV
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	4	–	–	10	
$T_{amb} = +25°C$		–	0.7	3	–	2	7.5	
Input offset current - (Note 3)	I_{IO}							nA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	20	–	–	70	
$T_{amb} = +25°C$		–	4	10	–	6	50	
Input bias current	I_{IB}							nA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		–	–	150	–	–	300	
$T_{amb} = +25°C$		–	60	100	–	100	250	
Large signal voltage gain ($T_{amb} = +25°C$)	A_{VD}	40	200	–	40	200	–	V/mV
Supply currents ($T_{amb} = +25°C$)								mA
Positive	I_{CC}^{+}	–	5.1	6	–	5.1	7.5	
Negative	I_{CC}^{-}	–	4.1	5	–	4.1	5	
Input voltage range	V_I	–	±14	–	–	±14	–	V
Low level output voltage	V_{OL}							V
$T_{min} \leqslant T_{amb} \leqslant T_{max}$								
$V_{CC}^{+} \geqslant +4.5$ V, $V_{CC}^{-} = 0$, $I_{sink} = 8$ mA, $V_I \leqslant -\ 6$ mV		–	0.23	0.4	–	–	–	
$V_I \leqslant -10$ mV		–	–	–	–	0.23	0.4	
$T_{amb} = +25°C$, $I_O = 50$ mA, $V_I \leqslant -\ 5$ mV		–	0.75	1.5	–	–	–	
$V_I \leqslant -10$ mV		–	–	–	–	0.75	1.5	
High level output current	I_{OH}							
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $V_I \geqslant +5$ mV, $V_O = +35$ V		–	0.1	0.5	–	–	–	µA
$T_{amb} = +25°C$, $V_I \geqslant +\ 5$ mV, $V_O = +35$ V		–	0.2	10	–	–	–	nA
$V_I \geqslant +10$ mV, $V_O = +25$ V		–	–	–	–	0.2	50	nA
Strobe current ($T_{amb} = +25°C$)	I_{strobe}	–	3	–	–	3	–	mA
Response time ($T_{amb} = +25°C$) - (Note 4)	t_{re}	–	200	–	–	200	–	ns

Note 2 : The offset voltage, offset current and bias current specifications apply for any supply voltage from a single +5 V supply up to ±15 V supplies.

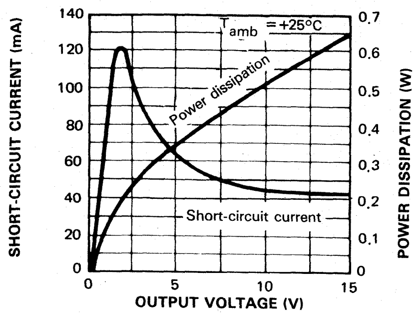
Note 3 : The offset voltages and offset currents given are the maximum values required to drive the output down to +1 V or up to +14 V with a 1 mA load. Thus, these parameters define an error band and take into account the worst-case of voltage gain and input impedance.

Note 4 : The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.

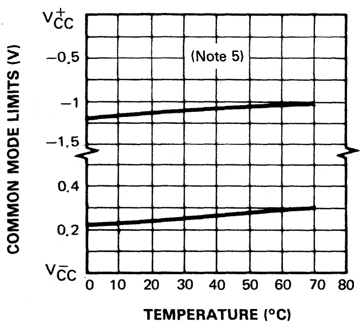
TRANSFER CHARACTERISTICS



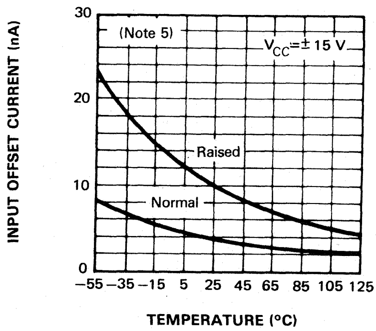
OUTPUT LIMITING CHARACTERISTICS



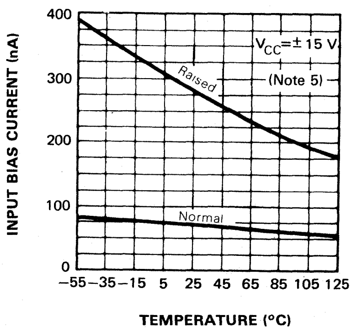
COMMON MODE LIMITS



INPUT OFFSET CURRENT

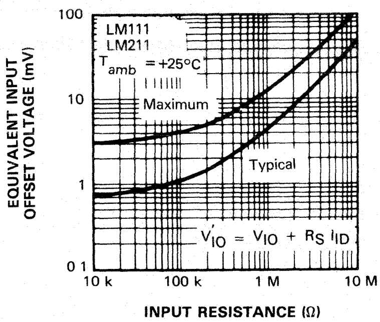


INPUT BIAS CURRENT

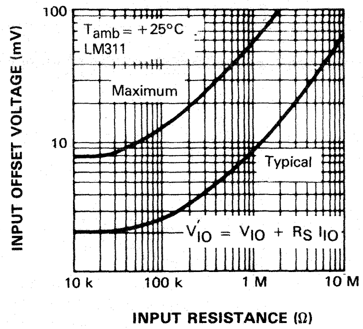


Note 5 : LM111 : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC} = \pm 15$ V
LM211 : $-25°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC} = \pm 15$ V
LM311 : $0°C \leqslant T_{amb} \leqslant +70°C$, $V_{CC} = \pm 15$ V

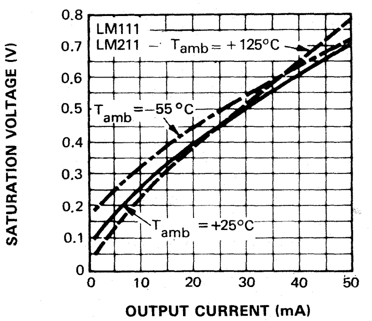
EQUIVALENT INPUT OFFSET ERROR



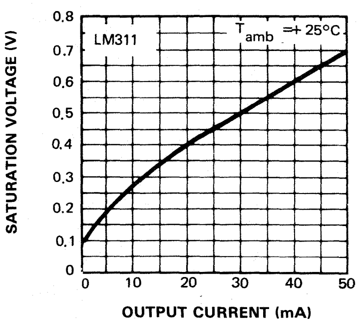
EQUIVALENT INPUT OFFSET ERROR



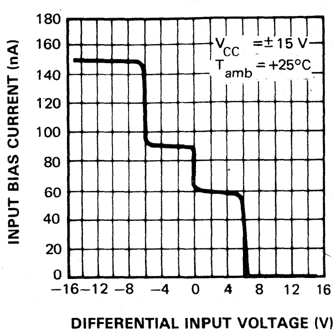
LOW LEVEL OUTPUT SATURATION VOLTAGE



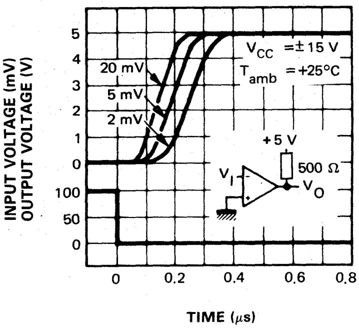
LOW LEVEL OUTPUT SATURATION VOLTAGE



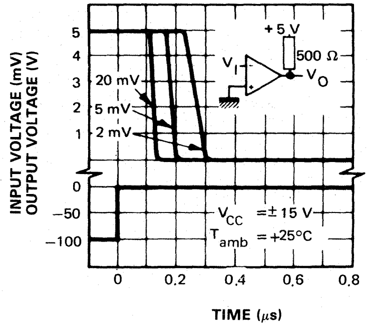
INPUT CHARACTERISTICS



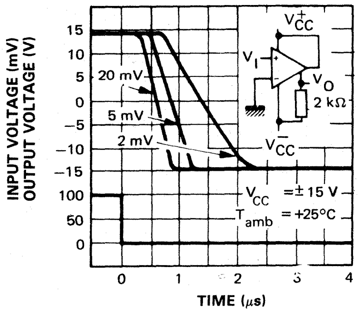
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



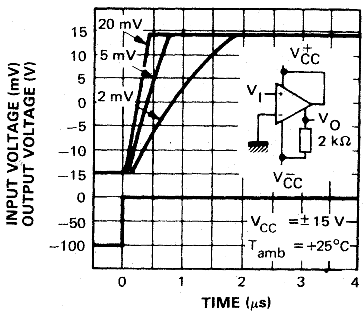
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

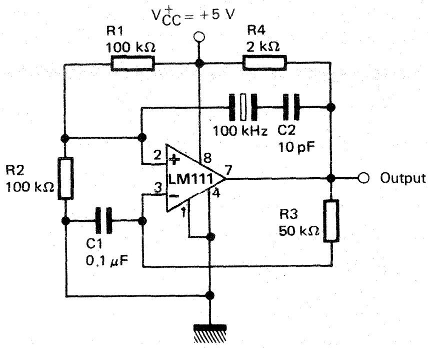


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

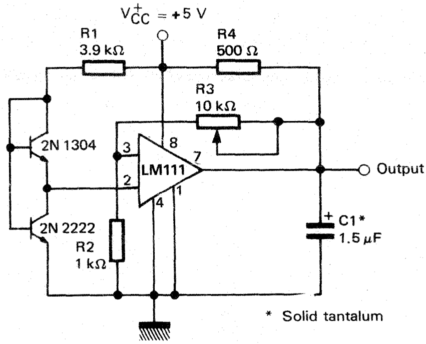


TYPICAL APPLICATIONS

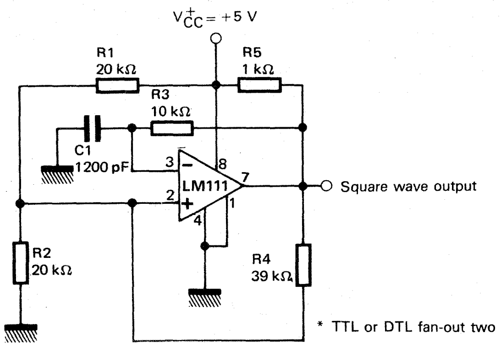
CRYSTAL OSCILLATOR



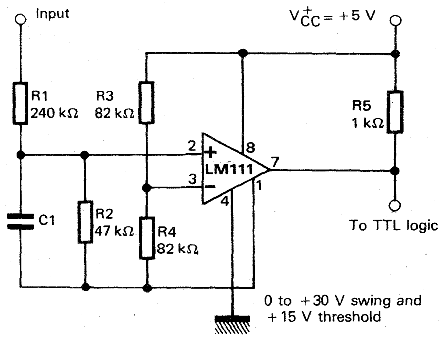
LOW VOLTAGE ADJUSTABLE REFERENCE SUPPLY



100 kHz FREE RUNNING MULTIVIBRATOR

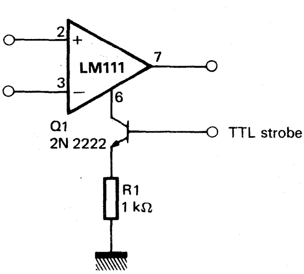


TTL INTERFACE WITH HIGH LEVEL LOGIC

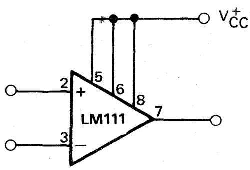


AUXILIARY CIRCUITS

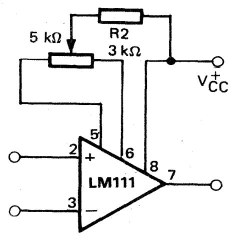
STROBE

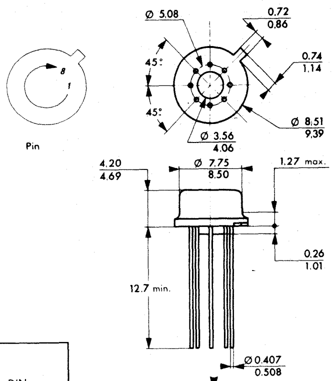


INCREASING INPUT STAGE CURRENT



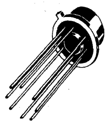
OFFSET BALANCING



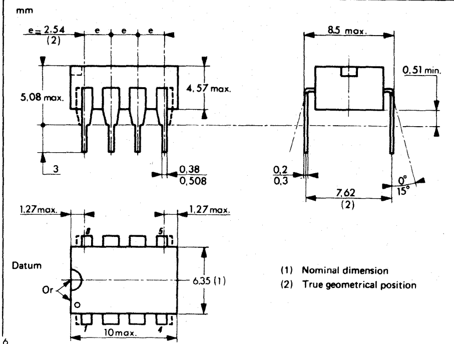


8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

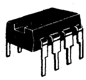


CB-11
H SUFFIX
METAL CAN

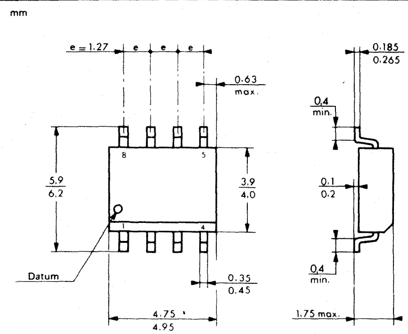


8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

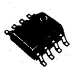


CB-98
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

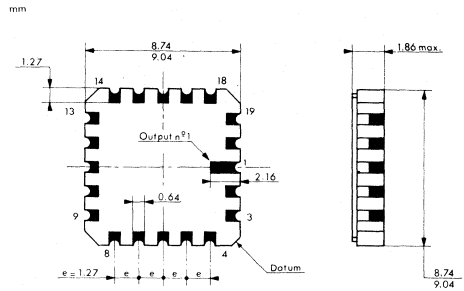


8 pins

DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

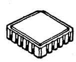


CB-342
FP SUFFIX
PLASTIC
MICROPACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

LM119 LM219 LM319

2

HIGH SPEED DUAL COMPARATORS

The LM119, LM219, LM319 are precision high speed dual comparators fabricated on a single monolithic chip. They are designed to operate over a wide range of supply voltages down to a single 5 V logic supply and ground and have extremely low input currents and high gains.

The open collector of the output stage makes the LM119, LM219, LM319 compatible with RTL, DTL and TTL as well as capable of driving lamps and relays at currents up to 25 mA.

Although designed primarily for applications requiring operation from digital logic supplies, the LM119, LM219, LM319 are fully specified for power supplies up to ± 15 V.

They feature faster response than the LM111 at the expense of higher power dissipation. However, the high speed, wide operating voltage range and low package count make the LM119, LM219, LM319 much more versatile.

The LM219 is identical to the LM119 except that the performance is specified over a − 25°C to + 85°C temperature range instead of − 55°C to + 125°C.

- Two independent comparators.
- Operation from a single + 5 V supply.
- Typically 80 ns response time at ± 15 V.
- Minimum fan-out of 2 each side.
- Maximum input current of 1 μA over operating temperature range.
- Inputs and outputs can be isolated from system ground.
- High common-mode slew rate.

ORDERING INFORMATION

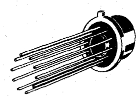
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE				
		H	DP	DG	FP	GC
LM119	− 55°C to + 125°C	•		•		•
LM219	− 25°C to + 85°C	•	•	•		
LM319	0°C to + 70°C	•	•	•	•	
Examples : LM119H, LM219DP						

HIGH SPEED DUAL COMPARATORS

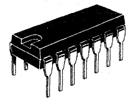
CASES

CB-3



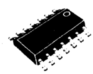
H SUFFIX
METAL CAN

CB-2



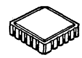
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

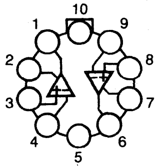
CB-705



GC SUFFIX
TRICECOP (LCC)

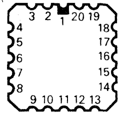
PIN ASSIGNMENTS
(Top views)

CB-3



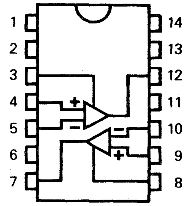
1 - Output 1
2 - Ground 1
3 - Non-inverting input 1
4 - Inverting input 1
5 - V_{CC}^-
6 - Output 2
7 - Ground 2
8 - Non-inverting input 2
9 - Inverting input 2
10 - V_{CC}^+

CB-705



1 - NC
2 - NC
3 - NC
4 - Ground 1
5 - NC
6 - Non-inverting input 1
7 - NC
8 - Inverting input 1
9 - V_{CC}^-
10 - Output 2
11 - NC
12 - Ground 2
13 - Non-inverting input 2
14 - Inverting input 2
15 - NC
16 - V_{CC}^+
17 - NC
18 - Output 1
19 - NC
20 - NC

CB-2
CB-511



1 - NC
2 - NC
3 - Ground 1
4 - Non-inverting input 1
5 - Inverting input 1
6 - V_{CC}^-
7 - Output 2
8 - Ground 2
9 - Non-inverting input 2
10 - Inverting input 2
11 - V_{CC}^+
12 - Output 1
13 - NC
14 - NC

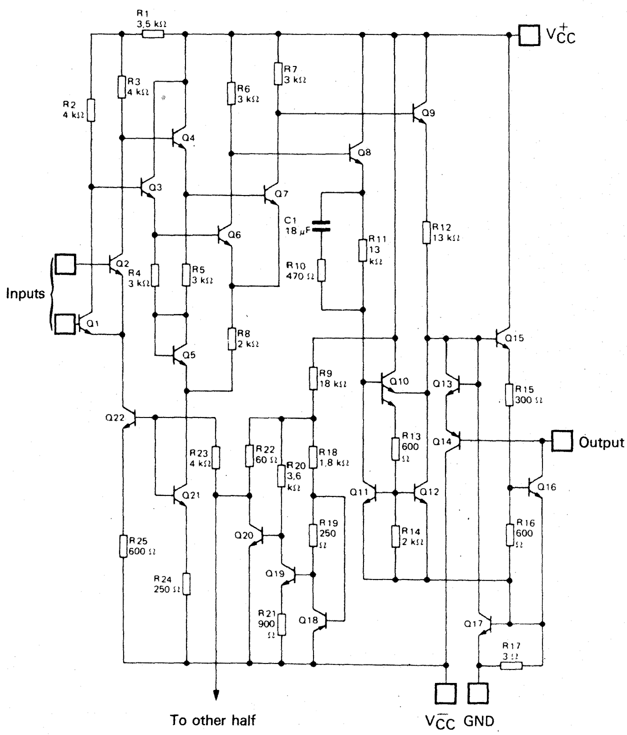
Réf. 00275

MAXIMUM RATINGS

Rating	Symbol	LM119	LM219	LM319	Unit
Ouput to negative supply voltage	$V_O - V_{CC}^-$	36	36	36	V
Negative supply voltage	V_{CC}^-	25	25	25	V
Positive supply voltage	V_{CC}^+	18	18	18	V
Differential input voltage	V_{ID}	±5	±5	±5	V
Input voltage - (Note 1)	V_I	±15	±15	±15	V
Power dissipation - (Note 2)	P_{tot}	500	500	500	mW
Operating free-air temperature range	T_{oper}	−55 to +125	−25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C

* All potentials referenced to ground unless otherwise specified.

SCHEMATIC DIAGRAM



CASE	Outputs	Inverting inputs	Non-inverting inputs	GND	V_{CC}^+	V_{CC}^-	N.C.
CB-3	1, 6	4, 9	3, 8	2, 7	10	5	–
CB-2/CB-511	7, 12	5, 10	4, 9	3, 8	11	6	1, 2, 13, 14
CB-705	10, 18	8, 14	6, 13	4, 12	16	9	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS (Note 3)
LM119 : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V
LM219 : $-25°C \leq T_{amb} \leq +85°C$, $V_{CC} = \pm 15$ V
LM319 : $0°C \leq T_{amb} \leq +70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

2

Characteristic	Symbol	LM119, LM219			LM319			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leq 5$ kΩ) - (Note 4)	V_{IO}							mV
$T_{amb} = +25°C$		–	0.7	4	–	2	8	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	7	–	–	10	
Input offset current - (Note 4)	I_{IO}							nA
$T_{amb} = +25°C$		–	30	75	–	80	200	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	100	–	–	300	
Input bias current	I_{IB}							nA
$T_{amb} = +25°C$		–	150	500	–	250	1000	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	1000	–	–	1200	
Large signal voltage gain ($T_{amb} = +25°C$)	A_{VD}	10	40	–	8	40	–	V/mV
Positive supply current	I_{CC}^+							mA
$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V		–	8	11.5	–	8	12.5	
$T_{min} \leq T_{amb} \leq T_{max}$, $V_{CC}^+ = +5$ V, $V_{CC}^- = 0$ V		–	4.3	–	–	4.3	–	
Negative supply current ($T_{amb} = +25°C$)	I_{CC}^-	–	3	4.5	–	3	5	mA
Input voltage range	V_I	–	±13	–	–	±13	–	V
($V_{CC}^+ = +5$ V, $V_{CC}^- = 0$ V)		1	–	3	1	–	3	
Differential input voltage	V_{ID}	–	–	±5	–	–	±5	V
Low level output voltage	V_{OL}							V
$T_{amb} = +25°C$, $I_O = 25$ mA								
$V_I < -5$ mV		–	0.75	1.5	–	–	–	
$V_I < -10$ mV		–	–	–	–	0.75	1.5	
$0°C \leq T_{amb} \leq T_{max}$		–	–	0.6	–	–	–	
$V_{CC}^+ > +4.5$ V, $V_{CC}^- = 0$ V, $V_I < -6$ mV, $I_{O(sink)} < 3.2$ mA		–	0.23	0.4	–	–	–	
$T_{min} \leq T_{amb} \leq T_{max}$								
$V_{CC}^+ > +4.5$ V, $V_{CC}^- = 0$ V, $V_I < -10$ mV, $I_{O(sink)} < 3.2$ mA		–	–	–	–	0.3	0.4	
High level output current ($V_O = +35$ V)	I_{OH}							μA
$T_{amb} = +25°C$, $V_I > +5$ mV		–	0.2	2	–	–	–	
$V_I > +10$ mV		–	–	–	–	0.2	10	
$T_{min} \leq T_{amb} \leq T_{max}$, $V_I > +5$ mV		–	1	10	–	–	–	
Rise time ($T_{amb} = +25°C$) - Note 5	t_r	–	80	–	–	80	–	ns

Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

Note 2 : CB-3 : $R_{th(j-a)} = 160°C/W$, $R_{th(j-c)} = 45°C/W$
CB-2 : $R_{th(j-a)} = 150°C/W$
CB-511 : $R_{th(j-a)} = 250°C/W$

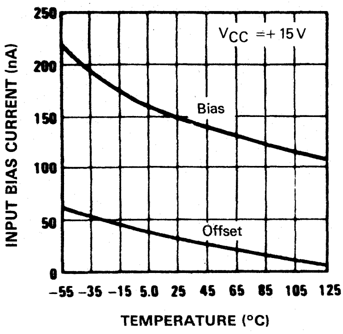
Note 3 : These specifications apply for $V_{CC} = \pm 15$ V, unless otherwise stated. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single +5 V supply up to ±15 V supplies.

Note 4 : The offset voltages and offset current given are the maximum values required to drive the output down to 1 V or up 14 V with a 1 mA load current.
Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.

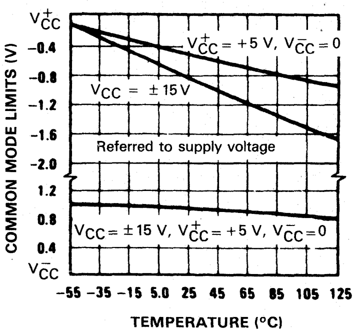
Note 5 : The response time specified is for a 100 mV input step with 5 mV overdrive.

LM119-LM219

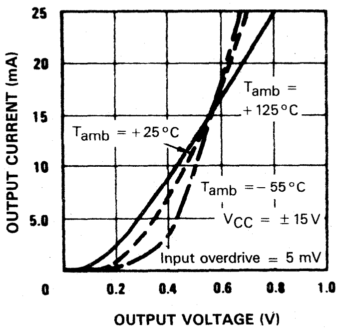
INPUT BIAS CURRENTS



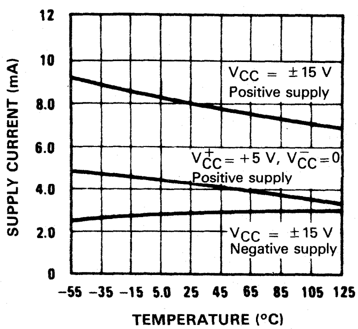
COMMON MODE LIMITS



OUTPUT SATURATION VOLTAGE



SUPPLY CURRENT



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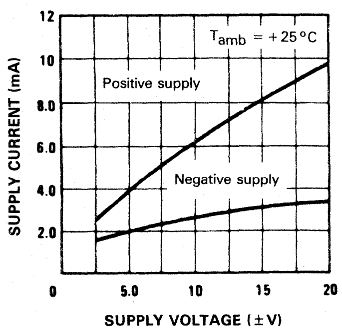
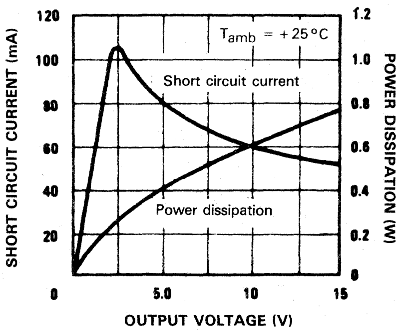
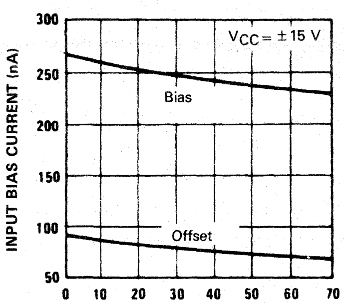


OUTPUT LIMITING CHARACTERISTICS

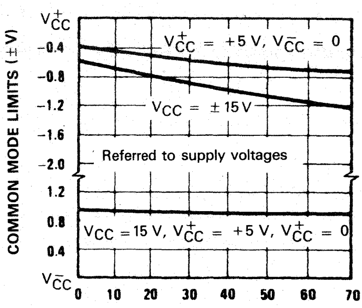


LM319

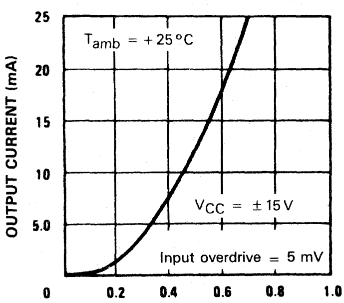
INPUT BIAS CURRENTS



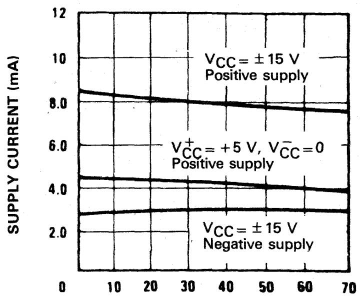
COMMON MODE LIMITS



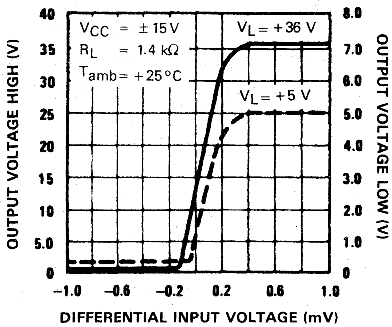
OUTPUT SATURATION VOLTAGE



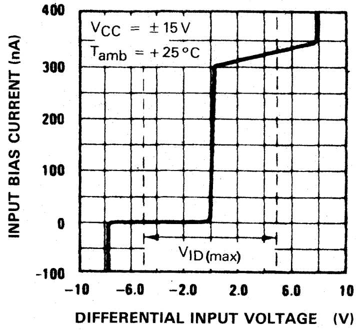
SUPPLY CURRENT



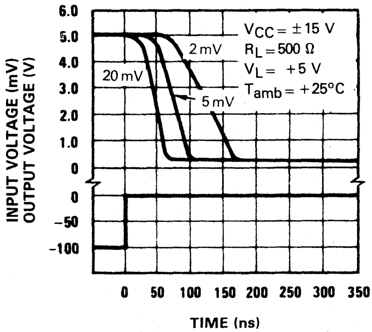
TRANSFER FUNCTION



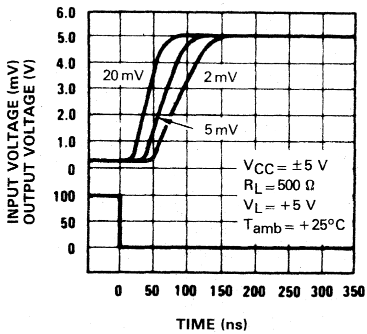
INPUT CHARACTERISTICS



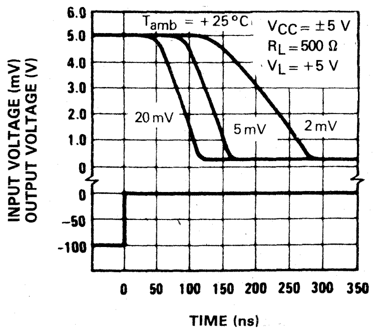
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



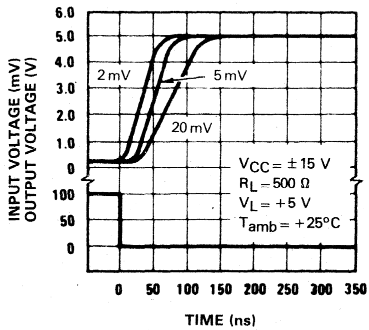
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

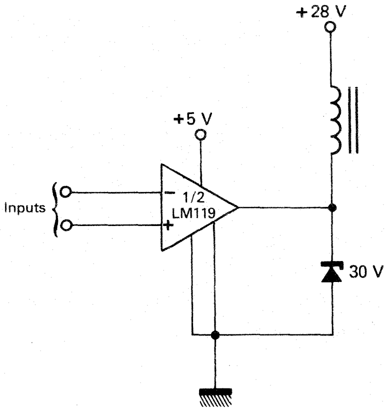


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

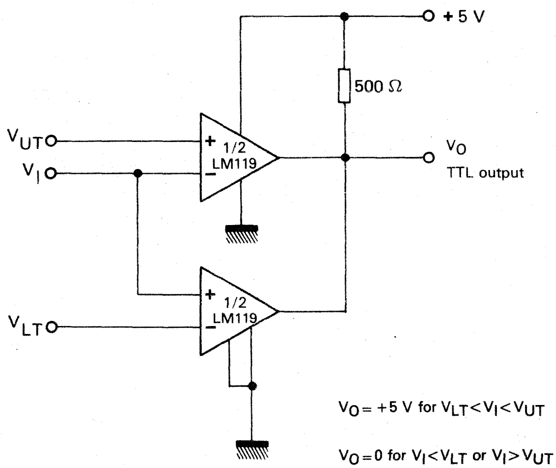


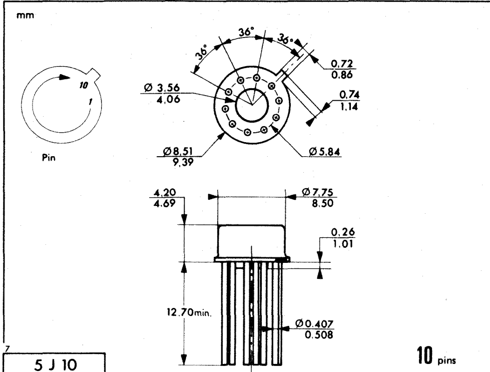
TYPICAL APPLICATION DIAGRAMS

RELAY DRIVER

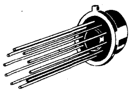


WINDOW DETECTOR

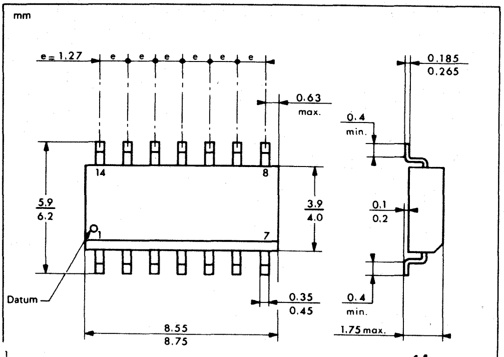




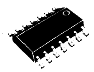
DIN				
5 J 10 41873 DIN				
Case : C-23 Base : B-33 CEI	TO-100 D.A.T.A.	TO-100 JEDEC	F95 SITELESC	CB-3 THOMSON SEMICONDUCTORS



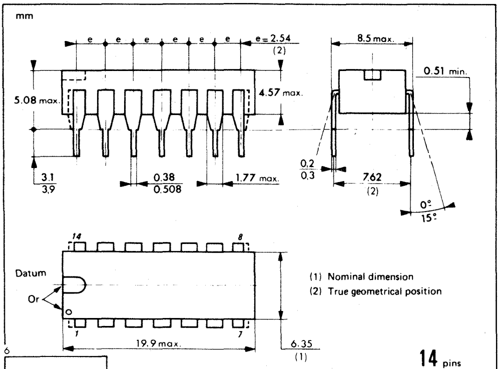
CB-3
H SUFFIX
METAL CAN



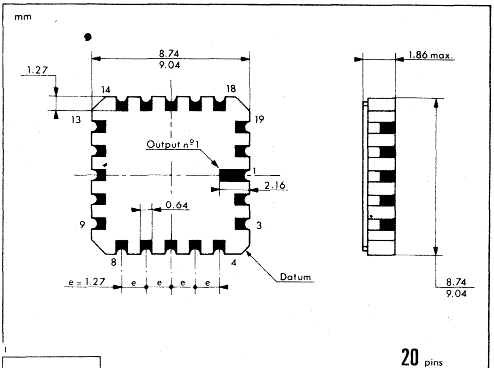
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



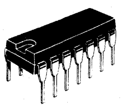
CB-511
FP SUFFIX
PLASTIC
MICROPACKAGE



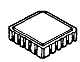
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM139,A
LM239,A
LM339,A
LM2901
MC3302

LOW POWER LOW OFFSET VOLTAGE QUAD COMPARATORS

These devices consist of four independent precision voltage comparators with an offset voltage specifications as low as 2 mV max for LM339A and LM139A. All these comparators were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

- Wide single supply voltage range or dual supplies for all devices (excepted MC3302) : +2 V to +36 V or ±1 V to ±18 V
- Very low supply current drain (0.8 mA) independent of supply voltage (2 mW/comparator at +5 V).
- Low input bias current : 25 nA typ.
- Low input offset current : ±5 nA typ.
- Low input offset voltage : ±3 mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage : 250 mV typ. ($I_O = 4$ mA).
- Differential input voltage range to the supply voltage.
- TTL compatible outputs.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	GC
LM139,A	−55°C to +125°C		•		•
LM239,A	−25°C to + 85°C	•	•		
LM339,A	0°C to + 70°C	•	•	•	
LM2901	−40°C to + 85°C	•		•	
MC3302	−40°C to + 85°C	•			

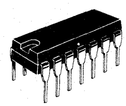
Examples : LM139GC, LM139ADG, LM2901FP

LOW POWER LOW OFFSET VOLTAGE QUAD COMPARATORS

2

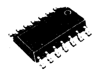
CASES

CB-2 (TO-116)



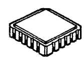
DP SUFFIX PLASTIC PACKAGE
DG SUFFIX CERDIP PACKAGE

CB-511 (SO-14)



FP SUFFIX PLASTIC MICROPACKAGE

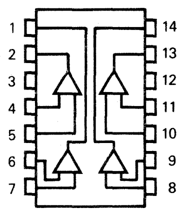
CB-705



GC SUFFIX TRICECOP (LCC)

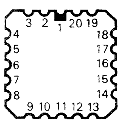
PIN ASSIGNMENTS
(Top views)

CB-2
CB-511



1 - Output 2
2 - Output 1
3 - V_{CC}^{+}
4 - Inverting input 1
5 - Non-inverting input 1
6 - Inverting input 2
7 - Non-inverting 2
8 - Inverting input 3
9 - Non-inverting input 3
10 - Inverting input 4
11 - Non-inverting input 4
12 - V_{CC}^{-}
13 - Output 4
14 - Output 3

CB-705



1 - NC
2 - Output 2
3 - Output 1
4 - V_{CC}^{+}
5 - NC
6 - Inverting input 1
7 - NC
8 - Non-inverting input 1
9 - Inverting input 2
10 - Non-inverting input 2
11 - NC
12 - Inverting input 3
13 - Non-inverting input 3
14 - Inverting input 4
15 - NC
16 - Non-inverting input 4
17 - NC
18 - V_{CC}^{-}
19 - Output 4
20 - Output 3

Réf. 00345

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

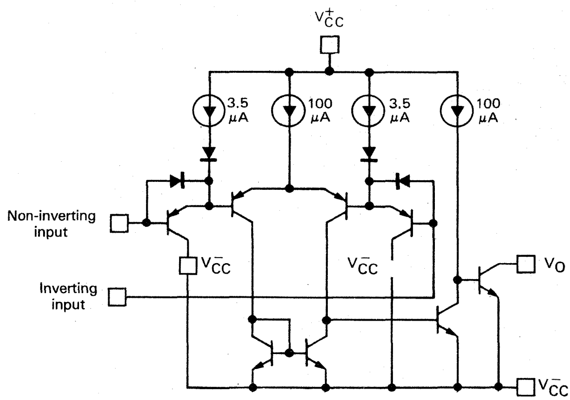
Rating	Symbol	LM139,A LM239,A	LM339,A	LM2901 MC3302	
Supply voltage MC3302	V_{CC}	± 18 to 36 —	± 18 to 36 —	± 18 to 36 ± 14 to 28	V
Differential input voltage	V_{ID}	36	36	36	V
Input voltage MC3302	V_I	− 0.3 to + 36 —	− 0.3 to + 36 —	− 0.3 to + 36 − 0.3 to + 28	V
Output short-circuit to ground - (Note 2)	—	Continuous	Continuous	Continuous	—
Power dissipation - (Note 1) LM139GC	P_{tot}	570 665	570 —	570 —	mW
Operating free-air temperature range LM239,A	T_{oper}	− 55 to + 125 − 25 to + 85	0 to + 70 —	− 40 to + 85 —	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

Note 1 : Short-circuit from the output to V_{CC}^{+} can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA, independent of the magnitude of V_{CC}^{+}.

Note 2 : For operating at high temperatures, the LM139, LM139A, LM2901 and MC3302 must be derated based on a + 125°C max junction temperature and a thermal resistance of 175°C/W which applies for the device soldered on a printed circuit board, operating in a still air ambient. The LM139 and LM139A must be derated based on a + 150°C max junction temperature.

* $R_{th(j-a)}$ = 250°C/W. Devices bonded on a 6 × 3 × 0.15 cm glass-epoxy substrate with 30 mm² of 35 μm thick copper.

SCHEMATIC DIAGRAM (1/4 LM139)



CASE	Outputs	Inverting inputs	Non-inverting inputs	V_{CC}^{-}	V_{CC}^{+}	N.C.
CB-2/CB-511	1, 2, 13, 14	4, 6, 8, 10	5, 7, 9, 11	12	3	—
CB-705	2, 3, 19, 20	6, 9, 12, 14	8, 10, 13, 16	18	4	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

LM139,A : $-55°C \leqslant T_{amb} \leqslant +125°C$, $V_{CC}^{+} = +5V$
LM239,A : $-25°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC}^{+} = +5$ V
LM339,A : $0°C \leqslant T_{amb} \leqslant +70°C$, $V_{CC}^{+} = +5$ V
(Unless otherwise specified)

Characteristic	Symbol	LM139,A/LM239,A			LM339,A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 3)	V_{IO}							mV
$T_{amb} = +25°C$		—	±2	±5	—	±2	±5	
LM139A, LM239A		—	±1	±2	—	—	—	
LM339A		—	—	—	—	±1	±2	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	9	—	—	9	
LM139A, LM239A		—	—	4	—	—	—	
LM339A		—	—	—	—	—	4	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		—	±3	±25	—	±5	±50	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	±100	—	—	±150	
Input bias current (I_I^+ or I_I^-)	I_{IB}							nA
$T_{amb} = +25°C$ - (Note 4)		—	25	100	—	25	250	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	300	—	—	400	
Large signal voltage gain	A_{VD}							V/mV
$V_{CC}^{+} = +15$ V, $T_{amb} = +25°C$, $R_L \geqslant 15$ kΩ		—	200	—	—	200	—	
LM139A, LM239A		50	200	—	—	—	—	
LM339A		—	—	—	50	200	—	
Supply current, $R_L = \infty$, $T_{amb} = +25°C$ (all comparators)	I_{CC}	—	0.8	2	—	0.8	2	mA
Input common-mode voltage range	V_I							V
$T_{amb} = +25°C$ - (Note 5)		0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		0	—	$V_{CC}^{+} - 2$	—	—	$V_{CC}^{+} - 2$	
Differential input voltage ($V_I^+ = 0$ or $V_I^- = 0$, if used) - Note 7	V_{ID}	—	—	36	—	—	36	V
LM139A, LM239A		—	—	V_{CC}^{+}	—	—	—	
LM339A		—	—	—	—	—	V_{CC}^{+}	
Low level output voltage ($V_I^- \geqslant 1V$, $V_I^+ = 0$ V, $I_{sink} \leqslant 4$ mA)	V_{OL}							mV
$T_{amb} = +25°C$		—	250	—	—	250	400	
$T_{min} \leqslant T_{amb} \leqslant T_{max}$		—	—	700	—	—	700	
High level output current ($V_I^+ \geqslant 1$ V, $V_I^- = 0$ V)	I_{OH}							
$T_{amb} = +25°C$, $V_O = +5$ V		—	0.1	—	—	0.1	—	nA
$T_{min} \leqslant T_{amb} \leqslant T_{max}$, $V_O = +30$ V		—	—	1	—	—	1	µA
Output sink current ($V_I^- \geqslant 1$ V, $T_{amb} = +25°C$, $V_I^+ = 0$ V, $V_O \leqslant +1.5$ V)	$I_{O(sink)}$	6	16	—	6	16	—	mA
Response time - (Note 6) ($V_L = +5$ V, $R_L = 5100$ Ω, $V_{(ref)} = +1.4$ V, $T_{amb} = +25°C$)	t_{re}	—	1.3	—	—	1.3	—	µs
Large signal response time ($V_L = 5$ V, $e_I = TTL$, $R_L = 5100$ Ω, $V_{(ref)} = +1.4$ V, $T_{amb} = +25°C$)	t_{rel}	—	300	—	—	300	—	ns

ELECTRICAL CHARACTERISTICS

LM2901, MC3302 : $-40°C \leqslant T_{amb} \leqslant +85°C$, $V_{CC} = +5$ V
(Unless otherwise specified)

Characteristic	Symbol	LM2901			MC3302			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 3) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_{IO}	 – –	 ±2 9	 ±7 15	 – –	 ±3 –	 ±20 40	mV
Input offset current $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IO}	 – –	 ±5 ±50	 ±50 ±200	 – –	 ±3 –	 ±100 ±300	nA
Input bias current (I_I^+ or I_I^-) $T_{amb} = +25°C$ - (Note 4) $T_{min} \leqslant T_{amb} \leqslant T_{max}$	I_{IB}	 – –	 25 200	 250 500	 – –	 25 –	 500 1000	nA
Large signal voltage gain ($V_{CC}^+ = +15$ V, $T_{amb} = +25°C$, $R_L \geqslant 15$ kΩ)	A_{VD}	25	100	–	2	30	–	V/mV
Supply current $R_L = \infty$, $T_{amb} = +25°C$ (all comparators) $R_L = \infty$, $T_{amb} = +25°C$, $V_{CC}^+ = +30$ V	I_{CC}	 – –	 0.8 1	 2 2.5	 – –	 0.8 –	 2 –	mA
Input common-mode voltage range $T_{amb} = +25°C$ - (Note 5) $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_I	 0 0	 – –	 $V_{CC}^+ -1.5$ $V_{CC}^+ -2$	 0 0	 – –	 $V_{CC}^+ -1.5$ $V_{CC}^+ -2$	V
Differential input voltage ($V_I^+ = 0$ or $V_I^- = 0$, if used) - Note 7	V_{ID}	–	–	V_{CC}^+	–	–	V_{CC}^+	V
Low level output voltage ($V_I^- \geqslant +1$ V, $V_I^+ = 0$ V, $I_{sink} \leqslant 4$ mA) $T_{amb} = +25°C$ $T_{min} \leqslant T_{amb} \leqslant T_{max}$	V_{OL}	 – –	 – 400	 400 700	 – –	 250 –	 500 700	mV
High level output current ($V_I^+ \geqslant +1$ V, $V_I^- = 0$ V) $T_{amb} = +25°C$, $V_O = +5$ V $T_{min} \leqslant T_{amb} \leqslant T_{max}$, $V_O = +30$ V	I_{OH}	 – –	 0.1 –	 – 1	 – –	 0.1 –	 – 1	 nA µA
Output sink current ($V_I^- = +1$ V, $V_I^+ = 0$ V, $T_{amb} = +25°C$, $V_O \leqslant +1.5$ V)	$I_{O(sink)}$	6	16	–	6	16	–	mA
Response time $V_L = +5$ V ($R_L = 5100$ Ω, $T_{amb} = +25°C$) - Note 6	t_{re}	–	1.3	–	–	1.3	–	µs
Large signal response time ($V_L = +5$ V, $e_I = TTL$, $R_L = 5100$ Ω, $V_{(ref)} = +1.4$ V, $T_{amb} = +25°C$)	t_{rel}	–	300	–	–	300	–	ns

Note 3 : At output switch point, $V_O \cong 1.4$ V, $R_S = 0$ with $V_{CC}^+ = 5$ V, and over the full input common-mode range (0 V to $V_{CC}^+ - 1.5$ V).

Note 4 : The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference or input lines.

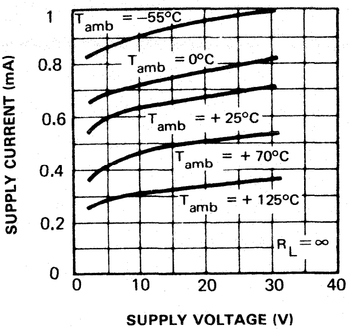
Note 5 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC}^+ - 1.5$ V, but either or both inputs can go to +30 V without damage.

Note 6 : The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.

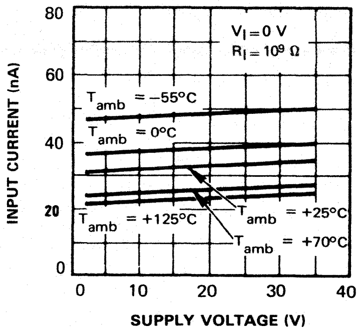
Note 7 : Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than −0.3 V (or 0.3 V bellow the negative power supply, if used).

LM139,A - LM339,A
MC3302

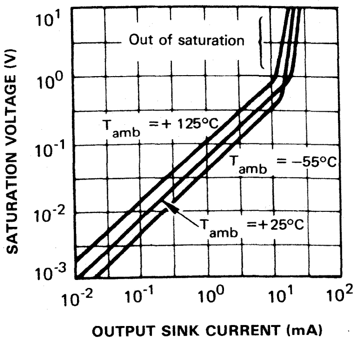
SUPPLY CURRENT



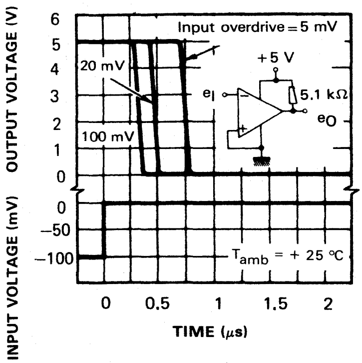
INPUT CURRENT



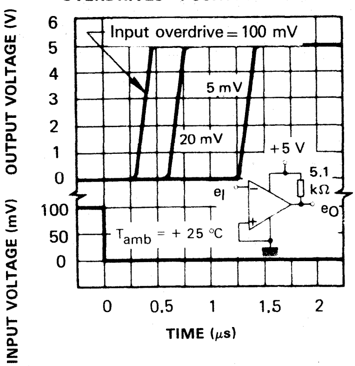
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES-NEGATIVE TRANSITION

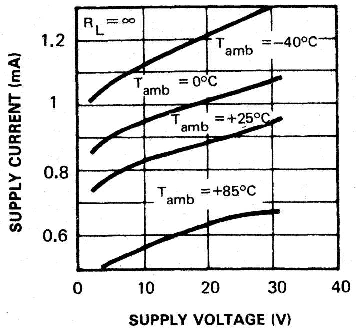


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION

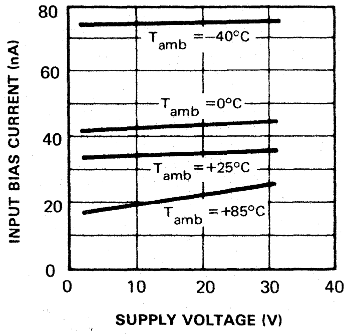


LM2901

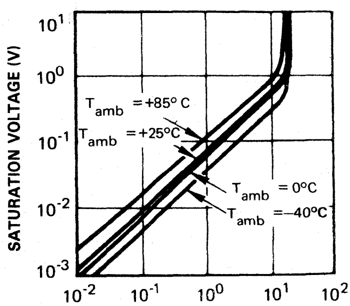
SUPPLY CURRENT



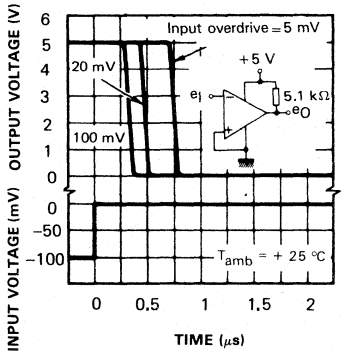
SUPPLY CURRENT



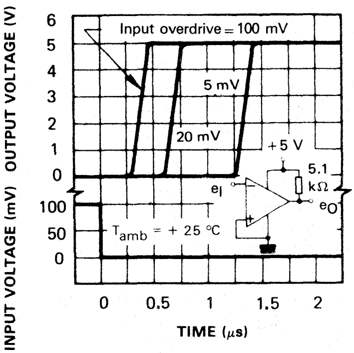
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES-NEGATIVE TRANSITION

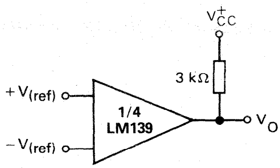


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION

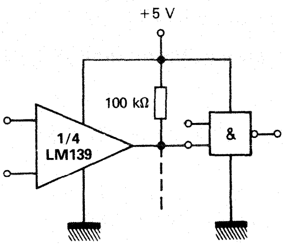


TYPICAL APPLICATIONS

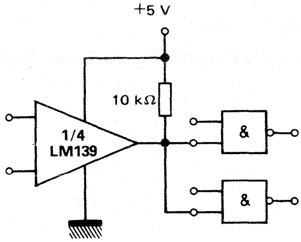
$V_{CC}^{+} = +5\ V$



BASIC COMPARATOR



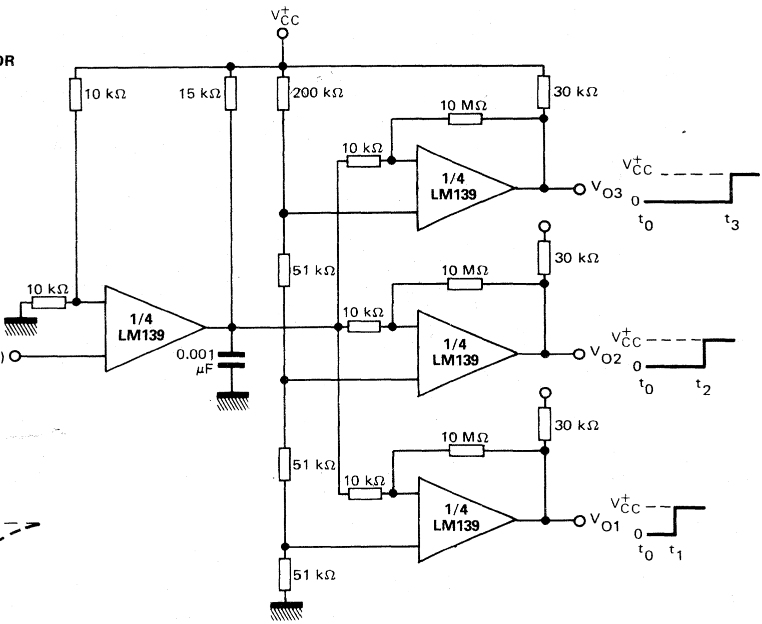
DRIVING CMOS

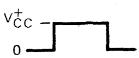


DRIVING TTL

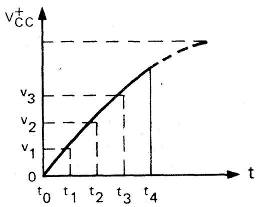
TYPICAL APPLICATION

TIME DELAY GENERATOR



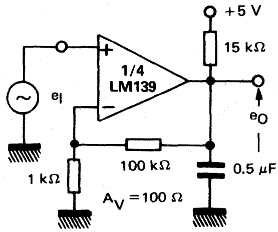


INPUT GATING SIGNAL



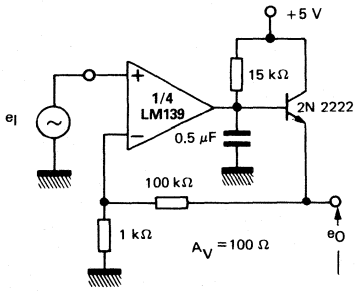
TYPICAL APPLICATIONS (continued)

LOW FREQUENCY OP AMP

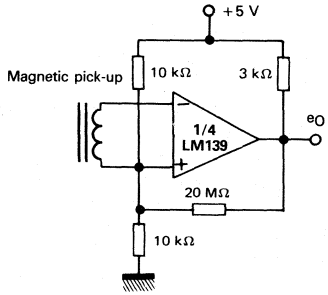


LOW FREQUENCY OP AMP

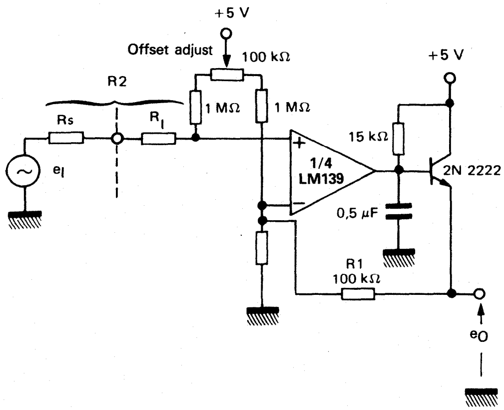
(eO = 0 V for eI = 0 V)



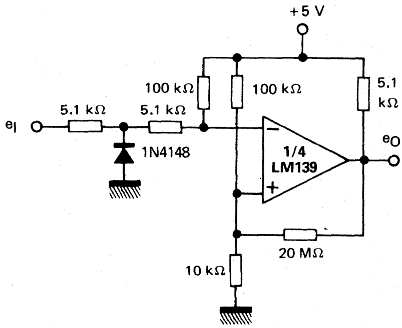
TRANSDUCER AMPLIFIER



LOW FREQUENCY OP AMP WITH OFFSET ADJUST



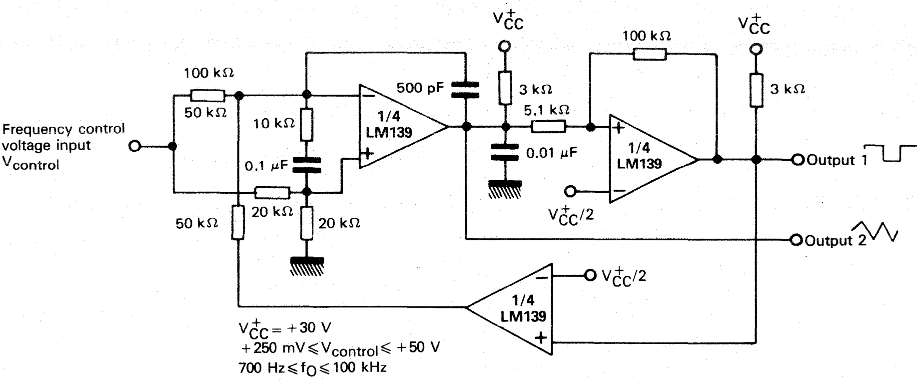
ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)



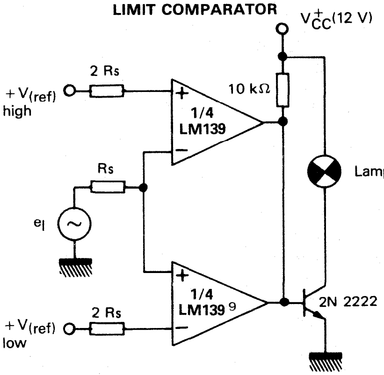
2

TYPICAL APPLICATIONS (continued)

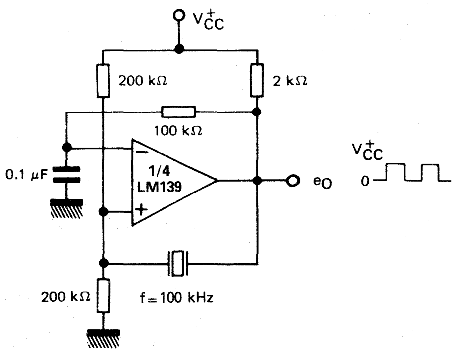
TWO-DECADE HIGH-FREQUENCY VCO



LIMIT COMPARATOR

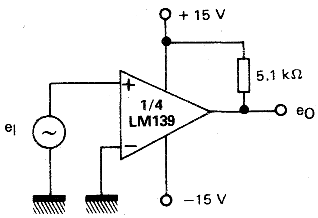


CRYSTAL CONTROLLED OSCILLATOR

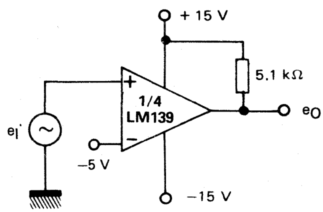


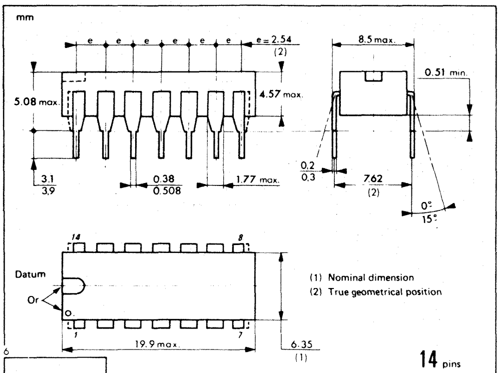
SPLIT-SUPPLY APPLICATIONS

ZERO CROSSING DETECTOR

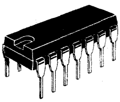


COMPARATOR WITH A NEGATIVE REFERENCE

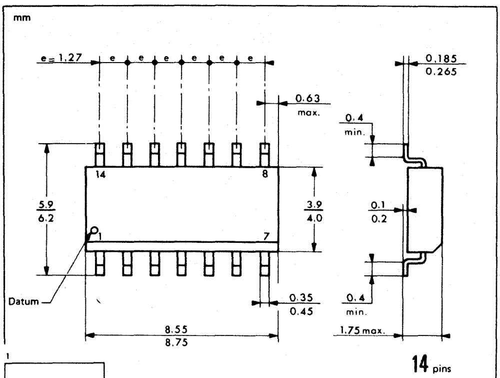




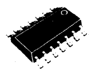
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



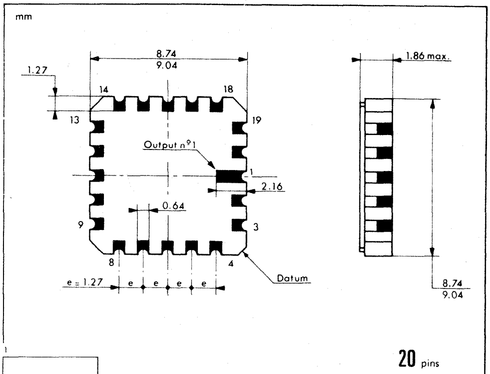
CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



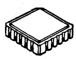
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM193,A
LM293,A
LM393,A
LM2903

2

LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS

These devices consist of two independent precision voltage comparators with an offset voltage specifications as low as 2 mV max for LM393 A and LM193A.

All these comparators were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristics in that the input common-mode voltage range includes ground even through operated from a single power supply voltage.

- Wide single supply voltage range or dual supplies +2 V to +36 V or ± 1 V to ± 18 V.
- Very low supply current drain (0.8 mA) independent of supply voltage (2 mW/comparator at +5 V).
- Low input biasing current : 25 nA typ.
- Low input offset current : ± 5 nA typ.
- Low input offset voltage : ± 3 mV typ.
- Input common-mode voltage range includes ground.
- Low output saturation voltage : 250 mV typ. (I_O = 4 mA).
- Differentiel input voltage range to the supply voltage.
- TTL, DTL, ECL, MOS, CMOS compatible outputs.

ORDERING INFORMATION

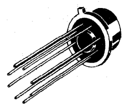
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		H	DP	FP	GC
LM193,A	−55°C to +125°C	•			•
LM293,A	−25°C to + 85°C	•	•		
LM393,A	0°C to + 70°C	•	•	•	
LM2903	0°C to + 70°C		•	•	
Examples : LM193H, LM393FP					

LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS

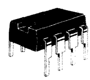
CASES

CB-11



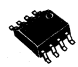
H SUFFIX
METAL CAN

CB-98



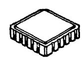
DP SUFFIX
PLASTIC PACKAGE

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

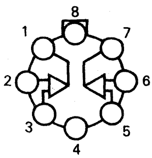
CB-705



GC SUFFIX
TRICECOP (LCC)

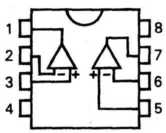
PIN ASSIGNMENTS
(Top views)

CB-11



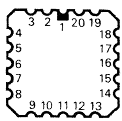
1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^-

CB-98
CB-342



5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

CB-705



1 - NC
2 - Output 1
3 - NC
4 - NC
5 - Inverting input 1
6 - NC
7 - Non-inverting input 1
8 - NC
9 - NC
10 - V_{CC}^-

11 - NC
12 - Non-inverting input 2
13 - NC
14 - NC
15 - Inverting input 2
16 - NC
17 - Output 2
18 - NC
19 - NC
20 - V_{CC}^+

Réf. 00350

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

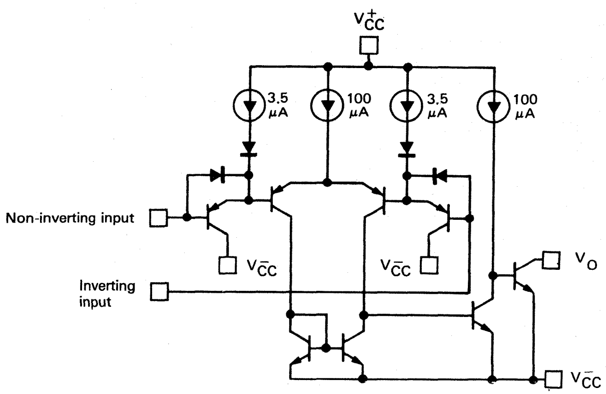
MAXIMUM RATINGS

Rating	Symbol	LM193,A	LM293,A	LM393,A LM2903	Unit
Supply voltage	V_{CC}	± 18 to 36	± 18 to 36	± 18 to 36	V
Differential input voltage	V_{ID}	36	36	36	V
Input voltage range	V_I	− 0.3 to + 36	− 0.3 to + 36	− 0.3 to + 36	V
Output short-circuit to ground - (Note 2)	—	Continuous	Continuous	Continuous	—
Power dissipation - (Note 1) LM393AH	P_{tot}	830 —	830 —	570 830	mW
Operating free-air temperature range LM2903	T_{oper}	− 55 to + 125 —	− 25 to + 85 —	0 to + 70 − 40 to + 85	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	− 65 to + 150	°C

Note 1 : For operating at high temperatures the LM393, LM393A, LM2903 must be derated based on a + 125°C max junction temperature and a thermal resistance of 175°C/W which applies for the devices soldered on a printed circuit board, operating in a still air ambient. The LM393, LM393A, LM293 and LM293A must be derated based on a + 150°C max junction temperature.

Note 2 : Short-circuit from the output to V_{CC}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA, independent of the magnitude of V_{CC}^+.

SCHEMATIC DIAGRAM (1/2 LM193)



CASE	Outputs	Non-inverting inputs	Inverting inputs	V_{CC}^-	V_{CC}^+	N.C.
CB-11 CB-98 CB-342	1, 7	3, 5	2, 6	4	8	—
CB-705	2, 17	7, 12	5, 15	10	20	*

* **CB-705** : Other pins are not connected.

ELECTRICAL CHARACTERISTICS

$V_{CC}^{+} = +5$ V, $V_{CC}^{-} =$ Ground
LM193, A : $-55°C \leq T_{amb} \leq +125°C$
LM293, A : $-25°C \leq T_{amb} \leq +85°C$
LM393, A : $0°C \leq T_{amb} \leq +70°C$
LM2903 : $-40°C \leq T_{amb} \leq +85°C$
(Unless otherwise specified)

Characteristic	Symbol	LM193,A			LM293,A/LM393,A LM2903			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 3)	V_{IO}							mV
$T_{amb} = +25°C$		—	±1	±5	—	±1	±5	
LM193A/LM293A/LM393A		—	±1	±2	—	±1	±2	
LM2903		—	—	—	—	±2	±7	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	9	—	—	9	
LM193A/LM293A/LM393A		—	—	4	—	—	4	
LM2903		—	—	—	—	9	15	
Input offset current	I_{IO}							nA
$T_{amb} = +25°C$		—	±3	±25	—	±50	±50	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	±100	—	—	±150	
LM2903		—	—	—	—	±50	±200	
Input bias current - (Note 4)	I_{IB}							nA
$T_{amb} = +25°C$, I_I^+ or I_I^-		—	25	100	—	25	250	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	300	—	—	400	
LM2903		—	—	—	—	200	500	
Large signal voltage gain	A_{VD}							V/mV
$T_{amb} = +25°C$, $R_L \geq 15$ kΩ, $V_{CC}^{+} = +15$ V		—	50	200	—	50	200	
LM2903		—	—	—	—	25	100	
Supply current	I_{CC}							mA
$R_L = \infty$ (all comparators), $T_{amb} = +25°C$		—	0.4	1	—	0.4	1	
$R_L = \infty$, $T_{amb} = +25°C$, $V_{CC}^{+} = +30$ V		—	1	25	—	1	2.5	
LM193/LM293		—	—	—	—	—	2.5	
Input common-mode voltage range - (Note 5)	V_I							V
$T_{amb} = +25°C$		0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	
$T_{min} \leq T_{amb} \leq T_{max}$		0	—	$V_{CC}^{+} - 2$	0	—	$V_{CC}^{+} - 2$	
Differential input voltage ($V_I \geq 0$ or if used $V_I^- = 0$) - Note 7	V_{ID}	—	—	V_{CC}^{+}	—	—	V_{CC}^{+}	V
Saturation voltage ($V_I^- \geq 1$ V, $V_I^+ = 0$ V, $I_{O(sink)} \leq 4$ mA)	V_{OL}							mV
$T_{amb} = +25°C$		—	250	400	—	250	400	
LM2903		—	—	—	—	—	400	
$T_{min} \leq T_{amb} \leq T_{max}$		—	—	700	—	—	700	
LM2903		—	—	—	—	400	700	
High level output current ($V_I^+ \geq 1$, $V_I^- = 0$ V)	I_{OH}							
$T_{amb} = +25°C$, $V_O = +5$ V		—	0.1	—	—	0.1	—	nA
$T_{min} \leq T_{amb} \leq T_{max}$, $V_I^- = 0$ V, $V_O = +30$ V		—	—	1	—	—	1	µA
Output sink current ($T_{amb} = +25°C$, $V_I^+ = 0$ V, $V_I^- \geq 1$ V, $V_O \leq +1.5$ V)	$I_{O(sink)}$	6	16	—	6	16	—	mA
Response time ($V_L = 5$ V, $R_L = 5100$ Ω) - Note 6	t_{re}	—	1.3	—	—	1.3	—	µs
LM2903		—	—	—	—	1.5	—	
Large signal response time ($e_I = TTL$, $V_{(ref)} = +1.4$ V, $V_L = 5$ V)	t_{rel}	—	300	—	—	300	—	ns

Note 3 : At output switch point, $V_O \cong 1.4$ V, $R_S = 0$ with V_{CC}^{+} from 5 V to 30 V the full input common-mode range (0 V to $V_{CC}^{+} - 1.5$ V).

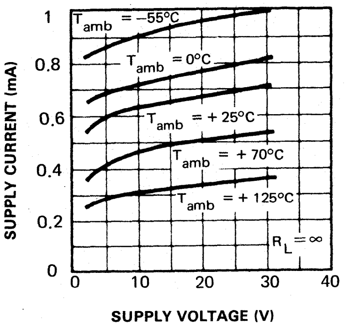
Note 4 : The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference or input lines.

Note 5 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC}^{+} - 1.5$ V, but either or both inputs can go to +30 V without damage.

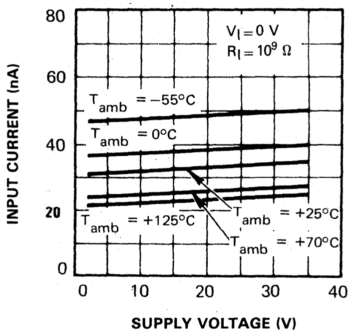
Note 6 : The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.

Note 7 : Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range the comparator will provide a proper output state. The low input voltage state must not be less than −0.3 V (or 0.3 V below the magnitude of the negative power supply, if used).

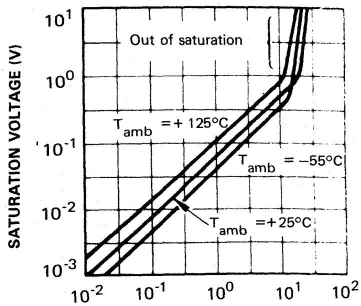
SUPPLY CURRENT



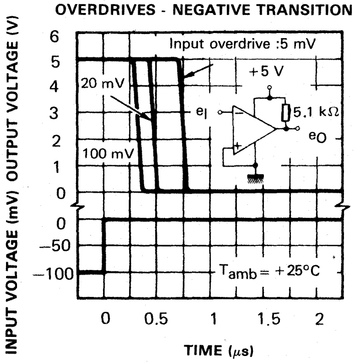
INPUT CURRENT



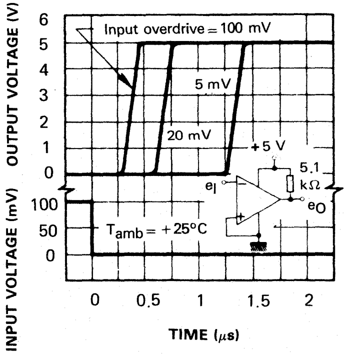
OUTPUT SATURATION VOLTAGE



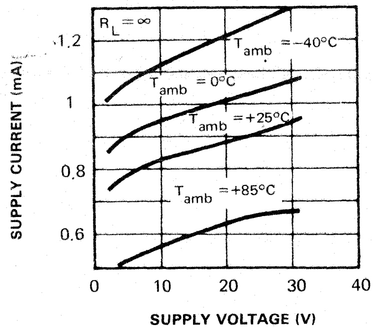
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION



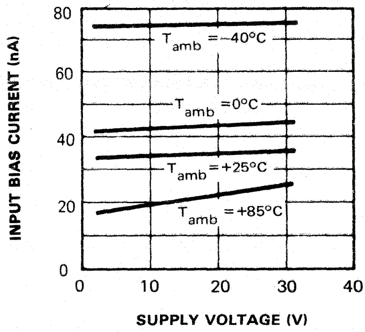
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION



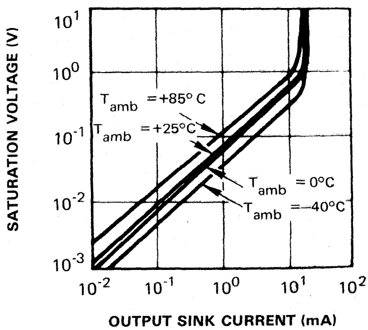
SUPPLY CURRENT



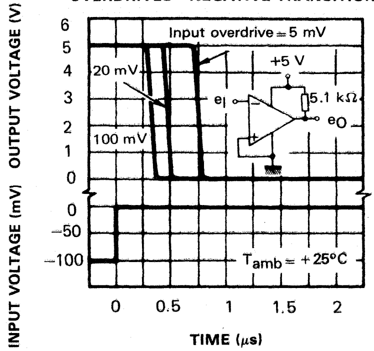
INPUT CURRENT



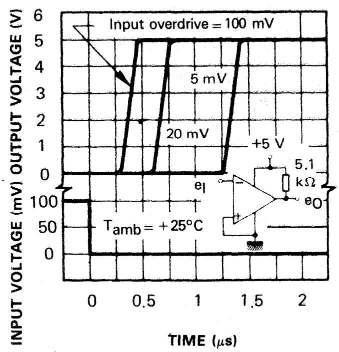
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION

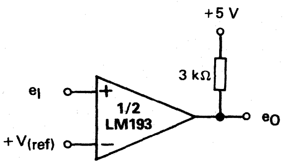


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION

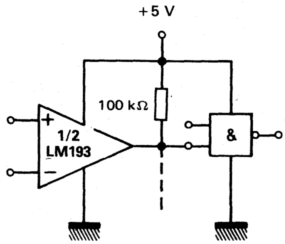


TYPICAL APPLICATIONS

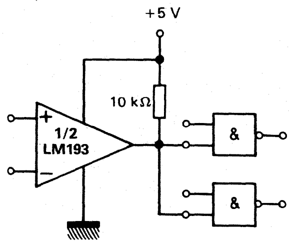
BASIC COMPARATOR



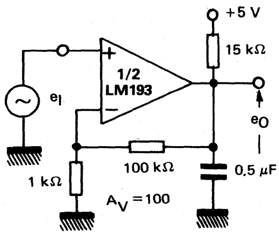
DRIVING CMOS



DRIVING TTL

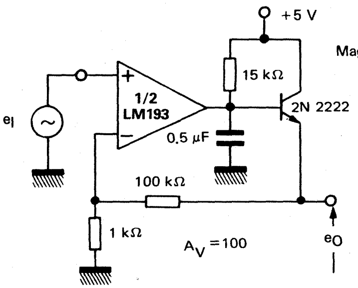


LOW FREQUENCY OP AMP

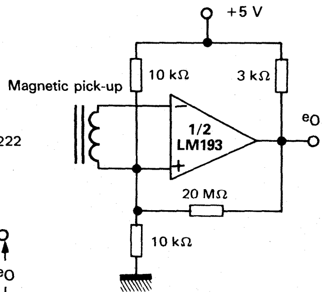


LOW FREQUENCY OP AMP

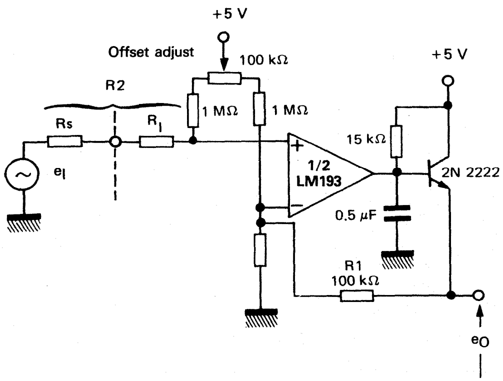
($V_O = 0$ V for $V_I = 0$ V)



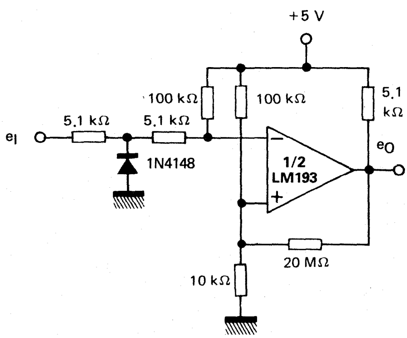
TRANSDUCER AMPLIFIER



LOW FREQUENCY OP AMP WITH OFFSET ADJUST

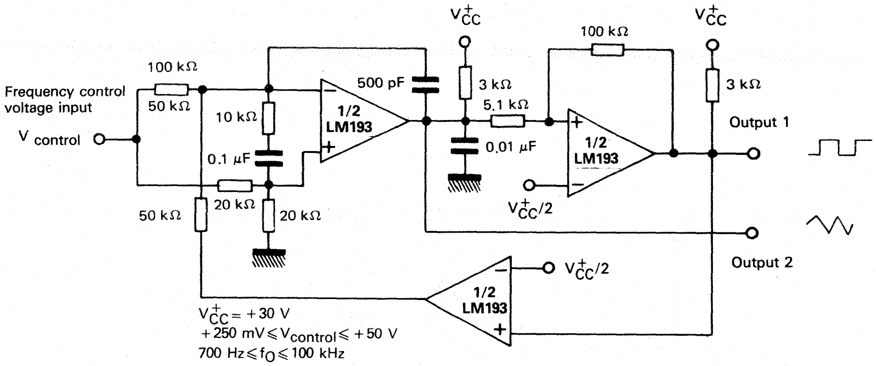


ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)

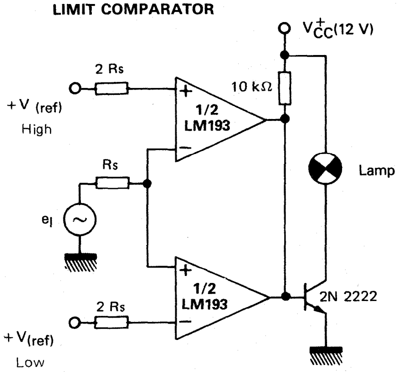


TYPICAL APPLICATIONS (continued)

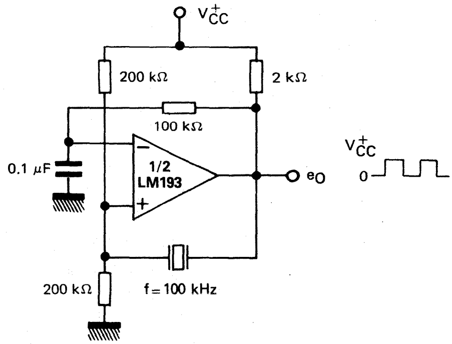
TWO DECADE HIGH FREQUENCY VCO



LIMIT COMPARATOR

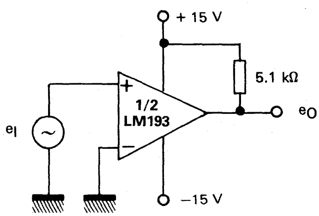


CRYSTAL CONTROLLED OSCILLATOR

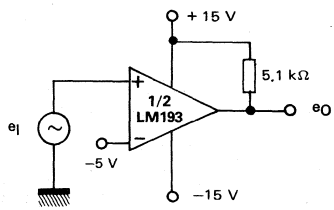


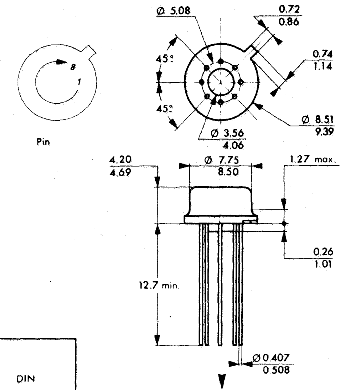
SPLIT-SUPPLY APPLICATIONS

ZERO CROSSING DETECTOR



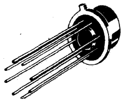
COMPARATOR WITH A NEGATIVE REFERENCE



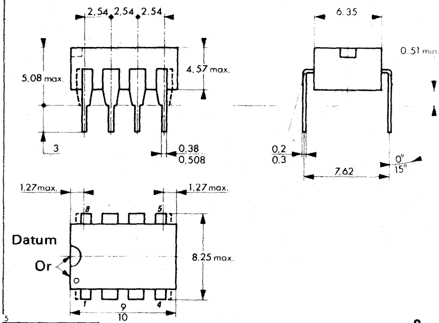


8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

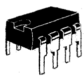


CB-11
H SUFFIX
METAL CAN

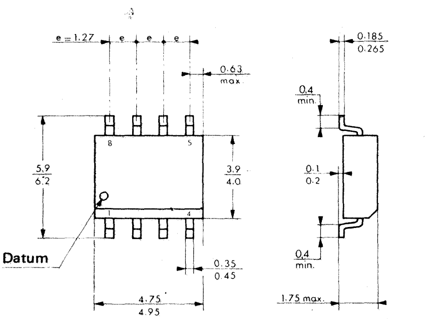


8 pins

DIN				
CEI	D.A.T.A.	JEDEC	F 116 SITELESC	CB-98 THOMSON SEMICONDUCTORS

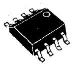


CB-98
DP SUFFIX
PLASTIC PACKAGE

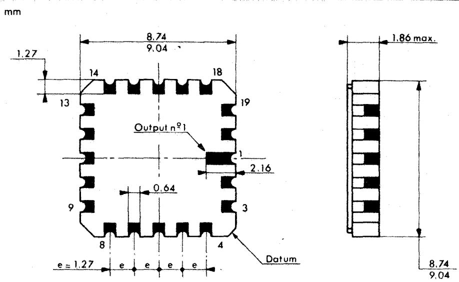


8 pins

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

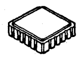


CB-342
FP SUFFIX
PLASTIC MICROPACKAGE



20 pins

DIN				
MS004 CB CEI	D.A.T.A.	TMS004 CB JEDEC	SITELESC	CB-705 THOMSON SEMICONDUCTORS



CB-705
GC SUFFIX
TRICECOP (LCC)

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

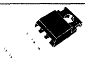
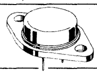
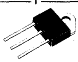
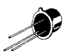
Voltage regulators

THREE-TERMINAL VOLTAGE REGULATORS

FIXED

Part number	Function		Page
LM109/LM209/LM309	Positive voltage regulator	1 A, 5 V	357
LM123/LM223/LM323	Positive voltage regulator	3 A, 5 V	375
UA78S00 Series	Positive voltage regulators	2 A	429
UA7800 Series	Positive voltage regulators	1 A	435 - 445
UA7900 Series	Negative voltage regulators	1 A	455 - 463

($T_{amb} = +25°C$)

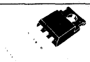
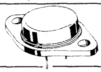
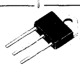
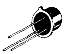
CHARACTERISTIC		SYMBOL	UNIT	LM109 LM209 LM309	LM123 LM223 LM323	UA78S00 series	UA7800 series	UA7900 series
Input voltage		$V_{I(max)}$	V	+35	+20	+35	+40	−35 to −40
Output voltage		$V_{O(typ)}$	V	+5	+5	+5, +9, +12, +15	+5, +6, +8, +12 +15, +18, +24	−5, −12, −15
Output current		$I_{O(max)}$	A	1.5	3	2	1.5	1.5
Line regulation		$K_{VI(typ)}$	%/V	0.1	0.1	0.1	0.1	0.1
Load regulation		$K_{VO(typ)}$	%/V	0.3	0.5	0.4	0.3	0.2
Long term stability		$K_{VH(max)}$	%/1000 h	0.4	0.7	0.4	0.4	0.4
PACKAGE			**SUFFIX**					
Plastic TO-220			SP			●	●	●
Steel can TO-3			K	●	●	●	●	●
Plastic TOP 3			SP3		●	●	●	●
Metal can TO-39			H	●				
Page				357	375	429	435 - 445	455 - 463

THREE-TERMINAL VOLTAGE REGULATORS

ADJUSTABLE

Part number	Function		Page
LM117/LM217/LM317	Positive voltage regulators	1 A	365
LM137/LM237/LM337	Negative voltage regulators	1 A	383
LM138/LM238/LM338	Positive regulator	5 A	393

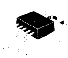
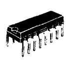
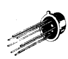
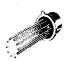
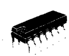
($T_{amb} = +25°C$)

CHARACTERISTIC		SYMBOL	UNIT	LM117/LM217/LM317	LM137/LM237/LM337	LM138/LM238/LM338
Input voltage		$V_{I(max)}$	V	40*	−40*	35*
Output voltage		$V_{O(typ)}$	V	1.2 to 37	−1.2 to −37	1.2 to 32
Output current		$I_{O(max)}$	A	1.5	−1.5	5
Line regulation		$K_{VI(typ)}$	%/V	0.01	0.01	0.02
Load regulation		$K_{VO(typ)}$	%/V	0.1	0.3	0.1
Long term stability		$K_{VH(max)}$	%/1000 h	1	1	1
PACKAGE			**SUFFIX**			
Plastic TO-220			SP	●	●	
Steel can TO-3			K	●	●	●
Plastic TOP 3			SP3	●	●	
Metal can TO-39			H	●	●	
Page				365	383	393

* $(V_I - V_O)$ max

MULTI TERMINAL VOLTAGE REGULATORS

Part number	Function		Page
L200	Adjustable voltage and current regulator, $I_O = 2$ A	Case CB-360, CB-367	341
LM105/205/305	Positive voltage regulator	Case TO-99	349
TEA5110	Dual voltage regulator (for microprocessor application), 5 V	Case CB-502	403
UA723,A	Precision voltage regulator	Case TO-100, TO-116, CB-511	421
TEA7028	Low dropout voltage regulator (for automotive application), 4.7 V ; $I_O = 0.2$ A	Case CB-360	409
TEA7034	Low dropout voltage regulator (for automotive application), 5 V ; $I_O = 0.5$ A	Case CB-360	415

CB-360	**CB-367**	**CB-502**	**CB-511**	**TO-99**	**TO-100**	**TO-116**	
							
PACKAGE							
Plastic SIL5	Plastic SIL5	Plastic DIL16	Plastic SO-14	Metal can	Metal can	Plastic DIL14	Cerdip DIL14
SUFFIX							
SP5-2	SP5-1	DP	FP	H	H	DP	DG

ADJUSTABLE VOLTAGE AND CURRENT REGULATOR

The L200 is silicon monolithic integrated circuit for voltage and current programmable regulation. Current limiting power limiting, thermal shutdown and input overvoltage protection (up to 60 V) make it virtually blowout proof. L200 can be used to replace fixed regulators where high precision output voltages are required.

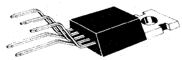
- Adjustable output current up to 2 A (guaranteed up to Tj = + 150°C)
- Adjustable output voltage down to 2.85 V
- Input overvoltage protection (up to 60 V, 10 ms)
- Short-circuit protection
- Output transistor safe area protection
- Thermal overload protection
- Low bias current on regulation terminal
- Low standby current drain

ADJUSTABLE VOLTAGE AND CURRENT REGULATOR

3

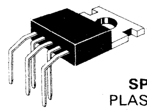
CASES

CB-360



SP5-2 SUFFIX
PLASTIC PACKAGE

CB-367

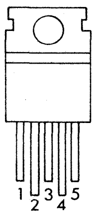


SP5-1 SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		SP5-1	SP5-2
L200	− 25°C to + 150°C	•	•
Example : L200SP5-1			

PIN ASSIGNMENT
(Front view)



1 - Input
2 - Current limit
3 - Ground
4 - Reference
5 - Output

Réf. 00150

MAXIMUM RATINGS

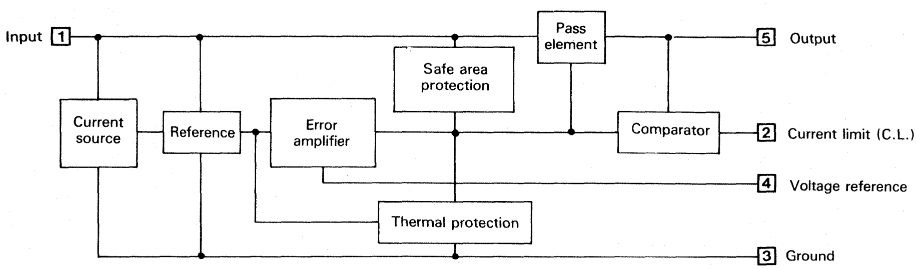
Rating	Symbol	Value	Unit
Input voltage	V_I	40	V
Maximum input voltage	$V_{I(max)}$*	60	V
Input-output voltage differential	$V_I - V_O$	32	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	mW
Operating ambient temperature range	T_{oper}	−25 to +150	°C
Storage temperature range	T_{stg}	−55 to +150	°C

* Max time = 10 ms

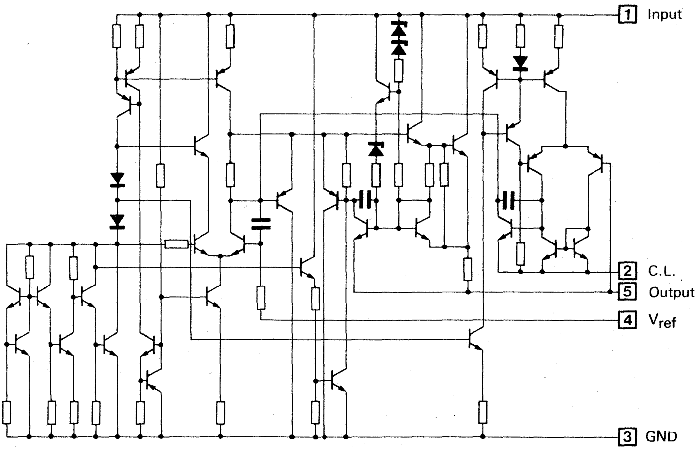
THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-ambient thermal resistance	$R_{th\ (j-a)}$	50	°C/W
Maximum junction-case thermal resistance	$R_{th\ (j-c)}$	3	°C/W

BLOCK DIAGRAM



SCHEMATIC DIAGRAM



CASE	Input	Current limit	GND	Reference	Output
CB-360 CB-367	1	2	3	4	5

ELECTRICAL CHARACTERISTICS

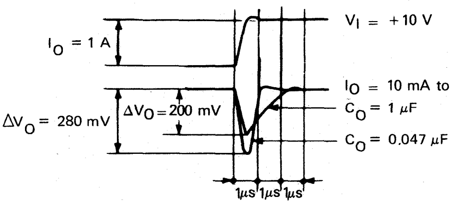
$T_{amb} = +25°C$ (Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage range ($I_O = 10$ mA)	V_O	2.85	–	36	V
Line regulation ($V_O = 5$ V, $V_I = +8$ to $+18$ V, $I_O = 500$ mA)	K_{VI}	48	60	–	dB
Voltage load regulation - (Note 1) $\Delta I_O = 2$ A $\Delta I_O = 1.5$ A	K_{VO}	 – –	 0.15 0.1	 1 0.9	%
Quiescent drain current ($V_I = +20$ V) Pin 3	I_{IB}	–	4.2	9.2	mA
Output noise voltage ($V_O = V_{ref}$, $I_O = 10$ mA, BW = 1 MHz)	V_{NO}	–	80	–	μV_{rms}
Reference voltage ($V_I = +20$ V, $I_O = 10$ mA)	V_{ref}	2.64	2.77	2.86	V
Average temperature coefficient of reference voltage ($V_I = +20$ V, $I_O = 10$ mA) $T_j = -25°C$ to $+125°C$ $T_j = +125°C$ to $+150°C$	αV_{ref}	 – –	 −0.25 −1.5	 – –	mV/°C
Supply voltage rejection ratio ($V_O = +5$ V, $I_O = 500$ mA, $\Delta V_I = 10$ Vpp, f = 100 Hz) - Note 2	SVR	 48	 60	 –	dB
Output impedance ($V_I = +10$ V, $V_O = V_{ref}$, $I_O = 0.5$ A, f = 100 Hz)	Z_O	–	1.5×10^{-3}	–	Ω
Dropout voltage between pins 1 and 5 ($I_O = 1.5$ A, $\frac{\Delta V_O}{V_O} \leq 2\%$)	$V_{(1)} - V_{(5)}$	–	2	2.5	V
Bias current at pin 4 ($T_j = +25°C$)	$I_{(4)}$	–	3	10	μA
Average temperature coefficient	$\frac{\Delta I_4}{\Delta T . I_4}$	–	−0.5	–	%/°C
Current limit sense voltage between pins 5 and 2 ($V_I = +10$ V, $V_O = V_{ref}$)	V_{sense}	0.38	0.45	0.52	V
Average temperature coefficient of V_{SC}	αV_{SC}	–	0.03	–	%/°C
Current load regulation ($V_I = +10$ V, $\Delta V_O = 3$ V) $I_O = +0.5$ A $I_O = +1$ A $I_O = +1.5$ A	$\frac{\Delta I_O}{I_O}$	 – – –	 1.4 1 0.9	 – – –	%
Short-circuit current ($V_I - V_O = +14$ V, pins 2 and 5 short-circuited)	I_{SC}	–	2.5	3.6	A

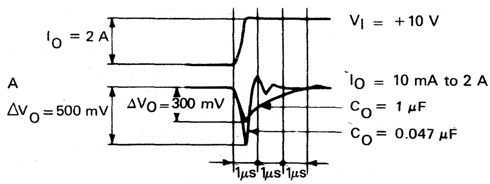
Note 1 : A load step of 2 A can be applied provided that input-output differential voltage is lower than 20 V (See curves of safe operating area protection).

Note 2 : The same performances can be maintained at higher output levels if a bypassing capacitor is provided between pins 2 and 4.

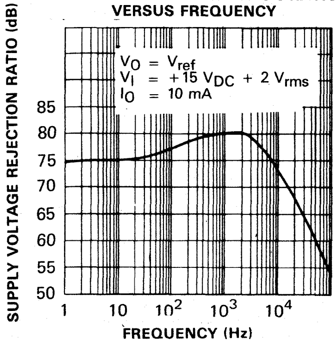
LOAD TRANSIENT RESPONSE



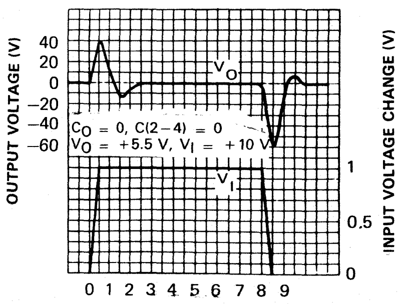
LOAD TRANSIENT RESPONSE



SUPPLY VOLTAGE REJECTION RATIO VERSUS FREQUENCY

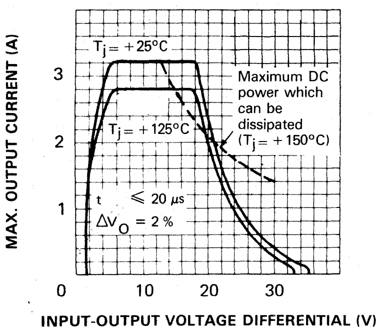


VOLTAGE TRANSIENT RESPONSE

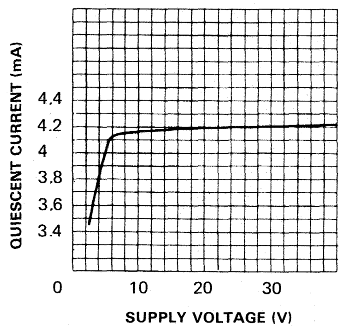


TYPICAL PERFORMANCE CHARACTERISTICS

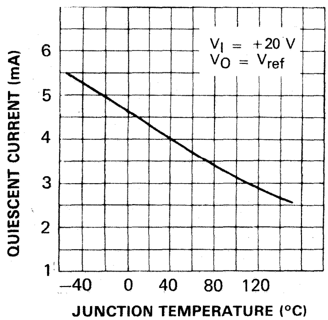
SAFE OPERATING AREA PROTECTION



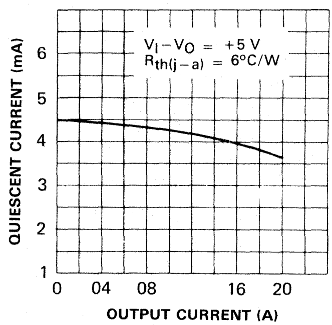
QUIESCENT CURRENT VERSUS SUPPLY VOLTAGE



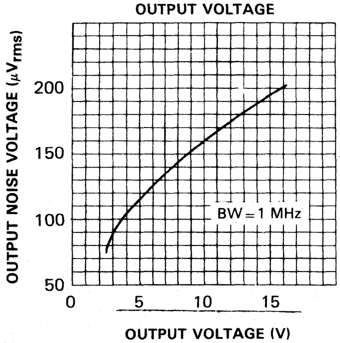
QUIESCENT CURRENT VERSUS JUNCTION TEMPERATURE



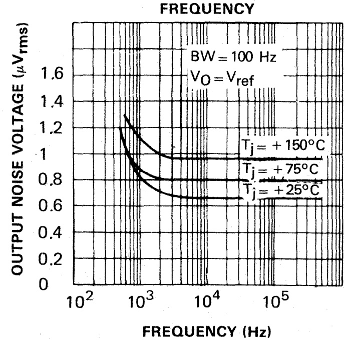
QUIESCENT CURRENT VERSUS OUTPUT CURRENT



OUTPUT NOISE VOLTAGE VERSUS OUTPUT VOLTAGE



OUTPUT NOISE VOLTAGE VERSUS FREQUENCY



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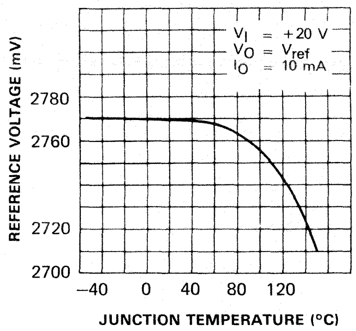
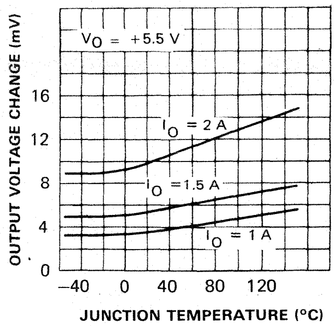
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

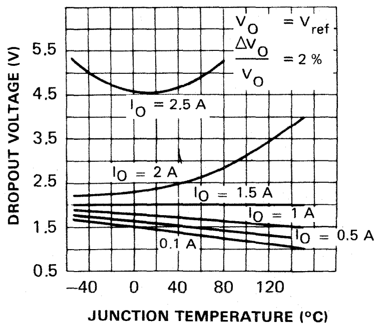
REFERENCE VOLTAGE VERSUS JUNCTION TEMPERATURE



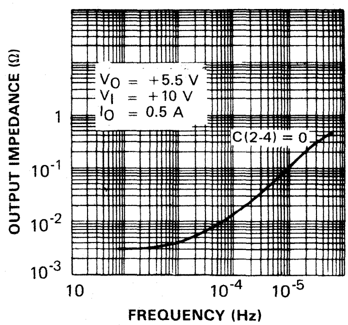
VOLTAGE LOAD REGULATION



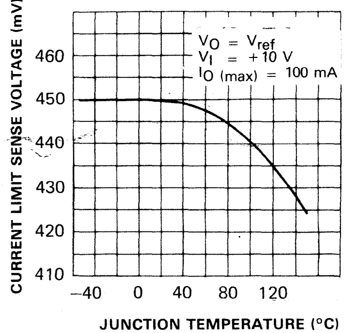
DROP-OUT VOLTAGE VERSUS JUNCTION TEMPERATURE



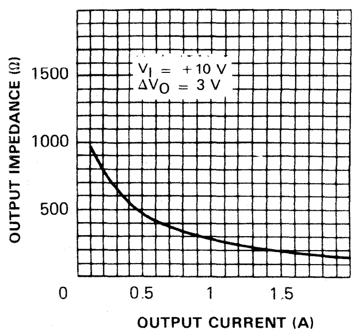
OUTPUT IMPEDANCE VERSUS FREQUENCY



CURRENT LIMIT VOLTAGE SENSING VERSUS JUNCTION TEMPERATURE

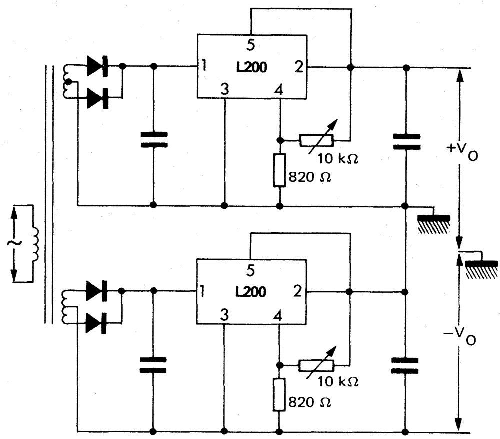


OUTPUT IMPEDANCE VERSUS OUTPUT CURRENT

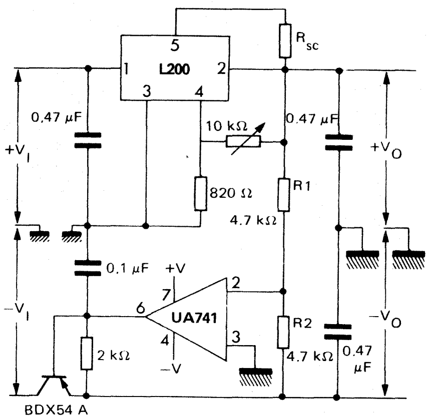


TYPICAL APPLICATIONS

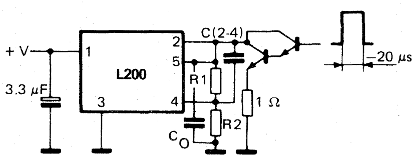
POSITIVE AND NEGATIVE REGULATOR



TRACKING VOLTAGE REGULATOR

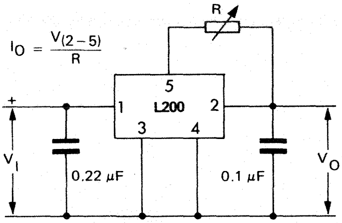


TEST CIRCUIT FOR PULSE MEASUREMENTS

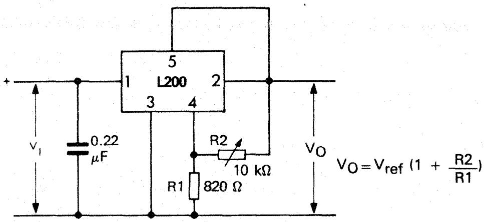


TYPICAL APPLICATIONS (continued)

PROGRAMMABLE CURRENT REGULATOR

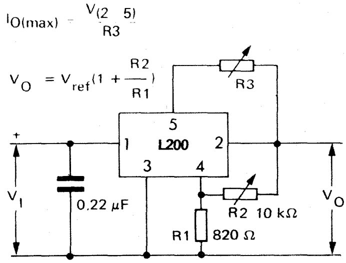


PROGRAMMABLE VOLTAGE REGULATOR

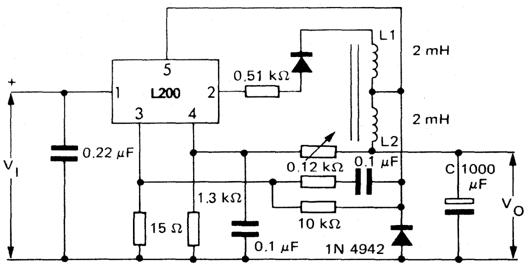


3

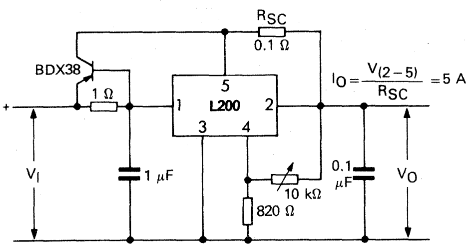
PROGRAMMABLE VOLTAGE REGULATOR WITH CURRENT LIMITING



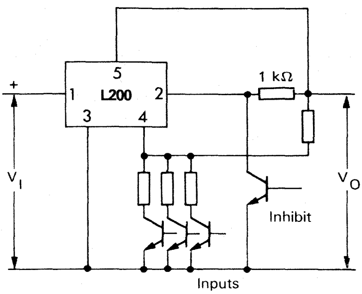
SWITCHING REGULATOR

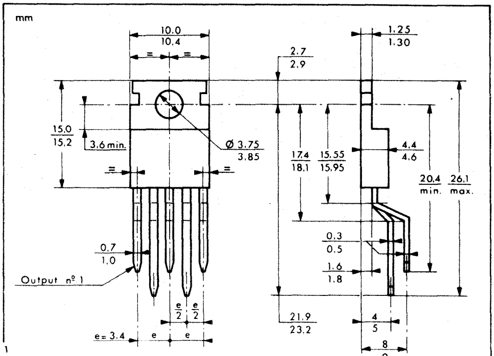


HIGH CURRENT VOLTAGE REGULATOR WITH SHORT CIRCUIT PROTECTION



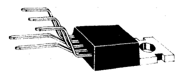
DIGITALLY SELECTED REGULATOR WITH INHIBIT



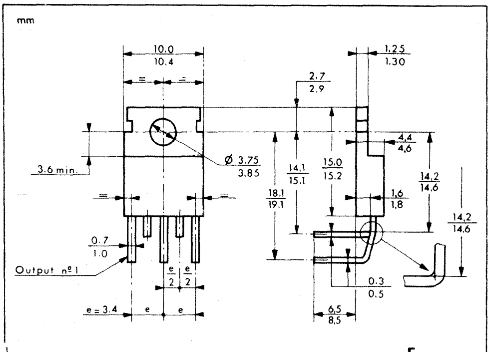


DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-360 THOMSON SEMICONDUCTORS

CB-360

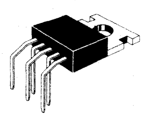


SP5-2 SUFFIX
PLASTIC PACKAGE



DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-367 THOMSON SEMICONDUCTORS

CB-367



SP5-1 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM105
LM205
LM305

ADJUSTABLE POSITIVE VOLTAGE REGULATORS

The LM105/LM205/LM305 are positive voltage regulators designed for a wide range of applications from digital power supplies to precision regulators for analog circuitry.

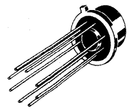
Important characteristics of these circuits are :
- Output voltage adjustable from 4.5 V to 40 V
- Output current in excess of 10 A possible by adding external transistors.
- Load regulation better than 0.1%, full load with current limiting.
- DC line regulation guaranteed at 0.03%/V
- Ripple rejection of 0.01%/V

Additional features are : fast response to both load and line transients, freedom from oscillation with varying resistive or reactive loads and the ability to start reliably on any load within rating.

ADJUSTABLE POSITIVE VOLTAGE REGULATORS

3

CASE CB-11
(TO-99)



H SUFFIX
METAL CAN

ORDERING INFORMATION

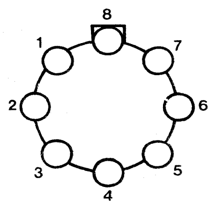
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE H
LM105	−55°C to +125°C	•
LM205	−25°C to + 85°C	•
LM305	0°C to + 70°C	•

Examples : LM105H, LM205H

PIN ASSIGNMENT

(Top view)



1 - Current limit
2 - Booster output
3 - Unregulated input
4 - Ground
5 - Reference bypass
6 - Feedback
7 - Compensation
8 - Regulated output

Réf. 00105

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

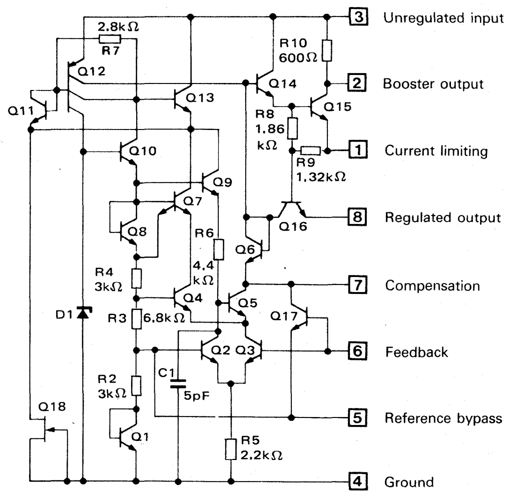
MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Input voltage	LM105, LM205 LM305	V_I	50 40	V
Input-output voltage differential		$V_I - V_O$	40	V
Internal power dissipation		P_{tot}	500	mW
Short-circuit output current		I_{OS}	25	mA
Operating free-air temperature range	LM105 LM205 LM305	T_{oper}	−55 to +125 −25 to + 85 0 to + 70	°C
Storage temperature range		T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	45	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	150	°C/W

SCHEMATIC DIAGRAM



ELECTRICAL CHARACTERISTICS
LM105 : $-55°C \leq T_j \leq +125°C$
LM205 : $-25°C \leq T_j \leq +85°C$
LM305 : $0°C \leq T_j \leq +70°C$
(Unless otherwise specified)

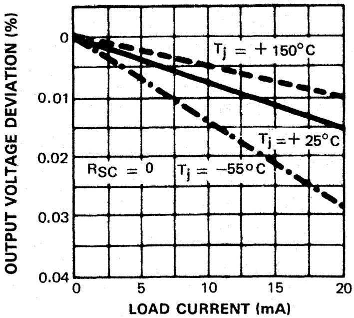
Characteristic	Symbol	LM105 - LM205			LM305			Unit
		Min	Typ	Max	Min	Typ	Max	
Input voltage range	V_I	8.5	–	50	8.5	–	40	V
Output voltage range	V_O	4.5	–	40	4.5	–	30	V
Input-output voltage differential	$V_I - V_O$	3	–	30	3	–	30	V
Line regulation	K_V							%/V
$V_I - V_O \leq 5$ V		–	0.025	0.06	–	0.025	0.06	
$V_I - V_O \geq$		–	0.015	0.03	–	0.015	0.03	
Load regulation ($0 \leq I_O \leq 12$ mA, $R_{sc} = 10\ \Omega$) - Note 2	K_{VO}							%
$T_j = +25°C$		–	0.02	0.05	–	0.02	0.05	
$T_j = T_{j(min)}$		–	0.03	0.1	–	0.03	0.1	
$T_j = T_{j(max)}$		–	0.03	0.1	–	0.03	0.1	
Ripple rejection ($C_{ref} = 10\ \mu F$, $f = 100$ Hz)	R_{vf}	–	0.003	0.01	–	0.03	0.01	%/V
Standby current drain	I_{IB}							mA
$V_I = 50$ V LM105, LM205		–	0.8	2	–	–	–	
$V_I = 40$ V LM305		–	–	–	–	0.8	2	
Reference voltage	V_{ref}	1.63	1.7	1.81	1.63	1.7	1.81	V
Output noise voltage ($10\ Hz \leq f \leq 10$ kHz)	V_{NO}							%
$C_{ref} = 0$		–	0.005	–	–	0.005	–	
$C_{ref} > 0.1\ \mu F$		–	0.002	–	–	0.002	–	
Average temperature coefficient of output voltage	αV_O	–	0.3	1	–	0.3	1	%
Long term stability	K_{VH}	–	0.1	1	–	0.1	1	%
Current limit sense voltage ($T_j = +25°C$, $R_{sc} = 10\ \Omega$, $V_O = 0$)	V_{sense}	225	300	375	225	300	375	mV

Note 1 : These specifications apply for a junction temperature between $T_{j(min)}$ and $T_{j(max)}$, for input and output voltages within the ranges given, and for a divider impedance seen by the feeback terminal of 2 kΩ, unless otherwise specified. The load and line regulation specifications are for constant junction temperature. Temperature drift effects must be taken into account separately when the unit is operating under conditions of high dissipation.

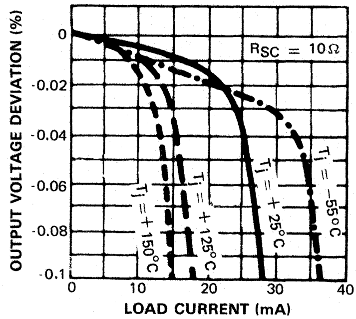
Note 2 : The output current given, as well as the load regulation, can be increased by the addition of external transistors. The improvement factor will be roughly equal to the composite current gain of the added transistors.

3

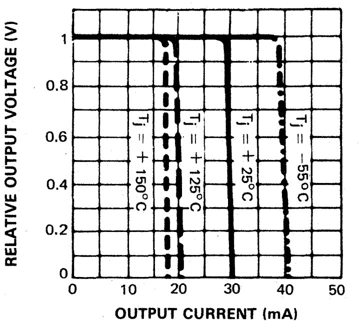
LOAD REGULATION WITHOUT CURRENT LIMITING



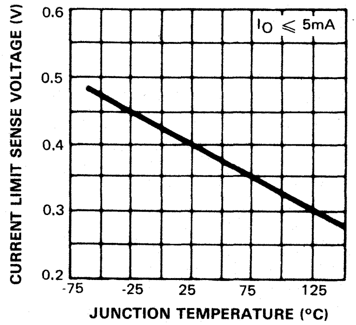
LOAD REGULATION WITH CURRENT LIMITING



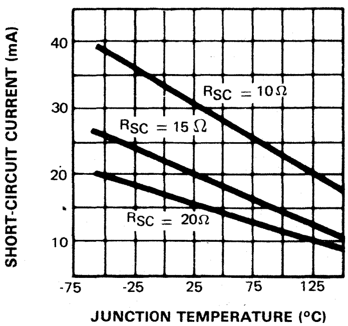
CURRENT LIMITING CHARACTERISTICS



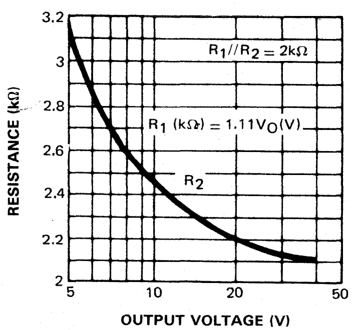
CURRENT LIMITING SENSE VOLTAGE



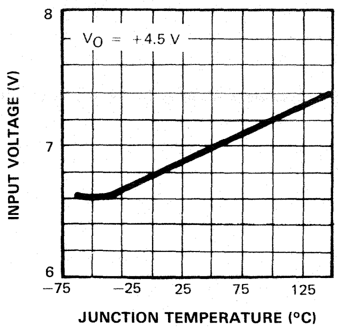
SHORT-CIRCUIT CURRENT



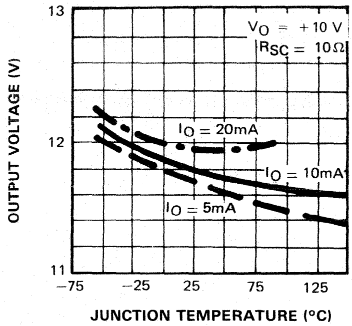
OPTIMUM DIVIDER RESISTANCE VALUE



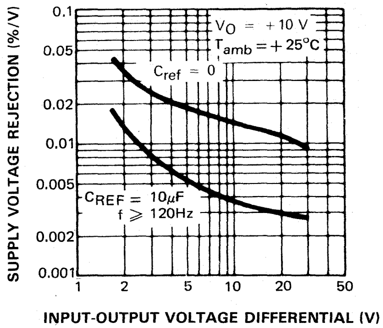
MINIMUM INPUT VOLTAGE



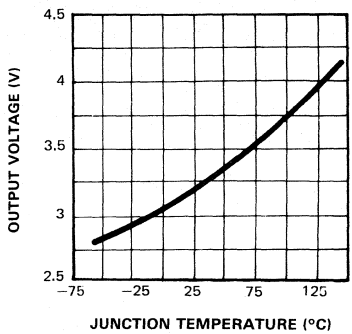
DROPOUT VOLTAGE



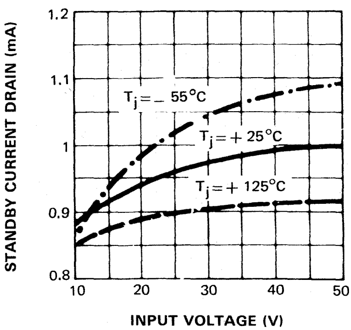
SUPPLY VOLTAGE REJECTION



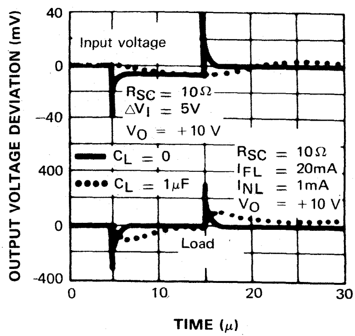
MINIMUM OUTPUT VOLTAGE



STANDBY CURRENT DRAIN

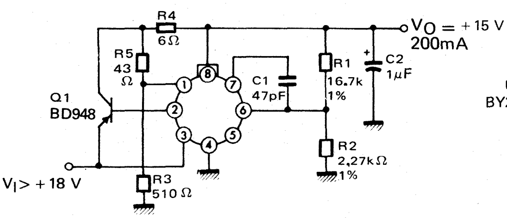


TRANSIENT RESPONSE

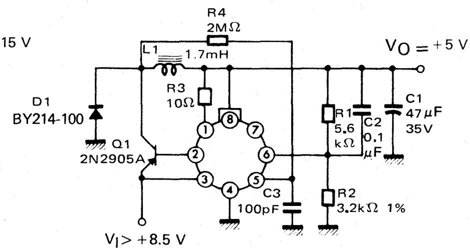


TYPICAL APPLICATIONS

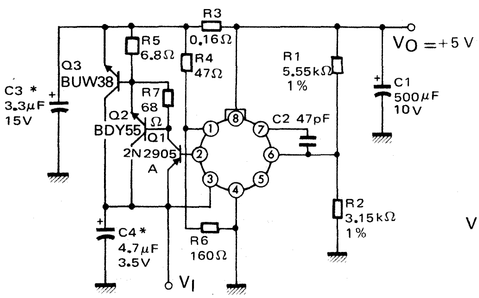
LINEAR REGULATOR WITH FOLDBACK CURRENT LIMITING



SWITCHING REGULATOR

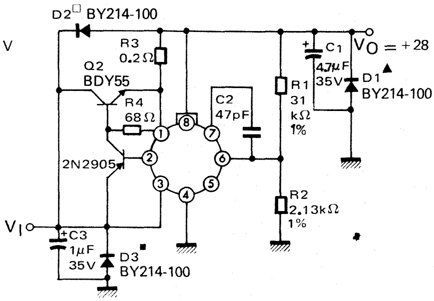


10 A REGULATOR WITH FOLDBACK CURRENT LIMITING



* Solid tantalum

1 A REGULATOR WITH PROTECTIVE DIODES

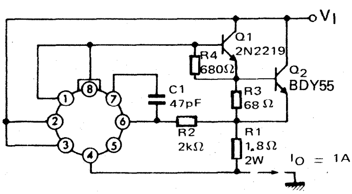


□ Protects against shorted input or inductive loads on unregulated supply.

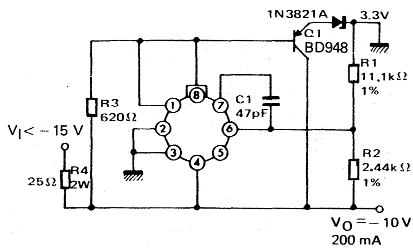
■ Protects against input voltage reversal.

▲ Protects against output voltage reversal.

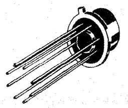
CURRENT REGULATOR



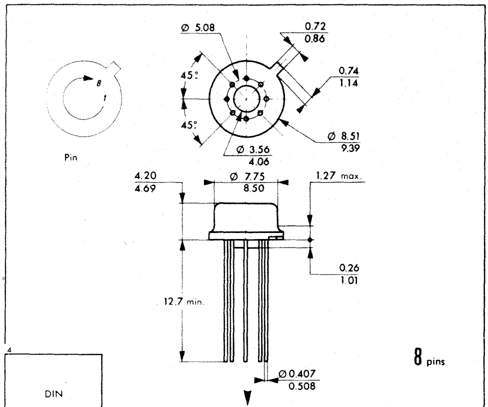
SHUNT REGULATOR ($V_O < 0$)



CB-11
(TO-99)



H SUFFIX
METAL CAN



Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

LM109
LM209
LM309

3

THREE-TERMINAL 5-VOLT REGULATORS

The LM 109, LM 209 and LM 309 are 5 V regulators. They are designed for local regulation on digital logic cards.

In CB-7 package, they can deliver output current in excess of 200 mA if adequate heatsink is provided. With CB-19 power package, the available output current is greater than 1 A.

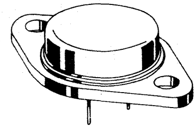
These regulators are essentially blow-out proof. Current limiting is included and thermal shut down is provided to keep the ICs from overheating. If internal dissipation becomes too great, the regulator will shut down to prevent excessive heating.

- Fixed voltage regulator requires no external component for adjusting
- Can provide other values of regulated voltages above 5 V using separate, bias resistors.
- Specified to be compatible, worst case, with TTL and DTL.

THREE-TERMINAL 5-VOLT REGULATORS

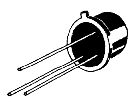
CASES

CB-19 (TO-3)



K SUFFIX
STEEL CAN

CB-7 (TO-39)



H SUFFIX
METAL CAN

ORDERING INFORMATION

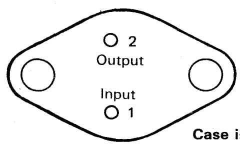
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		H	K
LM109	−55°C to +150°C	•	•
LM209	−25°C to +150°C	•	•
LM309	0°C to +125°C	•	•
Examples : LM109H, LM109K			

PIN ASSIGNMENTS

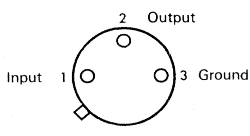
(Bottom views)

CB-19



Case is ground

CB-7



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THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
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THOMSON COMPONENTS

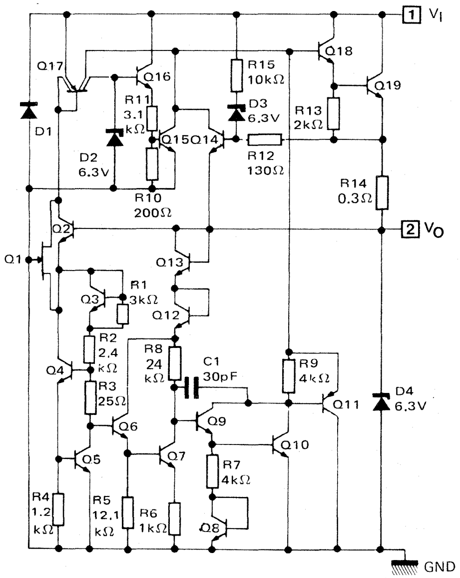
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage	V_I	35	V
Internal power dissipation	P_D	Internally limited	W
Short-circuit output current	I_{OS}	Internally limited	A
Operating free-air temperature range LM109 LM209 LM309	T_{oper}	 – 55 to + 150 – 25 to + 150 0 to + 125	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Min	Typ	Max	Unit
Junction-case thermal resistance CB-7 CB-19	$R_{th(j-c)}$	 – –	 – –	 15 4	°C/W
Junction-ambient thermal resistance CB-7 CB-19	$R_{th(j-a)}$	 – –	 – 35	 185 –	°C/W

SCHEMATIC DIAGRAM

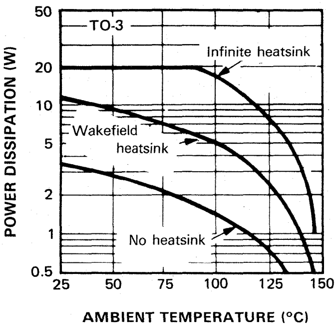


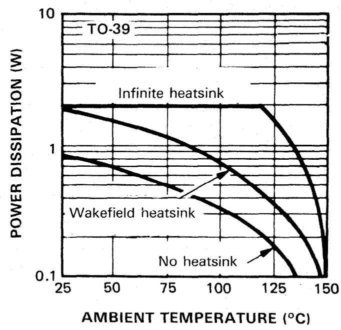
CASE	V_I	V_O	GND
CB-19	1	2	Case
CB-7	1	2	3

ELECTRICAL CHARACTERISTICS
LM109 : $-55°C \leq T_j \leq +150°C$
LM209 : $-25°C \leq T_j \leq +150°C$
LM309 : $0°C \leq T_j \leq +150°C$
$V_I = +10$ V, $I_O = 0.1$ A (CB-7) or 0.5 A (CB-19)
(Unless otherwise specified)

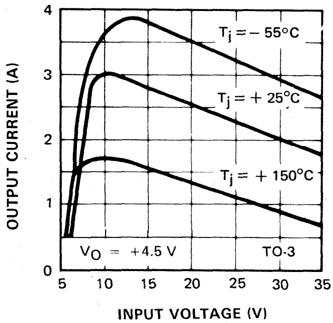
Characteristic		Symbol	LM109 - LM209			LM309			Unit
			Min	Typ	Max	Min	Typ	Max	
Output voltage range		V_O							V
$T_j = +25°C$			4.7	5.05	5.3	4.8	5.05	5.2	
$T_{min} \leq T_{amb} \leq T_{max}$									
$+7\ V \leq V_I \leq +25\ V$, $5\ mA \leq I_O \leq 200\ mA$, $P < 2\ W$	CB-7		4.6	–	5.4	4.75	–	5.25	
$5\ mA \leq I_O \leq 1\ A$, $P < 20\ W$	CB-19		4.6	–	5.4	4.75	–	5.25	
Line regulation ($+7\ V \leq V_I \leq +25\ V$, $T_j = +25°C$)		K_{VI}	–	4	50	–	4	50	mV
Load regulation ($T_j = +25°C$)		K_{VO}							mV
$5\ mA \leq I_O \leq 0.5\ A$	CB-7		–	20	50	–	20	50	
$5\ mA \leq I_O \leq 1.5\ A$	CB-19		–	50	100	–	50	100	
Quiescent current ($+7\ V \leq V_I \leq +25\ V$)		I_{IB}	–	5.2	10	–	5.2	10	mA
Quiescent current deviation		ΔI_{IB}							mA
$+7\ V \leq V_I \leq +25\ V$			–	–	0.5	–	–	0.5	
$5\ mA \leq I_O \leq 200\ mA$	CB-7		–	–	0.8	–	–	0.8	
$5\ mA \leq I_O \leq 1\ A$	CB-19		–	–	0.8	–	–	0.8	
Output noise voltage ($T_{amb} = +25°C$, $10\ Hz \leq f \leq 100\ kHz$)		V_{NO}	–	–	40	–	–	40	µV
Long term stability		K_{VH}	–	–	10	–	–	20	mV

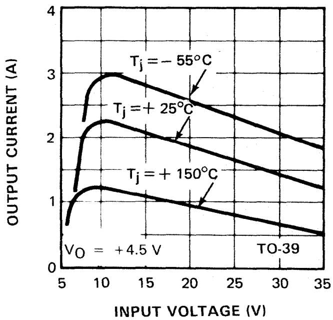
MAXIMUM AVERAGE POWER DISSIPATION



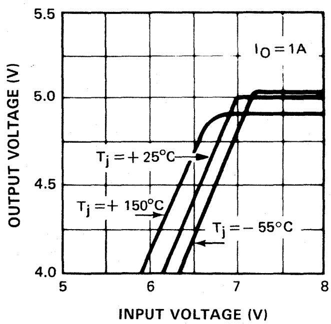


PEAK OUTPUT CURRENT

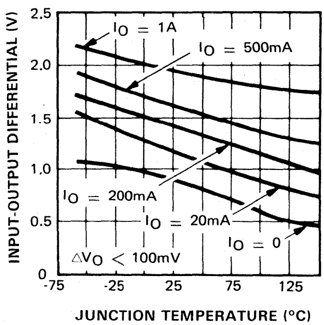




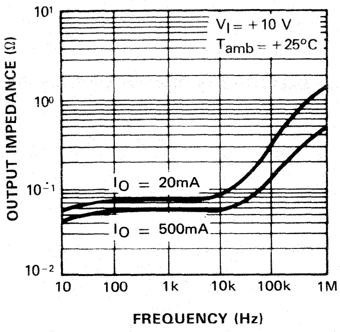
DROPOUT CHARACTERISTICS



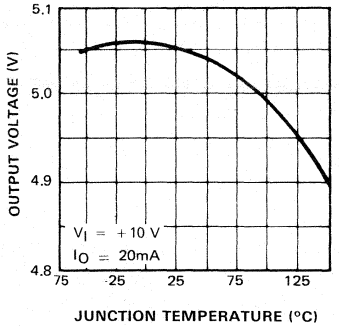
DROPOUT VOLTAGE



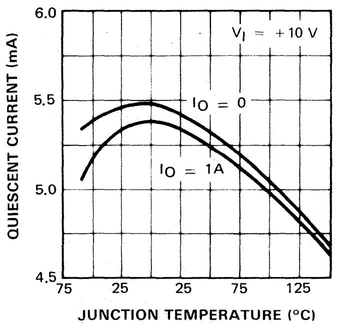
OUTPUT IMPEDANCE



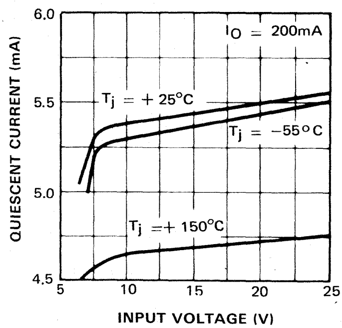
OUTPUT VOLTAGE



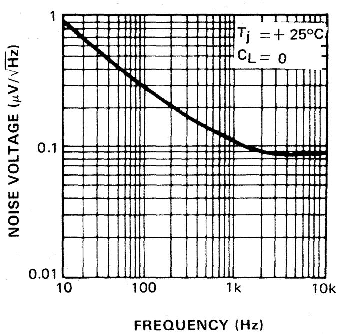
QUIESCENT CURRENT



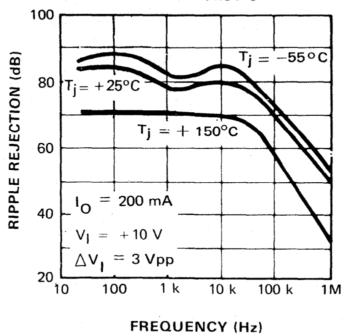
QUIESCENT CURRENT



OUTPUT NOISE VOLTAGE

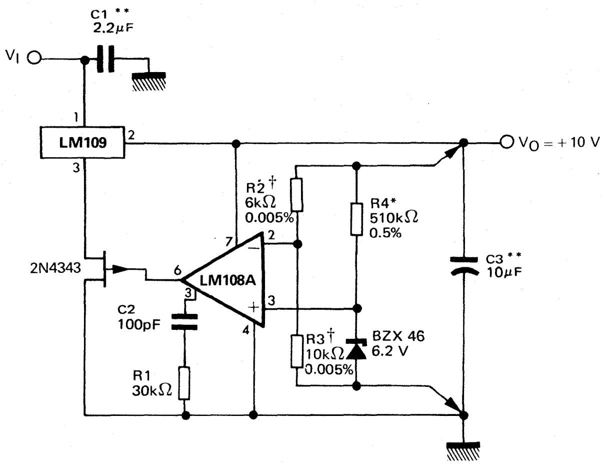


RIPPLE REJECTION



TYPICAL APPLICATIONS

☆ HIGH STABILITY REGULATOR



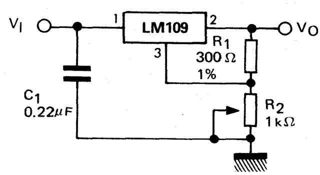
☆ Regulation better than 0.01% load, line and temperature can be obtained

* Determines zener current. May be adjusted to minimize thermal drift

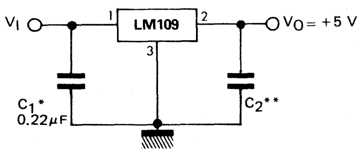
** Solid tantalum

† High stability resistors

ADJUSTABLE OUTPUT REGULATOR



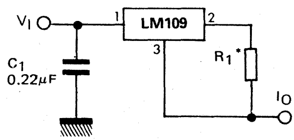
FIXED 5 V REGULATOR



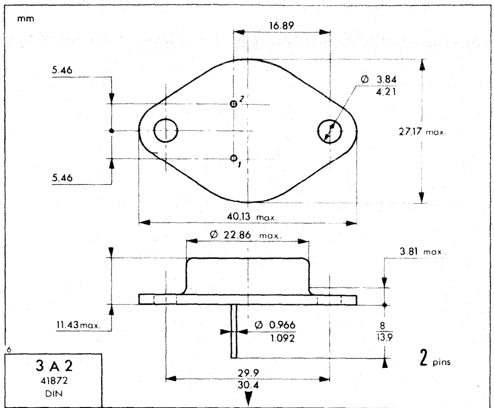
* Required if regulator is located an appreciable distance from power supply filter capacitor.

** Although no output capacitor is needed for stability, it does improve transient response.

CURRENT REGULATOR

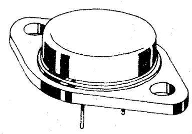


* Determines output current

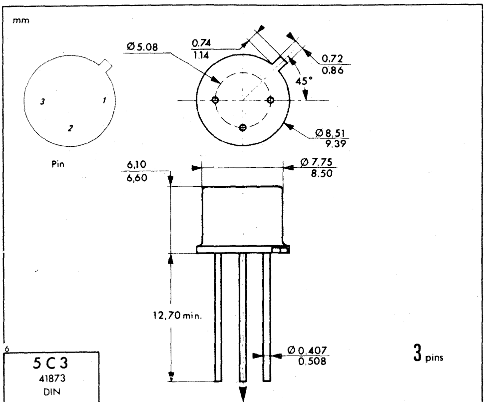


Case [C-14A] Base B-18 CEI	TO-3 D.A.T.A.	TO-3 JEDEC	F 24 A SITELESC	CB-19 THOMSON SEMICONDUCTORS

CB-19
(TO-3)

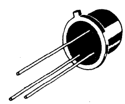


K SUFFIX
STEEL CAN



Case : C-4 Base : B-4C CEI	TO-39 D.A.T.A.	TO-39 JEDEC	F 59 SITELESC	CB-7 THOMSON SEMICONDUCTORS

CB-7
(TO-39)



H SUFFIX
METAL CAN

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

LM117
LM217
LM317

THREE-TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATORS

The LM 117 series are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 1.5 A over a 1.2 to 37 V output voltage range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. Also, LM 117 regulators are supplied in standard transistor packages which are easily mounted and handled. In addition to higher performance than fixed regulators, the LM 117 series offer full overload protection available only in integrated circuits. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

- Output voltage adjustable down to V_{ref}.
- 1.5 A guaranteed output current for TO-220, TO-3 and TOP 3 packages.
- 0.01%/V typical line regulation.
- Current limit constant with temperature.
- Ripple rejection : 80 dB.
- Standard 3-lead transistor packages.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

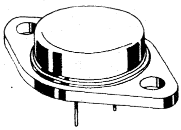
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		K	H	SP3	SP
LM117	−55°C to +150°C	•	•		
LM217	−25°C to +150°C	•	•		
LM317I	−40°C to +150°C			•	
LM317	0°C to +125°C	•	•	•	•
Examples : LM117K, LM117H, LM317ISP3					

THREE-TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATORS

3

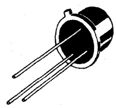
CASES

CB-19
(TO-3)



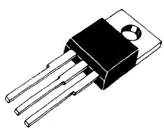
K SUFFIX
STEEL CAN

CB-7
(TO-39)



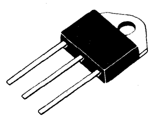
H SUFFIX
METAL CAN

CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE

CB-244
(TOP-3)

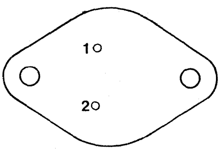


SP3 SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENTS

(Bottom views)

CB-19



1 - Input
2 - Adj.

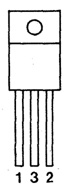
CB-7

1 - Input
2 - Adj.
3 - Output

Case is output

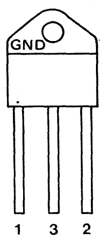
(Front views)

CB-117



1 - Adj.
2 - Input
3 - Output

CB-244



Heatsink surface connected to output

Réf. 00125

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

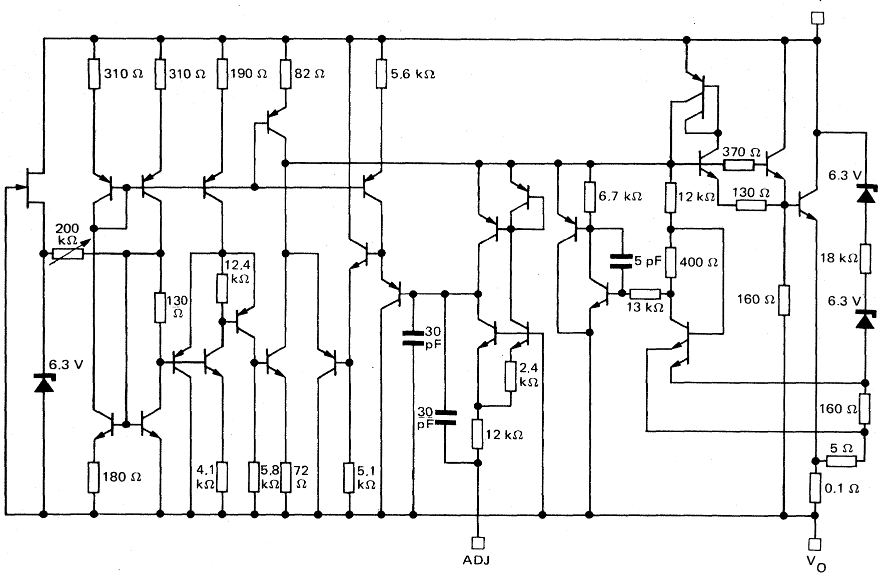
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input - Output voltage differential	$V_I - V_O$	40	V
Output current	I_O		A
CB-19, CB-117, CB-244		1.5	
CB-7		0.5	
Power dissipation	P_{tot}	Internally limited	W
Operating junction temperature range	T_{oper}		°C
LM117		− 55 to + 150	
LM217		− 25 to + 150	
LM317I		− 40 to + 150	
LM317		0 to + 125	
Storage temperature range	T_{stg}	− 65 to + 150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Typ	Max	Unit
Junction-case thermal resistance	$R_{th(j-c)}$			°C/W
CB-19		–	4	
CB-7		–	15	
CB-244		–	2.5	
CB-117		–	3	
Junction-ambient thermal resistance	$R_{th(j-a)}$			°C/W
CB-19		35	–	
CB-7		–	160	
CB-244		–	55	
CB-117		–	70	

SCHEMATIC DIAGRAM



CASE	V_I	V_O	ADJ
CB-19	1	CASE	2
CB-7	1	3	2
CB-117	2	3	1
CB-244	2	3	1

3

ELECTRICAL CHARACTERISTICS

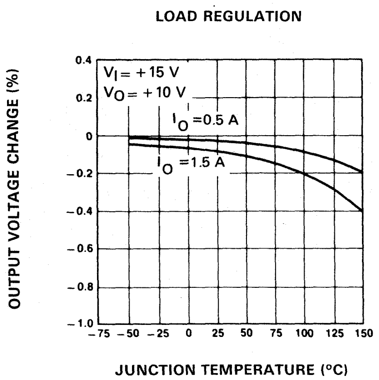
LM117 : $-55°C < T_j < +150°C$, **LM317I** : $-40°C < T_j < +150°C$
LM217 : $-25°C < T_j < +150°C$ **LM317** : $0°C < T_j < +125°C$
$V_I - V_O = 5$, $I_O = 0.1$ A (CB-7), $I_O = 0.5$ A (CB-19, CB-117, CB-244)
(Unless otherwise specified)

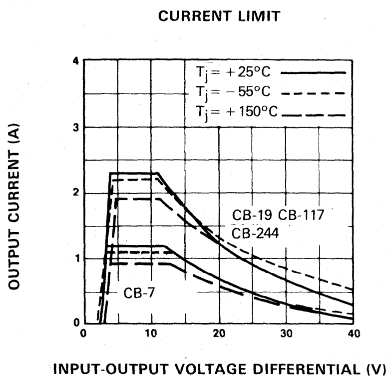
Characteristic	Symbol	LM117/LM217			LM317I/LM317			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference voltage (10 mA $\leq I_O \leq I_{O(max)}$, 3 V $\leq V_I - V_O \leq$ 40 V, $P \leq P$ max) - Note 1	$V_{(ref)}$	1.20	1.25	1.30	1.20	1.25	1.30	V
Line regulation (T_{amb} = +25°C, 3 V $\leq V_I - V_O \leq$ 40 V) - Note 2 I_O = 0.1 A CB-19, CB-117, CB-244 I_O = 20 mA CB-7	K_{VI}	 – –	 0.01 0.01	 0.02 0.02	 – –	 0.01 0.01	 0.04 0.04	%/V
Load regulation - Note 1, Note 2 T_{amb} = +25°C, 10 mA $\leq I_O \leq I_{O(max)}$ $V_O \leq$ +5 V $V_O \geq$ +5 V	K_{VO}	 – –	 5 0.1	 15 0.3	 – –	 5 0.1	 25 0.5	 mV %
Thermal regulation (T_{amb} = +25°C, pulse 20 ms)	–	–	0.03	0.07	–	0.04	0.07	%/W
Adjustment pin current	I_{adj}	–	50	100	–	50	100	µA
Adjustment pin current change - Note 1 (T_{amb} = +25°C, 10 mA $\leq I_O \leq I_{O(max)}$, 3 V $\leq V_I - V_O \leq$ 40 V)	ΔI_{adj}	–	0.2	5	–	0.2	5	µA
Line regulation (3 V $\leq V_I - V_O \leq$ 40 V) - Note 2	K_{VI}	–	0.02	0.05	–	0.02	0.07	%/V
Load regulation (10 mA $\leq I_O \leq I_{O(max)}$) - Note 1, Note 2 $V_O \leq$ +5 V $V_O \geq$ +5 V	K_{VO}	 – –	 20 0.3	 50 1	 – –	 20 0.3	 70 1.5	 mV %
Minimum load current ($V_I - V_O$ = 40 V)	$I_{O(min)}$	–	3.5	5	–	3.5	10	mA
Current limit $V_I - V_O \leq$ 15 V CB-19, CB-117, CB-244 CB-7 $V_I - V_O$ = 40 V, T_j = +25°C CB-19, CB-117, CB-244 CB-7	I_{OS}	 1.5 0.5 0.30 0.15	 2.2 – 0.40 0.20	 – – – –	 1.5 0.5 0.15 0.075	 2.2 – 0.4 0.2	 – – – –	A
RMS output noise (% of V_O) (T_{amb} = +25°C, 10 Hz $\leq f \leq$ 10 kHz)	V_{NO}	–	0.003	–	–	0.003	–	%
Ripple rejection ratio V_O = +10 V, f = 120 Hz C_{adj} = 10 µF	R_{vf}	 – 66	 65 80	 – –	 – 66	 65 80	 – –	dB
Temperature stability ($T_{min} \leq T_j \leq T_{max}$)	K_{VT}	–	1	–	–	1	–	%
Long term stability (T_{amb} = +125°C)	K_{VH}	–	0.3	1	–	0.3	1	%

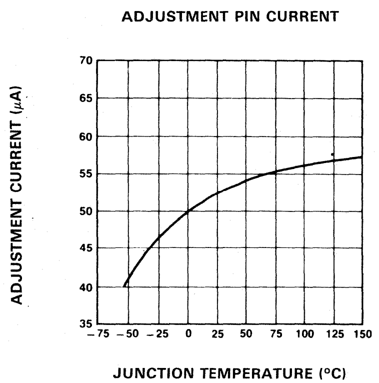
Note 1 : Although power dissipation is internally limited, these specifications are given for a power dissipation of :
- 2 W for CB-7,
- 15 W for CB-117,
- 20 W for CB-19 and CB-244.

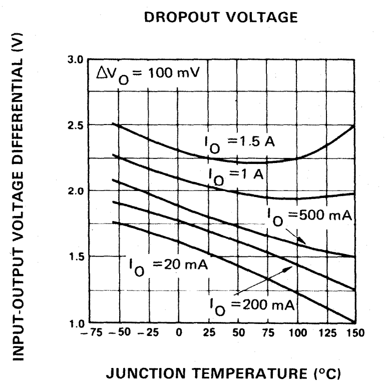
$I_{O(max)}$ is :
- 1.5 A for CB-19, CB-244 and CB-117,
- 0.5 A for CB-7.

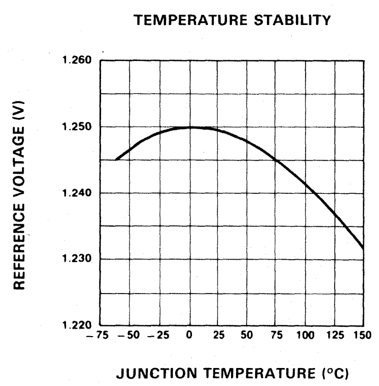
Note 2 : Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

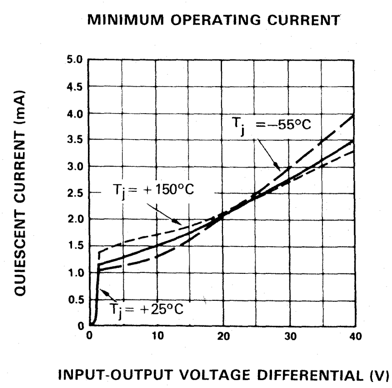

LOAD REGULATION
OUTPUT VOLTAGE CHANGE (%)
VI = +15 V
VO = +10 V
IO =0.5 A
IO =1.5 A
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1.0
-75 -50 -25 0 25 50 75 100 125 150
JUNCTION TEMPERATURE (°C)


CURRENT LIMIT
OUTPUT CURRENT (A)
Tj = +25°C
Tj = -55°C
Tj = +150°C
CB-19 CB-117
CB-244
CB-7
0 10 20 30 40
INPUT-OUTPUT VOLTAGE DIFFERENTIAL (V)

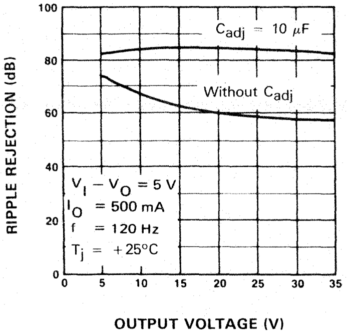

ADJUSTMENT PIN CURRENT
ADJUSTMENT CURRENT (µA)
70
65
60
55
50
45
40
35
-75 -50 -25 0 25 50 75 100 125 150
JUNCTION TEMPERATURE (°C)


DROPOUT VOLTAGE
INPUT-OUTPUT VOLTAGE DIFFERENTIAL (V)
ΔVO = 100 mV
IO =1.5 A
IO =1 A
IO =500 mA
IO =20 mA
IO =200 mA
3.0
2.5
2.0
1.5
1.0
-75 -50 -25 0 25 50 75 100 125 150
JUNCTION TEMPERATURE (°C)

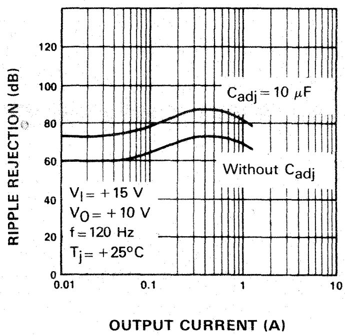

TEMPERATURE STABILITY
REFERENCE VOLTAGE (V)
1.260
1.250
1.240
1.230
1.220
-75 -50 -25 0 25 50 75 100 125 150
JUNCTION TEMPERATURE (°C)


MINIMUM OPERATING CURRENT
QUIESCENT CURRENT (mA)
Tj =-55°C
Tj = +150°C
Tj = +25°C
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0 10 20 30 40
INPUT-OUTPUT VOLTAGE DIFFERENTIAL (V)

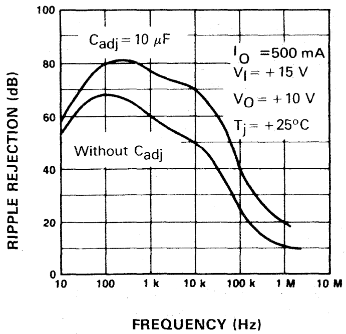
RIPPLE REJECTION VERSUS OUTPUT VOLTAGE



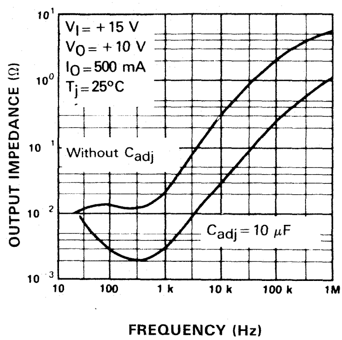
RIPPLE REJECTION VERSUS OUTPUT CURRENT



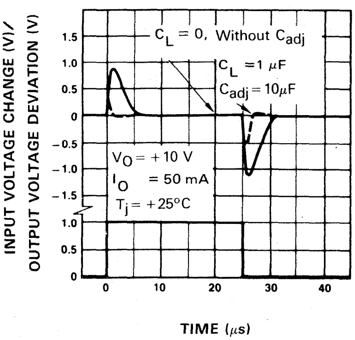
RIPPLE REJECTION VERSUS FREQUENCY



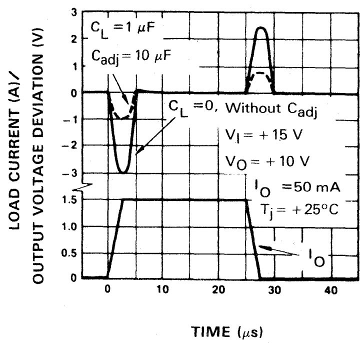
OUTPUT IMPEDANCE



LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



APPLICATIONS HINTS

BASIC CIRCUIT OPERATION

The LM 317 is a 3-terminal floating regulator. In operation, the LM 317 develops and maintains a nominal 1.25 volt reference ($V_{(ref)}$) between its output and adjustment terminals.

This reference voltage is converted to a programming current ($I_{prog.}$) by R1 (see figure 1), and this constant current flows through R2 to ground. The regulated output voltage is given by :

$$V_O = V_{ref}(1 + \frac{R2}{R1}) + I_{adj}R2$$

Since the current from the adjustment terminal (I_{adj}) represents an error term in the equation, the LM 317 was designed to control I_{adj} to less than 100 μA and keep it constant. To do this, all quiescent operating current is returned to the output terminal. This imposes the requirement for a minimum load current. If the load current is less than this minimum, the output voltage will rise.

Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded.

LOAD REGULATION

The LM 317 is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor (R1) should be connected as close to the regulator as possible to minimize line drops which effectively appear in series with the reference, thereby degrading regulation.

Care must be taken to minimize the wire length of the output lead. The ground end of R2 can be returned near the load ground to provide remote ground sensing and improve load regulation.

EXTERNAL CAPACITORS (Fig. 2)

Normally, no capacitors are needed unless the device is situated far from the input filter capacitors ; in which case an input bypass is needed.

A 0.1 μF disc or 1 μF tantalum input bypass capacitor (C_I) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor (C_{adj}) prevents ripple from being amplified as the output voltage is increased. A 10 μF capacitor should improve ripple rejection about 80 dB at 120 Hz in a 10 volt application.

Although the LM 317 is stable with no output capacitance, like any feedback circuit, certain values of external capacitance can cause excessive ringing. An output capacitance (C_O) in the form of a 1 μF tantalum or 25 μF aluminium electrolytic capacitor on the output swamps this effect and insures stability.

PROTECTION DIODES (Fig. 2)

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator.

Figure 2 show the LM317 with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values ($C_O > 25$ μF, $C_{adj} > 10$ μF). Diode D1 prevents C_O from discharging through the IC during an input short-circuit. The combination of diodes D1 and D2 prevents C_{adj} from discharging through the IC during an input or output short-circuit.

TYPICAL APPLICATIONS

FIGURE 1 - BASIC CIRCUIT CONFIGURATION

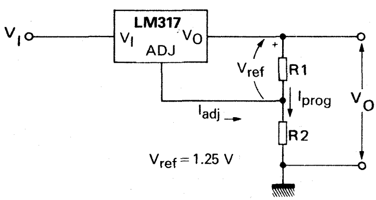
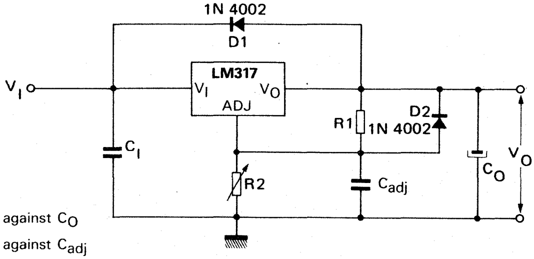


FIGURE 2 - VOLTAGE REGULATOR WITH PROTECTION DIODES

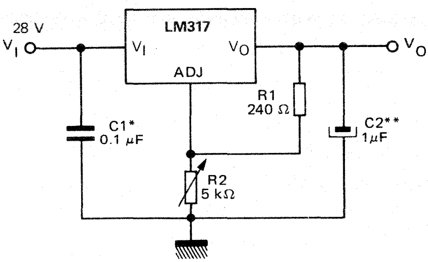


D1 protects against C_O

D2 protects against C_{adj}

TYPICAL APPLICATIONS (continued)

FIGURE 3 - 1.2 to 25 V ADJUSTABLE REGULATOR

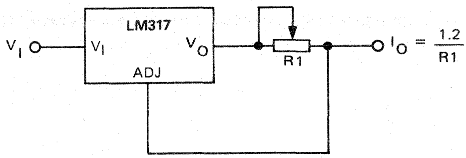


*Needed if device is far from filter capacitors

**Optional : improves transient response

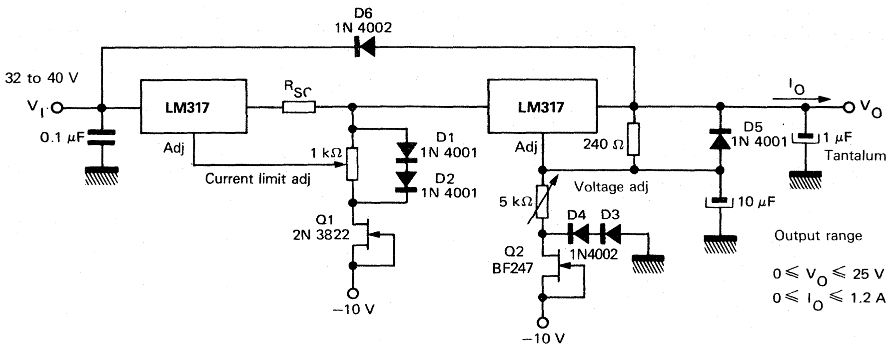
$V_O = 1.25\ V\ (1 + \frac{R2}{R1}) + I_{adj}\ R2$

FIGURE 4 - PRECISION CURRENT LIMITER



$0.8\ \Omega \leqslant R1 \leqslant 120\ \Omega$

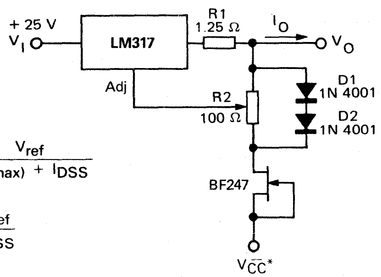
FIGURE 5 - "LABORATORY" POWER SUPPLY WITH ADJUSTABLE CURRENT LIMIT AND OUTPUT VOLTAGE



Diodes D1 and D2 and transistor Q2 are added to allow adjustment of output voltage to 0 volt

D6 protects both LM 317's during an input short-circuit

FIGURE 6 - ADJUSTABLE CURRENT LIMITER



$$R1 = \frac{V_{ref}}{I_{O(max)} + I_{DSS}}$$

$$R2 \geqslant \frac{V_{ref}}{I_{DSS}}$$

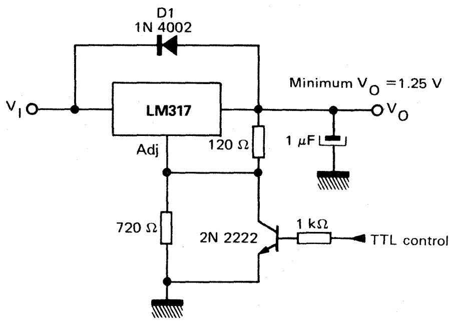
$V_O < BV_{DSS} + 1.25\ V + V_{CC}$

$I_{L(min)} - I_{DSS} < I_O < 1.5$ V

$0 < I_O < 1$ A

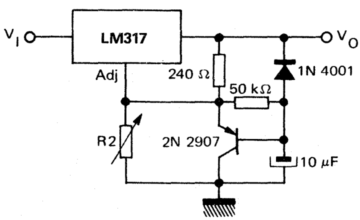
* To provide current limiting of I_O to the system ground, the source of the FET must be tied to a negative voltage below –1.25 V.

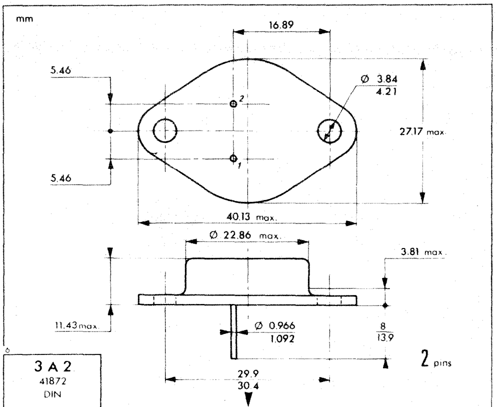
FIGURE 7 - 5 V ELECTRONIC SHUT DOWN REGULATOR



D1 protects the device during an input short-circuit.

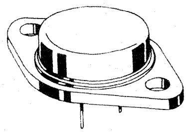
FIGURE 8 - SLOW TURN-ON REGULATOR



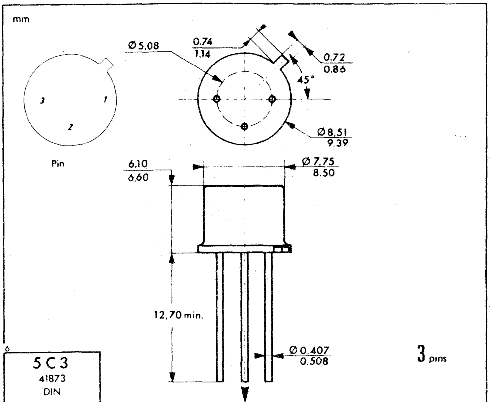


3 A 2 41872 DIN				
Case [C - 14 A] Base B - 18 CEI	TO - 3 D.A.T.A.	TO - 3 JEDEC	F 24 A SITELESC	CB - 19 THOMSON SEMICONDUCTORS

CB-19
(TO-3)

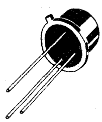


K SUFFIX
STEEL CAN

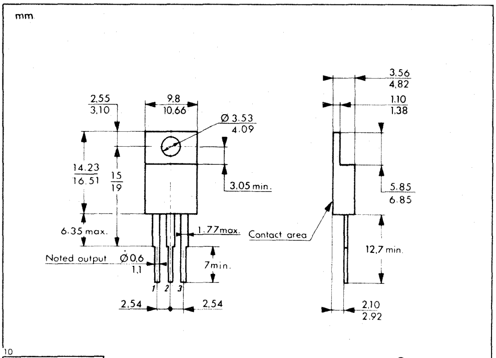


5 C 3 41873 DIN				
Case : C - 4 Base : B - 4 C CEI	TO - 39 D.A.T.A.	TO - 39 JEDEC	F 59 SITELESC	CB - 7 THOMSON SEMICONDUCTORS

CB-7
(TO-39)



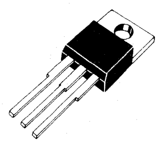
H SUFFIX
METAL CAN



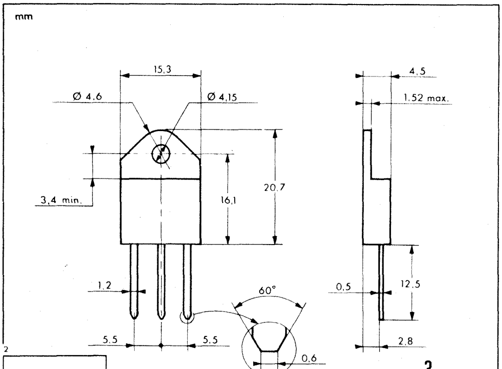
3 pins

DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

CB-117
(TO-220)



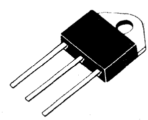
SP SUFFIX
PLASTIC PACKAGE



3 pins

DIN				
CEI	D.A.T.A.	TO-218 JEDEC	SITELESC	CB-244 THOMSON SEMICONDUCTORS

CB-244
(TOP 3)



SP3 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

LM123
LM223
LM323

THREE-TERMINAL 3 A-5 V POSITIVE VOLTAGE REGULATORS

The LM123, LM223, LM323 are three-terminal positive voltage regulators with a preset 5 V output and a load driving capability of 3 A. New circuit design and processing techniques are used to provide the high output current without sacrificing the regulation characteristics of lower current devices.

The 3 A regulator is virtually blowout proof.
Current limiting, power limiting and thermal shut-down provide the same high level of reliability obtained with these techniques in the LM109, 1 A regulator.

An overall worst case specification for the combined effects of intput voltage, load current, ambient temperature, and power dissipation ensure that the LM123, LM223, LM323 will perform satisfactorily as a system element.

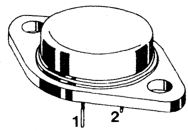
- Output current : 3 A
- Internal current and thermal limiting
- Typical output impedance : 0.01 Ω
- Minimum input voltage : 7.5 V
- Power dissipation : 30 W (CB-19), 20 W (CB-244)

THREE-TERMINAL 3 A-5 V POSITIVE VOLTAGE REGULATORS

3

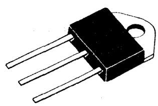
CASES

CB-19 (TO-3)



K SUFFIX
STEEL CAN

CB-244 (TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

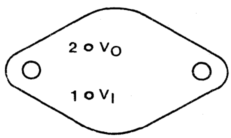
PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		K	SP3
LM123	− 55°C to + 150°C	•	
LM123I	− 40°C to + 150°C		•
LM223	− 25°C to + 150°C	•	
LM323	0°C to + 125°C	•	•

Examples : LM123K, LM123ISP3, LM223K

PIN ASSIGNMENTS

(Bottom view)

CB-19

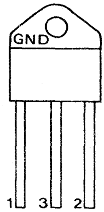


1 - Input
2 - Output

Case is ground

(Front view)

CB-244



1 - Input
2 - Output
3 - Ground

Réf. 00100

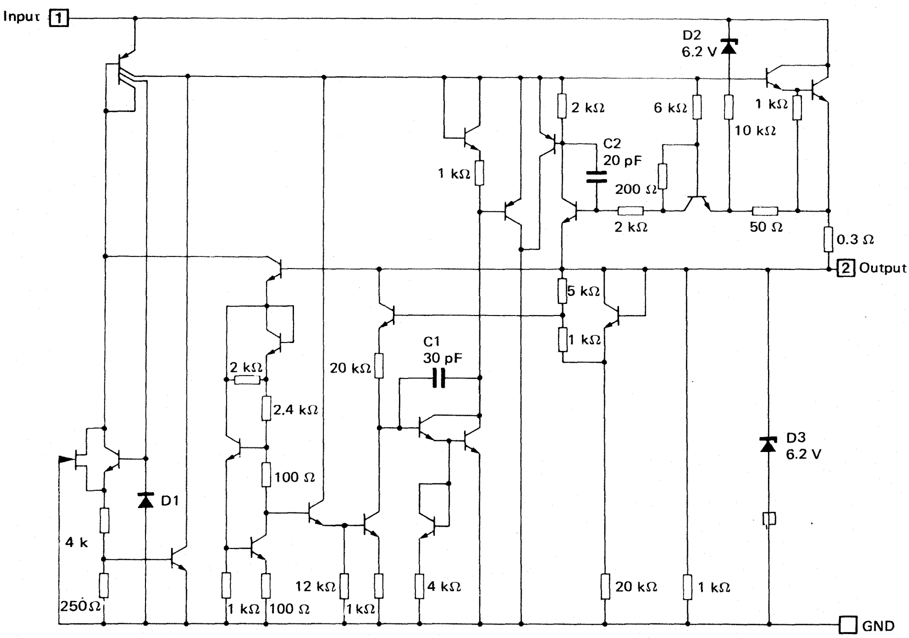
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage	V_I	20	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Operating junction temperature range	T_{oper}		°C
LM123		−55 to +150	
LM123I		−40 to +150	
LM223		−25 to +150	
LM323		0 to +125	
Storage temperature range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Typ	Unit
Jonction-case thermal resistance	$R_{th(j-c)}$			°C/W
CB-19		4	–	
CB-244		2.5	–	
Junction-ambient thermal resistance	$R_{th(j-a)}$			°C/W
CB-19		–	35	
CB-244		55	–	

SCHEMATIC DIAGRAM



CASE	V_I	V_O	GND
CB-19	1	2	Case
CB-244	1	2	3

ELECTRICAL CHARACTERISTICS

LM123 : $-55°C < T_j < +150°C$, **LM123I** : $-40°C < T_j < +150°C$
LM223 : $-25°C < T_j < +150°C$, **LM323** : $0°C < T_j < +125°C$
(Unless otherwise specified)

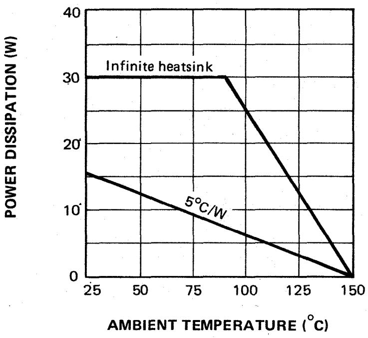
Characteristic	Symbol	LM123-LM123I-LM223			LM323			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range - (Note 2)	V_O							V
$T_j = +25°C$, $V_I = +7.5$ V, $I_O = 0$		4.7	5.0	5.3	4.8	5.0	5.2	
$T_{min} \leqslant T_j \leqslant T_{max}$, $P \leqslant P_{max}$, $+7.5\ V \leqslant V_I \leqslant +15$ V, $0 \leqslant I_O \leqslant 3$ A		4.6	–	5.4	4.75	–	5.25	
Line regulation ($T_j = +25°C$, $+7.5\ V \leqslant V_I \leqslant +15$ V) - Note 3	K_{VI}	–	5	25	–	5	25	mV
Load regulation ($T_j = +25°C$, $V_I = +7.5$ V, $0 \leqslant I_O \leqslant 3$ A) - Note 3	K_{VO}	–	25	100	–	25	100	mV
Quiescent current ($+7.5\ V \leqslant V_I \leqslant +15$ V, $0 \leqslant I_O \leqslant 3$ A)	I_{IB}	–	12	20	–	12	20	mA
Output noise voltage ($T_j = +25°C$, 10 Hz $\leqslant f \leqslant$ 100 kHz)	V_{NO}	–	40	–	–	40	–	μV_{rms}
Short-circuit current limit ($T_j = +25°C$)	I_{OS}							A
$V_I = +15$ V		–	3	4.5	–	3	4.5	
$V_I = +7.5$ V		–	4	5	–	4	5	
Long term stability	K_{VH}	–	–	35	–	–	35	mV

Note 1 : Although power dissipation is internally limited, specifications apply only for $P \leqslant 30$ W for CB-19 package and $P \leqslant 20$ W for CB-244 package.

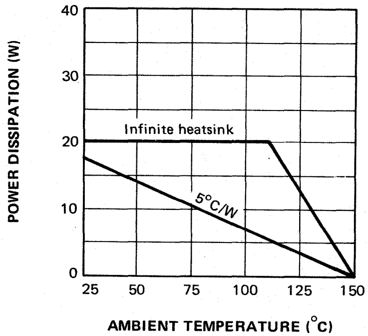
Note 2 : Selected devices with tightened tolerance output voltage available.

Note 3 : Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width $\leqslant 1$ ms and a duty cycle $\leqslant 5\%$.

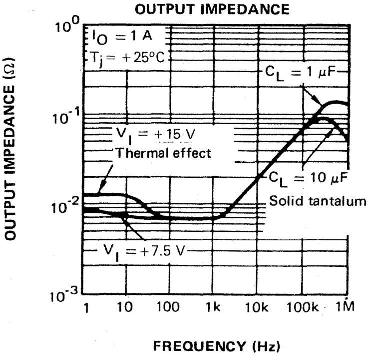
MAXIMUM POWER DISSIPATION
LM123I ; LM223SP3



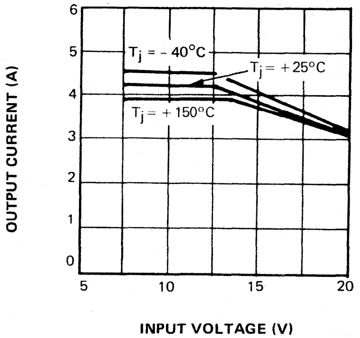
MAXIMUM POWER DISSIPATION
LM231I ; LM223K



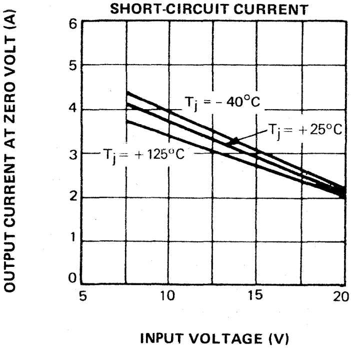
OUTPUT IMPEDANCE



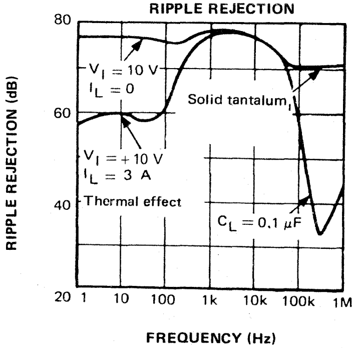
PEAK AVAILABLE OUTPUT CURRENT



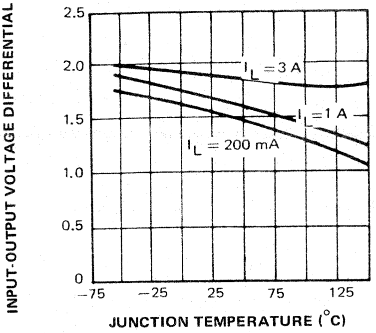
SHORT-CIRCUIT CURRENT



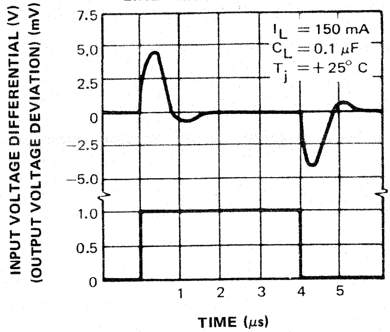
RIPPLE REJECTION



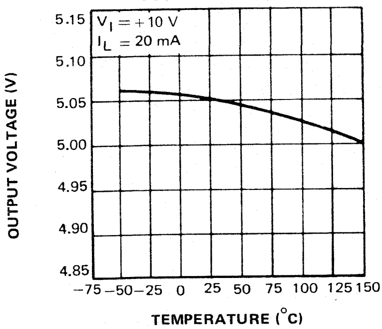
DROPOUT VOLTAGE



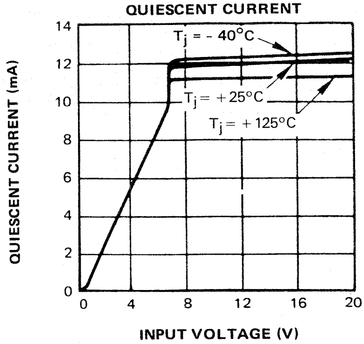
LINE TRANSIENT RESPONSE



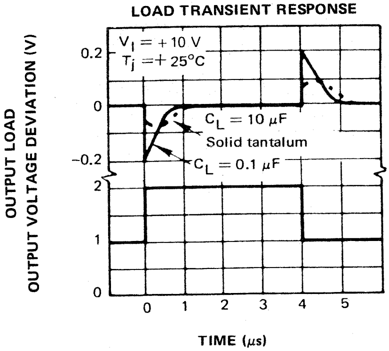
OUTPUT VOLTAGE



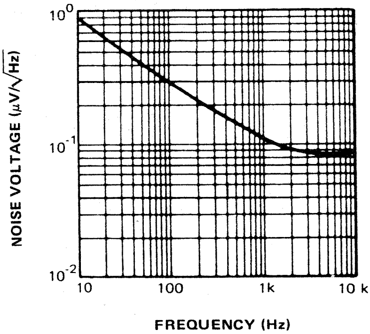
QUIESCENT CURRENT



LOAD TRANSIENT RESPONSE

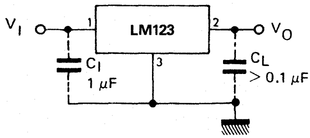


OUTPUT NOISE VOLTAGE



TYPICAL APPLICATIONS

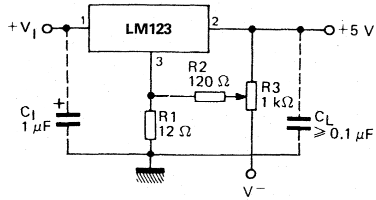
BASIC 3 A REGULATOR



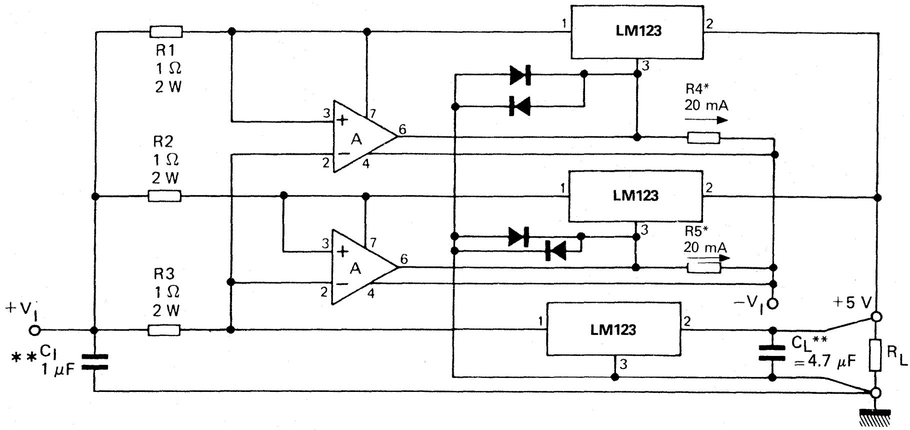
C_I = Required if regulator is distant from filter capacitors

C_L = Regulator is stable with no load capacitor into resistive loads.

TRIMMING OUTPUT TO 5 V



10 A REGULATOR WITH COMPLETE OVERLOAD PROTECTION

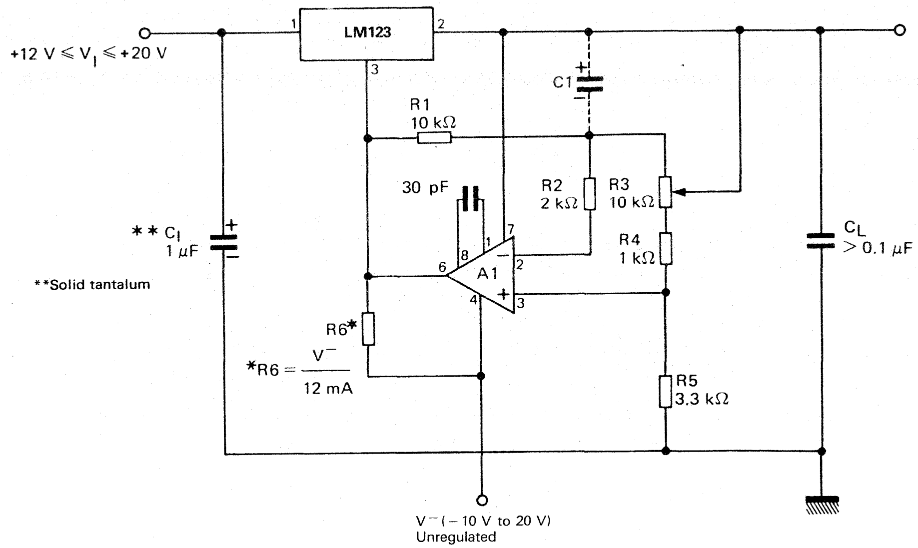


* Selected for 20 mA current from unregulated negative supply

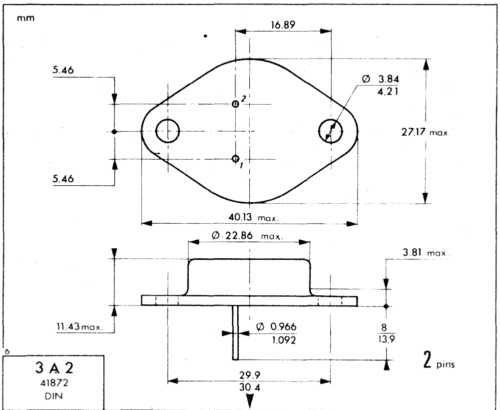
** Solid tantalum

A = LM101A, LM201A, LM301A

ADJUSTABLE REGULATOR 0 – 10 V / 3 A

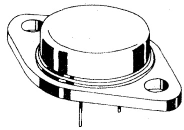


A1 = LM 101 A, LM 201 A, LM 301 A.
C1 = 2 µF optional - improves ripple rejection, noise and transient response.

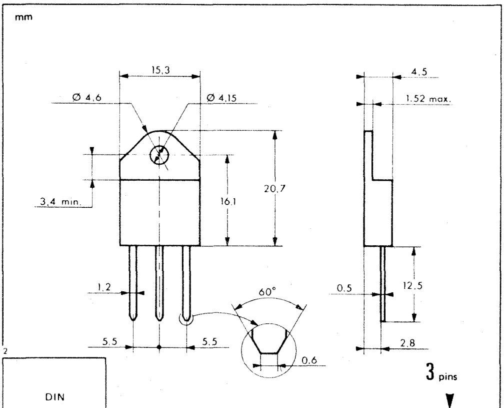


3 A 2 41872 DIN				
Case [C - 14 A] Base B - 18 CEI	TO - 3 D.A.T.A.	TO - 3 JEDEC	F 24 A SITELESC	CB - 19 THOMSON SEMICONDUCTORS

CB-19
(TO-3)

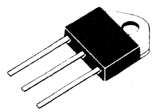


K SUFFIX
STEEL CAN



DIN				
CEI	D.A.T.A.	TO-218 JEDEC	SITELESC	CB-244 THOMSON SEMICONDUCTORS

CB-244
(TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM137
LM237
LM337

THREE-TERMINAL ADJUSTABLE NEGATIVE VOLTAGE REGULATORS

The LM137 series are adjustable 3-terminal negative voltage regulators capable of supplying in excess − 1.5 A over a − 1.2 to − 37 V output voltage range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. Also, LM137 regulators are supplied in standard transistor packages which are easily mounted and handled. In addition to higher performance than fixed regulators, the LM137 series offer full overload protection available only in integrated circuits. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

- Output voltage adjustable down to V_{ref}.
- 1.5 A guaranteed output current for TO-220, TO-3 and TOP-3 packages.
- 0.3%/V typical load regulation.
- 0.01%/V typical line regulation.
- Current limit constant with temperature.
- Ripple rejection : 77 dB.
- Standard 3-lead transistor packages.
- Excellent thermal regulation : 0.002%/V.
- 50 ppm/°C temperature coefficient.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

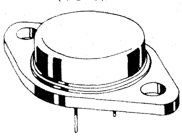
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		K	H	SP3	SP
LM137	− 55°C to + 150°C	●	●		
LM237	− 25°C to + 150°C	●	●		
LM337I	− 40°C to + 150°C			●	
LM337	0°C to + 125°C	●	●	●	●

Examples : LM137K, LM137H, LM337ISP3

THREE-TERMINAL ADJUSTABLE NEGATIVE VOLTAGE REGULATORS

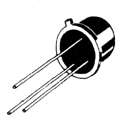
CASES

CB-19 (TO-3)



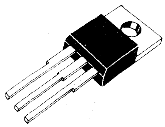
K SUFFIX
STELL CAN

CB-7 (TO-39)



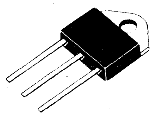
H SUFFIX
METAL CAN

CB-117 (TO 220)



SP SUFFIX
PLASTIC PACKAGE

CB-244 (TOP-3)

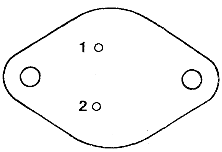


SP3 SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENTS

(Bottom views)

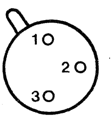
CB-19



1 - Output
2 - Adj

Case is input

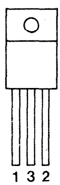
CB-7



1 - Adj
2 - Output
3 - Input

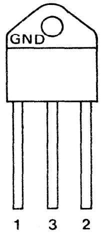
(Front views)

CB-117



1 - Adj
2 - Output
3 - Input

CB-244



Heatsink surface connected to input

Réf. 00120

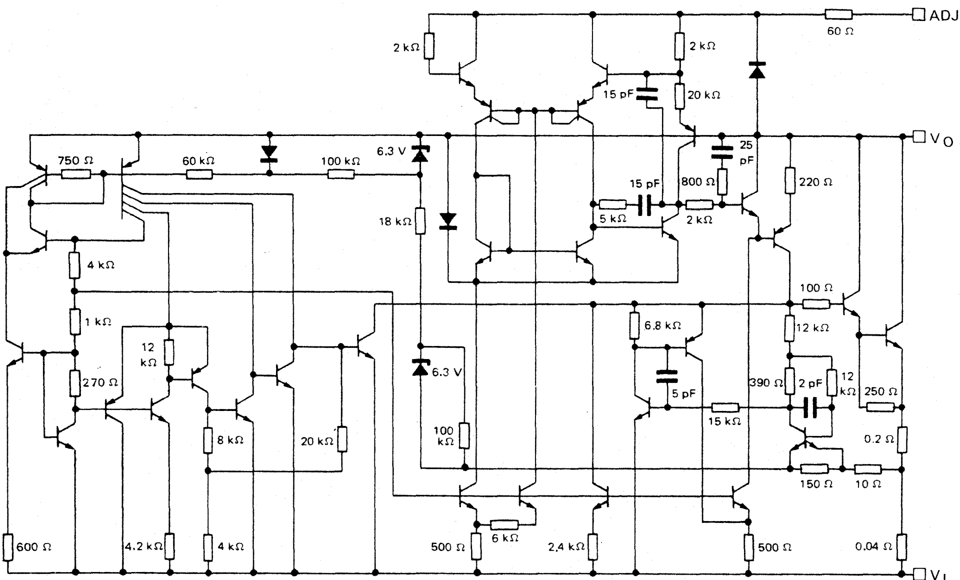
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input-output voltage differential	$V_I - V_O$	40	V
Output current CB-19, CB-117, CB-244 CB-7	I_O	 1.5 0.5	A
Operating junction temperature range LM137 LM237 LM337I LM337	T_{oper}	 − 55 to + 150 − 25 to + 150 − 40 to + 125 0 to + 125	°C
Storage temperature range	T_{stg}	− 65 to + 150	°C
Power dissipation	P_{tot}	Internally limited	W

THERMAL CHARACTERISTICS

Rating	Symbol	Typ	Max	Unit
Junction-case thermal resistance CB-19 CB-7 CB-244 CB-117	$R_{th(j-c)}$	 — — — —	 4 15 2.5 3	°C/W
Junction-ambient thermal resistance CB-19 CB-7 CB-244 CB-117	$R_{th(j-a)}$	 35 — — —	 — 160 55 70	°C/W

SCHEMATIC DIAGRAM



CASE	V_I	V_O	ADJ
CB-19	Case	1	2
CB-7	3	2	1
CB-117	3	2	1
CB-244	3	2	1

ELECTRICAL CHARACTERISTICS

LM137 : $-55°C < T_j < +150°C$
LM237 : $-25°C < T_j < +150°C$
LM337I : $-40°C < T_j < +150°C$
LM337 : $0°C < T_j < +125°C$
$|V_I - V_O| = 5$ V, $I_O = 0.1$ A (CB-7), $I_O = 0.5$ A (CB-19, CB-117, CB-244)
(Unless otherwise specified)

Characteristic	Symbol	LM137 - LM237			LM337 - LM337I			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference voltage $T_{amb} = +25°C$ $T_{min} \leq T_j \leq T_{max}$ $3\ V \leq \|V_I - V_O\| \leq 40\ V$, $10\ mA \leq \|I_O\| \leq \|I_{O(max)}\|$, $P \leq P\ max$	V_{ref}	 −1.225 −1.20	 −1.25 −1.25	 −1.275 −1.30	 −1.213 −1.20	 −1.25 −1.25	 −1.287 −1.30	V
Line regulation ($T_{amb} = +25°C$, $3\ V \leq \|V_I - V_O\| \leq 40\ V$) - Note 2 $I_O = 0.1$ A TO-3, TOP-3, TO-220 $I_O = 20$ mA TO-39	K_{VI}	 — —	 0.01 0.01	 0.02 0.02	 — —	 0.01 0.01	 0.04 0.04	%/V
Load regulation ($T_{amb} = +25°C$, $10\ mA \leq \|I_O\| \leq \|I_{O(max)}\|$) - Note 2 $\|V_O\| \leq 5$ V $\|V_O\| \geq 5$ V	K_{VO}	 — —	 15 0.3	 25 0.5	 — —	 15 0.3	 50 1	 mV %
Thermal regulation ($T_{amb} = +25°C$, Pulse 10 ms)	—	—	0.002	0.02	—	0.003	0.04	%/W
Adjustment pin current	I_{adj}	—	65	100	—	65	100	μA
Adjustment pin current change ($T_{amb} = +25°C$, $10\ mA \leq \|I_O\| \leq \|I_{O(max)}\|$, $3\ V \leq \|V_I - V_O\| \leq 40\ V$)	ΔI_{adj}	 —	 2	 5	 —	 2	 5	μA
Line regulation ($3\ V \leq \|V_I - V_O\| \leq 40\ V$) - Note 2	K_{VI}	—	0.02	0.05	—	0.02	0.07	%/V
Load regulation ($10\ mA \leq \|I_O\| \leq \|I_{O(max)}\|$) - Note 2 $V_O \leq 5$ V $V_O \geq 5$ V	K_{VO}	 — —	 20 0.3	 50 1	 — —	 20 0.3	 70 1.5	 mV %
Minimum load current $\|V_I - V_O\| \leq 40$ V $\|V_I - V_O\| \leq 10$ V	$\|I_{O(min)}\|$	 — —	 2.5 1.2	 5 3	 — —	 2.5 1.5	 10 6	mA
Short-circuit output current $\|V_I - V_O\| \leq 15$ V TO-3, TOP-3, TO-220 TO-39 $\|V_I - V_O\| = 40$ V, $T_j = +25°C$ TO-3, TOP-3, TO-220 TO-39	I_{OS}	 1.5 0.5 0.24 0.15	 2.2 — 0.4 0.2	 — — — —	 1.5 0.5 0.15 0.10	 2.2 — 0.4 0.2	 — — — —	A
RMS output noise (% of V_O) ($T_{amb} = +25°C$, $10\ Hz \leq f \leq 10\ kHz$)	V_{NO}	 —	 0.003	 —	 —	 0.003		%
Ripple rejection ratio $V_O = -10$ V, f = 120 Hz $C_{adj} = 10\ \mu F$	R_{vf}	 — 66	 60 77	 — —	 — 66	 60 77	 — —	dB
Temperature stability ($T_{min} \leq T_j \leq T_{max}$)	K_{VT}	—	0.6	—	—	0.6	—	%
Long term stability ($T_{amb} = +125°C$, 1000 H)	K_{VH}	—	0.3	1	—	0.3	1	%

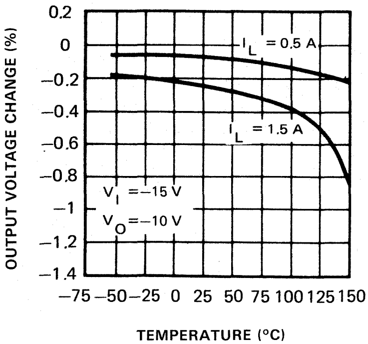
Note 1 : Although power dissipation is internally limited, these specifications are applicable for power dissipations of :
- 2 W for CB-7,
- 15 W for CB-117,
- 20 W for CB-19 and CB-244 packages.

$I_{O(max)}$ is :
- 1.5 A for CB-19, CB-244 and CB-117 packages,
- 0.5 A for CB-7 package.

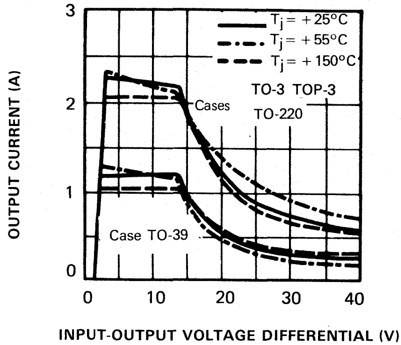
Note 2 : Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

TYPICAL PERFORMANCE CHARACTERISTICS

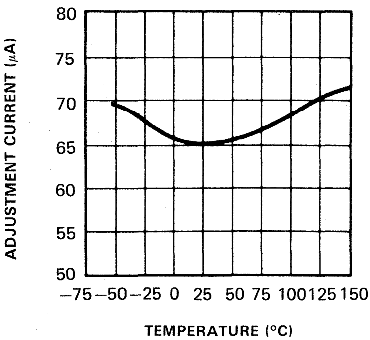
LOAD REGULATION



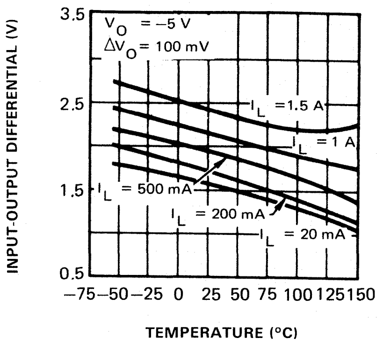
CURRENT LIMIT



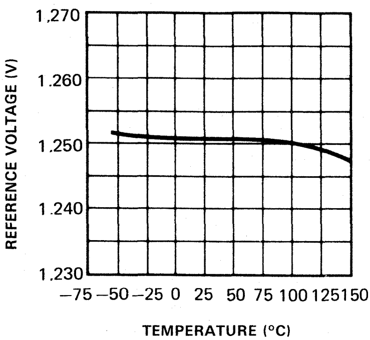
ADJUSTMENT CURRENT



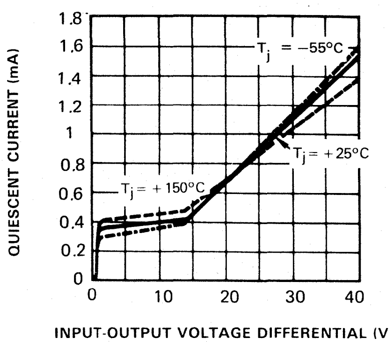
DROPOUT VOLTAGE



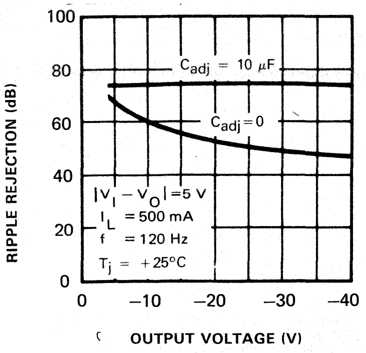
TEMPERATURE STABILITY



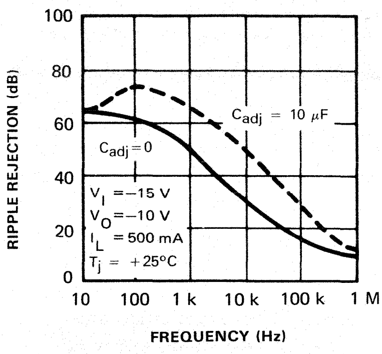
MINIMUM OPERATING CURRENT



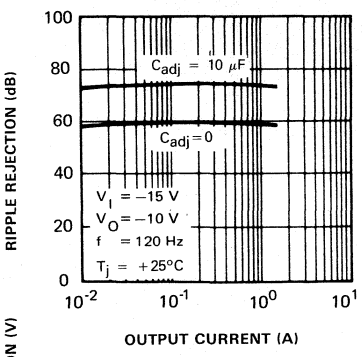
RIPPLE REJECTION VERSUS OUTPUT VOLTAGE



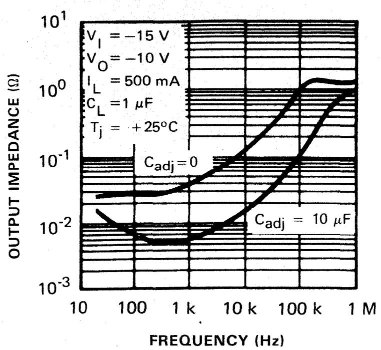
RIPPLE REJECTION VERSUS FREQUENCY



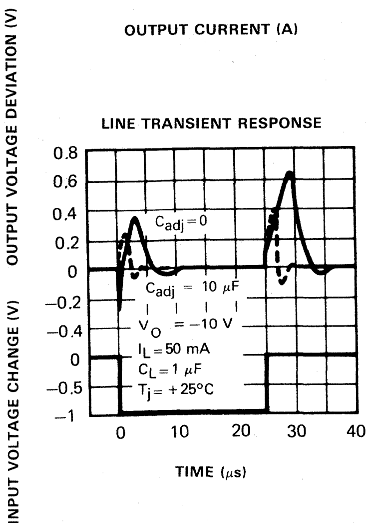
RIPPLE REJECTION VERSUS OUTPUT CURRENT



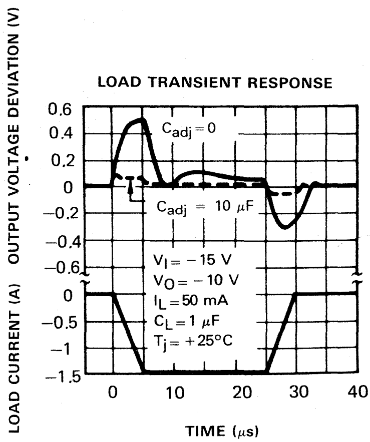
OUTPUT IMPEDANCE



LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



THERMAL REGULATION

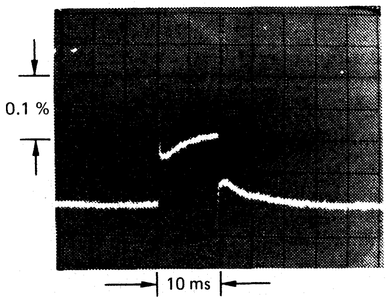
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large.

Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in power dissipation. Thermal regulation depends on IC layout as well as electrical design. The thermal regulation of a voltage regulator is defined as the percentage change of V_O, per watt, within the first 10 ms after a step of power, is applied. The LM 137 specification is 0.02%/W max.

In figure 1, a typical LM 137's output drifts only 3 mV (or 0.03% of $V_O = -10$ V) when a 10 W pulse is applied for 10 ms. This performance is thus well inside the specification limit of $0.02\%/W \times 10\ W = 0.2\%$ max. When the 10 W pulse is ended the thermal regulation again shows a 3 mV step as the LM 137 chip cools off. Note that the load regulation error of about 8 mV(0.08%) is additional to the thermal regulation error.

In figure 2, when the 10 W pulse is applied for 100 ms, the output drifts only slightly beyond the drift in the first 10 ms and the thermal error stays well within 0.1% (10 mV).

FIGURE 1



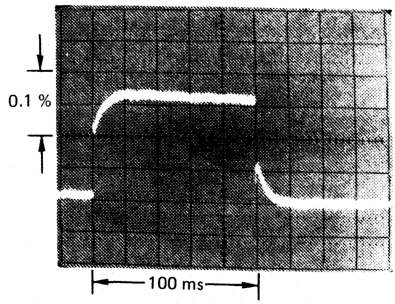
LM 337, $V_O = -10$ V

$V_I - V_O = -40$ V

$I_L = 0$ A → 0.25 A → 0 A

Vertical sensitivity 5 mV/div.

FIGURE 2



LM 337, $V_O = -10$ V

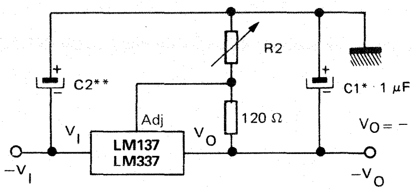
$V_I - V_O = -40$ V

$I_L = 0$ A → 0.25 A → 0 A

Horizontal sensitivity 20 ms/div.

TYPICAL APPLICATIONS

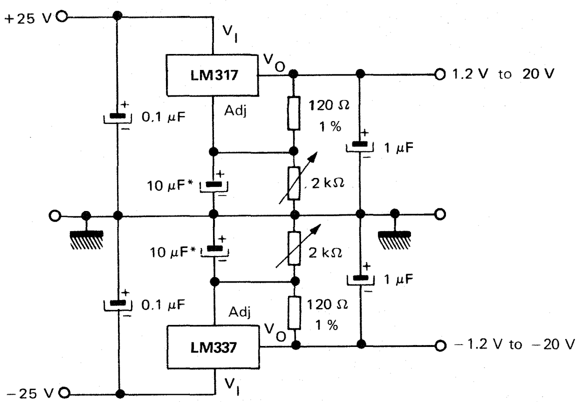
ADJUSTABLE NEGATIVE VOLTAGE REGULATOR



$V_O = -1.25\ V\ (1 + \frac{R2}{120\ \Omega}) + (-I_{adj} \times R2)$

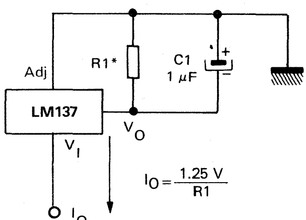
* C1 = 1 μF solid tantalum or 10 μF aluminium electrolytic required for stability
** C2 = 1 μF solid tantalum is required only if regulator is more than 10 cm from power supply filter capacitor

ADJUSTABLE LAB VOLTAGE REGULATOR



* The 10 μF capacitors are optional to improve ripple rejection

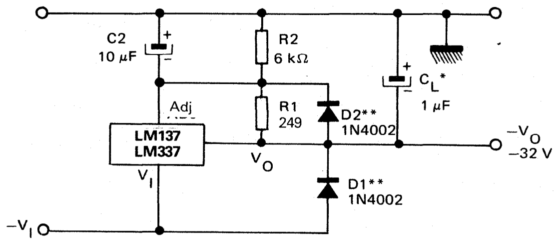
CURRENT REGULATOR



$I_O = \frac{1.25\ V}{R1}$

$*0.8\ \Omega \leqslant R1 \leqslant 120\ \Omega$

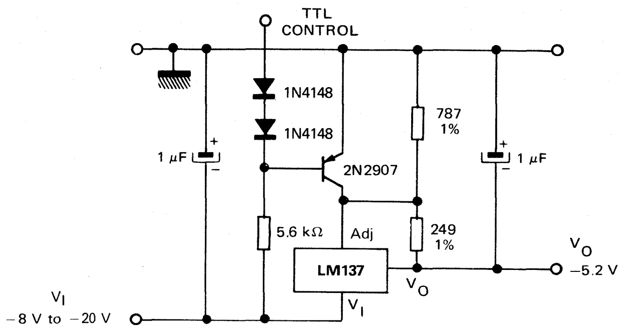
NEGATIVE REGULATOR WITH PROTECTION DIODES



* When C_L is larger than 20 μF, D1 protects the LM 137 in case the input supply is shorted

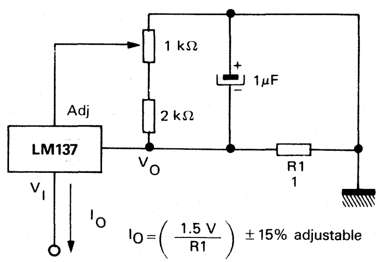
**When C2 is larger than 10 μF and V_O is larger than −25 V, D2 protects the LM 137 in case the output is shorted

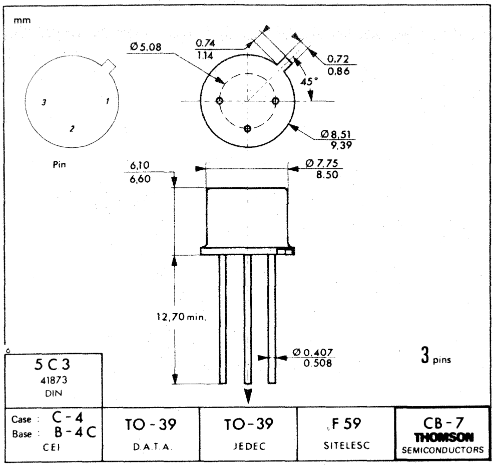
* −5.2 V REGULATOR WITH ELECTRONIC SHUTDOWN



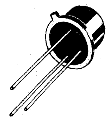
* Minimum output ≅ −1.3 V when control input is low

ADJUSTABLE CURRENT REGULATOR

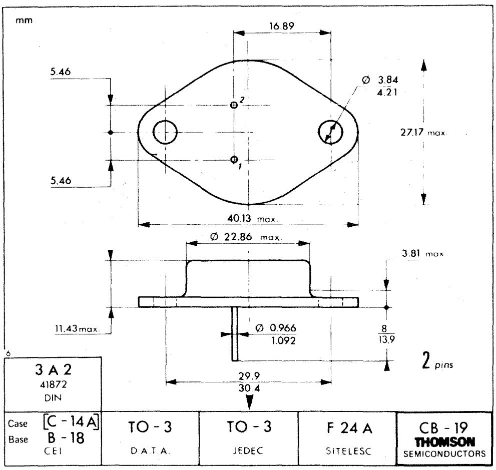




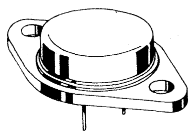
CB-7
(TO-39)



K SUFFIX
METAL CAN

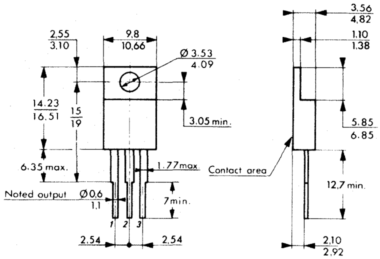


CB-19
(TO-3)



K SUFFIX
STEEL CAN

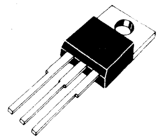
mm



3 pins

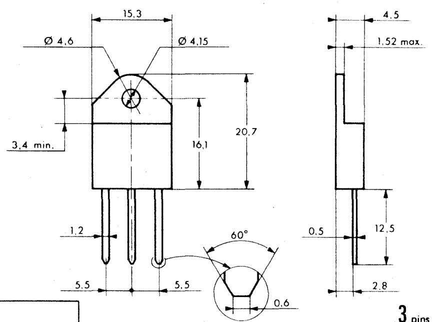
DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE

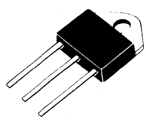
mm



3 pins

DIN				
CEI	D.A.T.A.	TO-218 JEDEC	SITELESC	CB-244 THOMSON SEMICONDUCTORS

CB-244
(TOP 3)



SP3 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

LM138
LM238
LM338

THREE-TERMINAL 5-A ADJUSTABLE VOLTAGE REGULATORS

The LM138/LM238/LM338 are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 5 A over a 1.2 V to 32 V output range. They are exceptionally easy to use and require only 2 resistors to set the output voltage. Careful circuit design has resulted in outstanding load and line regulation - comparable to many commercial power supplies. The LM138 family is supplied in a standard 3-lead transistor package.

A unique feature of the LM138 family is time-dependent current limiting. The current limit circuitry allows peak currents of up to 12 A to be drawn from the regulator for short periods of time. This allows the LM138 to be used with heavy transient loads and speeds start-up under full-load conditions. Under sustained loading conditions, the current limit decreases to a safe value protecting the regulator. Also included on the chip are thermal overload protection and safe area protection for the power transistor. Overload protection remains functional even if the adjustment pin is accidentally disconnected.

Normally, no capacitors are needed unless the device is situated far from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejection ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators or discrete designs, the LM138 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to input differential is not exceeded.

The LM128/LM228/LM338 are packaged in standard steel TO-3 transistor packages. The LM138 is rated for operation from −55°C to +150°C, the LM238 from −25°C to +150°C and the LM338 from 0°C to +125°C.

- Guaranteed 7 A peak output current.
- Guaranteed 5 A output current.
- Adjustable output down to 1.2 V
- Line regulation typically 0.005%/V
- Load regulation typically 0.1%.
- Guaranteed thermal regulation.
- Current limit constant with temperature.
- Standard 3-lead transistor package.

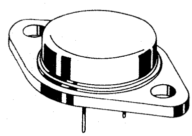
ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE K
LM138	−55°C to +150°C	•
LM238	−25°C to +150°C	•
LM338	0°C to +125°C	•
Example : LM138K		

THREE-TERMINAL 5-A ADJUSTABLE VOLTAGE REGULATORS

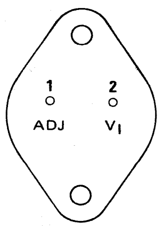
CASE CB-19
(TO-3)



K SUFFIX
STEEL CAN

PIN ASSIGNMENT

(Bottom view)



Case is output

Réf. 00075

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

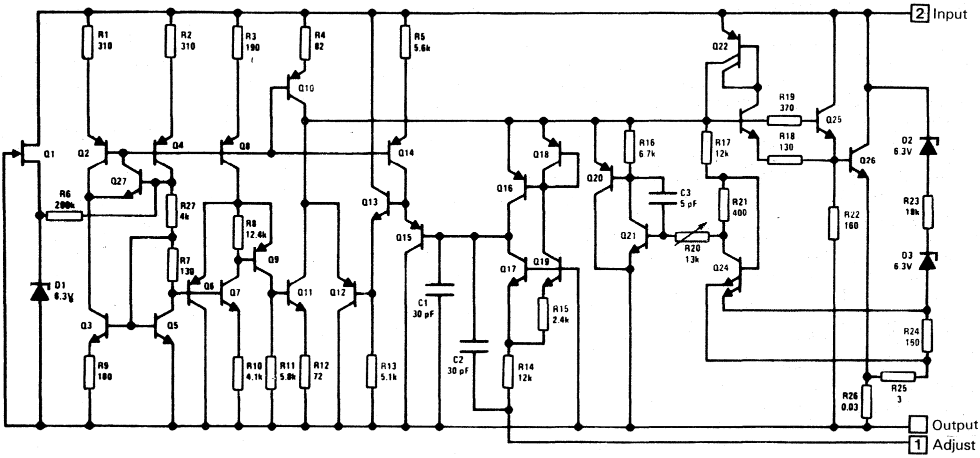
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power dissipation	P_{tot}	Internally limited	W
Input-output voltage differential	$V_I - V_O$	35	V
Operating junction temperature range LM138 LM238 LM338	T_{oper}	 – 55 to + 150 – 25 to + 150 0 to + 125	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C
Lead temperature (Soldering, 10 seconds)	T_{lead}	300	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	4	°C/W
Typical junction-ambient thermal resistance	$R_{th(j-a)}$	35	°C/W

SCHEMATIC DIAGRAM



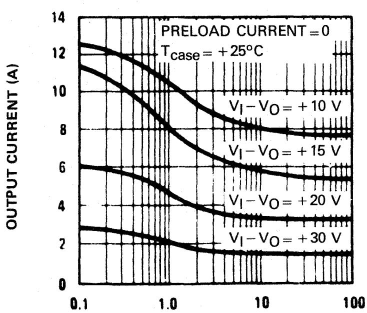
ELECTRICAL CHARACTERISTICS

LM138 : $-55°C \leqslant T_j \leqslant +150°C$, $V_I - V_O = +5$ V, $I_O = 2.5$ A
LM238 : $-25°C \leqslant T_j \leqslant +150°C$, $V_I - V_O = +5$ V, $I_O = 2.5$ A
LM338 : $0°C \leqslant T_j \leqslant +150°C$, $V_I - V_O = +5$ V, $I_O = 2.5$ A
Although power dissipation is internally limited, these specifications apply to power dissipation up to 50 W.
(Unless otherwise specified)

Characteristic	Symbol	LM138 - LM238			LM338			Unit
		Min	Typ	Max	Min	Typ	Max	
Line regulation - (Note 1) $T_{amb} = +25°C$, $+3\ V \leqslant (V_I - V_O) \leqslant +35$ V	K_{VI}	–	0.005	0.01	–	0.005	0.03	%/V
Load regulation $T_{amb} = +25°C$, $10\ mA \leqslant I_O \leqslant 5$ A $V_O \leqslant +5$ V - (Note 1) $V_O \geqslant +5$ V - (Note 1)	K_{VO}	– –	5 0.1	15 0.3	– –	5 0.1	25 0.5	mV %
Thermal regulation (Pulse = 20 ms)	–	–	0.002	0.01	–	0.002	0.02	%/W
Adjustment pin current	I_{adj}	–	45	100	–	45	100	μA
Adjustment pin current change $10\ mA \leqslant I_L \leqslant 5$ A, $+3\ V \leqslant (V_I - V_O) \leqslant +35$ V	ΔI_{adj}	–	0.2	5	–	0.2	5	μA
Reference voltage ($+3\ V \leqslant (V_I - V_O) \leqslant +35$ V, $10\ mA \leqslant I_O \leqslant 5$ A, $P \leqslant 50$ W)	$V_{(ref)}$	1.19	1.24	1.29	1.19	1.24	1.29	V
Line regulation $+3\ V \leqslant (V_I - V_O) \leqslant +35$ V - (Note 1)	K_{VI}	–	0.02	0.04	–	0.02	0.06	%/V
Load regulation ($10\ mA \leqslant I_O \leqslant 5$ A) - Note 1 $V_O \leqslant +5$ V $V_O \geqslant +5$ V	K_{VO}	– –	20 0.3	30 0.6	– –	20 0.3	50 1.0	mV %
Temperature stability ($T_{min} \leqslant T_j \leqslant T_{max}$)	K_{VT}	–	1	–	–	1	–	%
Minimum load current ($V_I - V_O = +35$ V)	$I_{O(min)}$	–	3.5	5	–	3.5	10	mA
Current limit ($V_I - V_O \leqslant +10$ V) DC 0.5 ms Peak $V_I - V_O = +30$ V	$I_{O(max)}$	5.0 7 –	8 12 1	– – –	5.0 7 –	8 12 1	– – –	A
RMS output noise, % of V_O ($T_{amb} = +25°C$, $10\ Hz \leqslant f \leqslant 10$ kHz)	–	–	0.003	–	–	0.003		%
Ripple rejection ratio $V_O = +10$ V, f = 120 Hz $C_{adj} = 10\ \mu F$	R_{vf}	– 60	60 75	– –	– 60	60 75	– –	dB
Long term stability ($T_{amb} = +125°C$)	K_{VH}	–	0.3	1	–	0.3	1	%

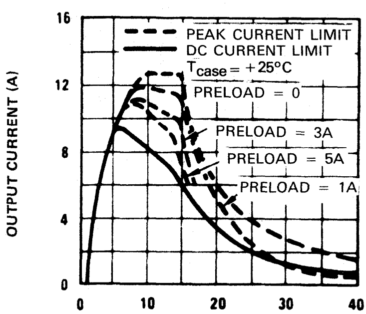
Note 1 : Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects are taken into account separately by thermal rejection.

CURRENT LIMIT



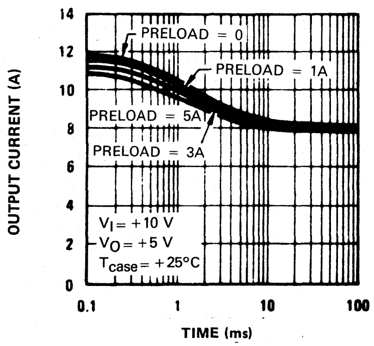
TIME (ms)

CURRENT LIMIT

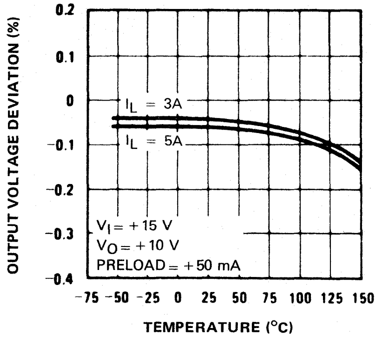


INPUT-OUTPUT DIFFERENTIAL (V)

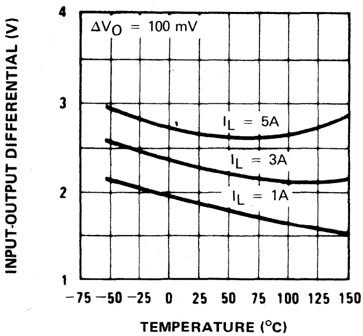
CURRENT LIMIT



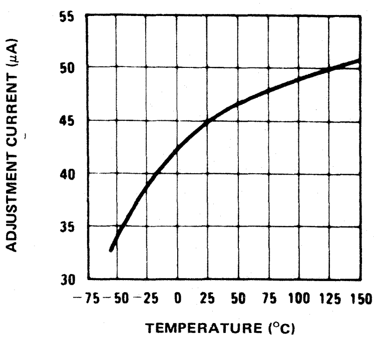
LOAD REGULATION



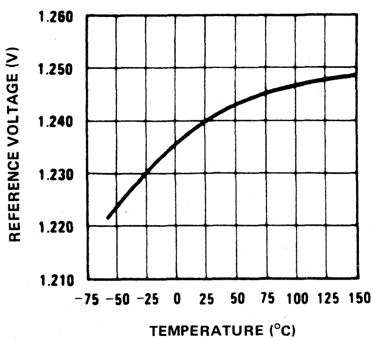
DROPOUT VOLTAGE



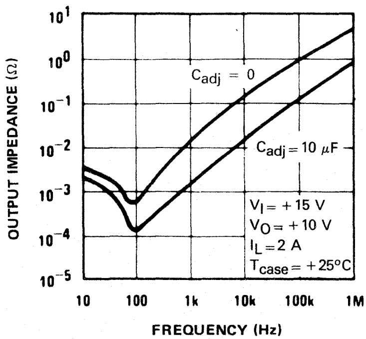
ADJUSTMENT CURRENT



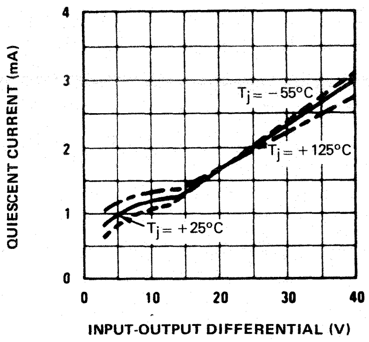
TEMPERATURE STABILITY



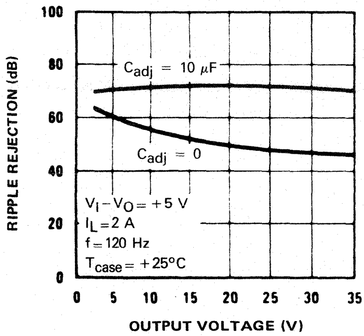
OUTPUT IMPEDANCE



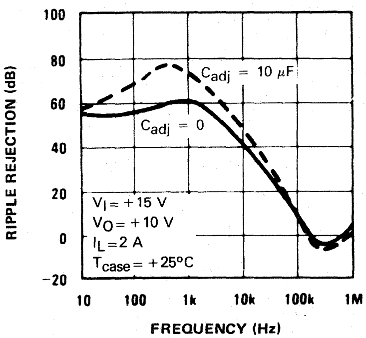
MINIMUM OPERATING CURRENT



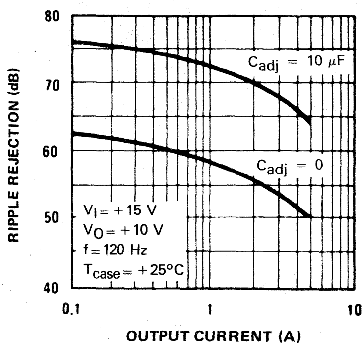
RIPPLE REJECTION



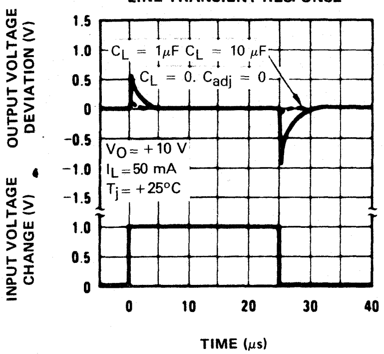
RIPPLE REJECTION



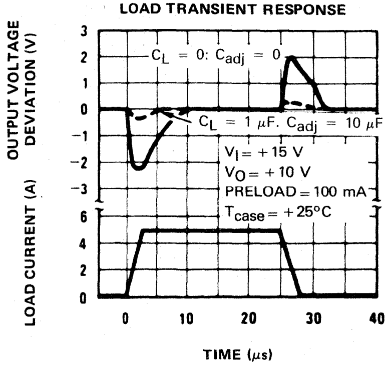
RIPPLE REJECTION



LINE TRANSIENT RESPONSE

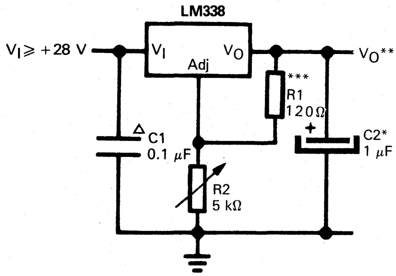


LOAD TRANSIENT RESPONSE



TYPICAL APPLICATIONS

+1.2 V to +25 V ADJUSTABLE REGULATOR



*Optional—improves transient response. Output capacitors in the range of 1 µF to 100 µF of aluminium or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

△Needed if device is far from filter capacitors.

** $V_O = 1.25\ V\ (1 + \frac{R2}{R1})$

*** R1 = 240 Ω for LM138 and LM238

APPLICATION HINTS

In operation, the LM338 develops a nominal 1.25 V reference voltage, $V_{(ref)}$, between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R2, giving an output voltage of

$$V_O = V_{(ref)}(1 + \frac{R2}{R1}) + I_{adj}R2$$

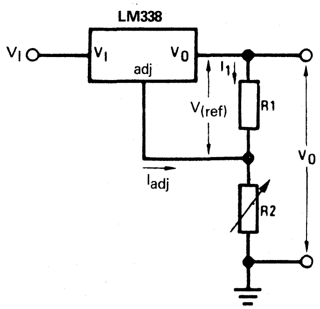


FIGURE 1

Since the 50 µA current from the adjustment terminal represents an error term, the LM338 was designed to minimize I_{adj} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

External Capacitors

An input bypass capacitor is recommended. A 0.1 µF disc or 1 µF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the LM338 to improve ripple rejection. This bypass capacitor prevents ripple form being amplified as the output voltage is increased. With a 10 µF bypass capacitor 75 dB ripple rejection is obtainable at any output level. Increases over 20 µF do not appreciably improve the ripple rejection at frequencies above 120 Hz. If the bypass capacitor is used, it is sometimes necessary to include protection diodes to prevent the capacitor from discharging through internal low current paths and damaging the device.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 µF in aluminum electrolytic to equal 1 µF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies, but some types have a large decrease in capacitance at frequencies around 0.5 MHz. For this reason, 0.01 µF disc may seem to work better than a 0.1 µF disc as a bypass.

Although the LM338 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1 µF solid tantalum (or 25 µF aluminium electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The LM338 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240 Ω) should be tied directly to the output of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 15 V regulator with 0.05 Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05 Ω × I_L. If the set resistor is connected near the load the effective line resistance will be 0.05 Ω (1 + R2/R1) or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 140 Ω set resistor.

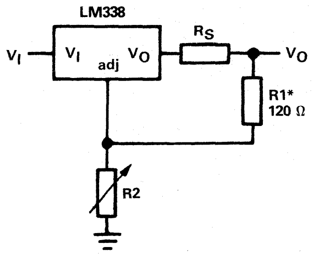


FIGURE 2 – REGULATOR WITH LINE RESISTANCE IN OUTPUT LEAD

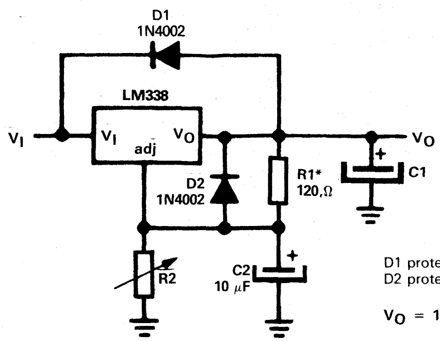
With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor, by using 2 separate leads to the case. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

Protection Diodes

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 20 μF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_I. In the LM338 this discharge path is through a large junction that is able to sustain 25 A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 100 μF or less at output of 15 V or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when either the input or output is shorted. Internal to the LM338 is a 50 Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25 V or less and 10 μF capacitance. Figure 3 shows an LM338 with protection diodes included for use with outputs greater than 25 V and high values of output capacitance.



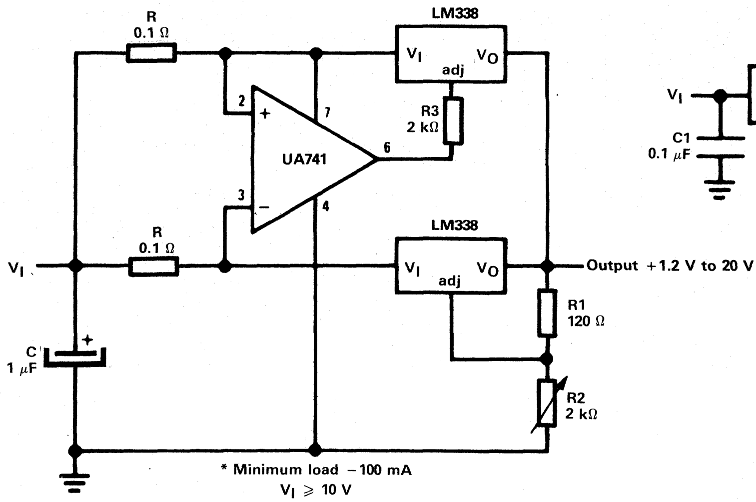
D1 protects against C1
D2 protects against C2

$$V_O = 1.25\ V\ (1 + \frac{R2}{R1}) + R2.I_{adj}$$

*R1 = 240 Ω for LM 138 and 238

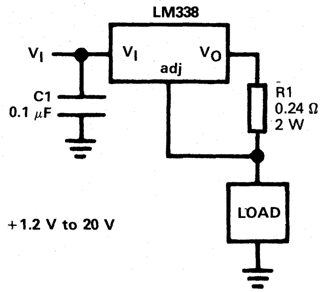
FIGURE 3 – REGULATOR WITH PROTECTION DIODES

10A REGULATOR

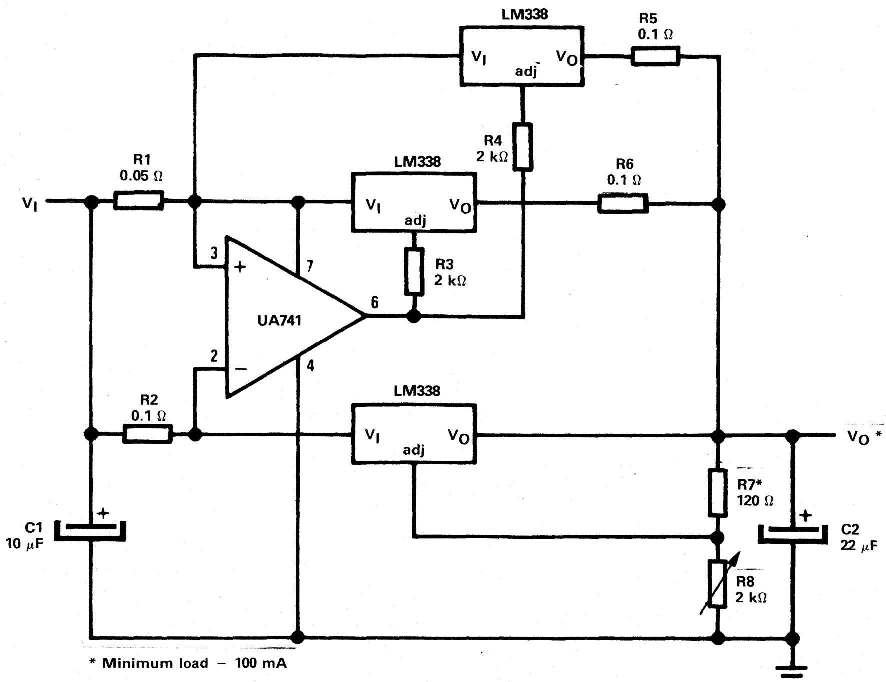


* Minimum load − 100 mA
$V_I \geqslant 10$ V
$V_O \geqslant 3$ V
$V_I - V_O \geqslant 3.5$ V

5A CURRENT REGULATOR

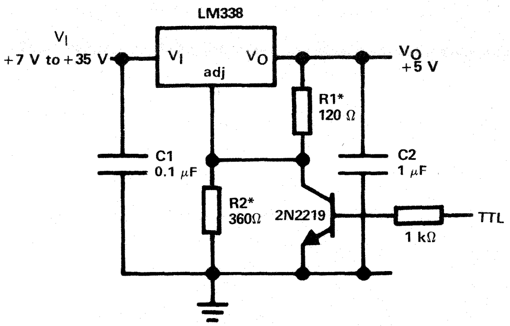


15 A REGULATOR



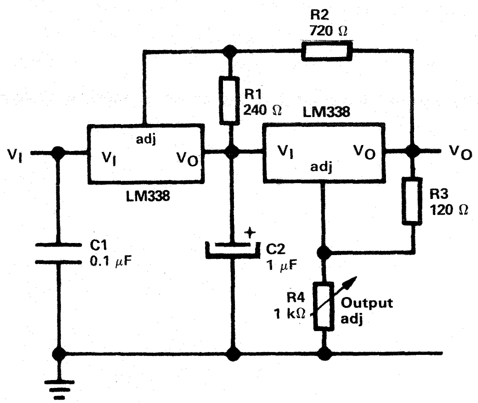
* Minimum load − 100 mA
$V_I \geqslant +10$ V
$V_O \geqslant +3$ V
$V_I - V_O \geqslant +4$ V

5 V LOGIC REGULATOR WITH ELECTRONIC SHUTDOWN**

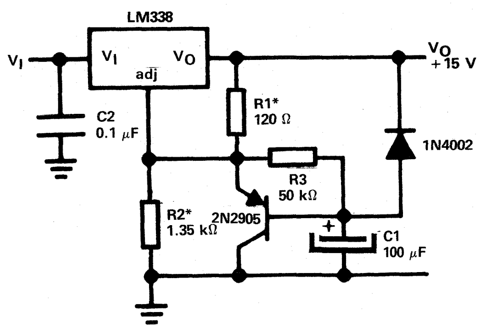


* R1 = 240 Ω for LM138 or LM238
* R2 = 720 Ω for LM138 or LM238
** Minimum output ≈ +1.2 V

TRACKING PREREGULATOR

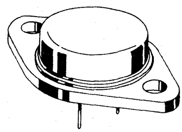


SLOW TURN-ON 15 V REGULATOR

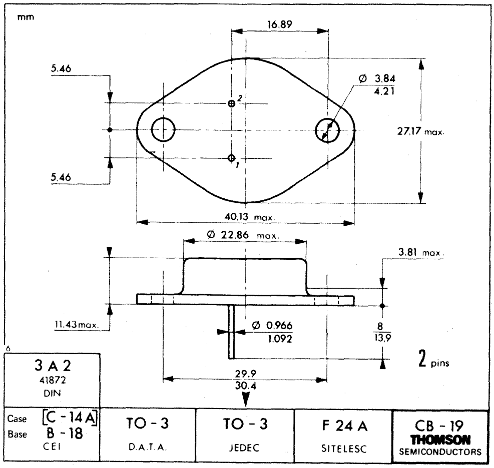


*R1 = 240 Ω
R2 = 2.7 kΩ } for LM 138 and LM 238

CB-19
(TO-3)



K SUFFIX
STEEL CAN



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TEA5110

LOW DROP-OUT 5-V DUAL VOLTAGE REGULATOR

The TEA 5110 is a dual positive 5-V voltage regulator specially designed to supply a microprocessor and associated circuits.

The first regulator supplies the microprocessor in normal operating conditions. In standby mode, the regulator has a very high output impedance (current drain less than 1 μA) and the microprocessor may be powered by a battery.

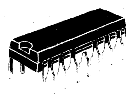
The second regulator supplies the peripherals and provides a halt signal to the microprocessor to turn it in standby mode.

The circuit generates a reset pulse when :
— the supply voltage is applied to the circuit and the output of the second regulator is at its nominal value, and
— when the output of the second regulator is at its nominal value again after a shut-down on the output of the first regulator (see Figure 2 page 5)

- Output current of both regulators : 100 mA guaranteed
- Internal short-circuit and thermal protection
- First regulator output : low discharge current
- Second regulator output : switched-off with active discharge
- Reset output with adjustable pulse width

LOW DROP-OUT 5-V DUAL VOLTAGE REGULATOR

CASE CB-502



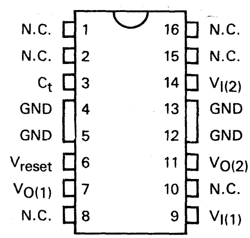
DP SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE DP
TEA 5110	0°C to +70°C	•

PIN ASSIGNMENT

(Top view)



Réf. 00205

MAXIMUM RATINGS

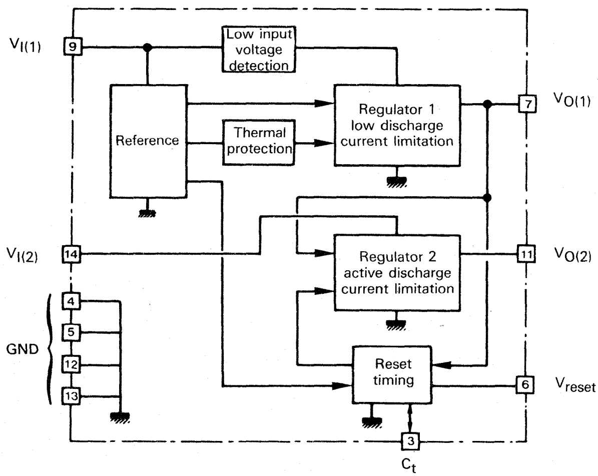
Rating	Symbol	Value	Unit
Input voltage	V_I	20	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Operating ambient temperature range	T_{oper}	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-ambient thermal resistance	$R_{th(j-a)}$*	45	°C/W
Junction-case thermal resistance	$R_{th(j-c)}$	11	°C/W

* The $R_{th(j-a)}$ is measured on devices soldered on 35 μm thick copper surface of 40 cm².

SCHEMATIC DIAGRAM



1 - N.C.
2 - N.C.
3 - C_t : Time constant capacitor
4 - GND : Ground
5 - GND : Ground
6 - V_{reset} : Reset output
7 - $V_{O(1)}$: Output voltage 1
8 - N.C.
9 - $V_{I(1)}$: Input voltage
10 - N.C.
11 - $V_{O(2)}$: Output voltage 2
12 - GND : Ground
13 - GND : Ground
14 - $V_{I(2)}$: Input voltage 2
15 - N.C.
16 - N.C.

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$
(Unless otherwise specified)

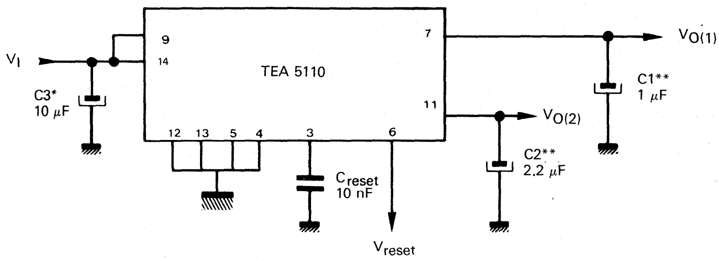
Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage ($+7\ V \leq V_I \leq +18\ V$, $0 \leq I_{O(1)} \leq 100\ mA$)	$V_{O(1)}$	4.9	5.05	5.2	V
Output voltage ($+7\ V \leq V_I \leq +18\ V$, $0 \leq I_{O(2)} \leq 100\ mA$)	$V_{O(2)}$	4.8	5	5.2	V
Output voltage difference $+7\ V \leq V_I \leq +18\ V$, $0 \leq I_{O(1)} \leq 100\ mA$, $0 \leq I_{O(2)} \leq 100\ mA$	$V_{O(1)}$-$V_{O(2)}$	0	50	100	mV
Line regulation $+6.8\ V \leq V_I \leq +18\ V$, $I_{O(1)} = 50\ mA$ $+6.8\ V \leq V_I \leq +18\ V$, $I_{O(2)} = 50\ mA$	 $K_{VI(1)}$ $K_{VI(2)}$	 – –	 10 20	 50 50	mV
Load regulation $5\ mA \leq I_{O(2)} \leq 100\ mA$, $V_I = +10\ V$ $5\ mA \leq I_{O(2)} \leq 100\ mA$, $V_I = +10\ V$	 $K_{VO(1)}$ $K_{VO(2)}$	 – –	 10 20	 50 50	mV
Quiescent current ($+6.8\ V \leq V_I \leq +18\ V$, $I_{O(1)} = I_{O(2)} = 0$)	I_Q	–	6	8	mA
Short-circuit current $V_I = +10\ V$, $0 \leq V_{O(1)} \leq +5\ V$ $V_I = +10\ V$, $0 \leq V_{O(2)} \leq +5\ V$	 $I_{SC(1)}$ $I_{SC(2)}$	 – –	 200 200	 – –	mA
Minimum dropout voltage - (Note 1) Output 1 $I_{O(1)} = 0$ Output 1 $I_{O(1)} = 0.1\ A$ Output 2 $I_{O(2)} = 0$ Output 2 $I_{O(2)} = 0.1\ A$	 V_I-$V_{O(1)}$ V_I-$V_{O(2)}$	 – – – –	 1.4 1.6 1.5 1.7	 – – – –	V
$V_{O(1)}$ discharge current ($V_I = 0$, $V_{O(1)} = +5\ V$)	$I_{dis(1)}$	–	–	1	µA
Minimum input voltage to switch on $V_{O(2)}$ output (Fig. 1, Note 2)	–	$(V_{O1} + 1.4)$	$(V_{O1} + 1.6)$	$(V_{O1} + 1.8)$	V
Input hysteresis to switch off $V_{O(2)}$ output (Fig. 1)	ΔV_{IL}	200	300	400	mV
Minimum $V_{O(1)}$ output voltage to switch on $V_{O(2)}$	–	4.5	4.6	4.7	V
$V_{O(1)}$ hysteresis voltage to switch off $V_{O(2)}$ (Fig. 2)	$\Delta V_{C(1)}$	30	50	70	mV
$V_{O(2)}$ low output voltage (active discharge) $V_I = +10\ V$, $I_{O(2)} = -90\ mA$ $V_I = +10\ V$, $I_{O(2)} = -10\ mA$	$V_{L(02)}$	 – –	 1.3 120	 1.6 180	 V mV
Reset low output voltage ($V_I = +10\ V$, $I_{reset} = -16\ mA$)	$V_{L(reset)}$	–	120	400	mV
Reset high output voltage ($V_I = +10\ V$, $I_{reset} = 1\ mA$)	$V_{H(reset)}$	$V_{O(2)} - 1$	–	$V_{O(2)}$	V
Reset pulse duration ($V_I = +10\ V$, $C_{reset} = 10\ nF$) - Note 3	t_{reset}	4	8	16	ms
Average temperature coefficient of output voltage ($T_j = 0°C$ to $-70°C$)	αV_O	–	0.5	–	mV/°C
Thermal shut down temperature	θ	110	–	–	°C
Supply voltage rejection ratio $V_I = +12\ V$, $\Delta V_I = 4\ Vpp$, $I_O = 10\ mA$, $f = 100\ Hz$	SVR	 –	 50	 –	dB

Note 1 : The dropout voltage (input-output voltage difference) is measured when the output voltage has dropped 100 mV from the nominal value obtained at 10 V input voltage.
Dropout voltage is dependent upon load current and junction temperature.

Note 2 : $V_{O(1)}$ voltage is measured at 10 V input voltage.

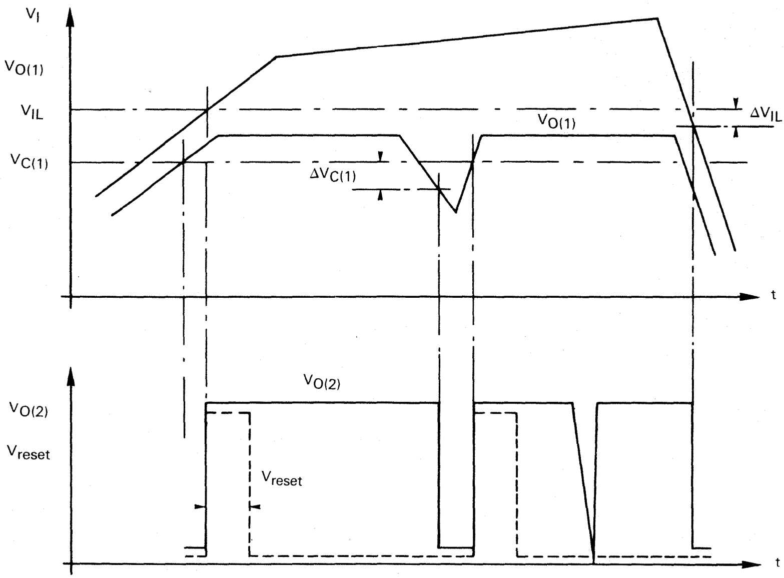
Note 3 : $t_{reset}(ms) = 0.8.C_{reset}(nF)$

FIG. 1 - TYPICAL APPLICATION AND TEST CIRCUIT

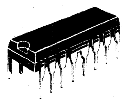


C1, C2, C3 solid tantalum capacitors
* Required when the circuit is far from power supply capacitors.
** Required for current limitation stability.

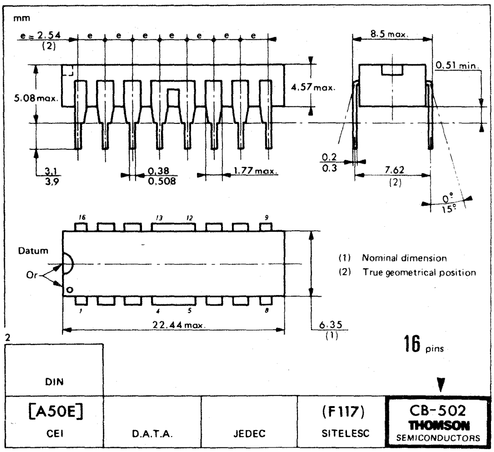
FIG. 2 - DYNAMIC CHARACTERISTICS OF $V_{O(1)}$, $V_{O(2)}$, V_{reset} OUTPUTS



CB-502



DP SUFFIX
PLASTIC PACKAGE



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TEA7028

ADVANCE INFORMATION

LOW DROP-OUT 5-V VOLTAGE REGULATOR

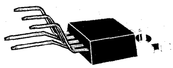
TEA7028 is a 5 volts regulator with low dropout voltage designed to operate in unfavourable automotive environments. The circuit also features a highly efficient protection function against micro-interruptions of the supply voltage.

TEA7028 includes also short-circuit and thermal protections.

- Output voltage : +4.7 V ± 2.5%
- Output current : ⩾500 mA
- Typical dropout voltage : 0.2 V @ 200 mA
- Input surge voltage : +80 V

LOW DROP-OUT 5-V VOLTAGE REGULATOR

CASE CB-360



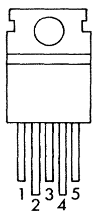
SP5-2 SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	PACKAGE SP5-2
TEA7028	●
Examples : TEA7028SP5-2	

PIN ASSIGNMENT
(Front view)

CB-360



1 - Input voltage
2 - Reset output
3 - Ground, substrate, heat sink
4 - Delay capacitor, drive to auxiliary series transistor
5 - Output

Réf. 00430

THOMSON SEMICONDUCTORS
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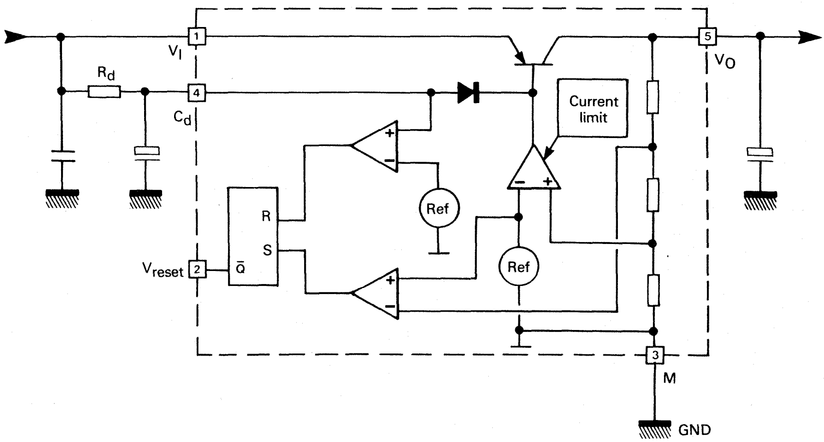
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage · — continuous — transitory $\tau = 300$ ms	V_I	 30 80	V
Continuous inverse input voltage	$V_{I(R)}$	− 18	V
Junction temperature	T_j	+ 150	°C
Storage temperature range	T_{stg}	− 55 to + 150	°C

SCHEMATIC DIAGRAM



1 - V_I : Input voltage
2 - V_{reset} : Reset output
3 - M : Ground, substrate, breat sink
4 - Cd : Delay capacitor, drive to auxiliary series transistor
5 - V_O : Output

ELECTRICAL CHARACTERISTICS

$V_I = +14.4$ V, $T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage, $I_O =$ 5 to 200 mA	V_O	4.5	4.7	4.9	V
Input supply voltage	V_I	–	–	28	V
Supply current $I_O = 0$ $I_O = 200$ mA	I_{CC}	 – –	 5 25	 – –	mA
Line regulation ($V_I = +6$ V to $+26$ V, $I_O = 5$ mA)	K_{VI}	–	15	–	mV
Load regulation ($I_O = 5$ to 200 mA)	K_{VO}	–	15	–	mV
Dropout voltage ($I_O = 200$ mA)	$V_I - V_O$	–	0.2	–	V
Output voltage drift	$\left\lvert \frac{\Delta V_O}{\Delta T} \right\rvert$	–	0.4	–	mV/°C
Supply voltage rejection ($I_O = 150$ mA, f = 120 Hz, $C_O = 10$ µF, $V_I = +12$ V ± 5)	SVR	–	60	–	dB
Short-circuit output current	I_{OS}	–	0.7	–	A
Reset voltage ($I_2 = 16$ mA, $V_O \leq +4.5$ V)	V_{reset}	–	–	0.80	V
Reset output leakage current (normal regulation)	I_{reset}	–	–	1	µA
Reset pulse duration (Application n°1) $C_d = 2.2$ µF, $R_d = 33$ kΩ	t_{d1}	 –	 30	 –	ms
Reset pulse duration (Application n° 2) $C_d = 47$ µF, $R_d = 1.5$ kΩ	t_{d1}	 –	 30	 –	ms
Reset lower threshold level	$V_{thL(reset)}$	4.5	$V_O - 0.05$	–	V
Reset upper threshold level	$V_{thH(reset)}$	–	6	–	V
Autonomy time ($C_d = 47$ µF, $R_d = 1.5$ kΩ, $I_O = 150$ mA)	t_{aut}	–	2.5	–	ms
Quiescent current (normal regulation)	$I_{(4)}$	–	−10	–	µA

TEA7028 voltage regulator is particularly intented to provide a stable and clean power supply to microprocessor-based systems operating in harsh environments encountered in automotive applications. The regulated output voltage is efficiently maintained constant under following conditions :

- On ignition switch-on, where supply voltage could drop to as low as 5 V.
- Battery disconnection "Load Dump" resulting in positive voltage transients.
- Input voltage interruption or short polarity reversals.

In addition, the regulator provides an initialization signal for microprocessor $\overline{\text{RESET}}$ input.

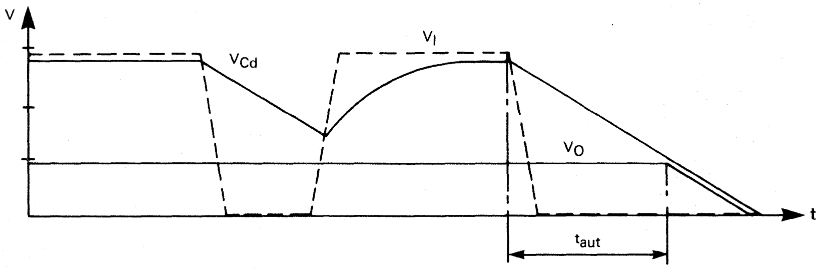
This signal has two distinct **functions** :

1. Upon initial power on, it maintains the microprocessor in initialization mode for a period long enough so as to stabilize the clock operation.
2. To reinitialize the microprocessor every time the supply voltage falls below the limit required for a reliable operation of the microprocessor.

In order to take full advantage of the remarkable features offered by this regulator, the user is recommended to use the application diagram 2. In this configuration, capacitor C_d is used to provide two functions :

- to determine the duration of the initialization cycle, and
- to act as a storage capacitor providing supply continuity in case of short interruptions of the input voltage.

Under normal operating conditions, capacitor C_d is charged to approximately the value of the input voltage. To guarantee output voltage continuity, as soon as a supply interruption occurs, this capacitor supplies required power to an external pass transistor which replaces in this event the internal series transistor included in the regulation loop.



The autonomy time (t_{aut}) is calculated using the following formula :

$$t_{aut} \cong \frac{R_d\ C_d\ (V_I - V_O)}{I_O}$$

With a storage capacitor value of 47 μF, t_{aut} will be in the order of a few ms and can be increased using higher capacitor values.

Fewer external components are required for configuration given by application diagram 1. However, it does not accomplish output continuity function in case of power supply interruption and on the other hand, initialization function is limited to that described in paragraph 1 above.

Under all circumstances, the duration of the initialization period (t_d) is determined by the voltage accross capacitor C_d ; that is, C_d begins charging through R_d - initialization ceases as soon as V_{Cd} reaches 6 V, restarts when V_O drops below +4.5 V.

Upon initial power on :

$$t_{d1} = R_d\ C_d \log \frac{V_I}{V_I - V_{thH(reset)}}$$

While operating, if V_O falls below $V_{thL(reset)}$ then :

$$t_{d2} = R_d\ C_d \log \frac{V_I - V_{thL(reset)}}{V_I - V_{thH(reset)}}$$

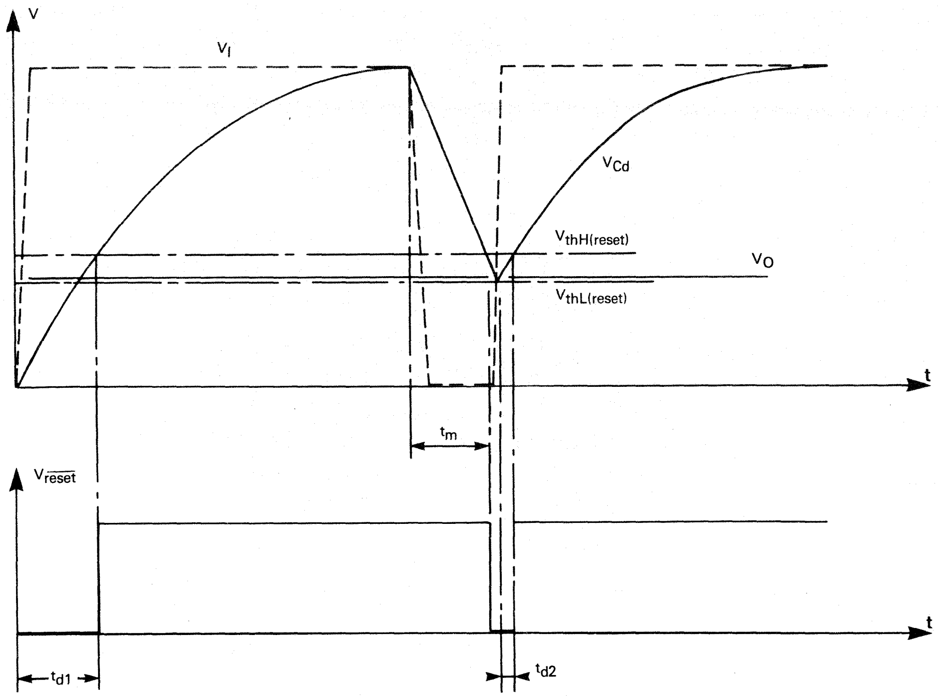
For a +14.4 V battery :

$t_{d1} = 0.54\ R_d\ C_d$

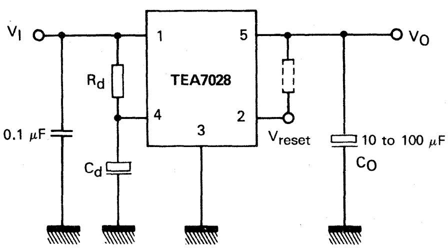
$t_{d2} = 0.17\ R_d\ C_d$

Note that in above given formulae factors such as pin 4 quiescent current and reverse current across the series transistor have not been taken into account. These factors once considered will alter slightly the results- but however, the above formulae can be used to obtain satisfactory results.

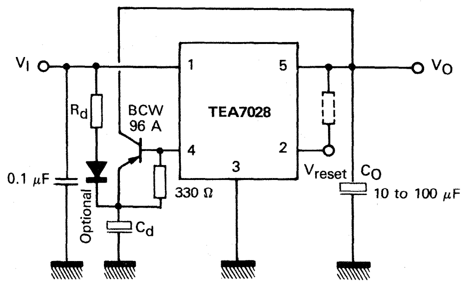
DEFINITION OF RESET PULSE DURATION



APPLICATION DIAGRAMS

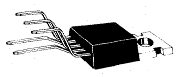


1. Without supply interruption back up

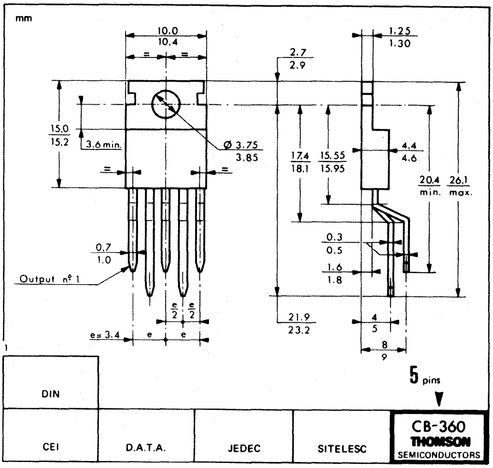


2. With supply interruption back up

CB-360



SP5-2 SUFFIX
PLASTIC PACKAGE



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Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TEA7034

ADVANCE INFORMATION

LOW DROP-OUT 5-V VOLTAGE REGULATOR

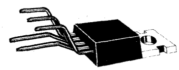
TEA7034 is a 5 volt regulator with low dropout voltage designed to operate in unfavourable automotive environments. The circuit also features a highly efficient protection function against micro-interruptions of the supply voltage.

TEA7034 includes also short-circuit and thermal protections.

- Output voltage : +5 V ±2.5%.
- Output current : ⩾500 mA.
- Typical dropout voltage : 0.6 V @ 500 mA.
- Input surge voltage : +80 V.

LOW DROP-OUT 5-V VOLTAGE REGULATOR

CASE CB-360

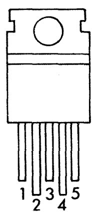


SP5-2 SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	PACKAGE SP5-2
TEA7034	•
Examples : TEA7034SP5-2	

PIN ASSIGNMENT
(Front view)



1 - Input voltage
2 - Reset output
3 - Ground, substrate, heat sink
4 - Delay capacitor, drive to auxiliary series transistor
5 - Output

Réf. 00360

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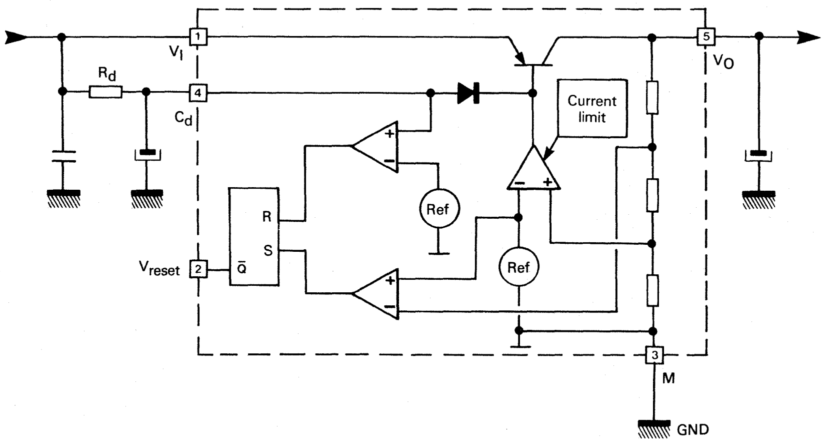
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage — continuous — transitory $\tau = 300$ ms	V_I	 30 80	V
Continuous inverse input voltage	$V_{I(R)}$	− 18	V
Junction temperature	T_j	+ 150	°C
Storage temperature range	T_{stg}	− 55 to + 150	°C

SCHEMATIC DIAGRAM



1 - Input supply voltage.
2 - Reset output.
3 - Ground, substrate, heat sink.
4 - Delay capacitor, drive to auxiliary series transistor.
5 - Output.

ELECTRICAL CHARACTERISTICS

$V_I = +14.4$ V, $T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage ($I_O = 5$ to 500 mA)	V_O	4.8	5	5.2	V
Input supply voltage	V_I	–	–	28	V
Supply current $I_O = 0$ mA $I_O = 150$ mA $I_O = 500$ mA	I_{CC}	 – – –	 5 20 100	 – – –	mA
Line regulation ($V_I = +6$ to $+26$ V, $I_O = 5$ mA)	K_{VI}	–	5	–	mV
Load regulation ($I_O = 5$ to 500 mA)	K_{VO}	–	15	–	mV
Dropout voltage $I_O = 500$ mA $I_O = 150$ mA	$V_I - V_O$	 – –	 0.6 0.18	 – –	V
Output voltage drift	$\left\| \frac{\Delta V_O}{\Delta T} \right\|$	–	0.5	–	mV/°C
Supply voltage rejection ($I_O = 350$ mA, f = 120 Hz, $C_O = 10$ µF, $V_I = +12$ V ±5)	SVR	–	60	–	dB
Short-circuit output current	I_{OS}	–	0.8	–	A
Reset voltage ($I_2 = 16$ mA, $V_O \leqslant +4.75$ V)	V_{reset}	–	–	0.80	V
Reset output leakage current (normal regulation)	I_{reset}	–	–	1	µA
Reset pulse duration (Application n° 1) ($C_d = 2.2$ µF, $R_d = 33$ kΩ)	t_{d1}	–	30	–	ms
Reset pulse duration (Application n° 2) ($C_d = 47$ µF, $R_d = 1.5$ kΩ)	t_{d1}	–	30	–	ms
Reset lower threshold level	$V_{thL(reset)}$	4.75	$V_O - 0.05$	–	V
Reset upper threshold level	$V_{thH(reset)}$	–	6	–	V
Autonomy time ($C_d = 47$ µF, $R_d = 1.5$ kΩ, $I_O = 150$ mA)	t_{aut}	–	2.5	–	ms
Quiescent current (normal regulation)	$I_{(4)}$	–	– 10	–	µA

TEA7034 voltage regulator is particularly intented to provide a stable and clean power supply to microprocessor-based systems operating in harsh environments encountered in automotive applications. The regulated output voltage is efficiently maintained constant under following conditions :

- On ignition switch-on, where supply voltage could drop to as low as 5 V.
- Battery disconnection "Load Dump" resulting in positive voltage transients.
- Input voltage interruption or short polarity reversals.

In addition, the regulator provides an initialization signal for microprocessor $\overline{RESET}$ input.

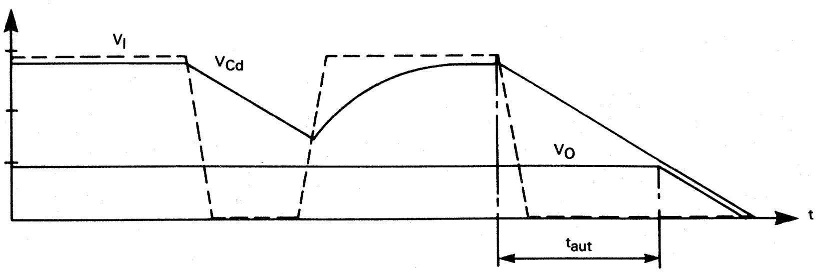
This signal has two distinct functions :

1. Upon initial power on, it maintains the microprocessor in initialization mode for a period long enough so as to stabilize the clock operation.
2. To reinitialize the microprocessor every time the supply voltage falls below the limit required for a reliable operation of the microprocessor.

In order to take full advantage of the remarkable features offered by this regulator, the user is recommended to use the application diagram 2. In this configuration, capacitor C_d is used to provide two functions :

- to determine the duration of the initialization cycle, and
- to act as a storage capacitor providing supply continuity in case of short interruptions of the input voltage.

Under normal operating conditions, capacitor C_d is charged to approximately the value of the input voltage. To guarantee output voltage continuity, as soon as a supply interruption occurs, this capacitor supplies required power to an external pass transistor which replaces in this event the internal series transistor included in the regulation loop.



The autonomy time(t_{aut})is calculated using the following formula :

$$t_{aut} \cong \frac{R_d\ C_d\ (V_I - V_O)}{I_O}$$

With a storage capacitor value of 47 μF, t_{aut} will be in the order of a few ms and can be increased using higher capacitor values.

Fewer external components are required for configuration given by application diagram 1. However, it does not accomplish output continuity function in case of power supply interruption and on the other hand, initialization function is limited to that discussed in paragraph 1 above.

Under all circumstances, the duration of the initialization period (t_d) is determined by the voltage accross capacitor C_d ; that is, C_d begins charging through R_d - initialization ceases as soon as V_{Cd} reaches 6 V, restarts when V_O drops below +4.75 V.

Upon initial power on :

$$t_{d1} = R_d\ C_d\ \log \frac{V_I}{V_I - V_{thH(reset)}}$$

While operating, if V_O falls below $V_{thL(reset)}$ then :

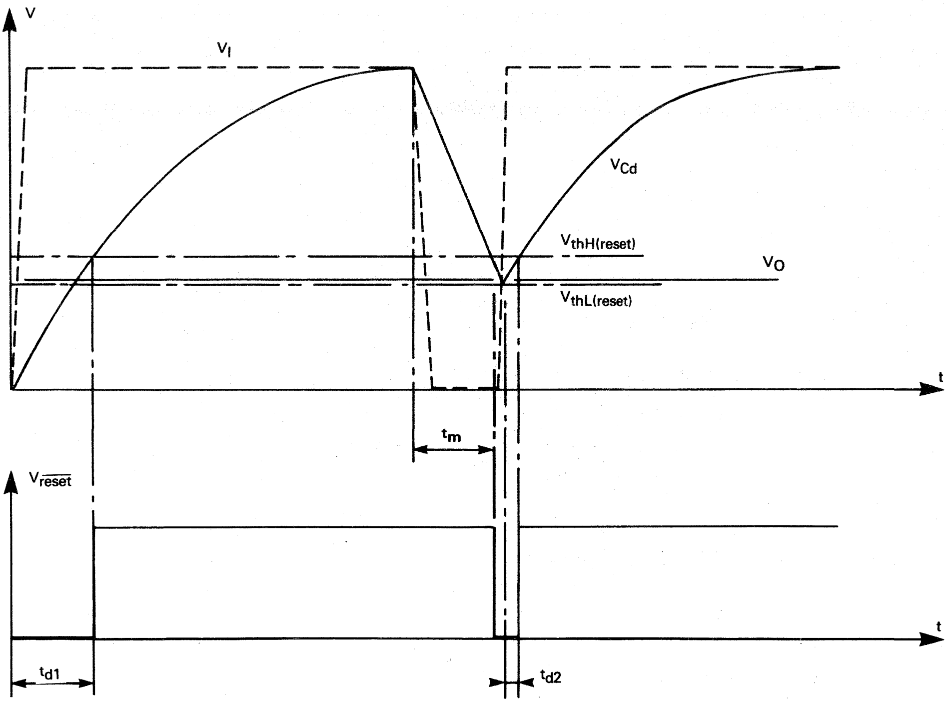
$$t_{d2} = R_d\ C_d\ \log \frac{V_I - V_{thL(reset)}}{V_I - V_{thH(reset)}}$$

For a +14.4 V battery :

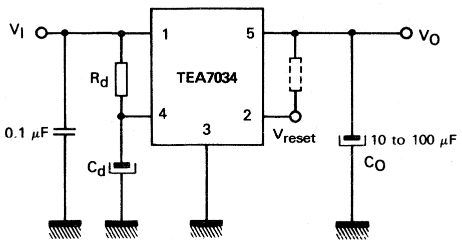
$t_{d1} = 0.54\ R_d\ C_d$
$t_{d2} = 0.17\ R_d\ C_d$

Note that in above given formulae factors such as pin 4 quiescent current and reverse current across the series transistor have not been taken into account. These factors once considered will alter slighty the results-but however, the above formulae can be used to obtain satisfactory results.

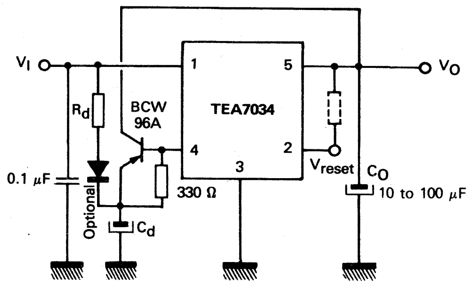
DEFINITION OF RESET PULSE DURATION



APPLICATION DIAGRAMS

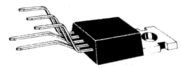


1. Without supply interruption back up

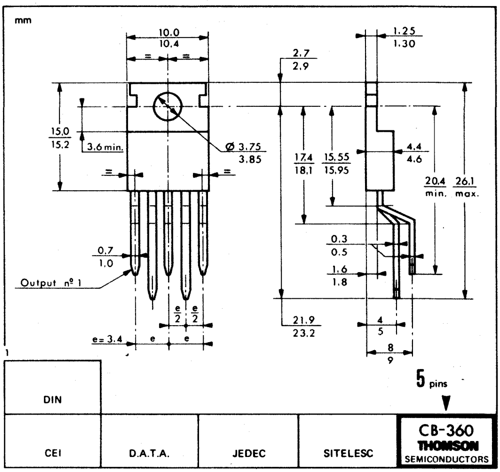


2. With supply interruption back up

CB-360



SP5-2 SUFFIX
PLASTIC PACKAGE



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Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA723
UA723A

PRECISION ADJUSTABLE POSITIVE VOLTAGE REGULATORS

The UA723,A is a monolithic voltage regulator constructed on a single silicon chip. The device consists of a temperature compensated reference amplifier, error amplifier, power series pass transistor and current limit circuitry. Additional NPN or PNP pass elements may be used when output currents exceeding 150 mA are required. Provisions are made for adjustable current limiting and remote shut down. In addition to the above the device features low standby current drain, low temperature drift and high ripple rejection. Applications include laboratory power supplies, airborne systems and other power supplies for digital and linear circuits.

- Positive or negative supply operation.
- Series, shunt, switching or floating operation.
- 0.01% line regulation.
- Output voltage adjustable from 2 to 37 volts.
- Output current up to 150 mA without external pass transistor.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

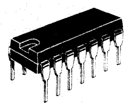
PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		H	DP	FP	DG
UA723C	0°C to + 70°C	•	•	•	•
UA723I	−25°C to + 85°C	•	•	•	
UA723M	−55°C to +125°C	•	•		•
UA723AC	0°C to + 70°C	•	•	•	
UA723AM	−55°C to +125°C	•	•		

Examples : UA723CH, UA723CDP, UA723CFP, UA723CDG

PRECISION ADJUSTABLE POSITIVE VOLTAGE REGULATORS

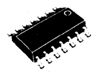
CASES

CB-2
(TO-116)



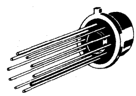
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511
(SO-14)



FP SUFFIX
PLASTIC
MICROPACKAGE

CB-3
(TO-100)

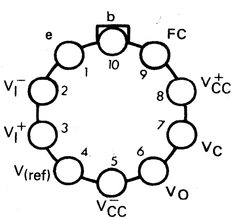


H SUFFIX
METAL CAN

PIN ASSIGNMENTS

(Bottom view)

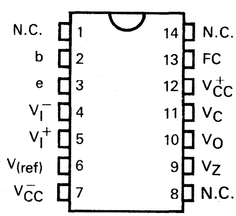
CB-3



Pin 5 is connected to case.

(Top view)

CB-2 - CB-511



Réf. 00115

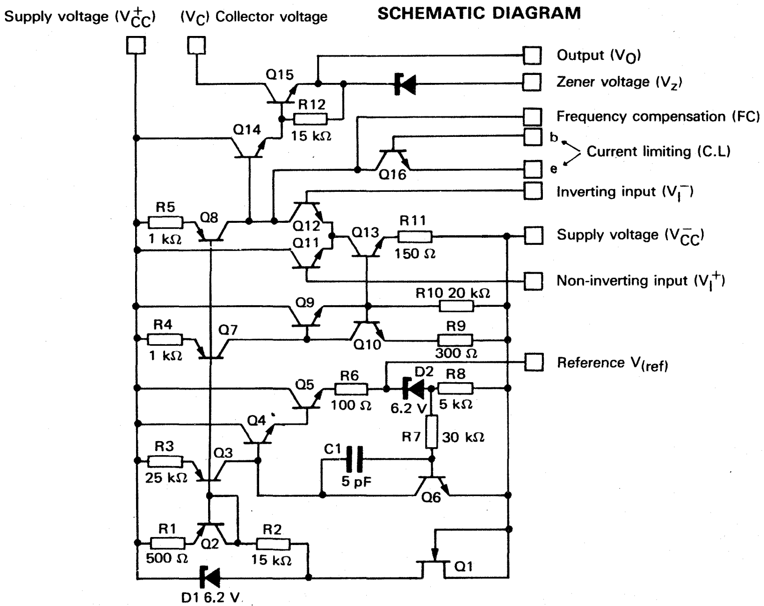
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage (Both inputs)	V_I	40	V
Pulse voltage from V_{CC}^{+} to V_{CC}^{-} (50 ms)	$V_{I(pulse)}$	50	V
Input-output voltage differential	$V_I - V_O$	38	V
Output current	I_O	150	mA
Operating junction temperature range UA723C UA723M UA723I	T_{oper}	 0 to + 70 −55 to +125 −25 to + 85	°C
Storage temperature range	T_{stg}	−65 to +150	°C
Internal power dissipation	P_D	500	mW

THERMAL CHARACTERISTICS

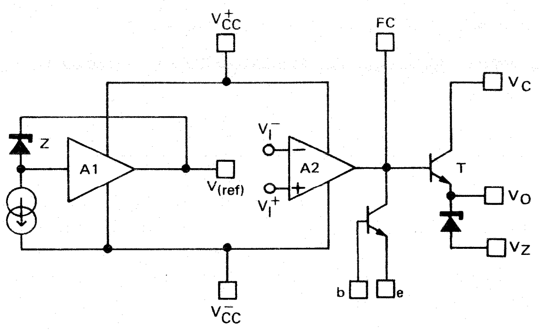
Rating	Symbol	Value	Unit
Maximum junction-case thermal resistance CB-3 (plastic) CB-2 (cerdip) CB-2	$R_{th(j-c)}$	 45 50 25	°C/W
Maximum junction-ambient thermal resistance CB-3 (plastic) CB-2 (cerdip) CB-2	$R_{th(j-a)}$	 185 150 100	°C/W
Junction ceramic-substrate (Case glued to substrate) CB-511	–	90	°C/W
Junction ceramic-substrate CB-511 (Case glued to substrate, substrate temperature maintained constant)	–	65	°C/W

SCHEMATIC DIAGRAM



CASE	V_I^-	V_I^+	$V_{(ref)}$	V_{CC}^-	V_{CC}^+	V_Z	V_O	F.C.	C.L.	V_C	N.C.
CB-3	2	3	4	5	8	–	6	9	1, 10	7	–
CB-2, CB-511	4	5	6	7	12	9	10	13	2, 3	11	1, 8, 14

EQUIVALENT CIRCUIT



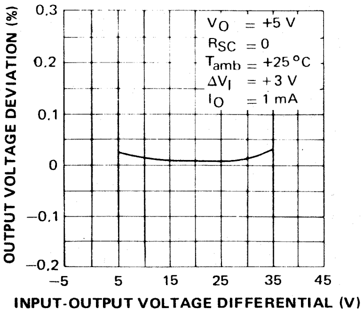
Z : Temperature compensated zener
A1 : Voltage reference amplifier
A2 : Error amplifier
T : Series pass transistor

ELECTRICAL CHARACTERISTICS

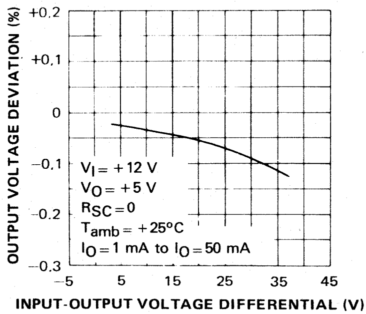
Unless otherwise specified, $T_{amb} = +25°C$, $V_I = V_{CC}^{+} = V_C = +12$ V, $V_{CC}^{-} = 0$, $V_O = +5$ V, $I_C = 1$ mA, $R_{SC} = 0$, C1 (compensation) = 100 pF and divider impedance as seen by error amplifier ⩽ 10 kΩ.
Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.

Characteristic	Symbol	UA723M			UA723C,I			Unit
		Min	Typ	Max	Min	Typ	Max	
Input voltage range	V_I	9.5	–	40	9.5	–	40	V
Output voltage range	V_O	2	–	37	2	–	37	V
Input-output voltage differential	$V_I - V_O$	3	–	38	3	–	38	V
Line regulation	K_{VI}							%/V_O
$T_{amb} = +25°C$, $+12\ V \leq V_I \leq +15$ V		–	0.01	0.1	–	0.01	0.1	
$+12\ V \leq V_I \leq +40$ V		–	0.02	0.2	–	0.1	0.5	
$T_{min} \leq T_{amb} \leq T_{max}$, $+12\ V \leq V_I \leq +15$ V		–	–	0.3	–	–	0.3	
Load regulation (1 mA ⩽ I_O ⩽ 50 mA)	K_{VO}							%/V_O
$T_{amb} = +25°C$		–	0.03	0.15	–	0.03	0.2	
$T_{min} \leq T_{amb} \leq T_{max}$		–	–	0.6	–	–	0.6	
Ripple rejection (50 Hz ⩽ f ⩽ 10 kHz)	R_{vf}							dB
$C_{(ref)} = 0$		–	74	–	–	74	–	
$C_{(ref)} = 5\ \mu F$		–	86	–	–	86	–	
Standby current drain ($I_O = 0$, $V_I = +30$ V)	I_{IB}	–	2.3	3.5	–	2.3	4	mA
Reference voltage	$V_{(ref)}$	6.95	7.15	7.35	6.8	7.15	7.5	V
Short-circuit current ($R_{SC} = 10\ \Omega$, $V_O = 0$)	I_{SC}	–	65	–	–	65	–	mA
Output noise voltage (100 Hz ⩽ f ⩽ 10 kHz)	V_{NO}							μV_{rms}
$C_{(ref)} = 0$		–	20	–	–	20	–	
$C_{(ref)} = 5\ \mu F$		–	2.5	–	–	2.5	–	
Average temperature coefficient of output voltage $T_{min} \leq T_{amb} \leq T_{max}$	αV_O	–	0.002	0.015	–	0.003	0.015	%/°C
Long term stability	K_{VH}							%/ 1000 H
UA723A		–	0.05	0.2	–	0.05	0.2	
UA723		–	0.1	–	–	0.1	–	

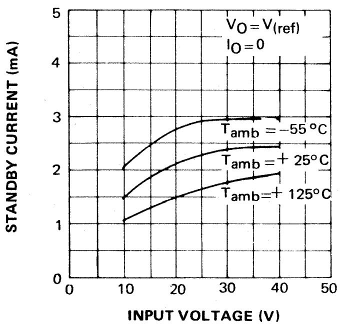
LINE REGULATION



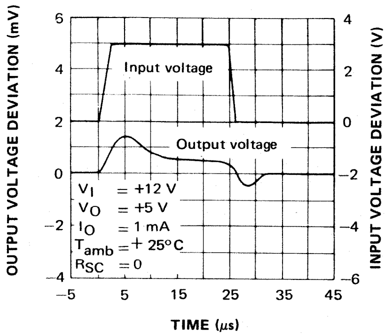
LOAD REGULATION



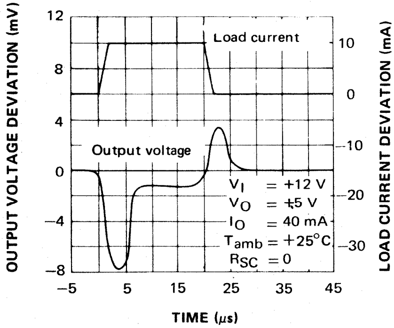
STANDBY CURRENT DRAIN



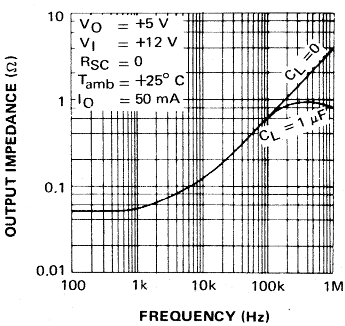
LINE TRANSIENT RESPONSE



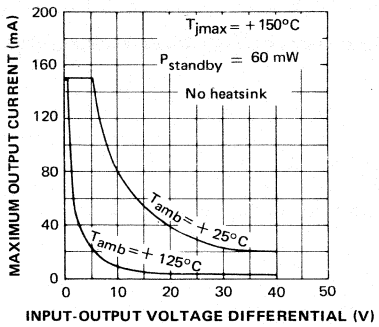
LOAD TRANSIENT RESPONSE



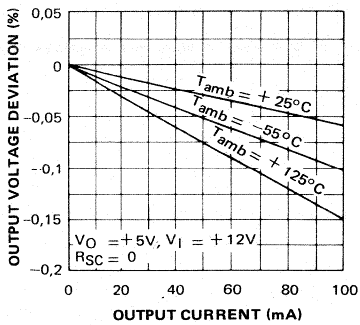
OUTPUT IMPEDANCE



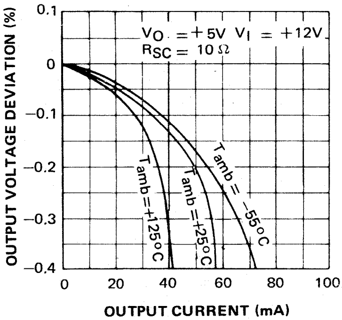
MAXIMUM LOAD CURRENT



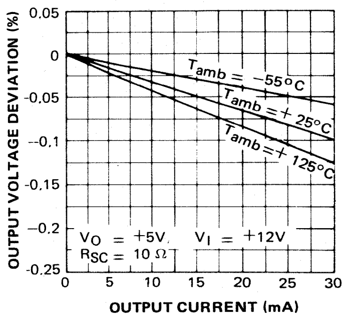
LOAD REGULATION WITHOUT CURRENT LIMITING



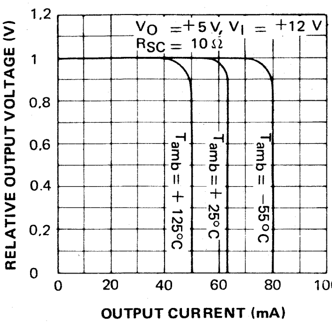
LOAD REGULATION WITH CURRENT LIMITING



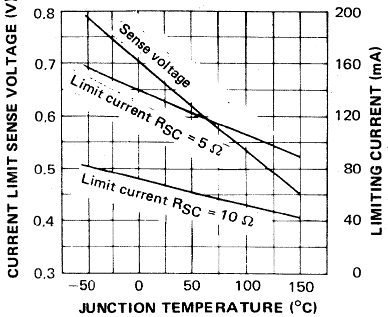
LOAD REGULATION WITH CURRENT LIMITING



CURRENT LIMITING CHARACTERISTICS

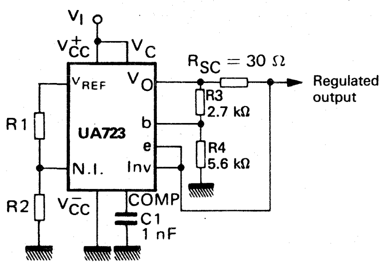


CURRENT LIMITING VS JUNCTION TEMPERATURE



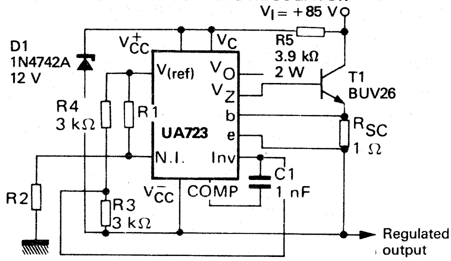
BASIC CIRCUITS

FOLDBACK CURRENT LIMITING



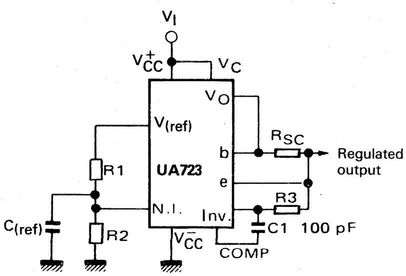
Regulated output voltage	+ 5 V
Line regulation (ΔV_I = 3 V)	0.5 mV
Load regulation (ΔI_L = 10 mA)	1 mV
Short-circuit current	20 mV

POSITIVE FLOATING REGULATOR



Regulated output voltage	+ 50 V
Line regulation (ΔV_I = 20 V)	15 mV
Load regulation (ΔI_L = 50 mA)	20 mV

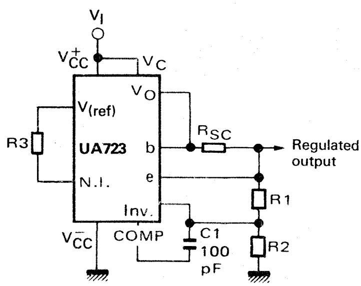
BASIC LOW VOLTAGE REGULATOR
(V_O = 2 to 7 V)



Regulated output voltage	5 V
Line regulation (ΔV_I = 3 V)	0.5 mV
Load regulation (ΔI_L = 50 mA)	1.5 mV

NOTE 3 : $R3 = \frac{R1\ R2}{R1 + R2}$ for minimum temperature drift

BASIC HIGH VOLTAGE REGULATOR
(V_O = 7 to 37 V)

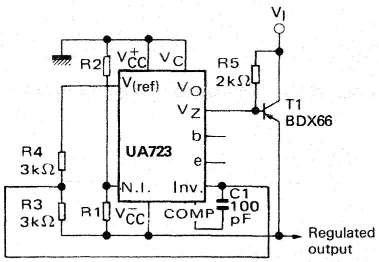


Regulated output voltage	15 V
Line regulation (ΔV_I = 3 V)	1.5 mV
Load regulation (ΔI_L = 50 mA)	4.5 mV

NOTE : $R3 = \frac{R1\ R2}{R1 + R2}$ for minimum temperature drift

R3 may be eliminated for minimum component count

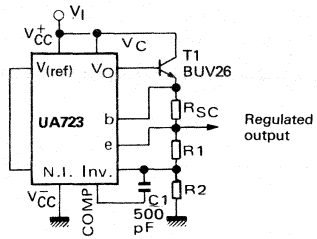
NEGATIVE VOLTAGE REGULATOR (Note 1)



Regulated output voltage	−15 V
Line regulation (ΔV_I = 3 V)	1 mV
Load regulation (ΔI_L = 100 mA)	2 mV

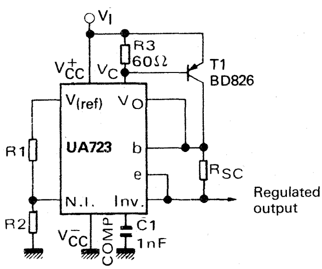
Note 1 : For applications using TO-100 metal cans ; V_Z can be implemented externally by connecting a 6.2 V zener diode to V_O pin.

POSITIVE VOLTAGE REGULATOR
(External NPN Pass Transistor)



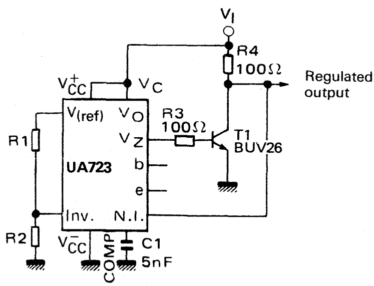
Regulated output voltage	+ 15 V
Line regulation (ΔV_I = 3 V)	1.5 mV
Load regulation (ΔI_L = 1 A)	15 mV

POSITIVE VOLTAGE REGULATOR
(External PNP Pass Transistor)

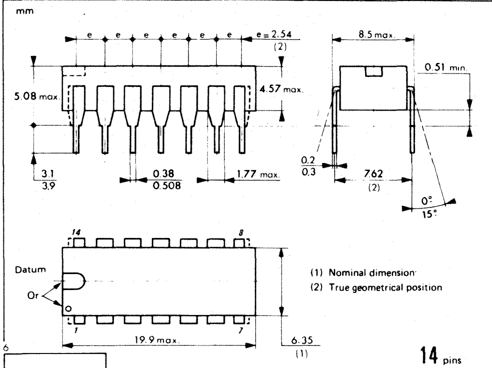


Regulated output voltage	+ 5 V
Line regulation (ΔV_I = 3 V)	0.5 mV
Load regulation (ΔI_L = 1 A)	5 mV

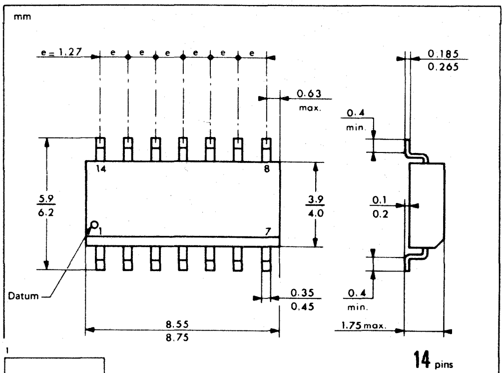
SHUNT REGULATOR



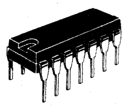
Regulated output voltage	+ 5 V
Line regulation (ΔV_I = 10 V)	0.5 mV
Load regulation (ΔI_L = 100 mA)	1.5 mV



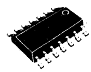
DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS



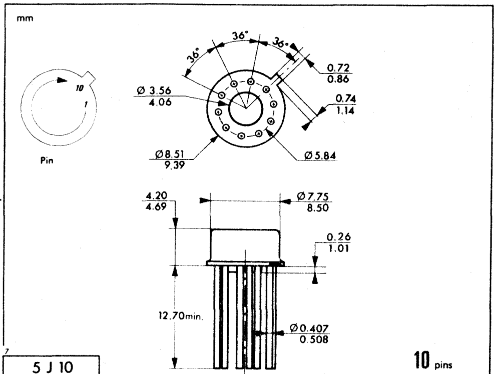
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



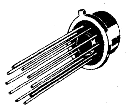
CB-2
DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE



5 J 10 41873 DIN				
Case : C-23 Base : B-33 CEI	TO-100 D.A.T.A.	TO-100 JEDEC	F95 SITELESC	CB-3 THOMSON SEMICONDUCTORS



CB-3
H SUFFIX
METAL CAN

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA78S00 SERIES

ADVANCE INFORMATION

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

The UA78S00 series is available with several fixed output voltages making them usefull in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation.

The UA78S00 series is available in plastic TO-220 and TOP-3, and metal TO-3 packages which allow a 2 A load current, if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

- Output current in excess of 2 A
- Output voltages of 5, 9, 12 and 15 V
- Internal short-circuit current limit
- Thermal overload protection
- Output transistor safe area protection
- Output voltage tolerance : ±2% at +25°C (B version)
  ±3% over full operating temperature range

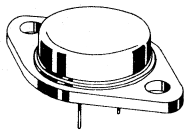
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		K	SP	SP3
UA78S00M	−55°C to +150°C	•		
UA78S00C	0°C to +150°C	•	•	•
UA78S00BM	−55°C to +150°C	•		
UA78S00BC	0°C to +150°C	•	•	•
Examples : UA78S00MK, UA78S00CSP				

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

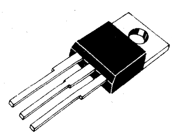
CASES

CB-19
(TO-3)



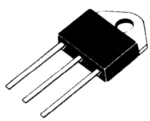
K SUFFIX
STEEL CAN

CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE

CB-244
(TOP 3)

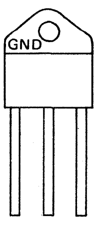


SP3 SUFFIX
PLASTIC PACKAGE

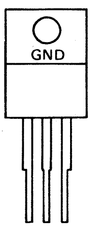
PIN ASSIGNMENTS

(Front views)

CB-244



CB-117

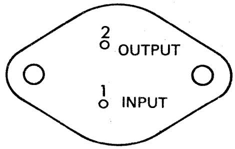


1 : Input
2 : Output
3 : Ground

Heatsink surface connected to ground

(Bottom view)

CB-19



Case is ground

Réf. 00080

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

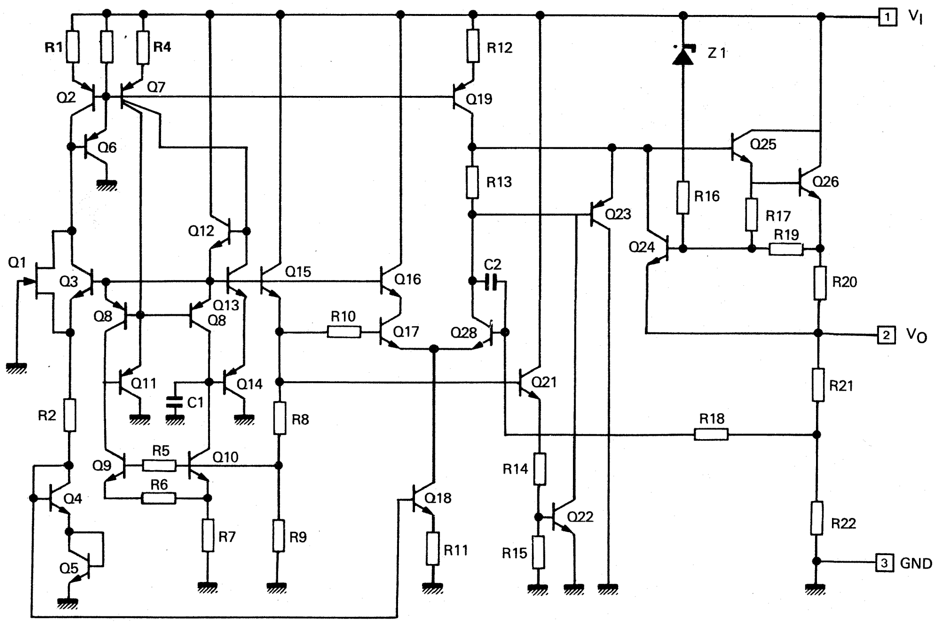
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage	V_I	35	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Junction temperature	T_j	+150	°C
Operating temperature range UA78S00M / UA78S00C	T_{oper}	−55 to +150 / 0 to +150	°C
Storage temperature range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance CB-19 / CB-117 / CB-244	$R_{th(j-c)}$	4 / 3 / 2.5	°C/W
Maximum junction-ambient thermal resistance CB-19 / CB-117 / CB-244	$R_{th(j-a)}$	35 / 70 / 55	°C/W

SCHEMATIC DIAGRAM



CASE	V_I	V_O	GND
CB-19	1	2	Case
CB-117	1	2	3
CB-244	1	2	3

ELECTRICAL CHARACTERISTICS
UA78S05C : $0°C \leq T_j \leq +150°C$
UA78S05M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +10$ V
(Unless otherwise specified)

Characteristic	Symbol	UA78S05B			UA78S05			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +7 V $\leq V_I \leq$ +25 V	V_O	 4.9 4.85	 5 5	 5.1 5.15	 4.8 4.75	 5 5	 5.2 5.25	V
Load regulation ($T_j = +25°C$, 5 mA $\leq I_O \leq$ 2 A)	K_{VO}	–	–	100	–	–	100	mV
Line regulation ($T_j = +25°C$) +7 V $\leq V_I \leq$ +25 V +8 V $\leq V_I \leq$ +12 V	K_{VI}	 – –	 – –	 100 50	 – –	 – –	 100 50	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	–	–	8	–	–	8	mA
Quiescent current change +7 V $\leq V_I \leq$ +25 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 – –	 – –	 1.3 0.5	 – –	 – –	 1.3 0.5	mA
Thermal regulation ($T_{amb} = +25°C$, Pulse 20 ms)	K_{TH}	–	0.07	–	–	0.07	–	%/V
Ripple rejection ($T_j = +25°C$, $I_O = 20$ mA, f = 120 Hz)	R_{vf}	54	–	–	54	–	–	dB
Long term stability ($T_j = +25°C$)	K_{VH}	–	–	20	–	–	20	mV
Output noise voltage ($T_j = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	40	–	–	40	–	μV_{rms}
Dropout voltage ($T_j = +25°C$, $I_O = 1.5$ A)	V_I-V_O	–	2	–	–	2	–	V

ELECTRICAL CHARACTERISTICS
UA78S09C : $0°C \leq T_j \leq +150°C$
UA78S09M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +14$ V
(Unless otherwise specified)

Characteristic	Symbol	UA78S09B			UA78S09			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +11 V $\leq V_I \leq$ +25 V	V_O	 8.82 8.73	 9 9	 9.18 9.27	 8.65 8.6	 9 9	 9.35 9.4	V
Load regulation ($T_j = +25°C$, 5 mA $\leq I_O \leq$ 2 A)	K_{VO}	–	–	130	–	–	130	mV
Line regulation ($T_j = +25°C$) +11 V $\leq V_I \leq$ +25 V +12 V $\leq V_I \leq$ +20 V	K_{VI}	 – –	 – –	 130 65	 – –	 – –	 130 65	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	–	–	8	–	–	8	mA
Quiescent current change +11 V $\leq V_I \leq$ +25 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 – –	 – –	 1.3 0.5	 – –	 – –	 1.3 0.5	mA
Thermal regulation ($T_{amb} = +25°C$, Pulse 20 ms)	K_{TH}	–	0.07	–	–	0.07	–	%/V
Ripple rejection ($T_j = +25°C$, $I_O = 20$ mA, f = 120 Hz)	R_{vf}	53	–	–	53	–	–	dB
Long term stability ($T_j = +25°C$)	K_{VH}	–	–	36	–	–	36	mV
Output noise voltage ($T_j = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	60	–	–	60	–	μV_{rms}
Dropout voltage ($T_j = +25°C$, $I_O = 1.5$ A)	V_I-V_O	–	2	–	–	2	–	V

ELECTRICAL CHARACTERISTICS

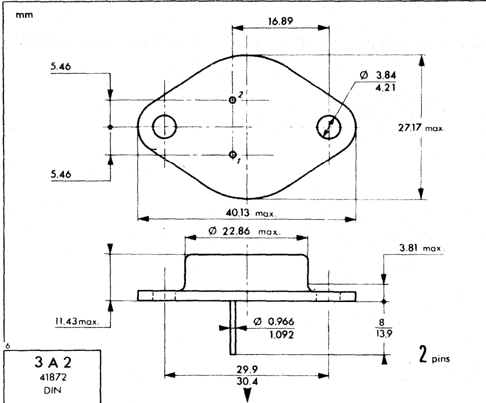
UA78S12C : $0°C \leq T_j \leq +150°C$
UA78S12M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +19$ V
(Unless otherwise specified)

Characteristic	Symbol	UA78S12B			UA78S12			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +14.5 V $\leq V_I \leq$ +30 V	V_O	 11.76 11.64	 12 12	 12.24 12.36	 11.5 11.4	 12 12	 12.5 12.6	V
Load regulation ($T_j = +25°C$, 5 mA $\leq I_O \leq$ 2 A)	K_{VO}	–	–	160	–	–	160	mV
Line regulation ($T_j = +25°C$) +14.5 V $\leq V_I \leq$ +30 V +16 V $\leq V_I \leq$ +22 V	K_{VI}	 – –	 – –	 240 120	 – –	 – –	 240 120	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	–	–	8	–	–	8	mA
Quiescent current change +14.5 V $\leq V_I \leq$ +30 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 – –	 – –	 1 0.5	 – –	 – –	 1 0.5	mA
Thermal regulation ($T_{amb} = +25°C$, Pulse 20 ms)	K_{TH}	–	0.07	–	–	0.07	–	%/V
Ripple rejection ($T_j = +25°C$, $I_O = 20$ mA, f = 120 Hz)	R_{vf}	53	–	–	53	–	–	dB
Long term stability ($T_j = +25°C$)	K_{VH}	–	–	48	–	–	48	mV
Output noise voltage ($T_j = +25°C$, 10 Hz $\leq$ f $\leq$ 100 kHz)	V_{NO}	–	75	–	–	75	–	μV_{rms}
Dropout voltage ($T_j = +25°C$, $I_O = 1.5$ A)	V_I-V_O	–	2	–	–	2	–	V

ELECTRICAL CHARACTERISTICS

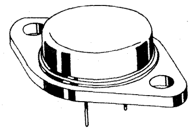
UA78S15C : $0°C \leq T_j \leq +150°C$
UA78S15M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +23$ V
(Unless otherwise specified)

Characteristic	Symbol	UA78S15B			UA78S15			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +17.5 V $\leq V_I \leq$ +30 V	V_O	 14.7 14.55	 15 15	 15.3 15.45	 14.4 14.25	 15 15	 15.6 17.75	V
Load regulation ($T_j = +25°C$, 5 mA $\leq I_O \leq$ 2 A)	K_{VO}	–	–	180	–	–	180	mV
Line regulation ($T_j = +25°C$) +17.5 V $\leq V_I \leq$ +30 V +20 V $\leq V_I \leq$ +26 V	K_{VI}	 – –	 – –	 300 150	 – –	 – –	 300 150	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	–	–	8	–	–	8	mA
Quiescent current change +17.5 V $\leq V_I \leq$ +30 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 – –	 – –	 1 0.5	 – –	 – –	 1 0.5	mA
Thermal regulation ($T_{amb} = +25°C$, Pulse 20 ms)	K_{TH}	–	0.07	–	–	0.07	–	%/V
Ripple rejection ($T_j = +25°C$, $I_O = 20$ mA, f = 120 Hz)	R_{vf}	52	–	–	52	–	–	dB
Long term stability ($T_j = +25°C$)	K_{VH}	–	–	60	–	–	60	mV
Output noise voltage ($T_j = +25°C$, 10 Hz $\leq$ f $\leq$ 100 kHz)	V_{NO}	–	90	–	–	90	–	μV_{rms}
Dropout voltage ($T_j = +25°C$, $I_O = 1.5$ A)	V_I-V_O	–	2	–	–	2	–	V

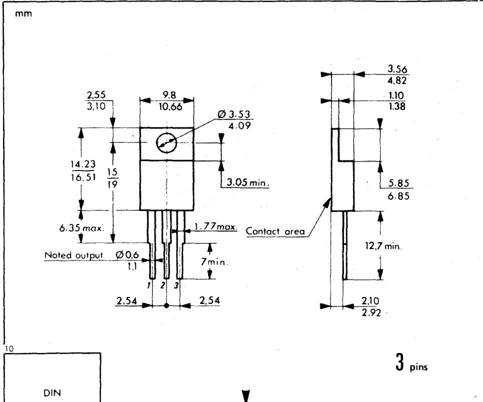


3 A 2 41872 DIN				
Case [C - 14 A] Base B - 18 CEI	TO - 3 D.A.T.A.	TO - 3 JEDEC	F 24 A SITELESC	CB - 19 THOMSON SEMICONDUCTORS

CB-19
(TO-3)

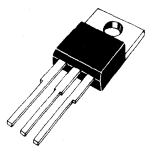


K SUFFIX
METAL CAN



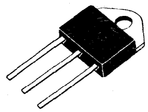
DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

CB-117
(TO-220)

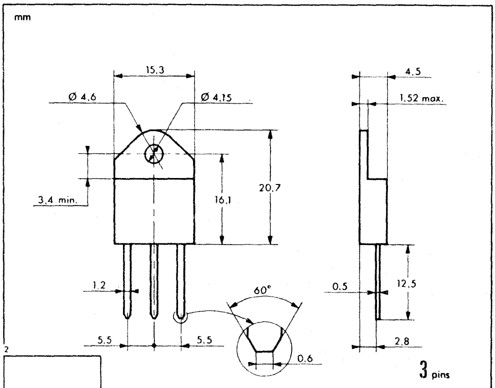


SP SUFFIX
PLASTIC PACKAGE

CB-244
(TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE



DIN				
CEI	D.A.T.A.	TO-218 JEDEC	SITELESC	CB-244 THOMSON SEMICONDUCTORS

This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA7800 SERIES

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

This series of three-terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

This series is available in two power packages. Both the plastic TOP-3 and metal TO-3 packages allow these regulators to deliver over 1.0 A if adequate heat sinking is provided. Even with over 1.0 A of output current available the regulators are essentially blow-out proof. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC form over-heating.

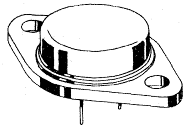
Considerable effort was expended to make this series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

- Output current in excess of 1 A,
- Internal thermal overload protection,
- No external components for adjusting,
- Output transistor safe area protection,
- Internal short-circuit current limit.

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

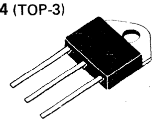
CASES

CB-19 (TO-3)



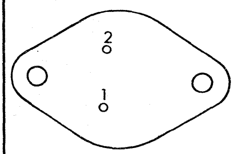
K SUFFIX
STEEL CAN

CB-244 (TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

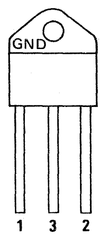
PIN ASSIGNMENTS



CB-19
(Bottom view)

1 - Input
2 - Output

Case is ground



CB-244
(Front view)

1 - Input
2 - Output
3 - Ground

Heatsink surface connected to ground

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		K	SP3
UA7800M	− 55°C to + 150°C	•	
UA7800I	− 40°C to + 150°C		•
UA7800C	0°C to + 150°C	•	•

Examples : UA7800MK, UA7800ISP3

Réf. 00095

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

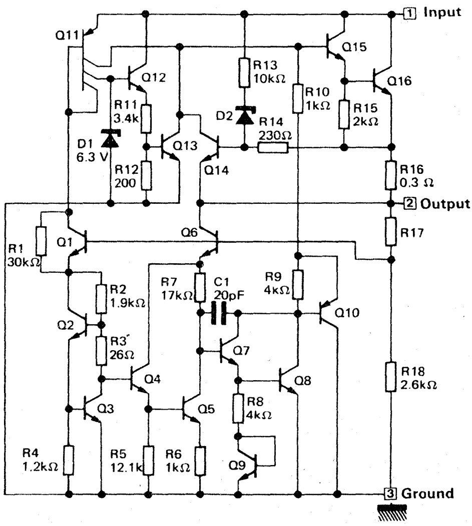
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage UA7824 UA7800	V_I	 40 35	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Junction temperature	T_j	+ 150	°C
Operating temperature range UA7800C UA7800I UA7800M	T_{oper}	 0 to + 150 − 40 to + 150 − 55 to + 150	°C
Operating temperature range	T_{stg}	− 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Junction-case thermal resistance CB-19 CB-244	$R_{th(j-c)}$	 – –	 4 2.5	°C/W
Junction-ambient thermal resistance CB-19 CB-244	$R_{th(j-a)}$	 35 –	 – 55	°C/W

SCHEMATIC DIAGRAM



CASE	V_I	V_O	GND
CB-19	1	2	CASE
CB-244	1	2	3

ELECTRICAL CHARACTERISTICS (Note 1)

UA7805C : $0°C \leq T_j \leq +150°C$,
UA7805I : $-40°C \leq T_j \leq +150°C$,
UA7805M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +10$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7805C, I			UA7805M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		4.8	5.0	5.2	4.8	5.0	5.2	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +8 V $\leq V_I \leq$ +20 V		–	–	–	4.65	–	5.35	
+7 V $\leq V_I \leq$ +20 V		4.75	–	5.25	–	–	–	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
+8 V $\leq V_I \leq$ +12 V		–	–	50	–	–	25	
+7 V $\leq V_I \leq$ +25 V		–	–	100	–	–	50	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	100	–	–	50	
250 mA $\leq I_O \leq$ 750 mA		–	–	50	–	–	25	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+8 V $\leq V_I \leq$ +25 V		–	–	–	–	–	0.8	
+7 V $\leq V_I \leq$ +25 V		–	–	1.3	–	–	–	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	40	–	–	40	–	μV_{rms}
Long term stability	K_{VH}	–	–	20	–	–	20	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	60	–	–	78	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 1 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 2)

UA7806C : $0°C \leq T_j \leq +150°C$,
UA7806I : $-40°C \leq T_j \leq +150°C$,
UA7806M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +11$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7806C, I			UA7806M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		5.75	6	6.25	5.75	6	6.25	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +8 V $\leq V_I \leq$ +21 V		5.7	–	6.3	–	–	–	
+9 V $\leq V_I \leq$ +21 V		–	–	–	5.65	–	6.35	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
+9 V $\leq V_I \leq$ +13 V		–	–	60	–	–	30	
+8 V $\leq V_I \leq$ +25 V		–	–	120	–	–	60	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	120	–	–	60	
250 mA $\leq I_O \leq$ 750 mA		–	–	60	–	–	30	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+9 V $\leq V_I \leq$ +25 V		–	–	–	–	–	0.8	
+8 V $\leq V_I \leq$ +25 V		–	–	1.3	–	–	–	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	45	–	–	45	–	μV_{rms}
Long term stability	K_{VH}	–	–	24	–	–	24	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	65	–	–	75	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 2 : Although power dissipation is internally limited, characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 3)
UA7808C : $0°C \leqslant T_j \leqslant +150°C$,
UA7808I : $-40°C \leqslant T_j \leqslant +150°C$,
UA7808M : $-55°C \leqslant T_j \leqslant +150°C$
$I_O = 0.5$ A, $V_I = +14$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7808C, I			UA7808M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		7.7	8	8.3	7.7	8	8.3	
$T_{min} \leqslant T_j \leqslant T_{max}$, 5 mA $\leqslant I_O \leqslant$ 1 A, $+11.5$ V $\leqslant V_I \leqslant +23$ V		–	–	–	7.6	–	8.4	
$+10.5$ V $\leqslant V_I \leqslant +23$ V		7.6	–	8.4	–	–	–	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
$+11$ V $\leqslant V_I \leqslant +17$ V		–	–	80	–	–	40	
$+10.5$ V $\leqslant V_I \leqslant +25$ V		–	–	180	–	–	80	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leqslant I_O \leqslant$ 1.5 A		–	–	160	–	–	80	
250 mA $\leqslant I_O \leqslant$ 750 mA		–	–	80	–	–	40	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
$+11.5$ V $\leqslant V_I \leqslant +25$ V		–	–	–	–	–	0.8	
$+10.5$ V $\leqslant V_I \leqslant +25$ V		–	–	1	–	–	–	
5 mA $\leqslant I_O \leqslant$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leqslant f \leqslant$ 100 kHz)	V_{NO}	–	52	–	–	52	–	μV_{rms}
Long term stability	K_{VH}	–	–	32	–	–	32	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	62	–	–	72	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 3 : Although power dissipation is internally limited, characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 4)
UA7812C : $0°C \leqslant T_j \leqslant +150°C$,
UA7812I : $-40°C \leqslant T_j \leqslant +150°C$,
UA7812M : $-55°C \leqslant T_j \leqslant +150°C$
$I_O = 0.5$ A, $V_I = +19$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7812C, I			UA7812M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		11.5	12	12.5	11.5	12	12.5	
$T_{min} \leqslant T_j \leqslant T_{max}$, 5 mA $\leqslant I_O \leqslant$ 1 A, $+15.5$ V $\leqslant V_I \leqslant +27$ V		–	–	–	11.4	–	12.6	
$+14.5$ V $\leqslant V_I \leqslant +27$ V		11.4	–	12.6	–	–	–	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
$+16$ V $\leqslant V_I \leqslant +22$ V		–	–	120	–	–	60	
$+14.5$ V $\leqslant V_I \leqslant +30$ V		–	–	240	–	–	120	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leqslant I_O \leqslant$ 1.5 A		–	–	240	–	–	120	
250 mA $\leqslant I_O \leqslant$ 750 mA		–	–	120	–	–	60	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
$+15$ V $\leqslant V_I \leqslant +30$ V		–	–	–	–	–	0.8	
$+14.5$ V $\leqslant V_I \leqslant +30$ V		–	–	1.3	–	–	–	
5 mA $\leqslant I_O \leqslant$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leqslant f \leqslant$ 100 kHz)	V_{NO}	–	75	–	–	75	–	μV_{rms}
Long term stability	K_{VH}	–	–	48	–	–	48	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	61	–	–	71	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 4 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 5)
UA7815C : $0°C \leq T_j \leq +150°C$,
UA7815I : $-40°C \leq T_j \leq +150°C$,
UA7815M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +23$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7815C, I			UA7815M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +18.5 V $\leq V_I \leq$ +30 V +17.5 V $\leq V_I \leq$ +30 V	V_O	 14.4 — 14.25	 15 — —	 15.6 — 15.75	 14.4 14.25 —	 15 — —	 15.6 15.75 —	V
Line regulation ($T_j = +25°C$) +20 V $\leq V_I \leq$ +26 V +17.5 V $\leq V_I \leq$ +30 V	K_{VI}	 — —	 — —	 150 300	 — —	 — —	 75 150	mV
Load regulation ($T_j = +25°C$) 5 mA $\leq I_O \leq$ 1.5 A 250 mA $\leq I_O \leq$ 750 mA	K_{VO}	 — —	 — —	 300 150	 — —	 — —	 150 75	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	—	6	10	—	5.5	8	mA
Quiescent current change +18.5 V $\leq V_I \leq$ +30 V +17.5 V $\leq V_I \leq$ +30 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 — — —	 — — —	 — 1 0.5	 — — —	 — — —	 0.8 — 0.5	mA
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	—	90	—	—	90	—	μV_{rms}
Long term stability	K_{VH}	—	—	60	—	—	60	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	—	60	—	—	70	—	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	—	2	—	—	2	—	V

Note 5 : Although power dissipation is internally limited, characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 6)
UA7818C : $0°C \leq T_j \leq +150°C$,
UA7818I : $-40°C \leq T_j \leq +150°C$,
UA7818M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +23$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7818C, I			UA7818M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +22 V $\leq V_I \leq$ +33 V +21 V $\leq V_I \leq$ +33 V	V_O	 17.3 — 17.1	 18 — —	 18.7 — 18.9	 17.3 17.1 —	 18 — —	 18.7 18.9 —	V
Line regulation ($T_j = +25°C$) +24 V $\leq V_I \leq$ +30 V +21 V $\leq V_I \leq$ +33 V	K_{VI}	 — —	 — —	 180 360	 — —	 — —	 90 180	mV
Load regulation ($T_j = +25°C$) 5 mA $\leq I_O \leq$ 1.5 A 250 mA $\leq I_O \leq$ 750 mA	K_{VO}	 — —	 — —	 360 180	 — —	 — —	 180 90	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	—	6	10	—	5.5	8	mA
Quiescent current change +22 V $\leq V_I \leq$ +33 V +21 V $\leq V_I \leq$ +33 V 5 mA $\leq I_O \leq$ 1 A	ΔI_{IB}	 — — —	 — — —	 — 1 0.5	 — — —	 — — —	 0.8 — 0.5	mA
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	—	110	—	—	110	—	μV_{rms}
Long term stability	K_{VH}	—	—	72	—	—	72	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	—	59	—	—	69	—	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	—	2	—	—	2	—	V

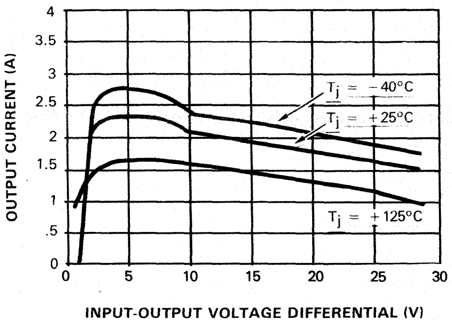
Note 6 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 20$ W.

ELECTRICAL CHARACTERISTICS (Note 7)
UA7824C : $0°C \leq T_j \leq +150°C$,
UA7824I : $-40°C \leq T_j \leq +150°C$,
UA7824M : $-55°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +33$ V
(Unless otherwise specified)

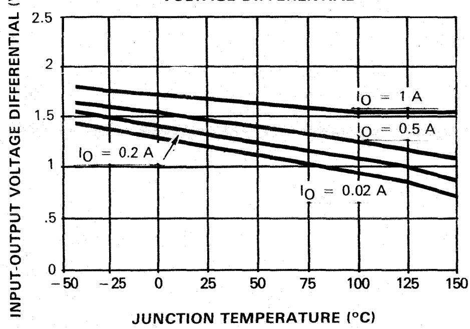
Characteristic	Symbol	UA7824C, I			UA7824M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		23	24	25	23	24	25	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +28 V $\leq V_I \leq$ +38 V		–	–	–	22.8	–	25.2	
+27 V $\leq V_I \leq$ +38 V		22.8	–	25.2	–	–	–	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
+30 V $\leq V_I \leq$ +36 V		–	–	240	–	–	120	
+27 V $\leq V_I \leq$ +38 V		–	–	480	–	–	240	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	480	–	–	240	
250 mA $\leq I_O \leq$ 750 mA		–	–	240	–	–	120	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+28 V $\leq V_I \leq$ +38 V		–	–	–	–	–	0.8	
+27 V $\leq V_I \leq$ +38 V		–	–	1	–	–	–	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	170	–	–	170	–	μV_{rms}
Long term stability	K_{VH}	–	–	96	–	–	96	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	56	–	–	66	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 7 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 20$ W.

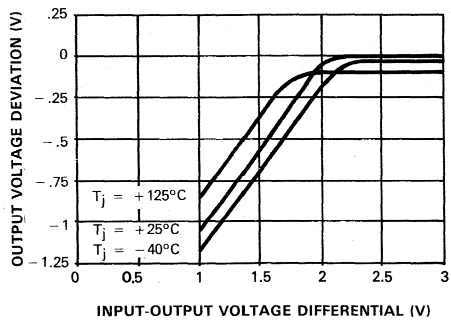
PEAK OUTPUT CURRENT



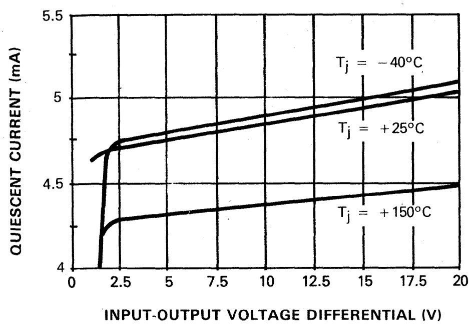
MINIMUM INPUT-OUTPUT VOLTAGE DIFFERENTIAL



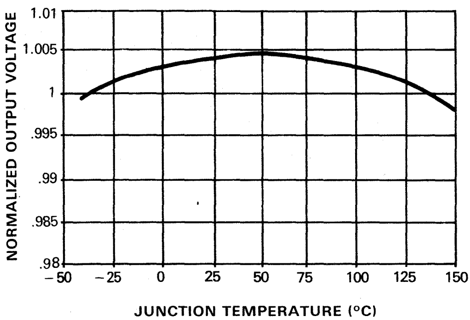
DROPOUT CHARACTERISTIC



QUIESCENT CURRENT



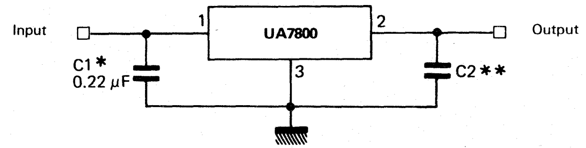
OUTPUT VOLTAGE



V_I-V_O = 5 V I_O = 20 mA

TYPICAL APPLICATIONS

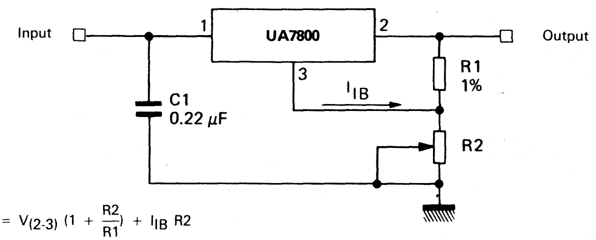
FIXED OUTPUT REGULATOR



* Required if regulator is located in appreciable distance from power supply filter.

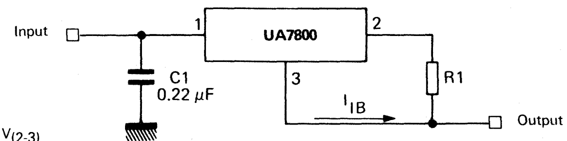
** Although no output capacitor is needed for stability it does improve transient response.

ADJUSTABLE OUTPUT REGULATOR



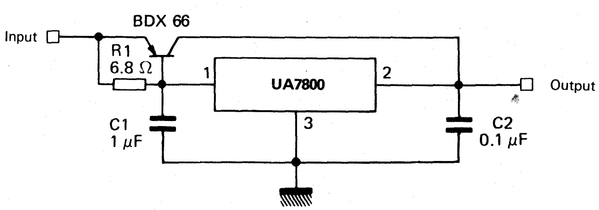
$$V_O = V_{(2\text{-}3)}\left(1 + \frac{R2}{R1}\right) + I_{IB}\,R2$$

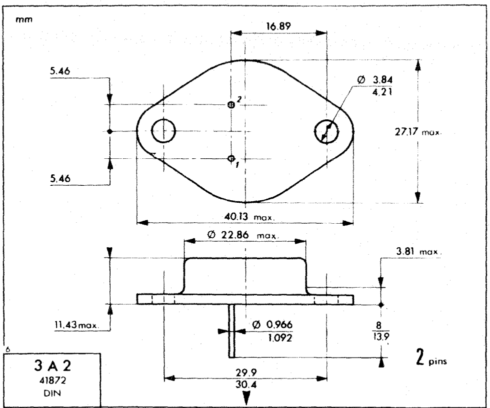
CURRENT REGULATOR



$$I_O = \frac{V_{(2\text{-}3)}}{R1} + I_{IB}$$

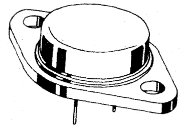
HIGH-CURRENT VOLTAGE REGULATOR



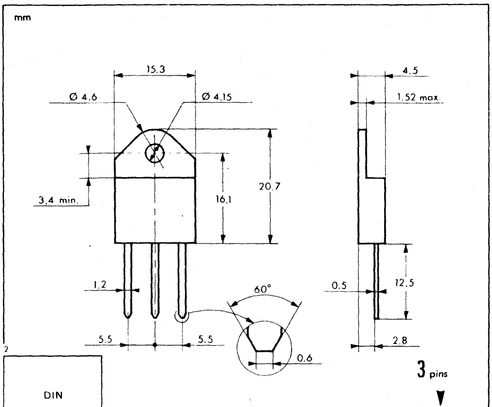


[C - 14 A] B - 18	TO - 3	TO - 3	F 24 A	CB - 19 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS

CB-19
(TO-3)

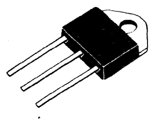


K SUFFIX
METAL STEEL



		TO-218		CB-244 THOMSON
CEI	D.A.T.A.	JEDEC	SITELESC	SEMICONDUCTORS

CB-244
(TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

UA7800C
UA7800BI
SERIES

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

This series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltage available allow these regulators to be used in logic systems, instrumentation. Hifi, and other solid state electronic equipment. Although designed primarely as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

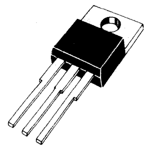
This series is available in TO-220 plastic package (CB-117) which allows these regulators to deliver over 1.0 A if adequates heat sinking is provided. Even with over 1.0 A of output current available the regulators are essentially blow-out proof. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from over-heating.

Considerable effort was expended to make this series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

- Output current in excess of 1 A.
- Internal thermal overload protection.
- No external components for adjustment.
- Output transistor safe area protection.
- Internal short-circuit current limit.
- Output voltage tolerance without external trimming for BI version.
  $\pm 2\%$ @ $T_{amb} = +25°C$
  $\pm 4\%$ @ $-40°C < T_{amb} < +150°C$

THREE-TERMINAL FIXED POSITIVE VOLTAGE REGULATORS

CASE CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE

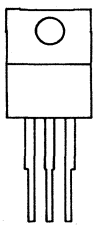
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
		SP
UA7805C	0°C to +150°C	•
UA7805BI	−40°C to +150°C	•
UA7806C	0°C to +150°C	•
UA7808C	0°C to +150°C	•
UA7812C	0°C to +150°C	•
UA7812BI	−40°C to +150°C	•
UA7815C	0°C to +150°C	•
UA7815BI	−40°C to +150°C	•
UA7818C	0°C to +150°C	•
UA7824C	0°C to +150°C	•

Examples : UA7805CSP, UA7805BISP

PIN ASSIGNMENT

(Front view)



Heatsink surface connected to ground

Réf. 00085

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

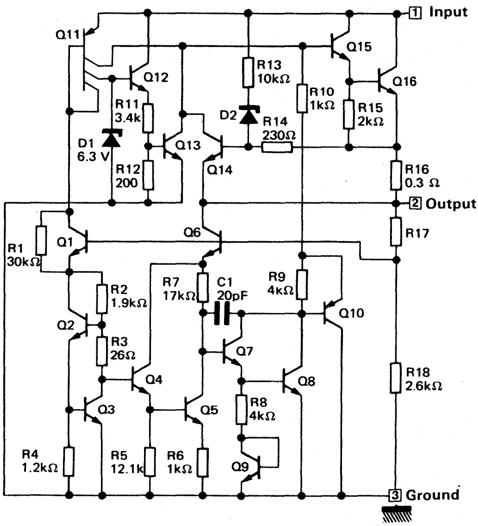
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage UA7824CSP UA7805/7806/7808/7812/7815/7818 and BISP series	V_I	 40 35	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Junction temperature	T_j	+ 150	°C
Operating free-air temperature range UA7800CSP UA7800BISP	T_{oper}	 0 to + 150 − 40 to + 150	°C
Storage temperature range	T_{stg}	− 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	3	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	70	°C/W

SCHEMATIC DIAGRAM



CASE	V_I	V_O	GND
CB-117	1	2	3

ELECTRICAL CHARACTERISTICS (Note 1)

UA7805CSP : $0°C \leq T_j \leq +150°C$
UA7805BISP : $-40°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +10$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7805CSP			UA7805BISP			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		4.8	5.0	5.2	4.9	5.0	5.2	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +7 V $\leq V_I \leq$ +20 V		4.75	–	5.25	–	–	–	
+8 V $\leq V_I \leq$ +20 V		–	–	–	4.8	–	5.2	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
+8 V $\leq V_I \leq$ +12 V		–	–	50	–	–	25	
+7 V $\leq V_I \leq$ +25 V		–	–	100	–	–	50	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	100	–	–	50	
250 mA $\leq I_O \leq$ 750 mA		–	–	50	–	–	25	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+8 V $\leq V_I \leq$ +25 V		–	–	–	–	–	0.8	
+7 V $\leq V_I \leq$ +25 V		–	–	1.3	–	–	–	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	40	–	–	40	–	μV_{rms}
Long term stability	K_{VH}	–	–	20	–	–	20	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	60	–	–	78	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 1 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 15$ W

ELECTRICAL CHARACTERISTICS (Note 2)

UA7806CSP : $0°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +11$ V
(Unless otherwise specified)

Characteristic	Symbol	UA7806CSP			Unit
		Min	Typ	Max	
Output voltage range	V_O				V
$T_j = +25°C$		5.75	6	6.25	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +8 V $\leq V_I \leq$ +21 V		5.65	–	6.35	
Line regulation ($T_j = +25°C$)	K_{VI}				mV
+9 V $\leq V_I \leq$ +13 V		–	–	30	
+8 V $\leq V_I \leq$ +25 V		–	–	60	
Load regulation ($T_j = +25°C$)	K_{VO}				mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	60	
250 mA $\leq I_O \leq$ 750 mA		–	–	30	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	5.5	8	mA
Quiescent current change	ΔI_{IB}				mA
+9 V $\leq V_I \leq$ +25 V		–	–	0.8	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	45	–	μV_{rms}
Long term stability	K_{VH}	–	–	24	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	75	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	V

Note 2 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 15$ W

ELECTRICAL CHARACTERISTICS (Note 3)
UA7808CSP : 0°C ⩽ T_j ⩽ +150°C
I_O = 0.5 A, V_I = +14 V
(Unless otherwise specified)

Characteristic	Symbol	UA7808CSP			Unit
		Min	Typ	Max	
Output voltage range	V_O				V
T_j = +25°C		7.7	8	8.3	
T_{min} ⩽ T_j ⩽ T_{max}, 5 mA ⩽ I_O ⩽ 1 A, +10.5 V ⩽ V_I ⩽ +23 V		7.6	–	8.4	
Line regulation (T_j = +25°C)	K_{VI}				mV
+11 V ⩽ V_I ⩽ +17 V		–	–	40	
+10.5 V ⩽ V_I ⩽ +25 V		–	–	80	
Load regulation (T_j = +25°C)	K_{VO}				mV
5 mA ⩽ I_O ⩽ 1.5 A		–	–	80	
250 mA ⩽ I_O ⩽ 750 mA		–	–	40	
Quiescent current (T_j = +25°C)	I_{IB}	–	5.5	8	mA
Quiescent current change	ΔI_{IB}				mA
+11.5 V ⩽ V_I ⩽ +25 V		–	–	0.8	
5 mA ⩽ I_O ⩽ 1 A		–	–	0.5	
Output noise voltage (T_{amb} = +25°C, 10 Hz ⩽ f ⩽ 100 kHz)	V_{NO}	–	52	–	μV_{rms}
Long term stability	K_{VH}	–	–	32	mV
Ripple rejection (I_O = 20 mA, f = 100 Hz)	R_{vf}	–	72	–	dB
Input-output voltage differential (T_j = +25°C, I_O = 1 A)	$V_I - V_O$	–	2	–	V

Note 3 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to P_{max} = 15 W

ELECTRICAL CHARACTERISTICS (Note 4)
UA7812CSP : 0°C ⩽ T_j ⩽ +150°C
UA7812BISP : −40°C ⩽ T_j ⩽ +150°C
I_O = 0.5 A, V_I = +19 V
(Unless otherwise specified)

Characteristic	Symbol	UA7812CSP			UA7812BISP			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
T_j = +25°C		11.5	12	12.5	11.76	12	12.24	
T_{min} ⩽ T_j ⩽ T_{max}, 5 mA ⩽ I_O ⩽ 1 A, +14.5 V ⩽ V_I ⩽ +27 V		11.4	–	12.6	–	–	–	
+15.5 V ⩽ V_I ⩽ +27 V		–	–	–	11.5	–	12	
Line regulation (T_j = +25°C)	K_{VI}							mV
+16 V ⩽ V_I ⩽ +22 V		–	–	120	–	–	60	
+14.5 V ⩽ V_I ⩽ +30 V		–	–	240	–	–	120	
Load regulation (T_j = +25°C)	K_{VO}							mV
5 mA ⩽ I_O ⩽ 1.5 A		–	–	240	–	–	120	
250 mA ⩽ I_O ⩽ 750 mA		–	–	120	–	–	60	
Quiescent current (T_j = +25°C)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+15 V ⩽ V_I ⩽ +30 V		–	–	–	–	–	0.8	
+14.5 V ⩽ V_I ⩽ +30 V		–	–	1.3	–	–	–	
5 mA ⩽ I_O ⩽ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage (T_{amb} = +25°C, 10 Hz ⩽ f ⩽ 100 kHz)	V_{NO}	–	75	–	–	75	–	μV_{rms}
Long term stability	K_{VH}	–	–	48	–	–	48	mV
Ripple rejection (I_O = 20 mA, f = 100 Hz)	R_{vf}	–	61	–	–	71	–	dB
Input-output voltage differential (T_j = +25°C, I_O = 1 A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 4 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to P_{max} = 15 W

ELECTRICAL CHARACTERISTICS (Note 5)

UA7815CSP : $0°C \leq T_j \leq +150°C$

UA7815BISP : $-40°C \leq T_j \leq +150°C$

$I_O = 0.5$ A, $V_I = +23$ V

(Unless otherwise specified)

Characteristic	Symbol	UA7815CSP			UA7815BISP			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O							V
$T_j = +25°C$		14.4	15	15.6	14.7	15.0	15.3	
$T_{min} \leq T_j \leq T_{max}$, 5 mA $\leq I_O \leq$ 1 A, +17.5 V $\leq V_I \leq$ +30 V		14.25	–	15.75	–	–	–	
+18.5 V $\leq V_I \leq$ +30 V		–	–	–	14.4	–	15.6	
Line regulation ($T_j = +25°C$)	K_{VI}							mV
+20 V $\leq V_I \leq$ +26 V		–	–	150	–	–	75	
+17.5 V $\leq V_I \leq$ +30 V		–	–	300	–	–	150	
Load regulation ($T_j = +25°C$)	K_{VO}							mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	300	–	–	150	
250 mA $\leq I_O \leq$ 750 mA		–	–	150	–	–	75	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+18.5 V $\leq V_I \leq$ +30 V		–	–	–	–	–	0.8	
+17.5 V $\leq V_I \leq$ +30 V		–	–	1	–	–	–	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	90	–	–	90	–	μV_{rms}
Long term stability	K_{VH}	–	–	60	–	–	60	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	60	–	–	70	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	–	2	–	V

Note 5 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 15$ W

ELECTRICAL CHARACTERISTICS (Note 6)

UA7818CSP : $0°C \leq T_j \leq +150°C$

$I_O = 0.5$ A, $V_I = +27$ V

(Unless otherwise specified)

Characteristic	Symbol	UA7818CSP			Unit
		Min	Typ	Max	
Output voltage range	V_O				V
$T_j = +25°C$		17.3	18	18.7	
$T_{min} \leq T_j \leq T_{max}$, +21 V $\leq V_I \leq$ +33 V, 5 mA $\leq I_O \leq$ 1 A		17.1	–	18.9	
Line regulation ($T_j = +25°C$)	K_{VI}				mV
+24 V $\leq V_I \leq$ +30 V		–	–	180	
+21 V $\leq V_I \leq$ +33 V		–	–	360	
Load regulation ($T_j = +25°C$)	K_{VO}				mV
5 mA $\leq I_O \leq$ 1.5 A		–	–	360	
250 mA $\leq I_O \leq$ 750 mA		–	–	180	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	mA
Quiescent current change	ΔI_{IB}				mA
+21 V $\leq V_I \leq$ +33 V		–	–	1	
5 mA $\leq I_O \leq$ 1 A		–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, 10 Hz $\leq f \leq$ 100 kHz)	V_{NO}	–	110	–	μV_{rms}
Long term stability	K_{VH}	–	–	72	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	59	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	V

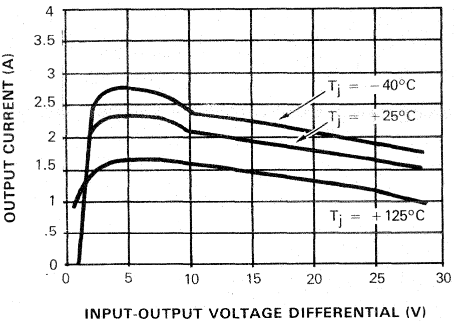
Note 6 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 15$ W

ELECTRICAL CHARACTERISTICS (Note 7)
UA7824CSP : $0°C \leq T_j \leq +150°C$
$I_O = 0.5$ A, $V_I = +33$ V
(Unless otherwise specified)

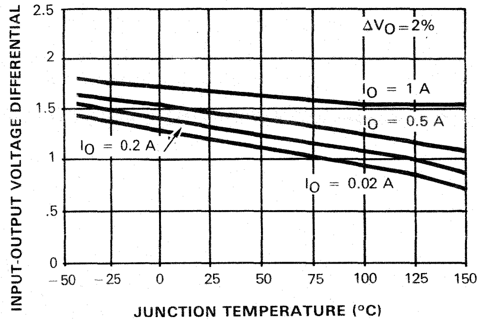
Characteristic	Symbol	UA7824CSP			Unit
		Min	Typ	Max	
Output voltage range	V_O				V
$T_j = +25°C$		23	24	25	
$T_{min} \leq T_j \leq T_{max}$, $+27\ V \leq V_I \leq +38\ V$, $5\ mA \leq I_O \leq 1\ A$		22.8	–	25.2	
Line regulation ($T_j = +25°C$)	K_{VI}				mV
$+30\ V \leq V_I \leq +36\ V$		–	–	240	
$+27\ V \leq V_I \leq +38\ V$		–	–	480	
Load regulation ($T_j = +25°C$)	K_{VO}				mV
$5\ mA \leq I_O \leq 1.5\ A$		–	–	480	
$250\ mA \leq I_O \leq 750\ mA$		–	–	240	
Quiescent current ($T_j = +25°C$)	I_{IB}	–	6	10	mA
Quiescent current change	ΔI_{IB}				mA
$+27\ V \leq V_I \leq +38\ V$		–	–	1	
$5\ mA \leq I_O \leq 1\ A$		–	–	0.5	
Output noise voltage ($T_{amb} = +25°C$, $10\ Hz \leq f \leq 100\ kHz$)	V_{NO}	–	170	–	μV_{rms}
Long term stability	K_{VH}	–	–	96	mV
Ripple rejection ($I_O = 20$ mA, f = 100 Hz)	R_{vf}	–	56	–	dB
Input-output voltage differential ($T_j = +25°C$, $I_O = 1$ A)	$V_I - V_O$	–	2	–	V

Note 7 : Although power dissipation is internally limited, electrical characteristics apply only for power levels up to $P_{max} = 15$ W

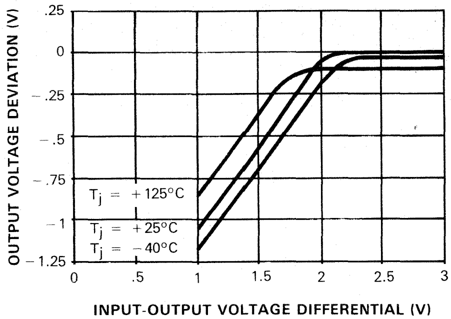
PEAK OUTPUT CURRENT



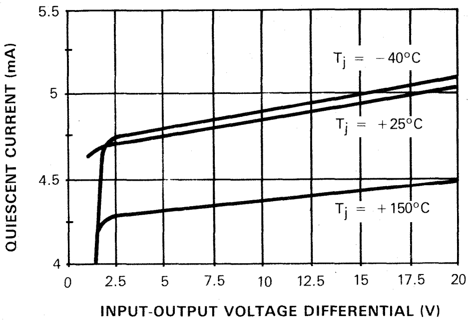
MINIMUM INPUT-OUTPUT VOLTAGE DIFFERENTIAL



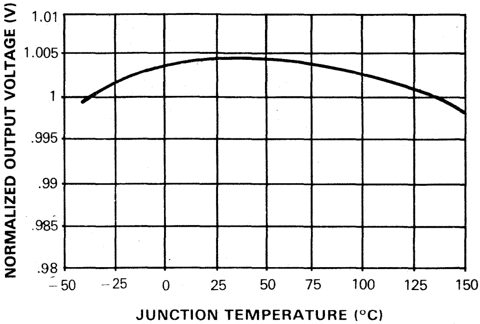
DROPOUT CHARACTERISTIC



QUIESCENT CURRENT



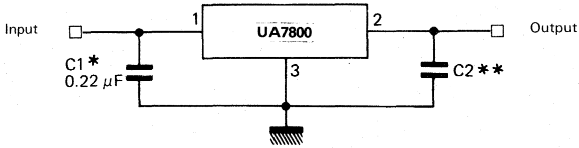
OUTPUT VOLTAGE



$V_I - V_O = 5$ V $I_O = 20$ mA

TYPICAL APPLICATIONS

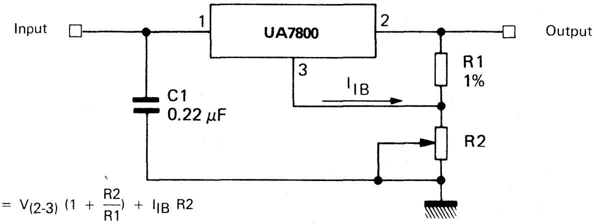
FIXED OUTPUT REGULATOR



* Required if regulator is located an appreciable distance from power supply filter

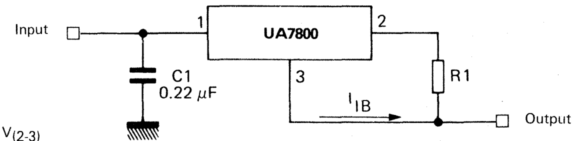
** Although no output capacitor is needed for stability it does improve transient response

ADJUSTABLE OUTPUT REGULATOR



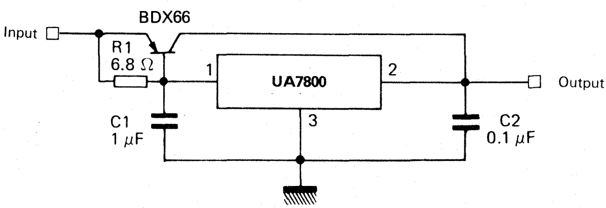
$$V_O = V_{(2\text{-}3)} \left(1 + \frac{R2}{R1}\right) + I_{IB}\, R2$$

CURRENT REGULATOR

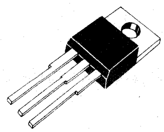


$$I_O = \frac{V_{(2\text{-}3)}}{R1} + I_{IB}$$

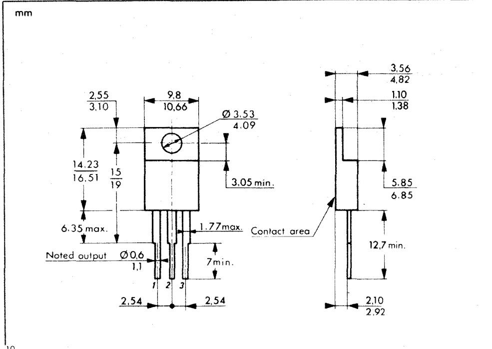
HIGH-CURRENT VOLTAGE REGULATOR



CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE



3 pins

DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

UA7900 SERIES

THREE-TERMINAL FIXED NEGATIVE VOLTAGE REGULATORS

The UA7900M, UA7900I, and UA7900C series are three-terminal negative regulators with a fixed output voltage of −5 V, −5.2 V, −12 V and −15 V and up to 1.5 A load current capability.

The UA7900M, UA7900I, and UA7900C series have current limiting which is independent of temperature, combined with thermal overload protection. Internal current limit protection against momentary faults while thermal shut down prevents junction temperature exceeding safe limits during prolonged overloads.

These circuits can deliver over 1.0 A if adequate heatsink is provided. Even with over 1.0 A of output current available, the regulators are essentially blowout proof. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heatsink provided, the thermal shutdown circuit takes over preventing the IC from overheating.

These devices need only one external component : a compensation capacitor at the output, making them easy to apply. Worst case guarantees on output voltage deviation due to any combination of line, load or temperature variation assure satisfactory system operation.

The UA7900M, UA7900I and UA 7900C series of three terminal regulators are available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipments. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

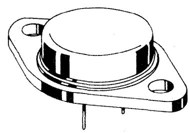
The UA7900M series are available in metal TO-3.
The UA7900I, C are available in plastic TOP-3 and in metal TO-3 packages.

- Output voltage tolerance without external trimming : UA7900C, I series : +4 % ; 7900M series : ±2 %.
- Preset curent limit
- Output current in excess of 1 A
- Internal thermal shut down
- Operates with input-output voltage differential down to 2 V
- Load regulation :
  - UA7900C, I : 80 mV
  - UA7900M : 50 mV

THREE-TERMINAL FIXED NEGATIVE VOLTAGE REGULATORS

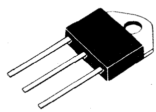
CASES

CB-19
(TO-3)



K SUFFIX
STEEL CAN

CB-244
(TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

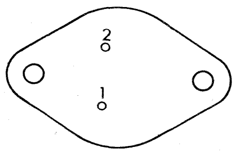
ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		K	SP3
UA7905C	0°C to +150°C	•	•
UA7905I	−25°C to +150°C	•	
UA7905I	−40°C to +150°C		•
UA7905M	−55°C to +150°C	•	
UA7912C	0°C to +150°C	•	•
UA7912I	−25°C to +150°C	•	
UA7912I	−40°C to +150°C		•
UA7912M	−55°C to +150°C	•	
UA7915C	0°C to +150°C	•	•
UA7915I	−25°C to +150°C	•	
UA7915I	−40°C to +150°C		•
UA7915M	−55°C to +150°C	•	

Example : UA7905CK, UA7905CSP3

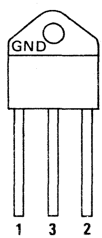
PIN ASSIGNMENTS



CB-19
(Bottom view)

1 - Ground
2 - Output

Case connected to input



CB-244
(Front view)

1 - Ground
2 - Output
3 - Input

Heatsink surface connected to ground

Réf. 00195

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage UA7915 UA7905 - UA7912	V_I	 −40 −35	V
Input-output voltage differential	$\|V_I - V_O\|$	35	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Operating ambient temperature range UA7900C UA7900I, (CB-19) UA7900I, (CB-244) UA7900M	T_{oper}	0 to +150 −25 to +150 −40 to +150 −55 to +150	°C
Storage temperature range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Typ	Max	Unit
Junction-case thermal resistance CB-19 CB-244	$R_{th(j-c)}$	 — —	 4 2.5	°C/W
Junction-ambient thermal resistance CB-19 CB-244	$R_{th(j-a)}$	 35 —	 — 55	°C/W

ELECTRICAL CHARACTERISTICS (Note 1)

UA7905C : $0°C \leqslant T_j \leqslant +150°C$ **UA7905ISP3 :** $-40°C \leqslant T_j \leqslant +150°C$
UA7905I : $-25°C \leqslant T_j \leqslant +150°C$ **UA7905M :** $-55°C \leqslant T_j \leqslant +150°C$
$V_I = -10$ V, $I_O = -0.5$ A, $I_{O(max)} = -1$ A
(Unless otherwise specified)

Characteristic	Symbol	7905I, C			7905M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leqslant T_j \leqslant T_{max}$, $-25\ V \leqslant V_I \leqslant -7\ V$, $-5\ mA \leqslant I_O \leqslant -1.5\ A$	V_O	 −5.2 −5.25	 −5 —	 −4.8 −4.75	 −5.1 −5.2	 −5 —	 −4.9 −4.8	V
Line regulation ($T_j = +25°C$, $-25\ V \leqslant V_I \leqslant -7\ V$, $I_O = -0.5$ A) - Note 2	K_{VI}	—	10	50	—	10	25	mV
Load regulation ($T_j = +25°C$, $-5\ mA \leqslant I_O \leqslant -1.5\ A$) – Note 2	K_{VO}	—	50	100	—	50	75	mV
Quiescent current ($-25\ V \leqslant V_I \leqslant -7\ V$)	I_{IB}	—	1	2	—	1	2	mA
Quiescent current change ($T_j = +25°C$, $-25\ V \leqslant V_I \leqslant -7\ V$, $-5\ mA \leqslant I_O \leqslant -1.5\ A$)	ΔI_{IB}	—	0.1	0.4	—	0.1	0.4	mA
Output noise voltage ($T_{amb} = +25°C$, $C_L = 1\ \mu F$, $10\ Hz \leqslant f \leqslant 100\ kHz$)	V_{NO}	—	40	—	—	40	—	μV_{rms}
Long term stability	K_{VH}	—	—	20	—	—	20	mV

Note 1 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to $P_{max} = 20$ W
Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

ELECTRICAL CHARACTERISTICS (Note 3)

UA7912C : $0°C \leq T_j \leq +150°C$ **UA7912ISP3 :** $-40°C \leq T_j \leq +150°C$
UA7912I : $-25°C \leq T_j \leq +150°C$ **UA7912M :** $-55°C \leq T_j \leq +150°C$
$V_I = -17$ V, $I_O = -0.5$ A, $I_{O(max)} = -1$ A
(Unless otherwise specified)

Characteristic	Symbol	7912I, C			7912M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, $-32\ V \leq V_I \leq -14$ V, $-5\ mA \leq I_O \leq -1$ A	V_O	 – 12.4 – 12.6	 – 12 —	 – 11.6 – 11.4	 – 12.3 – 12.5	 – 12 —	 – 11.7 – 11.5	V
Line regulation ($T_j = +25°C$, $-32\ V \leq V_I \leq -14$ V) - Note 4	K_{VI}	—	4	20	—	4	10	mV
Load regulation ($T_j = +25°C$, $-5\ mA \leq I_O \leq -1.5$ A) – Note 4	K_{VO}	—	30	80	—	30	80	mV
Quiescent current ($-32\ V \leq V_I \leq -14$ V)	I_{IB}	—	2	4	—	2	4	mA
Quiescent current change ($T_j = +25°C$, $-32\ V \leq V_I \leq -14$ V, $-5\ mA \leq I_O \leq -1.5$ A)	ΔI_{IB}	—	0.1	0.4	—	0.1	0.4	mA
Output noise voltage ($T_{amb} = +25°C$, $C_L = 1\ \mu F$, 10 Hz ≤ f ≤ 100 kHz)	V_{NO}	—	75	—	—	75	—	μV_{rms}
Long term stability	K_{VH}	—	—	48	—	—	48	mV

Note 3 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to $P_{max} = 20$ W
Note 4 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

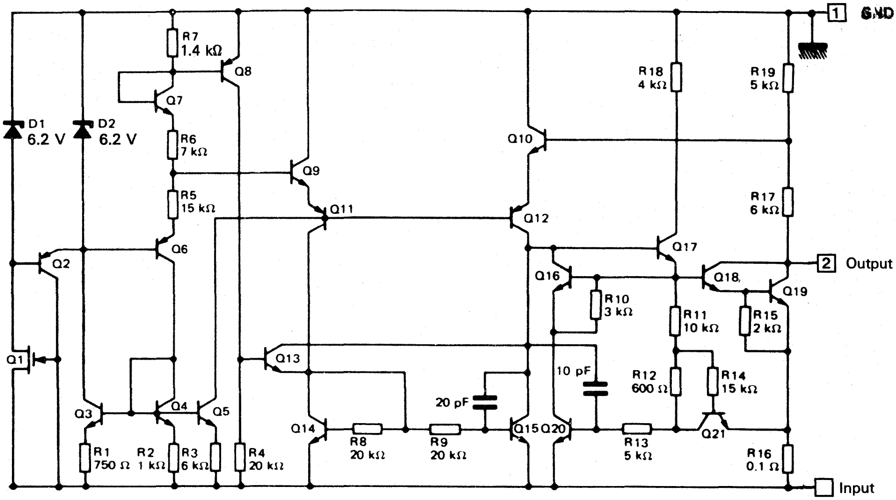
ELECTRICAL CHARACTERISTICS (Note 5)

UA7915C : $0°C \leq T_j \leq +150°C$ **UA7915ISP3 :** $-40°C \leq T_j \leq +150°C$
UA7915I : $-25°C \leq T_j \leq +150°C$ **UA7915M :** $-55°C \leq T_j \leq +150°C$
$V_I = -20$ V, $I_O = -0.5$ A, $I_{O(max)} = -1$ A
(Unless otherwise specified)

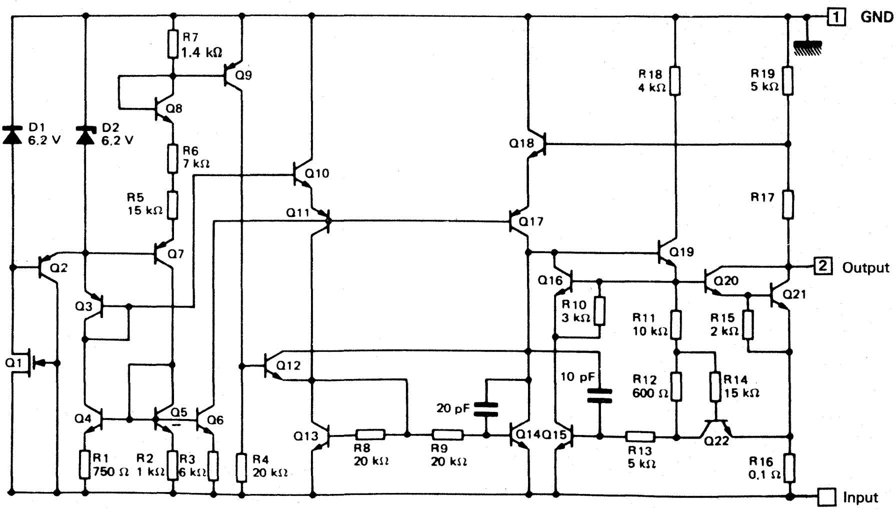
Characteristic	Symbol	7915I, C			7915M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range $T_j = +25°C$ $T_{min} \leq T_j \leq T_{max}$, $-35\ V \leq V_I \leq -17$ V, $-5\ mA \leq I_O \leq -1$ A	V_O	 – 15.4 – 15.6	 – 15 —	 – 14.6 – 14.4	 – 15.3 – 15.5	 – 15 —	 – 14.7 – 14.5	V
Line regulation ($T_j = +25°C$, $-35\ V \leq V_I \leq -17$ V, $I_O = -0.5$ A) - Note 6	K_{VI}	—	5	20	—	5	10	mV
Load regulation ($T_j = +25°C$, $-5\ mA \leq I_O \leq -1.5$ A) – Note 6	K_{VO}	—	30	80	—	30	80	mV
Quiescent current ($-35\ V \leq V_I \leq -17$ V)	I_{IB}	—	2	4	—	2	4	mA
Quiescent current change ($T_j = +25°C$, $-35\ V \leq V_I \leq -17$ V, $-5\ mA \leq I_O \leq -1.5$ A)	ΔI_{IB}	—	0.1	0.4	—	0.1	0.4	mA
Output noise voltage ($T_{amb} = +25°C$, $C_L = 1\ \mu F$, 10 Hz ≤ f ≤ 100 kHz)	V_{NO}	—	90	—	—	90	—	$\mu Vrms$
Long term stability	K_{VH}	—	—	60	—	—	60	mV

Note 5 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to $P_{max} = 20$ W
Note 6 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

SCHEMATIC DIAGRAM



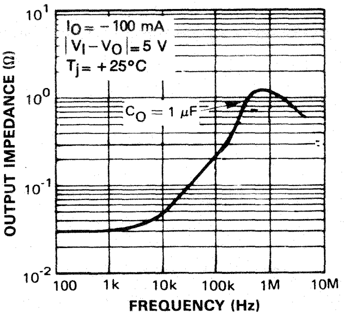
−5 V



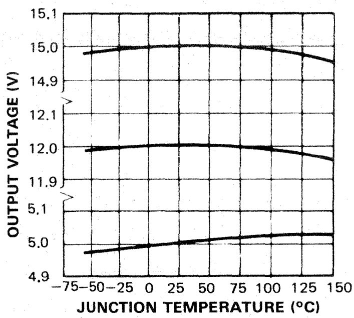
−12 V & −15 V

Case	GND	Output	Input
CB-19	1	2	Case
CB-244	1	2	3

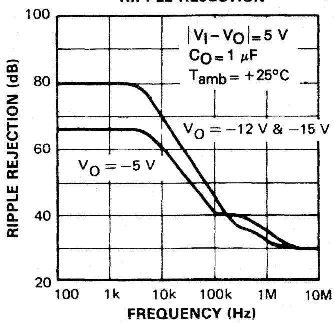
OUTPUT IMPEDANCE



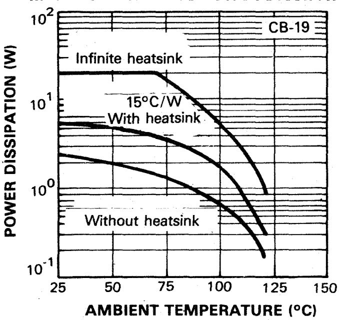
OUTPUT VOLTAGE VS JUNCTION TEMPERATURE



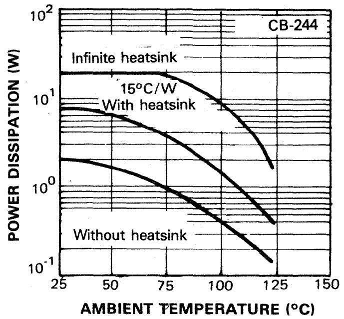
RIPPLE REJECTION



MAXIMUM AVERAGE POWER DISSIPATON

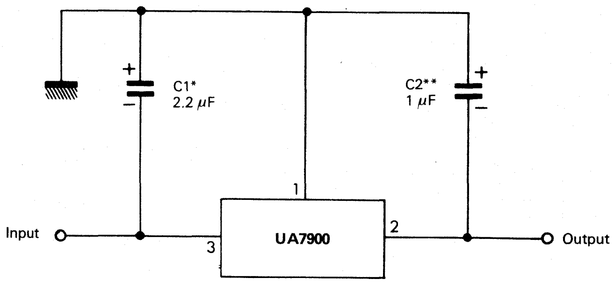


MAXIMUM AVERAGE POWER DISSIPATION



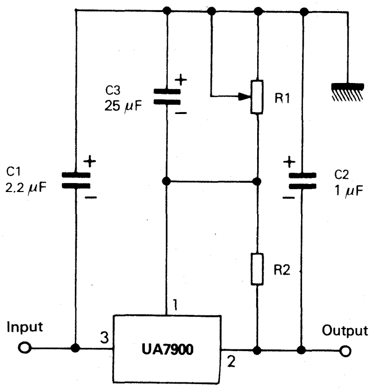
TYPICAL APPLICATIONS

FIXED OUTPUT REGULATOR



* Required if regulator is located an appreciable distance from power supply filter.
** Required for stability for value given.
For output capacitance in excess of 100 μF, a high current diode from input to output (1N4001) will protect the regulator from momentary input shorts.

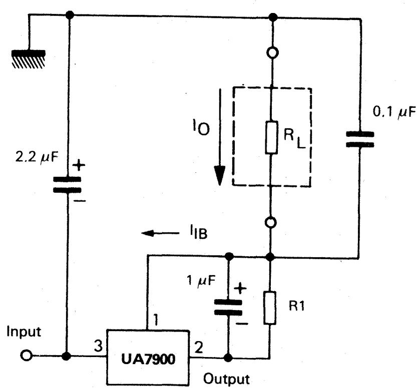
ADJUSTABLE OUTPUT REGULATOR



$V_O = V_{set} \frac{R1 + R2}{R2}$

UA7905 : R2 = 300 Ω
UA7912 : R2 = 750 Ω
UA7915 : R2 = 1 kΩ

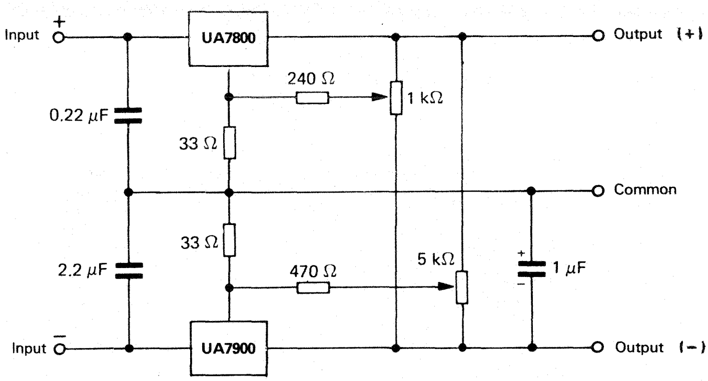
CURRENT REGULATOR



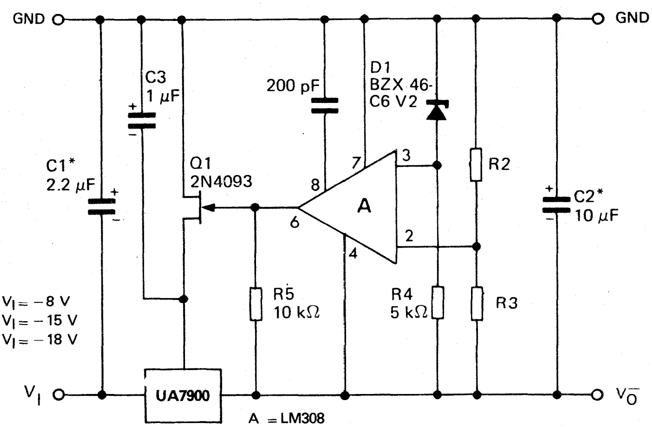
$I_O = \frac{V_{(2-1)}}{R1} + I_{IB}$

TYPICAL APPLICATIONS (continued)

DUAL TRIMMED SUPPLY



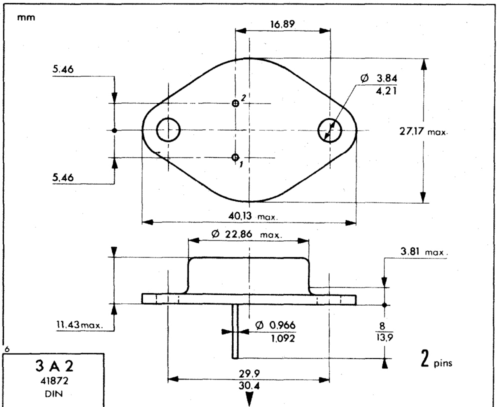
HIGH STABILITY 1 A REGULATOR



* Solid tantalum

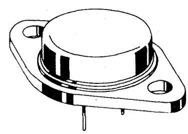
UA7905C, I, M ; $V_I = -8$ V
UA7912C, I, M ; $V_I = -15$ V
UA7915C, I, M ; $V_I = -18$ V

Load and line regulation < 0.01 %
Temperature stability < 0.1 %

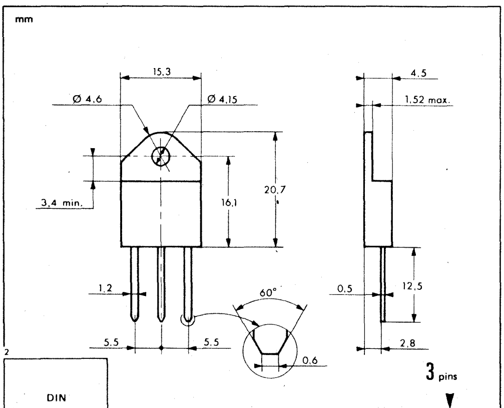


DIN				
3 A 2 41872 DIN				
Case [C - 14 A] Base B - 18 CEI	TO - 3 D.A.T.A.	TO - 3 JEDEC	F 24 A SITELESC	CB - 19 THOMSON SEMICONDUCTORS

CB-19
(TO-3)

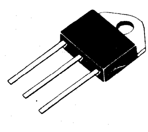


K SUFFIX
STEEL CAN



DIN				
CEI	D.A.T.A.	TO - 218 JEDEC	SITELESC	CB - 244 THOMSON SEMICONDUCTORS

CB-244
(TOP-3)



SP3 SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UA7900 C
UA7900BI
SERIES

THREE-TERMINAL FIXED NEGATIVE VOLTAGE REGULATORS

The UA7900C, BI series are three-terminal negative regulators with a fixed output voltage of −5 V, −12 V and −15 V and up to 1.5 A load current capability.

The UA7900C, BI series have current limiting which is independent of temperature, combined with thermal overload protection. Internal current limiting protects the circuit against momentary faults while thermal shut down prevents junction temperature exceeding safe limits during prolonged overloads.

These devices need only one external component : a compensation capacitor at the output, making them easy to apply. Worst case guarantees on output voltage deviation due to any combination of line, load or temperature variation assure satisfactory system operation.

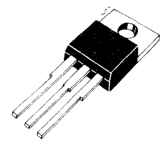
The UA7900C, BI series of three therminal regulators are available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipments. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

The UA7900C, BI are available in plastic TO-220 (CB-117) package.

- Output voltage tolerance without external trimming : ±4 %
- Internal short circuit current limit
- Output current over 1 A
- Internal thermal shut down
- Operates with input-output voltage differential down to 2 V
- Tightened specifications on regulation characteristics :
  load regulation : 80 mV
  line regulation : 20 mV
- Output voltage tolerance without external trimming for BI versions :
  ±2 % $T_{amb} = +25°C$
  ±4 % $-40°C \leqslant T_{amb} \leqslant +125°C$

THREE-TERMINAL FIXED NEGATIVE VOLTAGE REGULATORS

CASE CB-117
(TO-220)

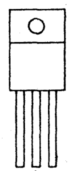


SP SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE SP
UA7905C	0°C to +125°C	•
UA7905BI	−40°C to +125°C	•
UA7912C	0°C to +125°C	•
UA7912BI	−40°C to +125°C	•
UA7915C	0°C to +125°C	•
UA7915BI	−40°C to +125°C	•
Examples : UA7905CSP, UA7905BISP		

PIN ASSIGNMENT
(Top view)



1 - GND
2 - Output
3 - Input

Réf. 00200

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage	V_I	−35	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Operating ambient temperature range 7900C 7900BI	T_{oper}	 0 to +125 −40 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	3	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	70	°C/W

100 47-2

ELECTRICAL CHARACTERISTICS (Note 1)

UA7905C : $0°C \leq T_j \leq +125°C$
UA7905BI : $-40°C \leq T_j \leq +125°C$
$V_I = -10$ V, $I_O = -0.5$ A
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage range $T_j = +25°C$ UA7905C UA7905BI $T_{min} \leq T_j \leq T_{max}$, $-20\ V \leq V_I \leq -7\ V$, $5\ mA \leq I_O \leq 1\ A$ UA7905C UA7905BI	V_O	 −5.2 −5.1 −5.25 −5.2	 −5 −5 – –	 −4.8 −4.9 −4.75 −4.8	V
Line regulation ($T_j = +25°C$, $-25\ V \leq V_I \leq -7\ V$) - Note 2	K_{VI}	–	35	100	mV
Load regulation ($T_j = +25°C$, $5\ mA \leq I_O \leq 1.5\ A$) – Note 2	K_{VO}	–	11	100	mV
Quiescent current ($T_j = +25°C$)	I_{IB}	–	4.3	8	mA
Quiescent current change ($T_j = +25°C$) $-25\ V \leq V_I \leq -7\ V$ $5\ mA \leq I_O \leq 1.5\ A$	ΔI_{IB}	 – –	 – –	 1.3 0.5	mA
Output noise voltage ($T_{amb} = +25°C$, $C_L = 1\ \mu F$, $10\ Hz \leq f \leq 100\ kHz$)	V_{NO}	–	40	–	μV_{rms}
Long term stability	K_{VH}	–	–	20	mV

Note 1 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to $P_{max} = 20$ W
Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

ELECTRICAL CHARACTERISTICS (Note 1)

UA7912C : 0°C ⩽ T_j ⩽ +125°C
UA7912BI : −40°C ⩽ T_j ⩽ +125°C
V_I = −19 V, I_O = −0.5 A
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage range	V_O				V
T_j = +25°C UA7912C		−12.5	−12	−11.5	
UA7912BI		−12.2	−12	−11.76	
T_{min} ⩽ T_j ⩽ T_{max}, −27 V ⩽ V_I ⩽ −14.5 V, 5 mA ⩽ I_O ⩽ 1 A UA7912C		−12.6	—	−11.4	
UA7912BI		−12.5	—	−11.5	
Line regulation (T_j = +25°C, −30 V ⩽ V_I ⩽ −14.5 V) - Note 2	K_{VI}	—	55	240	mV
Load regulation (T_j = +25°C, 5 mA ⩽ I_O ⩽ 1.5 A) – Note 2	K_{VO}	—	46	240	mV
Quiescent current (T_j = +25°C)	I_{IB}	—	4.4	8	mA
Quiescent current change (T_j = +25°C)	ΔI_{IB}				mA
−30 V ⩽ V_I ⩽ −14.5 V		—	—	1	
5 mA ⩽ I_O ⩽ 1.5 A		—	—	0.5	
Output noise voltage (T_{amb} = +25°C, C_L = 1 µF, 10 Hz ⩽ f ⩽ 100 kHz)	V_{NO}	—	75	—	μV_{rms}
Long term stability	K_{VH}	—	—	48	mV

Note 1 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to P_{max} = 20 W
Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

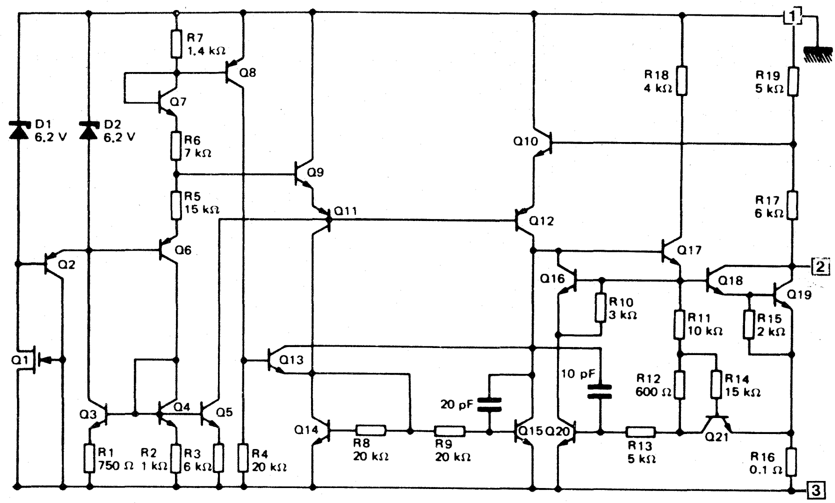
ELECTRICAL CHARACTERISTICS (Note 1)

UA7915C : 0°C ⩽ T_j ⩽ +125°C
UA7915BI : −40°C ⩽ T_j ⩽ +125°C
V_I = −23 V, I_O = −0.5 A
(Unless otherwise specified)

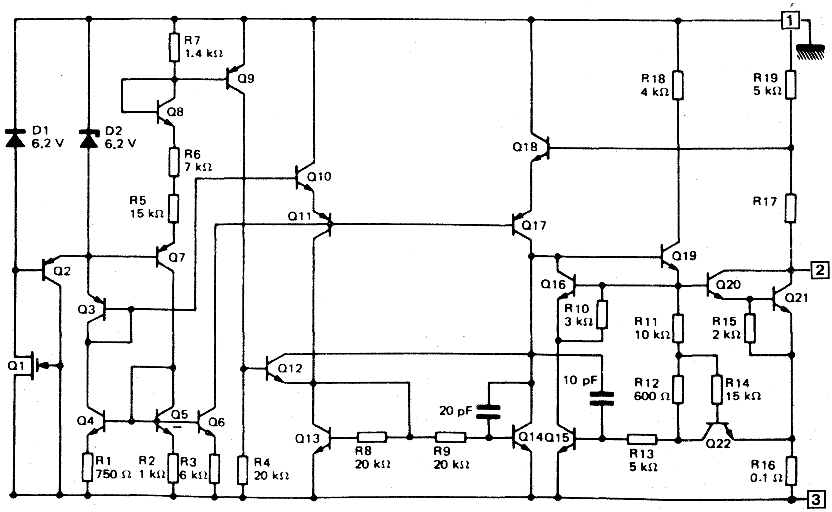
Characteristic	Symbol	Min	Typ	Max	Unit
Output voltage range	V_O				V
T_j = +25°C UA7915C		−15.6	−15	−14.4	
UA7915BI		−15.3	−15	−14.7	
T_{min} ⩽ T_j ⩽ T_{max}, −30 V ⩽ V_I ⩽ −17.5 V, 5 mA ⩽ I_O ⩽ 1 A UA7915C		−15.75	—	−14.25	
UA7915BI		−15.6	—	−14.4	
Line regulation (T_j = +25°C, −30 V ⩽ V_I ⩽ −17.5 V) - Note 2	K_{VI}	—	14	300	mV
Load regulation (T_j = +25°C, 5 mA ⩽ I_O ⩽ 1.5 A) – Note 2	K_{VO}	—	68	300	mV
Quiescent current (T_j = +25°C)	I_{IB}	—	4.4	8	mA
Quiescent current change (T_j = +25°C)	ΔI_{IB}				mA
−30 V ⩽ V_I ⩽ −17.5 V		—	—	1	
5 mA ⩽ I_O ⩽ 1.5 A		—	—	0.5	
Output noise voltage (T_{amb} = +25°C, C_L = 1 µF, 10 Hz ⩽ f ⩽ 100 kHz)	V_{NO}	—	90	—	μV_{rms}
Long term stability	K_{VH}	—	—	60	mV

Note 1 : Although power dissipation is internally limited, electrical specifications apply only for power levels up to P_{max} = 20 W
Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

SCHEMATIC DIAGRAM



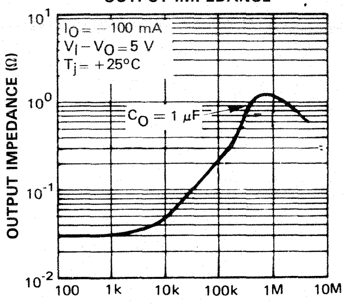
−5 V



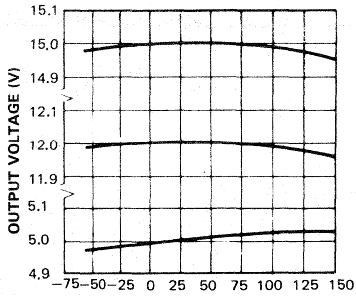
−12 V & −15 V

Case	GND	Output	Input
CB-117	1	2	3

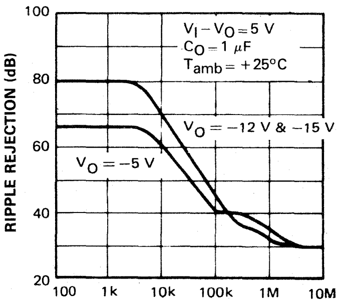
OUTPUT IMPEDANCE



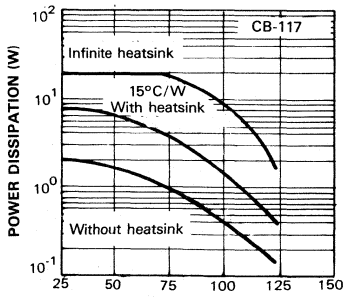
OUTPUT VOLTAGE VERSUS JUNCTION TEMPERATURE



RIPPLE REJECTION

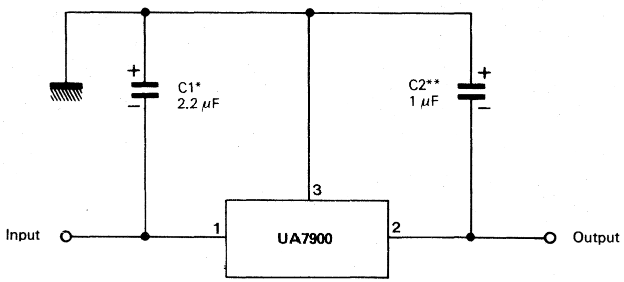


MAXIMUM AVERAGE POWER DISSIPATON



TYPICAL APPLICATIONS

FIXED OUTPUT REGULATOR

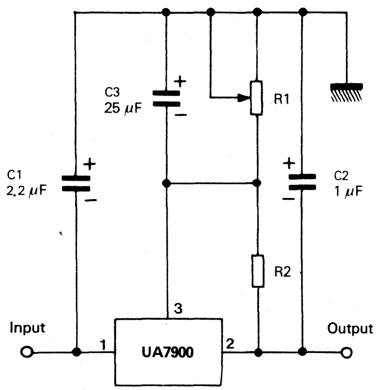


* Required if regulator is located an appreciable distance from power supply filter.

** Required for stability for value given.

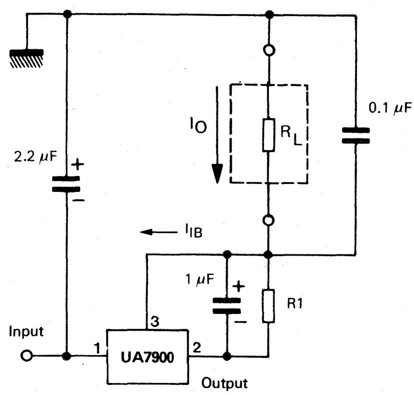
For output capacitance in excess of 100 μF, a high current diode from input to output (1N4001) will protect the regulator from momentary input shorts.

ADJUSTABLE OUTPUT REGULATOR



$V_O = V_{set} \frac{R1+R2}{R2}$ UA7905 : R2 = 300 Ω
UA7912 : R2 = 750 Ω
UA7915 : R2 = 1 kΩ

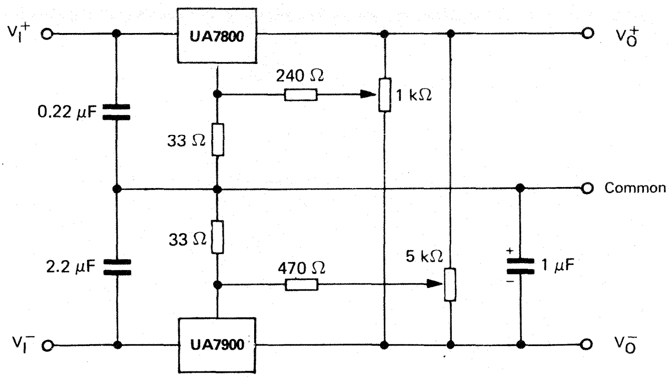
CURRENT REGULATOR



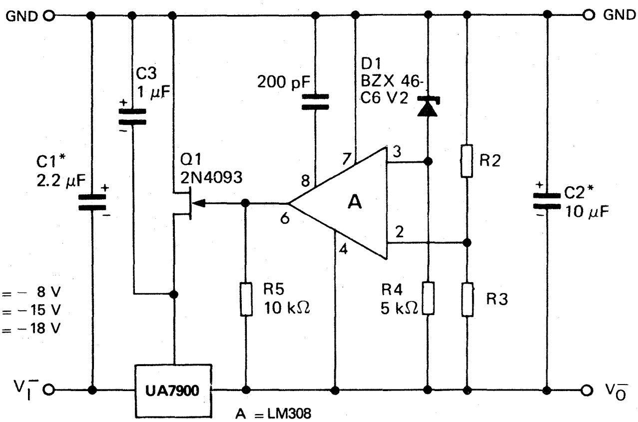
$I_O = \frac{V_{(2-1)}}{R1} + I_{IB}$

TYPICAL APPLICATIONS (continued)

DUAL TRIMMED SUPPLY



HIGH STABILITY 1 A REGULATOR

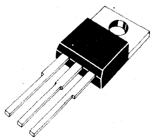


* Solid tantalum

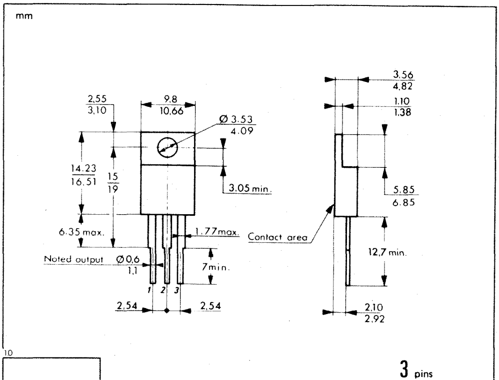
UA 7905C, BI	$V_I = -8$ V
UA 7912C, BI	$V_I = -15$ V
UA 7915C, BI	$V_I = -18$ V

Load and line regulation <0.01 %
Temperature stability <0.1 %

CB-117
(TO-220)



SP SUFFIX
PLASTIC PACKAGE



DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

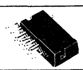
These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

Autoprotected control

		SINGLE										DUAL
		TDE1607	TDE1647	TDE1737	TDE1747	TDE1767	TDE1767A	TDE1787	TDE1787A	TDE1798	TDE3207	TDF1778
Load	Grounded	●	●		●	●	●	●	●	●	●	●
	V_{CC}			●								
Short-circuit current	Internally limited									●		●
	Programmable by external resistor	●	●	●	●	●	●	●	●		●	
Reset	Automatic	●	●	●	●						●	
	With input					●	●	●	●	●		●
Alarm output						●	●	●	●	●		●
Ground cut-off protection					●	●	●	●	●	●		●

4

($T_{amb} = +25°C$)

CHARACTERISTIC	SYMBOL	UNIT	TDE1607	TDE1647	TDE1737	TDE1747	TDE1767	TDE1767A	TDE1787	TDE1787A	TDE1798	TDE3207	TDF1778
Supply voltage	$V_{CC(max)}$	V	36	50	50	50	50	60	50	60	50	36	35
Output current	$I_{O(nom)}$	A	0.3	0.3	0.3	0.3	0.5	0.5	0.3	0.3	0.5	0.15	2
Input offset voltage	$V_{IO(max)}$	mV	50	50	50	50	50	50	50	50	50	50	—
Input bias current	$I_{IB(typ)}$	μA	0.1	0.1	0.1	0.1	15	15	15	15	15	0.1	20
Short-circuit current	$I_{SC(typ)}$	A	0.5*	0.5*	0.5*	0.5*	0.9*	0.9*	0.5*	0.5*	0.8*	0.25*	3.5
Output saturation voltage	$(V_{CC}-V_O)max$	V	1.8	1.4	Low 1.5	1.4	1.2	1.2	1.2	1.2	1.25	1.8	1.5
Input voltage range	V_{IM}	V	2 to V_{CC}-2	2 to V_{CC}-2	2 to V_{CC}-2	2 to V_{CC}-2	1 to 45	1 to 60	1 to 45	1 to 60	1 to 45	2 to V_{CC}-2	—
Switch-off output voltage	$V_{CC}-V_O$	V	—	—	—	—	—	—	—	—	—	—	44
PACKAGE		**SUFFIX**											
Plastic SO 14		FP	●		●	●							
Plastic DIL 8		DP	●	●	●	●	●	●	●	●	●	●	
6-pin metal can		CM	●	●	●	●							
Plastic SIL 11		SP											●
Page			475	475	487	475	493	493	493	493	503	511	517

* External limitation by one resistor

THOMSON SEMICONDUCTORS

TDE1647,A
TDE1747
TDE1607

INTERFACE CIRCUIT (RELAY AND LAMP DRIVER)

The TDE1647, TDE1747, TDE1607 are monolithic amplifiers designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

These devices are essentially blow-out proof. Current limiting is available to limit the peak output current to safe values, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the I.C. from overheating. If internal dissipation becomes too great, the driver will shut down to prevent excessive heating. Moreover, TDE1747 has an open ground protection.

The output is also protected from short-circuits with the positive power supply. The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 V used for industrial electronic systems.

- Open ground protection (TDE1747).
- High output current.
- Adjustable short-circuit protection to ground.
- Internal thermal protection with hysteresis to avoid the intermediate output levels.
- Large supply voltage range: + 10 V to + 45 V.
- Short-circuit protection to V_{CC}.

ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

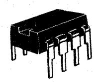
PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		CM	DP	FP
TDE1647	−25°C to +85°C	●	●	
TDE1747	−25°C to +85°C	●	●	●
TDE1607	−25°C to +85°C	●	●	●
TDE1647 A	−25°C to +85°C	●		

Examples : TDE1647CM, TDE1607DP

INTERFACE CIRCUIT
RELAY AND LAMP DRIVER

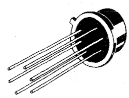
CASES

CB-98



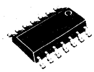
DP SUFFIX
PLASTIC PACKAGE

CB-107



CM SUFFIX
METAL CAN

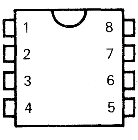
CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

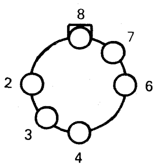
PIN ASSIGNMENT
(Top views)

CB-98



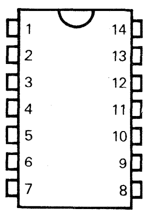
1 - N.C.
2 - Inverting input
3 - Non-inverting input
4 - GND
5 - Output
6 - V_{sense}
7 - V_{CC}
8 - N.C.

CB-107



2 - Inverting input
3 - Non-inverting input
4 - GND
6 - Output
7 - V_{sense}
8 - V_{CC}

CB-511



1 - N.C.
2 - N.C.
3 - N.C.
4 - V_{CC}
5 - Inverting input
6 - N.C.
7 - Non-inverting input
8 - GND
9 - N.C.
10 - Output
11 - V_{sense}
12 - N.C.
13 - N.C.
14 - N.C.

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THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

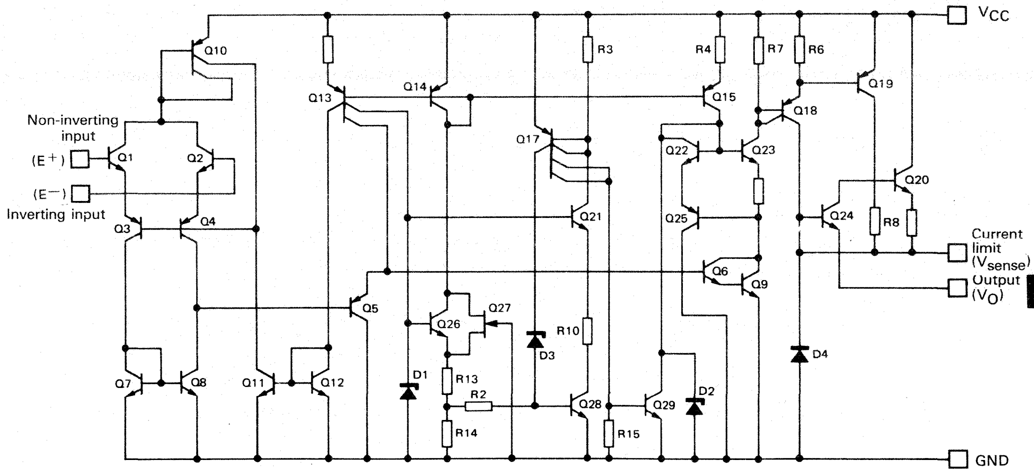
Rating	Symbol	TDE1647,A TDE1747	TDE1607	Unit
Supply voltage	V_{CC}	50*	36	V
Differential input voltage	V_{ID}	50	36	V
Input voltage	V_I	50	36	V
Output current	I_O	1000	500	mA
Power dissipation ($T_{amb} = +25°C$)	P_{tot}	Internally limited		W
Operating ambient temperature range	T_{oper}	−25 to + 85		°C
Storage temperature range	T_{stg}	−65 to +150		°C

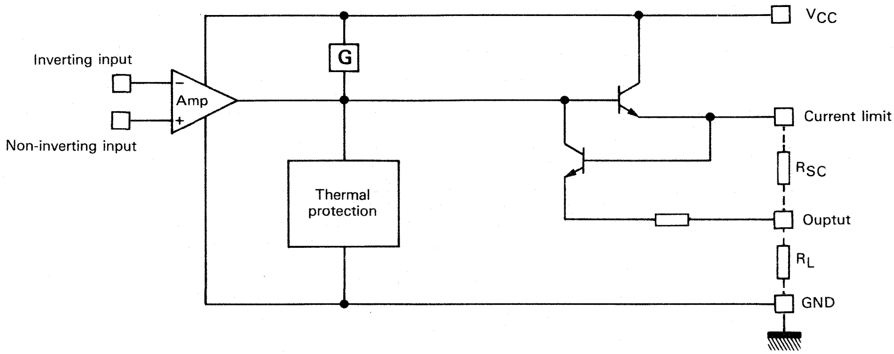
* $V_{CC} = +60$ V, $t \leqslant 10$ ms for TDE1647A

THERMAL CHARACTERISTICS

Characteristic		Symbol	Value	Unit
Junction-case thermal resistance		$R_{th(j-c)}$		°C/W
	CB-107		45	
	CB-98		50	
Junction-ambient thermal resistance		$R_{th(j-a)}$		°C/W
	CB-107		185	
	CB-98		120	
Junction-ceramic - Substrate thermal resistance (Case glued to substrate)	CB-511	–	90	°C/W
Junction-ceramic - Substrate thermal resistance (Case glued to substrate, substrate temperature maintained constant)	CB-511	–	65	°C/W

SCHEMATIC DIAGRAM





4

CASE	Inverting input	Non-inverting input	GND	Output	V_{sense}	V_{CC}	N.C.
CB-107	2	3	4	6	7	8	—
CB-98	2	3	4	5	6	7	1.8
CB-511	5	7	8	10	11	4	*

* **CB-511** : other pin are not connected

ELECTRICAL CHARACTERISTICS (Note 1) $T_j \leq +150°C$
TDE1647,A, TDE1747 : $-25°C \leq T_{amb} \leq +85°C$, $+8\ V \leq V_{CC} \leq +45\ V$, $I_O = 300\ mA$
TDE1607DP-FP : $-25°C \leq T_{amb} \leq +85°C$, $+8\ V \leq V_{CC} \leq +30\ V$, $I_O = 150\ mA$
TDE1607 CM : $-25°C \leq T_{amb} \leq +85°C$, $+8\ V \leq V_{CC} \leq +30\ V$, $I_O = 300\ mA$
(Unless otherwise specified)

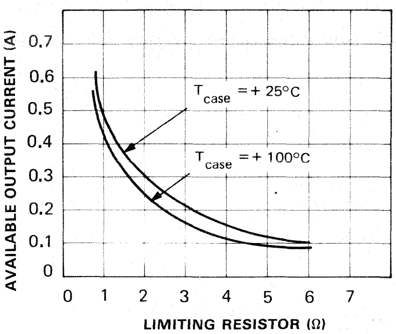
Characteristic	Symbol	TDE1647,A TDE1747			TDE1607CM(a) TDE1607DP, FP			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 2)	V_{IO}	—	2	50	—	2	50	mV
Input bias current	I_{IB}	—	0.1	1.5	—	0.1	1.5	μA
Supply current ($V_{CC} = +24\ V$, $I_O = 0$)	I_{CC}							mA
High level		—	4	6	—	4	6	
Low level		—	2	4	—	2	4	
Common-mode input voltage range	$V_{I(max)}$	2	—	$V_{CC}-2$	2	—	$V_{CC}-2$	V
Short-circuit current limit ($T_{amb} = +25°C$, $V_{CC} = +24\ V$)	I_{SC}							mA
$R_{SC} = 1.5\ \Omega$ TDE1747		—	480	—	—	—	—	
$R_{SC} = 1.5\ \Omega$ TDE1647		—	540	—	—	—	—	
$R_{SC} = 3.3\ \Omega$		—	—	—	—	230	—	
$R_{SC} = \infty$		—	35	50	—	35	50	
Output saturation voltage (output high) ($R_{SC} = 0$, $V_I^+ - V_I^- \geq 50\ mV$)	$V_{CC} - V_O$							V
$I_O = 300\ mA$, $T_j = +25°C$		—	1.15	1.4	—	1.2 (a)	1.8 (a)	
$T_j = +150°C$		—	1.05	1.3	—	1.1 (a)	1.5 (a)	
$I_O = 150\ mA$, $T_j = +25°C$ TDE1607DP, FP		—	—	—	—	1.2	1.8	
$T_j = +150°C$ TDE1607DP, FP		—	—	—	—	1.1	1.5	
Low level output current ($V_O = 0$, $V_{CC} = +24\ V$)	I_{OL}							μA
$T_j = +25°C$		—	—	—	—	0.01	10 (a)	
TDE1607DP, FP		—	—	—	—	—	100	
$T_{min} \leq T_j \leq T_{max}$		—	0.01	10	—	0.01	50 (a)	
TDE1607DP, FP		—	—	—	—	—	500	

Note 1 : For operating at high temperature, the TDE1607, TDE1747, TDE1647,A must be derated based on a +150°C maximum junction temperature and a junction-ambient thermal resistance of 185°C/W for the CB-107, 120°C/W for the CB-98 and 100°C/W for the CB-511.

Note 2 : The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

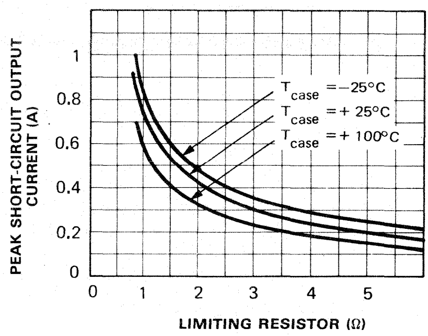
AVAILABLE OUTPUT CURRENT VERSUS LIMITING RESISTOR

TDE1747

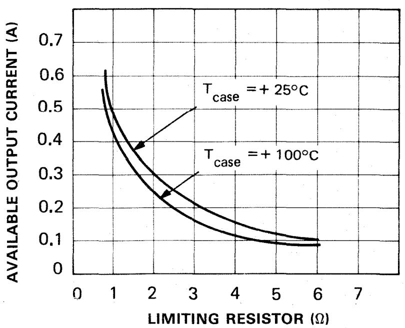


PEAK SHORT-CIRCUIT OUTPUT CURRENT VERSUS LIMITING RESISTOR

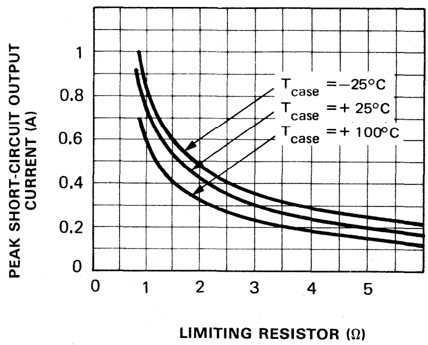
TDE1747



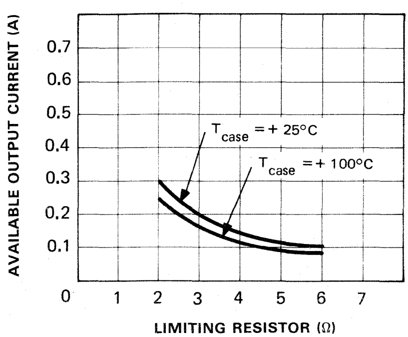
TDE1647,A - TDE1607 CM



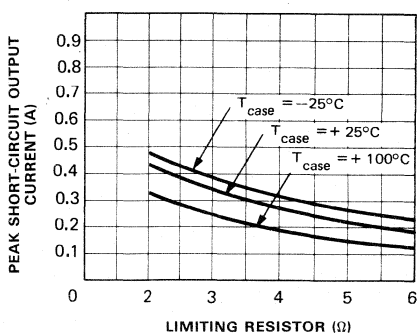
TDE1647,A - TDE1607 CM



TDE1607 DP, FP



TDE1607 DP, FP



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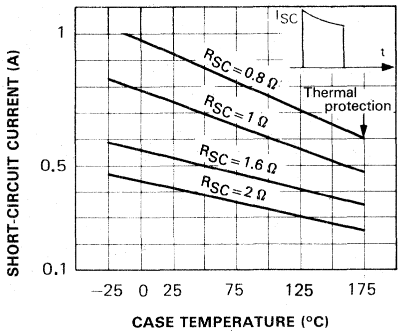
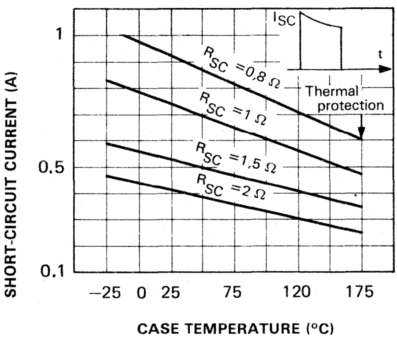
SHORT-CIRCUIT CURRENT VERSUS CASE TEMPERATURE

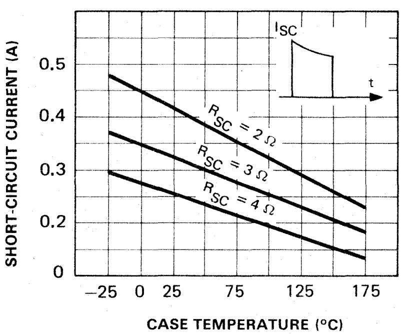
TDE1747



TDE 1647,A - TDE1607 CM

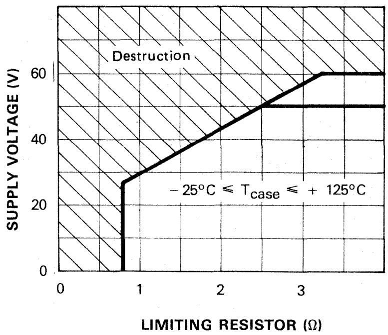


TDE1607 DP, FP

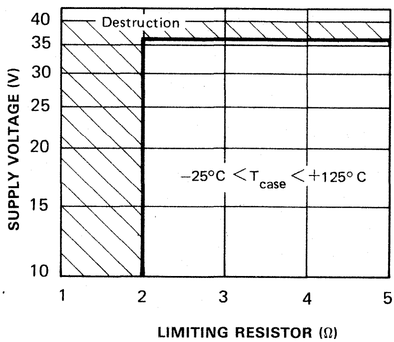


MINIMUM LIMITING RESISTOR VALUE VERSUS SUPPLY VOLTAGE

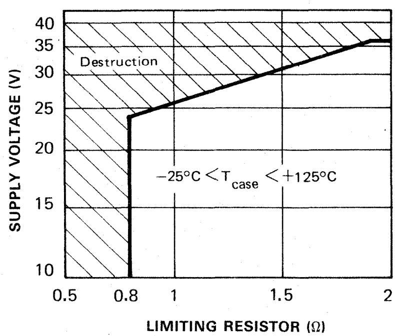
TDE1647,A - TDE1747



TDE1607 DP, FP

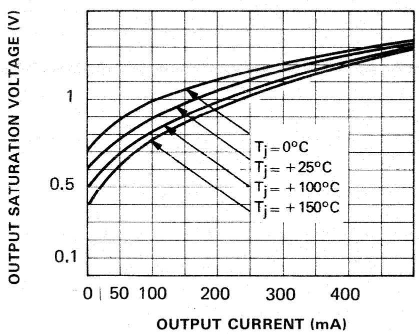


TDE1607 CM



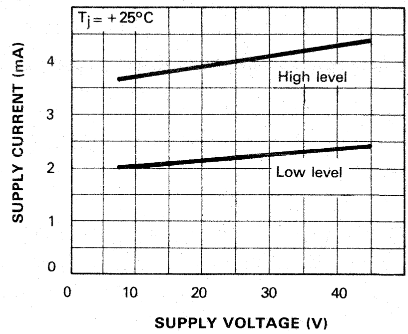
OUTPUT SATURATION VOLTAGE VERSUS CASE TEMPERATURE AND AVAILABLE OUTPUT CURRENT

TDE1647,A - TDE1747 - TDE1607 CM

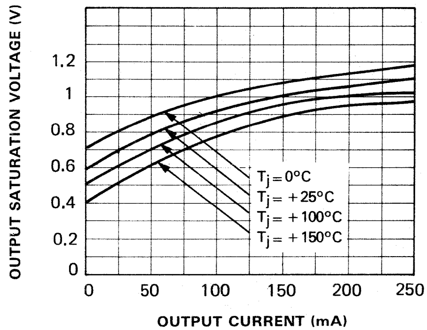


SUPPLY CURRENT VERSUS SUPPLY VOLTAGE

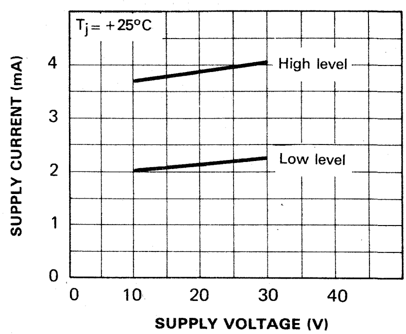
TDE1647,A - TDE1747



TDE1607 DP, FP

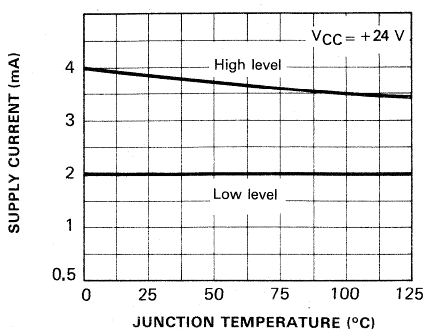


TDE1607 DP, FP, CM



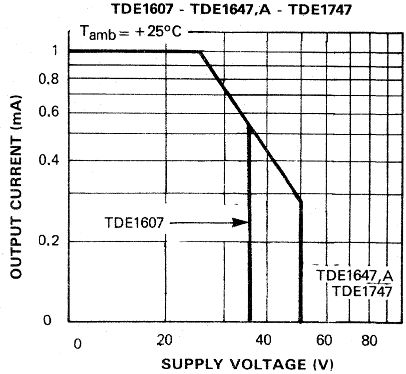
SUPPLY CURRENT VERSUS JUNCTION TEMPERATURE

TDE1647,A - TDE1747 - TDE1607

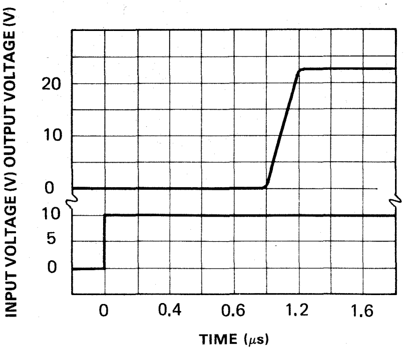


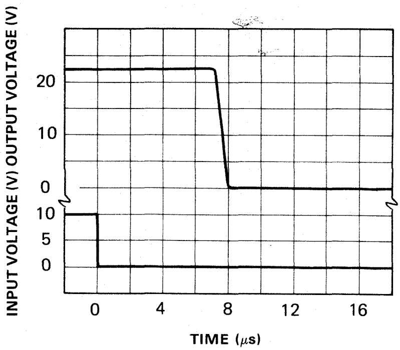
SAFE OPERATING AREA
(non repetitive surge)

TDE1607 - TDE1647,A - TDE1747

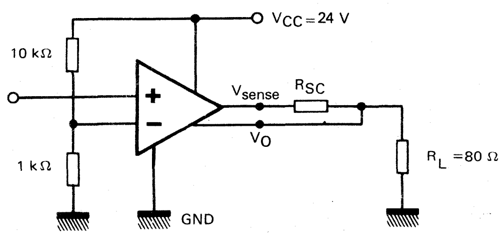


RESPONSE TIME





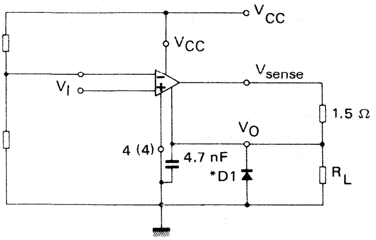
TEST CIRCUIT



TYPICAL APPLICATIONS

TDE1647,A - TDE1747

BASIC CIRCUIT



*D1: required if inductive load

OUTPUT CURRENT EXTENSION (5 A)

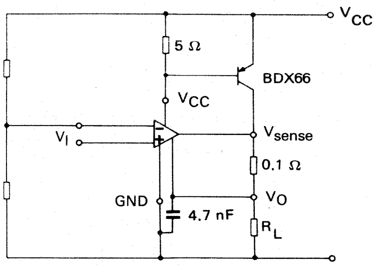
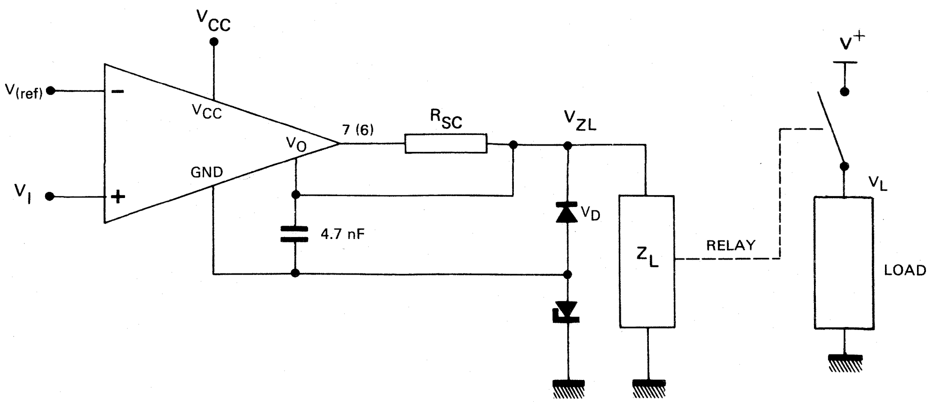
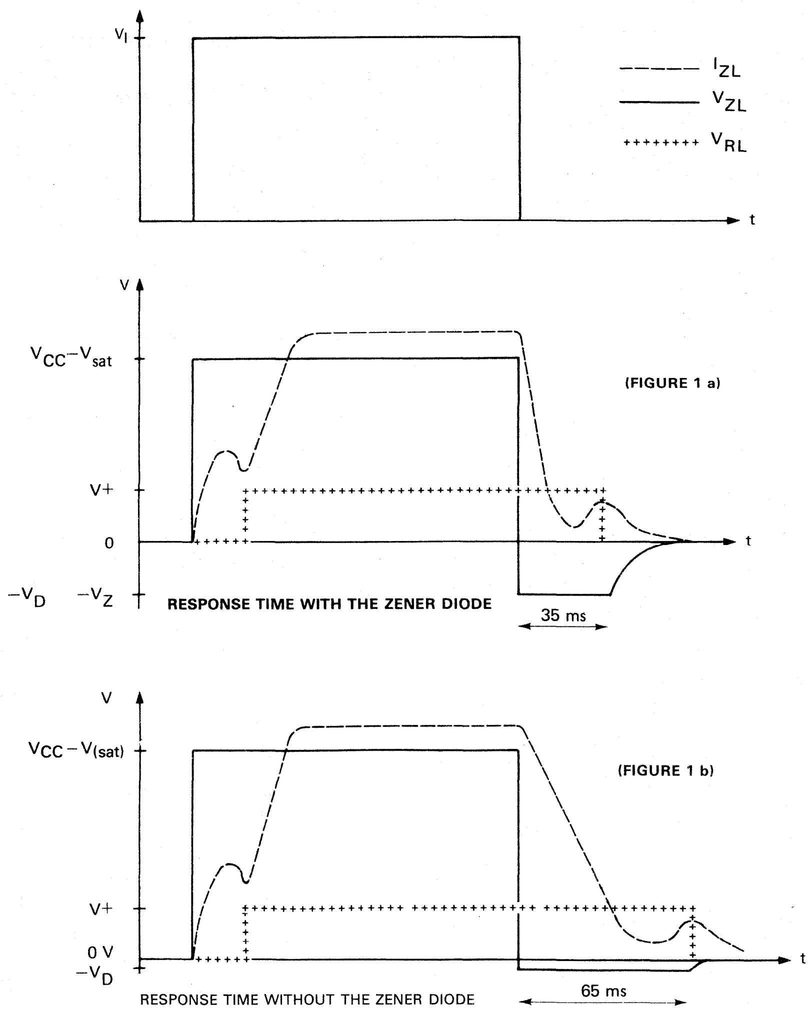


FIGURE 1 - DRIVING LOW IMPEDANCE RELAYS ($I_O = 300$ mA)

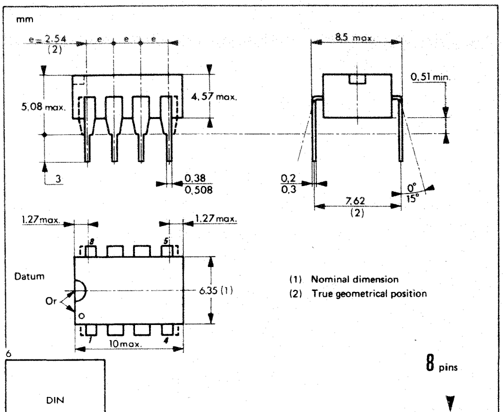


The device in the above application operates at :
$V_{CC} = +45$ V, $I_O = 300$ mA with a heatsink such that $R_{th(j-a)} \leqslant 80°C/W$. The device supports an output voltage of $V_{CC} + V_Z$ during the current cut off time, wich is decreased by the zener diode.
This voltage must be $\leqslant$ to the maximum supply voltage.

WAVEFORMS OF FIGURE 1

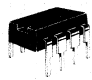


Note 1 : In the case of the figure 1a, the TDE1647,A-CM can withstand +60 V @ 400 mA for t⩽5 μs.



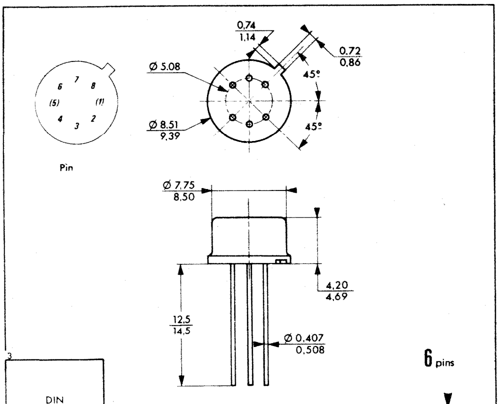
6 DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98



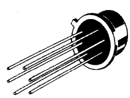
DP SUFFIX
PLASTIC PACKAGE

4



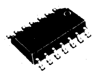
3 DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-107 THOMSON SEMICONDUCTORS

CB-107

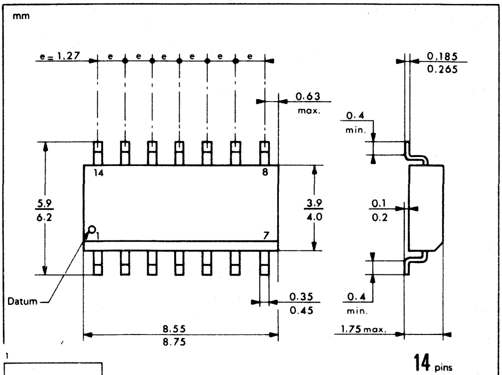


CM SUFFIX
METAL CAN

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TDE1737

INTERFACE CIRCUIT (RELAY AND LAMP-DRIVER)

The TDE1737 is a monolithic amplifier designed for high current and high voltage applications, specifically to drive lamps, relays and control of stepper motors.

This device is essentially blow-out proof. Current limiting is available to limit the peak output current to a safe value, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the I.C. from overheating. If internal dissipation becomes too great, the driver will shut down to prevent excessive heating.

The output is also protected against short-circuits with the positive power supply.

The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 V used for industrial electronic systems.

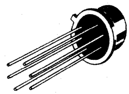
- High output current
- Adjustable short-circuit protection
- Internal thermal protection with hysteresis to avoid the intermediate output levels.
- Large supply voltage range : + 8 V to + 45 V

INTERFACE CIRCUIT RELAY AND LAMP DRIVER

4

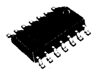
CASES

CB-107



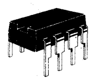
CM SUFFIX
METAL CAN

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

CB-98



DP SUFFIX
PLASTIC PACKAGE

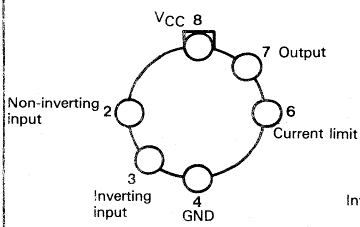
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		CM	DP	FP
TDE1737	− 25°C to + 85°C	•	•	•
Example : TDE1737DP				

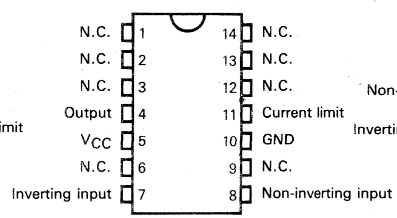
PIN ASSIGNMENTS

(Top views)

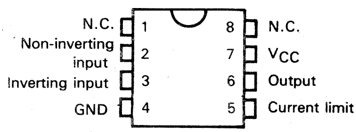
CB-107



CB-511



CB-98



Réf. 00160

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45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

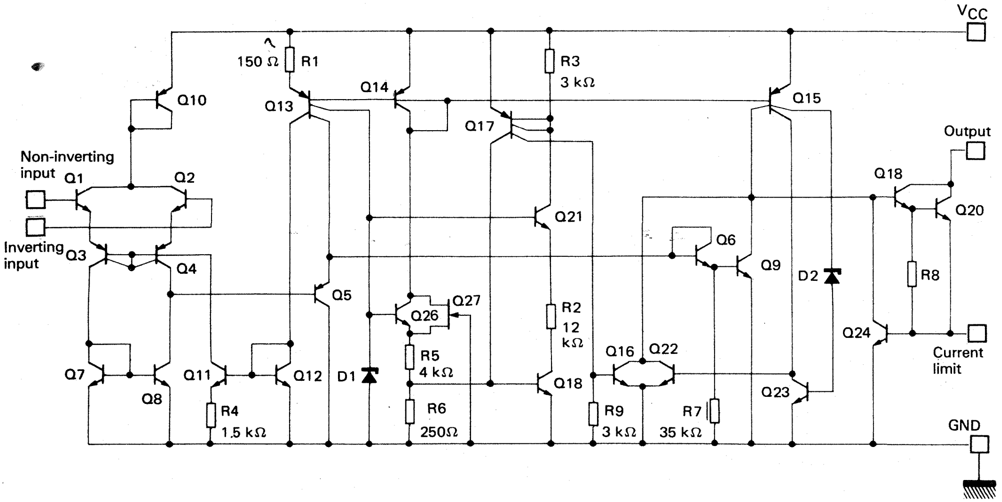
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	50	V
Input voltage	V_I	50	V
Differential input voltage	V_{ID}	50	V
Output current	I_O	1000	mA
Power dissipation	P_{tot}	Internally limited	W
Operating free-air temperature range	T_{oper}	– 25 to + 85	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-case thermal resistance CB-107 CB-98	$R_{th(j-c)}$	45 50	°C/W
Junction-ambient thermal resistance CB-107 CB-98	$R_{th(j-a)}$	185 120	°C/W
Junction-ceramic substrate (Case glued to substrate) CB-511	–	90	°C/W
Junction-ceramic substrate (Case glued to substrate, substrate temperature maintained constant) CB-511	–	65	°C/W

SCHEMATIC DIAGRAM



Case	Non-inverting input	Inverting input	GND	Current limit	Output	V_{CC}
CB-107	2	3	4	6	7	8
CB-98	2	3	4	5	6	7
CB-511	8	7	10	11	4	5

All other pins are not connected.

ELECTRICAL CHARACTERISTICS

$-25°C \leqslant T_{amb} \leqslant +85°C$, $+8\ V \leqslant V_{CC} \leqslant +45\ V$, $I_O \leqslant 300\ mA$, $T_j \leqslant +150°C$ (Unless otherwise specified)

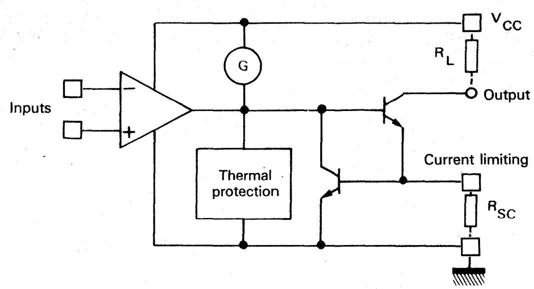
Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage - (Note 1)	V_{IO}	–	2	50	mV
Input bias current	I_{IB}	–	0.1	1.5	μA
Supply current ($V_{CC} = +24$ V, $I_O = 0$)	I_{CC}	–	3	5	mA
Common-mode input voltage range	V_{CM}	2	–	$V_{CC}-2$	V
Short-circuit current limit ($R_{SC} = 1.5\ \Omega$, $T_{case} = +25°C$)	I_{SC}	–	500	–	mA
Output saturation voltage (output low) ($V_I^+ - V_I^- \geqslant 50$ mA, $I_O = 300$ mA, $R_{SC} = 0$)	$V_{CC}-V_O$	–	1	1.5	V
Output leakage current (output high) ($V_O = V_{CC} = +24$ V, $T_{amb} = +25°C$)	I_{OL}	–	–	10	μA

Note 1 : The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

Note 2 : Devices bonded on a 40 cm² glass-epoxy printed circuit 0.15 cm thick with 4 cm² of copper.

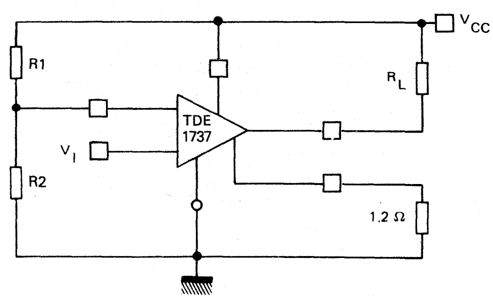
4

SIMPLIFIED SCHEMATIC

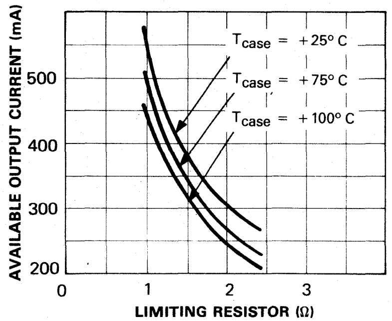


TYPICAL APPLICATION

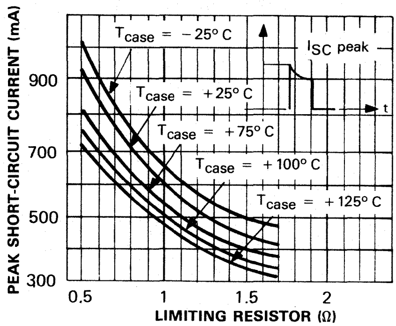
BASIC CIRCUIT



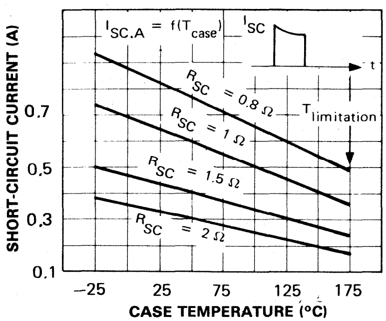
AVAILABLE OUTPUT CURRENT VERSUS LIMITING RESISTOR



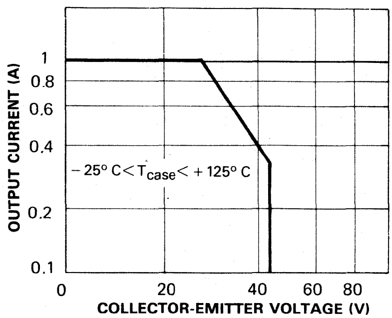
PEAK SHORT-CIRCUIT CURRENT VERSUS LIMITING RESISTOR



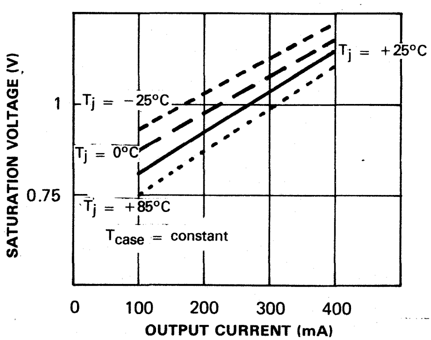
SHORT-CIRCUIT CURRENT VERSUS CASE TEMPERATURE

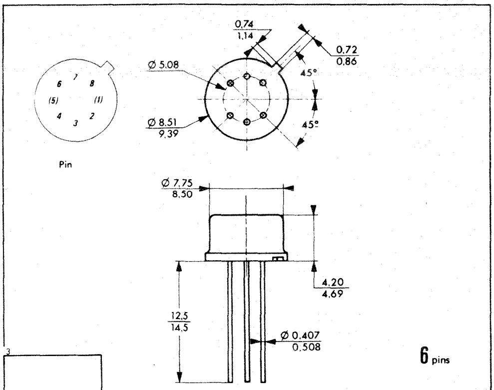


SAFE OPERATING AREA (NON REPETITIVE OVERLOAD)

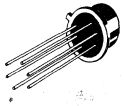


SATURATION VOLTAGE VERSUS OUTPUT CURRENT

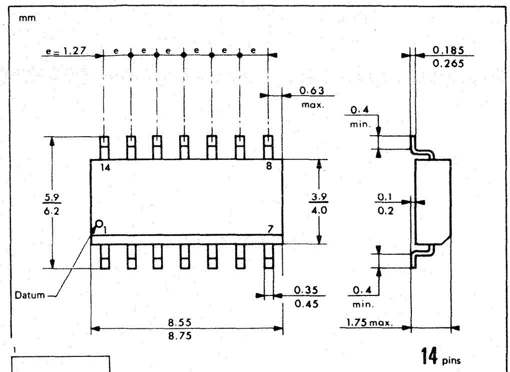




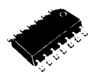
DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-107 THOMSON SEMICONDUCTORS



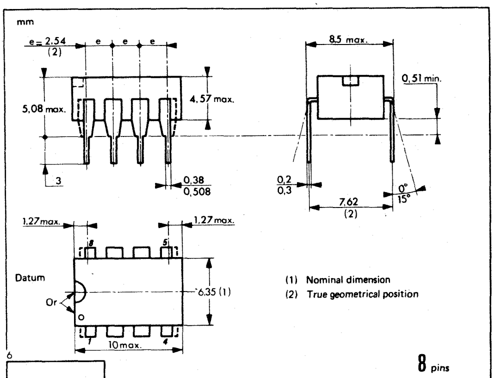
CB-107
CM SUFFIX
METAL CAN



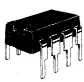
DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS



CB-511
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS



CB-98
DP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TDE1767,A
TDE1787,A

INTERFACE CIRCUIT (RELAY AND LAMP-DRIVER)

The TDE1767,A/TDE1787,A are monolithic amplifiers designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

These devices are essentially blow-out proof. The output is protected from short-circuits with the positive supply or ground. In addition thermal shut down is provided to keep the IC from overheating. If internal dissipation becomes too high, the driver will shut down to prevent excessive heating. The output stays null after the overheating is off, if the reset input is low. If high the output will alternatively switch-on and off until the overload is removed.

The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies to the single + 6 V or + 48 V used for industrial electronic systems. Input voltages can be higher than the V_{CC}.

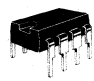
An alarm output suitable for driving a LED is provided. This LED, normally on (if referred to ground), will die out or flash during an overload depending on the state of the reset input.
The output is low in open ground conditions.

- Open ground protection.
- High output current.
- Adjustable short-circuit protection.
- Internal thermal protection with external reset.
- Large supply voltage range.
- Alarm output.
- Input voltage can be higher than V_{CC}.
- Output voltage can be lower than ground ($V_{CC} - V_O \leq V_{CC(max)}$.

INTERFACE CIRCUIT RELAY AND LAMP-DRIVER

4

CASE CB-98



DP SUFFIX
PLASTIC PACKAGE

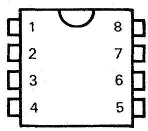
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE DP
TDE1767,A **TDE1787,A**	− 25°C to + 85°C	•
Example : TDE1767ADP		

PIN ASSIGNMENT

(Top view)

CB-98



Réf. 00415

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TDE1767A/TDE1787A	TDE1767/TDE1787	Unit
Supply voltage	V_{CC}	60	50	V
Input differential voltage	V_{ID}	60	50	V
Input voltage	V_I	− 10 to + 60	− 10 to + 50	V
Output current	I_O	1.2	1.2	A
Reset input voltage	$V_{I(reset)}$	− 0.5 to + 60	− 0.5 to + 50	V
Alarm output current	I_{OA}	− 10 to + 20	− 10 to + 20	mA
Power dissipation	P_{tot}	Internally limited		mW
Operating ambient temperature range	T_{oper}	− 25 to + 85	− 25 to + 85	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	30	°C/W
Maximum junction-ambient thermal resistance *	$R_{th(j-a)}$	80	°C/W

* Devices bonded on a 40 cm² glass-epoxy printed circuit 0.15 cm thick with 4 cm² of copper.

ELECTRICAL CHARACTERISTICS

TDE1767A : $-25°C \leq T_{amb} \leq +85°C$, $+6\ V \leq V_{CC} \leq +60\ V$, $I_O \leq 500\ mA$, $T_j \leq +150°C$
TDE1767 : $-25°C \leq T_{amb} \leq +85°C$, $+6\ V \leq V_{CC} \leq +45\ V$, $I_O \leq 500\ mA$, $T_j \leq +150°C$
TDE1787A : $-25°C \leq T_{amb} \leq +85°C$, $+6\ V \leq V_{CC} \leq +60\ V$, $I_O \leq 300\ mA$, $T_j \leq +150°C$
TDE1787 : $-25°C \leq T_{amb} \leq +85°C$, $+6\ V \leq V_{CC} \leq +45\ V$, $I_O \leq 300\ mA$, $T_j \leq +150°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage - (Note 1)	V_{IO}	–	2	50	mV
Power supply current (measured on pin 4)	I_{CC}				mA
Output high ($T_{amb} = +25°C$)		–	5.8	8	
Output high ($V_{CC} = V_{CC(max)}$, $T_j = +150°C$)		–	5	7	
Output low ($V_{CC} = V_{CC(max)}$, $T_{amb} = +25°C$)		–	1.5	4	
Input bias current	I_{IB}	–	15	100	µA
Common-mode input voltage range - (Note 2)	V_{CM}				V
TDE1787A, TDE1767A		1	–	60	
TDE1787, TDE1767		1	–	45	
Input voltage range ($V_{ref} \geq +1$ V), (Figure 1, Note 2)	V_I				V
TDE1787A, TDE1767A		0	–	60	
TDE1787, TDE1767		0	–	45	
Short-circuit output current ($V_{CC} = +35$ V, t = 10 ms)	I_{SC}				mA
$R_{SC} = 0.18\ \Omega$ TDE1767,A		–	700	–	
$R_{SC} = 0.33\ \Omega$ TDE1787,A		–	380	–	
Current limit sense voltage ($V_O = V_{CC} - 2$ V)	V_{sense}	–	120	–	mV
Output saturation voltage (output high $V_I^+ - V_I^- \geq 50$ mV, $R_{SC} = 0$, $V_{CC} = +30$ V)	$V_{O(sat)}$				V
$T_j = +25°C$ TDE1787A, TDE1767A		–	1	1.1	
TDE1787, TDE1767		–	1	1.2	
$T_j = +150°C$ TDE1787A, TDE1767A		–	1.1	1.2	
TDE1787, TDE1767		–	1.1	1.3	
Output leakage current (output low)	I_{OL}	–	–	100	µA
Available alarm output current	I_A				mA
Output source current ($V_{AH} = V_{CC} - 2.5$ V)		− 4	− 5	–	
Output sink current (in thermal shut-down) $V_A = 1.4$ V		5	10	–	
Reset input current	I_{reset}	–	2	40	µA
Reset threshold	$V_{th(reset)}$	–	1.4	–	V
Output leakage current (open ground)	–	–	10	–	µA

Note 1 : The offset voltage given is the maximum value of differential input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

Note 2 : Input voltage range is independent of the supply voltage.

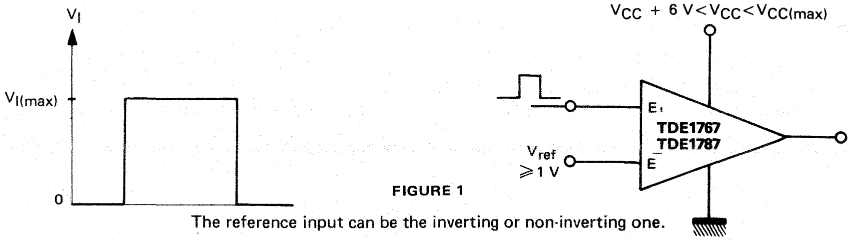
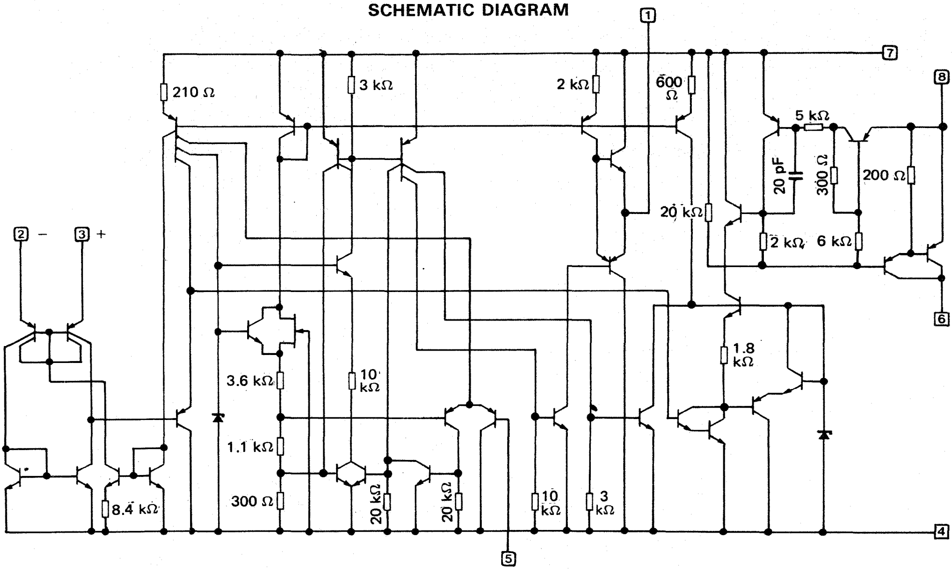


FIGURE 1

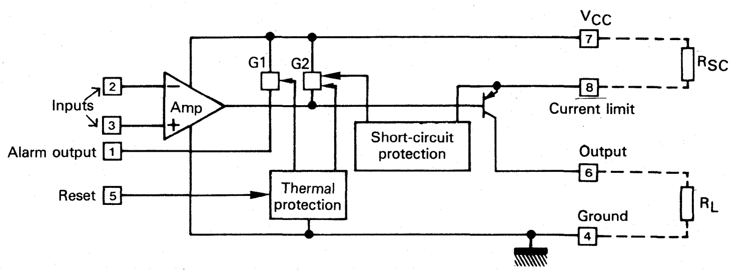
The reference input can be the inverting or non-inverting one.

SCHEMATIC DIAGRAM

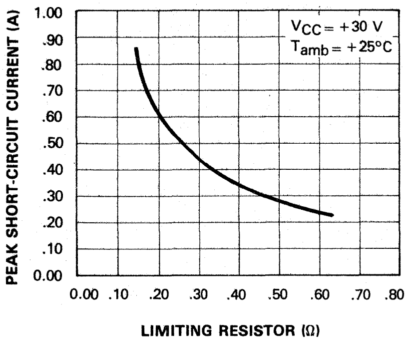


CASE	Alarm output	Inverting input	Non-inverting input	GND	Reset	Output	V_{CC}	Current limit
CB-98	1	2	3	4	5	6	7	8

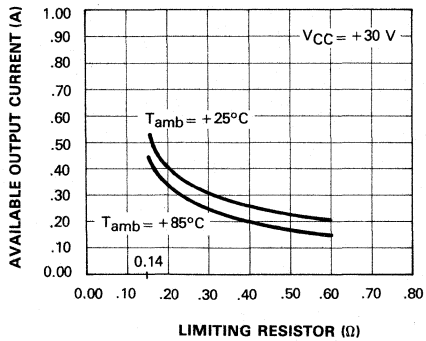
EQUIVALENT SCHEMATIC



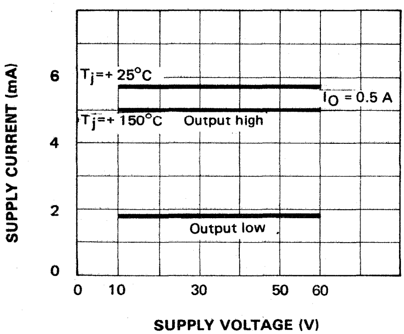
PEAK SHORT-CIRCUIT CURRENT vs LIMITING RESISTOR



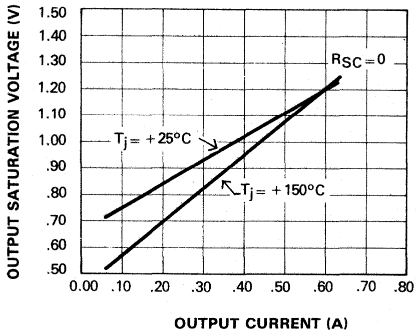
AVAILABLE OUTPUT CURRENT vs LIMITING RESISTOR



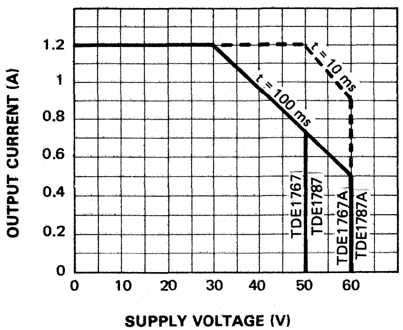
POWER SUPPLY CURRENT (pin 4)



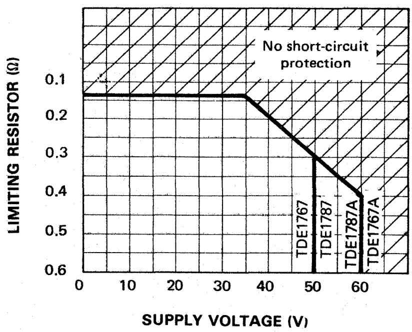
OUTPUT SATURATION VOLTAGE vs OUTPUT CURRENT



OUTPUT TRANSISTOR SAFE OPERATING AREA (Pulsed)

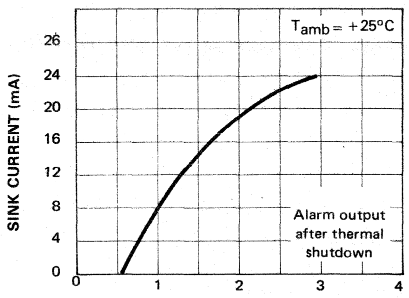


NORMAL OPERATING AREA (Short-circuit protected)



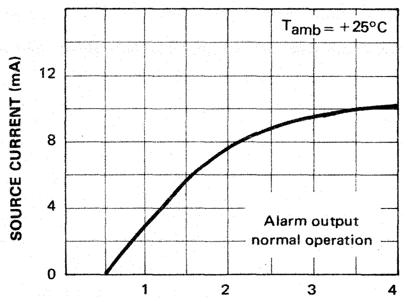
ALARM OUTPUT CAPABILITY CURRENT

CURRENT SINKING



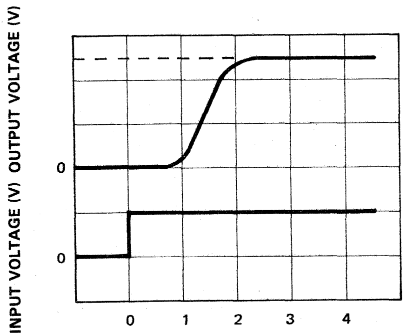
ALARM OUTPUT VOLTAGE
REFERENCED TO GROUND (V)

CURRENT SOURCING

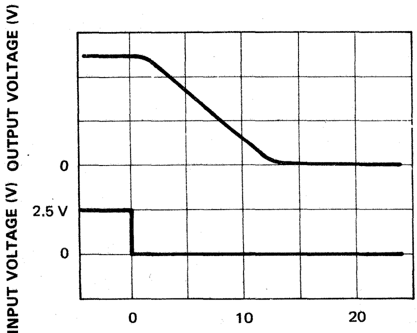


ALARM OUTPUT VOLTAGE
REFERENCED TO SUPPLY VOLTAGE (V)

RESPONSE TIME

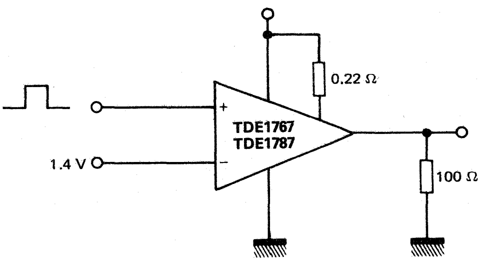


TIME (µs)



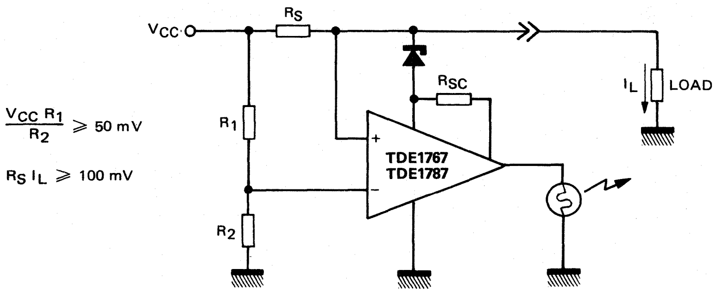
TIME (µs)

TEST CIRCUIT

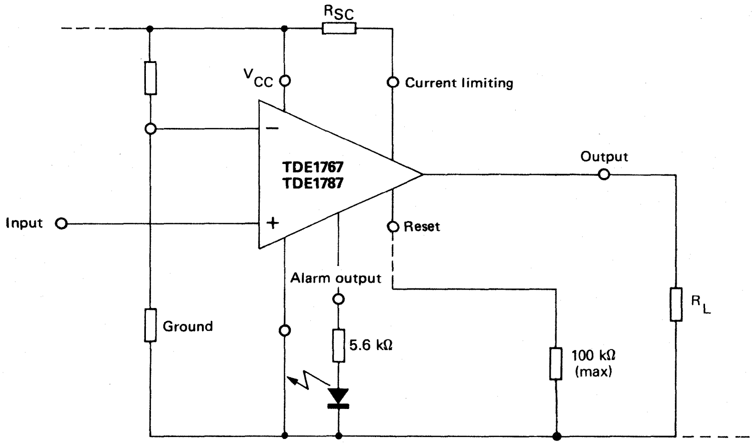


TYPICAL APPLICATIONS

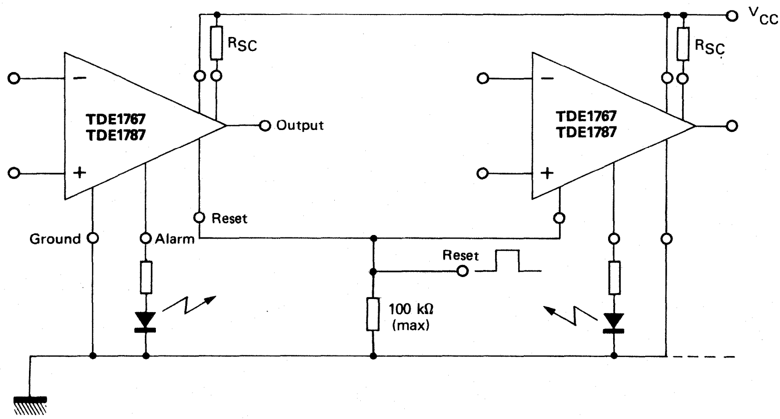
OPEN LOAD DETECTION



DRIVING LAMPS, RELAYS, etc...



COMMON RESET



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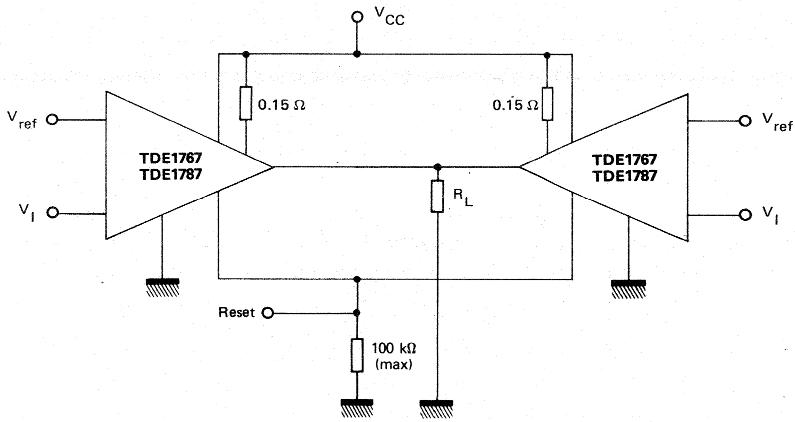
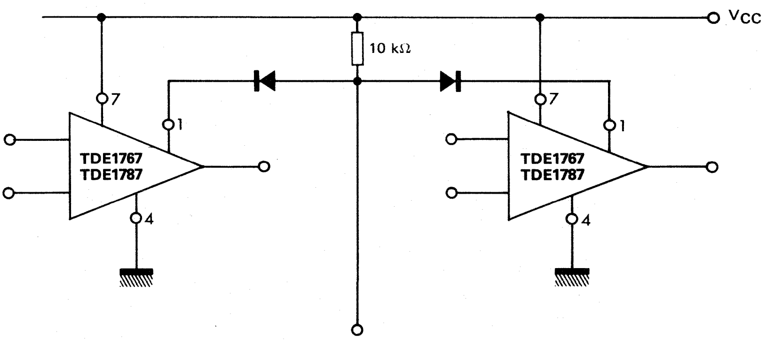
TYPICAL APPLICATIONS (continued)

PARALLEL DRIVING OF LOADS UP TO 1 A

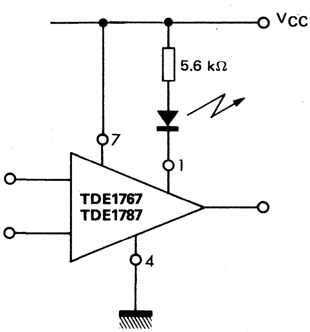


USING ALARM OUTPUT

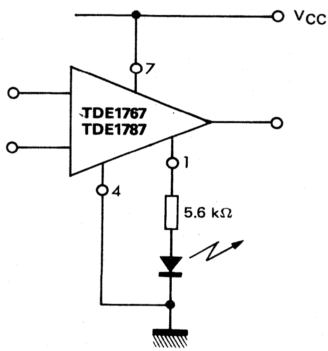
PARALLEL ALARM OUTPUTS



LED TO V_{CC}

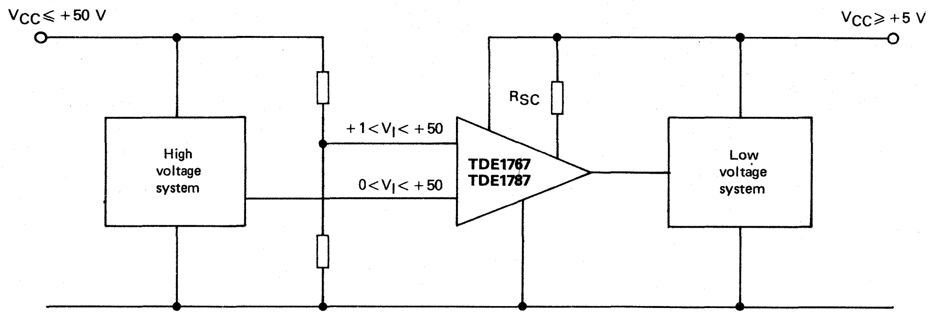


LED TO GROUND

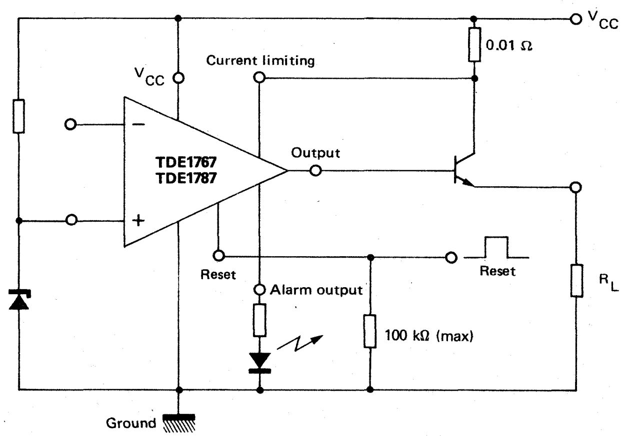


TYPICAL APPLICATIONS (continued)

INTERFACE BETWEEN HIGH VOLTAGE AND LOW VOLTAGE SYSTEMS



INCREASING OUTPUT CURRENT UP TO 10 A



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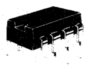
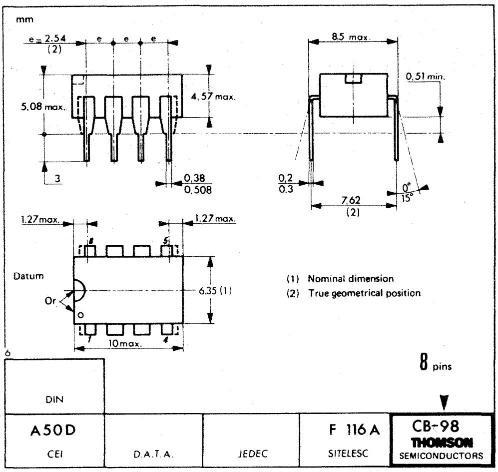
CB-98



DP SUFFIX
PLASTIC PACKAGE



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TDE1798

ADVANCE INFORMATION

INTERFACE CIRCUIT (RELAY AND LAMP-DRIVER)

The TDE1798 is a monolithic comparator designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

This device is essentially blow out proof. The output is protected from short circuits with the positive supply or ground. In addition thermal shut down is provided to keep the IC from overheating. If internal dissipation becomes too high, the driver will shut down to prevent excessive heating. The output stays null after the overload is off, if the reset input is low. If high the output will alternatively switch on and off until the overload is removed.

If several reset inputs of different devices are connected in parallel, their outputs will be reactivated simultaneously.

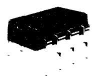
The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies to the single + 6 V or + 35 V used for industrial electronic systems. Input voltage can be higher than the V_{CC}. The output is low in open ground conditions.

- Open ground protection.
- High output current : 500 mA.
- Short-circuit protection up to $V_{CC} = +35$ V.
- Internal thermal protection with external reset and synchronization capability.
- Large supply voltage range.
- Sink and source alarm outputs.
- Input voltage can be higher than V_{CC}.
- Output voltage can be lower than ground ($V_{CC} - V_O \leq V_{CC}$ max).

INTERFACE CIRCUIT RELAY AND LAMP DRIVER

4

CASE CB-98

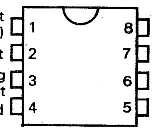


DP SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
		DP
TDE1798	−25°C to +85°C	•

PIN ASSIGNMENT
(Top view)



Réf. 00435

IOMSON SEMICONDUCTORS
es headquarters
av. de l'Europe - 78140 VELIZY - FRANCE
. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

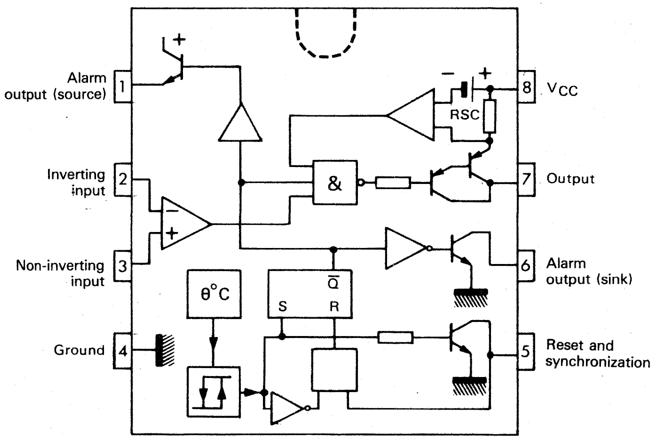
Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	50	V
Input differential voltage	V_{ID}	50	V
Input voltage	V_I	– 30 to + 50	V
Reset input voltage	$V_{I(reset)}$	V_{CC} – 50 to V_{CC}	V
Output current	I_O	Internally limited	A
Power dissipation, T_{amb} = + 25°C	P_{tot}	Internally limited	mW
Operating ambient temperature range	T_{oper}	– 25 to + 85	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C
Alarm output sink current	$I_{A(sink)}$	25	mA
Alarm output source current	$I_{A(source)}$	12	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance - (Note 1)	$R_{th(j-c)}$	30	°C/W
Maximum junction-ambient thermal resistance - (Note 1)	$R_{th(j-a)}$	70	°C/W

Note 1 : Devices bonded on a 40 cm² glass-epoxy printed circuit 0.15 cm thick with 4 cm² of copper.

SCHEMATIC DIAGRAM



ELECTRICAL CHARACTERISTICS (Note 2)
$-25°C \leq T_{amb} \leq +85°C$, $6\ V \leq V_{CC} \leq +35\ V$, $I_O \leq 500\ mA$, $T_j \leq +150°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage - (Note 3)	V_{IO}		2	50	mV
Power supply current Output high ($T_{amb} = +25°C$, $I_O = 500$ mA) Output low	I_{CC}	 — —	 6.5 1.5	 8 4	mA
Input bias current	I_{IB}	—	15	40	µA
Common-mode input voltage range - (Note 4)	V_{ICR}	1	—	45	V
Input voltage range ($V_{ref} \geq +1$ V, Figure 1, Note 4)	V_I	0	—	45	V
Short-circuit output current ($V_{CC} = 30$ V, t = 10 ms)	I_{SC}	—	800	—	mA
Output saturation voltage ($V_I^+ - V_I^- \geq 50$ mV, $I_O = 500$ mA, $V_{CC} = +30$ V, $-25° \leq T_j \leq +150°$)	$V_{CC} - V_O$	 —	 1	 1.25	V
Output low leakage current ($V_{CC} = +30$ V, $V_O = 0$ V, $T_{amb} = +85°C$)	I_{OL}	 —	 10	 100	µA
Available alarm output current Output source current ($V_{AH} = V_{CC} - 2.5$ V) Output sink current (in thermal shut-down), $V_A = 1.4$ V	I_A	 −4 6	 −8 15	 — —	mA
Reset high input current	I_{RL}	—	15	—	µA
Reset threshold	$V_{th(reset)}$	—	1.4	—	V
Reset output sink current (in thermal shut down) for $V_{reset} = +0.8$ V	I_{reset}	2	—	—	mA
Output leakage current (open ground)		—	10	—	µA

Note 2 : For operating at high temperature, the TDE1798 must be derated based on a +150°C maximum junction themperature and a junction-ambient thermal resistance of 70°C/W.

Note 3 : The offset voltage given is the maximum value of input differential voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

Note 4 : Input voltage range is independent of the supply voltage.

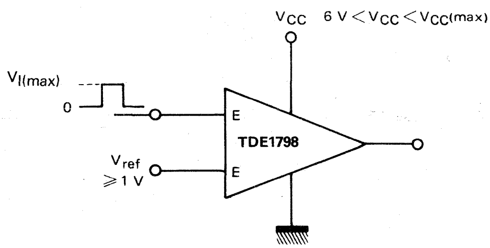
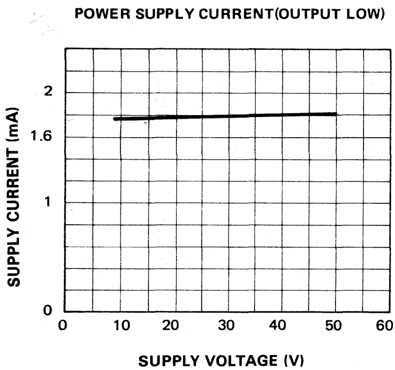
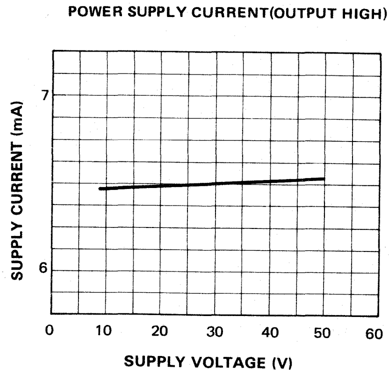


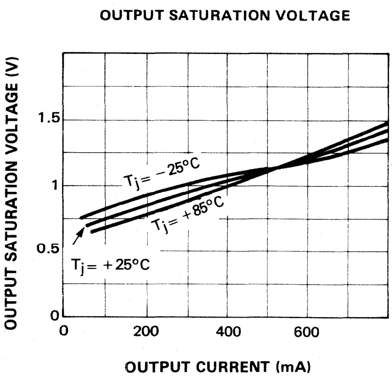
FIGURE 1

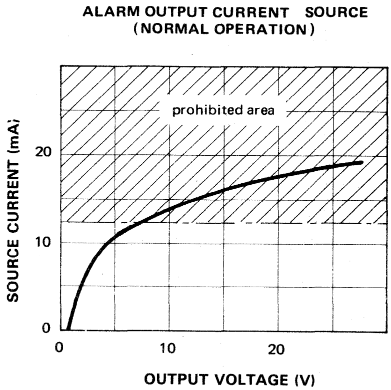
The reference input can be the inverting or the non-inverting one.

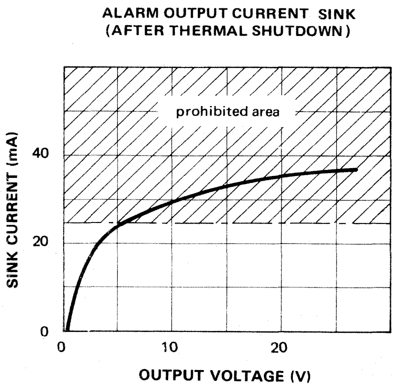
4


POWER SUPPLY CURRENT(OUTPUT LOW)
SUPPLY CURRENT (mA)
2
1.6
1
0
0 10 20 30 40 50 60
SUPPLY VOLTAGE (V)

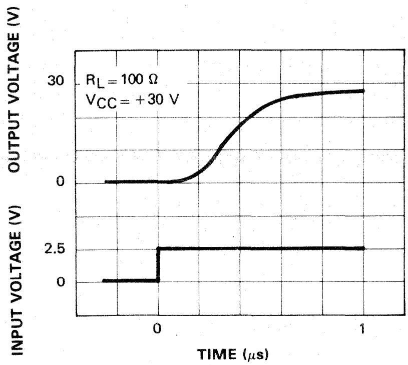

POWER SUPPLY CURRENT(OUTPUT HIGH)
SUPPLY CURRENT (mA)
7
6
0 10 20 30 40 50 60
SUPPLY VOLTAGE (V)

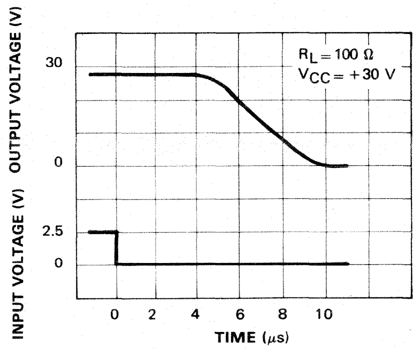

OUTPUT SATURATION VOLTAGE
OUTPUT SATURATION VOLTAGE (V)
1.5
1
0.5
0
Tj = −25°C
Tj = +85°C
Tj = +25°C
0 200 400 600
OUTPUT CURRENT (mA)


ALARM OUTPUT CURRENT SOURCE
(NORMAL OPERATION)
prohibited area
SOURCE CURRENT (mA)
20
10
0
0 10 20
OUTPUT VOLTAGE (V)


ALARM OUTPUT CURRENT SINK
(AFTER THERMAL SHUTDOWN)
prohibited area
SINK CURRENT (mA)
40
20
0
0 10 20
OUTPUT VOLTAGE (V)

RESPONSE TIME

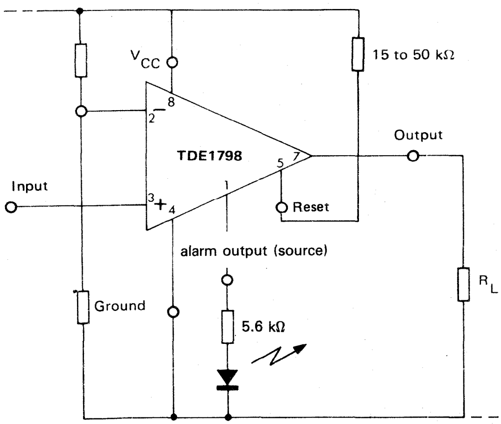




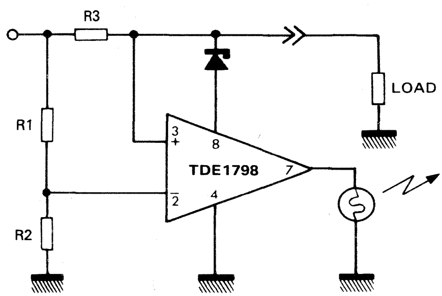
4

TYPICAL APPLICATIONS

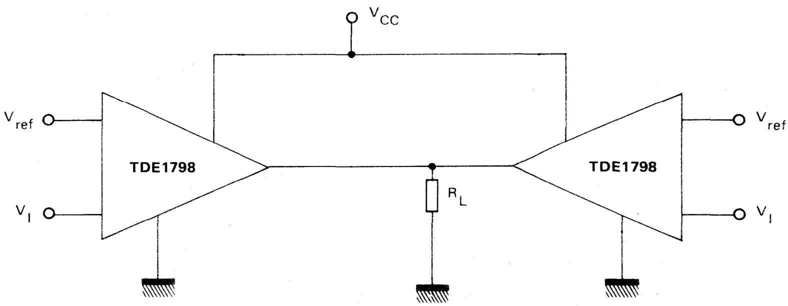
DRIVING LAMPS, RELAYS, etc...



OPEN LOAD DETECTION

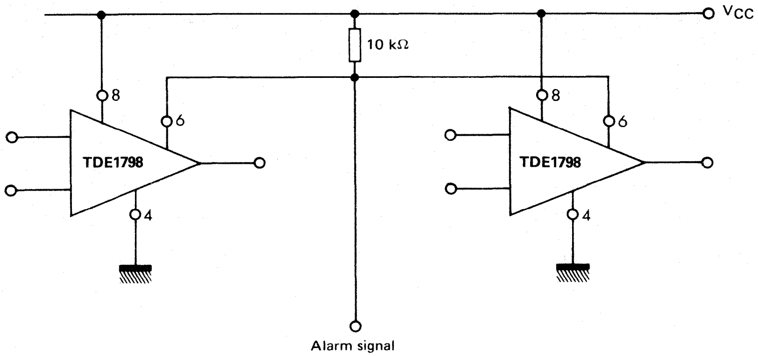


PARALLEL DRIVING OF LOADS UP TO 1 A

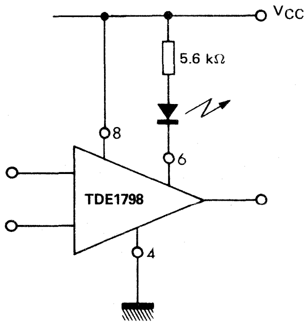


USING ALARM OUTPUT

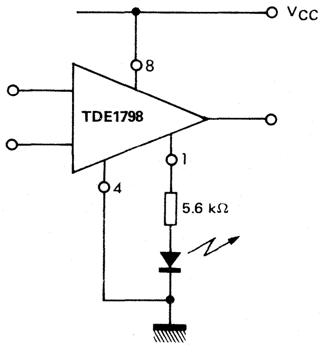
PARALLEL ALARM OUTPUTS



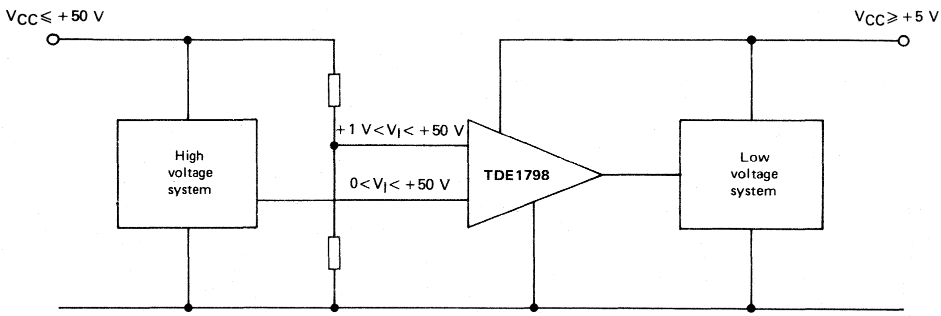
LED TO VCC



LED TO GROUND



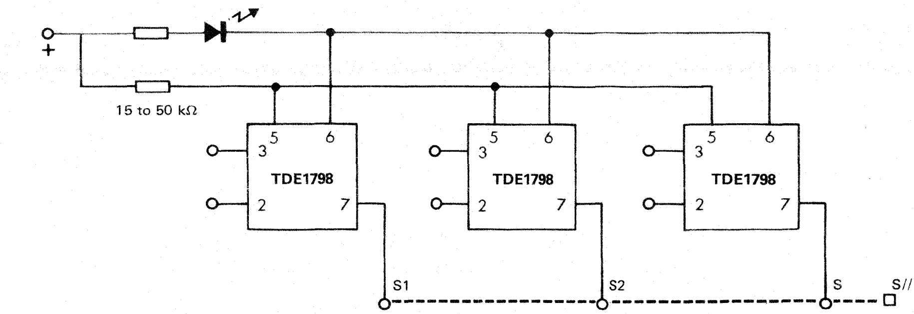
INTERFACE BETWEEN HIGH VOLTAGE AND LOW VOLTAGE SYSTEMS



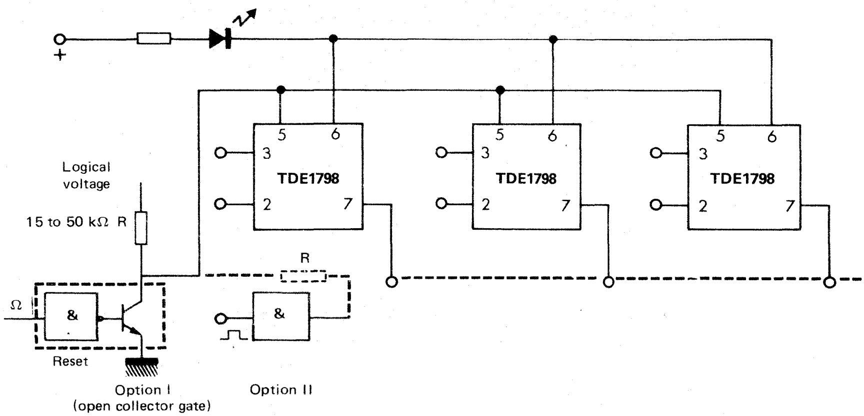
4

APPLICATION SCHEMATICS

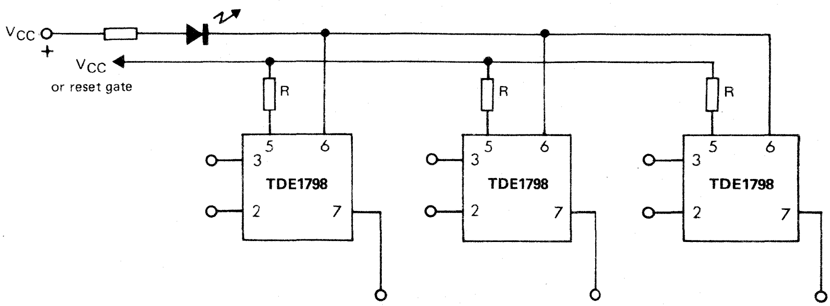
I – SYNCHRONOUS AUTOMATIC RESET (PARALLEL OR INDEPENDENT OUTPUTS)



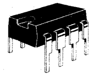
II – SYNCHRONOUS CONTROLLED RESET (PARALLEL OR INDEPENDENT OUTPUTS)



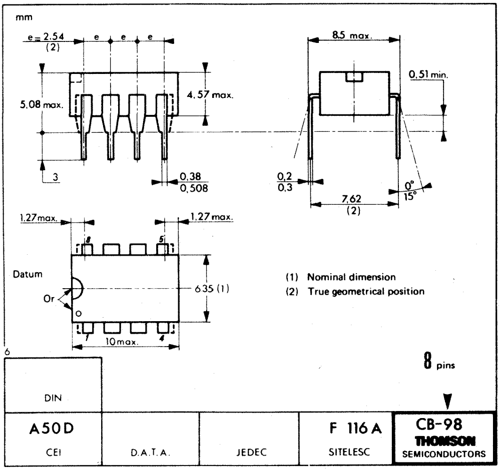
III – ASYNCHRONOUS RESET (CONTROLLED OR AUTOMATIC)



CB-98



DP SUFFIX
PLASTIC PACKAGE



This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TDE 3207

INTERFACE CIRCUIT (RELAY AND LAMP DRIVER)

The TDE3207 is a monolithic amplifier designed for high-current and high-voltage applications, specifically to drive lamps, relays and stepping motors.

This device is essentially blow-out proof. Current limiting is available to limit the peak output current to a safe value, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the IC from over-heating. If external dissipation becomes too high, the driver will shut down to prevent excessive heating.

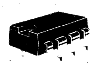
The output is also protected from short-circuits with the positive power supply.

The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 V used for industrial electronic systems.

- High output current.
- Adjustable short-circuit protection to ground.
- Internal thermal protection with hysteresis to avoid the intermediate output levels.
- Large supply voltage range : + 10 V to + 30 V.
- Short-circuit protection to V_{CC}.

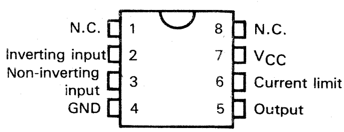
INTERFACE CIRCUIT
RELAY AND LAMP DRIVER

CASE CB-98



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT



ORDERING INFORMATION

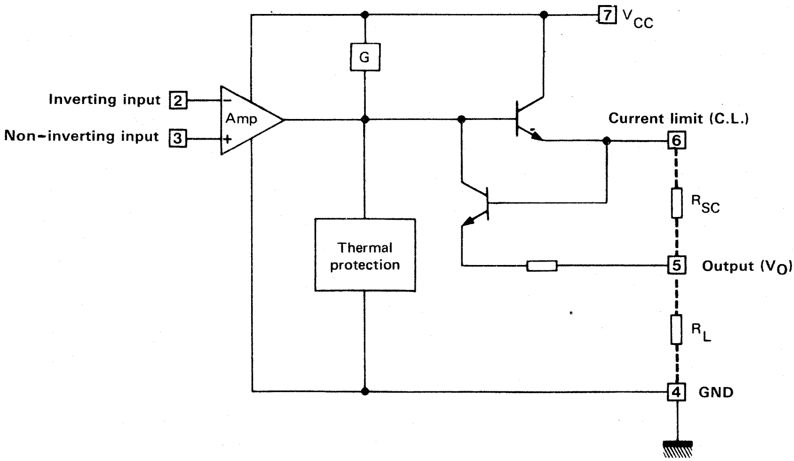
PART NUMBER	TEMPERATURE RANGE	PACKAGE
		DP
TDE3207	− 25°C to + 85°C	•
Example : TDE3207DP		

Réf. 00070

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	36	V
Differential input voltage	V_{ID}	36	V
Input voltage	V_I	36	V
Output current	I_O	300	mA
Power dissipation	P_{tot}	Internally limited	W
Operating ambient temperature range	T_{oper}	– 25 to + 85	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

SCHEMATIC DIAGRAM



CASE	Inverting input	Non-inverting input	GND	Output	C.L.	V_{CC}	N.C.
CB-98	2	3	4	5	6	7	1-8

ELECTRICAL CHARACTERISTICS

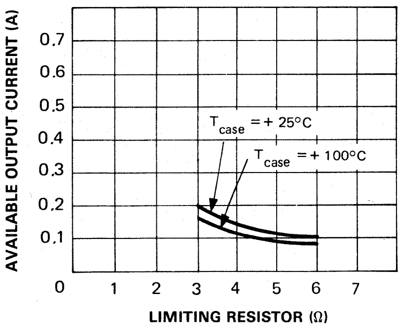
$-25°C \leqslant T_{amb} \leqslant +85°C$, $+8\ V \leqslant V_{CC} \leqslant +30\ V$, $I_O \leqslant 150\ mA$, $T_j \leqslant +150°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage - (Note 2)	V_{IO}	–	2	50	mV
Input bias current	I_{IB}	–	0.1	1.5	μA
Supply current ($V_{CC} = +24$ V, $I_O = 0$, $T_{amb} = +25°C$) High level Low level	I_{CC}	 – –	 4 2	 10 –	mA
Common-mode input voltage range	V_{CM}	2	–	$V_{CC}-2$	V
Short-circuit current ($T_{amb} = +25°C$, $V_{CC} = +24$ V, $R_{SC} = 3.3\ \Omega$)	I_{SC}	–	250	–	mA
Output saturation voltage (output high) $(V_I^+ - V_I^-) \geqslant +50$ mV, $I_O = 150$ mA, $R_{SC} = 0$, $T_j = +25°C$	$V_{CC}-V_O$	 –	 1.2	 1.8	V
Output leakage current (output low) $V_O = 0$ V, $V_{CC} = +24$ V $T_j = +25°C$ $T_j = +85°C$	I_{OL}	 – –	 1 –	 100 500	μA
Minimum short-circuit output current $T_{amb} = +25°C$, $V_{CC} = +24$ V, $R_{SC} = \infty$	I_{OS}	 –	 50	 –	mA

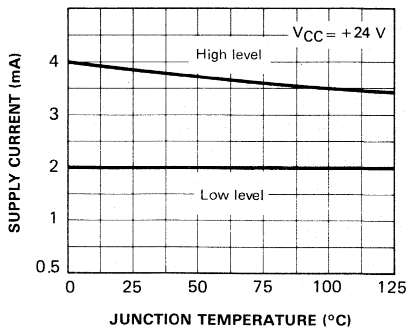
Note 1 : For operating at high temperatures, the TDE3207 must be derated based on a +150°C maximum junction temperature and a junction-ambient thermal resistance of 110°C/W.

Note 2 : The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

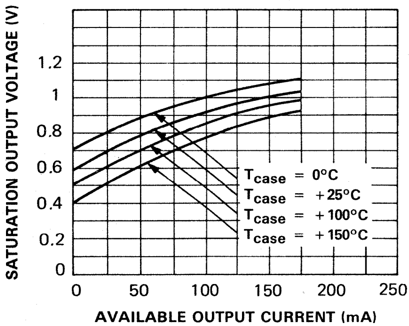
AVAILABLE OUTPUT CURRENT VERSUS LIMITING RESISTOR



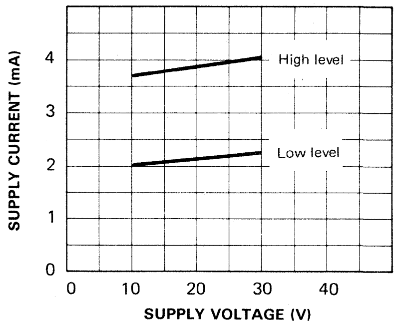
SUPPLY CURRENT VERSUS JUNCTION TEMPERATURE



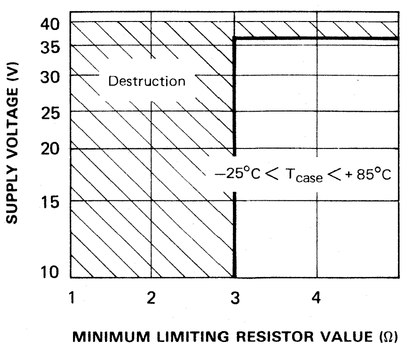
SATURATION OUTPUT VOLTAGE VERSUS CASE TEMPERATURE AND AVAILABLE OUTPUT CURRENT



SUPPLY CURRENT VERSUS SUPPLY VOLTAGE

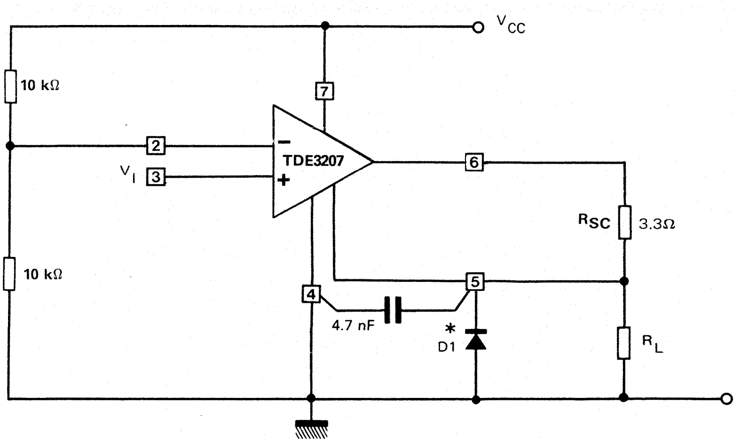


SUPPLY VOLTAGE vs MINIMUM LIMITING RESISTOR VALUE



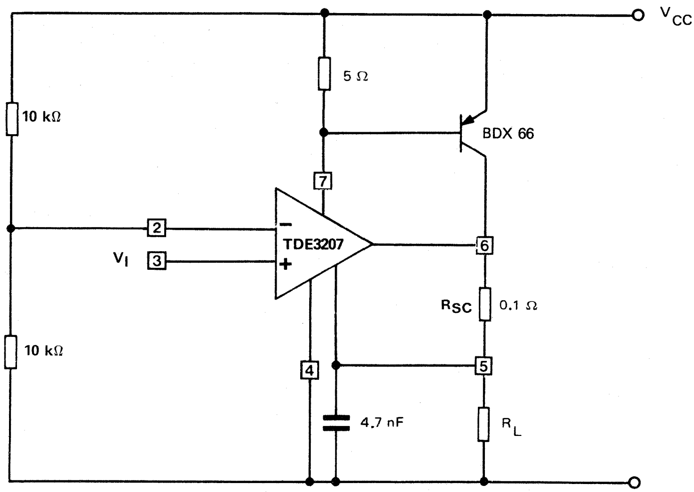
TYPICAL APPLICATIONS

BASIC CIRCUIT

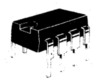


* D1 required for inductive loads

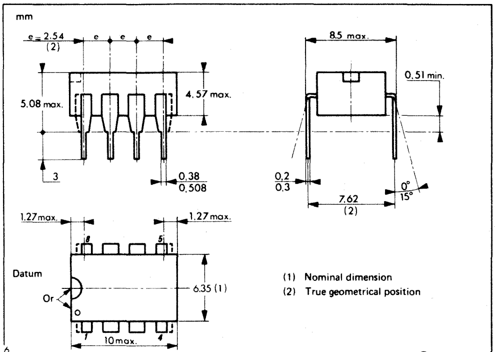
OUTPUT CURRENT BOOSTING (5 A)



CB-98



DP SUFFIX
PLASTIC PACKAGE



8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TDF1778

PRODUCT PREVIEW

DUAL 2-A SOURCE DRIVER

The TDF1778 is a dual source driver delivering high output currents and the capability to drive highly inductive loads (Electrovalves, contactors, relays...).

This device is essentially blow-out proof, each output is protected against short-circuits. If internal dissipation becomes too high, drivers will shut down to prevent excessive heating. An "ALARM" output is provided to indicate the action of the thermal protection. To reactivate the power outputs, the reset input must be forced to low state.

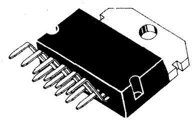
"SENSE" information of both power outputs are ORed together and then processed internally.

A "STROBE" input is also provided to offer the possibility of disabling the power outputs.

- Output current up to 2.5 A.
- Wide range of supply voltages : +8 to +32 V.
- Can withstand overvoltages of as high as 60 V between V_{CC} and ground.
- Internal zener diode provides fast switching of inductive loads.
- Output voltage can be lower than ground.

DUAL 2-A SOURCE DRIVER

CASE CB-500

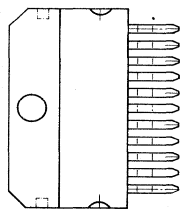


SP SUFFIX
PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE SP
TDF1778	−40°C to +85°C	•
Example : TDF1778SP		

PIN ASSIGNMENT
(Top view)



Tab is connected to pin 6

1 - Output 1
2 - V_{CC}
3 - Output 2
4 - N.C.
5 - Strobe
6 - Ground
7 - Input 2
8 - Sense output
9 - Alarm output
10 - $\overline{\text{Reset}}$ input
11 - Input 1

Réf. 00395

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

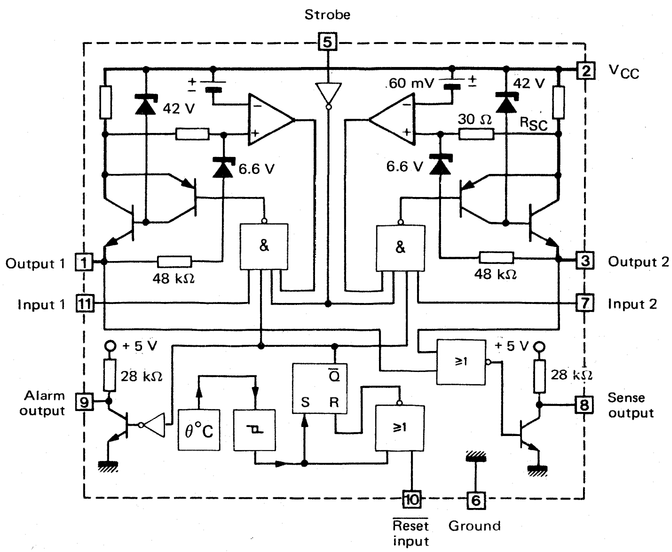
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	35 V (60 V/10 ms)	V
Input voltages (Pins 7, 10 and 11)	V_I, V_{reset}	−30 to +50	V
Strobe input voltage	V_{strobe}	−0.5 to V_{CC}	V
Output current	I_O	Internally limited	A
Power dissipation	P_{tot}	Internally limited	W
Operating ambient temperature range	T_{oper}	−40 to +85	°C
Junction temperature	T_j	+150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	3	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	40	°C/W

SCHEMATIC DIAGRAM



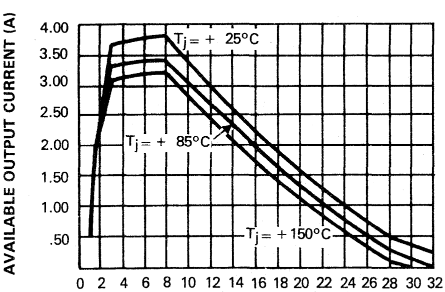
ELECTRICAL CHARACTERISTICS

$V_{CC} = +24$ V, $-40°C \leqslant T_{amb} \leqslant +85°C$ (Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Power supply voltage	V_{CC}	8	–	32	V
Power supply current (pin 6), $I_{O1} = I_{O2} = 2$ A	I_{CC}	–	15	–	mA
Logic threshold (pins 5, 7, 10, 11)	V_{th}	–	1.4	–	V
High level input current (pins 7, 10, 11), $V_I = +2$ V	I_{IH}	–	20	50	μA
Low level input current (pins 7, 10, 11), $V_I = +0.8$ V	I_{IL}	–	0	–	μA
High level logic output voltage (pins 8, 9), $I_{(8)} = I_{(9)} = -30$ μA	V_{OH}	2.4	4	–	V
Low level logic output voltage (pins 8, 9), $I_{(8)} = I_{(9)} = 2$ mA	V_{OL}	–	–	0.4	V
Output saturation voltage ($V_{(7)}$, $V_{(11)}$ high – $I_O = 2$ A)	$V_{CC} - V_{O1}$ $V_{CC} - V_{O2}$	–	1.5	1.8	V
Low level output current (pins 1, 3) - $V_{(7)}$, $V_{(11)}$ low – $V_O = 0$ V	I_{OL}	–	400	–	μA
Switch-off output voltage (Inductive load) - Note 1	$V_{CC} - V_{O1}$ $V_{CC} - V_{O2}$	–	44	–	V
Available output current (pins 1, 3), $V_{(7)}$, $V_{(11)}$ high	I_{O1}, I_{O2}	2	2.5	–	A
Available "alarm" output current, $V_{(9)} \leqslant +4$ V	$I_{O(alarm)}$	4	8	–	mA
Available "sense" output current, $V_{(8)} \leqslant +4$ V	$I_{O(sense)}$	4	8	–	mA

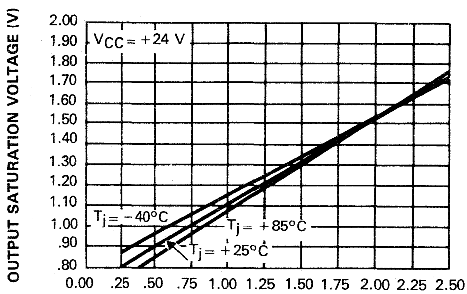
Note 1 : $L \leqslant 100$ mH for $I_O = 2.5$ A ; $L \leqslant 300$ mH for $I_O = 2$ A

AVAILABLE OUTPUT CURRENT



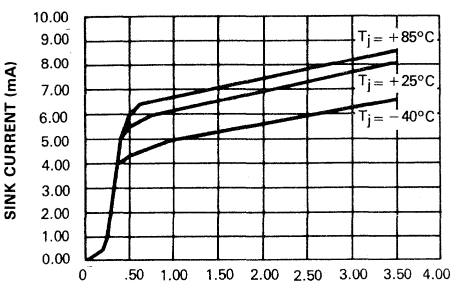
$V_{CC} - V_O$ (V)

OUTPUT SATURATION VOLTAGE



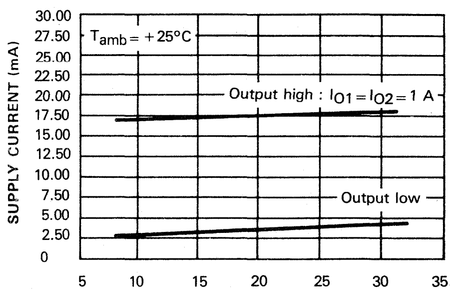
OUTPUT CURRENT (A)

AVAILABLE "ALARM" OR "SENSE" OUTPUT CURRENTS



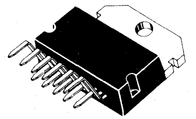
"ALARM" OR "SENSE" OUTPUT VOLTAGE (V)

POWER SUPPLY CURRENT

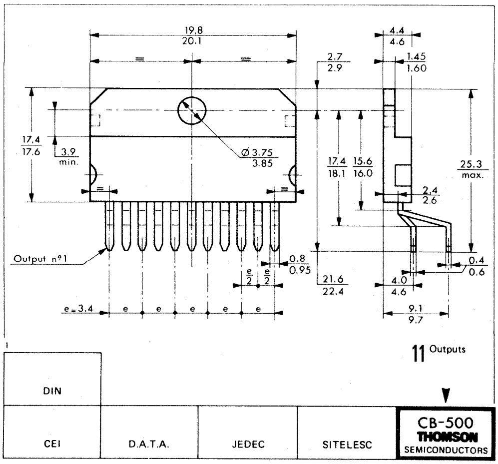


POWER SUPPLY VOLTAGE (V)

CB-500



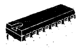
SP SUFFIX
PLASTIC PACKAGE



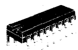
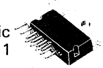
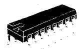
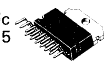
This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

Motor control

DC MOTOR REGULATION AND CONTROL

Part number	Function	Package	Suffix	Page
TDA1154	SPEED REGULATOR For permanent magnet DC motors for use in record players, tape recorders, toys... low cost applications	Plastic DIL 8 	DP	531
UAA4003	SWITCH MODE REGULATOR • Direct drive of the switching transistor or Darlington • Includes oscillator, PWM, and error amplifier • Self regulated base current (peak 1.5 A) • Full protection of switching transistor and output stage • Locked rotor protection	Plastic DIL 16 	DP	545

STEPPER MOTOR DRIVERS

Part number	Function	Package	Suffix	Page
L702	QUAD DARLINGTON SWITCHES (UNIPOLAR CONTROL) • V_{CEX} : 90 V • $V_{CE(sat)}$: less than 1.9 V @ 1.25 A	Plastic DIL 16  Plastic SIL 11 	DP SP	525
TEA3717	STEPPER MOTOR DRIVE CIRCUIT (BIPOLAR CONTROL) • Circuitry for bipolar chopper drive of one phase winding • Half step and full step mode • Wide range of current control (5 to 1000 mA) • Selectable current levels	Plastic DIL 16  Plastic SIL 15 	DP SP	537

THOMSON SEMICONDUCTORS

L702

QUAD DARLINGTON SWITCH

The L 702 is a monolithic integrated circuit for high current and high voltage switching applications. It comprises four darlington transistors with common emitter and open collector, suitable for current sinking applications. This circuit offers considerable reduction in cost, size and component count. It can provide direct interface between low level logic and a variety of high current applications.

- Sustaining voltage : min. 70 V.
- 2 A output current capability.
- High current gain.

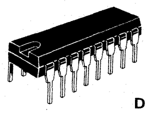
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	SP
L702	− 25°C to + 150°C	•	•
Examples : L702DP, L702SP			

QUAD DARLINGTON SWITCH

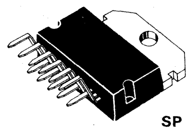
CASES

CB-79



DP SUFFIX
PLASTIC PACKAGE

CB-500

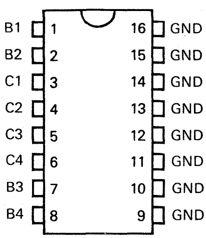


SP SUFFIX
PLASTIC PACKAGE

5

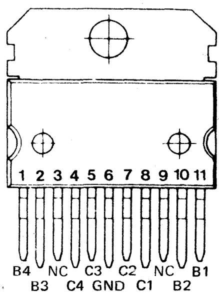
PIN ASSIGNMENTS

(Top view)
(CB-79)



(Front view)
(CB-500)

Tab is connected to pin 6



Réf. 00170

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

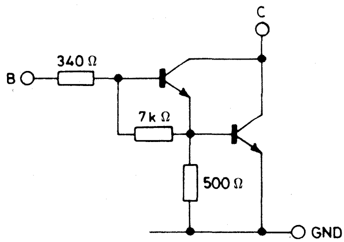
MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector emitter voltage (input open)		V_{CEX}	90	V
Input voltage		V_I	30	V
Collector current		I_C	2	A
Collector peak current (repetitive)		$I_{C(peak)}$	3	A
Total power dissipation		P_{tot}		W
$T_{pin\ 9\ to\ 16} \leq +90°C$	CB-79		4	
$T_{amb} \leq +70°C$	CB-79		1.1	
$T_{case} \leq +90°C$	CB-500		20	
Storage temperature range		T_{stg}	– 55 to + 150	°C
Operating junction temperature range		T_j	– 25 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic		Symbol	Value	Unit
Maximum junction-ambient thermal resistance	CB-79	$R_{th(j-a)}$	70	°C/W
Maximum junction thermal resistance (pins 9 to 16)	CB-79		14	°C/W
Maximum junction-case thermal resistance	CB-500	$R_{th(j-c)}$	3	°C/W
Maximum junction-ambient thermal resistance	CB-500	$R_{th(j-a)}$	40	°C/W

SCHEMATIC DIAGRAM (each Darlington)



CASE	B_1	B_2	C_1	C_2	C_3	C_4	B_3	B_4	GND	NC
CB-79	1	2	3	4	5	6	7	8	9, 10, 11 12, 13, 14 15, 16	—
CB-500	11	10	8	7	5	4	2	1	6	9-3

ELECTRICAL CHARACTERISTICS

T_{case} = + 25°C (unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output leakage current ($V_{CE} = +90$ V)	I_{CEX}	—	10	50	μA
Collector-emitter (*) sustaining voltage ($I_C = 100$ mA)	$V_{CE(sust)}$	70	—	—	V
Collector-emitter saturation voltage ($I_C = 1.25$ A, $I_I = 2$ mA)	$V_{CE(sat)}$	—	1.3	1.9	V
DC forward current gain ($I_C = 1$ A, $V_{CE} = +3$ V)	h_{FE}	1000	4000	—	
Input current	I_I				mA
$V_I = +3.75$ V		—	7	11	
$V_I = +2.4$ V open collector		—	3	6	
Input voltage	V_I				V
Off condition $V_{CE} = 70$ V, $I_C \leq 0.1$ mA		—	—	0.4	
On condition $V_{CE} = 3$ V, $I_C \geq 1$ A		2.4	—	—	
Turn on time ($V_S = +12$ V, $R_L = 10\ \Omega$)	t_{on}	—	0.3	—	μs
Turn off time ($V_S = +12$ V, $R_L = 10\ \Omega$)	t_{off}	—	1	—	μs

(*) Pulsed : pulse duration = 300 μs, duty cycle = 1.5%

FIGURE 1 - PEAK COLLECTOR CURRENT VS. DUTY CYCLE AND NUMBER OF OUTPUTS (L 702 DP ONLY)

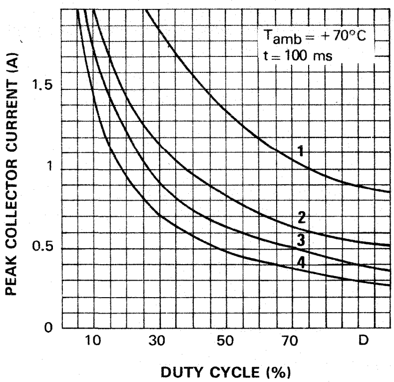


FIGURE 2 - COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

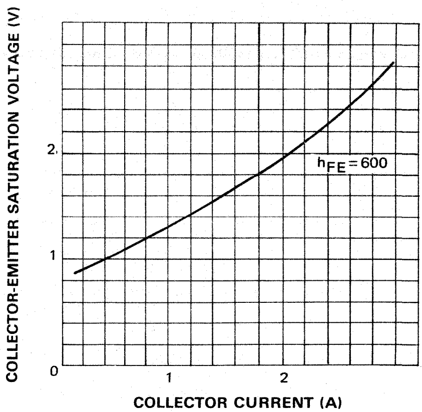


FIGURE 3 - COLLECTOR CURRENT VS INPUT VOLTAGE

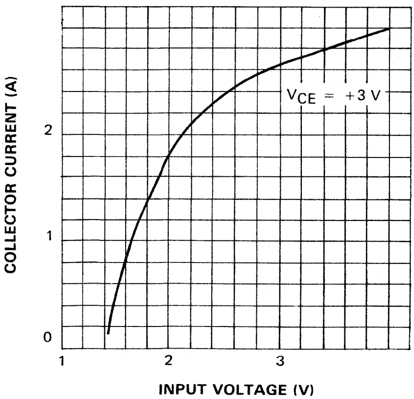


FIGURE 4 - INPUT CURRENT VS. INPUT VOLTAGE

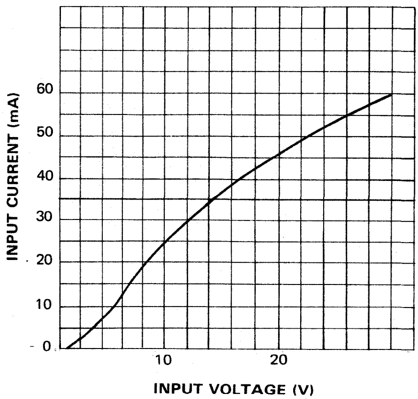


FIGURE 5 - SAFE OPERATING AREAS (L 702 DP)

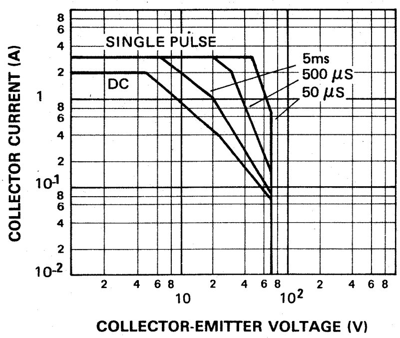


FIGURE 6 - SAFE OPERATING AREAS (L 702 SP)

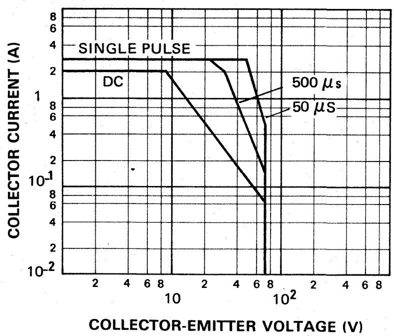
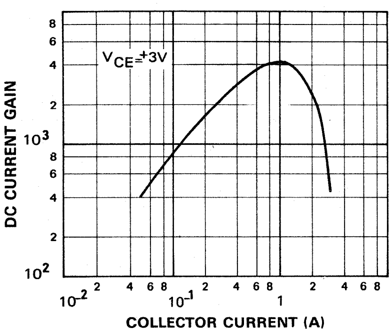


FIGURE 7 - DC CURRENT GAIN
VS. COLLECTOR CURRENT (*)



(*) Pulse width 300 μS, duty cycle 1.5%

FIGURE 8 - STEPPING MOTOR BUFFER

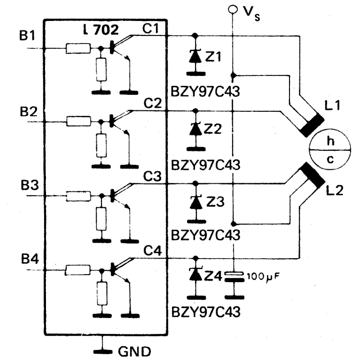


FIGURE 9 - SWITCHING TIME

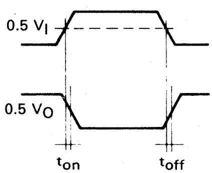
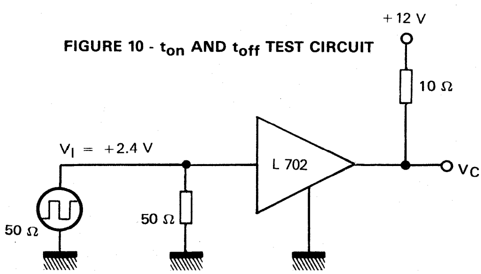
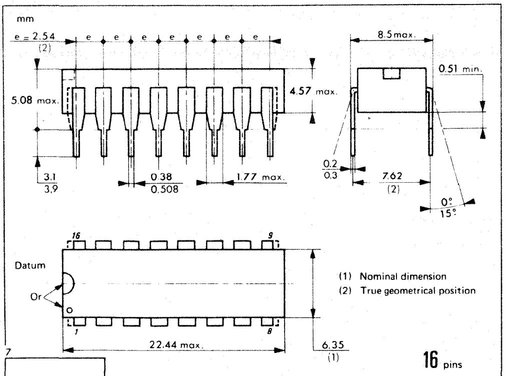


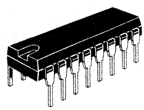
FIGURE 10 - t_{on} AND t_{off} TEST CIRCUIT



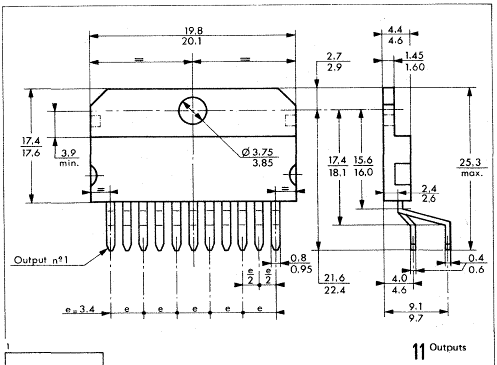


DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

CB-79

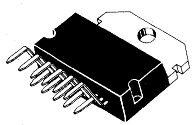


DP SUFFIX
PLASTIC PACKAGE



DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-500 THOMSON SEMICONDUCTORS

CB-500



SP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

Printed in France

THOMSON SEMICONDUCTORS

TDA1154

SPEED REGULATOR FOR DC MOTORS

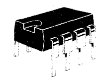
The TDA1154 is a monolithic integrated circuit intended for speed regulation of permanent magnet dc motors used in record players, tape recorders, cassette recorders and toys.

The circuit offers an excellent speed regulation with much higher power supply, temperature and load variations than conventional circuits built around discrete components.

- Matching flexibility to motors with various characteristics.
- Built-in current limit
- On-chip 1.2 V reference voltage
- Starting current : 0.5 A @ 2.5 V
- Reflection coefficient K = 20
- Supply voltage : ⩽ +20 V

SPEED REGULATOR FOR DC MOTORS

CASE CB-98



PLASTIC PACKAGE

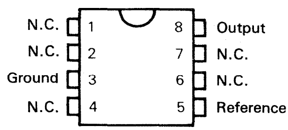
5

ORDERING INFORMATION

PART NUMBER	PACKAGE
	PLASTIC
TDA1154	•

Example : TDA1154

PIN ASSIGNMENT
(Top view)



Ref. 04470

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

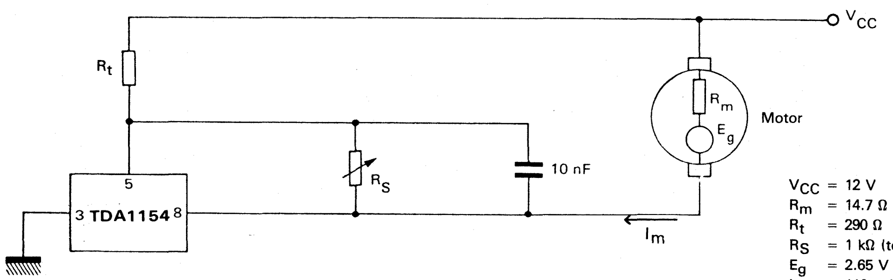
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	20	V
Output current	I_O	1.2	A
Power dissipation	P_{tot}	(see curve)	W
Junction temperature	T_j	+ 150	°C
Storage temperature range	T_{stg}	– 55 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-ambient thermal resistance	$R_{th(j-a)}$	110	°C/W
Junction-case thermal resistance	$R_{th(j-c)}$	19	°C/W

APPLICATION CIRCUIT



V_{CC} = 12 V
R_m = 14.7 Ω
R_t = 290 Ω
R_S = 1 kΩ (total)
E_g = 2.65 V
I_m = 110 mA

3 : Ground
5 : Reference
8 : Output
Other pins are not connected

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Reference voltage ($V_{CC} = +6$ V, I(8) = 0.1 A)	$V_{(ref)}$	1.15	1.25	1.35	V
Reference voltage temperature coefficient $V_{CC} = +6$ V, I(8) = 0.1 A, $T_{amb} = -20°C$ to +70°C	$\frac{\Delta V_{(ref)}}{V_{(ref)}} / \Delta T$	–	0.02	–	%/°C
Line regulator ($V_{CC} = +4$ V to +18 V, I(8) = 0.1 A)	$\frac{\Delta V_{(ref)}}{V_{(ref)}} / \Delta V_{CC}$	–	0.02	–	%/°C
Load regulator ($V_{CC} = +6$ V, I(8) = 25 to 400 mA)	$\frac{\Delta V_{(ref)}}{V_{(ref)}} / \Delta I(8)$	–	0.009	–	%/mA
Minimum supply voltage (I(8) = 0.1 A, $\frac{\Delta V_{(ref)}}{V_{(ref)}} = -5\%$)	V(5 – 3)	2.5	–	–	V
Starting current (*) ($\frac{\Delta V_{(ref)}}{V_{(ref)}} = -50\%$) $V_{CC} = +5$ V	I(8)	1.2	–	–	A
$V_{CC} = +2.5$ V	I(8)	0.5	0.8	–	A
Quiescent current on pin 5 ($V_{CC} = +6$ V, I(8) = 100 μA)	$I_O(5)$	–	1.7	–	mA
$K = \frac{\Delta I(8)}{\Delta I(5)}$ reflection coefficient ($V_{CC} = +6$ V, I(8) = 0.1 A)	K	18	20	22	
K spread versus V_{CC} ($V_{CC} = +6$ V to +18 V, I(8) = 0.1 A)	$\frac{\Delta K}{K} / \Delta V_{CC}$		0.45	–	%/V
K spread versus I(8) ($V_{CC} = +6$ V, I(8) = 25 to 400 mA)	$\frac{\Delta K}{K} / \Delta I(8)$	–	0.005	–	%/mA
K spread versus temperature $V_{CC} = +6$ V, I(8) = 0.1 A, $T_{amb} = +20°C$ to +70°C	$\frac{\Delta K}{K} / \Delta T$	–	0.02	–	%/°C

(*) An internal protection circuit reduces this current if the temperature of the junction increase : I(8) = 0.75 A at $T_j = +140°C$

5

OPERATING MODE

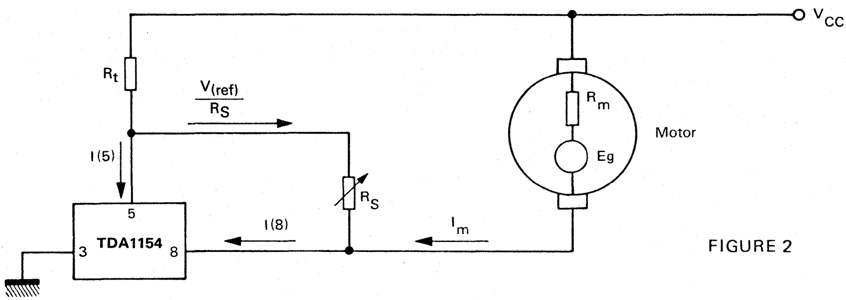


FIGURE 2

The circuit maintains a 1.2 V constant reference voltage between pins 5 and 8 :
$V(5-8) = V_{(ref)} = 1.2$ V

The current (I(5)) drawn by the circuit at pin 5 is sum of two currents.
One is constant : $I_O(5) = 1.7$ mA and the other is proportional to pin 8 current (I(8)) :
$I(5) = I_O(5) + I(8)\,K$ (a) $\quad (I_O(5) = 1.7$ mA, $K = 20)$

If E_g and R_m are motor back electromotive force and motor internal resistance respectively, then :

$$E_g + R_m I_m = R_t \left[I(5) + \frac{V_{(ref)}}{R_S} \right] + V_{(ref)} \text{ (b)}$$

From figure 2 it is seen that :

$$I(8) = I_m + \frac{V_{(ref)}}{R_S} \text{ (c)}$$

Substituting equations (a) and (c) into (b) yields :

$$E_g = \underbrace{I_m \left[\frac{R_t}{K} - R_m \right]}_{(1)} + \underbrace{V_{(ref)} \left[\frac{R_t}{R_S} \left(1 + \frac{1}{K}\right) + 1 \right] + R_t I_O(5)}_{(2)} \text{ (d)}$$

The motor speed will be independent of the resisting torque if E_g is also independent of I_m. Therefore, in order to determine the value of R_t term (1) in (d) must be zero :

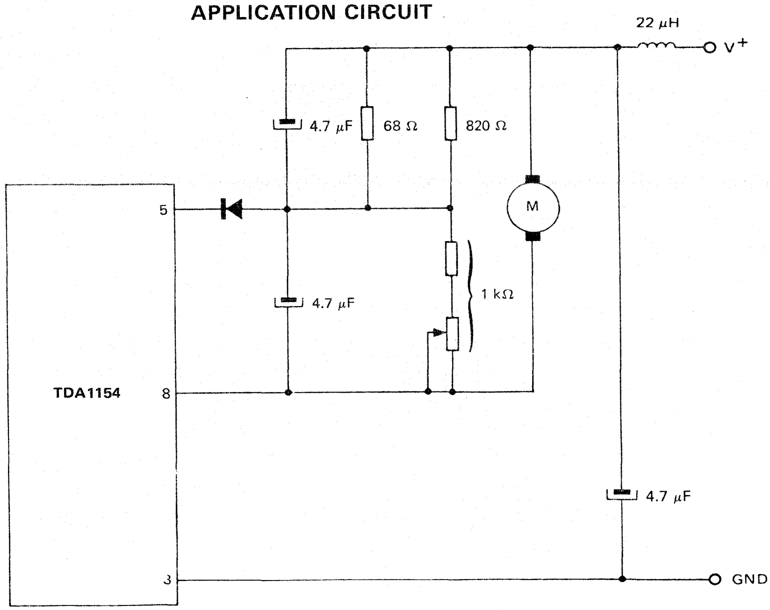
$$\boxed{R_t = K\,R_m \ (K = 20)}$$

If $R_t > KR_m$, an instability may occur as a result of overcompensation.
The value of R_S is determined by term (2) in (d) so as to obtain the back electromotive force (E_g) corresponding to required motor speed :

$$R_S = R_t \frac{V_{(ref)}\,(1 + 1/K)}{E_g - V_{(ref)} - R_t I_O(5)} \# R_t \frac{V_{(ref)}}{E_g - V_{(ref)} - R_t I_O(5)}$$

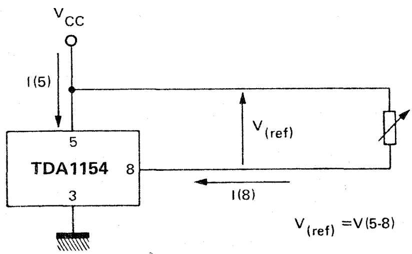
Where $V_{(ref)} = 1.2$ V and $I_O(5) = 1.7$ mA

APPLICATION CIRCUIT

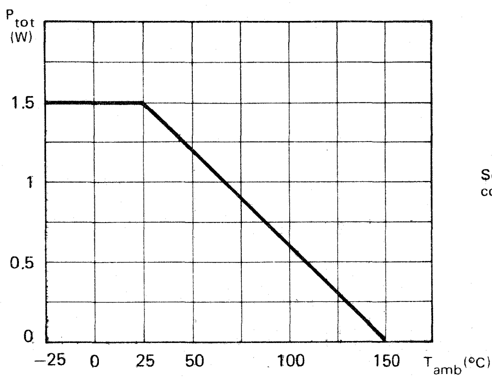


5

TEST CIRCUIT

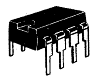


MAXIMUM POWER DISSIPATION

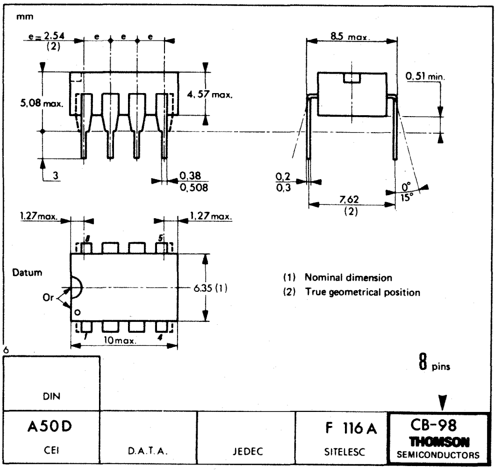


Soldering on a P.C. board, copper area: 5 cm²

CB-98



PLASTIC PACKAGE



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TEA3717

STEPPER MOTOR DRIVE CIRCUIT

The TEA3717 is a bipolar monolithic integrated circuit intended to control and drive the current in one winding of a bipolar stepper motor. The circuit consists of an LS-TTL-compatible logic input, a current sensor, a monostable and an output stage with built-in protection diodes. Two TEA3717 and a few external components form a complete control and drive unit for LS-TTL or microprocessor-controlled stepper motor systems.

- Half-step and full-step mode.
- Bipolar drive of stepper motor for maximum motor performance.
- Built-in protection diodes.
- Wide range of current control 5 to 1000 mA.
- Wide voltage range 10 to 45 V.
- Designed for unstabilized motor supply voltage.
- Current levels can be selected in steps or varied continuously.

ORDERING INFORMATION

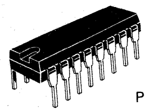
PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	SP
TEA3717	0°C to +70°C	•	•

Example : TEA3717DP

STEPPER MOTOR DRIVE CIRCUIT

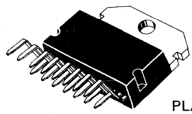
CASES

CB-79



DP SUFFIX
PLASTIC PACKAGE

CB-501

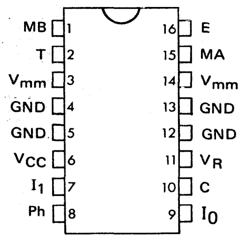


SP SUFFIX
PLASTIC PACKAGE

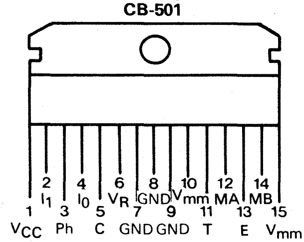
5

PIN ASSIGNMENTS
(Top view)

CB-79



(Front view)
CB-501



Réf. 00390

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THOMSON COMPONENTS

MAXIMUM RATINGS

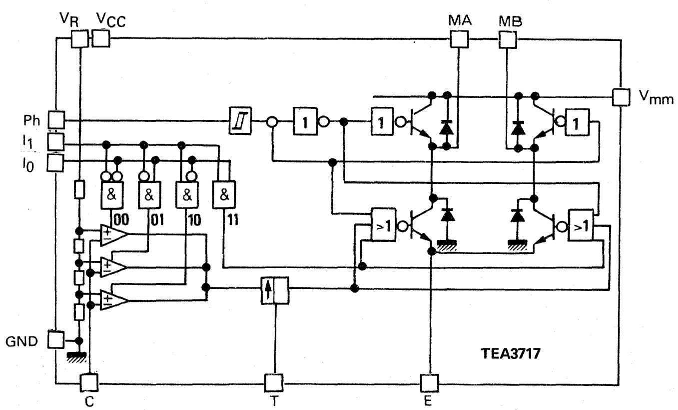
Rating	Symbol	Value	Unit
Supply voltage	V_{CC} V_{mm}	7 45	V V
Input voltage Logic inputs Analog inputs Reference input	V_I	 −0.5 to 6 V_{CC} 15	V
Input current Logic inputs Analog inputs	I_I	 −10 −10	mA
Output current	I_O	±1	A
Junction temperature	T_j	+150	°C
Operating ambient temperature range	T_{oper}	0 to + 70	°C
Storage temperature range	T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance CB-79 CB-501	$R_{th(j-c)}$	 11 3	°C/W
Maximum junction-ambient thermal resistance CB-79 CB-501	$R_{th(j-a)}$	 45* 40	°C/W

* Soldered on a 35 μm thick 40 cm² PC board copper area

SCHEMATIC DIAGRAM



CASE	MB	T	V_{mm}	GND	V_{CC}	I_1	Ph	I_0	C	V_R	MA	E
CB-79	1	2	3, 14	4, 5 12, 13	6	7	8	9	10	11	15	16
CB-501	14	11	10, 15	7, 8 9	1	2	3	4	5	6	12	13

RECOMMENDED OPERATING CONDITIONS

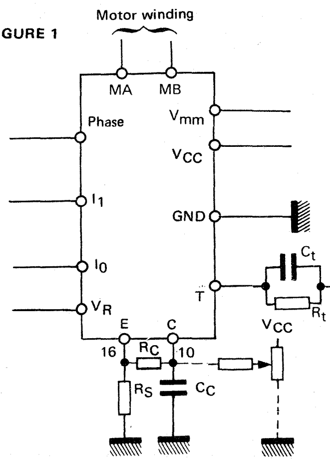
Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	4.75	5	5.25	V
Supply voltage	V_{mm}	10	–	40	V
Output current	I_m				A
CB-502		0.020	–	0.8	
CB-501		0.020	–	1	
Ambient temperature	T_{amb}	0	–	70	°C
Rise time, logic inputs	t_r	–	–	2	μs
Fall time, logic inputs	t_f	–	–	2	μs

ELECTRICAL CHARACTERISTICS

$V_{CC} = +5$ V ±5%, $V_{mm} = +10$ to $+40$ V, $T_{amb} = 0°C$ to $+70°C$
(Unless otherwise specified)

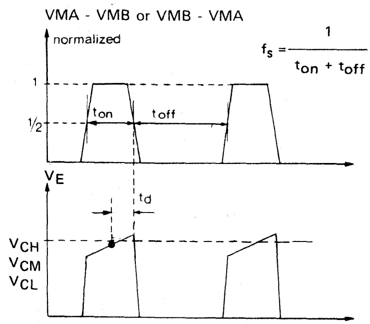
Characteristic	Symbol	Min	Typ	Max	Unit
Supply current	I_{CC}	–	–	25	mA
High level input voltage - Logic inputs	V_{IH}	2.0	–	–	V
Low level input voltage - Logic inputs	V_{IL}	–	–	0.8	V
High level input current - Logic inputs ($V_I = +2.4$ V)	I_{IH}	–	–	20	μA
Low level input current - Logic inputs ($V_I = +0.4$ V)	I_{IL}	−0.4	–	–	mA
Comparator threshold voltage ($V_R = +5.0$ V), $I_0 = 0$, $I_1 = 0$	V_{CH}	390	420	440	mV
$I_0 = 1$, $I_1 = 0$	V_{CM}	230	250	270	
$I_0 = 0$, $I_1 = 1$	V_{CL}	65	80	90	
Comparator input current	I_{CO}	−20	–	20	μA
Output leakage current ($I_0 = 1$, $I_1 = 1$)	I_{off}				μA
$T_{amb} = +25°C$		–	–	100	
$T_{amb} = +70°C$, $V_{mm} = 40$ V, $V_{CC} = 5$ V		–	100	200	
Total saturation voltage drop ($I_m = 500$ mA)	V_{sat}	–	–	4.0	V
Total power dissipation	P_{tot}				W
$I_m = 500$ mA, $f_s = 30$ kHz		–	1.8	2.3	
$I_m = 800$ mA, $f_s = 30$ kHz		–	3.7	–	
Cut off time (See figure 1 and 2, $V_{mm} = +10$ V, $t_{on} \geq 5$ μs)	t_{off}	25	30	35	μs
Turn off delay (See figure 1 and 2, $T_{amb} = +25°C$, $dV_C/dt \geq 50$ mV/μs)	t_d	–	1.6	2.0	μs

FIGURE 1



R_S = 1 Ω, inductance free
R_C = 1 kΩ
C_C = 820 pF, ceramic
R_t = 56 kΩ
C_t = 820 pF, ceramic

FIGURE 2



FUNCTIONAL DESCRIPTION

The circuit is intended to drive a bipolar constant current through one motor winding. The constant current is generated through switch mode regulation.
There is a choice of three different current levels with the two logic inputs I_0 and I_1. The current can also be switched off completely.

INPUT LOGIC

If any of the logic inputs is left open, the circuit will treat it as a high level input.

I_0	I_1	Current level
H	H	No current
L	H	Low current
H	L	Medium current
L	L	Maximum current

PHASE – This input determines the direction of current flow in the winding, depending on the motor connections. The signal is fed through a Schmidt-trigger for noise immunity, and through a time delay in order to guarantee that no short-circuit occurs in the output stage during phase-shift. High level on the PHASE-input causes the motor current flow from M_A through the winding to M_B.

I_0 and I_1 – The current level in the motor winding is selected with these inputs. The values of the different current levels are determined by the reference voltage V_R together with the value of the sensing resistor R_S.

CURRENT SENSOR

This part contains a current sensing resistor (R_S), a low pass filter (R_C, C_C) and three comparators. Only one comparator is active at a time. It is activated by the input logic according to the current level chosen with signals I_0 and I_1. The motor current flows through the sensing resistor R_S. When the current has increased so that the voltage across R_S becomes higher than the reference voltage on the other comparator input, the comparator output goes high, which triggers the pulse generator and its output goes high during a fixed pulse time (t_{off}), thus switching off the power feed to the motor winding, and causing the motor current to decrease during t_{off}.

SINGLE-PULSE GENERATOR

The pulse generator is a monostable triggered on the positive going edge of the comparator output. The monostable output is high during the pulse time, t_{off}, which is determined by the timing components R_t and C_t.
$t_{off} = 0.69 \cdot R_t C_t$

Functional blocks

A. TTL compatible input logic
B. Current sensor
C. Single-pulse generator (monostable)
D. Output stage with protection diodes.

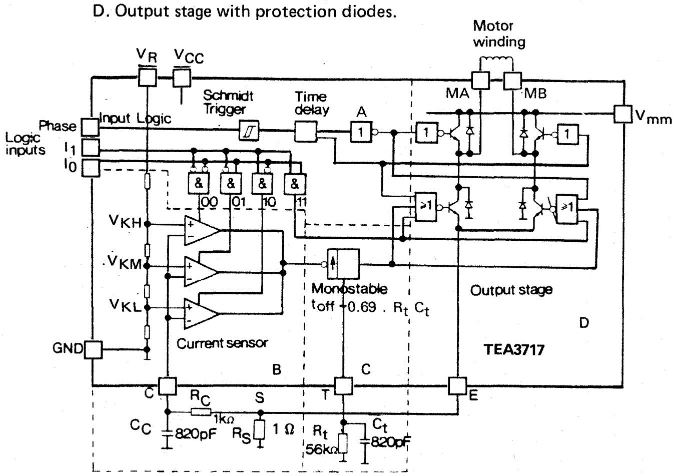


FIGURE 3

The single pulse switches off the power feed to the motor winding, causing the winding current to decrease during t_{off}.
If a new trigger signal should occur during t_{off}, it is ignored.

OUTPUT STAGE

The output stage contains four Darlington transistors and four diodes, connected in an H-bridge. The two sinking transistors are used to switch the power supplied to the motor winding, thus driving a constant current through the winding.
It should be noted however, that it is not permitted to short circuit the outputs.

V_{CC}, V_{mm}, V_R

The circuit will stand any order of turn-on or turn-off of the supply voltages V_{CC} and V_{mm}. Normal dV/dt values are then assumed.
Preferably, V_R should be tracking V_{CC} during power-on and power-off.

ANALOG CONTROL

The current levels can be varied continuously either if V_R is varied or with a circuit varying the voltage fed into the comparator terminal (see fig. 1).

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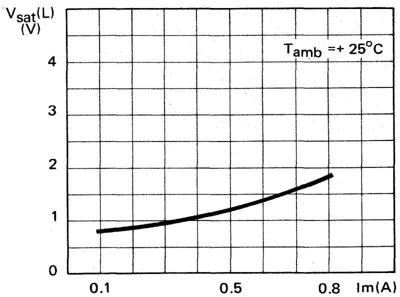


FIGURE 4 - TYPICAL SINK SATURATION VOLTAGE vs OUTPUT CURRENT

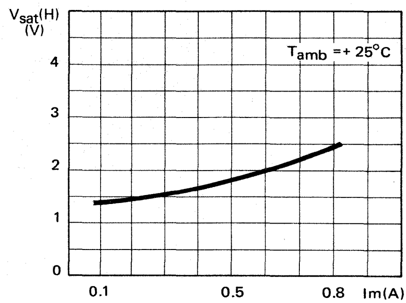


FIGURE 5 - TYPICAL SOURCE SATURATION VOLTAGE vs OUTPUT CURRENT

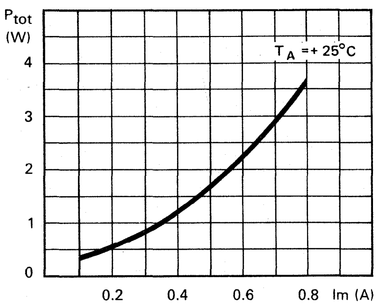


FIGURE 6
TYPICAL POWER LOSSES vs OUTPUT CURRENT

TYPICAL APPLICATION

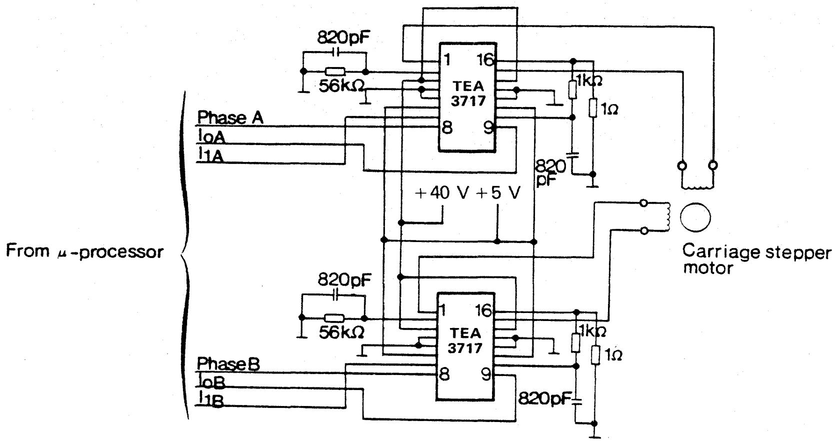


FIGURE 7 – SERIAL PRINTER CARRIAGE DRIVE

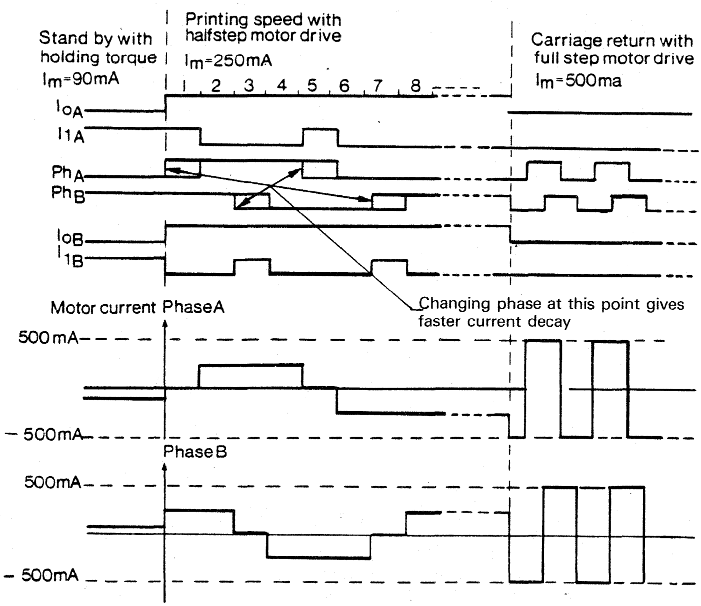


FIGURE 8 – PRINCIPAL OPERATING SEQUENCE

APPLICATION HINTS

Motor selection

Some stepper motors are not designed for continuous operation at maximum current. As the circuit drives a constant current through the motor, its temperature might increase exceedingly both at low and high speed operation.

Also, some stepper motors have such high core losses that they are not suited for switch mode current regulation.

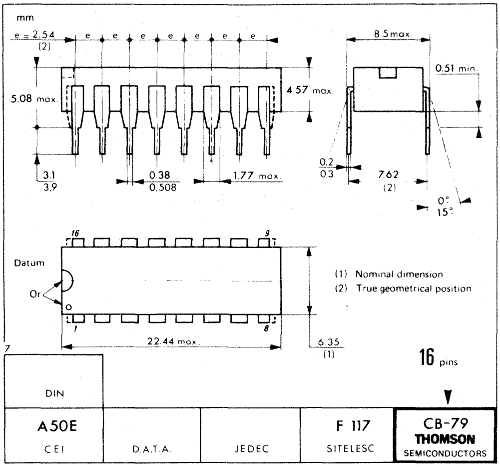
Unused inputs

Unused inputs should be connected to proper voltage levels in order to get the highest noise immunity.

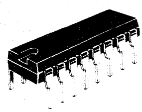
Interference

As the circuit operates with switch mode current regulation, interference generation problems might arise in some applications. A good measure might then be to decouple the circuit with a 15 nF ceramic capacitor, located near the package between power line V_{mm} and ground.

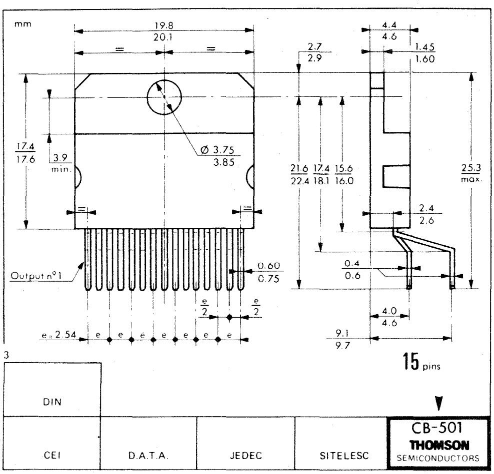
The ground lead between R_S, C_C and circuit GND should be kept as short as possible. This applies also to the lead between the sensing resistor R_S and point S, see fig. 3.



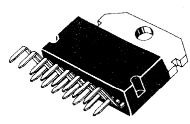
CB-79



DP SUFFIX
PLASTIC PACKAGE



CB-501



SP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

UAA4003

SWITCH MODE REGULATOR FOR DC MOTORS

The UAA4003 is a regulation and control device for the drive of DC motors.

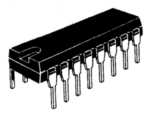
- Includes oscillator, PWM and error amplifier
- Soft start
- Direct drive of the switching transistor (or Darlington)
- Self-regulated positive base current (peak 1.5 A)
- Negative base current providing fast turn-off, and allowing the best use of the safe operating area (peak 1.5 A)
- Switching transistor protected against saturation failure
- Instantaneous limitation of the collector current
- Power supply monitoring
- On-chip thermal protection
- Includes 2 μs minimum conducting time (or no conduction) for use of a snubber circuit

ORDERING INFORMATION

PART NUMBER	PACKAGE
	DP
UAA4003	•

SWITCH MODE REGULATOR FOR DC MOTORS

CASE CB-79



DP SUFFIX
PLASTIC PACKAGE

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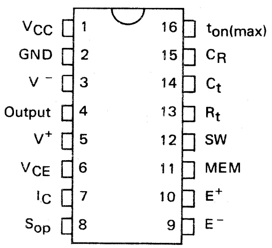
PIN ASSIGNMENT

(Top view)

CB-79



1 - Supply voltage
2 - Ground
3 - Negative supply (power stage)
4 - Power stage output
5 - Positive supply (power stage)
6 - $V_{CE(sat)}$ sensing
7 - Collector current monitoring
8 - Op. amp. output
9 - Op. amp. inverting input
10 - Op. amp. non-inverting input
11 - Memory input
12 - SW
13 - R_t resistor (oscillator)
14 - C_t capacitor (oscillator)
15 - Locked rotor
16 - Limit access

Réf. 00440

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THOMSON COMPONENTS

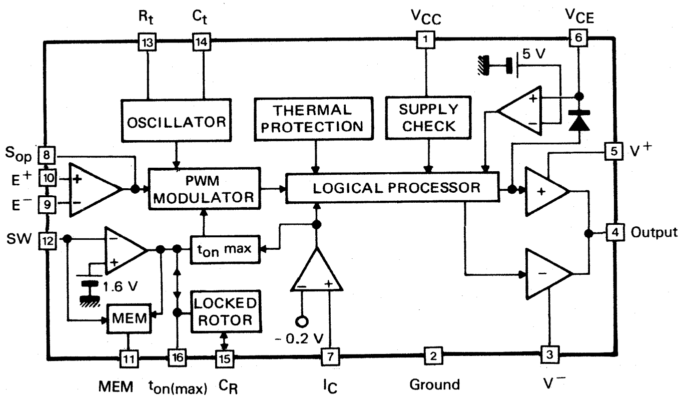
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	+15	V
Supply voltages (Power stage) Positive / Negative	V^+ / V^-	+15 / −9	V
Voltage between pin 5 and pin 3	$V^+ - V^-$	+18	V
Output current	I_O	±2	A
MEM output current	—	10	mA
Current into input I_C (internal protection diodes)	—	±5	mA
Minimum value of resistance R_t	R_t	10	kΩ
Junction temperature range	T_j	−40 to +150	°C
Storage temperature range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	80	°C/W

BLOCK DIAGRAM



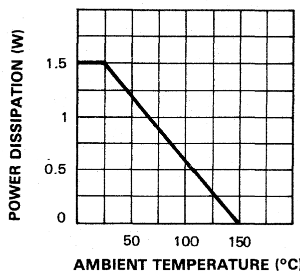
ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +10$ V, $V^{-} = -5$ V
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	6.2	–	14	V
Supply current ($V_{CC} = +10$ V)	I_{CC}	–	10	–	mA
Positive supply voltage (Power stage)	V^{+}	4	–	14	V
Negative supply voltage (Power stage)	V^{-}	0	–	–8	V
Threshold of input I_C	$V_{I(th)}$	–0.260	–0.2	–0.140	V
I_C input current ($V_{(7)} = 0$ V)	–	–	5	20	μA
Op. amp. open loop gain	A_V	60	–	–	dB
Op. amp. input current	–	–	–	1	μA
Op. amp. offset voltage	–	–	5	–	mV
Op. amp. common-mode voltage	–	0	–	$V_{CC}-3$	V
Oscillator frequency	f_{osc}	–	$\frac{2}{R_t.C_t}$	50	kHz
Value of resistance R_t	R_t	10	50	500	kΩ
Dead time	–	–	5	–	μs
Output current ($V_{(5)} - V_{(4)} = +3$ V)	I_O	±1.5	–	–	A
Input current into pin 12 (SW) ($V_{(12)} = 0$ V)	–	–	25	50	μA
MEM output current (open collector) ($V_{(11)} = +0.3$ V)	–	1.2	–	–	mA
"Locked rotor" time constant ($V_{CC} = +10$ V)	–	–	0.3	–	s/μF
V_{CE} comparator threshold voltage	–	–	5	–	V
Time constant $t_{on(min)}$	$t_{on(min)}$	–	2	–	μs

5

MAXIMUM POWER DISSIPATION



CIRCUIT DESCRIPTION

OSCILLATOR

It is a sawtooth generator whose fall time is much inferior to its rise time. The period is $T_{OSC} = 0.5\ R_t.C_t$, R_t and C_t being tied between pins 13 and 14 respectively, and ground.
The voltage swing is about $V_{CC}/2$ and the low level is + 1.5 V.
The maximum working frequency is 50 kHz.

PULSE WIDTH MODULATOR (PWM)

A signal with a variable duty cycle is generated by a comparison between pin 14 voltage (oscillator) and pin 8 voltage (output of the error amplifier).

A second comparator limits the maximum conduction ratio by a comparison between the sawtooth and pin 16 voltage ($t_{on(max)}$). If $V_{(16)} = 0$, there is an internal fixed dead time ($\simeq 5\ \mu s$).

CURRENT LIMITATION

A level lower than − 0.2 V on pin 7 (I_C) involves two actions.
• A direct action through a logic processor which stops the drive until the end of the period.

• An indirect action through the $t_{on(max)}$ function. The change of state at the output of comparator I_C is applied to pin 16 as long as the current overload persists. By inserting capacitor C_B between pin 16 and V_{CC} (about 0.1 μF), the voltage at this point rises up by a quantity ΔV proportional to the duration and the frequency of the oversteps.

This will consequently lower the maximum conduction ratio, thus decreasing the frequency of the oversteps.

At the end of an overload state, capacitor C_B slowly charges through a 20 kΩ internal impedance, in order to return progressively to normal operation.

This capacitor also achieves a soft-start during power-up.

NOTE : It is possible to use direct action only provided pin 16 is tied to ground.

In this case, "locked rotor" and "memory" functions cannot be used.

LOCKED ROTOR

A voltage greater than + 1.5 V at pin 16 starts up the linear charge of a capacitor C_R connected between pin 15 and ground (3μF/s).

If V_{16} becomes lower than + 1.5 V again before $V_{(15)}$ reaches V_{CC}, capacitor C_R is quickly discharged.

In the fault persists, $V_{(15)}$ reaches V_{CC}, and the output is definitively cut. There are two possible ways to return to normal drive :

• Tie temporarily pin 12 (SW) to ground.
• Tie temporarily pin 15 to ground to discharge C_R.

If this function is not to be used, simply tie pin 15 to ground.

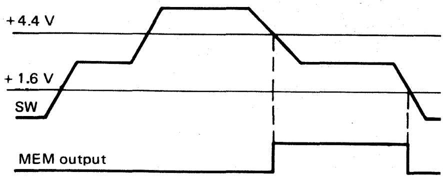
ERROR AMPLIFIER

This is an operational amplifier whose open loop gain is greater than 1000.

The input currents are lower than 1 μA, and the input offset voltage is typically 5 mV. The input common-mode voltage can range from 0 V to (V_{CC} − 3 V).

MEMORY AND INHIBITION

Input SW (pin 12) senses a three-state logic signal. The response of the output MEM is represented here-under :



When the input signal is lower than + 1.6 V, there is an inhibition of the output drive through the $t_{on(max)}$ function. In this case the voltage on pin 16 remains close to V_{CC}.

If the input SW becomes greater than + 1.6 V, the voltage $V_{(16)}$ (between t_{on} and ground) falls. The restart is accomplished in a soft mode.

PROTECTION AGAINST DESATURATION

If, because of a too low base current or a too heavy load, voltage V_{CE} on the switching transistor rises above 4.5 V approximately, the output of comparator V_{CE} changes state, and the drive is interrupted.

POWER SUPPLY MONITORING

The drive is disabled if V_{CC} is less than +6.2 V. Pin 3 should be connected to a voltage equal to or less than +0.5 V.

Note that under no circumstances should this pin be left open.

THERMAL PROTECTION

This protection becomes active when the junction temperature reaches + 150°C.

LOGIC PROCESSOR

A logic unit processes the information coming from the fault detectors, and ensures that the output signal fulfils two conditions :

• No double pulsing within a period : the occurrence of a fault is memorized until the end of the period.

• To allow the discharge of a snubber network, the minimum width of the output pulse is set at 2 μs by an internal monostable. If this monostable is not triggered, there will be no conduction.

OUTPUT STAGE

ON-state

The positive drive achieves a very efficient drive of the switching transistor.
Its features are essentially :

- Direct drive (neither inductor nor transformer).
- The transistor stays in a quasi-saturation mode, and thus has a reduced storage time.
- The drive energy is strictly limited to the required amount.
- Easy implementation.

K_1 is closed to turn the positive stage on. The maximum value of the positive base current is set by the limitation resistor R.

Diode D maintains Q in a quasi-saturation mode : the more Q is saturated, the more diode D will shunt an important part of the drive current I_{B1}, through diode D_1.

Resistor R_B has a low value (about 1 Ω), and is used to stabilize the regulation loop.

For a good efficiency of the negative drive, the value of this resistor should be as low as possible (about 1 Ω).

Integrated Darlington T_1 is able to supply a peak current of 1.5 A with a 12 V saturation voltage.

The voltage V_{CE} on transistor Q is :
$V_{CE} \simeq V_D + R_B I_{B1}$.

OFF-state

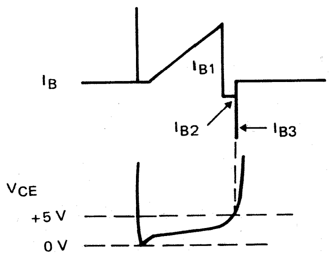
The turn off is accomplished in two steps :

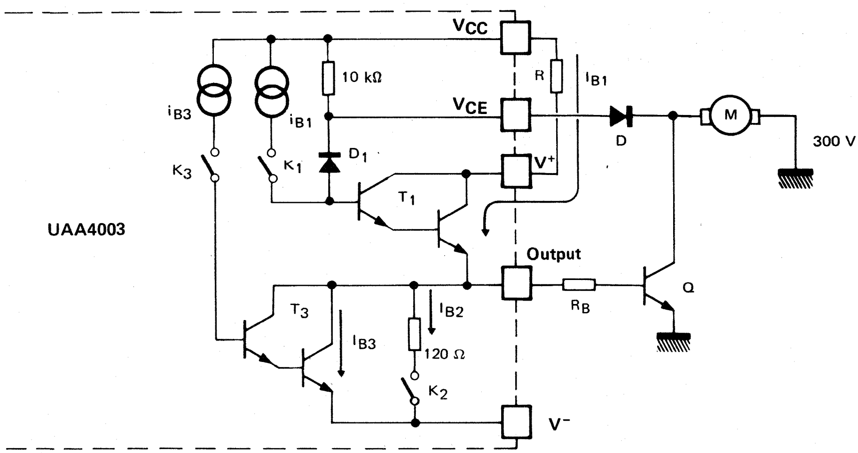
- An immediate action through K_2 which connects the base of the switching transistor to the negative supply through a 120 Ω integrated resistor (current I_{B2}).
- A delayed action through K_3 which is closed only after the desaturation of the external transistor.

This is detected by comparator V_{CE}, when collector to emitter voltage reaches 4.5 V.
Darlington T_2 can supply 1.5 A with a 2 V saturation voltage (current I_{B3}).

NOTE : The negative drive I_{B3} for the removal of the stored charges is delayed in order to limit the slope dI_B/dt at the on-off transition. A high dI_B/dt might indeed lead to a destructive overheating of the base-collector junction (see "The power transistor in its environment" published by Thomson CSF Division Semiconducteurs Discrets).

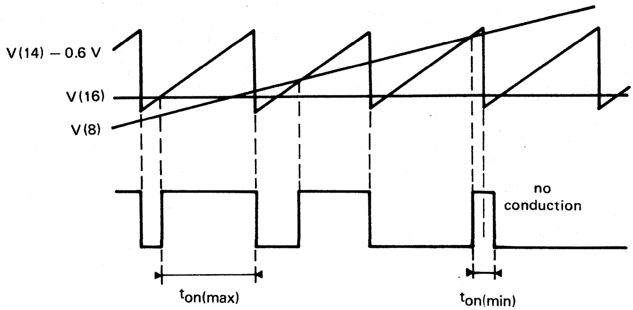
SELF REGULATED BASE CURRENT $I_B = f(V_{CE})$



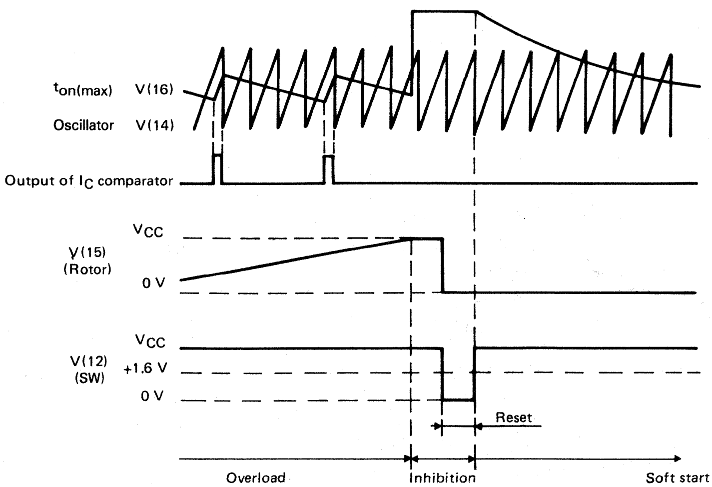


TYPICAL WAVEFORMS

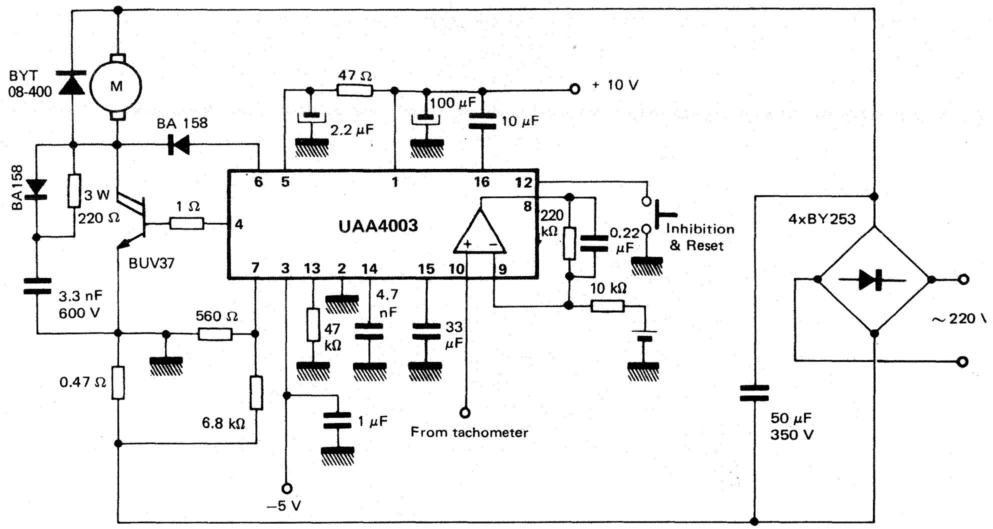
LIMITS OF THE DUTY CYCLE



"CURRENT LIMITATION" AND "LOCKED ROTOR" OPERATION



SPEED REGULATOR 1.5 kW



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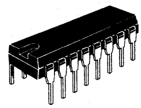
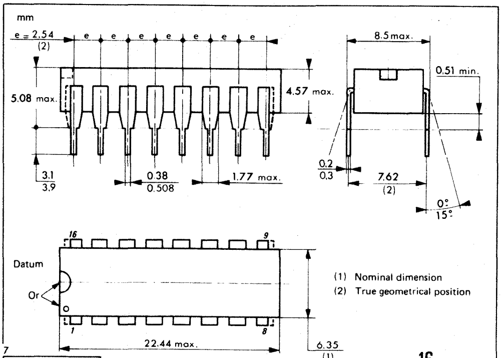
CB-79



DP SUFFIX
PLASTIC PACKAGE

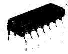
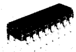
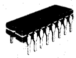


DIN				16 pins
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 **THOMSON** SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

Switch mode power supplies & power drivers

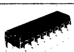
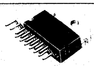
UNIVERSAL REGULATORS

Part number	Function	Package		Suffix	Page
MC34060	Pulse width modulation control circuit	Plastic DIL 14		DP	557
TL494	Pulse width modulation control circuit	Plastic DIL 16		DP	597
		Cerdip DIL 16		DG	

FLYBACK POWER SUPPLIES

Part number	Function	Page
TEA2018A	Switch mode power supply control circuit	585
TEA2019	Switch mode power supply control circuit	591
UAA4001	Switch mode power supply control circuit	609
UAA4006A	Switch mode power supply control circuit	633

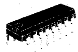
($T_{amb} = +25°C$)

CHARACTERISTIC		UNIT	TEA2018A	TEA2019	UAA4001	UAA4006A
Maximum output current	DIL 16 SIL 15	A	±0.5	±0.5	±1.0 ±3.0	±1.5
Base current regulation $I_B = f(I_C)$		—	$I_B = KI_C$	$I_B = KI_C$	Self regulated	Self regulated
Protection against desaturation		—	—	●	—	●
Secondary current supervision		—	●	●	●	●
Minimum conduction time		μs	Adjustable 1.0 to 10.0	2.0	2.0	Adjustable 2.0 to 10.0
Maximum duty cycle		—	80%	50%	Adjustable	Adjustable
Start supply current		mA	1.0	1.0	15.0	0.3
Soft-start		—	—	—	●	●
Oscillator synchronization		—	—	● PLL	—	●
Typical supply output power	DIL 16 SIL 15	W	<60	<60	<100 100 to 300	<100 100 to 200
PACKAGE		**SUFFIX**				
Plastic DIL 8		DP	●			
Plastic DIL 14		DP		●		
Plastic DIL 16		DP			●	●
Plastic SIL 15		SP			●	●
Page			585	591	609	633

TRIAC DRIVERS

Part number	Control	Power supply	Gate current	Applications	Package	Suffix	Page
TEA1510	ON/OFF : $\frac{t_{on}}{t_{on}+t_{off}}$ variable Adjustable cycle time	AC line : 1.5 mA typ	150 mA typ	– Thermal regulation – Rheostat – Heating	Plastic DIL 8 	DP	569
TEA1511	ON/OFF : zero voltage and zero current of triac switch	AC line : 1.5 mA typ	270 mA typ	– General purpose – Resistive or inductive loads	Plastic DIL 8 	DP	577

POWER TRANSISTOR CONTROL

Part number	Function	Package	Suffix	Page
UAA4002	Fast switching transistors control circuit	Plastic DIL 16 	DP	621

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THOMSON SEMICONDUCTORS

MC34060

PULSE WIDTH MODULATION CONTROL CIRCUIT

The MC34060 DP is a low cost fixed frequency, pulse width modulation control circuit designed primarily for single ended SWITCHMODE power supply control. This device features :

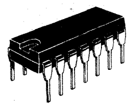
- Complete Pulse Width Modulation control circuitry
- On-chip oscillator with master or slave operation
- On-chip error amplifiers
- On-chip 5.0 Volt reference
- Adjustable dead time control
- Uncommitted output transistor for 200 mA source or sink

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE DP
MC 34060	0°C to +70°C	•

PULSE WIDTH MODULATION CONTROL CIRCUIT

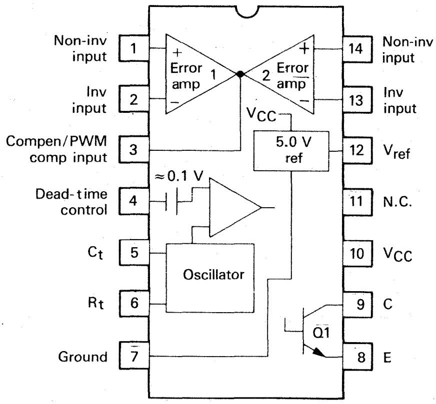
CASE CB-2



DP SUFFIX
PLASTIC PACKAGE

6

PIN ASSIGNMENT
(Top view)



Ref. 00240

MAXIMUM RATINGS

(Full operating ambient temperature range unless otherwise specified)

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	42	V
Collector voltage (output transistor)	V_C	42	V
Collector current (output transistor)	I_C	250	mA
Error amplifier input voltage	V_I	V_{CC} + 0.3	V
Power dissipation @$T_{amb} \leqslant +45°C$	P_{tot}	1000	mW
Operating junction temperature	T_j	+150	°C
Operating ambient temperature range	T_{amb}	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +125	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-ambient thermal resistance	$R_{th(j-a)}$	80	°C/W
Power derating factor	$1/R_{th(j-a)}$	12.5	mW/°C
Derating ambient temperature	T_{amb}	45	°C

BLOCK DIAGRAM

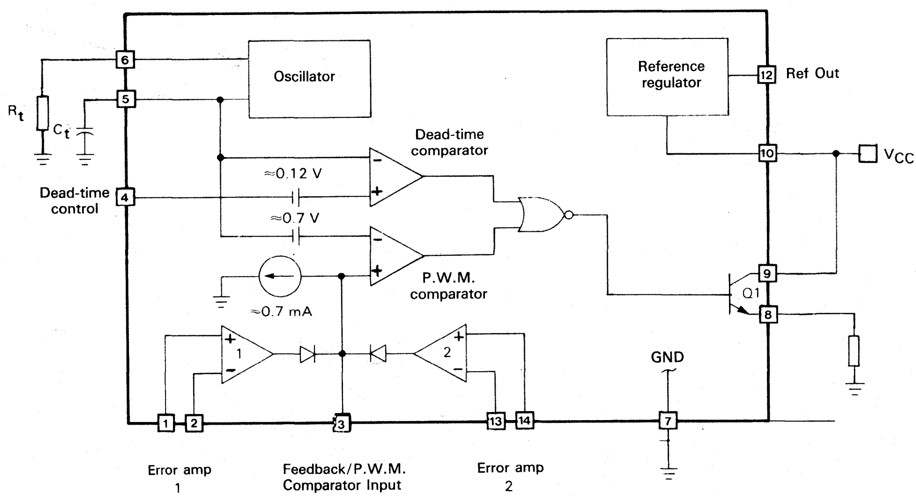
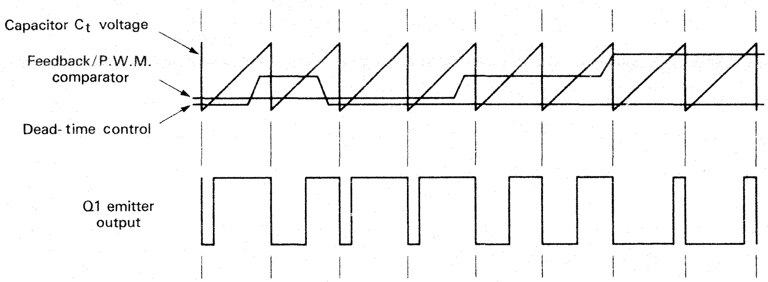


FIGURE 1 - TIMING DIAGRAMS



RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage	V_{CC}	7.0	15	40	V
Collector voltage (output transistor)	V_C	–	30	40	V
Collector current (output transistor)	I_C	–	–	200	mA
Error amplifier input voltage	V_I	−0.3	–	$V_{CC}-2$	V
Current into feedback terminal	I_{fb}	–	–	0.3	mA
Reference output current	I_{ref}	–	–	10	mA
Timing resistor	R_t	1.8	47	500	kΩ
Timing capacitor	C_t	0.00047	0.001	10	μF
Oscillator frequency	f_{osc}	1.0	25	200	kHz

DESCRIPTION

The MC34060 is a fixed-frequency pulse width modulation control circuit, incorporating the primary building blocks required from the control of switching power supplies (See block diagram). An internal-linear sawtooth oscillator is frequency-programmable by two external components, R_t and C_t. The oscillator frequency is determined by :

$$f_{osc} \cong \frac{1.1}{R_t \cdot C_t}$$

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor C_t to either of two control signals. The output is enabled only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control-signal amplitude causes a corresponding linear decrease of output pulse width. (Refer to the timing diagram shown in Figure 1).

The control signals are external inputs that can be fed into the dead-time control, the error amplifier inputs, or the feedback input. The dead-time control comparator has an effective 120 mV input offset which limits the minimum output dead time to approximately the first 4% of the sawtooth-cycle time. This would result in a maximum duty cycle of 96%. Additional dead-time may be imposed on the output by setting the dead time-control input to a fixed voltage, ranging from 0 to 3.3 V.

The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent on-time, established by the dead time control input, down to zero, as the voltage at the feed-back pin varies from 0.5 to 3.5 V. Both error amplifiers have a common-mode input range from −0.3 V to (V_{CC} − 2 V), and may be used to sense power supply output voltage and current. The error-amplifier outputs are active high and are ORed together at the non-inverting input of the pulse-width modulator comparator. With this configuration, the amplifier that demands minimum output on time, dominates control of the loop.

The MC34060 has an internal 5.0 V reference capable of sourcing up to 10 mA of load currents for external bias circuits. The reference has an internal accuracy of ±5% with a thermal drift of less than 50 mV over an operating temperature range of 0 to +70°C.

SOFT STARTING

It is possible to achieve soft starting by limiting the conduction angle during the first few periods after power-up by connecting a capacitor between V_{ref} and dead time control pins (see Fig. 15).

ELECTRICAL CHARACTERISTICS

$V_{CC} = +15$ V, $f_{osc} = 25$ kHz unless otherwise specified. For typical values $T_{amb} = +25°C$ for min/max values T_{amb} is the operating ambient temperature range that applies unless otherwise specified.

REFERENCE SECTION

Characteristic	Symbol	Min	Typ	Max	Unit
Reference voltage ($I_O = 1.0$ mA)	V_{ref}	4.75	5.0	5.25	V
Reference voltage change with temperature (ΔT_{amb} = Min to Max)	αV_{ref}	–	1.3	2.6	%
Input regulation ($V_{CC} = +7.0$ V to 40 V)	K_{VI}	–	2.0	25	mV
Output regulation ($I_O = 1.0$ mA to 10 mA)	K_{VO}	–	3.0	15	mV
Short-circuit output current ($V_{ref} = 0$ V, $T_{amb} = +25°C$)	I_{SC}	–	35	–	mA

OUTPUT SECTION

Characteristic	Symbol	Min	Typ	Max	Unit
Collector off-state current ($V_{CC} = +40$ V, $V_{CE} = +40$ V)	$I_{C(off)}$	–	2.0	100	µA
Emitter off-state current ($V_{CC} = +40$ V, $V_C = +40$ V, $V_E = 0$ V)	$I_{E(off)}$	–	–	–100	µA
Collector-emitter saturation voltage					V
Common-emitter ($V_E = 0$ V, $I_C = +200$ mA)	$V_{sat(C)}$	–	1.1	1.3	
Emitter-follower ($V_C = +15$ V, $I_E = -200$ mA)	$V_{sat(E)}$	–	1.5	2.5	
Output voltage rise time ($T_{amb} = +25°C$)	t_r				ns
Common-emitter (See Figure 11)		–	100	200	
Emitter-follower (See Figure 12)		–	100	200	
Output voltage fall-time ($T_{amb} = +25°C$)	t_f				ns
Common-emitter (See Figure 11)		–	25	100	
Emitter-follower (See Figure 12)		–	40	100	

ERROR AMPLIFIER SECTIONS

Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage ($V_{O[Pin\ 3]} = +2.5$ V)	V_{IO}	–	2.0	10	mV
Input offset current ($V_{O[Pin\ 3]} = +2.5$ V)	I_{IO}	–	5.0	250	nA
Input bias current ($V_{O[Pin\ 3]} = +2.5$ V)	I_{IB}	–	0.1	1.0	µA
Input common-mode voltage range ($V_{CC} = +7.0$ V to 40 V)	V_{ICR}	–0.3	–	$V_{CC}-2.0$	V
Open loop voltage gain ($\Delta V_O = 3.0$ V, $V_O = +0.5$ to 3.5 V, $R_L = 2.0$ kΩ)	A_{VOL}	70	95	–	dB
Unity-gain crossover frequency ($V_O = +0.5$ to 3.5 V, $R_L = 2.0$ kΩ)	f_c	–	350	–	kHz
Phase margin at unity-gain ($V_O = +0.5$ to 3.5 V, $R_L = 2.0$ kΩ)	ϕ_m	–	65	–	deg.
Common-mode rejection ratio ($V_{CC} = 40$ V)	CMR	65	90	–	dB
Power supply rejection ratio ($\Delta V_{CC} = 33$ V, $V_O = 2.5$ V, $R_L = 2.0$ kΩ)	PSRR	–	100	–	dB
Output sink current ($V_{O[Pin\ 3]} = -0.7$ V)	I_O^-	0.3	0.7	–	mA
Output source current ($V_{O[Pin\ 3]} = +3.5$ V)	I_O^+	–2.0	–4.0	–	mA

ELECTRICAL CHARACTERISTICS

$V_{CC} = +15$ V, $f_{osc} = 25$ kHz unless otherwise specified. For typical values $T_{amb} = +25°C$ for min/max values T_{amb} is the operating ambient temperature range that applies unless otherwise specified.

PWM COMPARATOR SECTION (Test circuit Figure 11)

Input threshold voltage (Zero duty cycle)	V_{TH}	—	3.5	4.5	V
Input sink current ($V_{[Pin\ 3]} = 0.7$ V)	I_I^-	0.3	0.7	—	mA

DEAD-TIME CONTROL SECTION (Test Circuit Figure 11)

Input bias current [Pin 4] ($V_I = 0$ to $+5.25$ V)	$I_{IB(DT)}$	—	−2.0	−10	µA
Maximum output duty cycle ($V_I = 0$ V, $C_t = 0.1$ µF, $R_t = 12$ kΩ) ($V_I = 0$ V, $C_t = 0.001$ µF, $R_t = 47$ kΩ)	DC_{max}	 90 —	 96 92	 100 100	%
Input threshold voltage [Pin 4] Zero duty cycle Maximum duty cycle	V_{TH}	 — 0	 2.8 —	 3.3 —	V

OSCILLATOR SECTION

Frequency ($C_t = 0.001$ µF, $R_t = 47$ kΩ)	f_{osc}	—	25	—	kHz
Standard deviation of frequency ($C_t = 0.001$ µF, $R_t = 47$ kΩ)	σf_{osc}	—	3.0	—	%
Frequency change with voltage ($V_{CC} = +7.0$ V to 40 V, $T_{amb} = +25°C$)	$\Delta f_{osc(\Delta V)}$	 —	 0.1	 —	%
Frequency change with temperature ($T_{amb} = 0°C$ to $+70°C$)	$\Delta f_{osc(\Delta T)}$	—	1.0	2.0	%

TOTAL DEVICE

Standby supply current (Pin 6 at V_{ref}, all other inputs and outputs open) $V_{CC} = +15$ V $V_{CC} = +40$ V	$I_{CC(sb)}$	 — —	 5.5 7.0	 10 15	mA
Average supply current ($V_{[Pin\ 4]} = +2.0$ V, $C_t = 0.001$ µF, $R_t = 47$ kΩ) See Figure 11	$I_{CC(av)}$	 —	 7.0	 —	mA

* Standard deviation is a measure of the statistical distribution about the mean as derived from the formula.

$$\sigma = \sqrt{\frac{\sum_{n=1}^{N} (X_n - \overline{X})^2}{N - 1}}$$

FIGURE 2 — OSCILLATOR FREQUENCY versus TIMING RESISTANCE

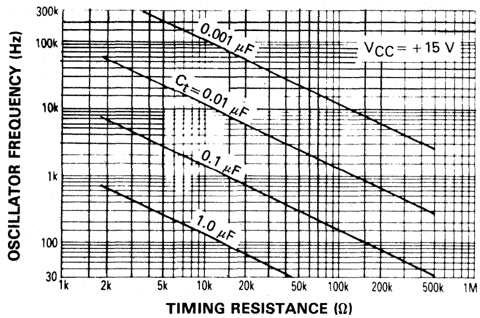


FIGURE 3 — OPEN LOOP VOLTAGE GAIN AND PHASE versus FREQUENCY

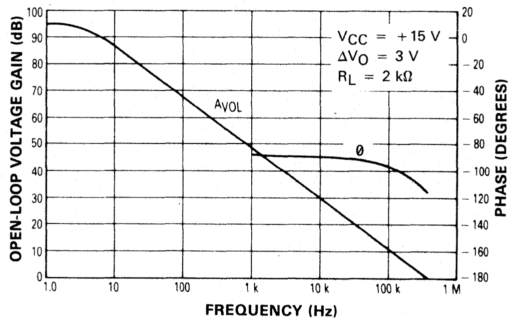


FIGURE 4 — PERCENT DEAD-TIME versus OSCILLATOR FREQUENCY

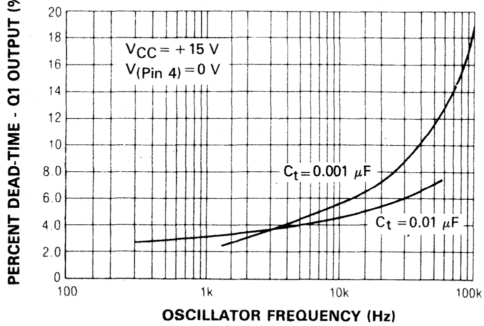


FIGURE 5 — PERCENT DUTY CYCLE versus DEAD-TIME CONTROL VOLTAGE

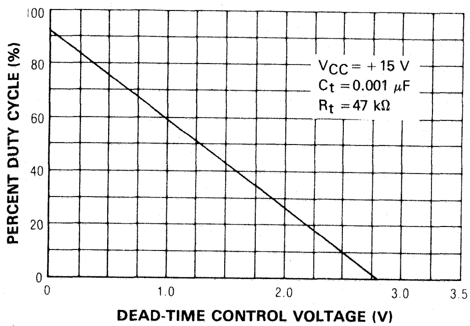


FIGURE 6 — EMITTER FOLLOWER CONFIGURATION OUTPUT-SATURATION VOLTAGE versus EMITTER CURRENT

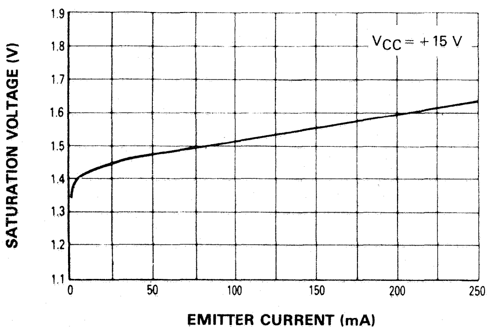


FIGURE 7 — COMMON EMITTER CONFIGURATION OUTPUT-SATURATION VOLTAGE versus EMITTER CURRENT

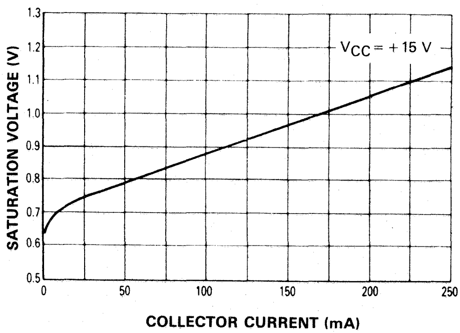


FIGURE 8 — STANDBY SUPPLY CURRENT versus SUPPLY VOLTAGE

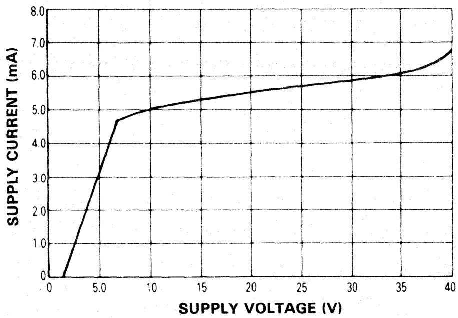


FIGURE 9 — ERROR AMPLIFIER CHARACTERISTICS

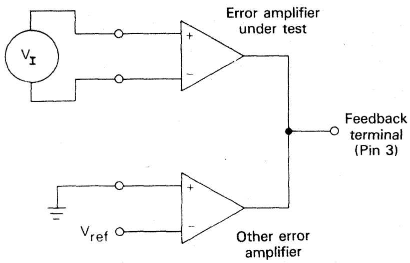


FIGURE 10 — DEAD-TIME AND FEEDBACK CONTROL TEST CIRCUIT

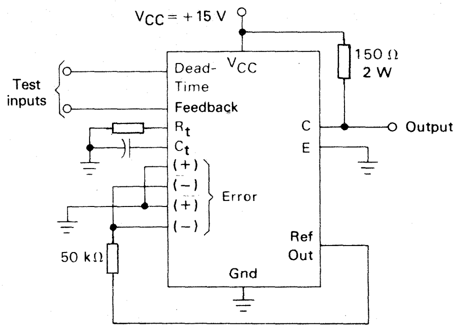


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FIGURE 11 — COMMON-EMITTER CONFIGURATION TEST CIRCUIT AND WAVEFORM

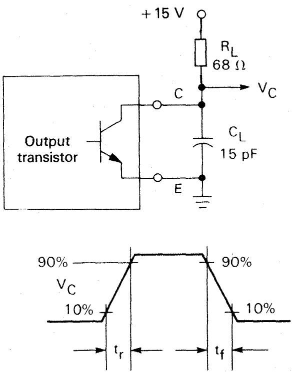


FIGURE 12 — EMITTER-FOLLOWER CONFIGURATION TEST CIRCUIT AND WAVEFORM

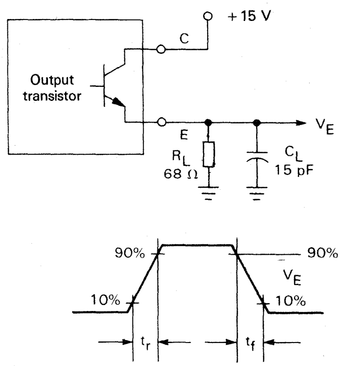
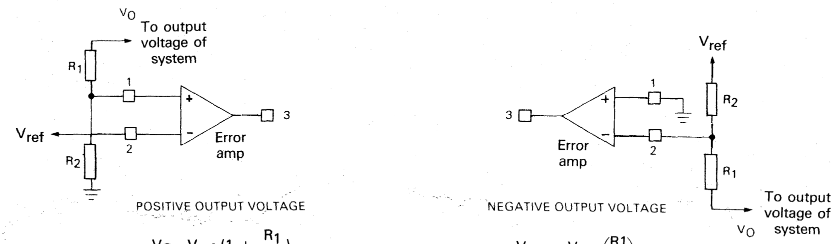


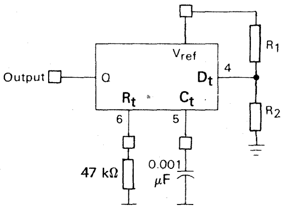
FIGURE 13 — ERROR AMPLIFIER SENSING TECHNIQUES



$V_O = V_{ref}\,(1 + \frac{R_1}{R_2})$

$V_O = -V_{ref}\left(\frac{R1}{R2}\right)$

FIGURE 14 — DEAD-TIME CONTROL CIRCUIT



$$\text{Max \% On Time} \approx 92 - \left(\frac{160}{1 + \frac{R1}{R2}}\right)$$

FIGURE 15 — SOFT-START CIRCUIT

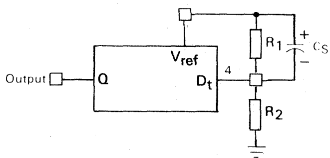


FIGURE 16 — SLAVING TWO OR MORE CONTROL CIRCUITS

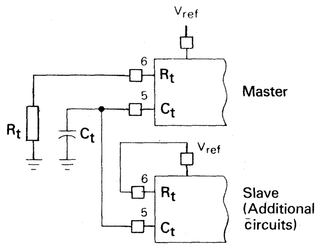
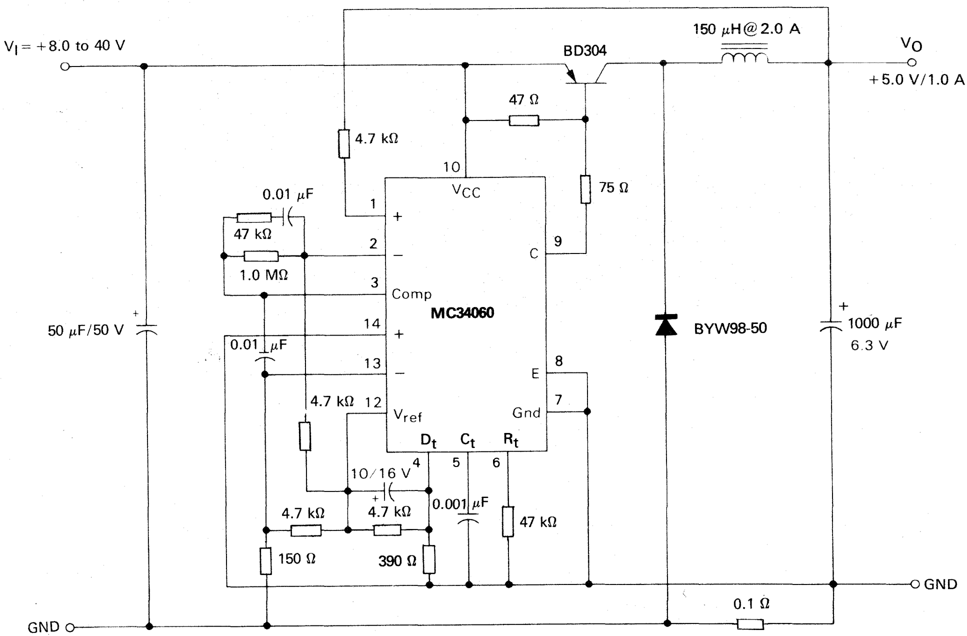
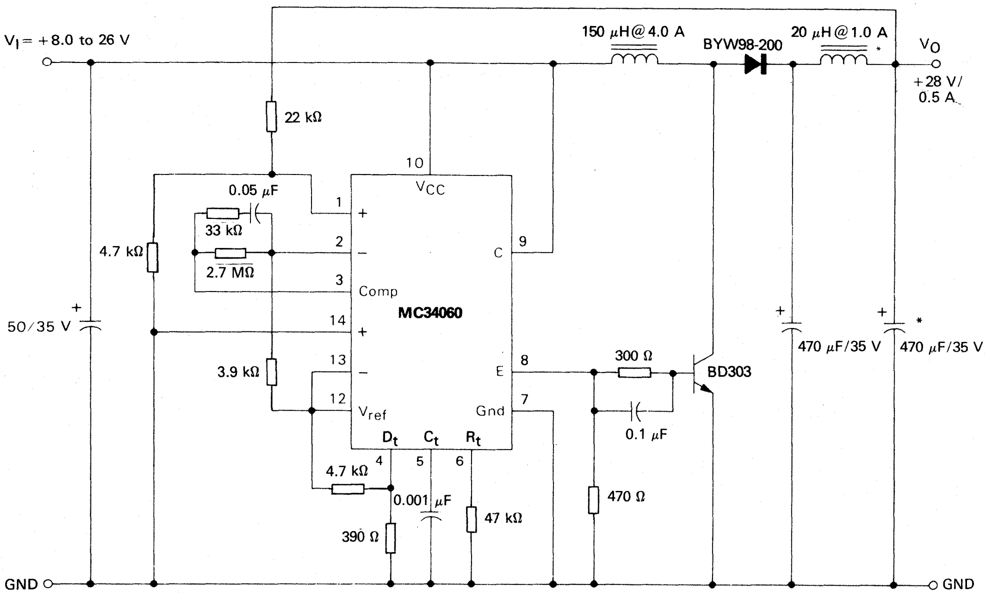


FIGURE 17 — STEP-DOWN CONVERTER WITH SOFT-START AND OUTPUT CURRENT LIMITING



TEST	CONDITIONS	RESULTS	
Line regulation	$V_I = +8.0$ V to 40 V, I_O = 1.0 A	25 mV	0.5%
Load regulation	$V_I = +12$ V, $I_O = 1.0$ mA to 1.0 A	3.0 mV	0.06%
Output ripple	$V_I = +12$ V, I_O = 1.0 A	75 mV p-p	
Short-circuit current	$V_I = +12$ V, $R_L = 0.1$ Ω	1.6 A	
Efficiency	$V_I = +12$ V, I_O = 1.0 A	73%	

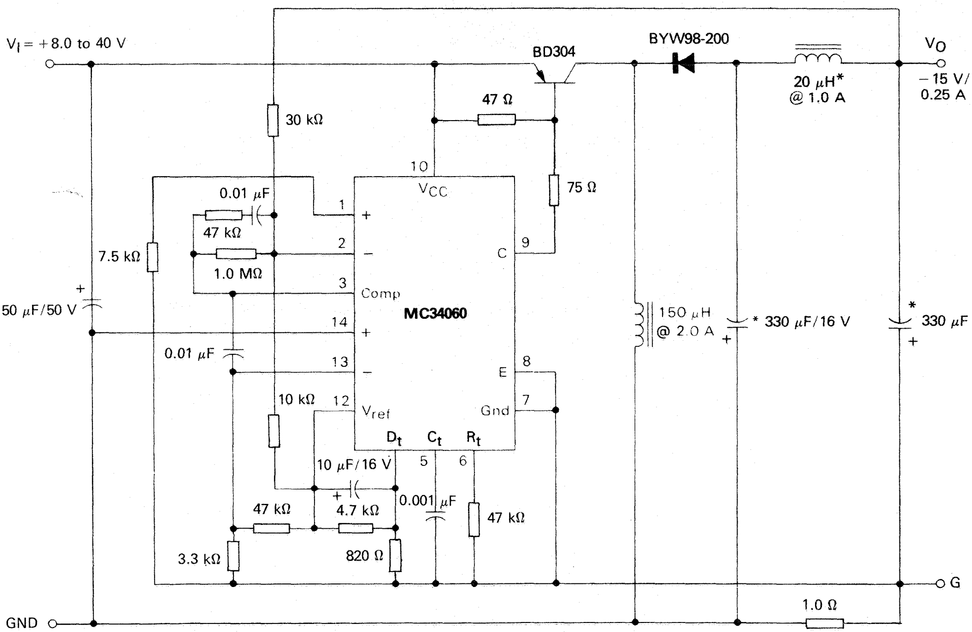
FIGURE 18 — STEP-UP CONVERTER



* Optional, to minimize output ripple.

TEST	CONDITIONS	RESULTS	
Line regulation	$V_I = +8.0$ V to 26 V, $I_O = 0.5$ A	40 mV	0.14%
Load regulation	$V_I = +12$ V, $I_O = 1.0$ mA to 0.5 A	5.0 mV	0.18%
Output ripple	$V_I = +12$ V, $I_O = 0.5$ A	24 mVpp	
Efficiency	$V_I = +12$ V, $I_O = 0.5$ A	75%	

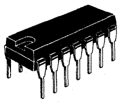
FIGURE 19 — STEP-UP/DOWN VOLTAGE INVERTING CONVERTER WITH SOFT-START AND CURRENT LIMITING



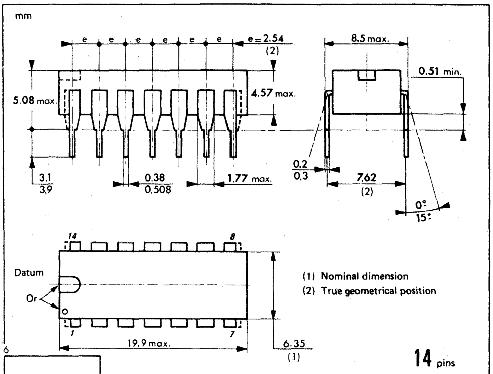
* Optional, to minimize output ripple

TEST	CONDITIONS	RESULTS
Line regulation	V_I = +8.0 V to 40 V, I_O = 250 mA	52 mV 0.35%
Load regulation	V_I = +12 V, I_O = 1 mA to 250 mA	47 mV 0.32%
Output ripple	V_I = +12 V, I_O = 250 mA	10 mVpp
Short circuit current	V_I = +12 V, R_L = 0.1 Ω	330 mA
Efficiency	V_I = +12 V, I_O = 250 mA	86%

CB-2



DP SUFFIX
PLASTIC PACKAGE



DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

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THOMSON SEMICONDUCTEURS

TEA1510

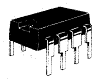
LONG-CYCLE ZERO VOLTAGE TRIAC DRIVER FOR PROPORTIONAL POWER CONTROL

The TEA1510 has been designed for high volume AC switching applications in conjunction with a triac or a relay. The circuit is suitable for proportional band temperature control, though the number of applications are by no means limited. One of the many outstanding features of this circuit is its long adjustable cycle time, the typical values of which lie between a few seconds and several tens of minutes.

- High impedance error amplifier inputs (E^+, E^-)
- No RFI generated
- Precise proportional power control by on-chip linear ramp generator
- Triggered during zero crossing of mains
- High output current (150 mA typ.)
- Fail safe feature avoids the triac turn on due to thermistor failure
- Original integrating PWM design allowing long cycle time with low external capacitor value (typ. 3 nF per second).

LONG-CYCLE ZERO VOLTAGE TRIAC DRIVER FOR PROPORTIONAL POWER CONTROL

CASE CB-98



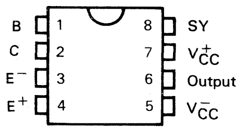
DP SUFFIX
PLASTIC PACKAGE

6

ORDERING INFORMATION

PART NUMBER	PACKAGE DP
TEA1510	●
Example : TEA1510DP	

PIN ASSIGNMENT
(Top view)



B	: t_{on} max adjustment
C	: Timing capacitor
E^+, E^-	: Error amp. inputs
SY	: Line synchronization
V_{CC}^+	: Positive supply
GT	: Output
V_{CC}^-	: Negative supply

Ref. 00405

THOMSON SEMICONDUCTEURS
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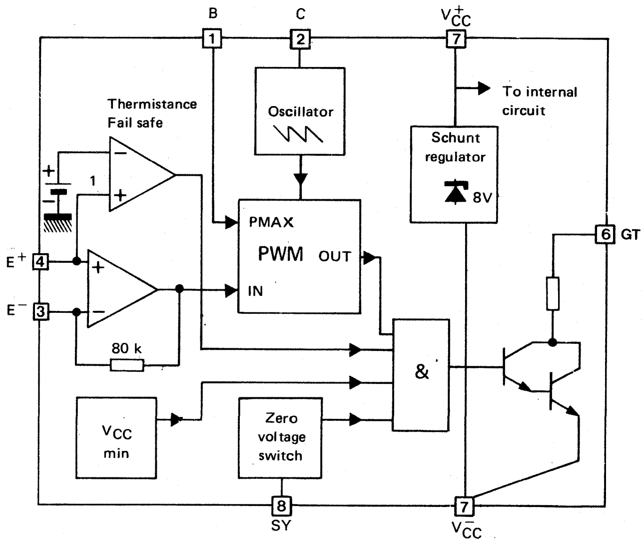
THOMSON COMPOSANTS

MAXIMUM RATINGS

(Voltages referenced to V_{CC}^- unless otherwise specified)

Rating	Symbol	Value	Unit
Supply current (V_{CC}^+ is internally stabilized at +8.2 V)	I_{CC}	30	mA
Input voltage on pins 1, 2, 3, 4	$V_{I(B)}$, $V_{I(C)}$ $V_{I(E^-)}$, $V_{I(E^+)}$	V_{CC}	V
Output voltage (pin 6)	V_O	15	V
Peak output current (pin 6)	$I_{O(peak)}$	200	mA
Input current, pin 8, 50 Hz	I_{SY}	10	mA rms
Junction temperature	T_j	+150	°C

BLOCK DIAGRAM



B : t_{on} max adjustment
C : Timing capacitor
E^+, E^- : Error amp. inputs
SY : Line synchronization
V_{CC}^+ : Positive supply
GT : Output
V_{CC}^- : Negative supply

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{E^+} = +4$ V, $I_{CC} = 1.5$ mA
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage $I_{CC} = 1.5$ mA $I_{CC} = 15$ mA (Note 4)	V_{CC}	 7 7	 8.2 8.5	 9 9	V
E^+ input current	$I_{I(E^+)}$	–	0.3	1	μA
B input current ($V_B = +5$ V)	$I_{I(B)}$	–	–	0.5	μA
Error amplifier input offset voltage	V_{IO}	–	–	10	mV
Error amplifier common-mode voltage range	V_{CM}	3	–	$V_{CC}^+ - 1.5$	V
Output leakage current ($V_{E^+} = 0$, $V_O = +10$ V)	I_{GToff}	–	–	50	μA
Output drive current ($V_{GT} = 5$ V)	I_{GTon}	100	150	–	mA
Timing capacitor charging current	$I_{C(t)}$	6	8.4	15	μA
Cycle time ($V_{E^+} = +5$ V, $V_B = 0$, $C_1 = 1$ μF, pin 3 (E^-) non connected) - (Note 1)	T	–	300	–	s
E^- input current $\frac{t_{on}}{T} = 15\%$ $\frac{t_{on}}{T} = 85\%$ (See figure 2)	$I_{I(E^-)}$	 –10.5 4	 –7 8	 –3.5 11	μA
Control voltage applied to pin 1 for power limitation (Note 2 and Fig. 1)	V_B	V_{CC}^-	–	V_{CC}^+	V
Output pulse symmetry (Note 5)	t_{P1}/t_{P2}	0.5	1	1.5	–
Fail safe features (Note 3) $V_{CC(min)}^+$ Thermistance failure	 $V_{CC(min)}^+$ $V_{E^-(min)}$	 – 0.3	 6.4 1.1	 7 1.7	V

Note 1 : Cycle time T is determined by external capacitor C1 connected to pin C, the value of which is typically 3 nF per second of cycle time.

Note 2 : Maximum value of t_{on} is set by signal V_B applied to high impedance input B. Therefore the voltage V_B controls the power limitation. $V_B = V_{CC}^+$ results in total limitation whereas $V_B = V_{CC}^-$ imposes no restriction whatsoever.
For other values of V_B and corresponding power limitations refer to Figure 1.

Note 3 : Fail safe feature : the voltage drop developed across thermistor R_t is applied to pin 4 (E^+) and is constantly monitored by the error amplifier. Should this voltage fall below 1.1 V, the internal logic will inhibit the output trigger pulses since the detected condition signifies thermistor failure.

Note 4 : Resistor R_8 is connected in series with internal shunt regulator and must be calculated so as to limit I_{CC} max to 15 mA, while bearing in mind that the minimum value of I_{CC} for regulator's proper operation is 1.5 mA. The stabilized voltage of the regulator is approximately +8.2 V. Using the components given in typical application, the appropriate value of R8 is 27 kΩ with 2 W power rating for 220 V mains.

Note 5 : The trigger pulse width is determined by resistor R_y connected to pin 8 (SY). See Figures 4 and 5 for characteristics.

FIGURE 1 – POWER LIMITATION BY B INPUT

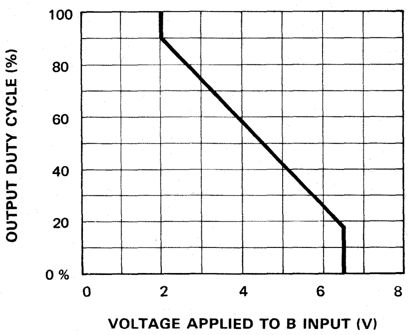


FIGURE 2 - DUTY CYCLE vs I_E^-

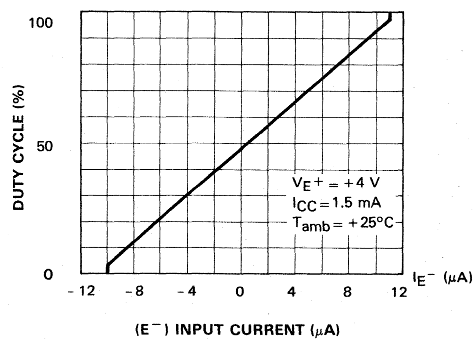


FIGURE 3 – CHARACTERISTICS OF THE SHUNT REGULATOR

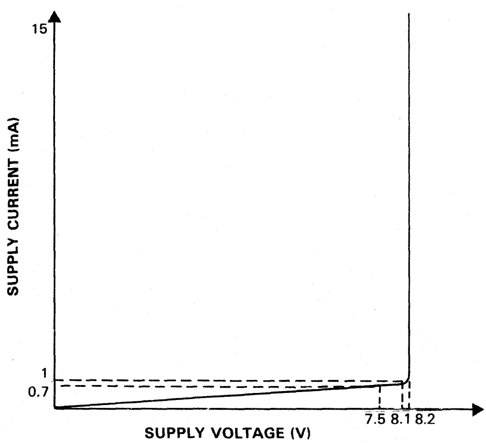


FIGURE 4 – OUTPUT PULSE WIDTH

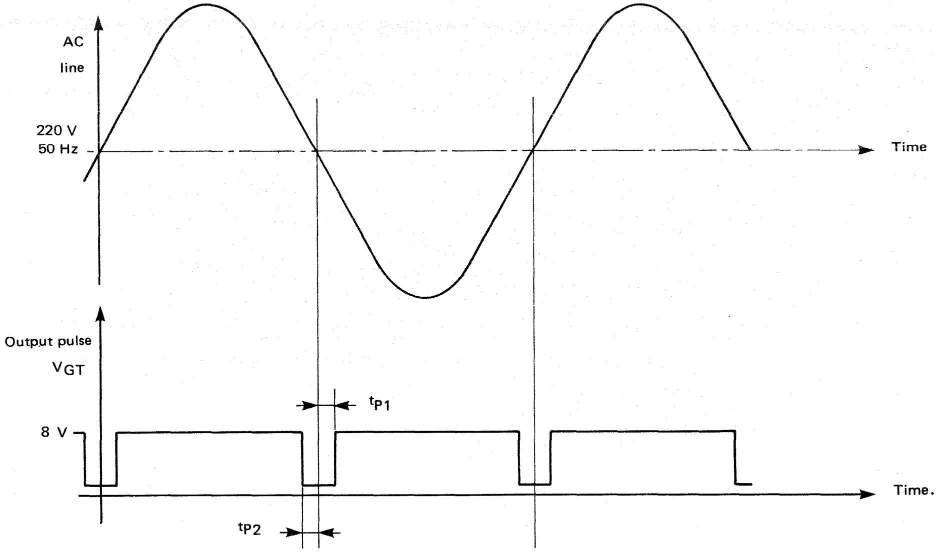
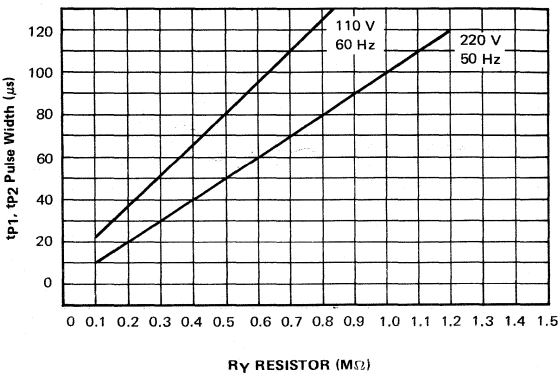


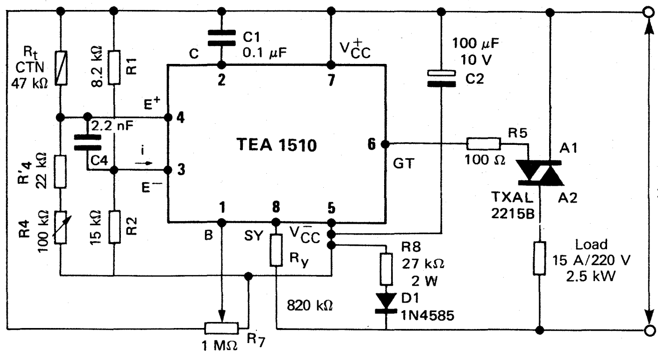
FIGURE 5 – OUTPUT PULSE WIDTH AS A FUNCTION OF R_Y



6

TYPICAL APPLICATIONS

TRIAC-CONTROLLED TEMPERATURE REGULATOR



Cycle time : ~ 30 s.

THOMSON components :

R_{to} = 47 kΩ ± 20 % $\quad$ t_o = 25°C

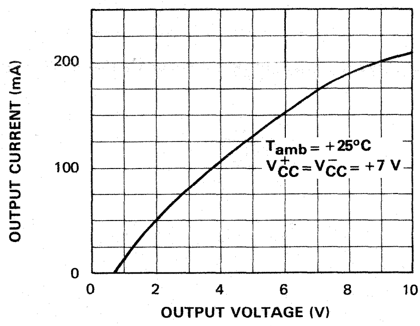
B = 4150 ± 5 %

$R_t = R_{to} \exp B(1/T . 1/T_o)$ $\quad$ T and T_o in °K

Proportional width scale = 1°C

Temperature range = + 10°C to + 40°C

AVAILABLE OUTPUT CURRENT



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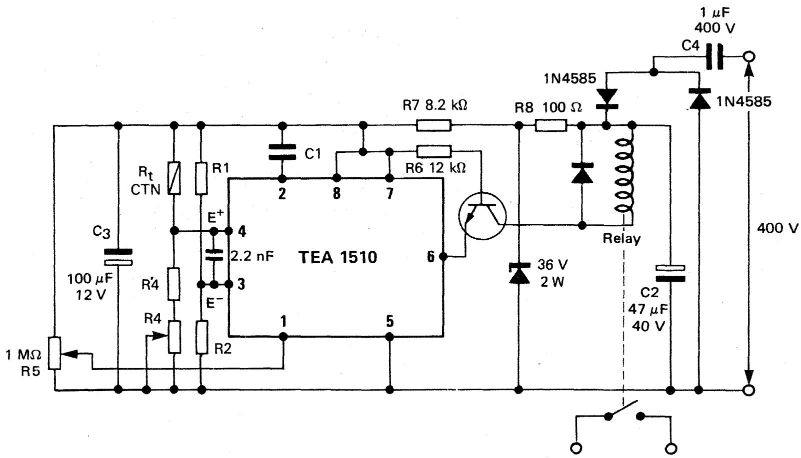
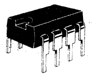
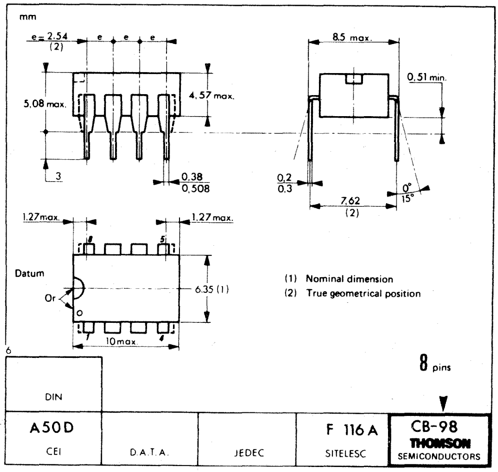
TEMPERATURE REGULATION WITH RELAY DRIVE



CB-98



DP SUFFIX
PLASTIC PACKAGE



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THOMSON SEMICONDUCTORS

TEA1511

ADVANCE INFORMATION

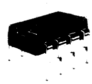
ZERO VOLTAGE ZERO CURRENT TRIAC CONTROL CIRCUIT

The TEA1511 integrated circuit contains a sampled comparator and an original zero voltage and/or current switching system, for the ON/OFF control of triacs with resistive or inductive loads, without the risk of missed triggering or feeding noise back to the mains. Power drain is very low.

- Large input common mode voltage range including zero (A1 triac voltage)
- Sampling at line frequency
- Triggering by negative pulsed current
- Synchronization of gate pulses on zero line voltage (S mode) or zero triac voltage (T mode)
- Very low power drain.

ZERO VOLTAGE ZERO CURRENT TRIAC CONTROL CIRCUIT

CASE CB-98



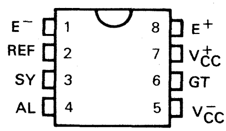
DP SUFFIX
PLASTIC PACKAGE

6

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE DP
TEA1511	−20°C to +75°C	•
Example : TEA1511DP		

PIN ASSIGNMENT
(Top view)



Réf. 00385

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THOMSON COMPONENTS

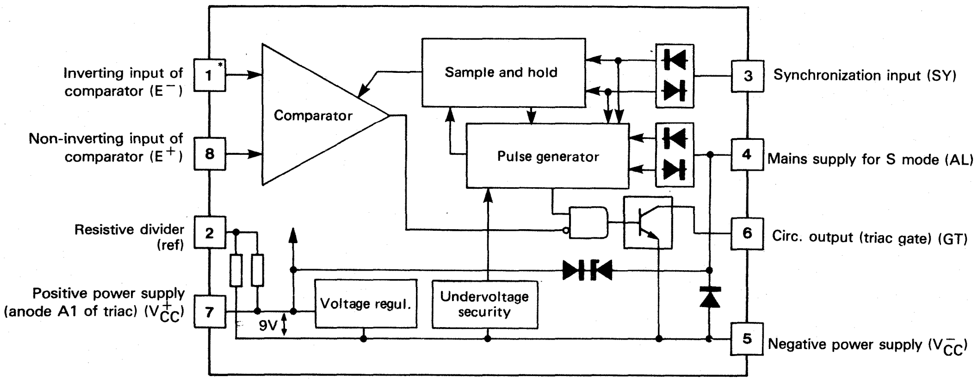
MAXIMUM RATINGS

Voltages referenced to V_{CC}^{-} (Unless otherwise specified)

Rating		Symbol	Value	Unit
Input voltage	Pin 1 or 8	V_I	+3 to V_{CC}^{-}	V
Current on SY input (Note 1)	Pin 3	$I_{(3)}$	±6	mA
Current on AL pin	Pin 4	$I_{(4)}$	±12	mA
Negative supply current	Pin 5	I_{CC}^{-}	−12	mA
Voltage on pin V_{CC}^{-}	Pin 5	V_{CC}^{-}	+7 to −10	V
Output sink current	Pin 6	$I_{O(sink)}$	350	mA
Gate voltage	Pin 6	$V_{(6)}$	+10 to (V_{CC}^{-} − 1 V)	V
Storage temperature range		T_{stg}	−40 to +150	°C
Power dissipation at +25°C		P_{tot}	600	mW
Operating temperature range		T_{oper}	−20 to +75	°C

Note 1 : R_{SY} > 30 kΩ for 220 V mains supply.

BLOCK DIAGRAM



(* Triac is fired at each zero-crossing whenever E⁻ is negative with respect to E⁺).

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
V_{CC}^{-} voltage, ($I_{(5)} = -2$ mA)	$V_{(5)}$	−8.4	−9.1	−9.7	V
Supply current on V_{CC}^{-}, (Output GT : open), $V_{(5)} = -8.5$ V	–	–	−0.9	−1.2	mA
Input voltage range (E^{+} connected to E^{-}) - (Note 2)	$V_{I(max)}$	+1toV_{CC}+2	+1 to −8	–	V
Input bias current (0 V<V_I< −6.5 V) - (Pins 1 and 8)	I_{IB}	–	0.2	1	µA
Input offset voltage - (Note 2)	V_{IO}	0	−30	−100	mV
Hysteresis S mode - (Note 2) T mode	V_H	– –	0 0	50 30	mV
REF pin voltage	V_{ref}	32	36	40	%V_{CC}^{-}
Gate current (Pins 6 and 7 connected) - ($V_5 = -8.5$ V)	$I_{(6)}$	200	270	–	mA

Note 2 : Parameters mesured with 30 kΩ input source impedance.

VARIOUS POWER SUPPLY AND SYNCHRONIZATION OPTIONS

Mode	Synchronization on		Power supply		R_{SY} connected to	Full wave	Preferred use
			From	To			
S	a.c. line	Figure 1	R_{al}	−AL	V_{CC}^{-}	n.g.	Resistive load and sensitive triac
ST	a.c. line and triac current	Figure 2	R_{al}	−AL	A2 triac	no	Any load (without iron-core), any triac
T	Triac voltage and triac current	Figure 3	R_{al} +D	V_{CC}^{-}	A2 triac	yes*	Varying load, inductive load or multiphased, any triac

n.g. : Full wave operation only within limited range of input conditions.
yes* : Full wave operation guaranteed within the input common-mode range provided adequate filtering (see page 5).

SYNCHRONIZATION MODES :

Several options of gate-pulse synchronization are available to solve every case of triac sensitivity and phase-shift between voltage and current.

S mode : Conventional zero mains voltage switching with few external components (only in case of resistive load and high current).

ST mode Extension of S mode for any non-saturable load.

T mode : Full-wave switching* at zero triac voltage and current through an original method, fitting any type of load (even inductive load or polyphase circuits).

* Switching occurs at zero-crossing just preceding a negative half-wave of the line voltage.

6

CONNECTION TO THE MAINS SUPPLY AND TO THE TRIAC

With an example of passive component values in case of a triac with I_{GT} and $I_L \leqslant 50$ mA, d.c. external current (resistive input dividers) $\leqslant 0.3$ mA, and 50 to 100 Hz line frequency.

TEA1511-DP, $R_G = 120\ \Omega$ (1/4 W), $C_d = 470\ \mu F$ (12)

Mode S

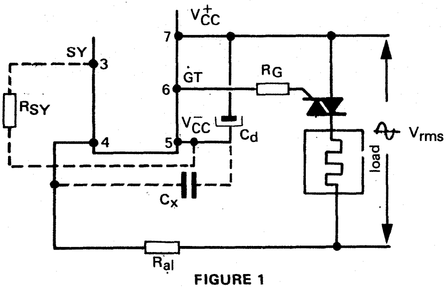


FIGURE 1

Mode S, resistive load with $I_{rms} > 1.5$ A

a.c. line =	115 V_{rms}	220 V_{rms}
R_{al} =	10 kΩ, 2 W	22 kΩ, 3 W

$C_x = 2$ to 3 nF : optional (for low I_{rms} current)

$R_{SY} = 680$ kΩ : optional (for full wave operation).

Mode ST

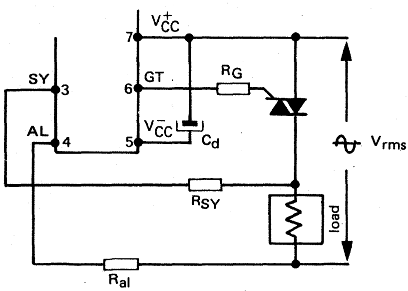


FIGURE 2

Mode ST, any non-saturable load with $I_{rms} > 1$ A

a.c. line =	115 V_{rms}	220 V_{rms}
R_{al} =	12 kΩ, 2 W	33 kΩ, 2 W
R_{SY} =	47 kΩ, 1/2 W	120 kΩ, 1/2 W

Mode T

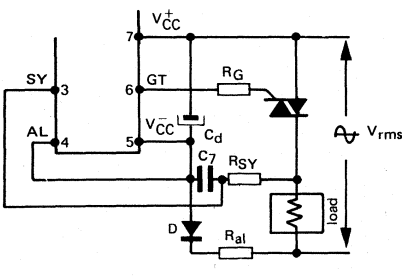


FIGURE 3

Mode T, resistive load with $I_{rms} > 0.5$ A or inductive load with $I_{rms} > 1$ A.

a.c. line =	115 V_{rms}	220 V_{rms}
R_{al} =	18 kΩ, 1/2 W	39 kΩ, 1 W
R_{SY} =	47 kΩ, 1/2 W	120 kΩ, 1/2 W

Cy (optional) : see page 5, "Filtering".

DETERMINATION OF PASSIVE EXTERNAL COMPONENTS

- Symbols :

  V_{rms}, T = Mains rms voltage and period
  I_{rms} = rms current in triac load
  I_{GT}, I_L = Gate trigger current and latching current
  I_G, tg = Peak current and output pulse duration
  I_{DC} = Average current drain
  I_{ex} = Current externally drawn for miscellaneous functions
  I_{gm} = Average output current (pin 6).

- Gate resistor

$$R_G \leqslant \frac{8500}{I_{GT}} - 30 \quad , \quad I_G = \frac{9000}{R_G + 30}$$

With R_G in ohms, I_G and I_{GT} in mA.

- Synchronization resistor (ST or T mode)

$$R_{SY} = 0.3\ V_{rms}\ (1 + \frac{RG}{180}) \pm 30\ \%$$

With R_{SY}, RΩ in ohm ; V_{rms} in volt ;

$$R_{SY} \text{ dissipation} = \frac{V^2_{rms}}{R_{SY}}$$

- Power line : ballast resistor R_{al} - Decoupling C_d

$$C_d \cdot R_{al} \geqslant 10 \text{ seconds} \qquad R_{al} \leqslant 0.45\ V_{rms}/DC_{max}$$

$$R_{al} \text{ dissipation} = \frac{V^2_{rms}}{R_{al}} \text{ in S or ST mode}$$

$$R_{al} \text{ dissipation} = \frac{V^2_{rms}}{2\ R_{al}} \text{ in T mode}$$

I_{DC} max : (see following table, with $I_G = \frac{9000}{R_G + 30}$

and $\alpha = I_L/I_{rms}$

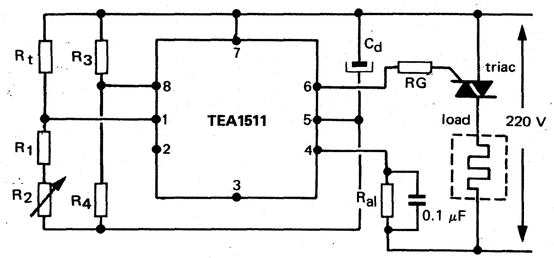
Load characteristics	Mode	$\theta = \frac{tg}{T}$ max	I_{gm}	I_{DC} max
$\cos\varphi = 1$ ($\varphi = 0$)* $I_{rms} \geqslant 30\ I_L$	S	$\theta_S = \frac{1.5}{V_{rms}} + \frac{0.36}{100}$	$2\ \theta_S\ I_G$	1.5 mA + I_{ex} + I_{gm}
$\varphi < 2°$ $I_{rms} \geqslant 15\ I_L$	ST			1 mA + I_{ex} + I_{gm}
$\varphi < 2°$ $I_{rms} \geqslant 2\ I_L$	T	$\theta_T = 0.11\ \alpha$	$\theta_T\ I_G$	
$\cos\varphi < 1$	T	$\theta'_T = 0.14\sqrt{\alpha}$	$\theta'_T\ I_G$	1 mA + I_{ex} + I_{gm}
	ST	$\theta_{ST} = 2\ \theta_S + \theta'_T$	$\theta_{ST}\ I_G$	

* C_X = 2.2 nF, S mode extended to $\varphi \leqslant 2°$ or $I_{rms} \geqslant 15\ I_L$

- Filtering : In very noisy surroundings, or without "snubber" systems on the triac, it is recommended to filter the inputs with a minimum of 250 μs time constant, and pin Y with a small capacitor about 200 pF (C_Y).

TYPICAL APPLICATIONS

ON/OFF temperature control (S mode)

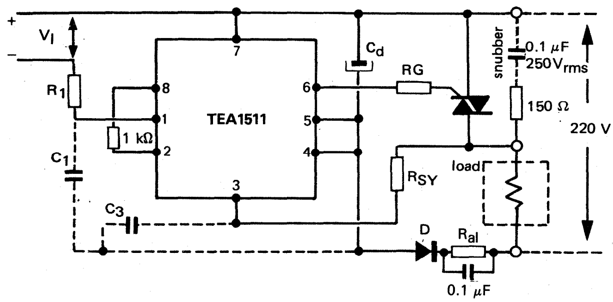


Example for electric heating 3 kW, with regulation from +3°C to+ 28°C (220 V mains supply)

- R_t = NTC thermistor, 33 kΩ (at +25°C)
- R_2 = potentiometer 100 kΩ, 1/4 W
- R_G = 120 Ω, 1/4 W
- R_{al} = 18 kΩ, 3 W
- C_d = 470 µF - 12 V
- Triac = BTA25-600

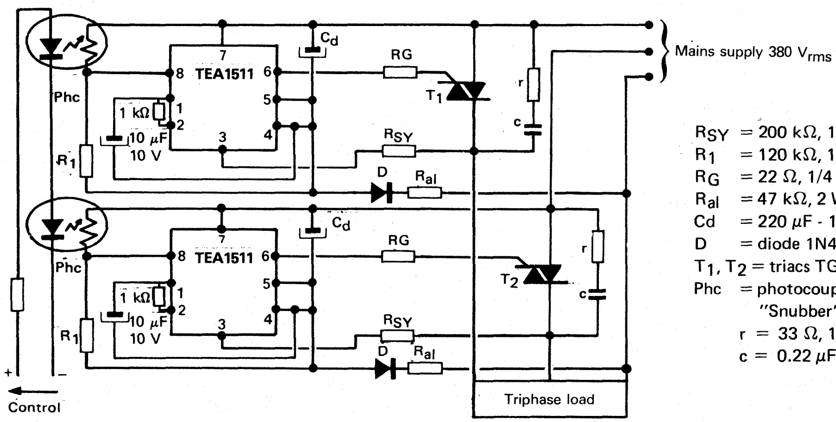
Note : R_3 and R_4 can be removed, and pin 8 connected to pin 2.

Static switch 220 V, 1 A (Tmode, any type of load)



- resistors 1/4 W - ± 5 %
  - R_1 = 33 kΩ
  - R_G = 100 Ω
  - R_{SY} = 120 kΩ
- resistor 1 W
  - R_{al} = 18 kΩ ± 10%
- capacitors (12 V)
  - C_d = 470 µF
  - C_1 = 0.1 µF (ceramic)
  - C_3 = 220 pF (ceramic)
- triac : BTA 12 700
- diode D : 1N4005

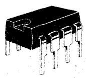
Triphase relay 380 V, 50 A for each phase (T mode)



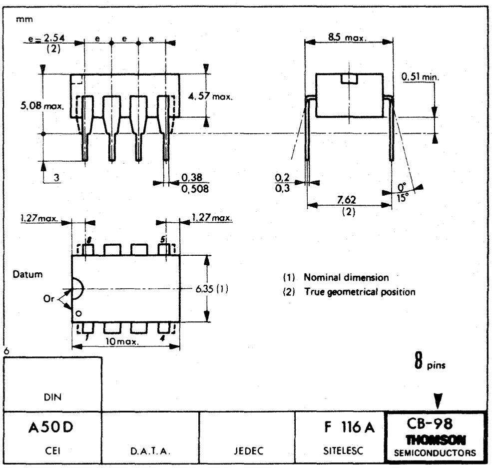
- R_{SY} = 200 kΩ, 1 W
- R_1 = 120 kΩ, 1/4 W
- R_G = 22 Ω, 1/4 W
- R_{al} = 47 kΩ, 2 W
- Cd = 220 µF - 12 V
- D = diode 1N4006
- T_1, T_2 = triacs TGAL 608
- Phc = photocouplers

"Snubber" systems :
- r = 33 Ω, 1/2 W
- c = 0.22 µF, 400 V_{rms}

CB-98



DP SUFFIX
PLASTIC PACKAGE



6

This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TEA2018A

ADVANCE INFORMATION

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

The TEA2018A is a large diffusion low-cost integrated circuit packaged in an 8-pin mini-Dip CB-98 case and designed for the control of switch mode power supplies in fly-back discontinuous mode.

By addition of external switching transistor, power levels of as high as 90 W are efficiently handled.

Application areas include : video display units, into video games, T.V. sets, Hi-Fi amplifiers, function generators.

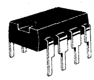
Where synchronization is required, use the **TEA2019**.

- Direct drive of the external switching transistor
- Positive and negative output currents of up to 0.5 A
- Current limitation
- Demagnetization sensing
- Full protection against overloads and short-circuits
- Output current is a function of the switching transistor collector current : $I_C = kI_B$ programmed externally
- Low standby current before starting
- $t_{on(min)}$: 2 μs
- Thermal protection

For further information refer to application note NA041

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

CASE CB-98



PLASTIC PACKAGE

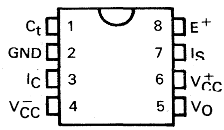
6

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
		PLASTIC
TEA2018A	– 20°C to + 70°C	•

PIN ASSIGNMENT

(Top view)



Réf. 00415

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THOMSON COMPONENTS

MAXIMUM RATINGS

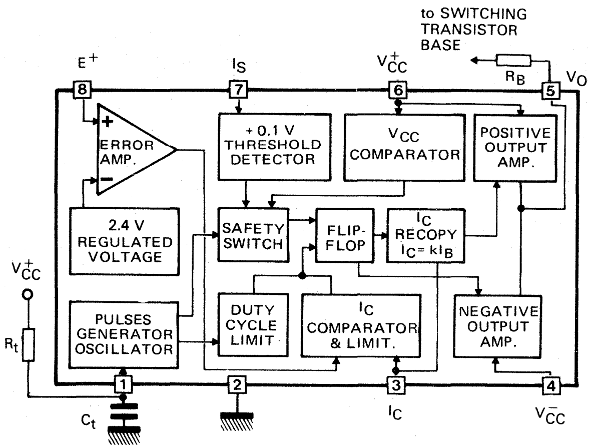
Rating	Symbol	Value	Unit
Positive supply voltage	V_{CC}^{+}	15	V
Negative supply voltage	V_{CC}^{-}	−5	V
Output current	I_O	±0.5	A
Peak output current (Duty cycle<5%)	I_O (peak)	±1	A
Pin 3 input current	$I_{(3)}$	±5	mA
Junction temperature	T_j	+150	°C
Operating ambient temperature range	T_{oper}	−20 to + 70	°C
Storage temperature range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-ambient thermal resistance*	$R_{th(j-a)}$	80	°C/W

* Ex : 0.7 Watt in the I.C. makes its junction temperature grow 56°C over the ambient temperature. To keep a good reliability a +100°C maximum junction working temperature is recommended.

BLOCK DIAGRAM



1 - C_t : Oscillator capacitor and resistor
2 - GND : Ground
3 - I_C : I_C sample (negative)
4 - V_{CC}^{-} : Negative supply (output stage)
5 - V_O : Output
6 - V_{CC}^{+} : Positive supply voltage
7 - I_S : Demagnetization sensing
8 - E^{+} : Error amplifier non-inverting input

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, potentials referenced to ground
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Positive supply voltage	V_{CC}^{+}	6	8	15	V
Negative auxiliary voltage	V_{CC}^{-}	−1	−3	−5	V
Release voltage of the supply voltage (V_{CC} increasing)	—	—	5.8	6.6	V
Stop voltage of the supply voltage (V_{CC} decreasing)	—	4.2	4.9	—	V
Hysteresis on V_{CC} threshold	$\Delta V_{(2-6)}$	0.6	0.9	1.5	V
Standby supply current before starting $V_{CC}^{+}/GND < +5.8$ V	$I_{(2-6)}$	—	1	1.6	mA
Current limitation threshold	I_C	−1080	−980	−880	mV
Current sample input resistance	$R_{(7)}$	—	1000	—	Ω
Demagnetization sensing threshold	I_S	75	100	125	mV
Demagnetization sensing input current ($V_{(2-7)} = 0$)	$I_{(7)}$	—	1	—	μA
Maximum conducting duty cycle	—	60	70	—	$\%T_o$
Error amplifier gain	—	—	50	—	—
Error amplifier input current	$I_{(8)}$	—	2	—	μA
Internal reference voltage	V_{ref}	2.3	2.4	2.5	V
Reference voltage temperature drift	—	—	10^{-4}	—	V/°C
Oscillator frequency drift with temperature ($V_{CC} = +8$ V)	—	—	0.005	—	%/°C
Oscillator frequency drift with V_{CC} (6 V < V_{CC} < 15 V)	—	—	0.2	—	%/V

6

GENERAL DESCRIPTION

The principles of the switching regulator described here is discontinuous mode with fixed frequency operation under normal regulating conditions.

However, lack of periods will occur if an overload or short-circuit is detected by demagnetization sensing circuitry implemented on the chip. In this case, any new cycle of operation is disabled until the secondary current has fallen to zero.

On every fall of the oscillator sawtooth, the flip-flop is set by a 2 μs pulse, thereby initiating the output current by supplying a large current pulse and thus providing a rapid turn on of the switching transistor. This current pulse is also used for $t_{on(min)}$ function.

Under normal operating conditions, the flip-flop is reset by a signal issued from comparing the following :
• The sawtooth waveform representing the collector current of the switching transistor, sampled across the emitter shunt resistor.
• The output of the error amplifier.
If the voltage drop across the shunt resistor is in excess of −1 V, the flip-flop is reset and as a result the output current is limited.

Outside the regulation area, and in the absence of current limitation, the flip-flop can be reset by a $t_{on(max)}$ signal of about 70% of the period.

In order to save power, the positive base current after the starting pulse becomes an increasing function of the collector current (this current is sampled across the emitter shunt resistor). The $\frac{I_C}{I_B}$ can be programmed as follows :

$$\frac{I_C}{I_B} = \frac{R_B}{R_e}$$

R_e must be calculated so as to obtain a 1 V voltage drop across it for the value of the limiting current.

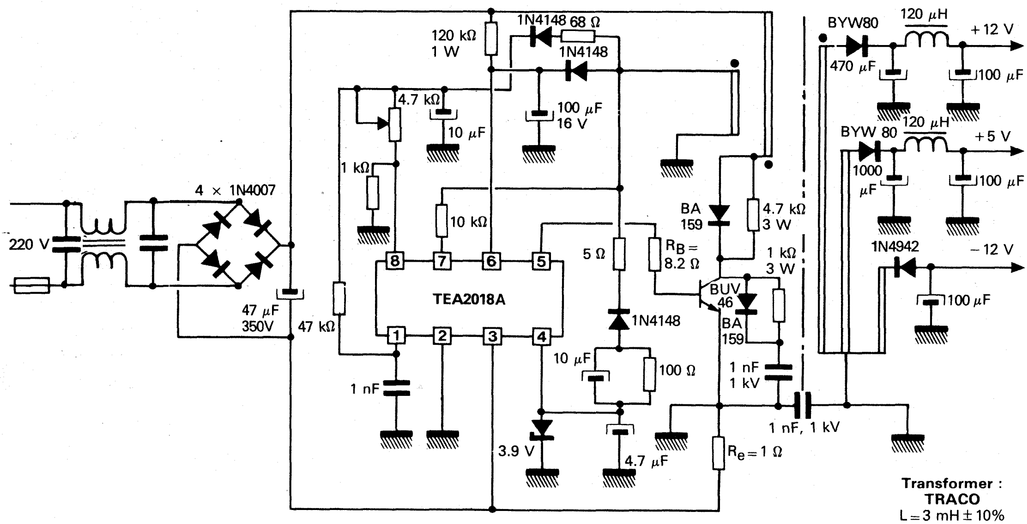
Then R_B is chosen to give the required forced gain.

When the positive base current is removed, 1 μs will elapse before the application of negative base current therefore allowing a rapid fall of the collector current.

Pin 4 (V_{CC}^{-}) must be supplied by a negative voltage of −2 V to −3 V.

Starting process
Prior to starting, a low current is drawn from +300 V through a high value resistor.
This current will charge the power supply storage capacitor of the I.C. No output pulse will be available before the voltage across the capacitor has reached 6 V. During this time, the device will draw only 1 mA. When the voltage across the capacitor reaches 6 V, base current pulses will appear at the output. The energy drawn by these pulses will tend to discharge the power supply storage capacitor. However a hysteresis of about 1 V is implemented to allow a satisfactory operation even with 5 V. Then the auxiliary winding of the transformer will provide the power required by the I.C.

TYPICAL APPLICATION



1 - MONOCHROME APPLICATION

- **Maximum power** ≃ 30 W
- **Operating frequency** ≃ 30 kHz
- $I_{nominal}$: 0.75 A
- I_{limit} : 1 A

$$R_e = \frac{1\ V}{1\ A} = \underline{1\ \Omega}$$

$$R_B = 8.2\ \Omega \Rightarrow \frac{I_C}{I_B} = \underline{8.2}$$

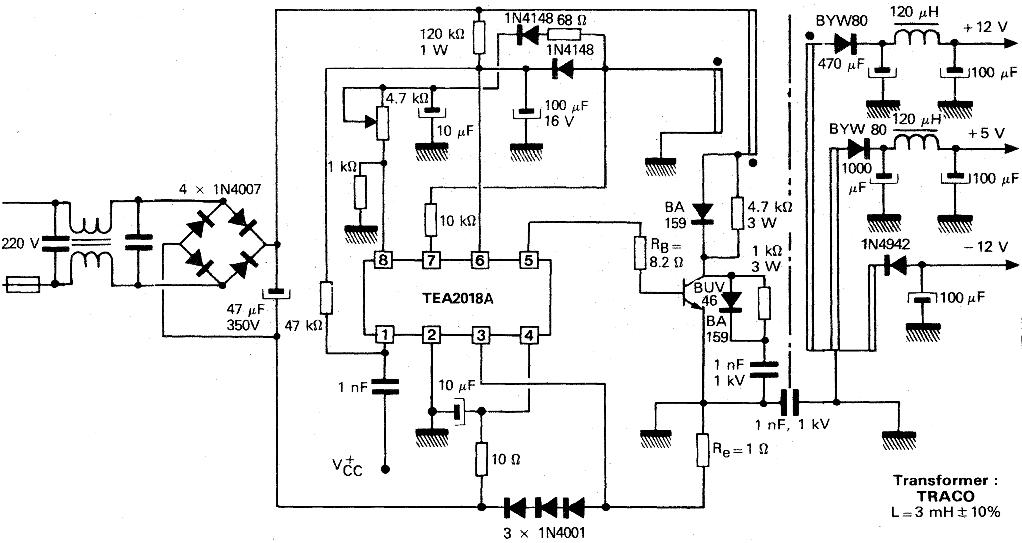
2 - OTHER EXAMPLE

- $I_C = 1.5$ A (normal operation)
- $I_{C(limit)} = 2$ A

$$R_e = \frac{1\ V}{2\ A} = \underline{0.5\ \Omega}$$

$$\text{To obtain } \frac{I_C}{I_B} = \underline{6} \Rightarrow R_B = 0.5 \times 6 = \underline{3\ \Omega}$$

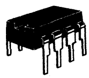
OTHER TYPICAL APPLICATION
(with −2 V negative voltage)



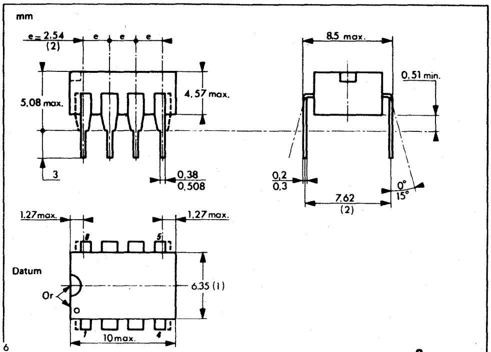
Transformer :
TRACO
L = 3 mH ± 10%

6

CB-98



PLASTIC PACKAGE



8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

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THOMSON SEMICONDUCTORS

TEA2019

ADVANCE INFORMATION

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

The TEA2019 is a large diffusion, low-cost integrated circuit packaged in an 14-pin Dip CB-2 case and designed for the control of switch mode power supplies in fly-back discontinuous mode.

The circuit is particularly suitable for applications where oscillator synchronization is required.

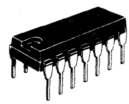
By addition of external switching transistor, power levels of as high as 90 W are efficiently handled.

Application areas include : video display units, video games, T.V. sets, Hi-Fi amplifiers, function generators. The circuit differs from TEA2018 in that it offers synchronization capability with internal PLL

- Direct drive of the switching transistor.
- Positive and negative output currents of up to 0.5 A.
- Current limitation.
- Demagnetization sensing.
- Full protection against overloads and short-circuits.
- Output current is a function of the switching transistor collector current : $I_C = kI_B$ programmed externally.
- Low standby current before starting.
- $t_{on(min)}$: 2 μs.
- Synchronization capability with internal PLL.
- Saturation sensing.
- Thermal protection.

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

CASE CB-2

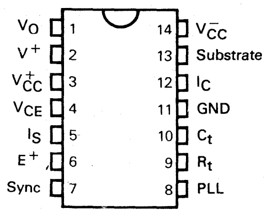


PLASTIC PACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE
		PLASTIC
TEA2019	−20°C to +70°C	•

PIN ASSIGNMENT
(Top view)



Ref. 04435

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THOMSON COMPONENTS

MAXIMUM RATINGS

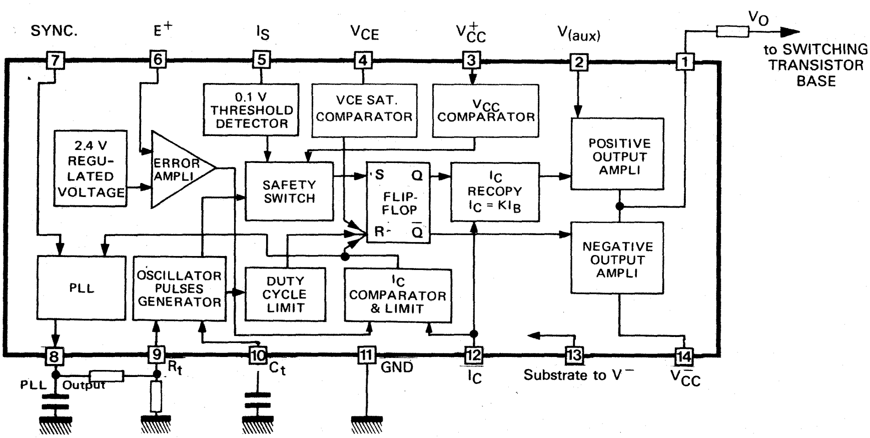
Rating	Symbol	Value	Unit
Positive supply voltage	V_{CC}^{+}	15	V
Auxiliary output supply voltage	$V_{(aux)}$	15	V
Negative supply voltage	$V_{(13-11)}$, $V_{(14-11)}$	−5	V
Output current	I_O	±0.5	A
Peak output current (Duty cycle<5%)	I_O (peak)	±1	A
Pin 5 input current	$I_{(5)}$	5	mA
Pin 4 input current	$I_{(4)}$	5	mA
Junction temperature	T_j	+150	°C
Operating ambient temperature range	T_{oper}	−20 to + 70	°C
Storage temperature range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Junction-ambient thermal resistance*	$R_{th(j-a)}$	80	°C/W

* Ex : 0.8 Watt in the I.C. makes its junction temperature grow 56°C over the ambient temperature.
To keep a good reliability a +100°C maximum junction working temperature is recommended.

BLOCK DIAGRAM



1 - V_O : Output
2 - $V_{(aux)}$: Auxiliary output supply
3 - V_{CC}^{+} : Positive supply voltage
4 - V_{CE} : Saturation sensing
5 - I_S : Demagnetization sensing
6 - E^{+} : Error amplifier non-inverting input
7 - Sync : Synchronization input
8 - PLL : PLL input
9 - R_t : Oscillator reference current
10 - C_t : Oscillator capacitor
11 - GND : Ground
12 - I_C : I_C sample (negative)
13 - Subst. : Substrate
14 - V_{CC}^{-} : Negative supply (output stage)

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Positive supply voltage	V_{CC}^{+}	6	8	15	V
Negative auxiliary voltage	V_{CC}^{-}	−1	−3	−5	V
Release voltage of the supply voltage (V_{CC} increasing)	$V_{(3-11)}$	—	5.8	6.6	V
Stop voltage of the supply voltage (V_{CC} decreasing)	$V_{(3-11)}$	4.2	4.8	—	V
Standby supply current before starting V_{CC}^{+}/GND < +5.8 V	$I_{(3-11)}$	—	1	1.6	mA
Current limitation threshold	I_C	−1100	−1000	−880	mV
Current sample input resistance	$R_{(12)}$	—	1000	—	Ω
Demagnetization sensing threshold	I_S	75	100	125	mV
Demagnetization sensing input current ($V_{(5-11)} = 0$)	I_5	—	1	—	μA
Maximum conducting duty cycle	—	70	80	—	$\%T_o$
Error amplifier internally adjusted gain	—	—	50	—	—
Error amplifier input current	$I_{(6)}$	—	−2	—	μA
Internal reference voltage	V_{ref}	2.3	2.4	2.5	V
Reference voltage temperature drift	—	—	10^{-4}	—	V/°C
Oscillator frequency drift with temperature ($V_{CC} = +8$ V)	—	—	0.005	—	%/°C
Oscillator frequency drift with V_{CC} (6 V < V_{CC} < 15 V)	—	—	0.05	—	%/V

SYNCHRONIZATION INPUT (PIN 7)

Peak to peak sawtooth voltage	V_{7pp}	—	0.5	2.5	V
Input impedance	$R_{(7)}$	—	20	—	kΩ

PLL CHARACTERISTICS

$C_t = 1.5$ nF, $R_t = 68$ kΩ, $R_{(8-9)} = 50$ kΩ, $+I_B/-I_B = 1.25$, $V_{7pp} = 0.5$ V
(See application diagram - page 5/6)

Frequency sensitivity	—	—	100	—	Hz/μA
Capture range ($T_o = 64$ μs)	ΔT	—	±8	—	μs

SATURATION SENSING (PIN 4)

Input threshold	$V_{(4)}$	—	3.2	—	V
Input current ($V_4 > 3.2$ V)	$I_{(4)}$	50	—	—	μA
Input internal resistance	—	—	1	—	kΩ

GENERAL DESCRIPTION

The principles of the switching regulator described here is discontinuous mode with fixed frequency operation under normal regulating conditions.

However, lack of periods will occur if an overload or short-circuit is detected by demagnetization sensing circuitry implemented on the chip. In this case, any new cycle of operation is disabled until the secondary current has fallen to zero.

On every fall of the oscillator sawtooth, the flip-flop is set by a 2 μs pulse, thereby initiating the output current by supplying a large current pulse and thus providing a rapid turn on of the switching transistor. This current pulse is also used for $t_{on(min)}$ function.

Under normal operating conditions, the flip-flop is reset by a signal issued from comparing the following :
• The sawtooth waveform representing the collector current of the switching transistor, sampled across the emitter shunt resistor.
• The output of the error amplifier.
If the voltage drop across the shunt resistor is in excess of − 1 V, the flip-flop is reset and as a result the output current is limited.

Outside the regulation area, and in the absence of current limitation, the flip-flop can be reset by a $t_{on(max)}$ signal of about 70% of the period.

In order to save power, the positive base current after the starting pulse becomes an increasing function of the collector current (this current is sampled across the emitter shunt resistor). The $\frac{I_C}{I_B}$ can be programmed as follow :

$$\frac{I_C}{I_B} = \frac{R_B}{R_e}$$

R_e must be calculated so as to obtain a 1 V voltage drop across it for the value of the limiting current.

Then R_B is chosen to give the required forced gain.
When the positive base current is removed, 1 μs will elapse before the application of negative base current therefore allowing a rapid fall of the collector current.

Pin 8 (V_{CC}^-) must be supplied by a negative voltage of − 2 V to − 3 V.

Starting process
Prior to starting, a low current is drawn from + 300 V through a high value resistor.
This current will charge the power supply storage capacitor of the I.C. No output pulse will be available before the voltage across the capacitor has reached 6 V. During this time, the device will draw only 1 mA. When the voltage across the capacitor reaches 6 V, base current pulses will appear at the output. The energy drawn by these pulses will tend to discharge the power supply storage capacitor. However a hysteresis of about 1 V is implemented to allow a satisfactory operation even with 5 V. Then the auxiliary winding of the transformer will provide the power required by the I.C.

The **TEA2019** has some additional capabilities compared to the TEA2018 :

• The oscillator charge current is supplied through an internal current generator, programmed externally - instead of using an external charge resistor. The sawtooth so obtained is linear.

• The oscillator can be synchronized through an internal PLL circuit. This feature provides synchronization between the external sync pulse and the end of the switching transistor current. The sync pulse can be for example the fly-back pulse of a TV horizontal sweep circuit. As indicated in the application diagram, this pulse is applied first to a R.C. network to obtain a low voltage sawtooth and then to pin 7 of the circuit. The PLL output (pin 8) supplies a correction current to pin 9 through an external resistor, so as to maintain the oscillator at the correct frequency.
The synchronization operates only when regulating.

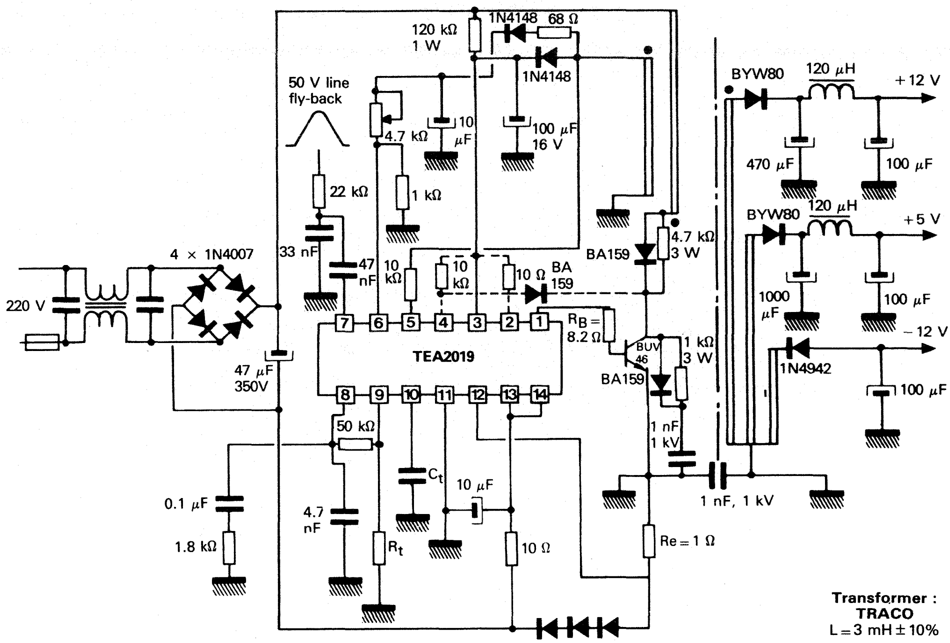
• In the **TEA2019**, the positive output power supply is separated from the low signal general power supply section, so that it can be supplied from a lower voltage in order to reduce the I.C. power dissipation.
For low power applications, the circuit can be normally supplied by connecting pins 2 and 3 together.

• In order to protect the substrate (pin 13) from the parasitic voltage peaks produced by negative output current peaks at pin 14, the substrate (pin 13) is internally separated from the negative supply (pin 14). They must be externally connected together.

• The switching transistor saturation voltage can be monitored at pin 4. To achieve this, a high voltage diode must be connected between the collector of the switching transistor and pin 4. Also a resistor must be connected from pin 4 to V_{CC}^+ (see application diagram). This arrangement is useful where the chosen value of base current is very low and as a consequence the saturation voltage will be high. In this event, when $V_{CE(sat)}$ increases above 2.5 V, the base current is interrupted before the normal end of the period.

Remark : the **TEA2019** can also operate without this protection.

TYPICAL APPLICATION



1 - MONOCHROME APPLICATION

- **Maximum power** ≃ 30 W
- **Operating frequency** ≃ 30 kHz
- $I_{nominal}$: 0.75 A
- I_{limit} : 1 A

$$R_e = \frac{1\ V}{1\ A} = 1\ \Omega$$

$$R_B = \underline{8.2\ \Omega} \Rightarrow \frac{I_C}{I_B} = 8.2$$

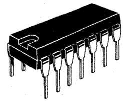
2 - OTHER APPLICATION EXAMPLE

- $I_C = 1.5$ A (normal operation)
- $I_{C(limit)} = 2$ A

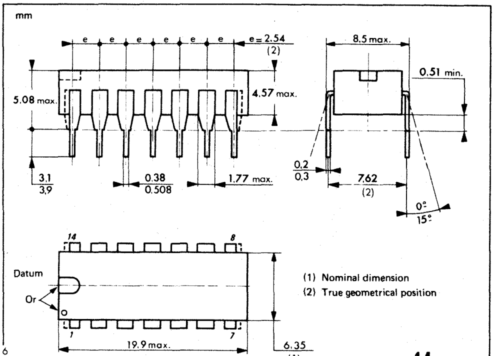
$$R_e = \frac{1\ V}{2\ A} = \underline{0.5\ \Omega}$$

To obtain $\frac{I_C}{I_B} = \underline{6} \Rightarrow R_B = 0.5 \times 6 = \underline{3\ \Omega}$

CB-2



PLASTIC PACKAGE



DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

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Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TL494
TL494I

PULSE WIDTH MODULATION CONTROL CIRCUIT

The TL494 is a fixed frequency, pulse width modulation control circuit designed primarily for Switchmode power supply control.

This device features :

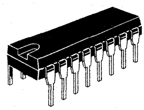
- Complete Pulse Width Modulation control circuitry
- On-chip oscillator with master or slave operation
- On-chip error amplifiers
- On-chip 5 volt reference
- Adjustable dead-time control
- Uncommitted output transistors capable of 200 mA current source or sink
- Output control for push-pull or single-ended operation

ORDERING INFORMATION

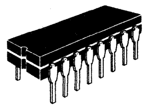
PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	DG
TL494	0°C to +70°C	•	•
TL494I	−25°C to +85°C	•	•
Example : TL494DP, TL494DG			

PULSE WIDTH MODULATION CONTROL CIRCUIT

CASE CB-79

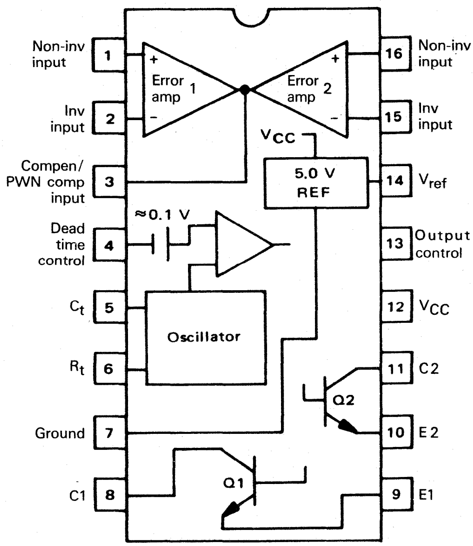


DP SUFFIX
PLASTIC PACKAGE



DG SUFFIX
CERDIP PACKAGE

PIN ASSIGNMENT



Réf. 00180

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

(Full operating ambient temperature range applies unless otherwise noted)

Rating	Symbol	TL494	TL494I	Unit
Power supply voltage	V_{CC}	42	42	V
Collector output voltage	V_{C1}, V_{C2}	42	42	V
Collector output current (each transistor)	I_{C1}, I_{C2}	250	250	mA
Amplifier input voltage	V_I	$V_{CC}+0.3$	$V_{CC}+0.3$	V
Power dissipation @ $T_{amb} \leqslant 45°C$	P_{tot}	1000	1000	mW
Operating junction temperature	T_j	+ 150	+ 150	°C
Operating ambient temperature range	T_{amb}	0 to + 70	− 25 to + 85	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic		Symbol	Value	Unit
Junction-ambient thermal resistance		$R_{th(j-a)}$		°C/W
	Cerdip package		100	
	Plastic package		80	
Junction-case thermal resistance		$R_{th(j-c)}$		°C/W
	Cerdip package		25	
	Plastic package		30	

FIGURE 1 — BLOCK DIAGRAM

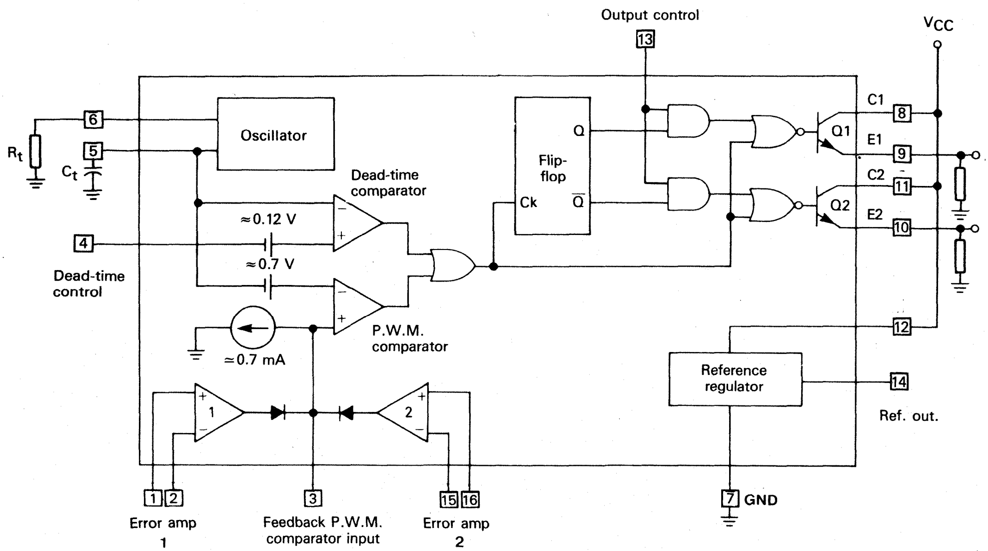
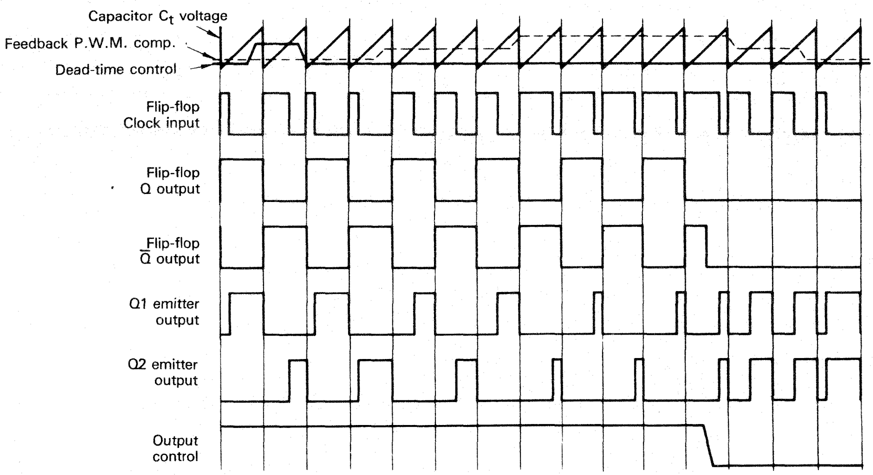


FIGURE 2 — TIMING DIAGRAMS



DESCRIPTION

The TL494 is a fixed frequency pulse width modulation control circuit, incorporating the primary building blocks required for the control of a switching power supply. (See Figure 1.) An internal-linear sawtooth oscillator is frequency-programmable by two external components, R_t and C_t. The oscillator frequency is determined by :

$$f_{osc} \approx \frac{1.1}{R_t \bullet C_t}$$

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor C_t to either of two control signals. The NOR gates, which drive output transistors Q1 and Q2, are enabled only when the flip-flop clock-input line is in its low state. This happens only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control-signal amplitude causes a corresponding linear decrease of output pulse width. (Refer to the timing diagrams shown in Figure 2.)

The control signals are external inputs that can be fed into the dead-time control, the error amplifier inputs, or the feedback input. The dead-time control comparator has an effective 120 mV input offset which limits the minimum output dead time to approximately the first 4% of the sawtooth-cycle time. This would result in a maximum duty cycle on a given output of 96% with the output control grounded, and 48% with it connected to the reference line. Additional dead time may be imposed on the output by setting the dead time-control input to a fixed voltage, ranging between 0 to 3.3 V.

The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent ON-time, established by the dead time control input, down to zero, as the voltage at the feedback pin varies from 0.5 to 3.5 V. Both error amplifiers have a common-mode input range from −0.3 V to (V_{CC} − 2 V), and may be used to sense power-supply output voltage and current. The error-amplifier outputs are active high and are ORed together at the non-inverting input of the pulse-width modulator comparator. With this configuration, the amplifier that demands minimum output ON time, dominates control of the loop.

When capacitor C_t is discharged, a positive pulse is generated on the output of the dead-time comparator, which clocks the pulse-steering flip-flop and inhibits the output transistors, Q1 and Q2. With the output-control connected to the reference line, the pulse-steering flip-flop directs the modulated pulses to each of the two output transistors alternately for push-pull operation. The output frequency is equal to half that of the oscillator. Output drive can also be taken from Q1 or Q2, when single-ended operation with a maximum ON-time of less than 50% is required. This is desirable when the output transformer has a ringback winding with a catch diode used for snubbing. When higher output-drive currents are required for single-ended operation, Q1 and Q2 may be connected in parallel, and the output-mode pin must be tied to ground to disable the flip-flop. The output frequency will now be equal to that of the oscillator.

The TL494 has an internal 5 V reference capable of sourcing up to 10 mA of load current for external bias circuits. The reference has an internal accuracy of ±5% with a thermal drift of less than 50 mV over an operating temperature range of 0 to +70°C.

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Min	Typ	Max	Unit
Power supply voltage	V_{CC}	7.0	15	40	V
Collector output voltage	V_{C1}, V_{C2}	–	30	40	V
Collector output current (each transistor)	I_{C1}, I_{C2}	–	–	200	mA
Amplifier input voltage	V_I	−0.3	–	$V_{CC}-2.0$	V
Current into feedback terminal	I_{fb}	–	–	0.3	mA
Reference output current	I_{ref}	–	–	10	mA
Timing resistor	R_t	1.8	30	500	kΩ
Timing capacitor	C_t	0.00047	0.001	10	μF
Oscillator frequency	f_{osc}	1.0	40	200	kHz

ELECTRICAL CHARACTERISTICS

(V_{CC} = +15 V, f_{osc} = 10 kHz unless otherwise specified).
For typical values T_{amb} = +25°C for min.max values, T_{amb} is the operating ambient temperature range that applies unless otherwise speficied.

REFERENCE SECTION

Characteristic	Symbol	Min	Typ	Max	Unit
Reference voltage (I_O = 1.0 mA, T_{amb} = +25°C)	V_{ref}	4.75	5.0	5.25	V
Reference voltage change with temperature over full operating temperature range	$\Delta_{ref(\Delta T)}$	–	1.3	2.6	%
Line regulation (V_{CC} = +7.0 V to +40 V)	K_{VI}	–	2.0	25	mV
Load regulation (I_O = 1.0 mA to 10 mA)	K_{VO}	–	3.0	15	mV
Short-circuit output current (V_{ref} = 0 V, T_{amb} = +25°C)	I_{SC}	–	35	–	mA

OUTPUT SECTION

Characteristic	Symbol	Min	Typ	Max	Unit
Collector off-state current (V_{CC} = +40 V, V_{CE} = +40 V)	$I_{C(off)}$	–	2.0	100	μA
Emitter off-state current (V_{CC} = +40 V, V_C = +40 V, V_E = 0 V)	$I_{E(off)}$	–	–	100	μA
Collector-emitter saturation voltage					V
Common-emitter (V_E = 0 V, I_C = 200 mA	$V_{sat(C)}$	–	1.1	1.3	
Emitter-follower (V_C = 15, I_E = −200 mA)	$V_{sat(E)}$	–	1.5	2.5	
Output control pin current					
Low state ($V_{OC} \leqslant 0.4$ V)	I_{OCL}	–	10	–	μA
High state ($V_{OC} = V_{ref}$)	I_{OCH}	–	0.2	3.5	mA
Output voltage rise time	t_r				ns
Common-emitter (See Figure 12)		–	100	200	
Emitter-follower (See Figure 13)		–	100	200	
Output voltage fall time	t_f				ns
Common-emitter (See Figure 12)		–	25	100	
Emitter-follower (See Figure 13)		–	40	100	

ERROR AMPLIFIER SECTIONS

Characteristic	Symbol	Min	Typ	Max	Unit
Input offset voltage (V_O (Pin3) = +2.5 V)	V_{IO}	—	2.0	10	mV
Input offset current (V_O (Pin 3) = +2.5 V)	I_{IO}	—	5.0	250	nA
Input bias current (V_O (Pin 3) = +2.5 V)	I_{IB}	—	0.1	1.0	μA
Input common-mode voltage range (V_{CC} = +7.0 V to +40 V)	V_{ICR}	0.3	—	$V_{CC} - 2.0$	V
Open-loop voltage gain (ΔV_O = 3.0 V, V_O = +0.5 to +3.5 V, R_L = 2.0 kΩ)	A_{VOL}	70	95	—	dB
Unity-gain crossover frequency (V_O = +0.5 to +3.5 V, R_L = 2.0 kΩ)	f_C	—	350	—	kHz
Phase margin at unity-gain (V_O = +0.5 to +3.5 V, R_L = 2.0 kΩ)	φm	—	65	—	deg.
Common-mode rejection ratio (V_{CC} = +40 V)	CMR	65	90		dB
Power supply rejection ratio (ΔV_{CC} = 33 V, V_O = +2.5 V, R_L = 2.0 kΩ)	PSRR	—	100	—	dB
Output sink current (V_O (Pin 3) = +0.7 V)	I_O^-	0.3	0.7	—	mA
Output source current (V_O (Pin 3) = +3.5 V)	I_O^+	2.0	−4.0	—	mA

PWM COMPARATOR SECTION (Test Circuit Figure 11)

Characteristic	Symbol	Min	Typ	Max	Unit
Input threshold voltage (Zero duty cycle)	V_{th}	—	3.5	4.5	V
Input sink current (V (Pin 3) = +0.7 V)	I_I^-	0.3	0.7	—	mA

DEAD-TIME CONTROL SECTION (Test Circuit Figure 11)

Characteristic	Symbol	Min	Typ	Max	Unit
Input bias current (Pin 4) - (V_I = 0 to +5.25 V)	$I_{IB\ (DT)}$	—	2.0	10	μA
Maximum duty cycle, Each output, push-pull mode	DC_{max}				%
V_I = 0 V, C_t = 0.1 μF, R_t = 12 kΩ		45	48	50	
V_I = 0 V, C_t = 0.001 μF, R_t = 30 kΩ		—	45	50	
Input threshold voltage (Pin 4)	V_{th}				V
Zero duty cycle		—	2.8	3.3	
Maximum duty cycle		0	—	—	

OSCILLATOR SECTION

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency (C_t = 0.001 μF, R_t = 30 kΩ)	f_{osc}	—	40	—	kHz
Standard deviation of frequency* (C_t = 0.001 μF, R_t = 30 kΩ)	σf_{osc}	—	3.0	—	%
Frequency change with voltage (V_{CC} = +7.0 V to +40 V, T_{amb} = +25°C)	$\Delta f_{osc(\Delta V)}$	—	0.1	—	%
Frequency change with temperature (ΔT_{amb} = +25°C to T_{amb} low, +25°C to T_{amb} high)	$\Delta f_{osc(\Delta T)}$	—	1.0	2.0	%

* Standard deviation is a measure of the statistical distribution about the mean as derived from the formula

$$\sigma = \sqrt{\frac{\sum_{n=1}^{N} (X_n - \overline{X})^2}{N-1}}$$

FIGURE 3 – OSCILLATOR FREQUENCY VERSUS TIMING RESISTANCE

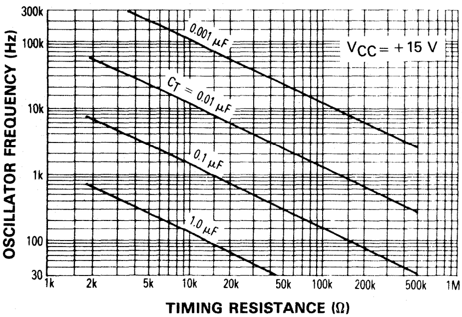


FIGURE 4 – OPEN LOOP VOLTAGE GAIN AND PHASE VERSUS FREQUENCY

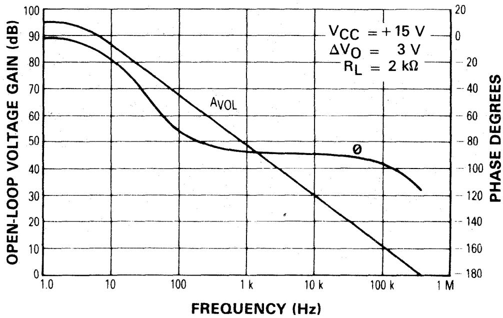


FIGURE 5 – PERCENT DEAD TIME VERSUS OSCILLATOR FREQUENCY

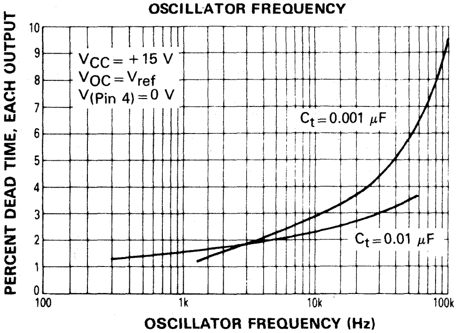


FIGURE 6 – PERCENT DUTY CYCLE VERSUS DEAD-TIME CONTROL VOLTAGE

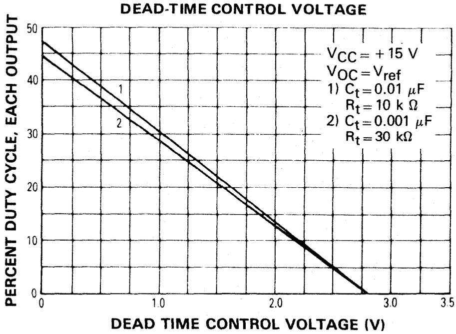


FIGURE 7 – EMITTER-FOLLOWER CONFIGURATION, OUTPUT-SATURATION VOLTAGE VERSUS EMITTER CURRENT

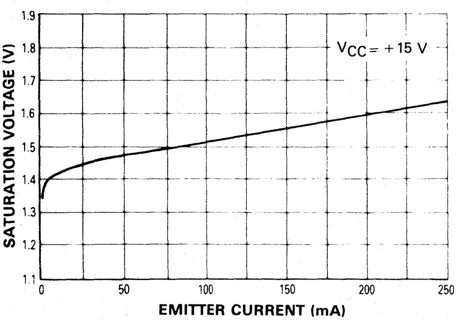


FIGURE 8 – COMMON-EMITTER CONFIGURATION OUTPUT-SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

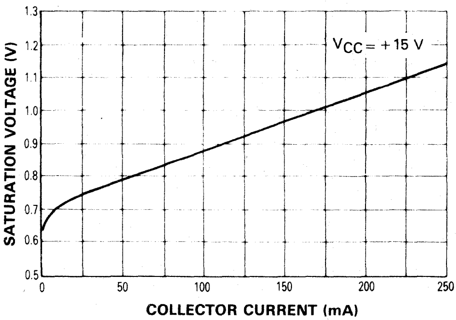


FIGURE 9 — STANDBY-SUPPLY CURRENT VERSUS SUPPLY VOLTAGE

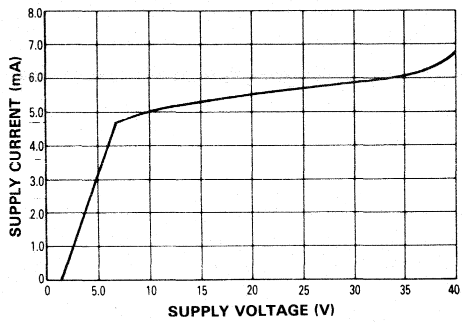


FIGURE 10 — ERROR AMPLIFIER CHARACTERISTICS

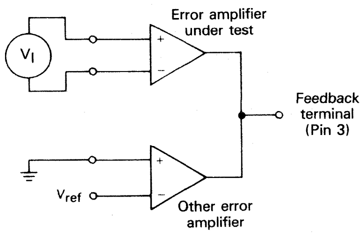


FIGURE 11 — DEAD-TIME AND FEEDBACK CONTROL TEST CIRCUIT

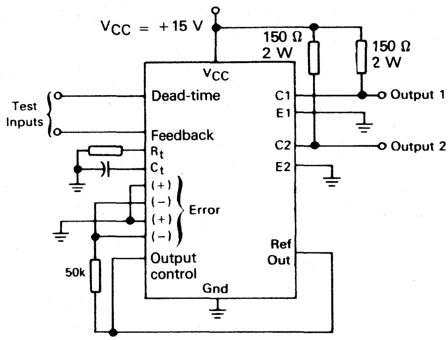


FIGURE 12 — COMMON-EMITTER CONFIGURATION TEST CIRCUIT AND WAVEFORM

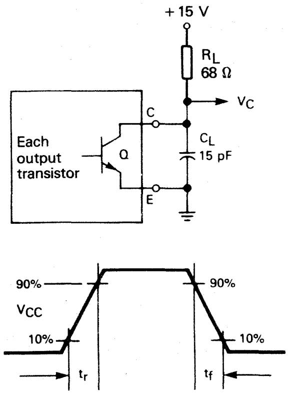


FIGURE 13 — EMITTER-FOLLOWER CONFIGURATION TEST CIRCUIT AND WAVEFORM

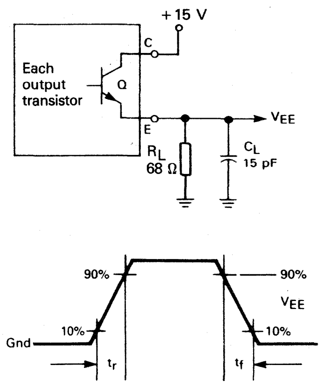


FIGURE 14 — ERROR-AMPLIFIER SENSING TECHNIQUES

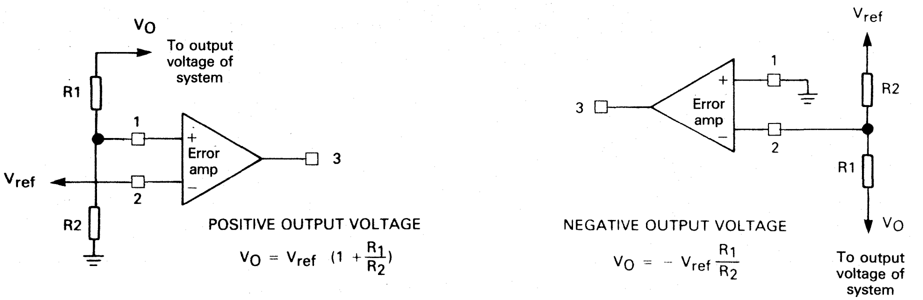
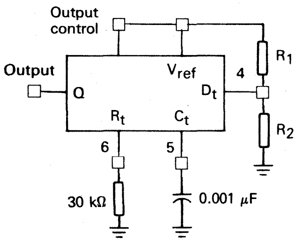


FIGURE 15 — DEAD-TIME CONTROL CIRCUIT



$$\text{Max \% ON Time, Each output} \approx 45 - \left(\frac{80}{1 + \frac{R_1}{R_2}}\right)$$

FIGURE 16 — SOFT-START CIRCUIT

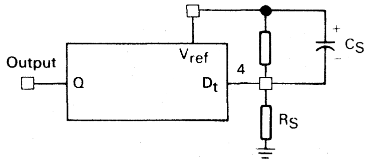
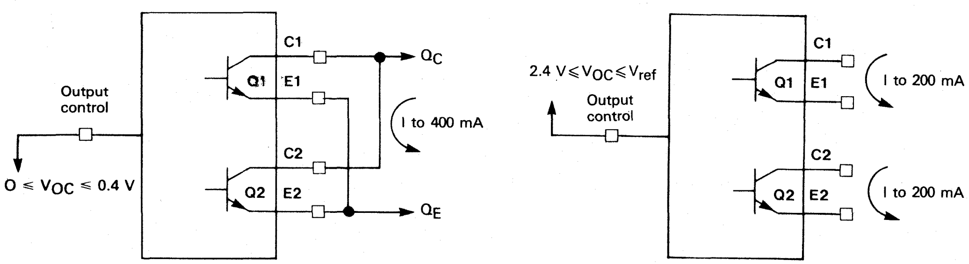


FIGURE 17 — OUTPUT CONNECTIONS FOR SINGLE-ENDED AND PUSH-PULL CONFIGURATIONS



Single ended configuration

Push-pull configuration

FIGURE 18 — SLAVING TWO OR MORE CONTROL CIRCUITS

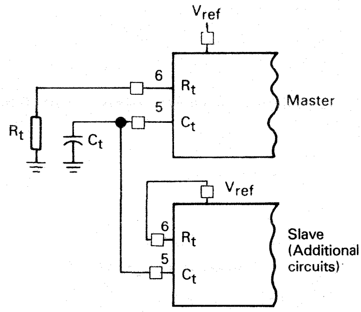
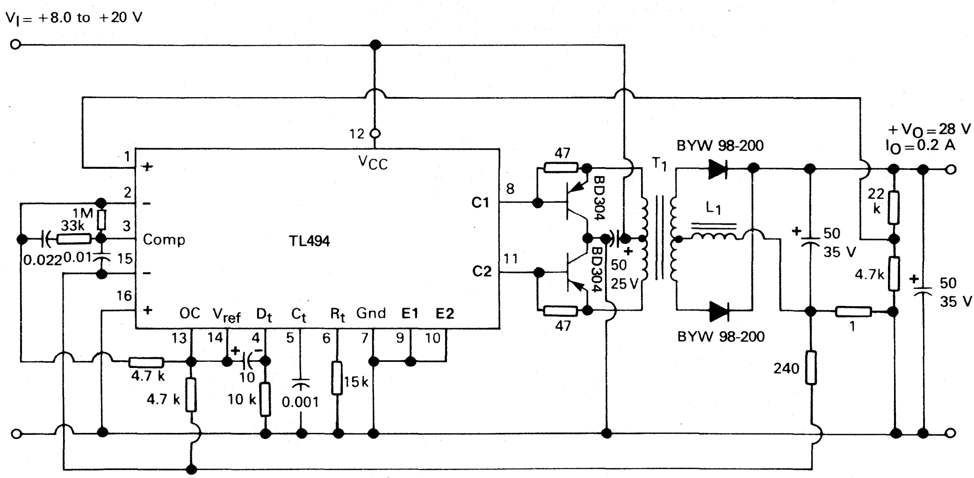


FIGURE 19 — PULSE-WIDTH MODULATED PUSH-PULL CONVERTER

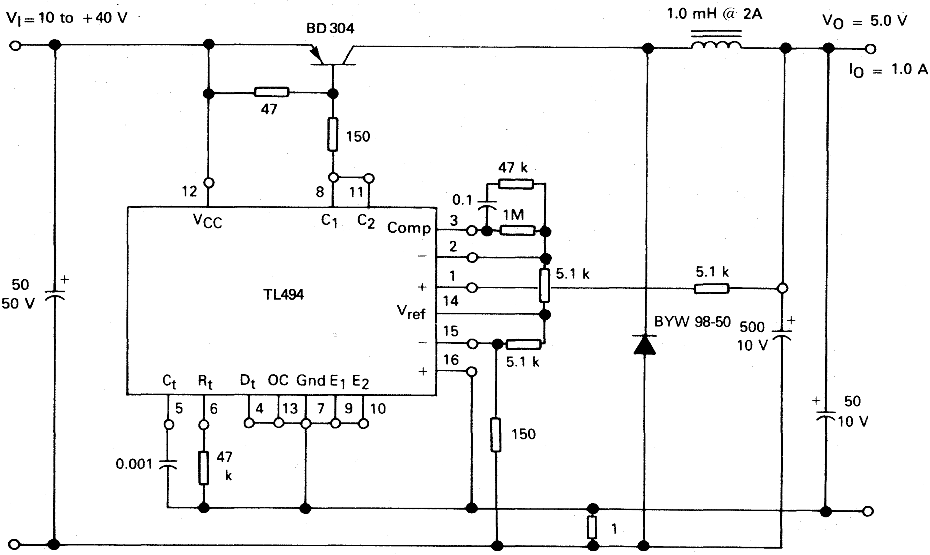


All capacitors in μF, resistors in Ω unless otherwise specified

L1 — 3.5 mh @ 0.3A
T1 — Primary: 20T C.T. #28 AWG
Secondary: 120T C.T. #36 AWG
Core : T22 - FP 14 x 8 - SE ' FERRINOX"®
LCC COMPONENTS

TEST	CONDITIONS	RESULTS
line regulation	$V_I = +8.0$ to $+20$ V	3.0 mV 0.01 %
Load regulation	$V_I = +12.6$ V, $I_O = 0.2$ to 200 mA	5.0 mV 0.02 %
Output ripple	$V_I = +12.6$ V, $I_O = 200$ mA	40 mV_{pp}
Short circuit current	$V_I = +12.6$ V, $R_L = 0.1$ Ω	250 mA
Efficiency	$V_I = +12.6$ V, $I_O = 200$ mA	72 %

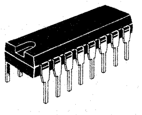
FIGURE 20 – PULSE-WIDTH MODULATED STEP-DOWN CONVERTER



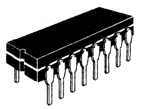
All capacitors in μF, resistors in Ω unless otherwise specified

TEST	CONDITIONS	RESULTS
line regulation	V_I = +10 V to +40 V	14 mV 0.28 %
Load regulation	V_I = +28 V, I_O = 1 mA to 1 A	3.0 mV 0.06 %
Output ripple	V_I = +28 V, I_O = 1.0 A	65 mV_{pp}
Short circuit current	V_I = +28 V, R_L = 0.1 Ω	1.6 A
Efficiency	V_I = +28 V, I_O = 1 A	71 %

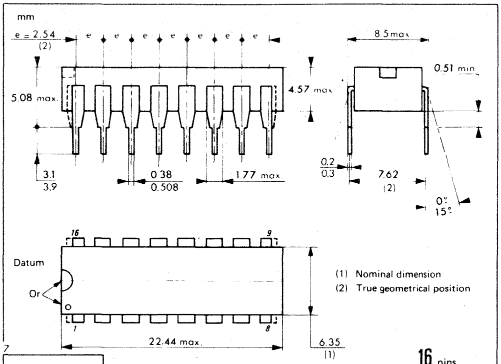
CB-79



DP SUFFIX
PLASTIC PACKAGE



DG SUFFIX
CERDIP PACKAGE



DIN				
A50E CEI	D.A.T.A	JEDEC	F 117 SITELESC	CB-79 **THOMSON** SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

11/11

NOTES

THOMSON SEMICONDUCTORS

UAA4001

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

The UAA4001 is a monolithic IC intended for power transistor control in single transistor DC-DC converter (Fly Back type).

- Direct drive of the switching transistor
- Complete PWM power control circuitry
- Up to ±1 A peak base current output for DP and ±3 A for SP (*)
- Output transistor $V_{CE(sat)}$ sensing
- Output transistor current limitation
- Under and over voltage lockout
- Programmable soft start
- Thermal overload protection
- Regulation better than 0.2%
- Low drift 2.5 V reference
- 50 kHz operating frequency

(*) The average current is limited by the package power dissipation

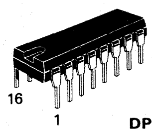
ORDERING INFORMATION

PART NUMBER	PACKAGE	
	DP	SP
UAA4001	•	•
Examples : UAA4001DP, UAA4001SP		

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

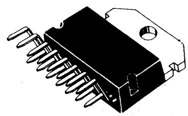
CASES

CB-79



DP SUFFIX
PLASTIC PACKAGE

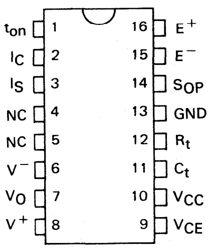
CB-501



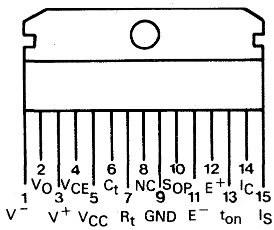
SP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENTS

CB-79
(Top view)



CB-501
(Front view)



- t_{on} : $t_{on(max)}$ access
- I_C : Current limit input
- I_S : Demagnetization sensing
- V^- : Power stage negative supply
- V_O : Power stage output
- V^+ : Power stage positive supply
- V_{CE} : $V_{CE(sat)}$ sensing
- V_{CC} : Supply voltage
- C_t : Oscillator timing capacitor
- R_t : Oscillator timing resistor
- GND : Ground
- E^- : Op-amp inverting input
- E^+ : Op-amp non-inverting input
- S_{op} : Op-amp output

Ref. 04480

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

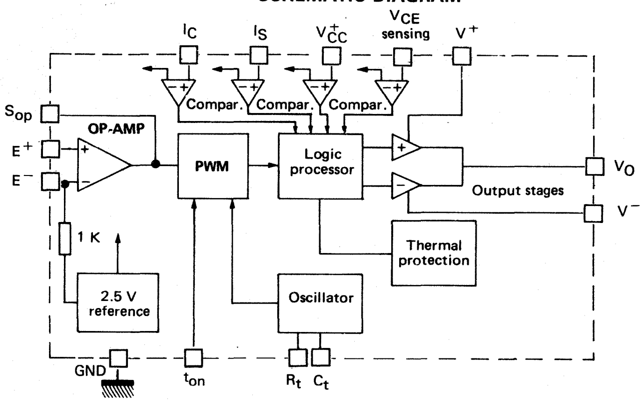
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage (V_{CC}/ground)	V_{CC}	+15	V
Positive auxiliary supply for the output stage (V^+/ground)	V^+	+15	V
Negative auxiliary supply for the output stage (V^-/ground)	V^-	−7	V
Voltage between pins V_{CC} and V^-	—	+20	V
Pulsed output current CB-79 CB-501	—	 ±1.5 ±3	A
V_{CE} pin current	—	10	mA
Primary current limitation (input current)	—	±5	mA
Secondary current checking (input current)	—	±5	mA
Junction temperature range	T_j	−40 to +150	°C
Storage temperature range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-ambient thermal resistance CB-79 CB-501	$R_{th(j-a)}$	 80 40	°C/W
Maximum junction-case thermal resistance CB-79 CB-501	$R_{th(j-c)}$	 30 2.5	°C/W

SCHEMATIC DIAGRAM



CASE	t_{on}	I_C	I_S	NC	V^-	V_O	V^+	V_{CE}	V_{CC}	C_t	R_t	GND	E^-	E^+	S_{op}
CB-79	1	2	3	4, 5	6	7	8	9	10	11	12	13	15	16	14
CB-501	13	14	15	8	1	2	3	4	5	6	7	9	11	12	10

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +10$ V, $V^- = -5$ V, $V^+ = +4$ V
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	–	10	14	V
Supply quiescent current	I_{CC}	–	15	25	mA
Positive output auxiliary supply voltage	V^+	–	4	V_{CC}	V
Negative output auxiliary supply voltage	V^-	–6	–5	–	V
V_{CC} threshold to insure operation (V_{CC} increasing) : V_S	V_S	6	6.5	7	V
Hysteresis on V_{CC} threshold	ΔV_{CC}	–	0.6	–	V
Positive primary current limit input threshold	V_{IC}^+	+170	+200	+230	mV
Negative primary current limit input threshold	V_{IC}^-	–230	–200	–170	mV
Primary current limit input current ($V_{IC}=0$ V)	I_C	–	±4	±20	μA
Output transistor saturation voltage ($V_{CE}=3$ V) CB-501 : $I_B=3$ A - Positive stage Negative stage CB-79 : $I_B=1$ A - Positive stage Negative stage	 $V^+ - V_O$ $V^- - V_O$ $V^+ - V_O$ $V^- - V_O$	 – – – –	 2.2 2.8 0.8 1.4	 3 – 1.5 –	 V V V V
Secondary current checking input threshold	V_{IS}	50	100	150	mV
Secondary current checking input current ($V_I=0$ V)	I_S	–	2	+10	μA
V_{CE} input threshold	V_{CE}	–	5	–	V
Op-amp. open loop gain	A_v	–	100	–	dB
Op-amp. feed back resistor	R_{fb}	47	–	–	kΩ
Op-amp. input current	I_E^+	–	50	250	nA
Op-amp. offset voltage	V_{IO}	–	2	7	mV
Op-amp. inverting input impedance	–	–	1	–	kΩ
Internal reference voltage	$V_{(ref)}$	2.4	2.55	2.7	V
Ref. voltage temperature coefficient	$\alpha V_{(ref)}$	–	100	–	ppm/°C
Oscillator operating frequency range Oscillator frequency temperature coefficient Oscillator free running frequency formula ($I_{R_t}=0.5$ mA)	f_{osc} $\alpha\ f_{osc}$	5 –	– 100 $f=\frac{1.85}{R_t.C_t}$	50 –	kHz ppm/°C Hz
R_t optimal current	–	–	0.5	–	mA
Maximum limit of conduction time (t_{on} pin not connected) $V_{CC}<V_S$ $V_S<V_{CC}<+14$ V (Note 1) $V_{CC}>+14$ V	–	 – – –	 0 50 0	 – – –	% of period
Maximum limit of conduction time (external voltage setting) $V_{t_{on}}<0.375\ V_{CC}$ $0.375<V_{t_{on}}<0.625\ V_{CC}$ $0.625\ V_{CC}<V_{t_{on}}$	–	 – –	 90 according to $V_{t_{on}}$ 0	 – –	% of period

Note 1 : V_S is V_{CC} threshold to insure operation

CIRCUIT DESCRIPTION

OSCILLATOR

It is a sawtooth generator whose free running frequency is set by resistor R_t and capacitor C_t. The charge current of the capacitor is $I = V_{CC}/2\ R_t$, the high and low levels are respectively 0.625 V_{CC} and 0.375 V_{CC}, and the discharge current is about 12 times greater than the charge current.

Thus the oscillator frequency is $f_{osc} = \frac{1.85}{R_t.C_t}$

PULSE - WIDTH MODULATOR (PWM)

Main modulator

This modulator produces a square wave whose duty cycle results from a comparison between the sawtooth and the output of the operational amplifier. The output is OFF during the return of the sawtooth.

Auxiliary modulator

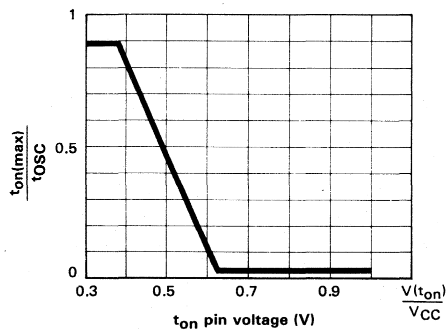
The voltage V (t_{on}) applied on t_{on} pin sets the maximum duty cycle.

An internal divider between V_{CC} and ground presets the maximum ON time at 50% of the period. This limit can be externally altered by paralleling two external resistors across the internal divider. These resistors should be lower than 30 kΩ.

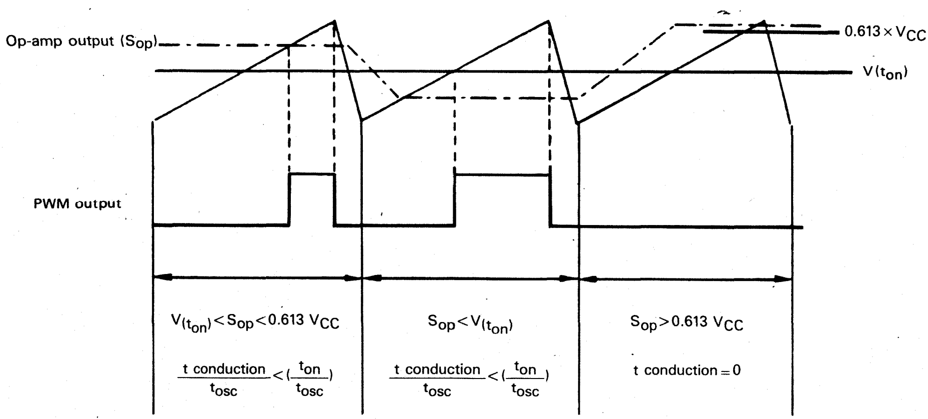
Minimum conducting time

In order to allow the discharge of the capacitor of the switching aid network, a minimum conducting time (about 5% of the period t_{osc}) is realized by a comparison between a voltage equal to $0.613 \times V_{CC}$ and the sawtooth (Fig. 2).

FIGURE 1 $\frac{t_{on(max)}}{t_{OSC}}$ versus $V_{(t_{on})}$



Limits of the PWM - FIGURE 2



SAFETY ELEMENTS

V_{CC} supply check

A comparator pulls pin t_{on} up to V_{CC} as long as V_{CC} has not reached V_S or if V_{CC} exceeds + 14 V. A soft start can be achieved by connecting a capacitor between pin t_{on} and ground (or V_{CC}) - Fig. 3

Primary current limitation

The primary current I_p is measured accross a shunt, and the thresholds of the comparator are +0.2 V and −0.2 V. When the detector senses an over-current, the output is turned off. The information coming from the detector is also transmitted to pin t_{on}, so that, during a permanent overload, the external capacitor integrates the oversteps, thus reducing the duty cycle.

SECONDARY CURRENT

An internal detector whose threshold is 0.1 volt checks after each period that the secondary current I_{sec} has been completely drained to zero before storing energy again in the primary inductance, thus avoiding magnetization of the core. When a secondary winding is continuously short-circuited (Fig. 4), the total flow of current I_{sec} spreads over several periods, during which the output is inhibited.

FIGURE 3

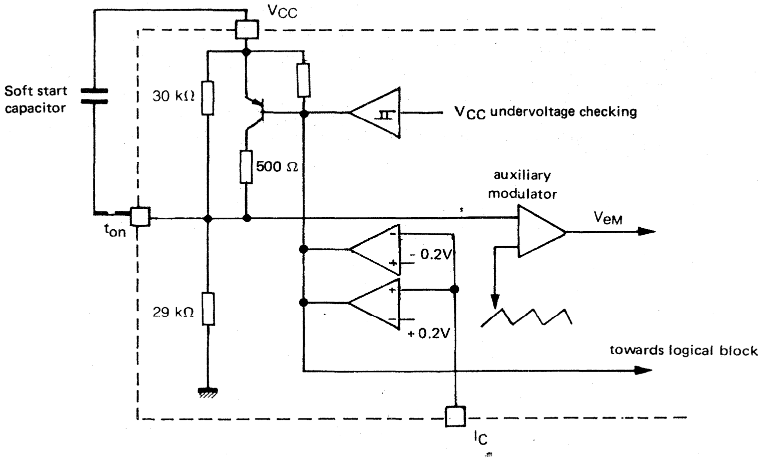
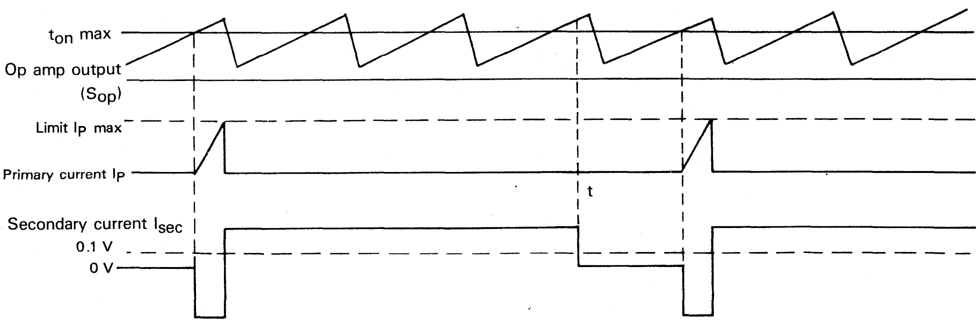


FIGURE 4

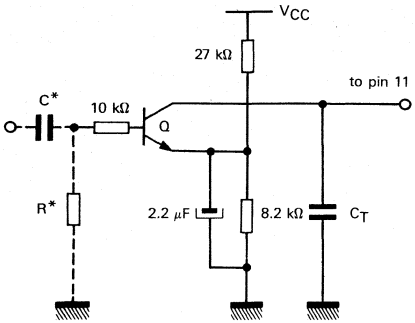


SYNCHRONIZATION

For some applications, it may be desirable to synchronize the internal oscillator of the UAA4001 with an external oscillator.

The following typical diagram illustrates this arrangement :

FIGURE 5



• Synchronization pulses must have the following characteristics :

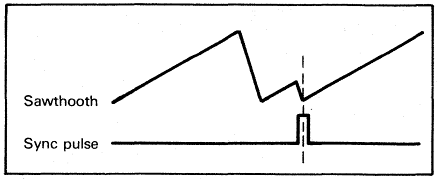
$\frac{V_{CC}}{2} <$ amplitude $< V_{CC}$, $5\% < \frac{t}{T} < 20\%$

where $\frac{t}{T}$ is the duty cycle.

• If the duty cycle is higher than 10%, an RC differentiator network will be added. Its time constant τ should be related to the oscillator period so that $10\% < \frac{\tau}{T} < 20\%$.

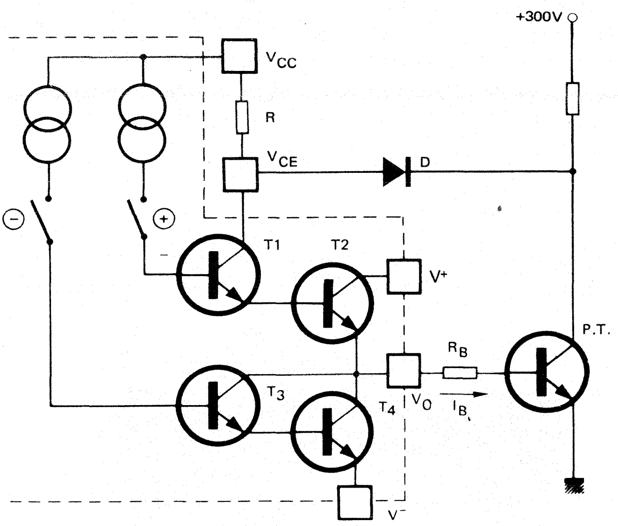
• The transistor Q is driven into conduction by the synchronization pulse. It discharges capacitor C_T below the oscillator low threshold. That way, C_T charging time increases which in turn lowers the oscillator frequency. A frequency of $f_{free} > f_{sync}$ has to be selected.

The proposed arrangement allows, in a frequency range from 5 kHz to 50 kHz, the synchronizing frequency to deviate from the oscillator frequency by an amount of up to 20%. However it is necessary not to exceed this amount in order to avoid secondary sawtooth as shown on the following diagram.



This phenomenon may also happen if the synchronization pulse is too short.

FIGURE 6 - POWER STAGE



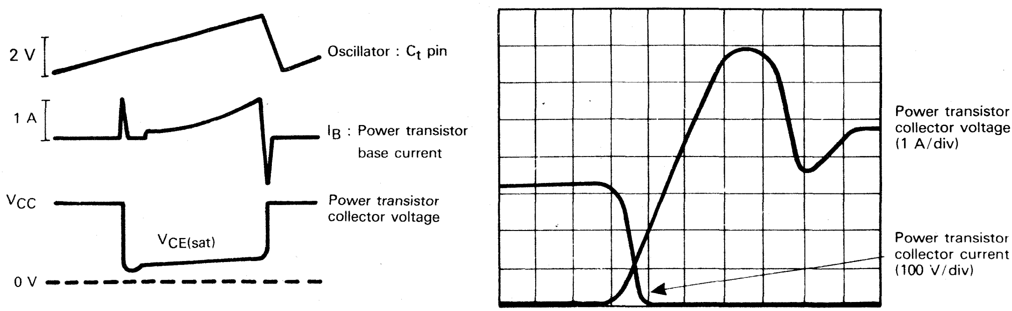
Positive stage

A compensation loop provides an output current which is matched to the instantaneous requirement of the switching transistor. The higher the level of saturation of this transistor, the greater proportion of the current flowing through resistor R is shunted by diode D. Thus the base current of T_2, and consequently the output current of the IC, decrease. Transistor T_1 remains saturated and the voltage V_{CE} of the power transistor (P.T.) is given by :
(V_{CE}) P.T. $= (V_{BE})$ P.T. $+ R_B.I_B$
Resistor R_B stabilizes the compensation loop. Its value must be as low as possible, generally around 1 Ω.

Negative stage

When the voltage V_{CE} of the switching transistor reaches 5 V, the negative stage of the UAA4001 is set into conduction and a high reverse base current is applied, resulting in very fast cut-off.

FIGURE 7 - TYPICAL WAVEFORMS



For more information concerning internal structure of UAA4001, refer to application note AN011.

FIGURE 8 - VOLTAGE ON PIN t_{on} VERSUS SUPPLY VOLTAGE

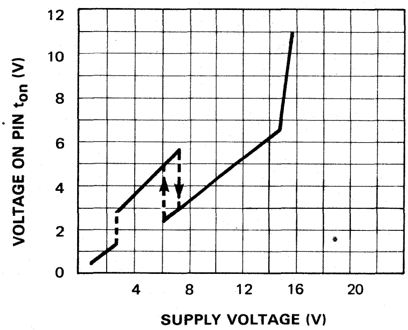


FIGURE 9 - REFERENCE VOLTAGE VERSUS JUNCTION TEMPERATURE

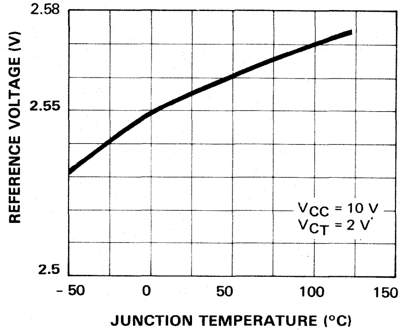


FIGURE 10 - SECONDARY CURRENT VERSUS PIN I_S AND PIN I_C VOLTAGE

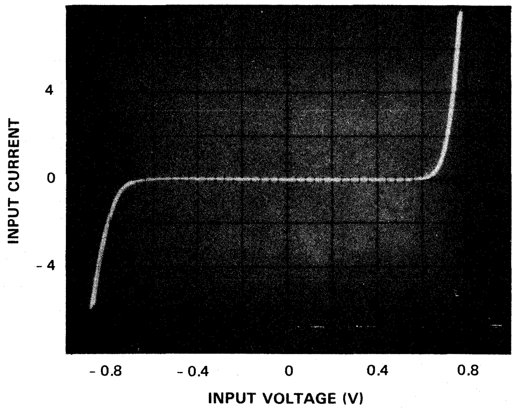
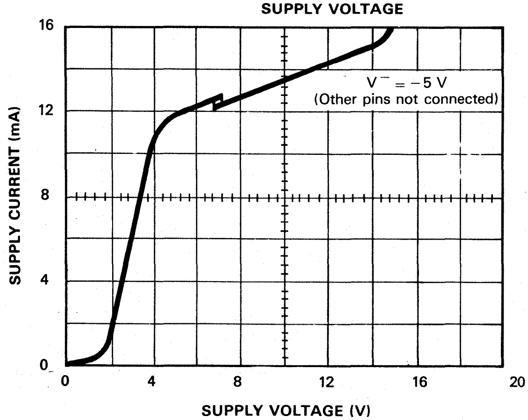


FIGURE 11 - SUPPLY CURRENT VERSUS SUPPLY VOLTAGE



NEGATIVE STAGE MEASUREMENT CIRCUIT

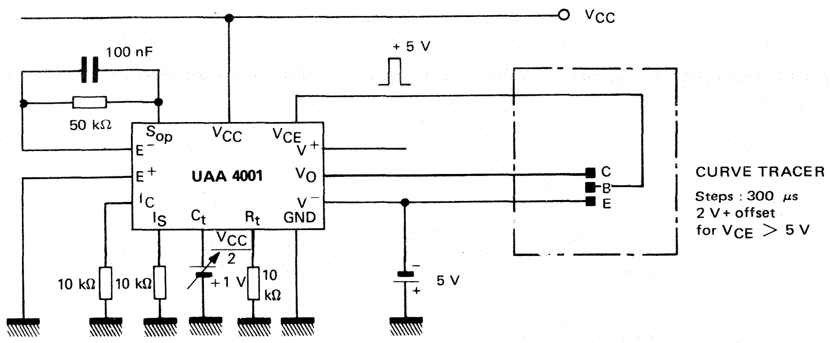
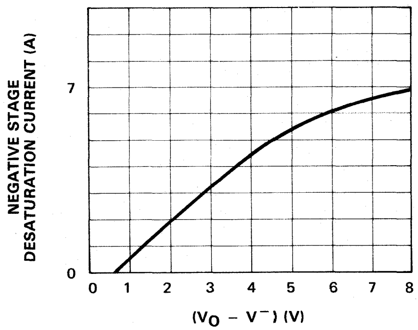


FIGURE 12 - NEGATIVE STAGE CURRENT VERSUS OUTPUT VOLTAGE (REFERENCED TO V⁻)



POSITIVE STAGE MEASUREMENT CIRCUIT

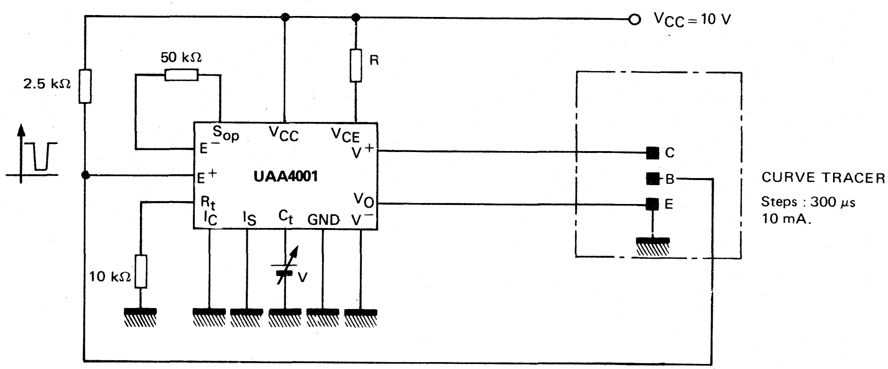


FIGURE 13 - POSITIVE SOURCE OUTPUT

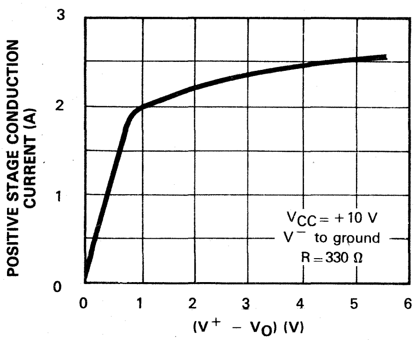
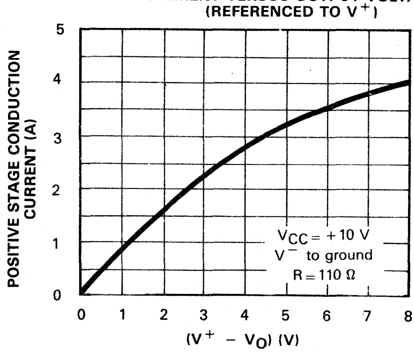
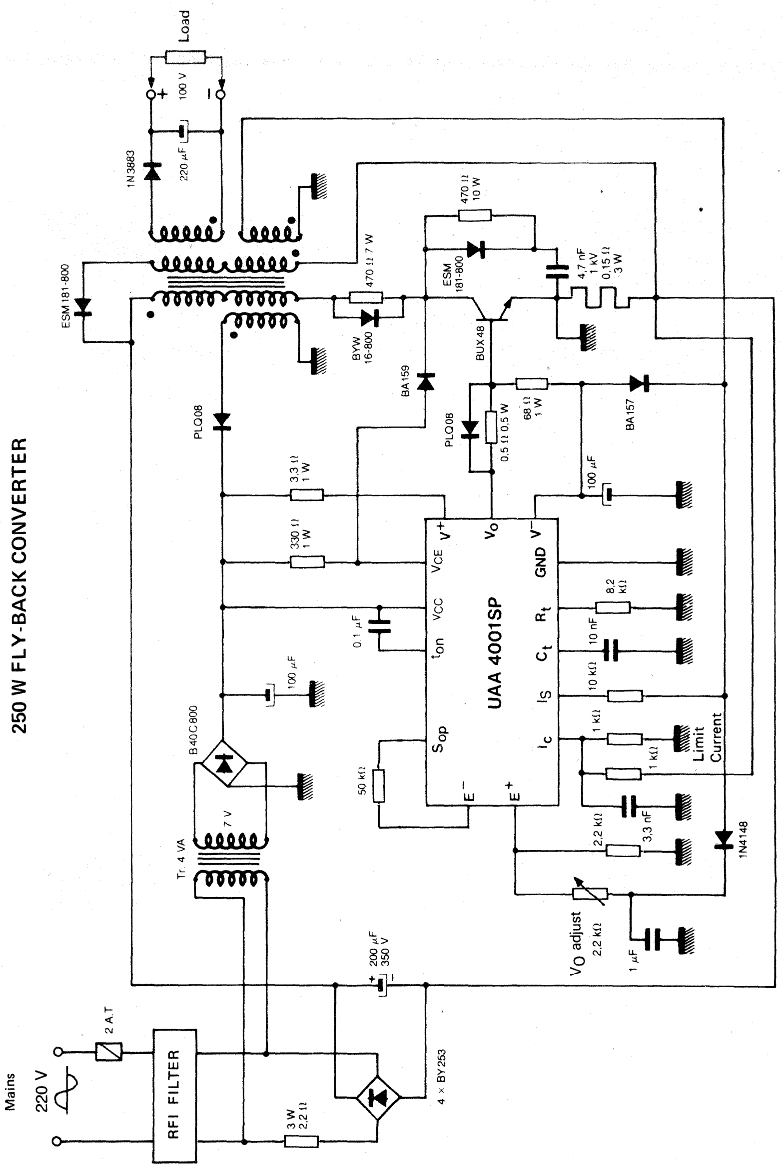


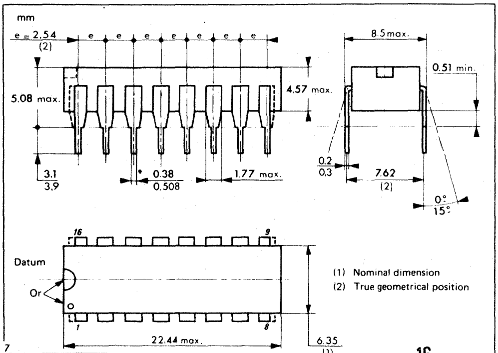
FIGURE 14 - CURRENT VERSUS OUTPUT VOLTAGE (REFERENCED TO V^+)



TYPICAL APPLICATION 250 W FLY-BACK CONVERTER

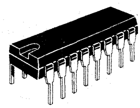
(See application note AN011)



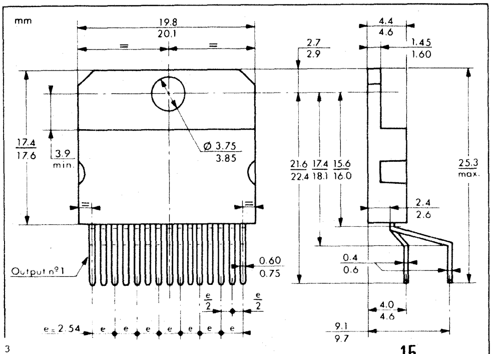


7				
DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

CB-79

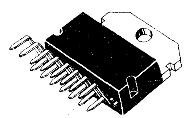


DP SUFFIX
PLASTIC PACKAGE



3				
DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-501 THOMSON SEMICONDUCTORS

CB-501



SP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

UAA4002

CONTROL CIRCUIT FOR FAST SWITCHING TRANSISTORS

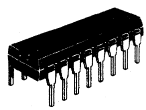
- Direct drive of the switching transistor
- Self regulated positive base current (1 A max)
- Negative base current ensuring fast turn-off (3 A max)
- The output current can be increased by means of one (or more) external transistor(s)
- Minimum conducting time (or no conduction) to allow the discharge of a RDC network
- Protection against saturation failure of the power transistor during conducting period, with adjustable detection threshold
- Instantaneous collector current limitation
- Positive supply (V_{CC}) monitoring
- Negative supply monitoring with adjustable threshold
- On-chip thermal protection
- Programmable maximum ON time
- TTL and CMOS compatible input
- Can be driven with alternate pulses
- Adjustable delay between the rising edge of the input signal and the beginning of the positive base drive.
- Application note available : NA031A

ORDERING INFORMATION

PART NUMBER	PACKAGE
	DP
UAA4002	•
Example : UAA4002DP	

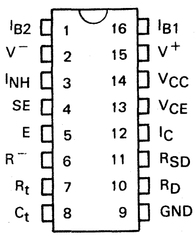
CONTROL CIRCUIT FOR FAST SWITCHING TRANSISTORS

CASE CB-79



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT
(Top view)



I_{B2}	: Output sink current	I_{B1}	: Output source current
V^-	: Negative power supply (Power stage)	V^+	: Positive power supply (Power stage)
I_{NH}	: Inhibition input	V_{CC}	: Positive supply voltage
S_E	: Input selection	V_{CE}	: $V_{CE(sat)}$ sensing
E	: Input	I_C	: Collector current monitoring input
R^-	: Negative supply monitoring resistor	R_{SD}	: $V_{CE(sat)}$ threshold voltage monitoring
R_t	: Minimum conducting time resistor	R_D	: Delay time resistor
C_t	: Minimum conducting time capacitor	GND	: Ground

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

MAXIMUM RATINGS

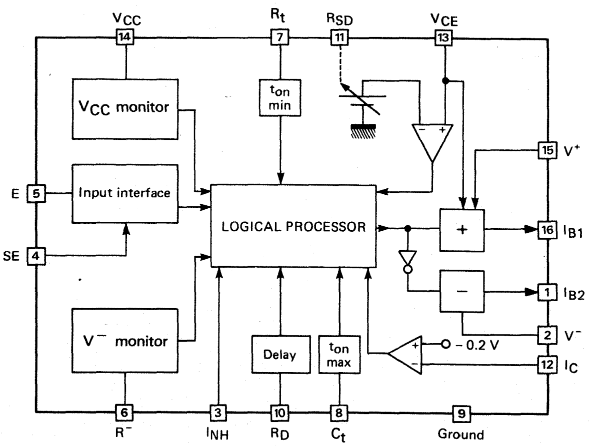
Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	+15	V
Positive supply voltage (Power stage)	V^+	+15	V
Negative supply voltage (Power stage)	V^-	−10	V
Voltage between pins 15 and 2	$V^+ - V^-$	+18	V
Positive output current	I_{B1}	+1.5	A
Negative output current	I_{B2}	−3.5	A
Current into input I_C (Internal protection diodes)	I_C	±5	mA
Minimum value of resistors R_t and R_D	—	5	kΩ
Voltage between input and V^-	—	+18	V
Junction temperature range	T_j	−40 to +150	°C
Storage temperature range	T_{stg}	−40 to +150	°C

Note : Pin 2 (V^-) should not be left open.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	80	°C/W
Maximum junction-case thermal resistance	$R_{th(j-c)}$	30	°C/W

FIGURE 1 - BLOCK DIAGRAM



I_{B2} : Output sink current
V^- : Negative power supply (Power stage)
I_{NH} : Inhibition input
S_E : Input selection
E : Input
R^- : Negative supply monitoring resistor
R_t : Minimum conducting time resistor
C_t : Minimum conducting time capacitor
I_{B1} : Output source current
V^+ : Positive power supply (Power stage)
V_{CC} : Positive supply voltage
V_{CE} : $V_{CE(sat)}$ sensing
I_C : Collector current monitoring input
R_{SD} : $V_{CE(sat)}$ threshold voltage monitoring
R_D : Delay time resistor
GND : Ground

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +10$ V, $V^{-} = -5$ V
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	7	–	14	V
Positive supply voltage monitoring threshold	–	–	7	–	V
Supply current	I_{CC}	–	12	–	mA
Positive supply voltage (Power stage)	V^{+}	4	–	14	V
Negative supply voltage (Power stage)	V^{-}	−1	–	−9	V
Threshold of input I_C	V_I	0.160	0.2	0.240	V
Current into input I_C	I_I	–	5	20	μA
Value of resistor R_t (R_t between pin 7 and ground)	R_t	10	47	200	kΩ
Value of resistor R_D (R_D between pin 10 and ground)	R_D	20	–	200	kΩ
Positive output current ($V_{(15)} - V_{(16)} = +2$ V)	I_{B1}	0.5	–	–	A
Positive output current (Peak value)	$I_{B1(peak)}$	1	–	–	A
Negative output current ($V_{(1)} - V_{(2)} = +4$ V)	I_{B2}	3	–	–	A
Comparator V_{CE} threshold voltage	V_{SD}	1	–	5.6	V
High level on input E ($V_{(5)} - V^{-} < +18$ V)	–	2	–	V_{CC}	V
Low level on input E (Input SE not connected)	–	V^{-}	–	0.8	V
Low level on input E ($\|V^{-}\| > 2.5$ V, Input SE tied to ground)	–	V^{-}	–	−2	V
Current into input E ($V_{(5)} = 0$ V)	–				
Input SE left open		–	10	50	μA
Input SE grounded		–	0.2	0.3	mA
Low level on input I_{NH}	–	0	–	0.8	V
High level on input I_{NH}	–	2	–	V_{CC}	V
Time constant t_{on} min (R_t between pin 7 and ground)	$t_{on(min)}$		0.06 R_t (kΩ)		μs
Delay between input pulse and rise of output current (R_D between pin 10 and ground)	t_d		0.05 R_D (kΩ)		μs
Propagation between input pulse and rise of output current	–		0.3		μs
Desaturation threshold (R_{SD} between pin 11 and ground)	V_{SD}		$10 \times \frac{R_{SD}}{R_t}$		V
V^{-} min detection resistor value (R^{-} between pin 6 and V^{-})	R^{-}		$\frac{R_t}{2}\left(1 + \frac{V^{-}min}{5}\right)$		Ω
Time constant t_{on} max (C_t between pin 8 and ground)	$t_{on(max)}$		$2R_tC_t$		s
Thermal shut down	–		150		°C

RECOMMENDATIONS REGARDING UAA4002 APPLICATIONS

The coexistence of a power circuit handling high voltages and currents, and a control circuit carrying low amplitude signals, does not represent any special difficulty provided that a few simple rules are observed.

For further application and design information, refer to the application note NA031A : "optimum base drive and protection of switching transistors using the UAA4002", published by Thomson-Semiconductors.

Positive and negative supply voltages of the integrated circuit must be carefully filtered by means of capacitors located very close to the device.
The device itself must by situated close to the power transistor, using short connections.
The control circuit ground (pin 9) and the power circuit ground (emitter of the power transistor) must be linked by a single connection, as short as possible and of adequate cross-section.

A ground plane on the printed circuit board may be favourable in noisy environments. With regards to upper switches of a bridge configuration, the auxiliary supplies of the integrated circuit must have a low parasitic capacitor with respect to the ground potentiel. In the same way, the isolated components driving the UAA4002 (optocoupler or pulse transformer) must have also a low parasitic capacitor in order to reduce dv/dt phenomenons and to avoid risks of reswitching or conduction cut-off.

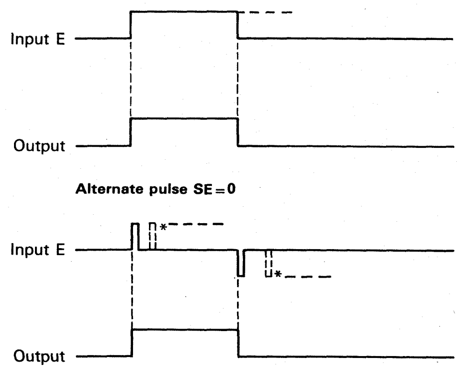
If a free-wheel diode is connected in parallel with the power transistor (witch is generally the case in bridge systems), a diode (1N4148) must be connected between pin 13 and ground (cathode on pin 13 and anode on ground) in order to limit the negative voltage applied to this pin during the conduction of the free-wheel diode.

CIRCUIT DESCRIPTION
(See block diagram Figure 1)

INPUT INTERFACE E AND SE INPUT

It translates the input signal into the logic levels required by the internal processor.
It also includes a RS flip-flop for the pulse mode operation.

Figure 2 - Level mode SE = 1



* These parasitic pulses are not taken into account.

Note : Pulse duration > 100 ns

FAULT DETECTORS

• Power transistor collector current limiting (I_C input)

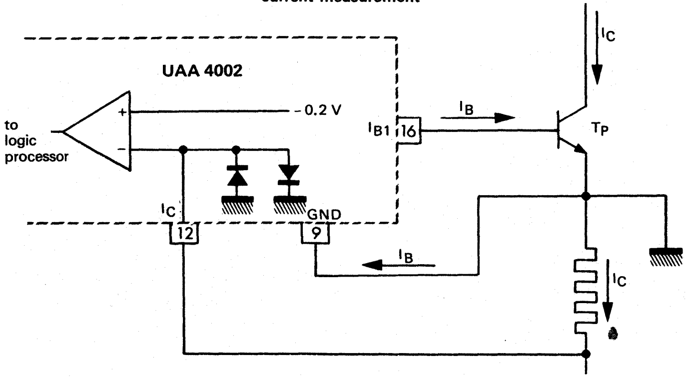
The collector current of the power transistor is measured by means of a shunt connected in the negative return of the power supply. As a result the current rather than the emitter current, since the base current of the switching does not flow through the shunt.

A voltage below −0.2 V on input I_C causes comparator to change state. This information is transmitted to the logic unit, which blocks the output pulses from the circuit until the next positive transition of the input signal.

If the voltage across the measuring shunt exceeds 0.2 V for the required limiting current value, a voltage divider bridge may be used (See application note NA031A).

If input I_C is not used, it must be connected directly to ground.

Figure 3 : Switching transistor collector current measurement



CIRCUIT DESCRIPTION (continued)

• Protection against desaturation of the power transistor.

A comparator monitors continuously during the conduction that the collector voltage on the switching transistor remains lower than the preset value.

The preset value V_{RSD} (see figure 4) is given by :

$$V_{RSD} = 5\ V \times 2 \frac{R_{SD}}{R_t}$$

Current I set by external resistor R_t is :

$$I\ (mA) = \frac{5\ (V)}{R_t\ (k\Omega)}$$

Without resistor R_{SD}, the threshold is set internally at +5.6 V

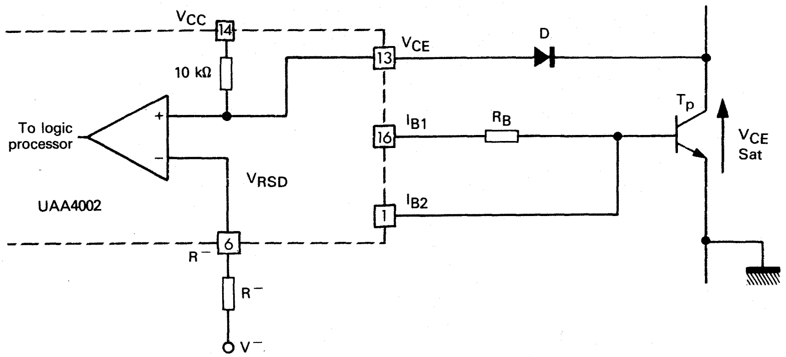
In case of overstep, the information is transmitted to the logic unit, which turns the output off until the next positive edge of the input signal.

To enable the switching transistor collector emitter voltage to fall when conduction begins, the protection function against desaturation is disabled during t_{on} min (See application note NA031A).

This protection is disabled by connecting pin R_{SD} directly to V^-.

(FOR THRESHOLD EXEEDING 5.5 V SEE NA031A.)

Figure 4 - V_{CEsat} voltage monitoring



Diode D must be a high-speed diode able to withstand the transistor collector-emitter voltage when the transistor is cut-off.

SUPPLY DEFECT

• Negative supply (R^- input, see figure 4)
It is possible to disable the output pulses if the negative supply voltage V^- is insufficient to guarantee the switching of the power transistor (Optional).
(FOR USING WITHOUT NEGATIVE POWER SUPPLY SEE NA031A)
For this a resistor R^- is tied between pin 6 and the negative supply.
A current 2 I flows into it, and the threshold of the detector is +5 V on pin 6.
Thus giving the relationship :

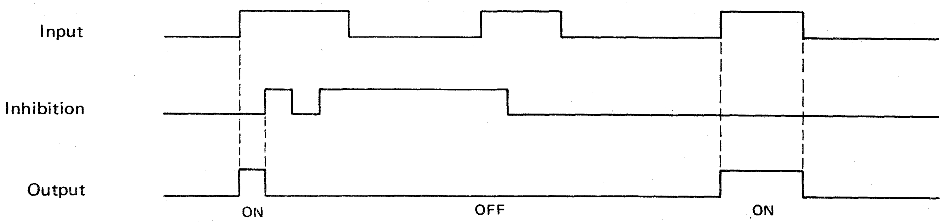
$$\frac{5 + V^- min}{R^-} = 2 \times \frac{5}{R_t} \qquad R^- = \frac{R_t}{2}\left(1 + \frac{V^- min}{5}\right)$$

This function can be disabled by tying pin 6 to ground.

• Positive supply (V_{CC} input)
An internal comparator ensures that there is no output voltage if positive supply V_{CC} is less than +7 V. This threshold is not adjustable.

• Inhibition (I_{NH} input)
The action of the inhibition input is shown in the diagram below.
This input is CMOS and TTL compatible. If not used, it must be connected directly to ground.

Figure 5



• Thermal protection
The UAA4002 is protected against excessive overheating by a thermal cut-out which automatically cuts off the output pulses if the chip temperature exceeds +150°C. The interruption is stored for a complete conduction period, but the output pulses reappear as soon as the chip temperature falls below the limiting temperature value.

TIME CONSTANTS

• Minimum conducting time (R_t input)
To enable the capacitor of the switching aid network associated with power transistor to discharge completely, the logic processor ensures that the integrated circuit output pulse has a minimum duration t_{on} min. To be effective, this must be at least four times the time constant of the RDC network.
The value of t_{on} min is programmed by a resistor R_t
Typically t_{on} min (μs) = 0.06 × R_t (kΩ)
The usable range of values for t_{on} min is between 1 and 12 μs.
Resistor R_t has a key role in the operation of the UAA4002 integrated circuit. It sets the value of a bias current internal to the circuit :

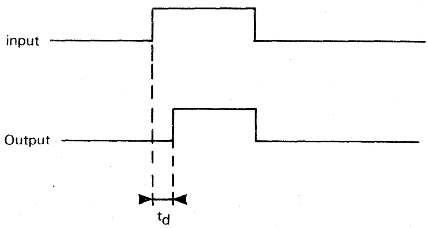
$$I\ (mA) = \frac{5}{R_t\ (k\Omega)}$$

t_{on} min embodies a priority function : no other security function can stop the conduction during t_{on} min.
The t_{on} min function cannot be disabled.

• Maximum conducting time (R_t and C_t inputs)
At the start of each conduction period the capacitor C_t is loaded by a constant current 1/2, where I is the current through resistor R_t ($I = 5/R_t$). When the voltage across C_t reaches +5 V the conduction is stopped. The value of t_{on} max is thus given by the equation :
t_{on}max (μs) = 2 × R_t (kΩ) × C_t (nF)
If the t_{on} max function is not to be used, it is only necessary to replace capacitor C_t with a short-circuit.

• Time delay function
A constant time delay may be implemented between the rising edge of the control pulse and the beginning of the conduction pulse at the circuit output (1 to 20 μs by using resistor R_D, t_d (μs) = 0.05 R_D (kΩ)).

Figure 6



LOGIC PROCESSOR

A logic unit processes the information coming from the fault detectors, and ensures that the output signal fulfils two conditions :

- No double pulsing within a period : the occurence of a defect is memorized until the end of the period.
- To allow the discharge of a snubber network, the minimum output pulse width is set at a given value t_{on} min.

OUTPUT STAGE : V^+, V^-, I_{B1}, I_{B2}, INPUTS

• Introduction

The highly sophisticated output stage of the UAA4002 offers high performance in terms of switching transistor control. Its principal features are as follows :
– the switching transistor is direct driven
– the transistor remains in a quasi-saturated state, whence reduced storage time
– control power is limited to the strict minimum
– it is easy to use

This stage is in fact in two parts, a positive driver stage which turns on the transistor and a negative driver stage which turns off the transistor.

Figure 7

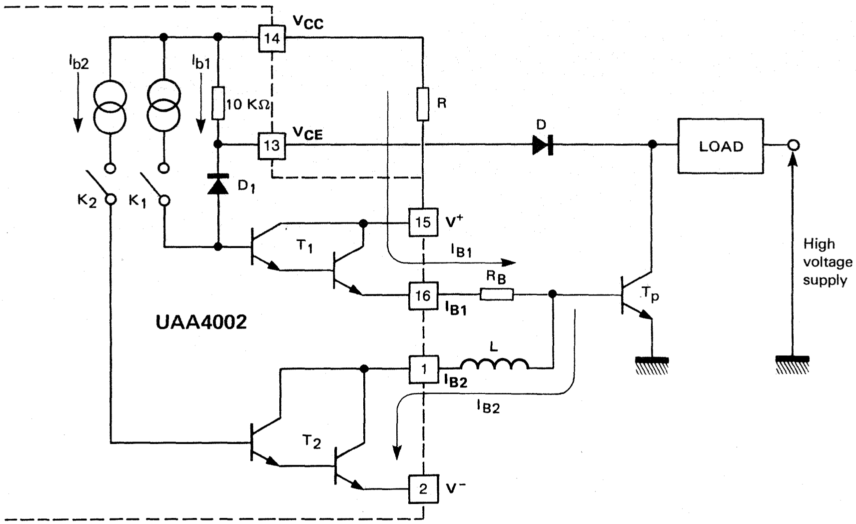
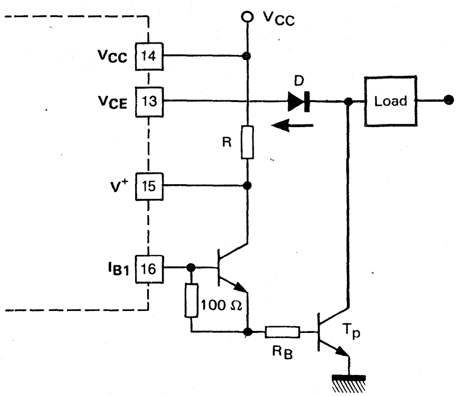


Figure 8



• Power transistor conduction

The maximum value of the positive base current is determined by the limitation resistor R ($I_{B1} < 1$ A). A regulation loop is used to keep T_p in a quasi-saturation mode : the more T_p becomes saturated, the more diode D will shunt an important part of the drive current I_{B1}, through diode D_1. R_B is a low value resistor (about 1 Ω) which helps to stabilize the regulation loop.

Voltage V_{CE} across transistor Q is :

V_{CE} (V) $\simeq V_{BE}$ (V) + R_B (Ω) I_{B1} (A)

If the required drive current is greater than 0.5 A, one external NPN transistor may be added.

In this case :

V_{CE} (V) = 2 V_{BE} (V) + R_B (Ω).I_B (A)

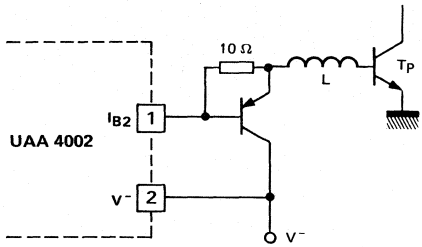
• Turn-off switching of power transistors

The closing of contact K_2 (Figure 10) causes Darlington T_2 to conduct. The negative supply voltage is applied to the base of transistor T_P and a high negative base current I_{B2} flows, permitting the rapid evacuation of charges stored in the base-emitter junction of transistor T_P.

A low-value inductor L may be required between the base of transistor T_P and the I_{B2} output of the UAA4002, so as to limit the gradient dI_{B2}/dt (see "The Power Transistor in its Environment" published by the Discrete Semiconductors Division of Thomson-CSF). In many cases, this inductor is not required.

The Darlington T_2 can carry a maximum current of 3 A. The corresponding saturation voltage is typically 3 V. Like the positive stage, this stage is designed for easy augmentation of the available output current by the addition of one or more external transistors.

Figure 9

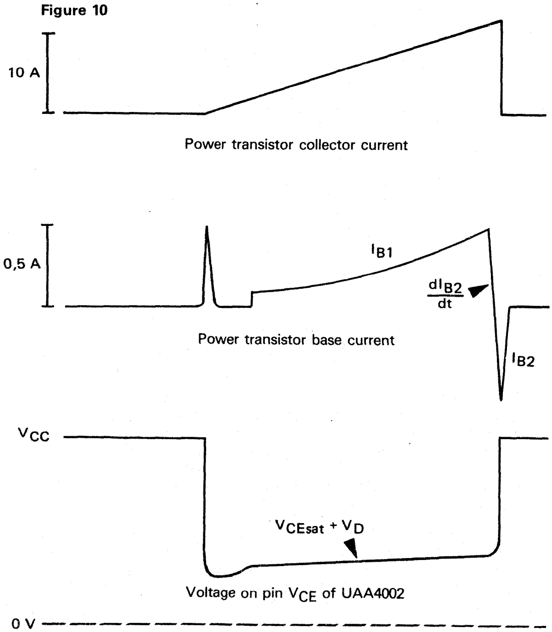


The external PNP transistor increases the negative current available while decreasing the power dissipation in the UAA4002.

• Typical inductive load waveforms

When conduction begins, the base current assumes a high value briefly and then reverts to zero. This base current spike permits rapid switching on of the power transistor. The base current value is then that required for quasi-saturation of the transistor. The base current curve is generally curved upwardly, due to the decreased gain of the power transistor with increased collector current.

Figure 10

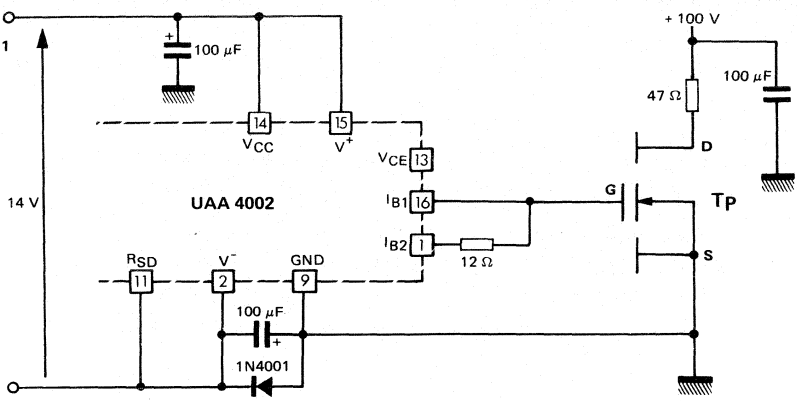


CONTROL OF MOS POWER TRANSISTORS

Ideally, MOS power transistors should be voltage-controlled. In practice, in order to benefit from the high speed typical of this type of transistor it is necessary to charge and discharge the spurious input capacitance at high speed, so that high currents flow. By virtue of the high current capability of its output stages, the UA4002 is particularly suitable for controlling MOS power transistors.

The output of the positive stage is connected directly to the gate of the MOS transistor, to switch it into conduction very fast. The negative stage controls the turning off of the MOS transistor, by discharging the gate capacitance of the transistor. There is no need for a high negative supply voltage, and the arrangement described in the previous section is therefore used.

Figure 11

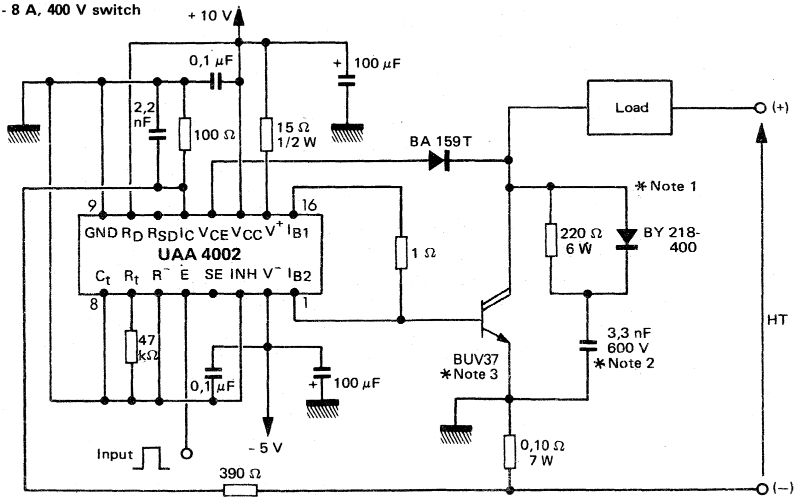


FOR MORE INFORMATION SEE NA031A

TYPICAL APPLICATIONS

(For more information see NA031A)

Figure 12 - 8 A, 400 V switch

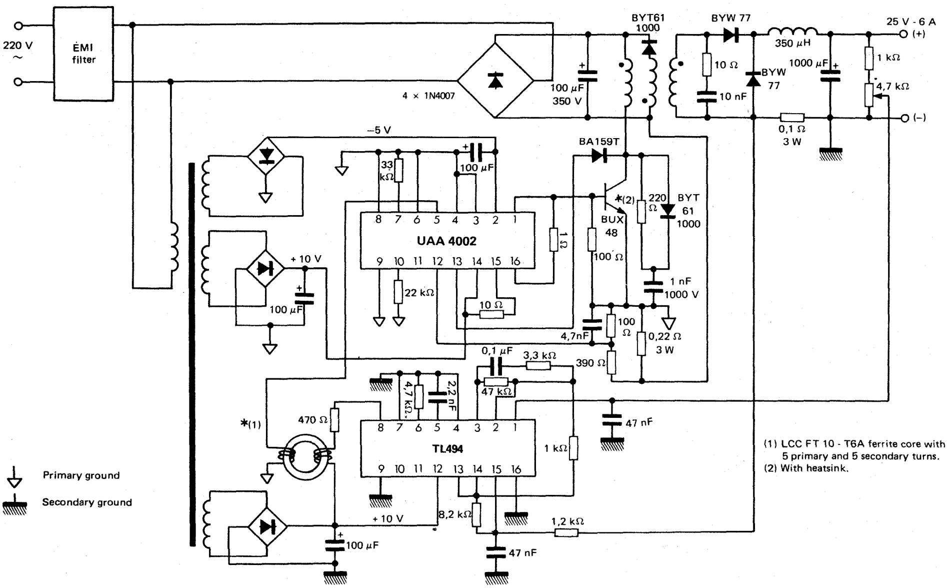


Note 1 : Switching aid network
2 : Polypropylene capacitor
3 : With heatsink, $R_{TH} < 3.5°/W$

In this circuit the UAA4002 is used in a completely conventional manner, in "level" control mode.
The time constant t_{on} min is set at 2.8 µs, which is four times the time constant of the snubber network associated with the BUV37 transistor. The positive output stage of the UAA4002 is connected to the V_{CC} rail through a 15 Ω resistor. The maximum base current is approximately 0.45 A. The collector current is measured using a 0.10 Ω shunt, and is limited to 10 A. The BUV37 Darlington for which the specified value of I_{Csat} is 12 A, is thus operated with a considerable safety margin.

TYPICAL APPLICATIONS (continued)

Figure 13 : 150 W forward type power supply



Performance

- Output voltage stability :
  For an input voltage varying from 190 to 245 V, the maximum relative variation in the output voltage is 0.7% at nominal operating conditions.
  (V_{OUT} = 25 V, I_{OUT} = 6 A).
  For a variation in the load from 0 to 100% the relative variation in the output voltage is 1.3%.
  For a variation in the load from 10 to 100% (I_{OUT} = 0.6 to 6 A), the relative variation in the output voltage is 0.4%.
- Efficiency 80% under nominal operating conditions.
- Behaviour on overload :
  The power supply is fully protected against overloads and short-circuits, the output current being limited to 7 A.

TYPICAL APPLICATIONS (continued)

Figure 14 : Capacitor type half bridge symmetrical converter

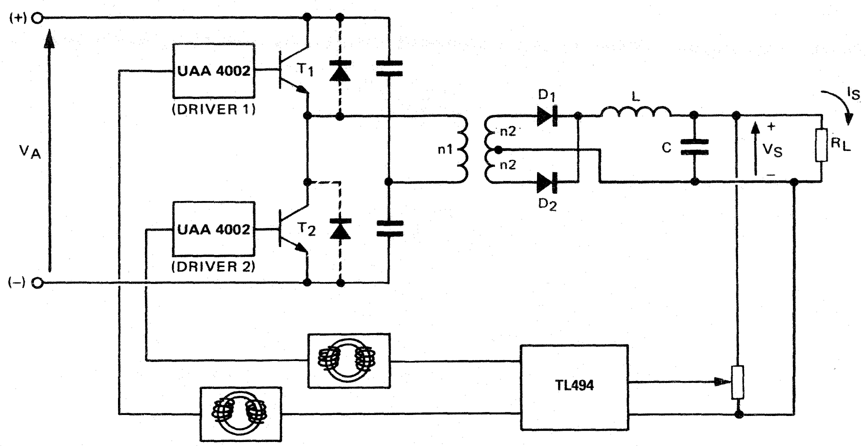
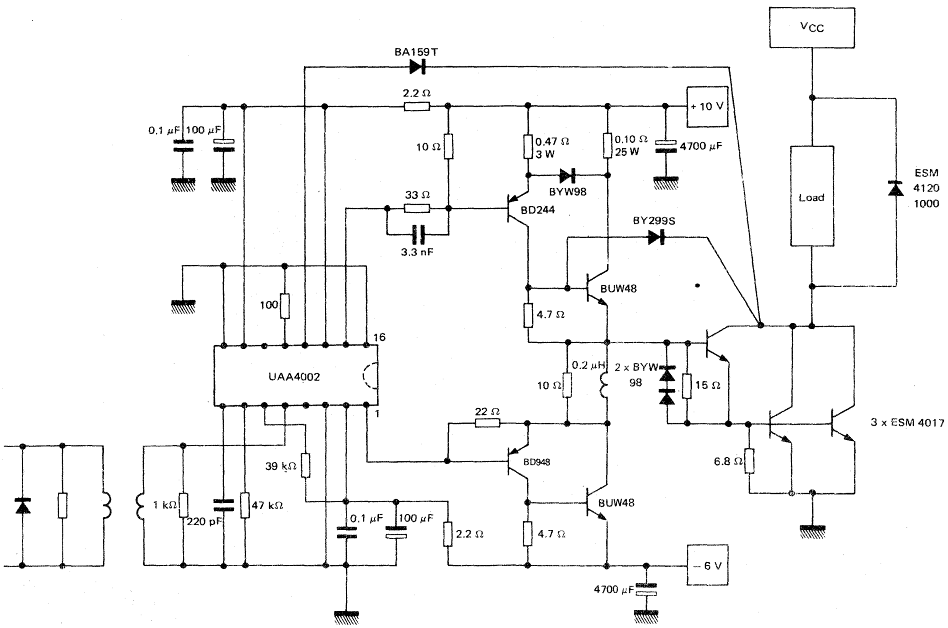
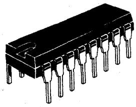


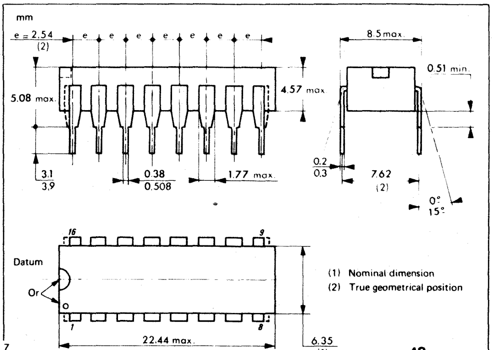
Figure 15 : 200 A, 700 V switch



CB-79



DP SUFFIX
PLASTIC PACKAGE



DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

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Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UAA4006A

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

The UAA4006A is a regulation and control device for fly-back switch mode power supplies using one external switching transistor.

- Includes oscillator, PWM and error amplifier
- Soft start
- Direct drive of the switching transistor
- Self-regulated positive base current (peak 1.5 A)
- Negative base current providing fast turn-off and allowing the best use of the safe operating area (peak 1.5 A)
- Switching transistor protected against saturation failure
- Instantaneous collector current limitation
- Positive power supply monitoring
- On chip thermal protection
- Adjustable minimum conducting time for use of a snubber circuit
- Internal reference voltage
- Start up with very low supply current

* Application note available AN027R1

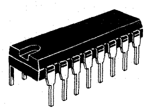
ORDERING INFORMATION

PART NUMBER	PACKAGE	
	DP	SP
UAA4006A	•	•
Example : UAA4006ADP		

SWITCH MODE POWER SUPPLY CONTROL CIRCUIT

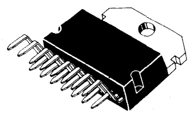
CASES

CB-79



DP SUFFIX
PLASTIC PACKAGE

CB-501

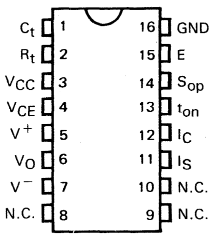


SP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENTS

(Top view)

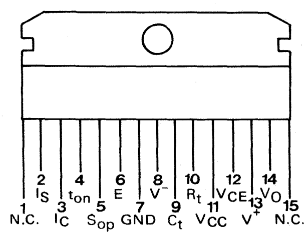
CB-79



- C_t : Oscillator timing capacitor
- R_t : Oscillator timing resistor
- V_{CC} : Supply voltage
- V_{CE} : $V_{CE(sat)}$ sensing
- V^+ : Power stage positive supply
- V_O : Power stage output
- V^- : Power stage negative supply
- I_S : Secondary current monitoring input
- I_C : Primary current limit input
- t_{on} : $t_{on(max)}$ limit access
- S_{op} : Amplifier output
- E : Amplifier input
- GND : Ground

(Front view)

CB-501



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THOMSON COMPONENTS

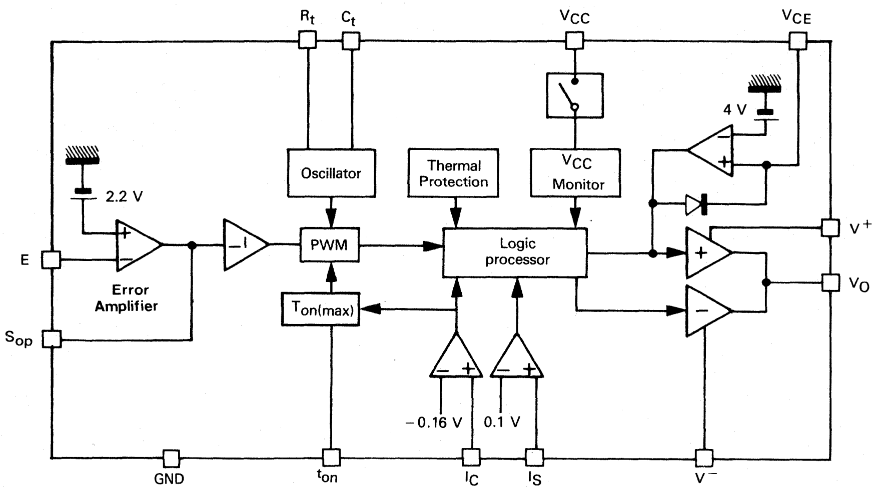
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	+15	V
Supply voltages (Power stage) Positive Negative	V^+ V^-	+15 −6	V V
Voltage between pins 11 and 13	$V^+ - V^-$	+18	V
Output current	I_O	±1.6	A
Current into input I_C (internal protection diodes)	—	±5	mA
Current into input I_S	—	±5	mA
Minimum value of resistance R_t	$R_{t(max)}$	18	kΩ
Junction temperature range	T_j	−40 to +150	°C
Storage temperature range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	CB-79	CB-501	Unit
Junction-ambient thermal resistance	$R_{th(j-a)}$	50	40	°C/W
Junction-case thermal resistance	$R_{th(j-c)}$	7	2.5	°C/W

BLOCK DIAGRAM



CASE	C_t	R_t	V_{CC}	V_{CE}	V^+	V_O	V^-	NC	I_S	I_C	t_{on}	S_{op}	E	GND
CB-79	1	2	3	4	5	6	7	8, 9, 10	11	12	13	14	15	16
CB-501	9	10	11	12	13	14	8	1, 15	2	3	4	5	6	7

CIRCUIT DESCRIPTION

OSCILLATOR

The oscillator provides a triangular waveform with a fall time much smaller than the rise time. The voltage swings between + 1.5 V and about $V_{CC}/2$. The maximum operating frequency is 60 kHz, the period being given by $T_{osc} = 0.5R_tC_t$ Resistor R_t adjusts the frequency, but determines also the value of $t_{on(min)}$ (see logic processor).

PULSE WIDTH MODULATOR (PWM)

The variable duty-cycle signal is elaborated by comparing the oscillator voltage (pin C_t) to the inverted error amplifier output voltage. Another comparator determines the maximum value of the duty-cycle by comparing the oscillator signal with the voltage on pin "t_{on}". If $V(t_{on}) = 0$, then the maximum duty-cycle is internally set to 0.9 T_{osc}, otherwise, the maximum duty-cycle is given by :

$$\left(\frac{t_{on}}{T_{osc}}\right) max = 1 - \frac{R_{ton}}{2R_t}$$

(valid only if $Rt_{on} > 0.2\ R_t$, where Rt_{on} is the resistor inserted between t_{on} pin and ground).

CURRENT LIMITATION

A level lower than − 0.15 V on pin I_C involves two actions :
• a direct action through the logic processor which stops the drive until the end of the oscillator period ;
• an indirect action through the t_{on} funtion. The change of state at the output of comparator I_C is applied to pin t_{on} as long as the overload current persists. By inserting capacitor C_B between pin t_{on} and V_{CC} (about 0.1 μF), the voltage at this point rises by a quantity ΔV proportional to the duration and the frequency of the overcurrent.
This will consequently lower the maximum conduction ratio, thus decreasing the frequency of the overcurrent. At the end of an overload condition, capacitor C_B slowly charges up through a 20k internal impedance, in order to return progressively to normal operation.

NOTE : If capacitor C_B is omitted, direct action will only be implemented.

SUPERVISION OF THE SECONDARY CURRENT

In order to avoid the magnetization of the transformer core in case of short-circuits or heavy overloads on the secondary winding, a new cycle of conduction can only begin after the secondary current has completly fallen to zero.
This task is accomplished by comparator I_S whose threshold is 0.1 V and detects the zero crossing of the secondary current.

PROTECTION AGAINST DESATURATION

If, because of a too low base current or a too heavy load, the collector to emitter voltage of the switching transistor rises above 4 V approximately, the output of comparator V_{CE} changes state, and the drive is interrupted.

ERROR AMPLIFIED

This is an operational amplifier whose open loop gain is about 1000. The input current are less than 3 μA, and the input offset voltage is lower than 5 mV.
The input common-mode voltage range is 0 V to (V_{CC} − 3 V).
Due to an internal limitation the output source current of the amplifier can not exceed 2 mA.

START SWITCH

An internal switch is inserted between pin V_{CC} supply line and internal voltage.
During power-up, this switch closes when V_{CC} reaches + 7.2 V. The leakage current $(I_{CC})L$ is about 0.4 mA before the switch closes. This original feature enables starting the converter by means of a high value resistance directly connected between V_{CC} and the high supply voltage. The smoothing capacitor on V_{CC} supply provides the energy required for the start. The turn-off of the internal switch requires that V_{CC} falls below + 6.2 V.

THERMAL PROTECTION

This protection becomes active when the junction temperature reaches + 160°C.

LOGIC PROCESSOR

A logic unit processes the information coming from the fault detectors, and ensures that the output signal fulfils two conditions :

• No double pulsing with a period : the occurrence of a hault detection is memorized until the end of the period.

• To allow the discharge of a snubber network, the minimum width of the output pulse is set at a given value $t_{on(min)}$ by an internal monostable. If this monostable is not triggered, there will be no conduction. The duration $t_{on(min)}$ is programmable by resistor R_t using the relationship :

$t_{on(min)} = 0.144\ R_t - 2$ @ (V_{CC} = + 12 V)
μs (kΩ)

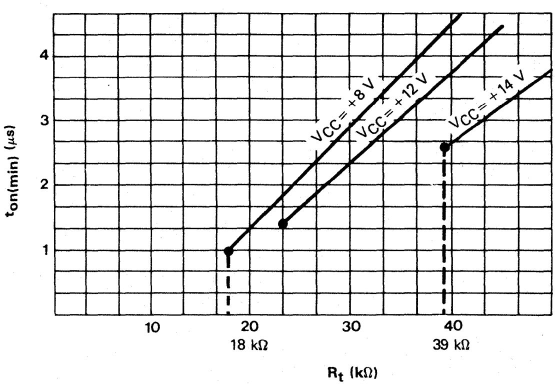
ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 10$ V, $V^- = -5$ V
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	–	–	14	V
Rise supply voltage threshold	V_{CCR}	6.5	7.2	7.9	V
Fall supply voltage threshold	V_{CCF}	5.3	6.0	6.7	V
Hysteresis on V_{CC} threshold	ΔV_{CC}	1	1.2	1.7	V
Current I_{CC} (V_{CC} under threshold voltage)	–	–	0.4	1	mA
Supply current ($V_{CC} = +10$ V)	I_{CC}	–	10	–	mA
Positive supply voltage (Power stage)	V^+	4	–	15	V
Negative supply voltage (Power stage)	V^-	−6	–	−1	V
Threshold of input I_C	$I_{C(th)}$	−0.176	−0.16	−0.144	V
I_C input current ($V_{(I_C)} = 0$ V)	–	–	5	20	µA
Threshold of input I_S	$I_{S(th)}$	0.065	0.1	0.135	V
I_S input current ($V_{(I_S)} = 0$ V)	–	–	5	20	µA
Error amplifier open-loop gain	A_V	60	–	–	dB
Error amplifier offset voltage	V_{IO}	–	5	–	mV
Internal reference voltage	$V_{(ref)}$	2.1	2.2	2.3	V
Oscillator frequency $f_{osc} = \frac{1}{T_{osc}}$	f_{osc}	–	$2/R_tC_t$	60	kHz
Value of resistance R_t ($V_{CC} = +14$ V) (See figure 1) ($V_{CC} = +8$ V)	R_t	39 18	50 50	100 100	kΩ
Output current ($V^+ - V_S = 3$ V, $V_S - V^- = 3$ V)	I_O	±1.5	–	–	A
V_{CE} comparator threshold voltage	$V_{CE(th)}$	3.6	4	4.4	V
$t_{on(min)}$ adjustment range ($V_{CC} = +14$ V) (See figure 1) ($V_{CC} = +8$ V)	–	4 1	– –	8 13	µs
Max duty cycle : $\left(\frac{t_{on}}{T_{osc}}\right)_{max}$ ($R_{t_{on}} > 0.2\ R_t$) - Note 1 ($R_{t_{on}} < 0.2\ R_t$)	– –	– –	$1 - \frac{R_{t_{on}}}{2R_t}$ 0.9	– –	– –
Oscillator frequency drift with temperature ($V_{CC} = 12$ V)	–	–	0.02	0.05	%/°C
Oscillator frequency drift with V_{CC}	–	–	0.2	0.5	%/V

Note 1 : $R_{t_{on}}$ externally connected between pin "t_{on}" and GND
R_t externally connected between pin "R_t" and GND

FIGURE 1 - $t_{on(min)}$ ADJUSTMENT RANGE



OUTPUT STAGE

ON-state

The positive stage achieves a very efficient drive of the switching transistor.
Its features are essentially :
- Direct drive (neither inductor, nor tranformer) ;
- The transistor stays in a quasi-saturation mode, and thus has a reduced storage time ;
- The drive energy is strictly limited to the required amount ;
- Easy implementation.

K_1 is closed to turn the positive stage on. The maximum value of the positive base current is determined by the external limitation resistor R (between V_{CC} and V^+).
Diode D maintains Q in a quasi-saturation mode : the more Q is saturated, the more diode D will shunt an important part of the drive current I_{B1}, through diode D_1.
Resistor R_B has a low value (about 1 Ω), and is used to stabilize the regulation loop. For a good efficiency of the negative drive, the value of this resistor should be as low as possible.
Integrated Darlington T_1 is able to supply a peak current of 1.5 A with a 2 V saturation voltage.
The voltage V_{CE} on transistor Q is :
$V_{CE} = V_D + R_B I_{B1}$

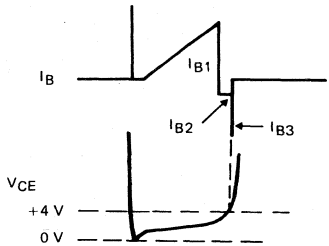
OFF-state

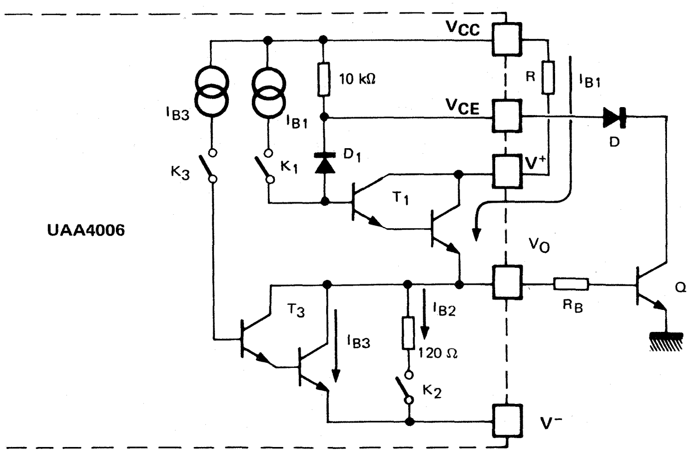
The turn off is accomplished in two steps :
- an immediate action through K_2 which connects the base of the switching transistor to the negative supply through a 120 Ω integrated resistor (current I_{B2}) :
- a delayed action through K_3 which is closed only after the desaturation of the external transistor. This is detected by comparator V_{CE}, when the collector to emitter voltage reaches 4.5 V.

Darlington T_3 can supply 1.5 A with a 2 V saturation voltage (current I_{B3}).

NOTE : The negative drive I_{B3} for the removal of the stored charges is delayed in order to limit the slope dI_B/dt at the on-off transition. A high dI_B/dt might indeed lead to a destructive overheating of the base-collector junction (see "The power transistor in its environment" published by Thomson-CSF Division Semiconducteurs Discrets).

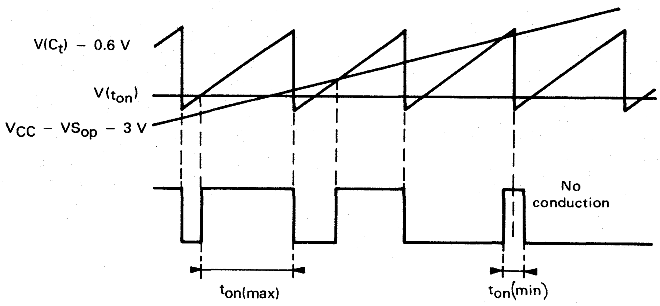
SELF REGULATED BASE CURRENT $I_B = f(V_{CE})$



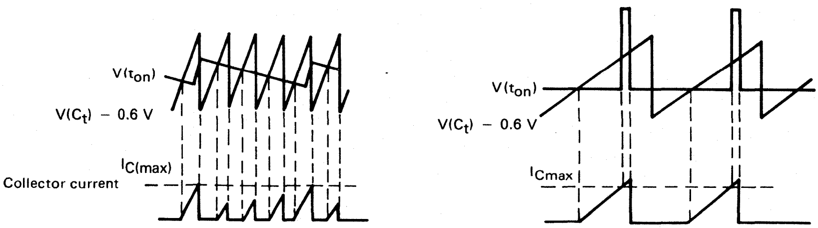


TYPICAL WAVEFORMS

LIMITS OF THE DUTY CYCLE

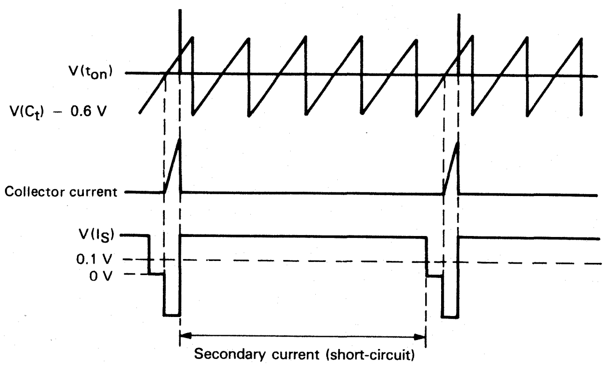


CURRENT LIMITATION

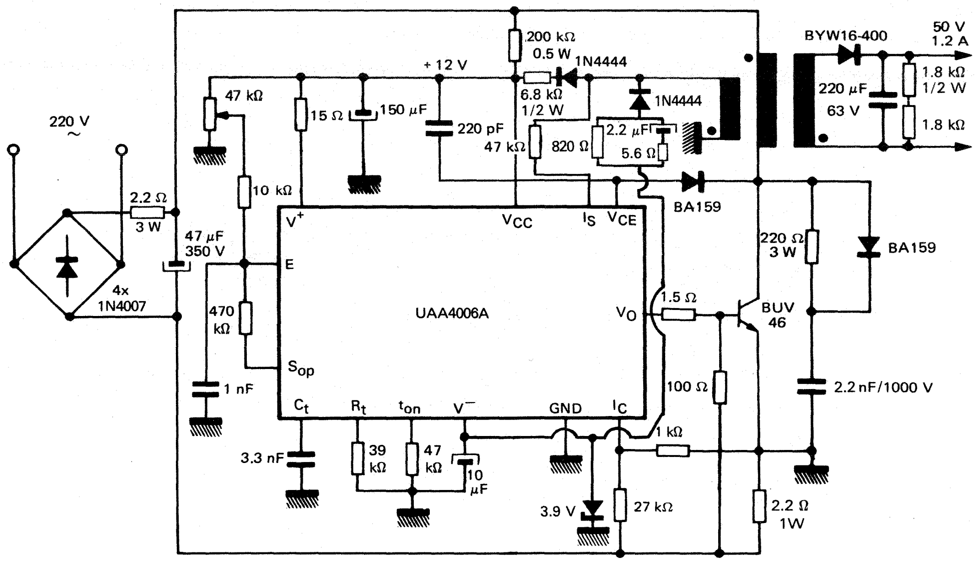


WITH C_B CAPACITOR

WITHOUT C_B CAPACITOR

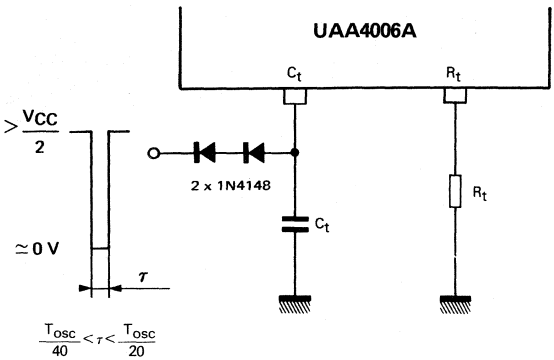


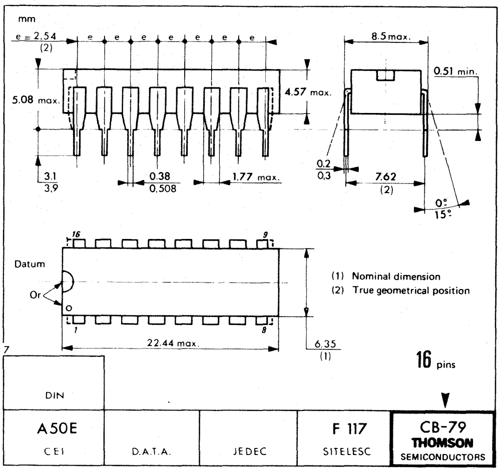
50 W FLY-BACK CONVERTER



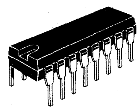
EXTERNAL SYNCHRONIZATION

The oscillator may be synchronized to an external frequency f_{ext} so that : $f_{osc} < f_{ext} < 1.2\ f_{osc}$

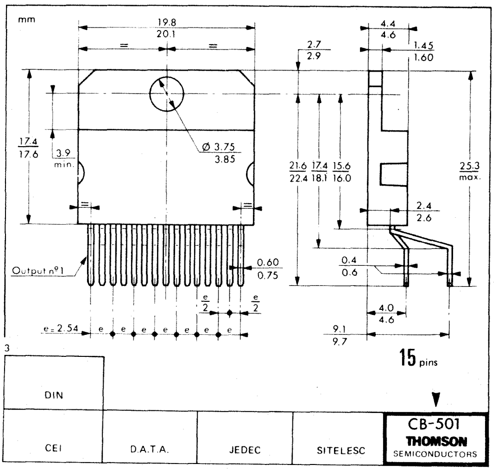




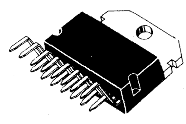
CB-79



DP SUFFIX
PLASTIC PACKAGE



CB-501



SP SUFFIX
PLASTIC PACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

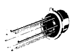
Printed in France

7

Proximity detectors

Part number	Characteristic	Page
TDA0159A	Output voltage signal	645
TDA0161	Output current signal	651
TDA0162	Output current signal - Built-in peak limiter	651
TDE0160	Output current signal - Adjustable hysteresis	657

($T_{amb} = +25°C$)

CHARACTERISTIC		SYMBOL	UNIT	TDA0159A	TDA0161	TDA0162	TDE0160
Supply voltage		V_{CC}	V	5 to 16	4 to 35	4 to 20	4 to 36
Supply current close target		I_{CC}	mA	–	10	10	–
Supply current remote target		$I_{CC(max)}$	mA	–	1	1	–
Max. hysteresis		–	%	2	5	5	Adjustable
Output saturation voltage		$V_{CE(sat)max}$	V	2 @ 10 mA	–	–	1.1 @ 20 mA
Output leakage current		$I_{(max)}$	μA	–	–	–	2
Output current		$I_{O(max)}$	mA	± 20	–	–	40
PACKAGE			**SUFFIX**		**NUMBER OF PINS**		
Plastic SO 8-14			FP	8	8	8	14
Plastic DIL 8-14			DP	8	8	8	14
Metal can TO-99			CM		●	●	
Page				645	651	651	657

THOMSON SEMICONDUCTORS

TDA 0159A

PROXIMITY DETECTOR

The TDA0159A has been designed for metallic body detection by detecting variations in high frequency Eddy current losses. The circuit acts as an oscillator with the addition of an external tuned circuit. Output signal level is varied by an approaching metallic object.

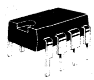
The circuit is protected against overvoltages (+ 26 to + 35 V) by a built-in peak limiter.
Output to ground and output to V_{CC} short-circuit protections are also implemented.

- Supply voltage : + 5 to + 16 V
- Oscillator frequency : 50 kHz to 10 MHz
- Output current : ± 20 mA

PROXIMITY DETECTOR

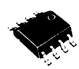
CASES

CB-98



DP SUFFIX
PLASTIC PACKAGE

CB-342

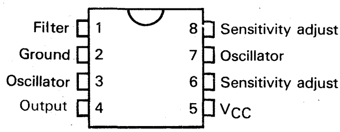


FP SUFFIX
PLASTIC MICROPACKAGE

PIN ASSIGNMENT

(Top view)

CB-98 - CB-342



ORDERING INFORMATION

PART NUMBER	PACKAGE	
	DP	SP
TDA0159A	•	•
Example : TDA0159ADP		

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Réf. 00185

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage (Internally limited by zener)	V_{CC}	26	V
Output current (Internally limited)	I_O	±20	mA
Oscillator frequency	f_{osc}	10	MHz
Junction temperature	T_j	+150	°C
Storage temperature range	T_{stg}	−55 to +150	°C

OPERATING MODE

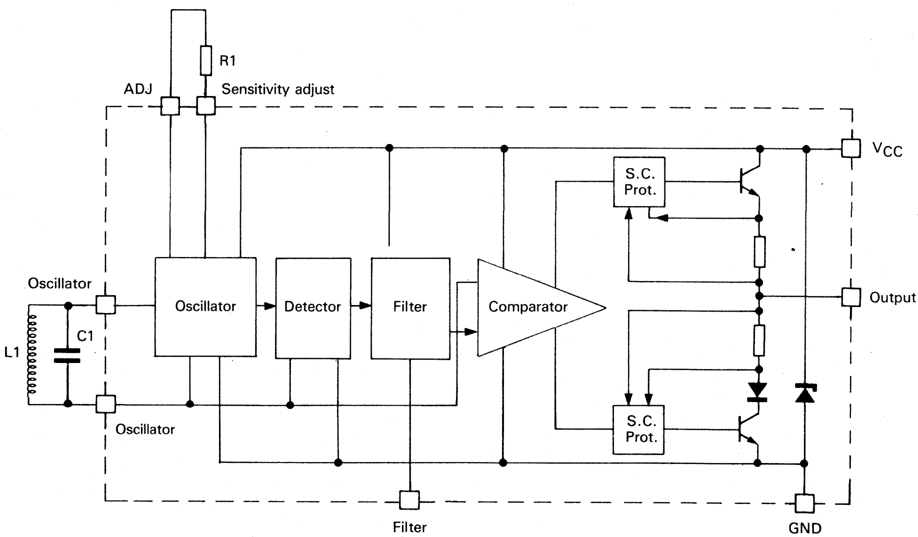
Between terminals 7 and 3 integrated circuit acts like a negative resistance equal to external resistor R1 connected on terminals 6 and 8.

The oscillation stops when load resistance R_p of tuned circuit is smaller than R1. Then the output voltage is high (pin 4).

The oscillation sustains when loss resistance R_p of tuned circuit is higher than R1. Then the output voltage is low. ($f_{osc} = \frac{1}{2\pi\sqrt{L1.C1}}$)

Eddy-currents induced by coil L1 in a metallic piece, fix loss resistance R_p.

SCHEMATIC DIAGRAM

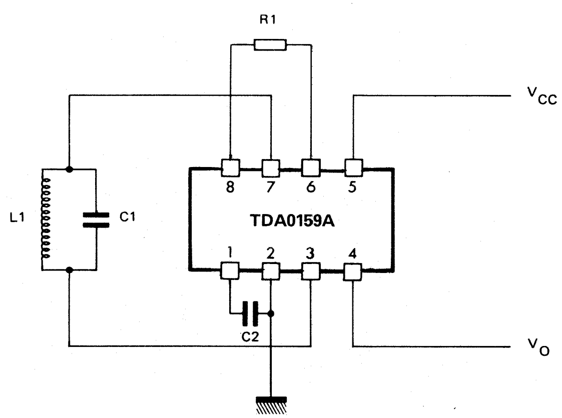


CASE	Filter	GND	Oscillator	Output	V_{CC}	Sensitivity adjustment
CB-98 CB-342	1	2	3, 7	4	5	6, 8

ELECTRICAL CHARACTERISTICS

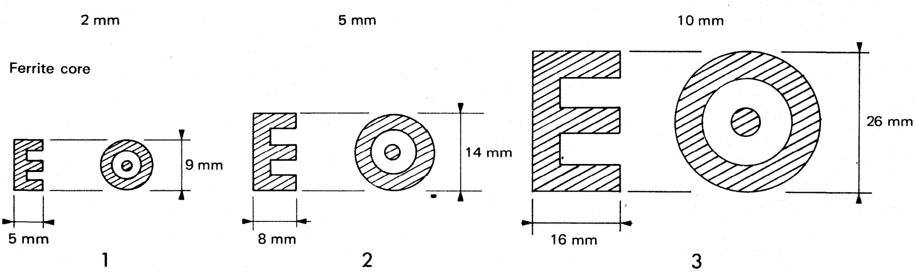
Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	5	–	16	V
Maximum voltage (Non-destructive t < 1 min)	$V_{CC(max)}$	–	–	24	V
Clipping voltage (Limited by integrated zener diode, I_{CC} continuous < 10 mA, I_C pulse < 150 mA (peak), t < 10 ms)	$V_{CC(peak)}$	26	30	35	V
Supply current (V_{CC} = + 13.5 V, I_O = 0)	I_{CC}	–	2	–	mA
Output low voltage (Remote target V_{CC} = + 13.5 V, $I_O \geqslant -10$ mA)	V_{OL}	–	–	2	V
Output high voltage determined by internal $V_{CC} \geqslant +7$ V (Close target) 7 V $\leqslant V_{CC} \leqslant$ + 16 V, $I_O \leqslant$ 10 mA 5 V $\leqslant V_{CC} \leqslant$ + 7 V, $I_O \leqslant$ 4 mA	V_{OH}	 5.4 3.9	 – –	 6.7 $V_{CC} - 0.2$	V
Oscillator frequency (operating conditions)	f_{osc}	–	–	10	MHz
Target detection frequency	f	–	–	10	kHz
Negative value of the resistance between pin 7 and pin 3 : 4 kΩ < R1 < 50 kΩ (R1 = sensitivity adjustment resistor)	R_n	0.9 × R1	R1	1.1 × R1	–
Maximum value of sensitivity adjustment resistor R1 connected between pin 6 and pin 8	R1	–	–	50	kΩ
Hysteresis (measured on detection range)	H_{yst}	–	2	–	%

APPLICATION SCHEMATIC



TYPICAL APPLICATION EXAMPLES

Detection distance



	Detection distance (*)	L1 (μH)	C1 (pF)	f_{osc} (kHz)	R1 (kΩ)	C2 pF
1	2 mm	30	120	2 650	6.8	–
2	5 mm	300	470	425	27	100
3	10 mm	2 160	4 700	50	27	10.000

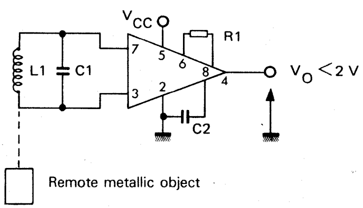
(*) Ingot steel target

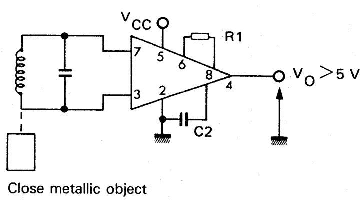
COIL CHARACTERISTICS

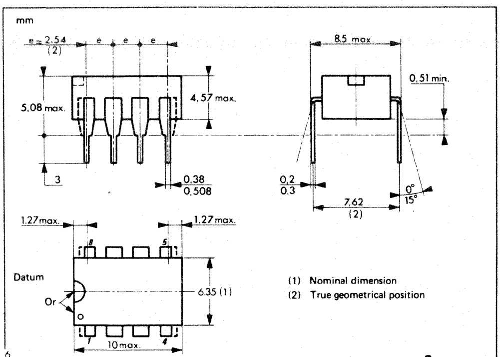
	Core	Coil former	Wire	Number of turns
1	Cofelec 432 FP 9 × 5 SE	1/2 CAR 091 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	40
2	Cofelec 432 FP 14 × 8 SE	1/2 CAR 142 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	100
3	Cofelec 432 FP 26 × 16 SE	1/2 CAR 262 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	200

** The above results are obtained with single wire coil. When using Litz wire instead of single wire, the parallel resistance of the coil becomes higher and the value of R1 may be increased, resulting in better sensitivity.

Coil sensor

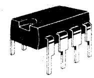




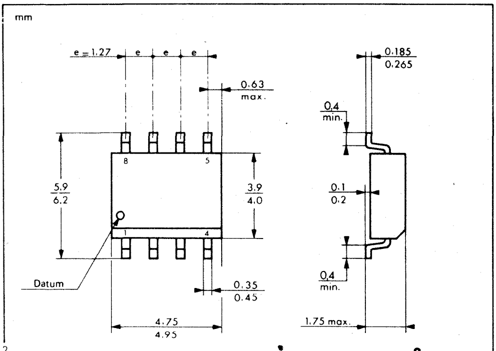


DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98

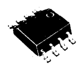


DP SUFFIX
PLASTIC PACKAGE



DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TDA0161
TDA0162

PROXIMITY DETECTORS

These monolithic integrated circuits are designed for metallic body detection by detecting the variations in high frequency Eddy current losses. With an external tuned circuit they act as oscillators. Output signal level is altered by an approaching metallic object.

Output signal is determined by supply current changes. Independent of supply voltage, this current is high or low according to the presence or the absence of a close metallic object.

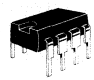
TDA0162 supply voltage is internally limited to 22 V by a built-in peak limiter.

- Supply voltage : +4 to +35 V (TDA0161)
  +4 to +20 V (TDA0162)
- Output current : <10 mA
- Oscillator frequency : <10 MHz

PROXIMITY DETECTORS

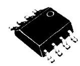
CASES

CB-98



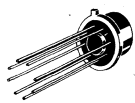
DP SUFFIX
PLASTIC PACKAGE

CB-342



FP SUFFIX
PLASTIC MICROPACKAGE

CB-11
TO-99



CM SUFFIX
METAL CAN

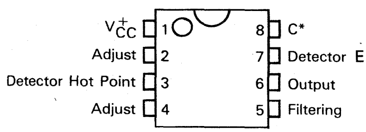
ORDERING INFORMATION

PART NUMBER	PACKAGE		
	DP	FP	CM
TDA 0161	•	•	•
TDA 0162	•	•	•
Examples : TDA0161DP, TDA0161FP, TDA0161CM			

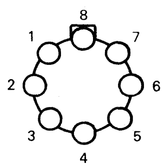
PIN ASSIGNMENTS

(Top views)

CB-98, CB-342



CB-11 (TO-99)



1 Detector Hot Point
2 Adjust
3 Filtering
4 Output
5 Detector E
6 C*
7 V_{CC}^{+}
8 Adjust

Pin 4 connected to case.
* : (22 V peak limiter for TDA0162 only)

7

Réf. 00190

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

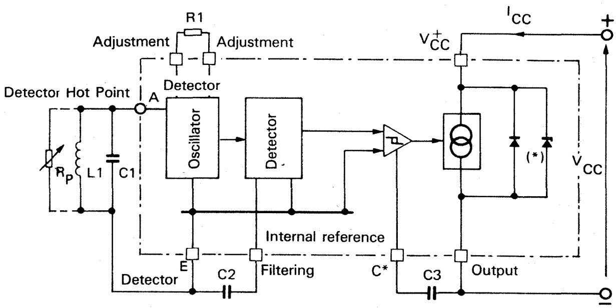
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	TDA0161	TDA0162	Unit
Supply voltage	V_{CC}	35	22*	V
Junction temperature	T_j			°C
DP, FP suffix		+150	+150	
CM suffix		+175	+175	
Storage temperature range	T_{stg}	−55 to +150		°C

* V_{CC} max. limited by internal zener diode.

SCHEMATIC DIAGRAM



(*) : 22 V peak limiter (TDA 0162 only)

CASE	Detector hot point	Ajustment	Filtering	C*	V_{CC}^+	Output	Detector E
CB-11	1	2-8	3	6	7	4	5
CB-98 CB-342	3	2-4	5	8	1	6	7

ELECTRICAL CHARACTERISTICS

TDA0161-DP, TDA0162-DP : $-40°C < T_{amb} < +100°C$
TDA0161-FP, TDA0162-FP : $-40°C < T_{amb} < +100°C$
TDA0161-CM, TDA0162-CM : $-40°C < T_{amb} < +140°C$
$P_{tot} < 150$ mW
(Unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Unit
Supply voltage	TDA0161 TDA0162	V_{CC}	4 4	– –	35 20	V
Direct voltage limitation (I_{CC} = 50 mA, pulse 10 ms)	TDA0162	–	–	–	22	V
Reverse voltage limitation (I_{CC} = – 100 mA)		–	–	– 1	–	V
Supply current, close target (T_{amb} = + 25°C) + 4 V < V_{CC} < + 35 V + 4 V < V_{CC} < + 20 V	 TDA 0161 TDA 0162	I_{CC}	 8 8	 10 10	 12 12	mA
Supply current, remote target + 4 V < V_{CC} < + 35 V + 4 V < V_{CC} < + 20 V	 TDA 0161 TDA 0162	I_{CC}	 – –	 – –	 1 1	mA
Supply current transition time C3 = 0 C3 ≠ 0		–	 – –	 1 (100 × C3(nF))	 – –	µs
Oscillator tuning frequency		f_{osc}	–	–	10	MHz
Output frequency (C3 = 0)		f_O	0	–	10	kHz
Output current ripple - C3 = 0, C2 (pF) > 150/f_{osc} (MHz)		ΔI_{CC}	–	–	20	µA
Negative resistance on terminals A and E (4 kΩ < R1 < 50 kΩ, f_{osc} < 3 MHz)		R_n	0.9 R1	R1	1.1 R1	–
Hysteresis at detection point C2 (pF) > 150/f_{osc} (MHz)		H_{yst}	0.5	–	5	%

If the circuit is used at a frequency higher than 3 MHz, it is recommended to connect a capacitor of 100 pF between terminals E and D.

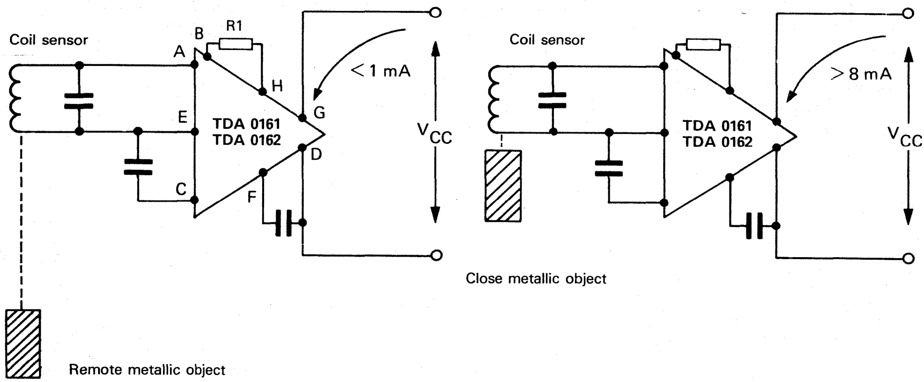
OPERATING MODE

Between terminals A and E, the integrated circuit acts like a negative resistance equal to the external resistor R1 connected between terminals B and H.

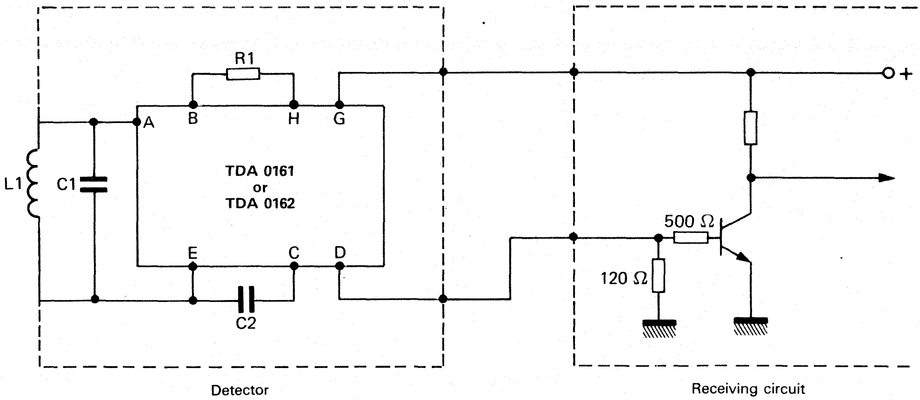
The oscillation stops when loss resistance Rp of tuned circuit becomes smaller than R1. Then, the supply current will be $I_{CC} = 10$ mA (pins G and D).

The oscillation sustains when loss resistance Rp of tuned circuit becomes higher than R1. Then, the supply current will be $I_{CC} < 1$ mA (pins G and D).

Eddy currents induced by coil L1 in a metallic body, determine loss resistance Rp.



TYPICAL APPLICATIONS



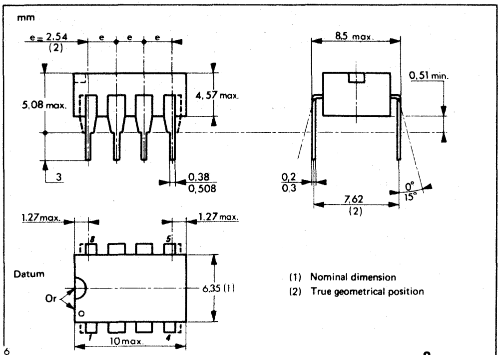
Detection range (*)	L1 (μH)		C1 (pF)	f_{osc} (kHz)	R1 (kΩ)	C2 pF
2 mm	30	(1)	120	2 650	6.8	47
5 mm	300	(2)	470	425	27	470
10 mm	2 160	(3)	4 700	50	27	3 300

(*) Ingot steel target

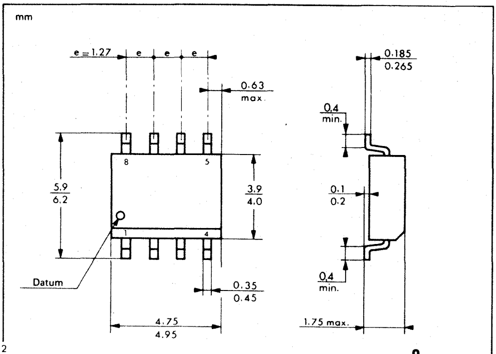
COIL CHARACTERISTICS

	Core	Coil former	Wire**	Number of turns
1	Cofelec 432 FP 9 × 5 SE	1/2 CAR 091 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	40
2	Cofelec 432 FP 14 × 8 SE	1/2 CAR 142 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	100
3	Cofelec 432 FP 26 × 16 SE	1/2 CAR 262 - 2	THOMSON Fils et Câbles Thomrex 14 (14/100 mm)	200

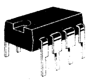
** The above results are obtained with single wire coil. When using Litz wire instead of single wire, the parallel resistance of the coil becomes higher and the value of R1 may be increased, resulting in better sensitivity.



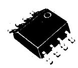
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS



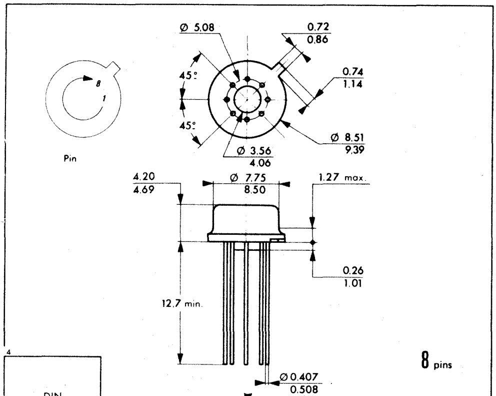
DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS



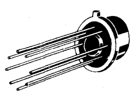
CB-98
DP SUFFIX
PLASTIC PACKAGE



CB-342
FP SUFFIX
PLASTIC MICROPACKAGE



DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS



CB-11
CM SUFFIX
METAL CAN

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

TDE0160

PROXIMITY DETECTOR

The TDE0160 is designed to detect metal bodies by the effect of Eddy currents on the HF losses of a coil. It has two complementary open collector outputs with peak limiting. Hysteresis is adjustable, and an electronic switching circuit is incorporated for disabling both outputs.

An internal zener diode maintains the supply voltage to the circuit in "dipole" operation.

- Supply voltage : +4 to +36 V
- Supply current : <1.2 mA
- Output transistors : I = 20 mA ; $V_{CE(sat)} \leqslant 1100$ mV
- Oscillator frequency : <1 MHz
- Loss resistance : 5 to 50 kΩ.

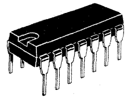
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	FP
TDE0160	−25°C to +85°C	•	•
Examples : TDE0160DP, TDE0160FP			

PROXIMITY DETECTOR

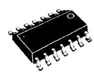
CASES

CB-2



DP SUFFIX
PLASTIC PACKAGE

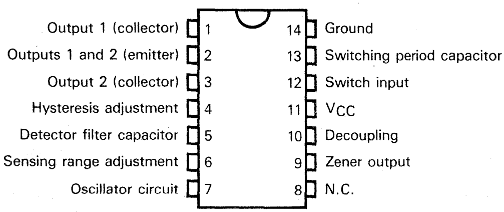
CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

7

PIN ASSIGNMENT



Réf. 00165

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

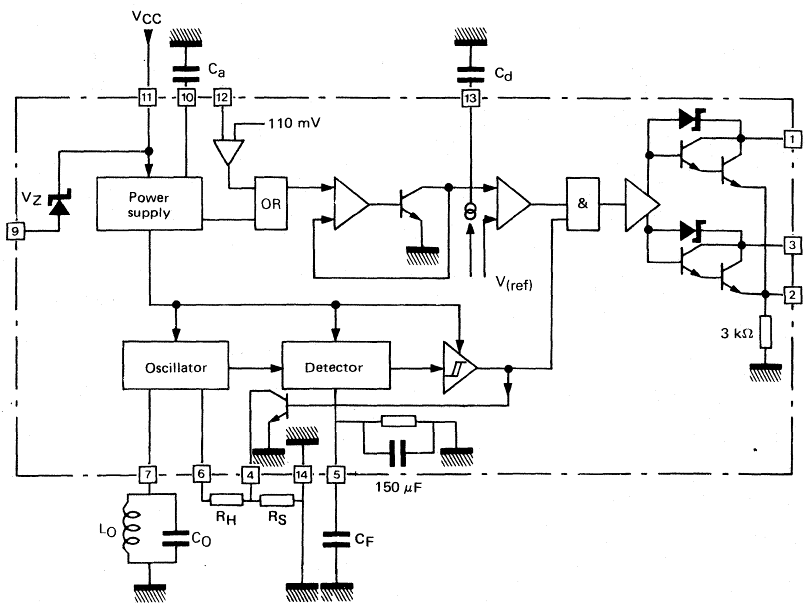
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	36	V
Output voltage*	V_{O*}	36	V
Output current (I_1 – I_3)	I_O (I_1 – I_3)	40	mA
Zener current	I_Z	40	mA
Junction temperature	T_j	+ 150	°C
Ambient temperature range	T_{oper}	– 25 to + 85	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

* Internal peak limiting to protect against transient voltage surges.

SCHEMATIC DIAGRAM



1. Output 1 (collector)
2. Outputs 1 and 2 (emitter)
3. Output 2 (collector)
4. Hysteresis adjustment
5. Detector filter capacitor
6. Sensing range adjustment
7. Oscillator circuit
8. N.C.
9. Zener output
10. Decoupling
11. V_{CC}
12. Switch input
13. Switching period capacitor
14. Ground

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$ (Unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Unit
Supply voltage	Pin 11	V_{CC}	4	–	36	V
Zener voltage ($I_Z = 20$ mA)	Pins 9 - 11	V_Z	3	–	4	V
Supply current	Pin 11	I_{CC}	–	–	1.2	mA
Limiting (I = 0.1 mA)	Pin 1 or 3	–	–	42	–	V
Output transistor saturation voltage (I_1 or $I_3 = +20$ mA)	Pin 1 or 3	–	–	0.9	1.1	V
Output transistor leakage current (V = +30 V)	Pin 1 or 3	–	–	–	2	μA
Switching threshold	Pin 12	–	90	110	130	mV
Negative resistance* (5 kΩ < R_H < 50 kΩ ; f = 100 kHz ; $R_S = 0$)		R_n	–	$R_n = R_H$	–	–
Inherent hysteresis ($R_2 = 0$)		–	–	1	2	%
Programmed hysteresis (H < 15%)		–	–	$\frac{R_S}{R_S + R_H}$	–	%
Oscillation frequency		f_{osc}	–	–	1	MHz
Switching frequency (with matched oscillator circuit)		–	–	750	–	Hz
Switching time-delay		–	–	0.5 C_d (μF)	–	s
Switching response time ($C_d = 10$ nF ; $V_{CC} = +20$ V)		–	–	10	–	μs

* See characteristic curves

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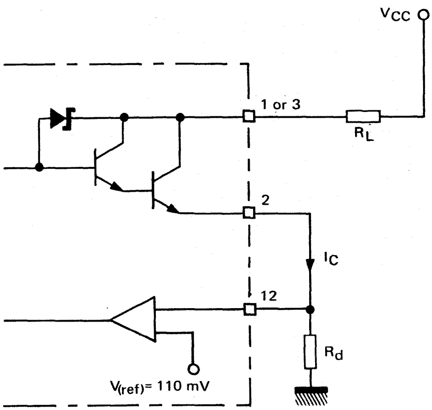
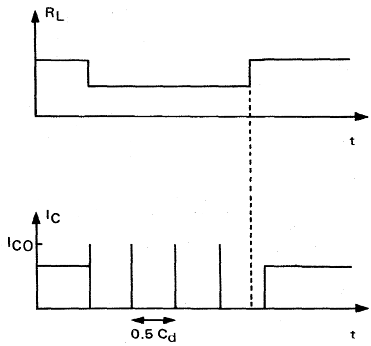
SWITCHING OPERATION

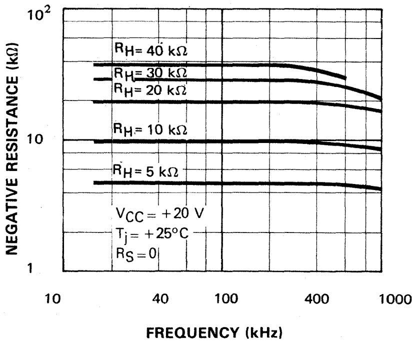




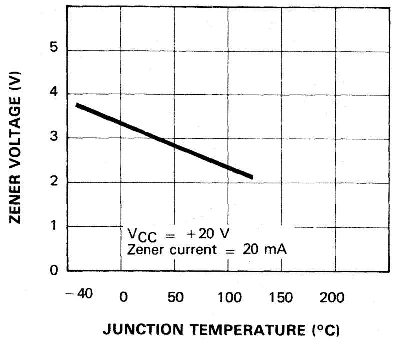
If I_C exceeds I_{CO}, where $I_{CO} = \frac{V_{(ref)}}{R_d}$, the switch cuts off the output transistors and tests the value of current I_C, with time constant 0.5 C_d.

On power up the internal start system cuts off the output transistors until V_{CC} reaches a value permitting normal operation of the circuit.

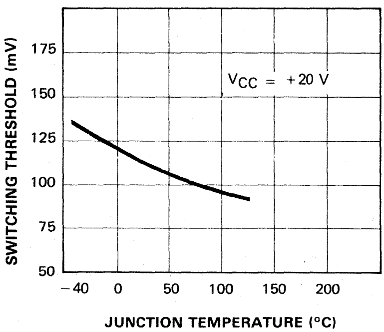
NEGATIVE RESISTANCE
vs
FREQUENCY



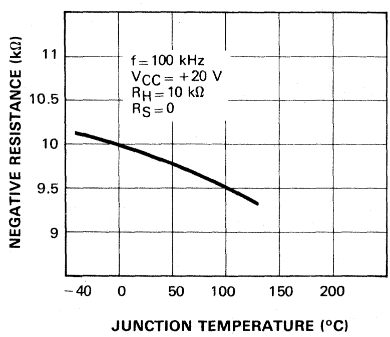
ZENER VOLTAGE
vs
JUNCTION TEMPERATURE



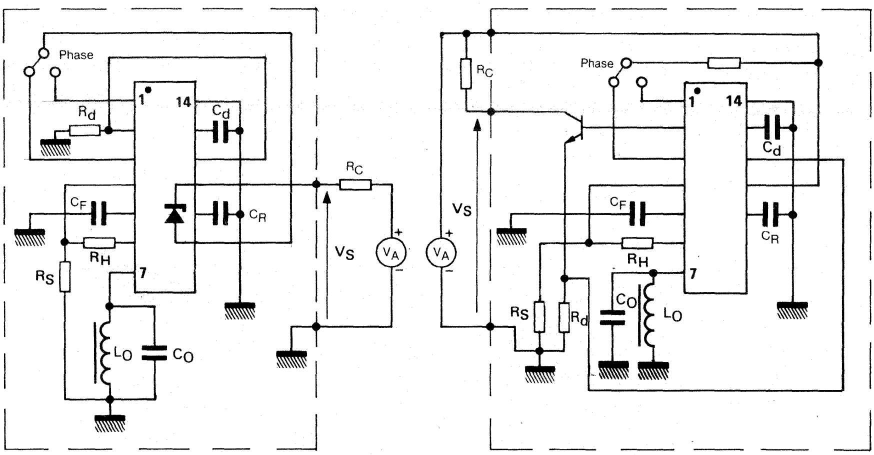
SWITCHING THRESHOLD
vs
JUNCTION TEMPERATURE

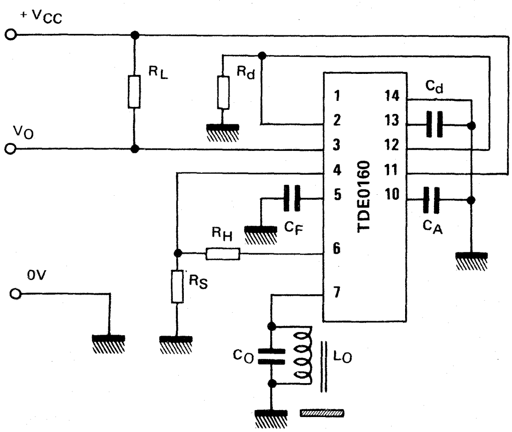


NEGATIVE RESISTANCE
vs
JUNCTION TEMPERATURE



TYPICAL APPLICATION DIAGRAMS



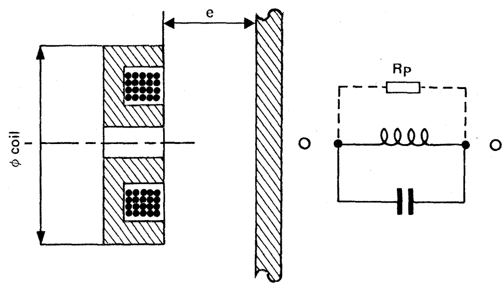


C_a : 10 nF
C_F : 1 nF
C_d : 10 nF
C_O : 390 pF
L_O : 65 μH to 1 MHz
R_d : 10 Ω
R_H : 15 kΩ
R_S : 3 kΩ
R_L : 2.2 kΩ

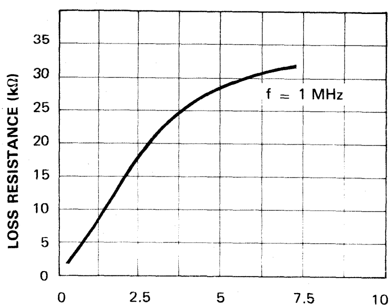
V_{CC} : 20 V
f_O $\simeq$ 1 MHz
e_{mean} = 2.5 mm

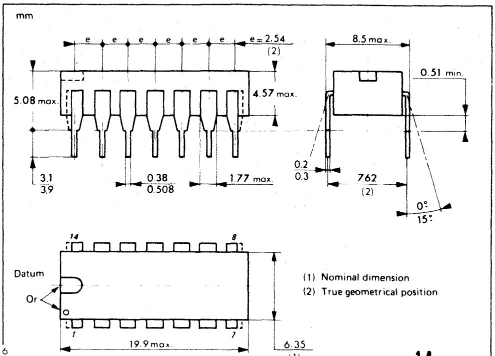
ϕ coil : 14 mm
Core COFELEC 432 FP
Turns : 47
Stranded wire : 15 x 5/100.

MILD STEEL



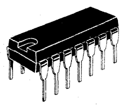
LOSS RESISTANCE vs DETECTION RANGE (mm)



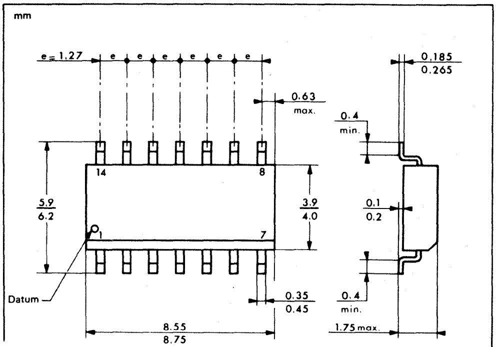


DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

CB-2

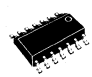


DP SUFFIX
PLASTIC PACKAGE



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

Miscellaneous

Part number	Function	Package	Suffix	Page
LF198,A/LF298/LF398,A	J-FET sample and hold circuits	Plastic DIL 8 Metal can TO-99	DP H	667
LM134/LM234/LM334	Three-terminal adjustable current sources	Plastic TO-92	Z	679
LM135/LM235/LM335,A	Precision temperature sensors	Plastic TO-92	Z	689
LM236,A/LM336,A	2.5 V voltage references	Plastic TO-92	Z	699
NE555/SE555/NE555I	Single timer circuit	DIL 8 Plastic SO 8 Metal can TO-99	DP, DG FP H	707
NE556/SE556	Dual timer circuit	DIL 14 Plastic SO 14	DP, DG FP	715
TDB2046	Transistor arrays	Plastic DIL 14 Plastic SO 14	DP FP	723
TEA7087	Alternator voltage regulator	Plastic DIL 16 Plastic SO 16	DP FP	727
TS8306	6-bit flash A/D converter	DIL 16	P, J, C	733
TS8308	8-bit flash A/D converter	DIL 24	P, C	739
TS8408	8-bit video speed voltage output D/A converter	DIL 16	P, J, C	743
TS85XX	Industrial switched capacitor filter family	Plastic DIL 8 Plastic DIL 16	P P	747
UAC1005/UAB1005	High speed 4-bit A/D converters	Ceramic DIL 24	DC	749

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THOMSON SEMICONDUCTORS

LF198, LF198A
LF298
LF398, LF398A

J-FET SAMPLE AND HOLD CIRCUITS

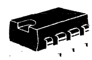
The LF198, LF298, LF398 are monolithic sample and hold circuits which utilize J-FET technology to obtain ultra high dc accuracy with fast acquisition of signal and low droop rate. Operating as a unity gain follower, dc gain accuracy is 0.002% typical and acquisition time is as low as 6 μs to 0.01%. A bipolar input stage is used to achieve low offset voltage and wide bandwidth. Input offset adjust is accomplished with a single pin and does not degrade input offset drift. The wide bandwidth allows the LF198 to be included inside the feedback loop of 1 MHz operational amplifiers without having stability problems. Input impedance of $10^{10}\ \Omega$ allows high source impedances to be used without degrading accuracy.

- Operates from ± 5 V to ± 18 V supplies
- Less than 10 μs acquisition time
- TTL, PMOS, CMOS compatible logic input
- 0.5 mV typical hold step at $C_h = 0.01\ \mu$F
- Low input offset
- 0.002% gain accuracy
- Low output noise in hold mode
- High supply rejection ratio in sample or hold
- Wide bandwidth

J-FET SAMPLE AND HOLD CIRCUITS

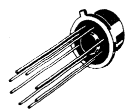
CASES

CB-98



DP SUFFIX
PLASTIC PACKAGE

CB-11



H SUFFIX
METAL CAN

ORDERING INFORMATION

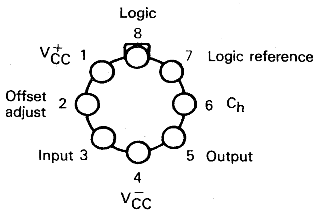
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		H	DP
LF198,A	−55°C to +125°C	•	
LF298	−25°C to + 85°C	•	
LF398,A	0°C to + 70°C	•	•

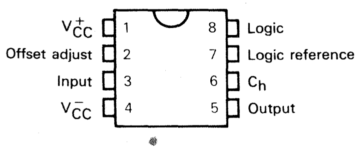
Examples : LF198H, LF398ADP

PIN ASSIGNMENT
(Top views)

CB-11



CB-98



Ref. 04485

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THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

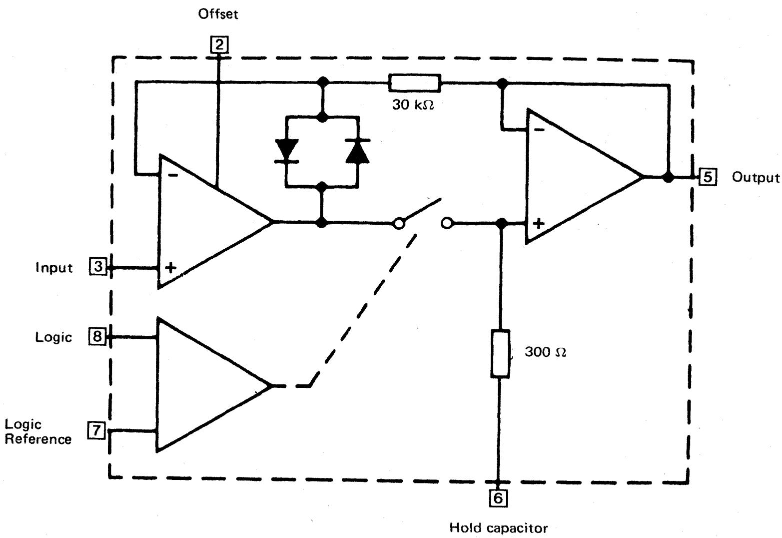
MAXIMUM RATINGS

Rating	Symbol	LF198,A	LF398,A	LF298	Unit
Supply voltage	V_{CC}	± 18	± 18	± 18	V
Power dissipation (Note 1)	P_{tot}	500	500	500	mW
Input voltage	V_I	V_{CC}	V_{CC}	V_{CC}	V
Logic to logic reference differential voltage (Note 2)	—	+7 to −30	+7 to −30	+7 to −30	V
Output short-circuit duration	t_{SC}	Indefinite	Indefinite	Indefinite	—
Hold capacitor short-circuit duration	—	10	10	10	s
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	−25 to + 85	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C

Note 1 : The maximum junction temperature of the LF198,A is +150°C, for the LF298 +115°C and for the LF398,A +100°C. When operating at elevated ambient temperatures, the power dissipation must be derated based on a thermal resistance $R_{th(j-a)}$ of 150°C/W.

Note 2 : Although the differential voltage may not exceed the limits given, the common-mode voltage on the logic pins may be equal to the supply voltages without causing damage to the circuit. For proper logic operation, however, one of the logic pins must always be at least 2 V below the positive supply and 3 V above the negative supply.

BLOCK DIAGRAM



CASE	V_{CC}^{+}	Offset adjust	Input	V_{CC}^{-}	Output	C_h	Logic reference	Logic
CB-11 CB-98	1	2	3	4	5	6	7	8

ELECTRICAL CHARACTERISTICS (Note 3)

Characteristic	Symbol	LF198/LF298			LF398			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 6)	V_{IO}							mV
$T_j = +25°C$		—	1	3	—	2	7	
$T_{min} \leq T_j \leq T_{max}$		—	—	5	—	—	10	
Input bias current - (Note 6)	I_{IB}							nA
$T_j = +25°C$		—	5	25	—	10	50	
$T_{min} \leq T_j \leq T_{max}$		—	—	75	—	—	100	
Input impedance ($T_j = +25°C$)	Z_I	—	10^{10}	—	—	10^{10}	—	Ω
Gain error ($R_L = 10$ kΩ)	—							%
$T_j = +25°C$		—	0.002	0.005	—	0.004	0.01	
$T_{min} \leq T_j \leq T_{max}$		—	—	0.02	—	—	0.02	
Feed through attenuation ratio at 1 kHz ($T_j = +25°C$, $C_h = 0.01$ µF)	—	86	96	—	80	90	—	dB
Output impedance ("Hold" mode)	Z_O							Ω
$T_j = +25°C$		—	0.5	2	—	0.5	4	
$T_{min} \leq T_j \leq T_{max}$		—	—	4	—	—	6	
"Hold" step ($T_j = +25°C$, $C_h = 0.01$ µF, $V_O = 0$) - (Note 4)	—	—	0.5	2	—	1	2.5	mV
Supply current ($T_j \geq +25°C$) - (Note 6)	I_{CC}	—	4.5	5.5	—	4.5	6.5	mA
Logic and logic reference input current ($T_j = +25°C$)	I_I	—	2	10	—	2	10	µA
Leakage current into hold capacitor - (Note 6) $T_j = +25°C$, (Note 5), "hold" mode	—	—	30	100	—	30	200	pA
Acquisition time to 0.1% ($\Delta V_O = 10$ V)	—							µs
$C_h = 1$ nF		—	4	—	—	4	—	
$C_h = 10$ nF		—	20	—	—	20	—	
Hold capacitor charging current ($V_I - V_O$) = +2 V	—	—	5	—	—	5	—	mA
Supply voltage rejection ratio ($V_O = 0$ V)	SVR	80	110	—	80	110	—	dB
Differential logic threshold ($T_j = +25°C$)	—	0.8	1.4	2.4	0.8	1.4	2.4	V

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ELECTRICAL CHARACTERISTICS (continued) - **Note 3**

Characteristic	Symbol	LF198A			LF398A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 6)	V_{IO}							mV
$T_j = +25°C$		–	1	1	–	2	2	
$T_{min} \leqslant T_j \leqslant T_{max}$		–	–	2	–	–	3	
Input bias current - (Note 6)	I_{IB}							nA
$T_j = +25°C$		–	5	25	–	10	25	
$T_{min} \leqslant T_j \leqslant T_{max}$		–	–	75	–	–	50	
Input impedance ($T_j = +25°C$)	Z_I	–	10^{10}	–	–	10^{10}	–	Ω
Gain error ($R_L = 10$ kΩ)	–							%
$T_j = +25°C$		–	0.002	0.005	–	0.004	0.005	
$T_{min} \leqslant T_j \leqslant T_{max}$		–	–	0.01	–	–	0.01	
Feed through attenuation ratio at 1 kHz ($T_j = +25°C$, $C_h = 0.01$ µF)	–	86	96	–	86	90	–	dB
Output impedance ("Hold" mode)	Z_O							Ω
$T_j = +25°C$		–	0.5	1	–	0.5	1	
$T_{min} \leqslant T_j \leqslant T_{max}$		–	–	4	–	–	6	
"Hold" step ($T_j = +25°C$, $C_h = 0.01$ µF, $V_O = 0$) - (Note 4)	–	–	0.5	1	–	1	1	mV
Supply current ($T_j \geqslant +25°C$) - (Note 6)	I_{CC}	–	4.5	5.5	–	4.5	6.5	mA
Logic and logic reference input current ($T_j = +25°C$)	I_I	–	2	10	–	2	10	µA
Leakage current into hold capacitor - (Note 6) $T_j = +25°C$, (Note 5), "hold" mode	–	–	30	100	–	30	100	pA
Acquisition time to 0.1% ($\Delta V_O = 10$ V)	–							µs
$C_h = 1$ nF		–	4	6	–	4	6	
$C_h = 10$ nF		–	20	25	–	20	25	
Hold capacitor charging current ($V_I - V_O$) = +2 V	–	–	5	–	–	5	–	mA
Supply voltage rejection ratio ($V_O = 0$ V)	SVR	90	110	–	90	110	–	dB
Differential logic threshold ($T_j = +25°C$)	–	0.8	1.4	2.4	0.8	1.4	2.4	V

Note 3 : Unless otherwise specified, the following conditions apply. Unit is in "sample" mode, $V_{CC} = \pm 15$ V, $T_j = +25°C$, $-11.5\ V \leqslant V_I \leqslant +11.5$ V, $C_h = 0.01$ µF and $R_L = 10$ kΩ, logic reference voltage = 0 V and logic voltage = +2.5 V.

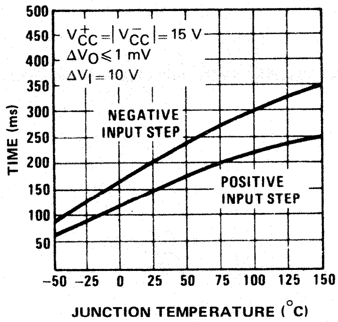
Note 4 : Hold step is sensitive to stray capacitive coupling between input logic signals and the hold capacitor. 1 pF, for instance, will create and additional 0.5 mV step with a 5 V logic swing and a 0.01 µF hold capacitor. Magnitude of the hold step is inversely proportional to hold capacitor value.

Note 5 : Leakage current is measured at a junction temperature of +25°C. The effects of junction temperature rise due to power dissipation or elevated ambient can be calculated by doubling the 25°C value for each 11°C increase in chip temperature. Leakage is guaranteed over full input signal range.

Note 6 : These parameters guaranteed over a supply voltage range of ±5 V to ±18 V.

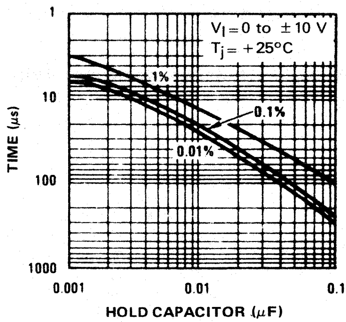
TYPICAL PERFORMANCE CHARACTERISTICS

APERTURE TIME*

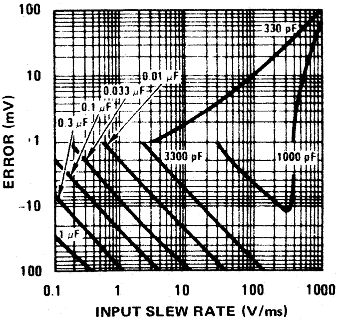


* See definition of terms

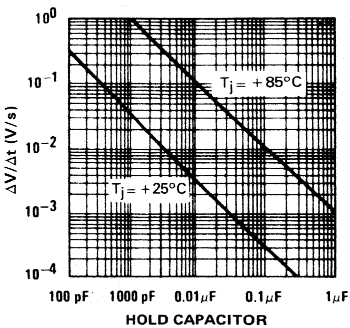
ACQUISITION TIME



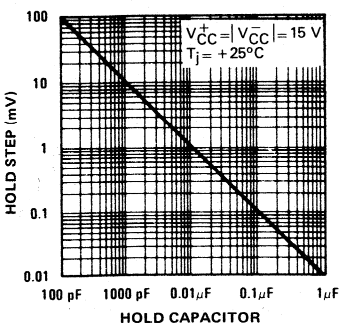
DYNAMIC SAMPLING ERROR



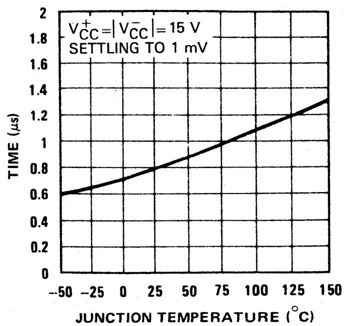
OUTPUT DROOP RATE



HOLD STEP

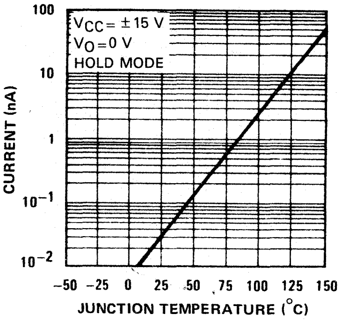


"HOLD" SETTLING TIME*

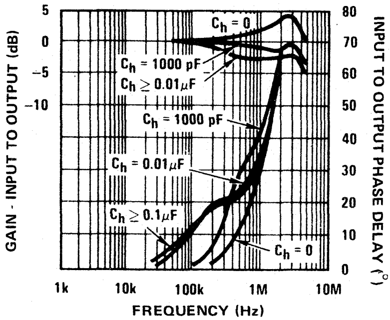


* See definition of terms

LEAKAGE CURRENT INTO HOLD CAPACITOR

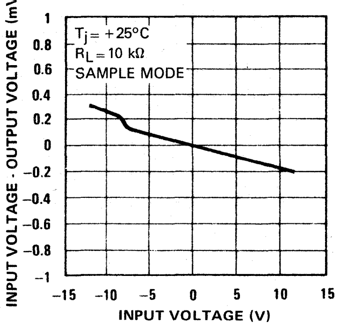


PHASE AND GAIN (INPUT TO OUTPUT, SMALL SIGNAL)

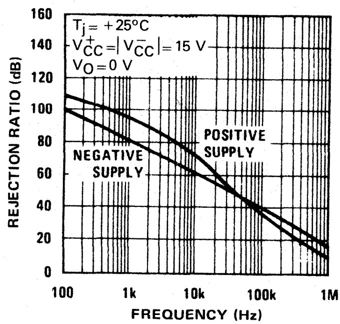


*See definition of terms

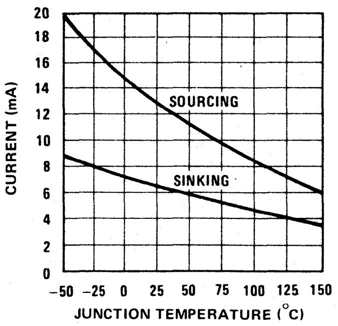
GAIN ERROR



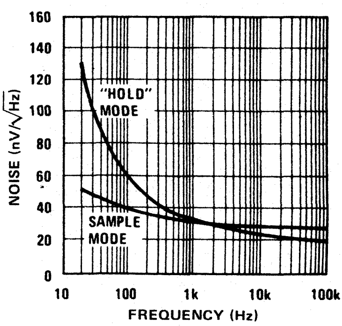
POWER SUPPLY REJECTION

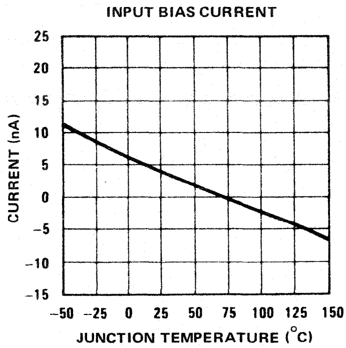


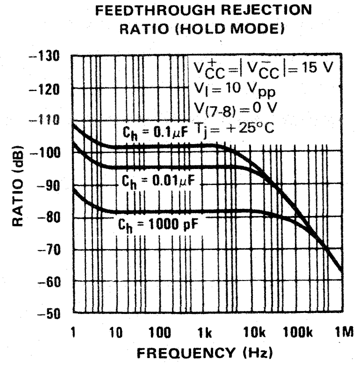
OUTPUT SHORT CIRCUIT CURRENT

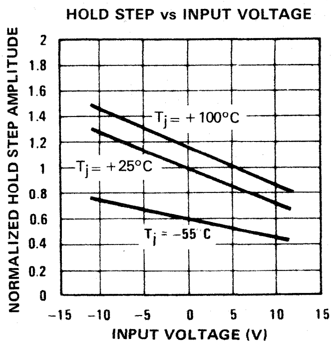


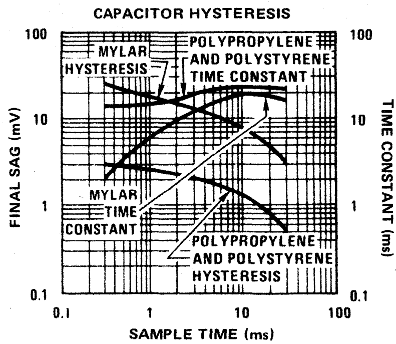
OUTPUT NOISE











8

DEFINITION OF TERMS

Acquisition Time : The time required to acquire a new analog input voltage with an output step of 10 V. Note that acquisition time is not just the time required for the output to settle, but also includes the time required for all internal nodes to settle so that the output assumes the proper value when switched to the hold mode.

Aperture Time : The delay required between "Hold" command and an input analog transition, so that the transition does not affect the held output.

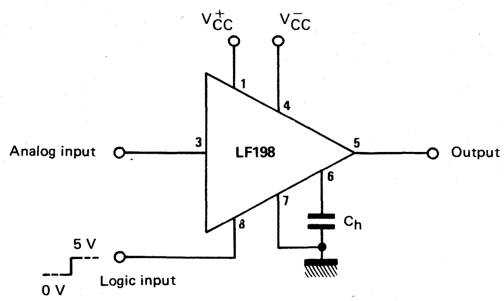
Dynamic Sampling Error : The error introduced into the held output due to a changing analog input at the time the hold command is given. Error is expressed in mV with a given hold capacitor value and input slew rate. Note that this error term occurs even for long sample times.

Gain Error : The ratio of output voltage swing to input voltage swing in the sample mode expressed as a percent difference.

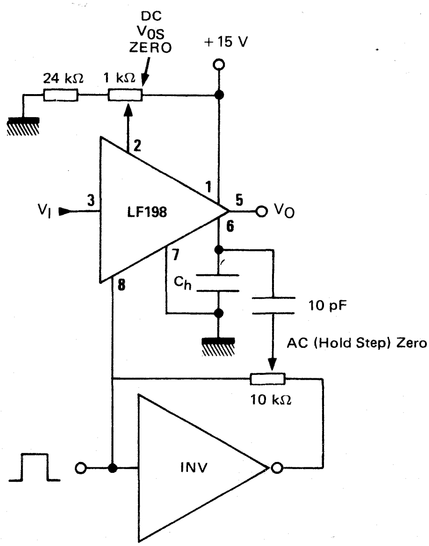
Hold Settling Time : The time required for the output to settle within 1 mV of final value after the "hold" logic command.

Hold Step : The voltage step at the output of the sample and hold when switching from sample mode to hold mode with a steady (dc) analog input voltage. Logic swing is 5 V.

TYPICAL APPLICATIONS

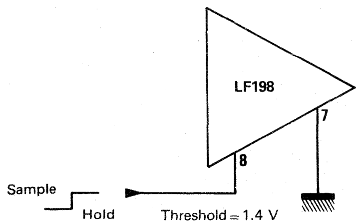


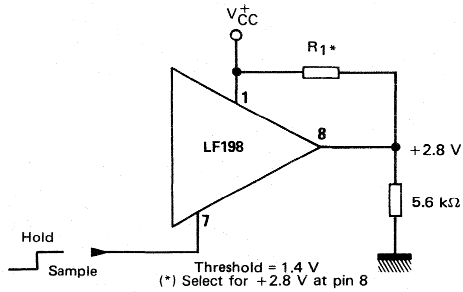
DC & AC Zeroing



LOGIC INPUT CONFIGURATIONS

TTL & CMOS
+3 V ⩽ V_L(High state) ⩽ +7 V





APPLICATION HINTS

Hold Capacitor

Hold step, acquisition time, and droop rate are the major trade-offs in the selection of a hold capacitor value. Size and cost may also become important for larger values. Use of the curves included with this data sheet should be helpful in selecting a reasonable value of capacitance. Keep in mind that for fast repetition rates or tracking fast signals, the capacitor drive currents may cause a significant temperature rise in the LF398.

A significant source of error in an accurate sample and hold circuit is dielectric absorption in the hold capacitor. A mylar cap, for instance, may "sag back" up to 0.2 % after a quick change in voltage. A long "soak" time is required before the circuit can be put back into the hold mode with this type of capacitor. Dielectrics with very low hysteresis are polystyrene, polypropylene, and Teflon. Other types such as mica and polycarbonate are not nearly as good. Ceramic is unusable with > 1 % hysteresis. The advantage of polypropylene over polystyrene is that it extends the maximum ambient temperature from +85°C to +160°C. "NPO" or "COG" capacitors are now available for 125° C operation and also have low dielectric absorption. For more exact data, see the curve labeled dielectric absorption error vs sample time. The hysteresis numbers on the curve are final values, taken after full relaxation. The hysteresis error can be significantly reduced if the output of the LF398 is digitized quickly after the hold mode is initiated. The hysteresis relaxation time constant in polypropylene, for instance, is 10 to 50 ms. If A-to-D conversion can be made within 1 ms, hysteresis error will be reduced by a factor of ten.

DC and AC Zeroing

DC zeroing is accomplished by connecting the offset adjust pin to the wiper of a 1 kΩ potentiometer which has one end tied to V_{CC}^+ and the other end tied through a resistor to ground. The resistor should be selected to give ≈ 0.6 mA through the 1 k potentiometer.

AC zeroing (hold step zeroing) can be obtained by adding an inverter with the adjustment pot tied input to output. A 10 pF capacitor from the wiper to the hold capacitor will give ± 4 mV hold step adjustment with a 0.01 µF hold capacitor and +5 V logic supply. For larger logic swings, a smaller capacitor (< 10 pF) may be used.

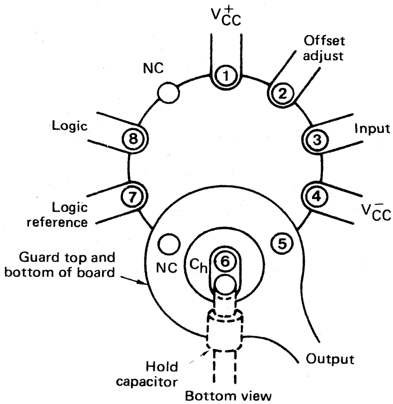
Logic Rise Time

For proper operation, logic signals into the LF398 must have a minimum dV/dt of 0.2 V/µs. Slower signals will cause excessive hold step. If a R/C network is used in front of the logic input for signal delay, calculate the slope of the waveform at the threshold point to ensure that it is at least 0.2 V/µs.

Sampling Dynamic Signals

Sample error due to moving input signals probably causes more confusion among sample-and-hold users than any other parameter. The primary reason for this is that many users make the assumption that the sample and hold amplifier is truly locked on to the input signal while in the sample mode. In actuality, there are finite phase delays through the circuit creating an input-output differential for fast moving signals. In addition, although the

GUARDING TECHNIQUE



Use 10-pin layout. Guard around C_h is tied to output.

output may have settled, the hold capacitor has an additional lag due to the 300 Ω series resistor on the chip. This means that at the moment the "hold" command arrives, the hold capacitor voltage may be somewhat different than the actual analog input. The effect of these delays is opposite to the effect created by delays in the logic which switches the circuit from sample to hold. For example, consider an analog input of 20 Vp-p at 10 kHz. Maximum dV/dt is 0.6 V/μs. With no analog phase delay and 100 ns logic delay, one could expect up to (0.1 μs) (0.6 V/μs) = 60 mV error if the "hold" signal arrived near maximum dV/dt of the input. A positive going input would give a +60 mV error. Now assume a 1 MHz (3 dB) bandwidth for the overall analog loop. This generates a phase delay of 160 ns. If the hold capacitor sees this exact delay, then error due to analog delay will be (0.16 μs) (0.6 V/μs) = –96 mV. Total output error is +60 mV (digital) –96 mV (analog) for a total of –36 mV. To add to the confusion, analog delay is proportional to hold capacitor value while digital delay remains constant. A family of curves (dynamic sampling error) is included to help estimate errors.

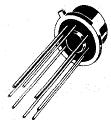
A curve labeled "Aperture Time" has been included for sampling conditions where the input is steady during the sampling period, but may experience a sudden change nearly coincident with the "hold" command. This curve is based on a 1 mV error fed into the output.

A second curve, "Hold Settling Time" indicates the time required for the output to settle to 1 mV after the "hold" command.

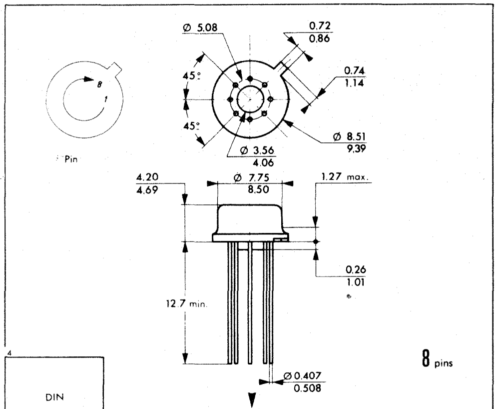
Digital Feedthrough

Fast rise time logic signals can cause hold errors by feeding externally into the analog input at the same time the amplifier is put into the hold mode. To minimize this problem, board layout should keep logic lines as far as possible from the analog input. Grounded guarding traces may also be used around the input line, especially if it is driven from a high impedance source. Reducing high amplitude logic signals to +2.5 V will also help.

CB-11

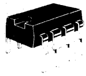


H SUFFIX
METAL CAN

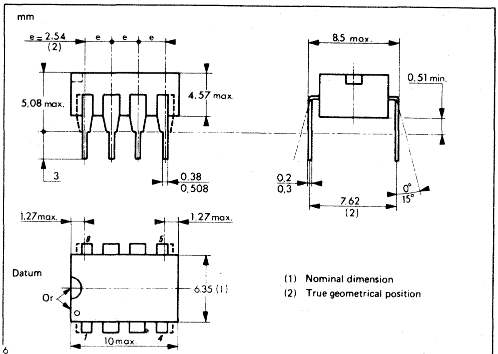


DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-98



DP SUFFIX
PLASTIC PACKAGE



DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116A SITELESC	CB-98 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM134
LM234
LM334

THREE TERMINAL ADJUSTABLE CURRENT SOURCES

The LM134/LM234/LM334 are 3-terminal adjustable current sources characterized by :
— an operating current range of 10000 : 1
— an excellent current regulation
— a wide dynamic voltage range of 1 V to 40 V
The current is determined by an external resistor without requiring other external components.

Reverse voltages of up to 20 V will only draw a current of several microamperes. This enables the circuit to operate as a rectifier and as a source of current in a.c. applications.

For the LM134/LM234/LM334, the voltage on the control pin is 64 mV at +25°C and is directly proportional to the absolute temperature (°K). The simplest external resistor connection generates a current with ≈ 0.33%/°C temperature dependence. Zero drift can be obtained by adding an additional resistor and a diode to the external circuit.

- Operates from 1 V to 40 V.
- 0.02% V current regulation.
- Programmable from 1 μA to 10 mA.
- ±3% initial accuraty.

THREE-TERMINAL ADJUSTABLE CURRENT SOURCES

CASE CB-97
(TO-92)

Z SUFFIX
PLASTIC PACKAGE

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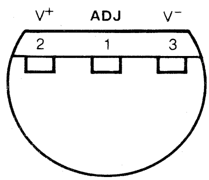
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE Z
LM134	−55°C to +150°C	●
LM234	−25°C to +100°C	●
LM334	0°C to + 70°C	●

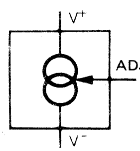
Example : LM134Z

PIN ASSIGNMENT

(Bottom view)



BLOCK DIAGRAM



Réf. 00090

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

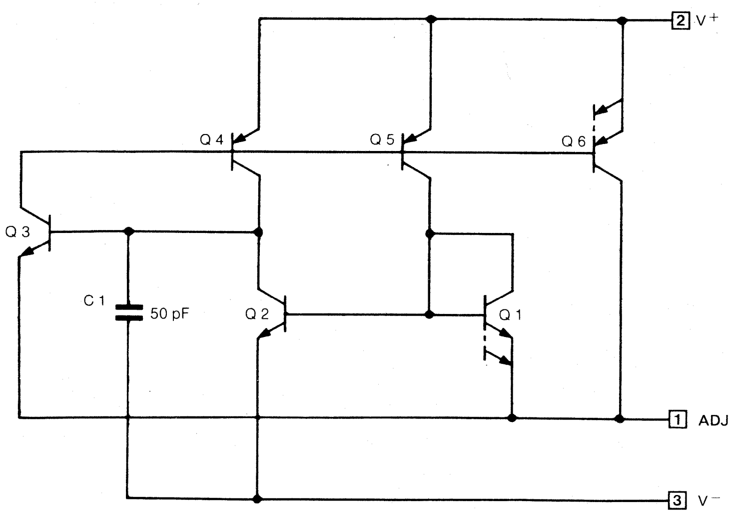
MAXIMUM RATINGS

Rating	LM134, LM234	LM334	Unit
Voltage V^+ to V^- Forward Reverse	 40 20	 30 20	V
ADJ pin to V^- voltage	5	5	V
Set current	10	10	mA
Power dissipation	200	200	mW
Storage temperature range	– 65 to + 150		°C
Operating free-air temperature range LM134 LM234 LM334	 – 55 to + 125 – 25 to + 100 0 to + 70		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	60	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	200	°C/W

SCHEMATIC DIAGRAM



ELECTRICAL CHARACTERISTICS

$T_j = +25°C$ with pulse testing so that junction temperature does not change during testing.
(Unless otherwise specified)

Characteristic	LM134 - LM234			LM334			Unit
	Min	Typ	Max	Min	Typ	Max	
Set current error ($V^+ = +25$ V) - Note 1							%
10 μA ≤ I_{set} ≤ 1 mA	–	–	3	–	–	6	
1 mA ≤ I_{set} ≤ 5 mA	–	–	5	–	–	8	
2 μA ≤ I_{set} ≤ 10 μA	–	–	8	–	–	12	
Ratio of set current to V^- current							–
10 μA ≤ I_{set} ≤ 1 mA	14	18	23	14	18	26	
1 mA ≤ I_{set} ≤ 5 mA	–	14	–	–	14	–	
2μA ≤ I_{set} ≤ 10 μA	–	14	–	–	14	–	
Minimum operating voltage							V
2 μA ≤ I_{set} ≤ 100 μA	–	0.8	–	–	0.8	–	
100 μA ≤ I_{set} ≤ 1 mA	–	0.9	–	–	0.9	–	
1 mA ≤ I_{set} ≤ 5 mA	–	1	–	–	1	–	
Average change in set current with input voltage							%/V
2 μA ≤ I_{set} ≤ 1 mA							
+1.5 V ≤ V^+ ≤ +5 V	–	0.02	0.05	–	0.02	0.1	
+5 V ≤ V^+ ≤ +40 V	–	0.01	0.03	–	0.01	0.05	
1 mA ≤ I_{set} ≤ 5 mA							
+1.5 V ≤ V^+ ≤ +5 V	–	0.03	–	–	0.03	–	
+5 V ≤ V^+ ≤ +40 V	–	0.02	–	–	0.02	–	
Temperature dependence of set current - (Note 2) (25 μA ≤ I_{set} ≤ 1 mA)	0.96T	T	1.04 T	0.96 T	T	1.04 T	–
Effective shunt capacitance	–	15	–	–	15	–	pF

Note 1 : Set current is the current flowing into the V^+ pin. It is determined by the following formula $I_{set} = 67.7\ mV/R_{set}(T_j = +25°C)$. Set current error is expressed as a percent deviation from this amount.

Note 2 : I_{set} is directly proportional to absolute temperature (°K). I_{set} at any temperature can be calculated from $I_{set} = I_O\ (T/T_O)$ where I_O is I_{set} measured at T_O (°K).

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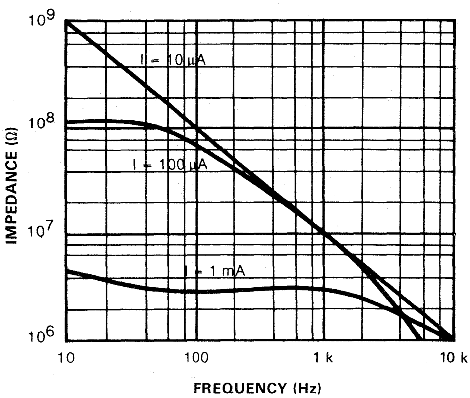
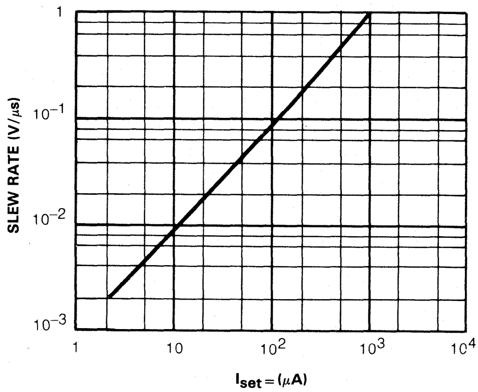
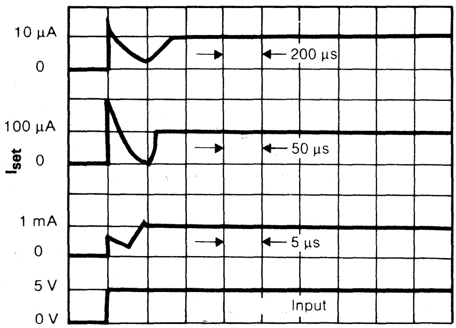
OUTPUT IMPEDANCE



MAXIMUM SLEW RATE FOR LINEAR OPERATION

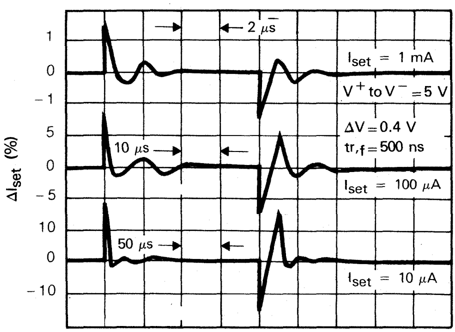


START UP



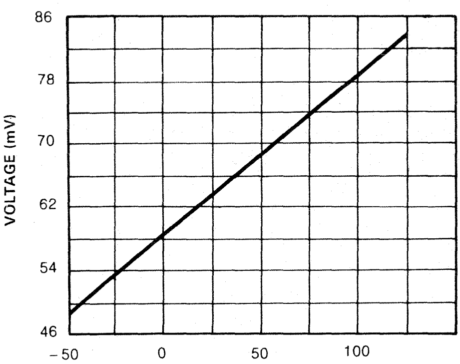
TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

TRANSIENT RESPONSE

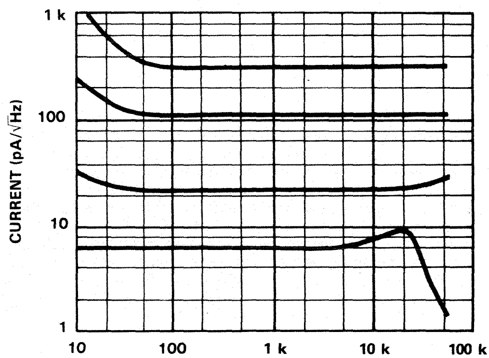


TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

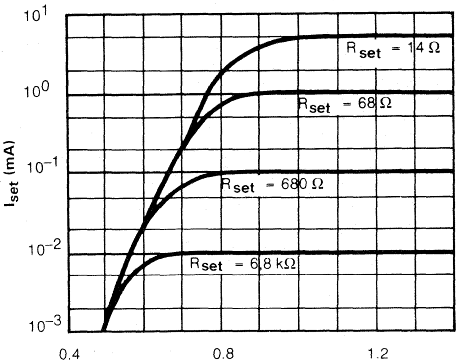
VOLTAGE ACROSS R_{set}



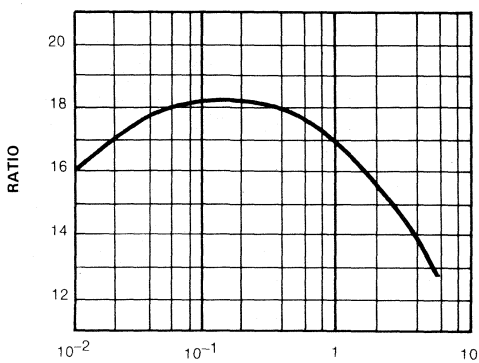
CURRENT NOISE



TURN-ON VOLTAGE



RATIO OF I_{set} to V^- CURRENT



APPLICATION HINTS

SLEW RATE

At slew rates above a threshold (see curve) the LM134, LM234, LM334 can have a non-linear current characteristic. The slew rate at which this takes place is directly proportional to I_{set}. At $I_{set} = 10\ \mu A$, dv/dt max. $= 0.01\ V/\mu s$; at $I_{set} = 1$ mA, dv/dt max. $= 1\ V/\mu s$. Slew rates of more than $1\ V/\mu s$ do not damage the circuit nor do they produce high currents.

THERMAL EFFECTS

Internal heating can have a significant effect on current regulation for an I_{set} above 100 μA. For example, each increase of 1 V in the voltage across the LM134 at $I_{set} = 1$ mA will increase the junction temperature by $\simeq 0.4°C$ (in still air). The output current (I_{set}) has a temperature coefficient of about 0.33%/°C. Thus the change in current due to the increase in temperature will be (0.4) (0.33) = 0.132%. This is a degradation of 10 : 1 in regulation versus the true electrical effects. Thermal effects should be taken into account when d.c. regulation is critical and I_{set} is higher than 100 μA. The dissipation of the connections of CB-97 package can reduce this thermal effect by a coefficient of more than 3.

SHUNT CAPACITANCE

In certain applications, the 15 pF value for the shunt capacitance should be reduced :
— because of loading problems,
— because of limitation of the output impedance of the current source in a.c. applications. This reduction of the capacitance can be easily carried out by adding a FET as indicated in the typical applications. The value of this capacitance can be reduced by at least 3 pF and regulation can be improved by an order of magnitude without any modification of the d.c. characteristics (except for the minimum input voltage).

NOISE

The current noise produced by LM134, LM234, LM334 is about 4 times that of a transistor. If the LM134, LM234, LM334 is utilized as an active load for a transistor amplifier, the noise at the input will increase by about 12 dB. In most cases this is acceptable, and a single amplifier can be built with a voltage gain higher than 2 000.

LEAD RESISTANCE

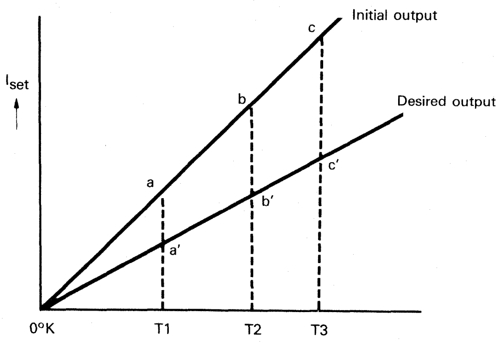
The sense voltage which determines the current of the LM134, LM234, LM334, is less than 100 mV. At this level, the effects of the thermocouple and the connection resistance should be reduced by locating the current setting resistor close to the device. Do not use sockets for the ICs. A contact resistance of 0.7 Ω is sufficient to decrease the output current by 1% at the 1 mA level.

SENSING TEMPERATURE

The LM134, LM234, LM334 are excellent remote controlled temperature sensors because their operation as sources of current preserves their accuracy even in the case of long connecting wires. The output current is directly proportional to the absolute temperature in degrees Kelvin according to the following equation.

$$I_{set} = \frac{(227\ \mu V/°K)\ (T)}{R_{set}}$$

The calibration of the LM134, LM234, LM334 is simplified by the fact that most of the initial accuracy is due to gain limitation (slope error) and not an offset. Gain adjustment is a one point trim because the output of the device extrapolates to zero at 0°K.



This particularity of the LM134, LM234, LM334 is illustrated in the above diagram. Line abc represents the sensor current before adjustment and line a'b'c' represents the desired output. An adjustment of the gain provided at T2 will move the output from b to b' and will correct the slope at the same time so that the output at T1 and T3 will be correct. This gain adjustment can be carried out by means of R_{set} or the load resistor utilized in the circuit. After adjustment, the slope error should be less than 1%. A low temperature coefficient for R_{set} is necessary to keep this accuracy. A 33 ppm/°C temperature drift of R_{set} will give an error of 1% on the slope because the resistance follows the same temperature variations as the LM134, LM234, LM334. Three wires are required to isolate R_{set} from the LM134, LM234, LM334. Since this solution is not recommended. Metal-film resistors with a drift less than 20 ppm/°C are now available. Wirewound resistors can be utilized when very high stability is required.

TYPICAL APPLICATIONS

FIGURE 1 — BASIC 2-TERMINAL CURRENT SOURCE

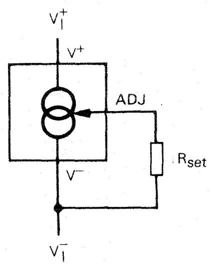
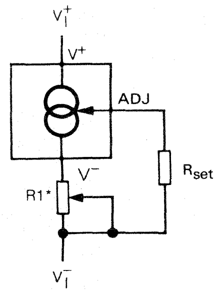


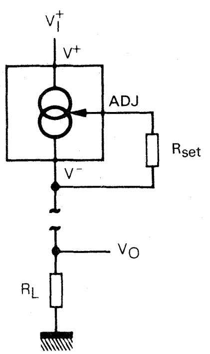
FIGURE 2 — ALTERNATE TRIMMING TECHNIQUE



* For ±10% adjustment, select R_{set} 10% high and make $R1 \approx 3\ R_{set}$

8

FIGURE 3 - TERMINATING REMOTE SENSOR FOR VOLTAGE OUTPUT

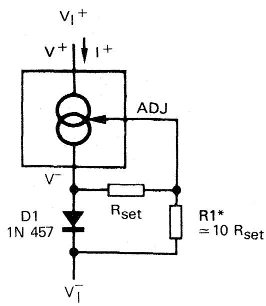


$V_O = (I_{set})\ (R_L) \pm 10\ mV/°K$

$R_{set} = 230\ \Omega$

$R_L = 10\ k\Omega$

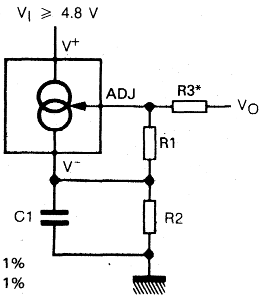
FIGURE 4 - ZERO TEMPERATURE COEFFICIENT CURRENT SOURCE



* Select ration of R1 to R_{set} to obtain zero drift $I^+ = 2\ I_{set}$

TYPICAL APPLICATIONS (continued)

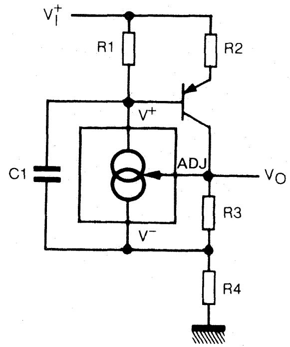
FIGURE 5 — LOW OUTPUT IMPEDANCE THERMOMETER



R1 = 230 Ω, 1%
R2 = 10 kΩ, 1%
R3 = 600 Ω
V_O = 10 mV/°C
$Z_O \leqslant 100$ Ω

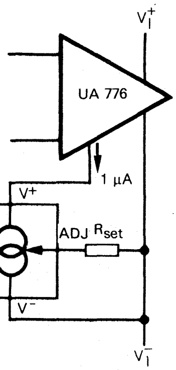
* Output impedance of the LM134, LM234, LM334 at the "ADJ" pin is approximately $\frac{-R_O\ \Omega}{16}$ where R_O is the equivalent external resistance connected to the V^- pin. This negative resistance can be reduced by a factor of 5 or more by inserting an equivalent resistor in series with the output.

FIGURE 6 — LOW OUTPUT IMPEDANCE THERMOMETER



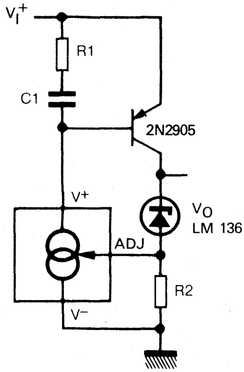
R1 = 15 kΩ
R2 = 300 Ω
R3 = 100 Ω
R4 = 4.5 kΩ
C1 = 2.2 nF
V_O = 10 mV/°C
$Z_O \leqslant 2$ Ω

FIGURE 7 — MICROPOWER BIAS



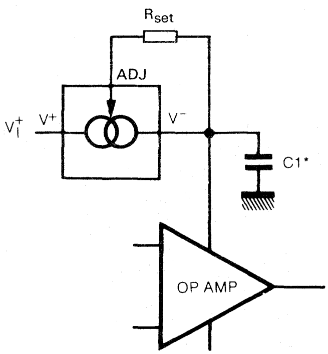
R_{set} = 68 kΩ

FIGURE 8 — LOW INPUT VOLTAGE REFERENCE DRIVER



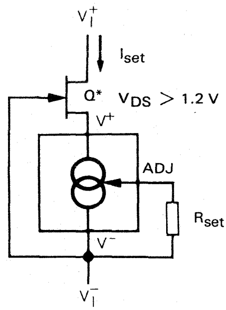
$V_I^+ \geqslant V_{ref} + 200$ mV
C1 = 0.1 µF
R1 = 1.5 kΩ
R2 = 120 Ω
$V_O = V_Z + 64$ mV @ +25°C
$I_O \leqslant 3$ mA

FIGURE 9 — IN-LINE CURRENT LIMITER



* Use minimum value required to ensure stability of protected circuit.

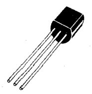
FIGURE 10 — FET CASCADING FOR LOW CAPACITANCE



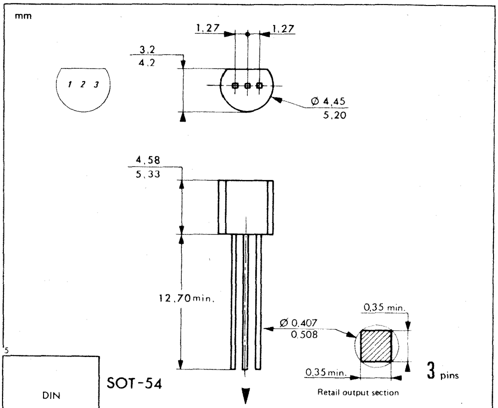
* Select Q to ensure at least 1 V across the LM134, LM234, LM334.
$V_p\,(1 - I_{set}/I_{DSS}) \geqslant 1.2$ V

8

CB-97
(TO-92)



Z SUFFIX
PLASTIC PACKAGE



DIN	SOT-54			
CEI	TO-92 D.A.T.A.	TO-92 JEDEC	F 129 B SITELESC	CB-97 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

LM135
LM235
LM335,A

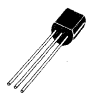
PRECISION TEMPERATURE SENSORS

The LM 135, LM 235, LM 335 are precison temperature sensors which can be easily calibrated. They operate as a 2-terminal Zener and the breakdown voltage is directly proportional to the absolute temperature at 10 mV/°K. The circuit has a dynamic impedance of less than 1 Ω and operates within a range of current from 400 μA to 5 mA without alteration of its characteristics. Calibrated at +25°C, the LM 135, LM 235, LM 335 have a typical error of less than 1°C over a 100°C temperature range. Unlike other sensors, the LM 135, LM 235, LM 335 have a linear output.

- Directly calibrated in °K
- 1°C initial accuracy
- Operates from 400 μA to 5 mA
- Less than 1 Ω dynamic impedance.

PRECISION TEMPERATURE SENSORS

CASE CB-97
(TO-92)



Z SUFFIX
PLASTIC PACKAGE

8

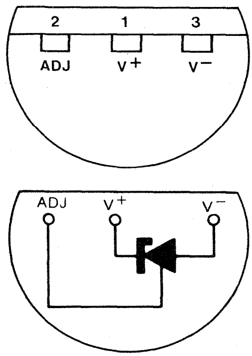
ORDERING INFORMATION

PART NUMBER	TEMPERATURE		PACKAGE
	Continuous	Intermittent	Z
LM135	−55°C to +150°C	+150°C to +200°C	•
LM235	−40°C to +125°C	+125°C to +150°C	•
LM335,A	−10°C to +100°C	+100°C to +125°C	•

Examples : LM135Z, LM335AZ

PIN ASSIGNMENT

(Bottom view)



Réf. 00145

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

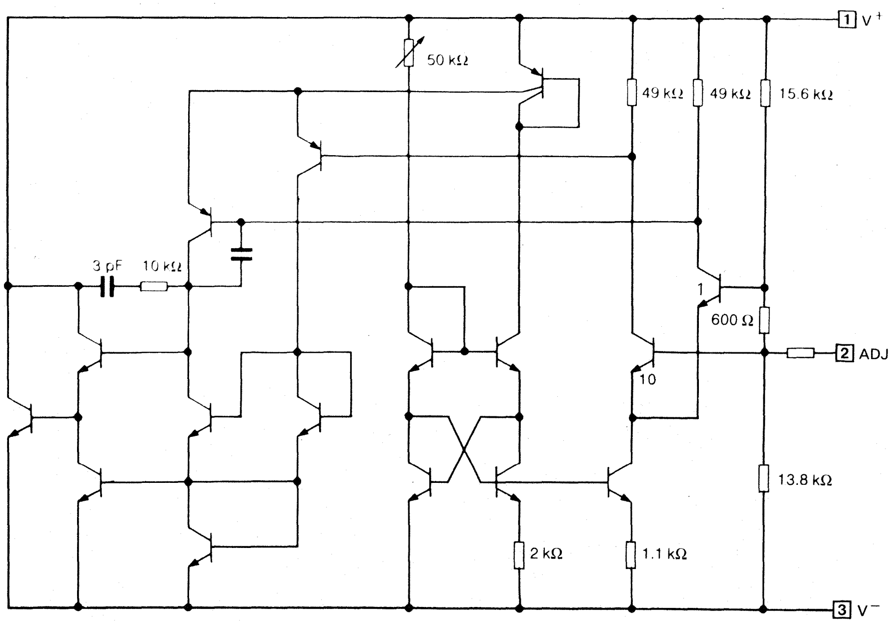
MAXIMUM RATINGS

Rating	Symbol	LM135	LM235	LM335,A	Unit
Current Reverse Forward	 I_R I_F	 15 10	 15 10	 15 10	mA
Operating free-air temperature range Continuous Intermittent	T_{oper}	 – 55 to + 150 + 150 to + 200	 – 40 to + 125 + 125 to + 150	 – 10 to + 100 + 100 to + 125	°C
Storage temperature range	T_{stg}	– 60 to + 180	– 60 to + 180	– 60 to + 180	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Maximum junction-case thermal resistance	$R_{th(j-c)}$	60	°C/W
Maximum junction-ambient thermal resistance	$R_{th(j-a)}$	200	°C/W

SCHEMATIC DIAGRAM



TEMPERATURE ACCURACY

Characteristic	LM135 - LM235 LM335A			LM335			Unit
	Min	Typ	Max	Min	Typ	Max	
Operating output voltage ($T_{case} = +25°C$, $I_R = 1$ mA)	2.95	2.98	3.01	2.92	2.98	3.04	V
Uncalibrated temperature error ($I_R = 1$ mA)							°C
$T_{case} = +25°C$	–	1	3	–	2	6	
$T_{(min)} < T_{case} < T_{(max)}$	–	2	5	–	4	9	
Temperature error with 25°C calibration ($T_{(min)} < T_{case} < T_{(max)}$, $I_R = 1$ mA)							°C
LM135 - LM235	–	0.5	1.5	–	–	–	
LM335	–	–	–	–	1	2	
LM335A	–	0.5	1	–	–	–	
Calibrated error at external temperature $T_{case} = T_{(max)}$ (intermittent)	–	2	–	–	2	–	°C
Non-linearity ($I_R = 1$ mA)							°C
LM135 - LM235	–	0.3	1	–	–	–	
LM335	–	–	–	–	0.3	1.5	
LM335A	–	0.3	1.5	–	–	–	

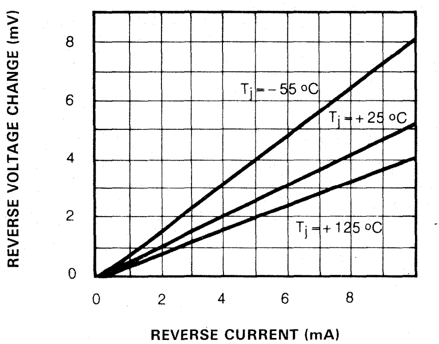
ELECTRICAL CHARACTERISTICS (Note 1)

Characteristic	LM135 - LM235			LM335,A			Unit
	Min	Typ	Max	Min	Typ	Max	
Operating output voltage change with current (400 μA < I_R < 5 mA at constant temperature)	–	2.5	10	–	3	14	mV
Dynamic impedance ($I_R = 1$ mA)	–	0.5	–	–	0.6	–	Ω
Output voltage temperature drift	–	+ 10	–	–	+ 10	–	mV/°C
Time constant							s
Still air	–	80	–	–	80	–	
Air 0.5 m/s	–	10	–	–	10	–	
Stirred oil	–	1	–	–	1	–	
Time stability ($T_{case} = +125°C$)	–	0.2	–	–	0.2	–	°C/kh

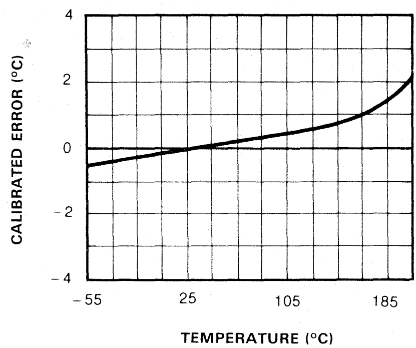
Note 1 : Accuracy measurements are made in a well-stirred oil bath. For other conditions, self heating must be considered.

8

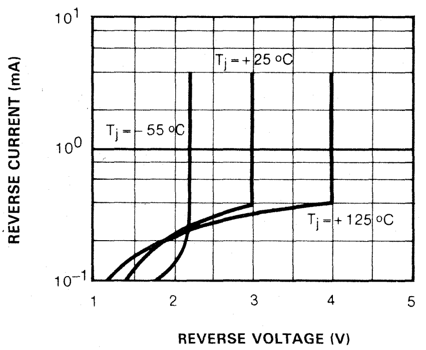
REVERSE VOLTAGE CHANGE



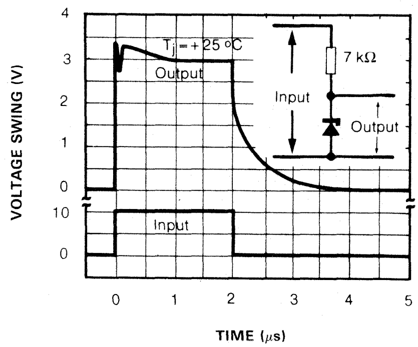
CALIBRATED ERROR



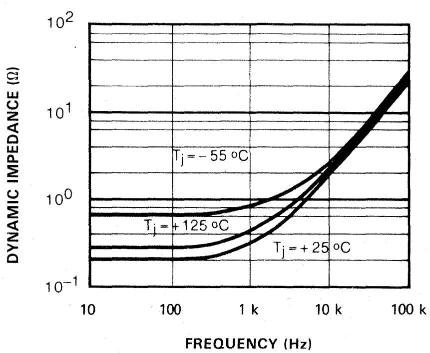
REVERSE CHARACTERISTICS



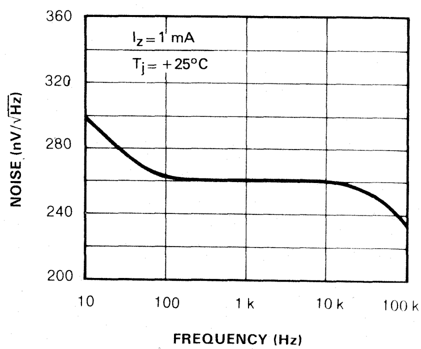
RESPONSE TIME



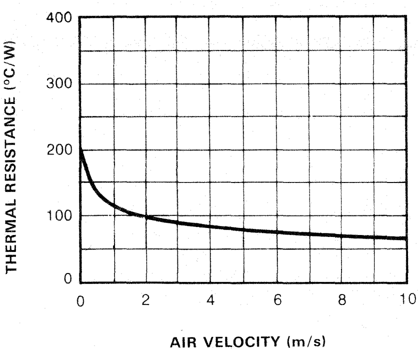
DYNAMIC IMPEDANCE



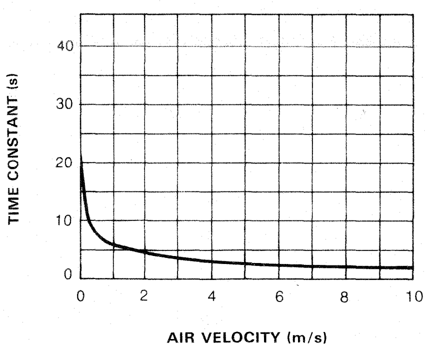
NOISE VOLTAGE



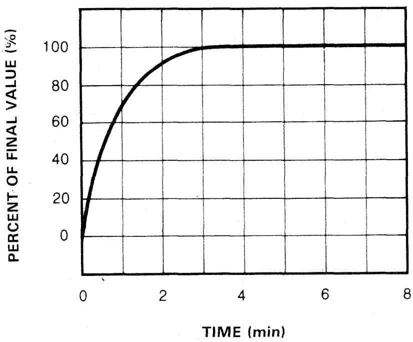
THERMAL RESISTANCE JUNCTION TO AIR



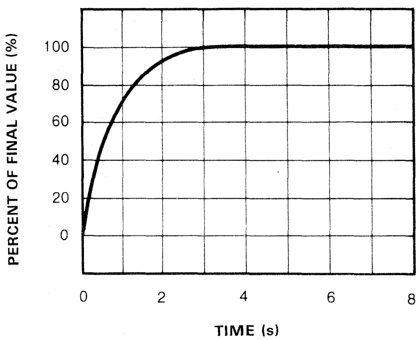
THERMAL TIME CONSTANT



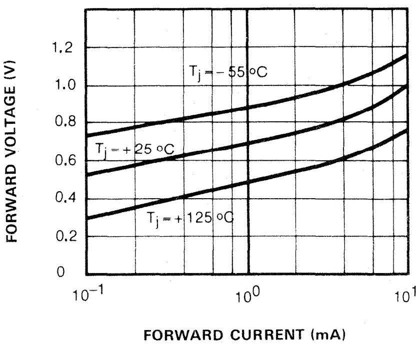
THERMAL RESPONSE IN STILL AIR



THERMAL RESPONSE IN STIRRED OIL BATH



FORWARD CHARACTERICS



APPLICATION HINTS

There is an easy method of calibrating the device for higher accuracies (see typical applications).

The single point calibration works because the output of the LM135, LM235, LM335 is proportional to the absolute temperature with the extrapolated output of sensor going to 0 V at 0°K (– 273.15°C). Errors in output voltage versus temperature are only slope. Thus a calibration of the slope at one temperature corrects errors at all temperatures.

The output of the circuit (calibrated or not) can be given by the equation :

$$V_{OT} = V_{OT_O} \times \frac{T}{T_O}$$

where T is the unknown temperature and T_O is the reference temperature (in °K).

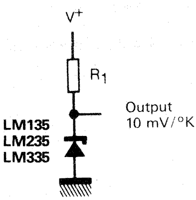
Nominally the output is calibrated at 10 mV/°K.

Precautions should be taken to ensure good sensing accuracy. As in the case of all temperatures sensors, self heating can decrease accuracy. The LM135, LM235, LM335 should operate with a low current,but sufficient to drive the sensor and its calibration circuit to their maximum operating temperature.

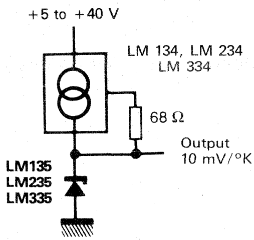
If the sensor is used in surroundings where the thermal resistance is constant, the errors due to self heating can be externally calibrated. This is possible if the circuit is biased with a temperature stable current. Heating will then be proportional to zener voltage and therefore temperature. In this way the error due to self heating is proportional to the absolute temperature as scale factor errors.

TYPICAL APPLICATIONS

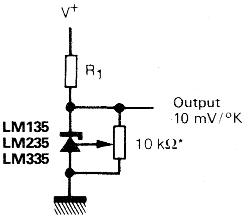
BASIC TEMPERATURE SENSOR



WIDE OPERATING SUPPLY

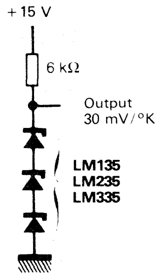


CALIBRATED SENSOR



* Calibrate for 2.982 V at +25°C

AVERAGE TEMPERATURE SENSING



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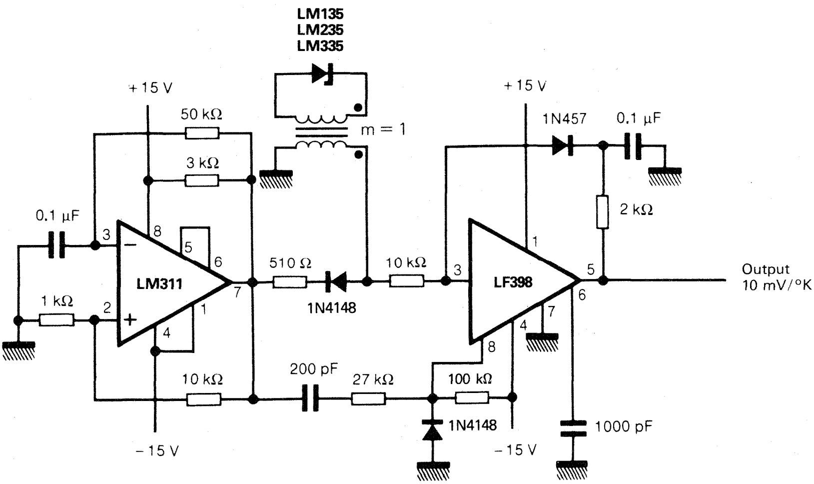
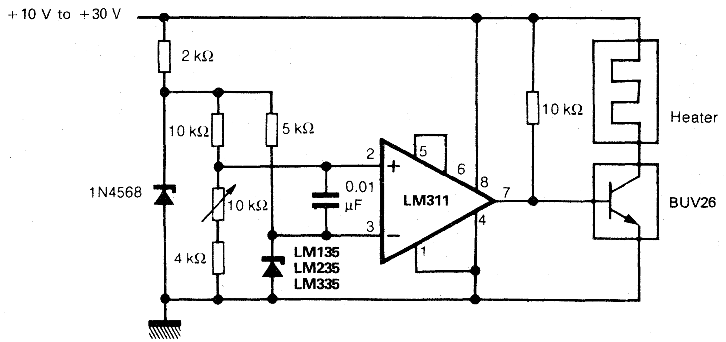
ISOLATED TEMPERATURE SENSOR

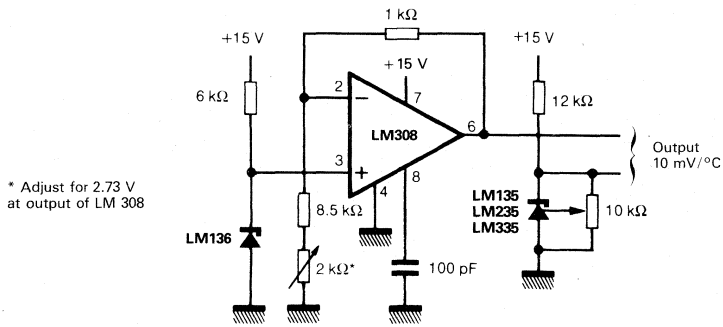


TYPICAL APPLICATIONS (continued)

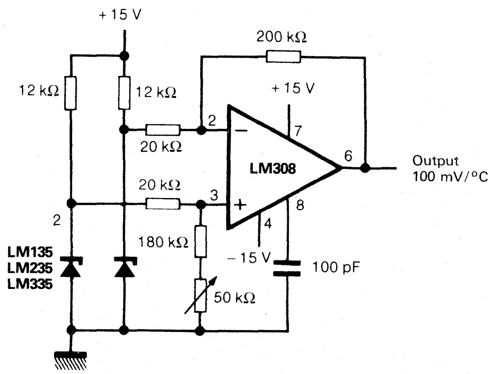
SIMPLE TEMPERATURE CONTROLLER



CENTIGRADE THERMOMETER



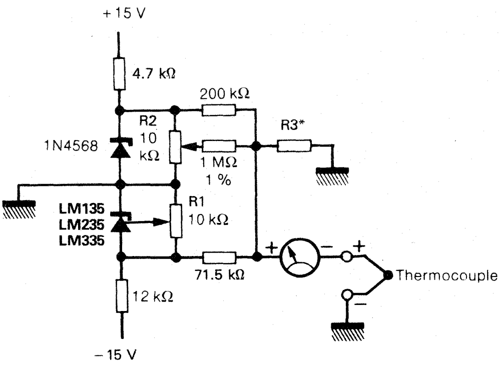
DIFFERENTIAL TEMPERATURE SENSOR



TYPICAL APPLICATIONS (continued)

THERMOCOUPLE COLD JUNCTION COMPENSATION

Compensation for grounded thermocouple



* Select R_3 for proper thermocouple type

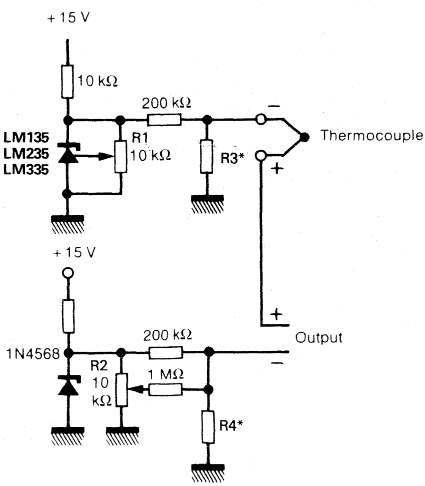
THERMO-COUPLE	R3	SEEBECK COEFFICIENT
J	377 Ω	52.3 µV/°C
T	308 Ω	42.8 µV/°C
K	293 Ω	40.8 µV/°C
S	45.8 Ω	6.4 µV/°C

Adjustments : compensates for both sensor and resistor tolerances.

1. Short 1N4568.
2. Adjust R1 for SEEBECK coefficient times ambient temperature (in degrees K) across R3.
3. Short LM335 and adjust R2 for voltage across R3 corresponding to thermocouple type.

J	14.32 mV	K	11.17 mV
T	11.79 mV	S	1.768 mV

Single power supply cold junction compensation



* Select R3 and R4 for proper thermocouple type.

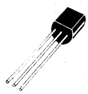
THERMO-COUPLE	R3	R4	SEEBECK COEFFICIENT
J	1.05 kΩ	365 Ω	52.3 µV/°C
T	856 Ω	315 Ω	42.8 µV/°C
K	816 Ω	300 Ω	40.8 µV/°C
S	128 Ω	46.3 Ω	6.4 µV/°C

Adjustments :

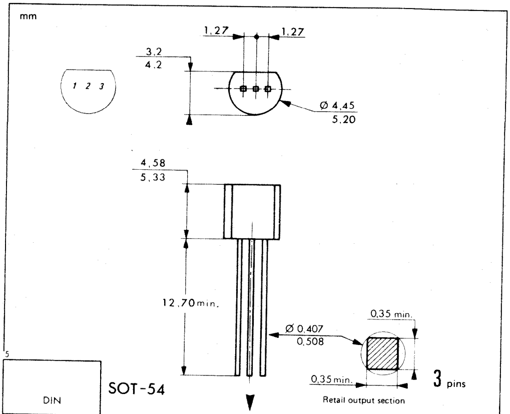
1. Adjust R1 for the voltage across R3 equal to the SEEBECK coefficient times ambient temperature in degrees Kelvin.
2. Adjust R2 for voltage across R4 corresponding to thermocouple.

J	14.32 mV	K	11.17 mV
T	11.79 mV	S	1.768 mV

CB-97
(TO-92)



Z SUFFIX
PLASTIC PACKAGE



DIN	SOT-54			
CEI	TO-92 D.A.T.A.	TO-92 JEDEC	F 129 B SITELESC	CB-97 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

LM236,A
LM336,A

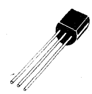
2.5 V VOLTAGE REFERENCES

The LM236 and LM336 are precision 2.5 V regulator diodes. These voltage reference monolithic ICs operate like 2.5 V zener diodes with a low temperature coefficient and a dynamic impedance of 0.2 Ω. A third pin enables adjusting the reference voltage and the temperature coefficient.

- Low temperature coefficient
- Wide operating current of 300 μA to 10 mA
- 0.2 Ω dynamic impedance
- Guaranteed temperature stability
- Fast turn-on.

2.5 V
VOLTAGE REFERENCES

CASE CB-97
(TO-92)

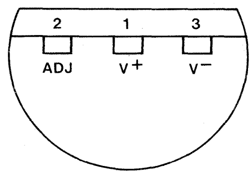


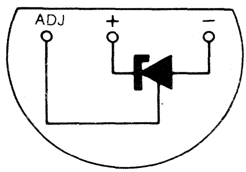
Z SUFFIX
PLASTIC PACKAGE

8

PIN ASSIGNMENT

(Bottom view)





ORDERING INFORMATION

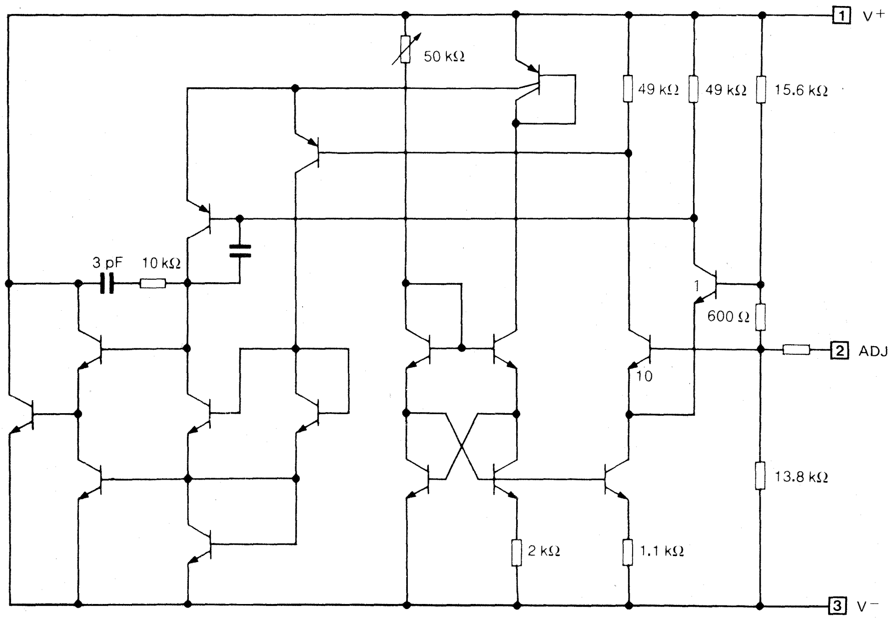
PART NUMBER	TEMPERATURE RANGE	PACKAGE Z
LM236,A	−25°C to +85°C	•
LM336,A	− 0°C to +70°C	•
Example : LM236AZ		

Réf. 00060

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		LM236,A	LM336,A	
Current				mA
Reverse	I_R	15	15	
Forward	I_F	10	10	
Operating free-air temperature range	T_{oper}	−25 to + 85	0 to + 70	°C
Storage temperature range	T_{stg}	−60 to +150	−60 to +150	°C

SCHEMATIC DIAGRAM

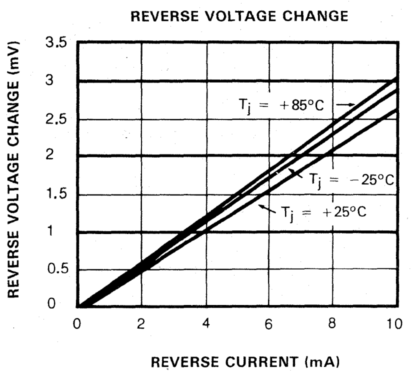


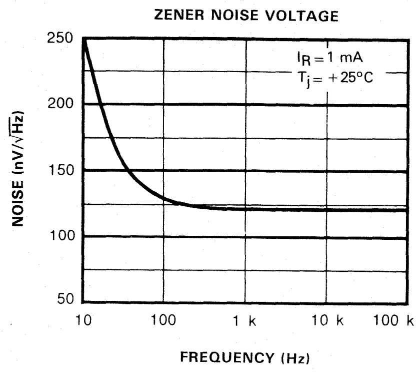
ELECTRICAL CHARACTERISTICS
LM236,A : $-25°C \leq T_{amb} \leq +85°C$
LM336,A : $0°C \leq T_{amb} \leq +70°C$
(Unless otherwise specified)

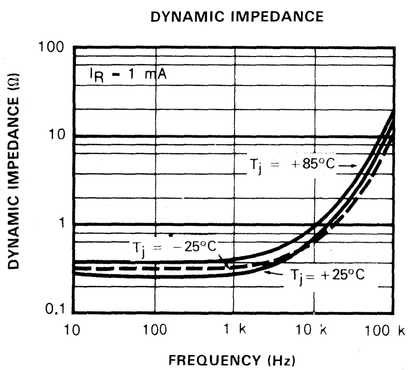
Characteristic	Symbol	LM236,A			LM336,A			Unit
		Min	Typ	Max	Min	Typ	Max	
Reverse breakdown voltage	V_R							V
$T_{amb} = +25°C$ LM236, LM336		2.44	2.49	2.54	2.39	2.49	2.59	
$I_R = 1$ mA LM236A, LM336A		2.465	2.49	2.515	2.44	2.49	2.54	
Reverse breakdown change with current (400 $\mu A \leq I_R \leq 10$ mA)	ΔV_R							mV
$T_{amb} = +25°C$		–	2.6	6	–	2.6	10	
$T_{min} \leq T_{amb} \leq T_{max}$		–	3	10	–	3	12	
Reverse dynamic impedance ($I_R = 1$ mA)	Z_D							Ω
$T_{amb} = +25°C$		–	0.2	0.6	–	0.2	1	
$T_{min} \leq T_{amb} \leq T_{max}$		–	0.4	1	–	0.4	1.4	
Temperature stability ($V_R = 2.49$ V, $I_R = 1$ mA)	K_{VT}	–	3.5	9	–	1.8	6	mV
Long term stability ($T_{amb} = +25°C \pm 0.1°C$, $I_R = 1$ mA)	K_{VH}	–	20	–	–	20	–	ppm

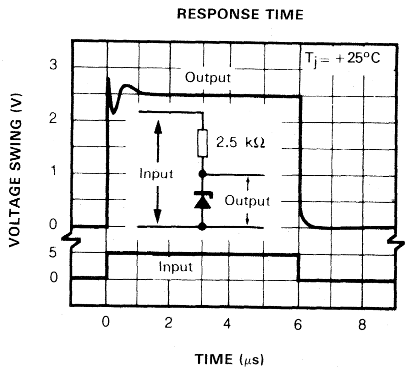
Note 1 : The maximum junction temperature of the LM 236 is + 125°C and the LM 336 is + 100°C. For elevated junction temperature, devices should be derated based on a thermal resistance of 180°C/W junction to ambient with 10 mm leads from a PC board or 160°C/W junction to ambient with 3 mm lead length to a PC board.

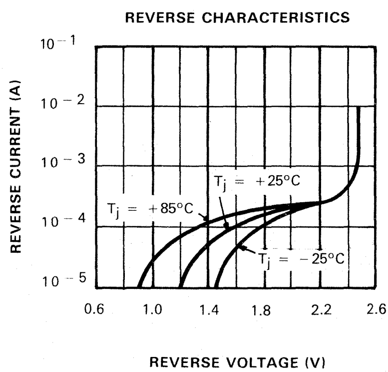
8


REVERSE VOLTAGE CHANGE
REVERSE VOLTAGE CHANGE (mV)
3.5
3
2.5
2
1.5
1
0.5
0
Tj = +85°C
Tj = −25°C
Tj = +25°C
0
2
4
6
8
10
REVERSE CURRENT (mA)

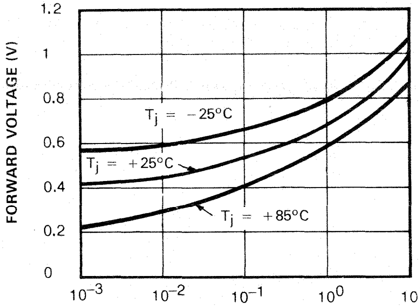

ZENER NOISE VOLTAGE
NOISE (nV/√Hz)
250
200
150
100
50
IR = 1 mA
Tj = +25°C
10
100
1 k
10 k
100 k
FREQUENCY (Hz)


DYNAMIC IMPEDANCE
DYNAMIC IMPEDANCE (Ω)
100
10
1
0.1
IR = 1 mA
Tj = +85°C
Tj = −25°C
Tj = +25°C
10
100
1 k
10 k
100 k
FREQUENCY (Hz)


RESPONSE TIME
VOLTAGE SWING (V)
3
2
1
0
5
0
Tj = +25°C
Output
2.5 kΩ
Input
Output
Input
0
2
4
6
8
TIME (μs)

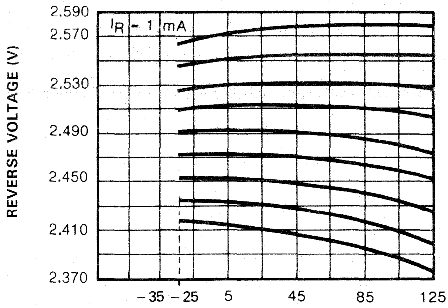

REVERSE CHARACTERISTICS
REVERSE CURRENT (A)
10 − 1
10 − 2
10 − 3
10 − 4
10 − 5
Tj = +25°C
Tj = +85°C
Tj = −25°C
0.6
1.0
1.4
1.8
2.2
2.6
REVERSE VOLTAGE (V)

FORWARD CHARACTERISTICS



FORWARD CURRENT (mA)

TEMPERATURE DRIFT



TEMPERATURE (°C)

APPLICATION HINTS

The LM236, LM336 voltage references are easier to use than zener diodes. Their low impedance and wide current range facilitate biasing in any circuits. Besides, the breakdown voltage or the temperature coefficient can be adjusted so as to optimize the performance of the circuit.

Figure 1 represents a LM 336 with a 10 kΩ potentiometer to adjust the reverse breakdown voltage. By adding resistor R1, the breakdown voltage can be adjusted without altering the temperature coefficient of the circuit. The adjustment range is generally sufficient to adjust the initial tolerance of the circuit and the inaccuracy of the amplifier circuit.

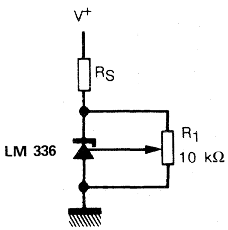


FIGURE 1 – THE LM 336 WITH POT FOR ADJUSTMENT OF BREAKDOWN VOLTAGE

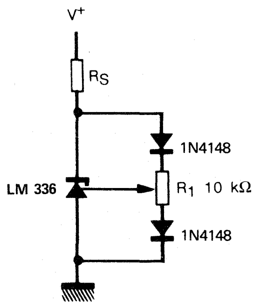


FIGURE 2 – TEMPERATURE COEFFICIENT ADJUSTMENT

To obtain a lower temperature coefficient two diodes can be connected in series as indicated in fig. 2. When the circuit is adjusted to 2.49 V the temperature coefficient is minimized.

For a correct temperaturee coefficient, the diodes should be at the same ambient temperature as the LM 336. The value of R1 is not critical (2-20 kΩ).

TYPICAL APPLICATIONS

FIGURE 3 — 2.5 V REFERENCE

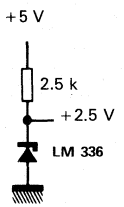
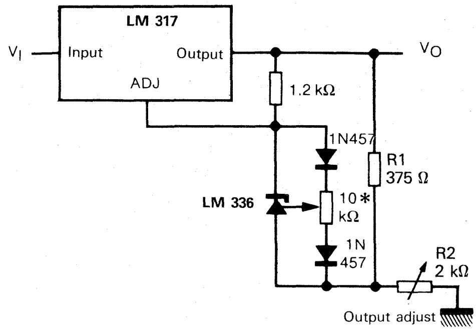


FIGURE 4 — PRECISION POWER REGULATOR WITH LOW TEMPERATURE COEFFICIENT



* Adjust for 3.75 V across R1

FIGURE 5 — WIDE INPUT RANGE REFERENCE

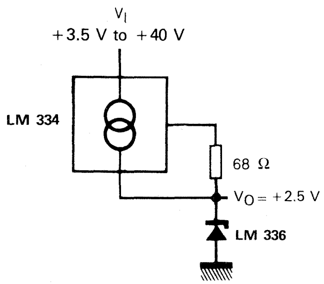
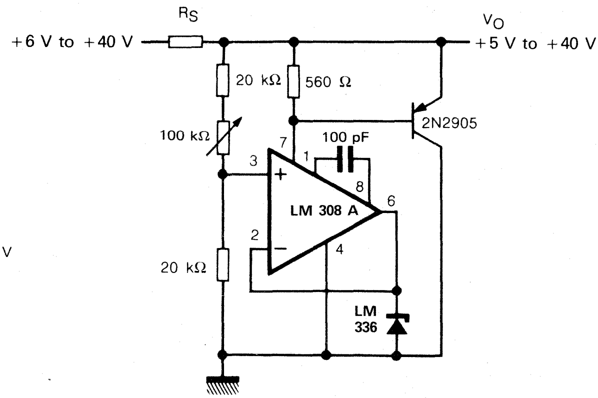


FIGURE 6 — ADJUSTABLE SHUNT REGULATOR



TYPICAL APPLICATIONS (continued)

FIGURE 7 – LINEAR OHMMETER

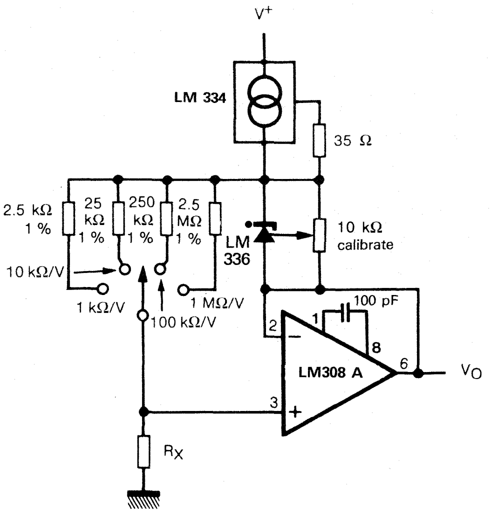


FIGURE 8 – BIPOLAR OUTPUT REFERENCE

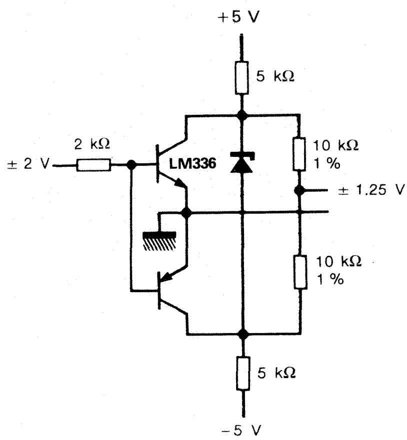


FIGURE 9 – 5 V BUFFERED REFERENCE

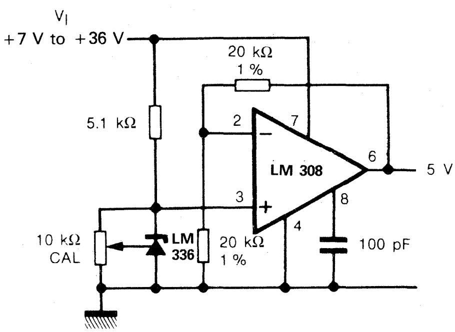
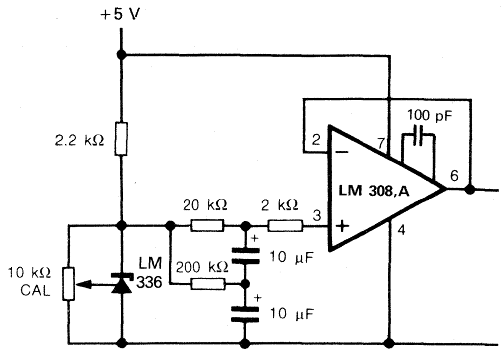
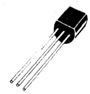


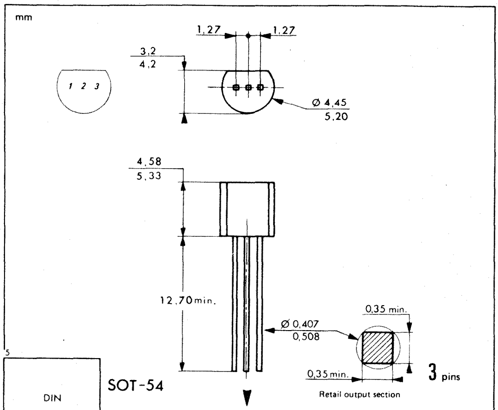
FIGURE 10 – LOW NOISE BUFFERED REFERENCE



CB-97
(TO-92)



Z SUFFIX
PLASTIC PACKAGE



DIN	SOT-54			
CEI	TO-92 D.A.T.A.	TO-92 JEDEC	F 129 B SITELESC	CB-97 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

NE555
SE555

TIMER CIRCUIT

The NE555/SE555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillations.
Additionnal terminals are provided for triggering or resetting if desired.
In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor.

For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor.

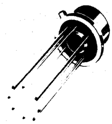
The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive TTL circuits.

- Timing from microseconds through hours.
- Operates in both astable and monostable modes.
- Adjustable duty cycle.
- High current output can source or sink 200 mA.
- Temperature stability of 0.005% per °C.

TIMER CIRCUIT

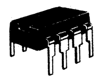
CASES

CB-11



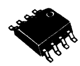
H SUFFIX
METAL CAN

CB-98



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE

ORDERING INFORMATION

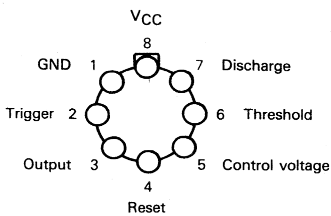
Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE			
		DP	DG	FP	H
NE555	0°C to + 70°C	•	•	•	•
SE555	−55°C to +125°C	•	•		•
NE555I	−40°C to + 85°C	•	•		

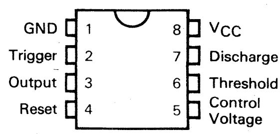
Examples : NE555DP, NE555IDG

PIN ASSIGNMENTS
(Top views)

CB-11



CB-98
CB-342

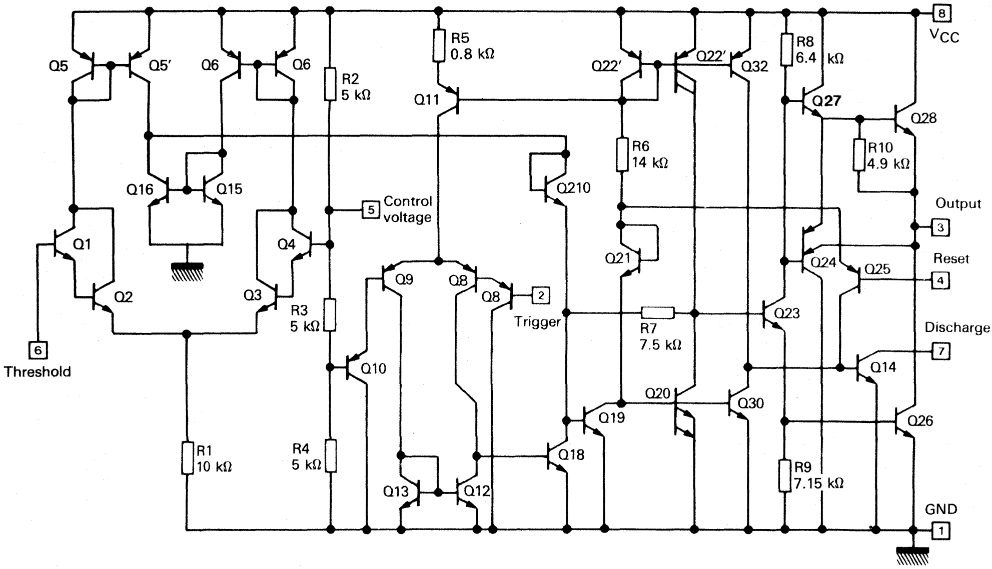


Réf. 00360

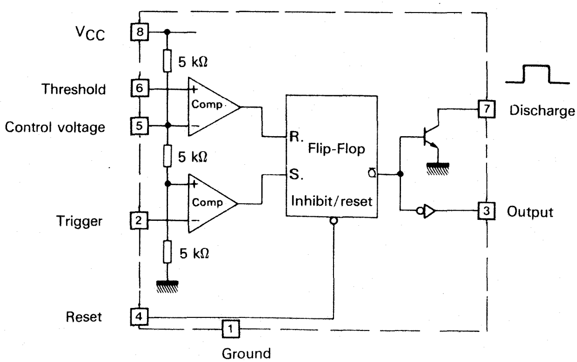
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	18	V
Output current	I_O	200	mA
Power dissipation	P_{tot}	600	mW
Operating free-air temperature range SE555 NE555 NE555I	T_{oper}	 – 55 to + 125 0 to + 70 – 40 to + 85	°C
Storage temperature range	T_{stg}	– 65 to + 150	°C

SCHEMATIC DIAGRAM



EQUIVALENT SCHEMATIC



ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +5$ V to $+15$ V
(Unless otherwise specified)

Characteristic	Symbol	SE555			NE555, NE555I			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply voltage	V_{CC}	4.5	–	18	4.5	–	16	V
Supply current ($R_L = \infty$) - Note 1	I_{CC}							mA
Low state $V_{CC} = +5$ V		–	3	5	–	3	6	
$V_{CC} = +15$ V		–	10	12	–	10	15	
High state $V_{CC} = +5$ V		–	2	–	–	2	–	
Timing error (monostable) ($R_A = 1$ to 100 kΩ, $C = 0.1$ μF)	–							
– Initial accuracy (Note 2)		–	0.5	2	–	1	–	%
– Drift with temperature		–	30	100	–	50	–	ppm/°C
– Drift with supply voltage		–	0.05	0.2	–	0.1	–	%/V
Timing error (astable) (R_A, $R_B = 1$ kΩ to 100 kΩ, $C = 0.1$ μF, $V_{CC} = +15$ V)	–							
– Initial accuracy (Note 2)		–	1.5	–	–	2.25	–	%
– Drift with temperature		–	90	–	–	150	–	ppm/°C
– Drift with supply voltage		–	0.15	–	–	0.3	–	%/V
Control voltage level	V_{CL}							V
$V_{CC} = +15$ V		9.6	10	10.4	9	10	11	
$V_{CC} = +5$ V		2.9	3.33	3.8	2.6	3.33	4	
Threshold voltage	V_{th}							V
$V_{CC} = +15$ V		9.4	10	10.6	8.8	10	11.2	
$V_{CC} = +5$ V		2.7	3.33	4	2.4	3.33	4.2	
Threshold current - (Note 3)	I_{th}	–	0.1	0.25	–	0.1	0.25	μA
Trigger voltage	V_{trig}							V
$V_{CC} = +15$ V		4.8	5	5.2	4.5	5	5.5	
$V_{CC} = +5$ V		1.45	1.67	1.9	1.1	1.67	2.2	
Trigger current ($V_{trig} = 0$ V)	I_{trig}	–	0.5	0.9	–	0.5	2.0	μA
Reset voltage - (Note 4)	V_{reset}	0.4	0.7	1	0.4	0.7	1	V
Reset current	I_{reset}							mA
$V_{reset} = +0.4$ V		–	0.1	0.4	–	0.1	0.4	
$V_{reset} = 0$ V		–	0.4	1	–	0.4	1.5	
Low level output voltage	V_{OL}							V
$V_{CC} = +15$ V, $I_{O(sink)} = 10$ mA		–	0.1	0.15	–	0.1	0.25	
$I_{O(sink)} = 50$ mA		–	0.4	0.5	–	0.4	0.75	
$I_{O(sink)} = 100$ mA		–	2.0	2.2	–	2.0	2.5	
$I_{O(sink)} = 200$ mA		–	2.5	–	–	2.5	–	
$V_{CC} = +5$ V, $I_{O(sink)} = 8$ mA		–	0.1	0.25	–	0.3	0.4	
$I_{O(sink)} = 5$ mA		–	0.05	0.2	–	0.25	0.35	
High level output voltage	V_{OH}							V
$V_{CC} = +15$ V, $I_{O(source)} = 200$ mA		–	12.5	–	–	12.5	–	
$I_{O(source)} = 100$ mA		13.0	13.3	–	12.75	13.3	–	
$V_{CC} = +5$ V, $I_{O(source)} = 100$ mA		3	3.3	–	2.75	3.3	–	
Discharge pin leakage current (Output high)	$I_{dis(off)}$	–	1	100	–	1	100	nA
Discharge pin saturation voltage (Output low) - Note 5	$V_{dis(sat)}$							mV
$V_{CC} = +15$ V, $I_{dis} = 15$ mA		–	150	–	–	180	–	
$V_{CC} = +4.5$ V, $I_{dis} = 4.5$ mA		–	70	100	–	80	200	
Output rise time	t_r	–	100	200	–	100	300	ns
Output fall time	t_f	–	100	200	–	100	300	

Note 1 : Supply current when output is high is typically 1 mA less.

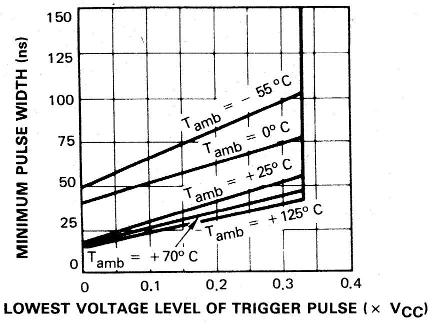
Note 2 : Tested at $V_{CC} = +5$ V and $V_{CC} = +15$ V.

Note 3 : This will determine the maximum value of $R_A + R_B$ for +15 V operation, the max total is R = 20 MΩ.

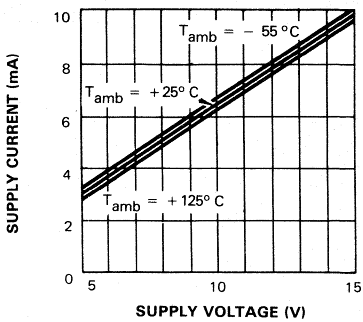
Note 4 : Specified with trigger input high.

Note 5 : No protection against excessive pin 7 current is necessary, providing the package dissipation rating will not be exceeded.

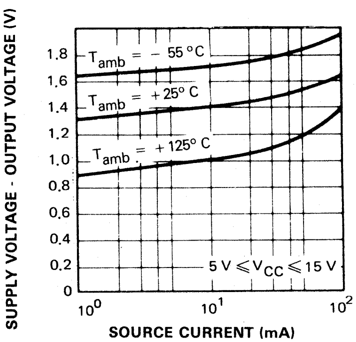
MINIMUM PULSE WIDTH REQUIRED FOR TRIGGERING



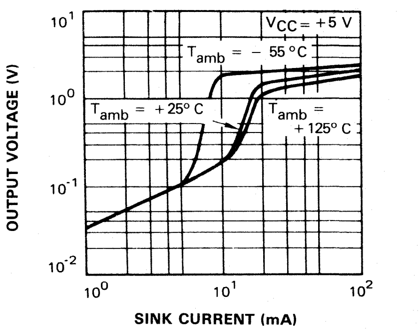
SUPPLY CURRENT vs SUPPLY VOLTAGE



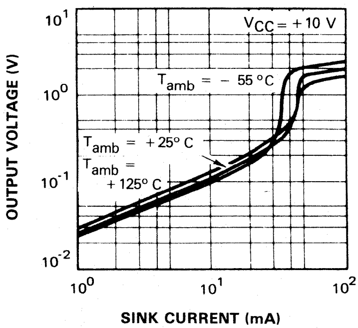
HIGH OUTPUT VOLTAGE vs OUTPUT SINK CURRENT



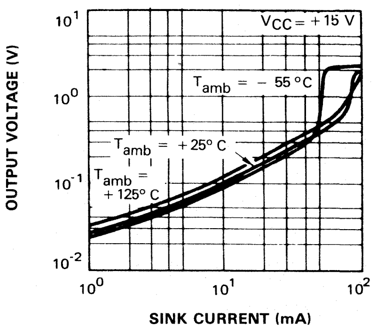
LOW OUTPUT VOLTAGE vs OUTPUT SINK CURRENT



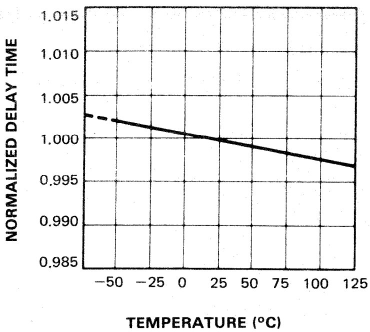
LOW OUTPUT VOLTAGE vs OUTPUT SOURCE CURRENT



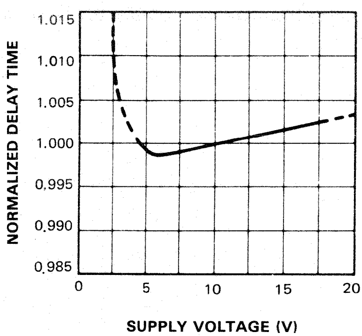
LOW OUTPUT VOLTAGE vs OUTPUT SINK CURRENT



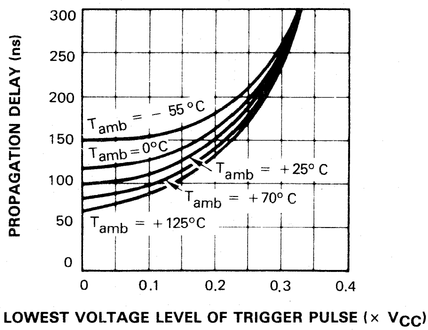
DELAY TIME vs TEMPERATURE



DELAY TIME vs SUPPLY VOLTAGE

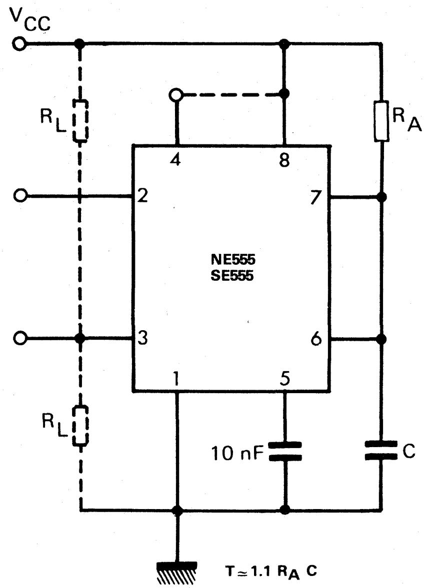


PROPAGATION DELAY vs
VOLTAGE LEVEL OF TRIGGER PULSE

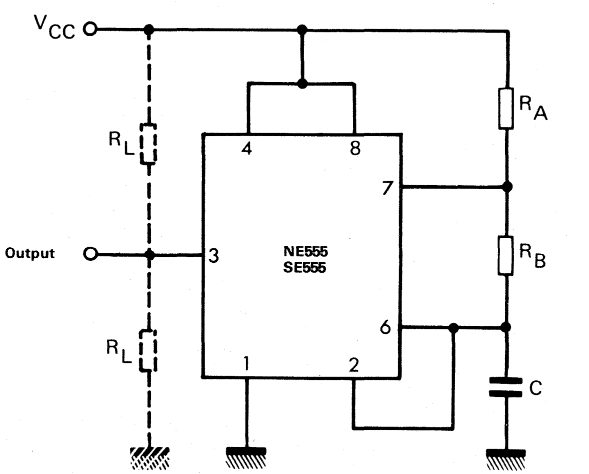


TYPICAL CHARACTERISTICS

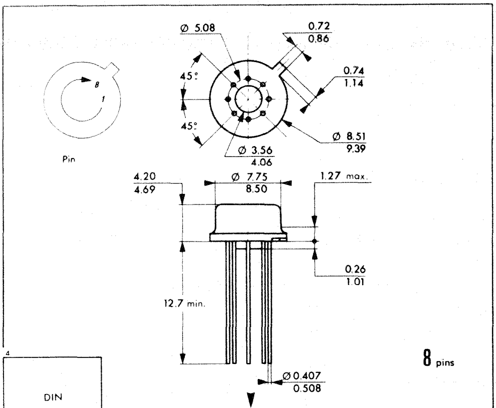
MONOSTABLE OPERATION



ASTABLE OPERATION

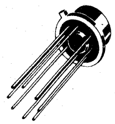


Operating frequency $f \simeq \frac{1.44}{(R_A + 2\,R_B)\,C}$ R_A and R_B in kΩ, C in μF

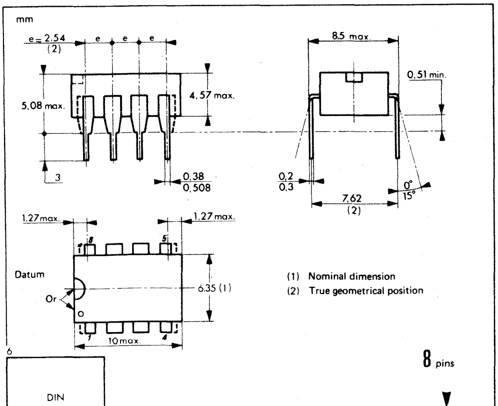


DIN				
Case : Base : C-23 CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

CB-11
(TO-99)

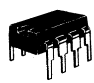


H SUFFIX
METAL CAN



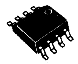
DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

CB-98

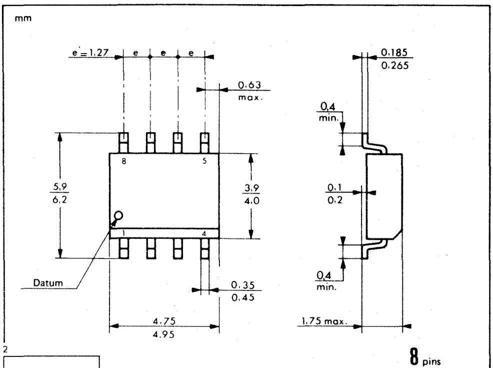


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-342



FP SUFFIX
PLASTIC
MICROPACKAGE



DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

NE556 SE556

DUAL TIMERS

The NE556/SE556 dual timing circuits are highly stable controllers capable of producing accurate time delays, or oscillation.

The NE556/SE556 are dual 555. The two timers operate independently of each other sharing only V_{CC} and ground.

For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor.

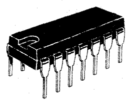
The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive TTL circuits.

- Replaces two NE555/SE555 timers.
- Timing from microseconds through hours.
- Operates in both astable and monostable modes.
- Adjustable duty cycle.
- High current output can source or sink 200 mA.
- Temperature stability of 0.005% per °C.

DUAL TIMERS

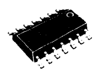
CASES

CB-2



DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

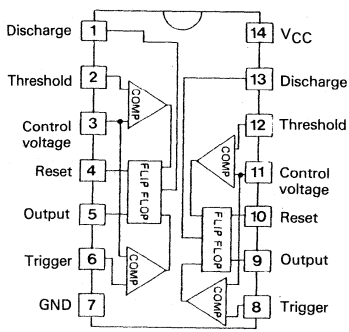
ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE		
		DP	DG	FP
NE556C	0°C to + 70°C	•	•	•
SE556M	−55°C to +125°C		•	
Examples : NE556CDP, SE556MDG				

PIN ASSIGNMENT

(Top view)



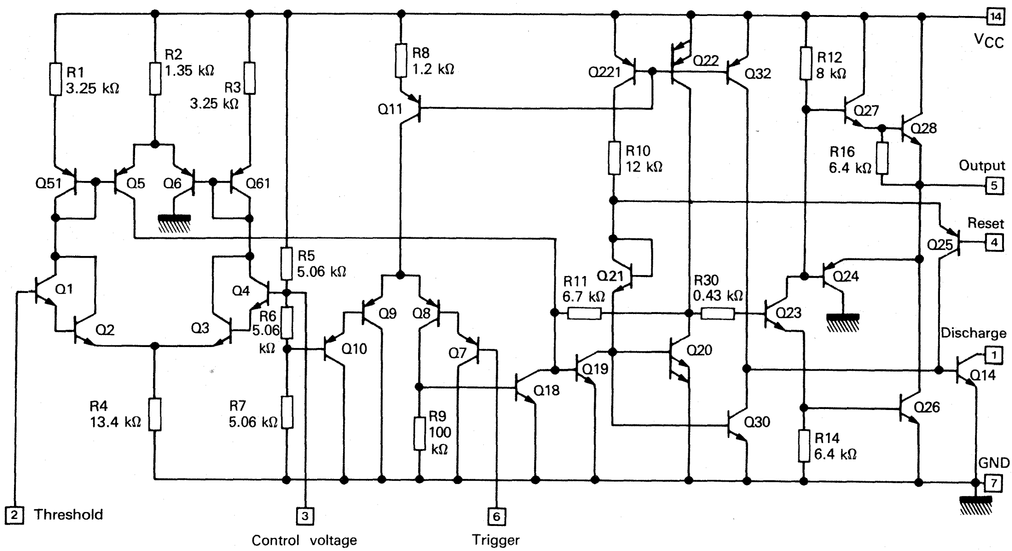
CB-2, CB-511

Réf. 00355

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	+18	V
Output current	I_O	200	mA
Power dissipation	P_{tot}	600	mW
Operating ambient temperature range SE556 / NE556	T_{oper}	−55 to +125 / 0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	°C

SCHEMATIC DIAGRAM (1/2 NE556)



CASE	Discharge	Threshold	Control voltage	Reset	Outputs	Trigger	GND	V_{CC}
CB-2 CB-511	1, 13	2, 12	3, 11	4, 10	5, 9	6, 8	7	14

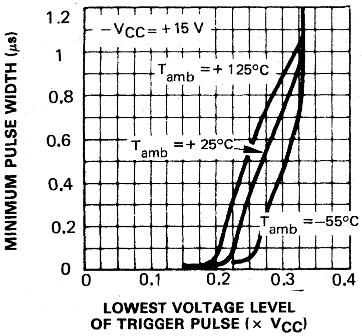
ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +5$ to $+15$ V
(Unless otherwise specified)

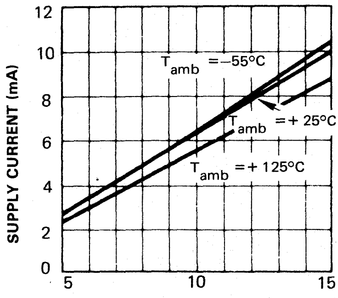
Characteristic	Symbol	SE556			NE556			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply voltage	V_{CC}	4.5	–	18	4.5	–	16	V
Supply current ($R_L = \infty$) - Note 1	I_{CC}							mA
Low state, $V_{CC} = +5$ V		–	6	10	–	6	12	
$V_{CC} = +15$ V		–	20	24	–	20	30	
High state, $V_{CC} = +5$ V		–	4	–	–	4	–	
Timing error (monostable)	–							
$R_A = 1$ kΩ to 100 kΩ, $C = 0.1$ µF								
– Initial accuracy (Note 2)		–	0.5	1.5	–	0.75	–	%
– Drift with temperature		–	30	100	–	50	–	ppm/°C
– Drift with supply voltage		–	0.05	0.2	–	0.1	–	%/V
Timing error (astable)								
R_A, $R_B = 1$ kΩ to 100 kΩ, $C = 0.1$ µF, $V_{CC} = +15$ V								
– Initial accuracy (Note 2)		–	1.5	–	–	2.25	–	%
– Drift with temperature		–	90	–	–	150	–	ppm/°C
– Drift with supply voltage		–	0.15	–	–	0.3	–	%/V
Control voltage level	V_{CL}							V
$V_{CC} = +15$ V		9.6	10	10.4	9	10	11	
$V_{CC} = +5$ V		2.9	3.33	3.8	2.6	3.33	4	
Threshold voltage	V_{th}							V
$V_{CC} = +15$ V		9.4	10	10.6	8.8	10	11.2	
$V_{CC} = +5$ V		2.7	3.33	4	2.4	3.33	4.2	
Threshold current (Note 3)	I_{th}	–	0.1	0.25	–	0.1	0.25	µA
Trigger voltage	V_{trig}							V
$V_{CC} = +15$ V		4.8	5	5.2	4.5	5	5.5	
$V_{CC} = +5$ V		1.45	1.67	1.9	1.1	1.67	2.2	
Trigger current ($V_{trig} = 0$ V)	I_{trig}	–	0.5	0.9	–	0.5	2	µA
Reset voltage (Note 4)	V_{reset}	0.4	0.7	1	0.4	0.7	1	V
Reset current	I_{reset}							mA
$V_{reset} = 0.4$ V		–	0.1	0.4	–	0.1	0.4	
$V_{reset} = 0$ V		–	0.4	1	–	0.4	1.5	
Low level output voltage	V_{OL}							V
$V_{CC} = +15$ V, $I_{O(sink)} = 10$ mA		–	0.1	0.15	–	0.1	0.25	
$I_{O(sink)} = 50$ mA		–	0.4	0.5	–	0.4	0.75	
$I_{O(sink)} = 100$ mA		–	2	2.25	–	2	2.75	
$I_{O(sink)} = 200$ mA		–	2.5	–	–	2.5	–	
$V_{CC} = +5$ V, $I_{O(sink)} = 8$ mA		–	0.1	0.25	–	0.3	0.4	
$I_{O(sink)} = 5$ mA		–	0.05	0.2	–	0.25	0.35	
Output voltage drop (high state)	V_{OH}							V
$V_{CC} = +15$ V, $I_{O(source)} = 200$ mA		–	12.5	–	–	12.5	–	
$I_{O(source)} = 100$ mA		13	13.3	–	12.75	13.3	–	
$V_{CC} = +5$ V, $I_{O(source)} = 100$ mA		3	3.3	–	2.75	3.3	–	
Discharge leakage current (pins 1 and 13)	$I_{dis(off)}$	–	1	100	–	1	100	nA
Discharge saturation voltage (pins 1 and 13) - Note 6	$V_{dis(sat)}$							nV
$V_{CC} = +15$ V, $I_{(7)} = 15$ mA		–	150	–	–	180	–	
$V_{CC} = +4.5$ V, $I_{(7)} = 4.5$ mA		–	70	100	–	80	200	
Rise time of output	t_r	–	100	200	–	100	300	ns
Fall time of output	t_f	–	100	200	–	100	300	ns
Matching characteristics (Note 5)	–							
Initial accuracy (Note 2)		–	0.5	1	–	1	2	%
Drift with temperature		–	± 10	–	–	± 10	–	ppm/°C
Drift with supply voltage		–	0.1	0.2	–	0.2	0.5	%/V

Note 1 : Supply current when output high typically 1 mA less at $V_{CC} = +5$ V.
Note 2 : Tested at $V_{CC} = +5$ V and $V_{CC} = +15$ V.
Note 3 : This will determine the maximum value of $R_A + R_B$ for 15 V operation. The maximum total is R = 20 MΩ.
Note 4 : Specified with trigger input high.
Note 5 : Matching characteristics refer to the difference between performance characteristics of each timer section.
Note 6 : No protection against excessive pin 1, 13 current is necessary providing the package dissipation rating will not be exceeded.

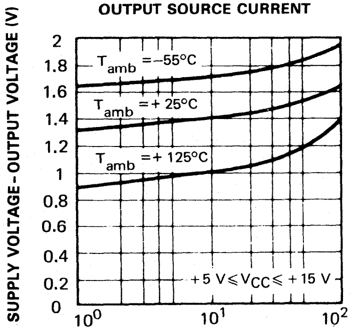
MINIMUM PULSE WIDTH REQUIRED FOR TRIGGERING



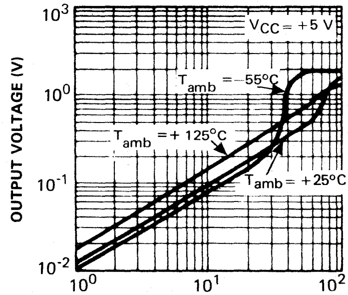
SUPPLY CURRENT VERSUS SUPPLY VOLTAGE (each section)



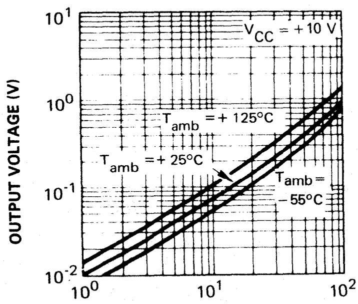
HIGH OUTPUT VOLTAGE VERSUS OUTPUT SOURCE CURRENT



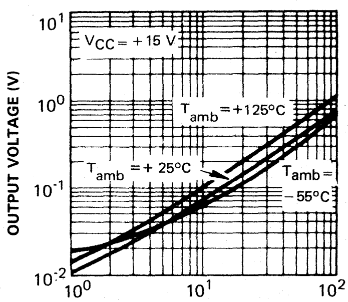
LOW OUTPUT VOLTAGE VERSUS OUTPUT SINK CURRENT



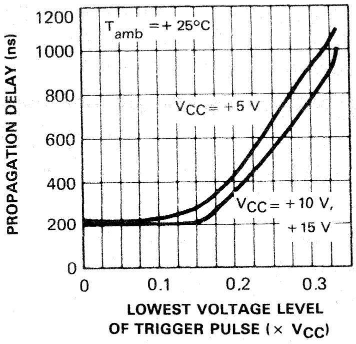
LOW OUTPUT VOLTAGE VERSUS OUTPUT SINK CURRENT



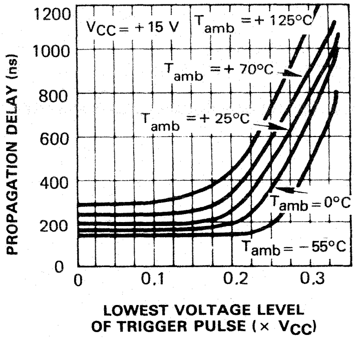
LOW OUTPUT VOLTAGE VERSUS OUTPUT SINK CURRENT



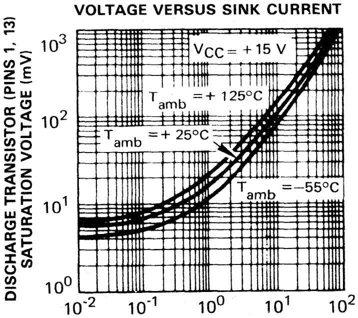
OUTPUT PROPAGATION DELAY VERSUS VOLTAGE LEVEL OF TRIGGER PULSE



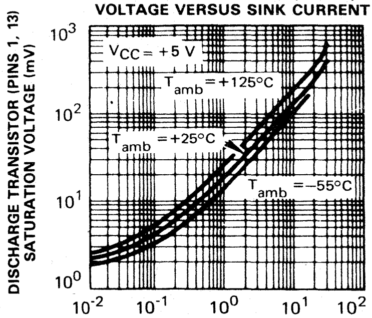
OUTPUT PROPAGATION DELAY VERSUS VOLTAGE LEVEL OF TRIGGER PULSE



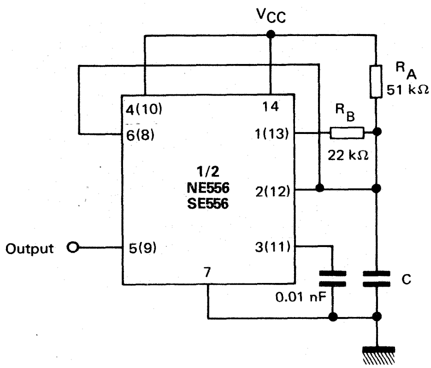
DISCHARGE TRANSISTOR (PINS 1, 13) VOLTAGE VERSUS SINK CURRENT



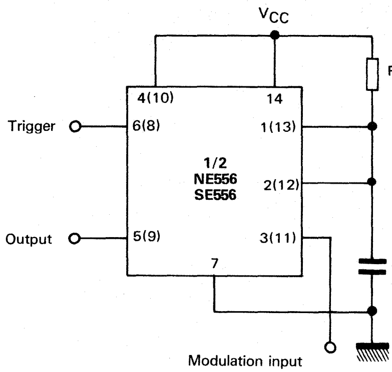
DISCHARGE TRANSISTOR (PINS 1, 13) VOLTAGE VERSUS SINK CURRENT



50% DUTY CYCLE OSCILLATOR



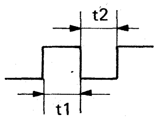
PULSE WIDTH MODULATOR



$t1 = 0.693\ R_A.C$

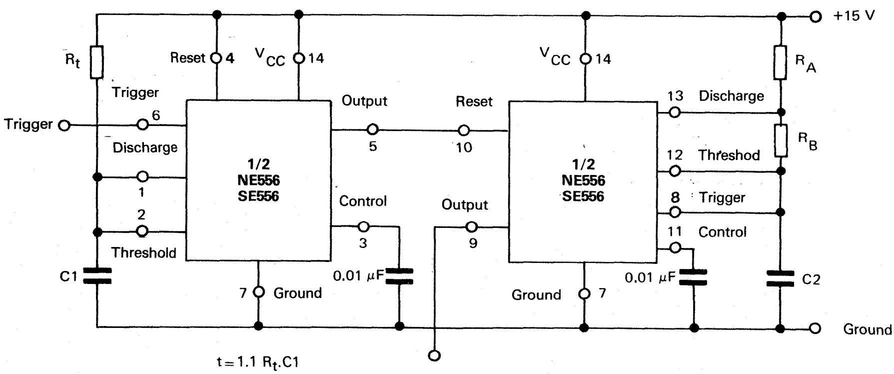
$$t2 = [(R_A R_B)/(R_A + R_B)]\,C \quad l_n \quad \left[\frac{R_B - 2R_A}{2R_B - R_A}\right]$$

$$f = \frac{1}{t1 + t2} \qquad R_B < \frac{1}{2} R_A$$



TONE BURST GENERATOR

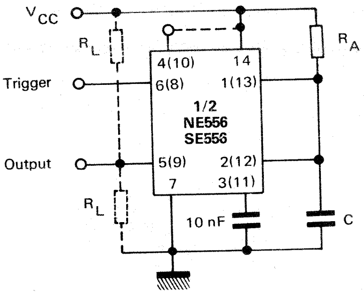
For a tone burst generator the first timer is used as a monostable and determines the tone duration when triggered by a positive pulse at pin 6. The second timer is enabled by the high output of the monostable. It is connected as an astable and determines the frequency of the tone.



$t = 1.1\ R_t.C1$

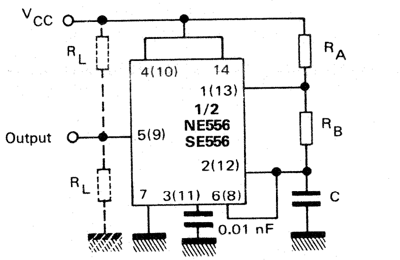
$$f = \frac{1.44}{(R_A + 2R_B)\ C}$$

MONOSTABLE OPERATION

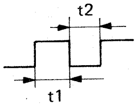


$T \cong 1.1\ R_A.C$

ASTABLE OPERATION

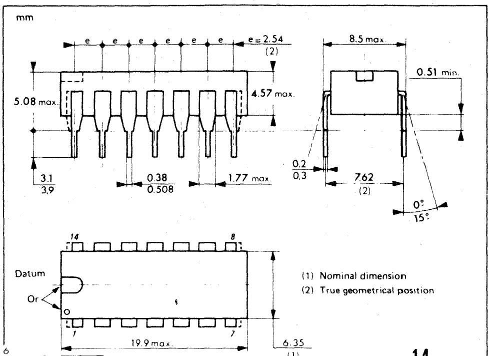


Operating frequency $f \cong \frac{1.44}{(R_A + 2\ R_B)C}$



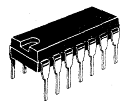
$t1 = 0.693\ (R_A + R_B)C$ Output high

$t2 = 0.693\ R_B C$ Output low

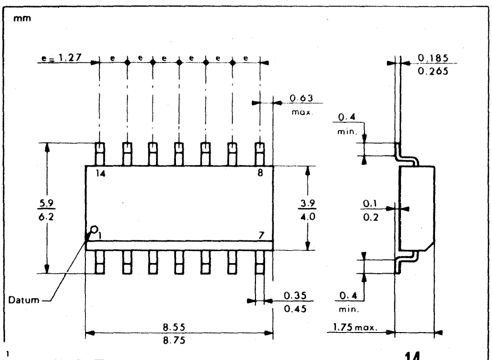


DIN				
A50B CEI	TO-116 DATA	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

CB-2
(TO-116)

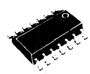


DP SUFFIX
PLASTIC PACKAGE
DG SUFFIX
CERDIP PACKAGE



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS

CB-511



FP SUFFIX
PLASTIC MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TDB2046

TRANSISTOR ARRAYS

The TDB2046 consists of 5 NPN general-purpose monolithic transistors. They are well suited to a wide range of applications and offer significant inherent integrated circuit advantages of excellent electrical characteristics matching and good thermal coupling thus minimizing temperature drifts.

Two of the transistors are internally connected through emitters thus forming a differential pair.

The TDB2046 is used in high and low frequency linear applications for both discrete component design and prototyping models intented for monolithic integration.

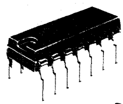
The circuit is particularly suitable to building low drift direct coupled amplifiers.

- Matched pair of transistors : ΔV_{BE} ±5 mV max.
- Operating frequency range : DC to 120 MHz.

TRANSISTOR ARRAYS

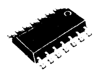
CASES

CB-2 (TO-116)



DP SUFFIX
PLASTIC PACKAGE

CB-511



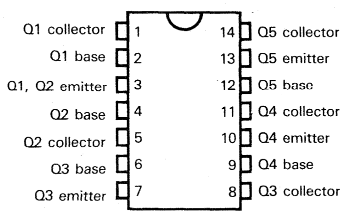
FP SUFFIX
PLASTIC MICROPACKAGE

ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	FP
TDB2046	−0°C to +85°C	•	•
Example : TDB2046DP			

PIN ASSIGNMENT

(Top view)



Réf. 00155

THOMSON SEMICONDUCTORS
Sales headquarters
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Tel. : (3) 946 97 19 / Telex : 204780 F

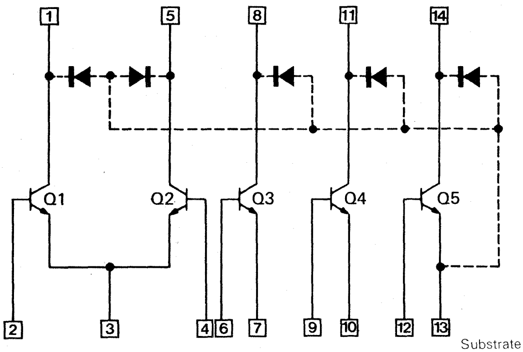
THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-emitter voltage	V_{CEO}	15	V
Collector-base voltage	V_{CBO}	20	V
Emitter-base voltage	V_{EBO}	5	V
Collector current-continuous	I_C	50	mA
Collector-substrate voltage (Note 1)	V_{CSO}	20	V
Power dissipation ($T_{amb} = +25°C$)	P_{tot}	750	mW
Operating free-air temperature range	T_{oper}	0 to +85	°C
Storage temperature range	T_{stg}	−55 to +125	°C

Note 1 : The collector of each transistor is isolated from the substrate by an integrated diode. The substrate must be connected to the most negative point in the external circuit to provide for normal transistor action.

SCHEMATIC DIAGRAM

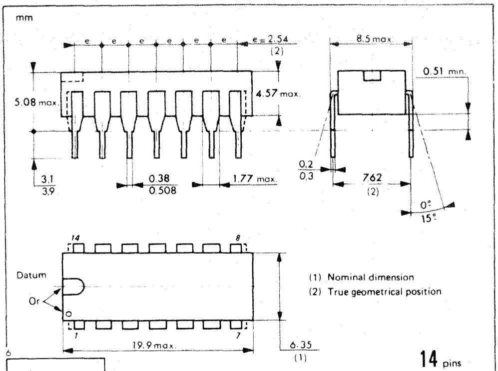


CASE		Collector	Emitter	Base
CB-2 CB-511	Q1	1	3	2
	Q2	5	3	4
	Q3	8	7	6
	Q4	11	10	9
	Q5	14	13	12

ELECTRICAL CHARACTERISTICS

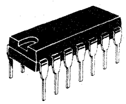
$T_{amb} = +25°C$, potentials referenced to ground
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector substrate breakdown voltage ($I_C = 10\ \mu A$, $I_{SC} = 0$)	$V_{(BR)CSO}$	20	60	–	V
Collector-base breakdown voltage ($I_C = 10\ \mu A$, $I_E = 0$)	$V_{(BR)CBO}$	20	60	–	V
Collector-emitter breakdown voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	15	24	–	V
Emitter-base breakdown voltage ($I_E = 10\ \mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5	7	–	V
Static forward current transfer ratio ($V_{CE} = 3$ V, $I_C = 1$ mA)	h_{21E}	40	100	–	–
Collector-emitter saturation voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(sat)}$	–	0.23	–	V
Gain bandwidth product ($V_{CE} = 3$ V, $I_C = 3$ mA)	f_T	300	550	–	MHz
Collector-substrate capacitance ($V_{CE} = 3$ V, $I_C = 0$)	C_{CS}	–	2.8	–	pF
Collector-base capacitance ($V_{CB} = +3$ V, $I_C = 0$)	C_{CB}	–	0.58	–	pF
Noise figure (f = 1 kHz, $V_{CE} = +3$ V, $I_C = 100\ \mu A$, $R_S = 1\ k\Omega$)	F	–	3.25	–	dB
Base-emitter differential voltage ($V_{BE1} - V_{BE2}$) - $V_{CE} = +3$ V, $I_C = 1$ mA	V_{ID}	–	0.45	5	mV
Base-differential current ($I_{B1} - I_{B2}$) - $V_{CE} = +3$ V, $I_C = 1$ mA	I_{ID}	–	0.3	2	μA

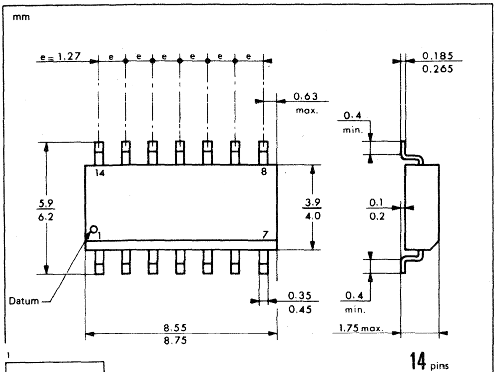


DIN				
A50B CEI	TO-116 D.A.T.A.	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

CB-2
(TO-116)

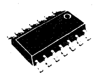


DP SUFFIX
PLASTIC PACKAGE



DIN	SO14			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-511 THOMSON SEMICONDUCTORS

CB-511
(SO-14)



FP SUFFIX
PLASTIC MICROPACKAGE

This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TEA7087

ADVANCE INFORMATION

ALTERNATOR VOLTAGE REGULATOR WITH FAILURE DETECTION

The TEA7087 has been specially designed for automotive applications where it performs the following functions :

- Correct regulation of alternator output voltage even with battery disconnected.
- Regulator threshold, and high alternator voltage warning threshold, are externally adjustable and stay proportional.
- Driving a warning lamp to indicate the following failures :
  - High battery voltage.
  - Regulated voltage sensing circuit disconnected (at the same time, alternator excitation current cuts-off).
  - Lack of phase voltage (broken belt).
  - Broken alternator to battery connecting cable.
  - Regulator supply voltage failure.

The TEA7087 includes warning lamp drive, overvoltage, short-circuit and thermal protections. It is particularly suitable for hybrid applications.

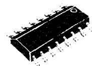
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	
		DP	FP
TEA7087	−30°C to +130°C	•	•
Example : TEA7087DP			

ALTERNATOR VOLTAGE REGULATOR WITH FAILURE DETECTION

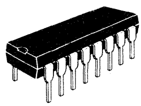
CASES

CB-359



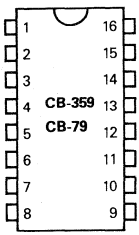
FP SUFFIX
PLASTIC MICROPACKAGE

CB-79



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT



PIN DESCRIPTION	DP Suffix	FP Suffix
+ alternator battery broken cable detection	2, 15	1, 16
Regulated voltage sense filtering	3	2
N.C.	1, 9, 10, 16	3, 9, 10, 15
Regulator output	4	4
GND	5	5
Delay capacitor	6	6
Phase sense	7	7
Lamp driver ground	8	8
Output to drive warning lamp	11	11
Warning lamp voltage monitoring	12	12
Base of lamp-driving darlington	13	13
V_{CC}	14	14

Réf. 00175

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage D.C. voltage during $t \leqslant 5$ min For overvoltage (Fig. 1)	 V_{CC} V_{CCO}	 28 80	V
Operating temperature range	T_{oper}	−30 to +130	°C

THERMAL CHARACTERISTICS

Characteristic		Symbol	Value	Unit
Maximum junction-case thermal resistance Maximum junction-ambient thermal resistance	CB-79 CB-79	$R_{th(j-c)}$ $R_{th(j-a)}$	30 80	°C/W
Junction-ceramic substrate (Case glued to substrate)	CB-511	–	90	°C/W

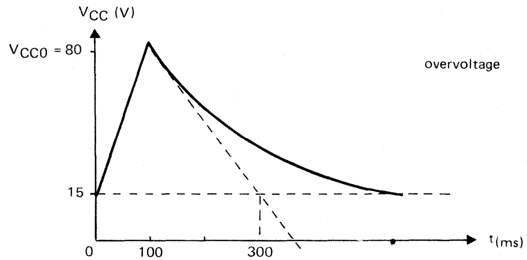
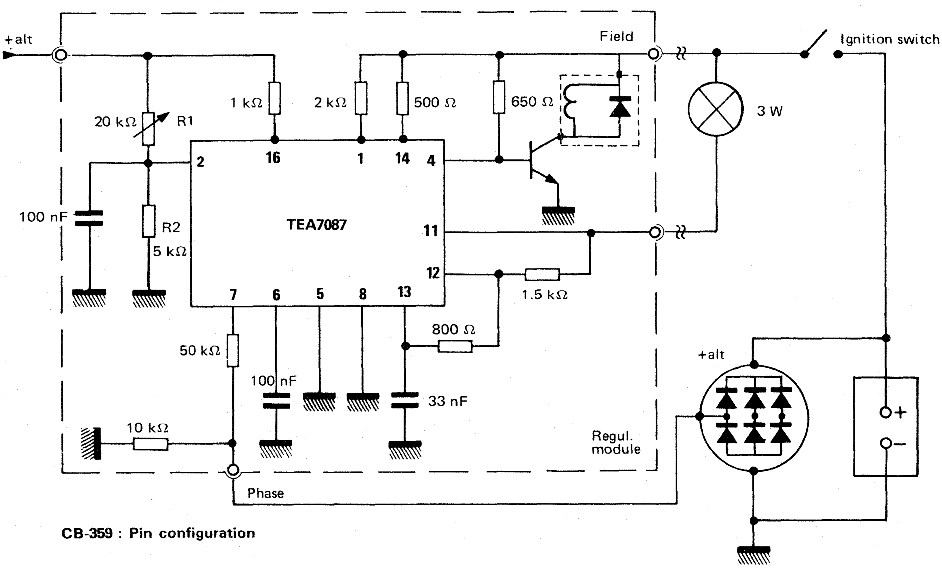


FIGURE 1 - $V_{CC} = V_{CCO} \cdot e^{-t/T}$
where T = 300 ms

TYPICAL APPLICATION



CB-359 : Pin configuration

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$ (unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	10	–	20	V
Regulator threshold (before adjusting) (R1/R2 = 4)	R_t	13.4	14.4	15.4	V
Temperature coefficient of regulator threshold ($R_t = +14.4$ V)	αR_t	−8	−10	−12	mV/°C
Upper threshold (before adjusting) (R1/R2 = 4)	UT	14.7	15.8	16.9	V
Temperature coefficient of upper threshold (UT = +15.8 V)	αUT	−9	−11	−13	mV/°C
Supply current (Pin 1, 14) - ($V_{CC} = +14.4$ V)	I_{CC}	–	5	–	mA
Maximum current through regulator output (Pin 4) - ($V_{CC} = +14.4$ V)	I_{RO}	–	–	30	mA
Pin 11 output current capability to drive the warning lamp (Pin 11) ($V_{CC} = +14.4$ V)	I_{LO}	–	–	300	mA
Regulator output saturation voltage (Pin 4) - ($V_{CC} = +14.4$ V ; $I_4 = 30$ mA)	V_{SR}	–		300	mV
Pin 11 output saturation voltage - ($V_{CC} = +14.4$ V ; I = 250 mA)	V_{SL}	–	–	1.4	V
+ Alternator / + battery broken cable detection voltage ($V_{reg} = +14.4$ V, $V_{alt} - V_{battery}$)	V_{AB}	–	3.3	–	V
Lower threshold on regulated voltage sense	LT	–	5	6	V
Phase failure indication voltage	V_p	–	6	8	V
Warning lamp output voltage (V_{CC} supply pins disconnected) (Pin 11) ($V_{battery} = +12.5$ V)	–	–	3.8	–	V
Warning lamp on-delay (C(pin 6) = 100 nF) Upper and lower thresholds or lack of phase voltage	–	–	2	–	s
Input 14 limiting zener voltage	$V_{Z(14)}$	–	34	–	V
Inputs 1 and 16 limiting zener voltage CB-359	$V_{Z(1)}$, $V_{Z(16)}$	–	34	–	V
Inputs 2 and 15 limiting zener voltage CB-79	$V_{Z(2)}$, $V_{Z(15)}$	–	34	–	V
Input 7 limiting zener voltage	$V_{Z(7)}$	–	40	–	V
Input 12 limiting zener voltage	$V_{Z(12)}$	–	16	–	V
Pin 11 short-circuit current ($V_{CC} = +14.4$ V)	$I_{SC(11)}$	–	–	500	mA

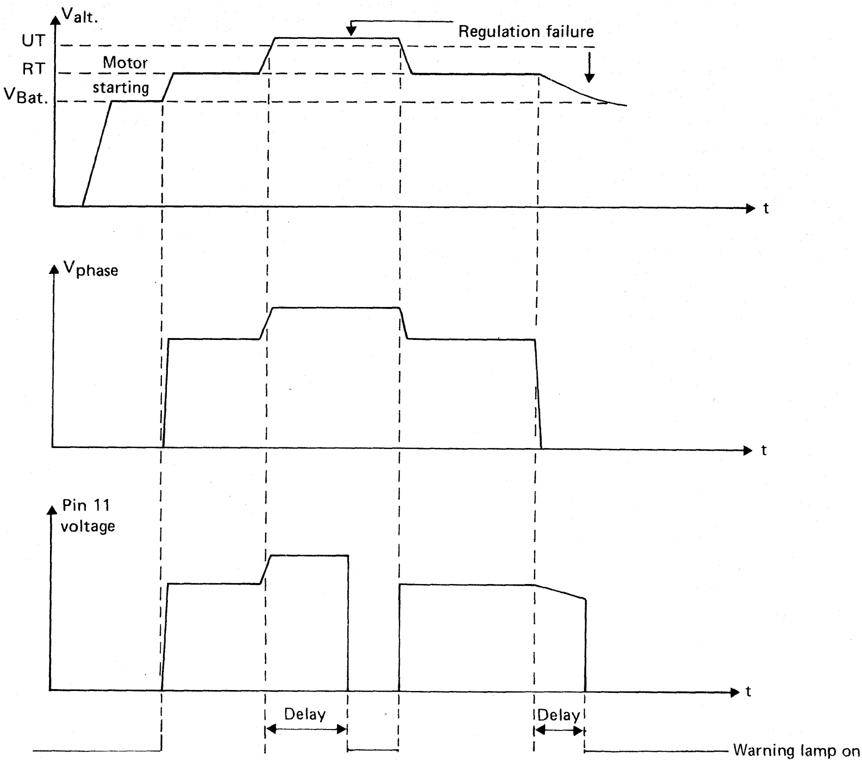
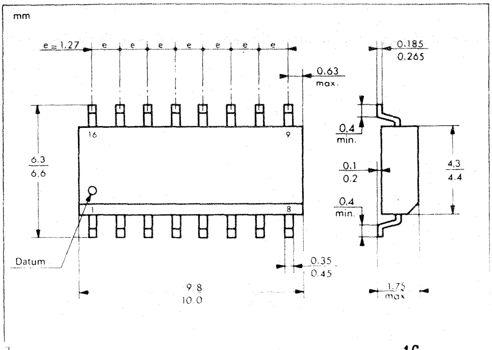


FIGURE 2

Warning lamp lights when :

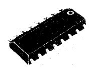
Starting, before alternator rotates
Battery voltage exceeds UT (delay of 2 s.)
Battery charge interruption (regulation failure, no phase voltage)
Voltage sense disconnected
Broken + alternator to battery connecting cable
Regulator module's supply voltage interrupted.



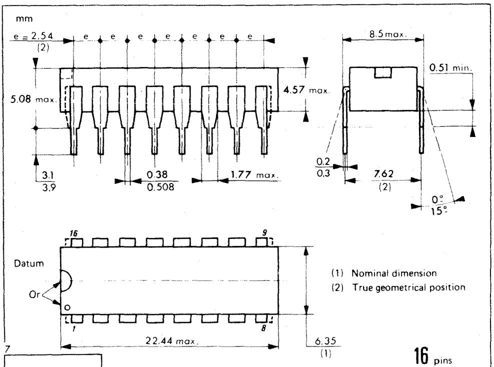
16 pins

DIN	SO16			
CEI	D.A.T.A	JEDEC	SITELESC	CB-359 THOMSON SEMICONDUCTORS

CB-359



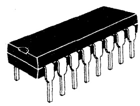
FP SUFFIX
PLASTIC MICROPACKAGE



16 pins

DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

CB-79



DP SUFFIX
PLASTIC PACKAGE

This is advance information and specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TS8306

PRODUCT PREVIEW

VIDEO SPEED 6-BIT FLASH A/D CONVERTER

The TS8306 is a monolithic 6-bit HMOS2 parallel (flash) A/D converter designed for 20 MSPS conversion speed.
Parallel sampling is performed via a resistor ladder and 64 auto-balanced comparators. Conversion is accomplished within one clock pulse.

A very low input capacitance (less than 15 pF) and a low input dynamic range (1 volt possible) allow very easy drive of the TS8306.

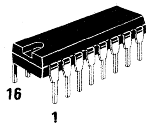
- 20 MHz sampling rate
- 10 MHz input bandwidth without sample and hold
- Accuracy better than 6 mV (operation at low reference possible)
- Single +5V supply
- Logic inputs and outputs are TTL and CMOS compatible
- 6 bit data, underflow and overflow lines are 3-state outputs
- 16 pin package (chip also available)
- Very low cost device
- Soon available in SO16 plastic micropackage

- High speed data acquisition
- TV video digitizing
- Radar pulse analysis
- Medical imaging
- General purpose hybrid ADC's
- Optical recognition
- Fax machine and video printer

HMOS2

**20 MHz
6-BIT FLASH
A/D CONVERTER**

CASE CB-79



P SUFFIX
PLASTIC PACKAGE

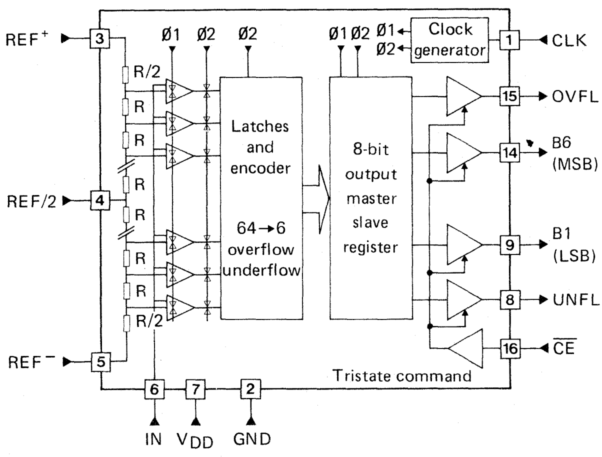
ALSO AVAILABLE

C SUFFIX CERAMIC PACKAGE

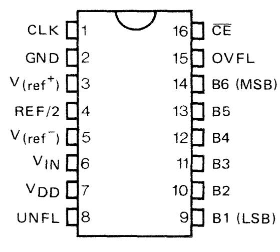
J SUFFIX CERDIP PACKAGE

Hi-Rel versions available - See chapter 14

BLOCK DIAGRAM



PIN ASSIGNMENT



Ref. 04355-R1

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THOMSON COMPONENTS

PIN DESCRIPTION

NAME	PIN TYPE	N°	FUNCTION	DESCRIPTION
CLK	I	1	Clock input	TTL level accepted
GND	I	2	General ground	Inside, analog and digital ground are separated.
$V(ref^+)$	I	3	Upper reference	Access to the upper resistance ladder
REF/2	I	4	Middle reference	Access to the middle resistance ladder. The conversion law can be changed by forcing this point by an external voltage source.
$V(ref^-)$	I	5	Lower reference	Access to the lower resistance ladder.
V_{IN}	I	6	Analog input	
V_{DD}	I	7	Positive supply	Inside, analog and digital supply are separated.
UNFL	O	8	Under flow status line	This line is set to logical "1" when the input signal is lower than the $V(ref^-)$ voltage. All data (B1 to B6) are reset to logical "0".
B1 (LSB) to B6 (MSB)	O	9 to 14	Output data	
OVFL	O	15	Overflow status line	This line is set to logical "1" when the input signal is higher than the $V(ref^+)$ voltage ; all data (B1 to B6 are set to logical "1".
$\overline{CE}$	I	16	Tristate enable	$\overline{CE}$ commands the tristate mode for all output buffers (B1 to B6, OVFL and UNFL). When $\overline{CE}$ = "1" : tristate $\overline{CE}$ = "0" : output valid

MAXIMUM RATINGS

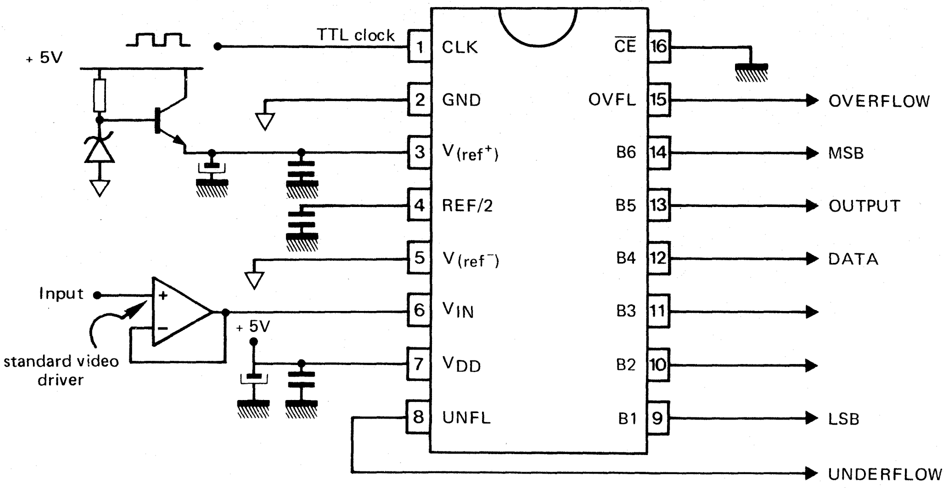
Rating	Symbol	Value	Unit
Supply voltage	V_{DD}	0 to + 7	V
Storage temperature	T_{stg}	- 60 to + 150	°C
Operating temperature	T_{amb}	- 60 to + 130	°C
Power supply current on pins (2, 7)	I_7, I_2	150	mA

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$

Characteristic	Symbol	Min	Typ	Max	Unit
Resolution	N	–	–	6	BIT
Integral linearity error	I_{LE}	–	–	1/2	LSB
Differential linearity error	D_{LE}	–	–	1/4	LSB
Quantizing error	Q_E	- 1/2	–	+ 1/2	LSB
Voltage supply	V_{DD}	4	5	5.25	V
Power dissipation	–	–	–	120	mW
Maximum sample rate	–	–	20	–	MHz
Analog bandwith	–	–	10	–	MHz
Aperture jitter	–	–	–	250	pS
Reference ladder :					
lower reference voltage	REF^-	- 0.5	0	–	V
upper reference voltage	REF^+	0.8	2	V_{DD} - 1.5	V
full scale range	$REF^+ - REF^-$	–	2	–	–
ladder resistance	R_L	–	1.5	–	kΩ
Input capacitance	C_{in}	–	–	15	pF

TYPICAL CONFIGURATION



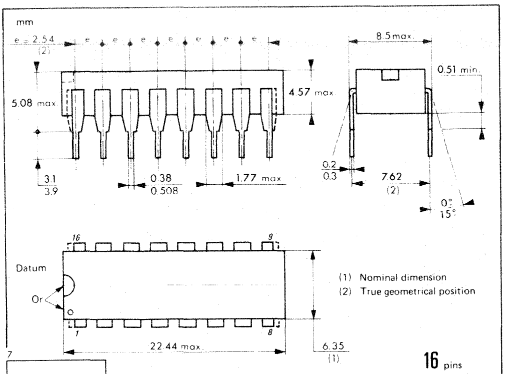
Conventions

- (symbol) = Incoming ground pin
- (symbol) = Ground plane connected to the incoming ground pin

Caution for use

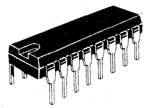
- (symbol) = 22 μF tantalum capacitors (as near as possible to the incoming ground pin)
- (symbol) = 100 nF ceramic capacitors (as near as possible to the device pin)

- Avoid DC current flows in the ground plane
- Try to respect star connections for high DC current flows (connection to the incoming pin)



DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

CB-79

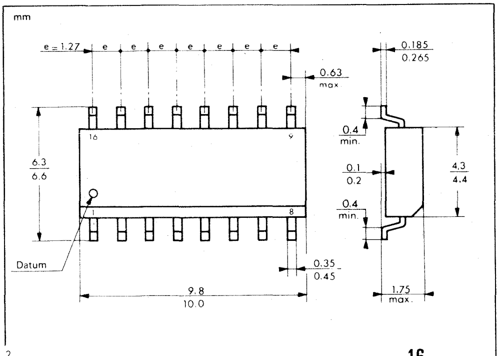


P SUFFIX
PLASTIC PACKAGE

ALSO AVAILABLE

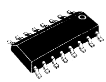
C SUFFIX CERAMIC PACKAGE

J SUFFIX CERDIP PACKAGE



DIN	SO16			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-359 THOMSON SEMICONDUCTORS

CB-359



FP SUFFIX
PLASTIC PACKAGE

This is advance information and specifications are subject to change without notice
Please inquire with our sales offices about the availability of the different packages.

NOTES

THOMSON SEMICONDUCTORS

TS8308

ADVANCE INFORMATION

VIDEO SPEED 8-BIT FLASH A/D CONVERTER

The TS8308 is a monolithic 8-bit HMOS2 parallel (flash) A/D converter designed for **20 MSPS** conversion speed.
Parallel sampling is performed via resistor ladder and 256 comparators. Conversion is accomplished within one pulse.
Low input capacitance and input voltage dynamic allow particularly easy drive of the TS8308.

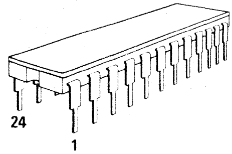
- Single + 5 V supply
- Logic input and output levels CMOS and TTL compatible
- 8-bit latched 3-state outputs with overflow status line
- Accuracy better than 6 mV at the lowest input level (1.5 V)
- 24-pin DIL compatible with RCA CA 3308.

Applications include TV video digitizing, transient signal analysis, high speed instrumentation and radar signal processing.

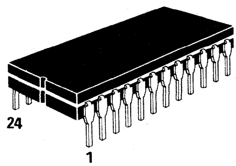
HMOS2

VIDEO SPEED 8-BIT FLASH A/D CONVERTER

CASE CB-68



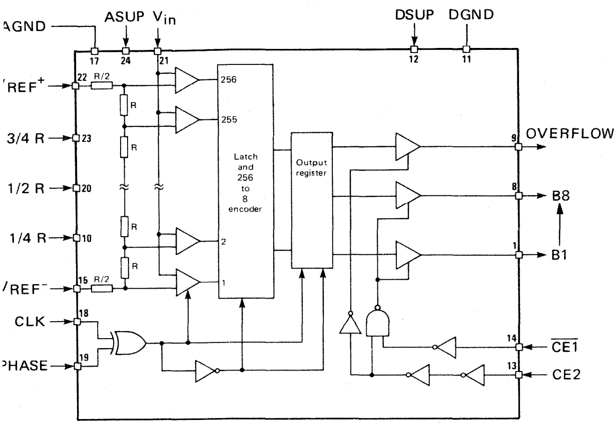
C SUFFIX
CERAMIC PACKAGE



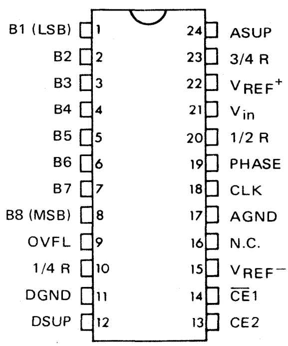
J SUFFIX
CERDIP PACKAGE

Hi-REL versions available - See Chapter 14

BLOCK DIAGRAM



PIN ASSIGNMENT



Ref. 01960

HOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

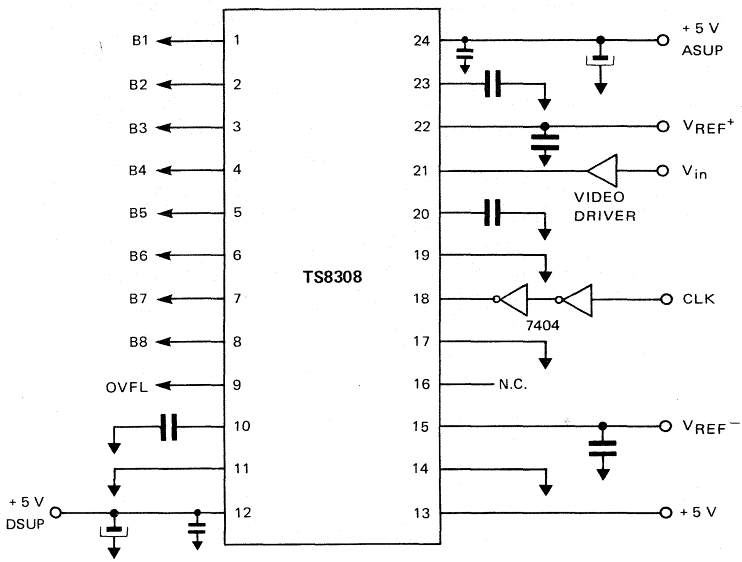
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{DD}	– 0.3 to + 7	V
Storage temperature	T_{stg}	– 40 to + 125	°C
Operating temperature	T_{amb}	0 to + 70	°C
Power supply current	I_{12}, I_{24}	150	mA

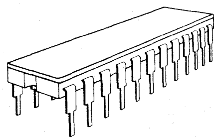
ELECTRICAL CHARACTERISTICS
$T_{amb} = +25°C$

Characteristic	Symbol	Min	Typ	Max	Unit
Resolution		–	–	8	Bits
Linearity error		–	–	± 1	LSB
Differential linearity error		–	± 1/2	–	LSB
Quantizing error		– 1/2	–	+ 1/2	LSB
Voltage supply	V_{DD}	4	5	5.25	V
Power dissipation (15 MHz) : Analog supply	P_{DA}	–	150	–	mW
: Digital supply	P_{DD}	–	250	–	mW
Maximum sample rate		15	20	–	MSPS
Analog bandwith		–	5	–	MHz
Aperture jitter		–	–	–	ps
Reference ladder :					
Lower reference voltage	V_{REF^-}	0	0	–	V
Upper reference voltage	V_{REF^+}	–	2	$V_{DD} - 2$	V
Full scale range	$V_{REF^+} - V_{REF^-}$	1.5	2	$V_{DD} - 2$	V
Ladder resistance	R_{REF}	400	650	900	Ω
Input capacitance	C_{in}	–	25	30	pF
Logic output low voltage	V_{OL}	–	–	0.4	V
high voltage	V_{OH}	2.4	–	–	V
Digital input low voltage	V_{IH}	–	–	0.8	V
high voltage	V_{IL}	2	–	–	V

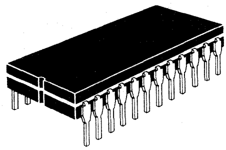
TYPICAL CIRCUIT CONFIGURATION



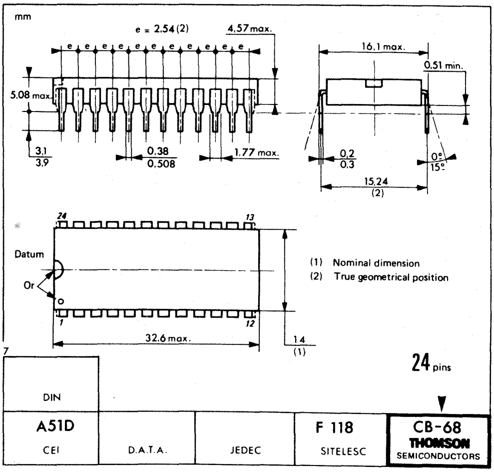
CB-68



C SUFFIX
CERAMIC PACKAGE



J SUFFIX
CERDIP PACKAGE



This is advance information and specifications are subject to change without notice
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TS8408

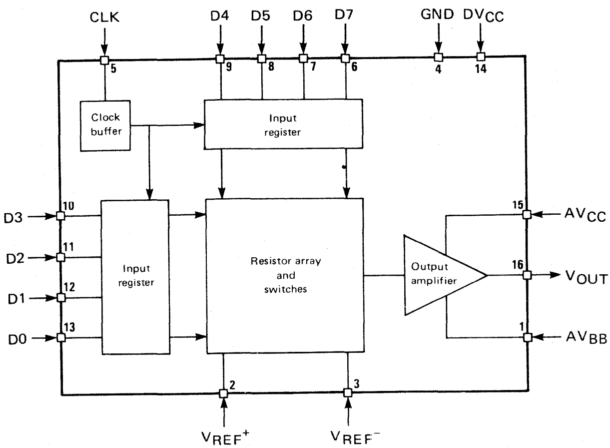
ADVANCE INFORMATION

VIDEO SPEED 8-BIT VOLTAGE OUTPUT D/A CONVERTER

The TS8408 circuit is an 8-bit monolithic digital to analog converter incorporating latches for the logic inputs, designed for **20 MHz** conversion rate. Implemented in HMOS2 technology the circuit contains an on-chip output amplifier, allowing loads as low as **75** Ω, while the full scale settling time within 1/2 LSB is only 35 ns. The circuit is supplied between + 5 V and − 3 V. This converter offers an inherent monotonicity due to the structure and an integral linearity of ± 1/2 LSB.

- Differential linearity : ± 1/4 LSB error maximum.
- Integral linearity error : ± 1/2 LSB typ.
- Fast settling time : 35 ns typ.
- Digital inputs are TTL and CMOS compatible.
- No external output amplifier required.
- Loads : 75 Ω min. - 25 pF max.
- 16-pin DIL package.

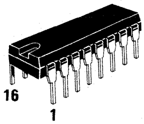
BLOCK DIAGRAM



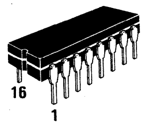
HMOS2

**VIDEO SPEED
8-BIT VOLTAGE OUTPUT
D/A CONVERTER**

CASE CB-79



P SUFFIX
PLASTIC PACKAGE



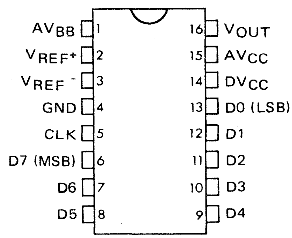
J SUFFIX
CERDIP PACKAGE

ALSO AVAILABLE

C SUFFIX
CERAMIC PACKAGE

Hi-REL versions available - See Chapter 14

PIN ASSIGNMENT



Ref. 01965

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
V_{CC} with respect to V_{GND}	V_d^+, V_a^+	- 0.3 / + 6	V
V_{BB} with respect to V_{GND}	V_a^-	- 4 / + 0.3	V
Operating temperature	T_{amb}	0 to + 70	°C
Storage temperature	T_{stg}	- 40 to + 125	°C

ELECTRICAL CHARACTERISTICS

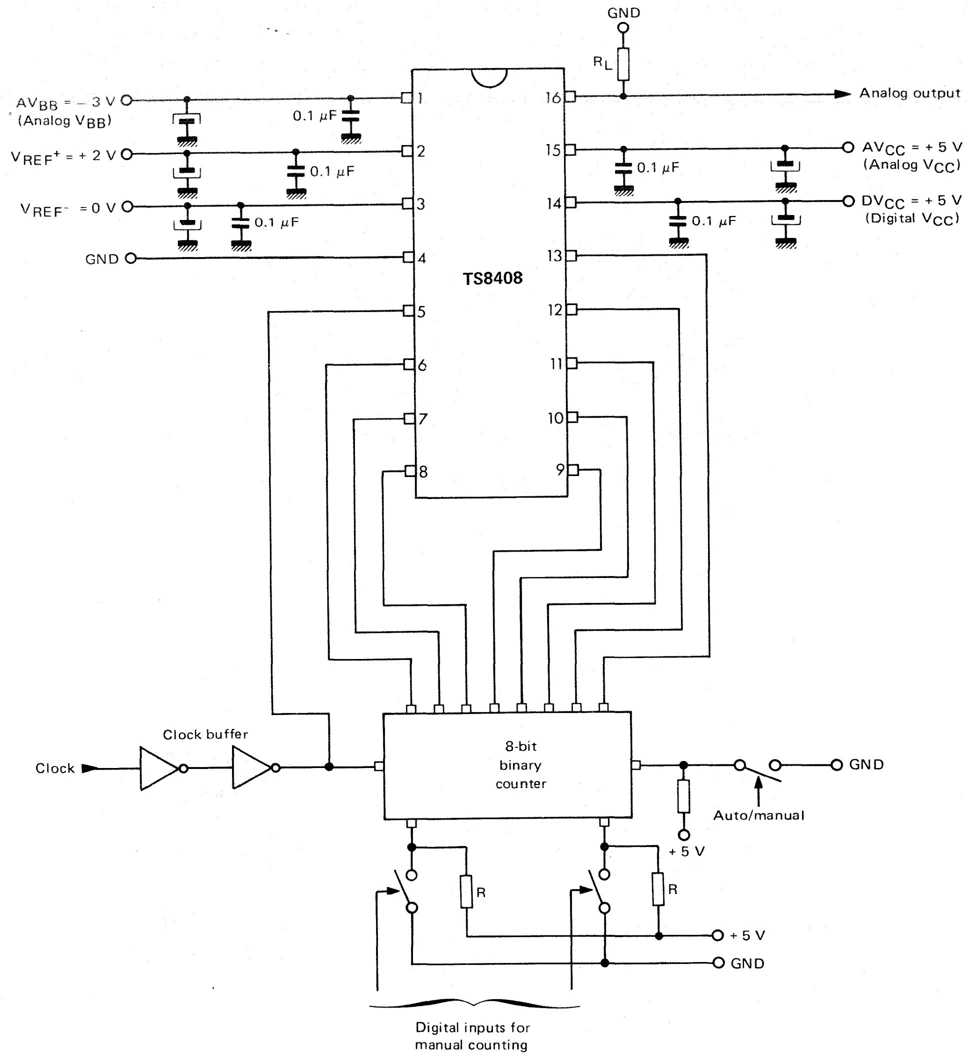
$T_{amb} = +25°C$.

Characteristic	Symbol	Min	Typ	Max	Unit
Positive digital supply	V_d^+	4.5	5	5.25	V
Positive analog supply	V_a^+	4.75	5	5.25	V
Negative analog supply	V_a-	- 3.15	- 3	- 2.85	V
Digital input logic levels					
High level, logic "1"	V_{IH}	2.0	–	–	V
Low level, logic "0"	V_{IL}	–	–	0.8	V
Higher reference	V_{REF}^+	–	2	2.5	V
Lower reference	$V_{REF}-$	- 0.5	0	–	V
Differential linearity error		–	± 1/10	± 1/4	LSB
Integral linearity error		–	± 1/2	± 1	LSB
Maximum sample rate		20	25	–	MHz
Current from digital supply	I_d	–	18.5	–	mA
Current from analog supply	I_a	–	8.5	–	mA
Power dissipation	P_D	–	150	–	mW
Ladder resistance		3.5	5	9	kΩ

OUTPUT AMPLIFIER

Slew-rate	S_{VO}	–	125	–	V/μs
Closed loop gain	A_V	–	0.9	–	
Output impedance	Z_O	–	3	–	Ω
Input offset voltage (for 0V input)	V_{DI}	–	150	–	mV
Load capacitance	C_L	–	–	25	pF
Load resistance	R_L	75	–	–	Ω

TYPICAL EVALUATION CIRCUIT CONFIGURATION



Important :

(22 μF tantalum capacitor symbol) : 22 μF tantalum capacitors
(as near as possible to the incoming power pin).

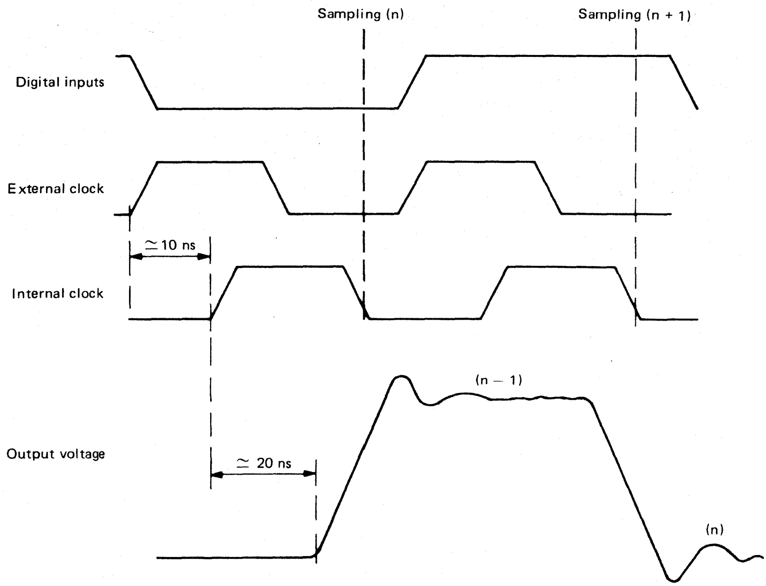
(0.1 μF ceramic capacitor symbol) : 0.1 μF ceramic capacitors
(as near as possible to the device pin).

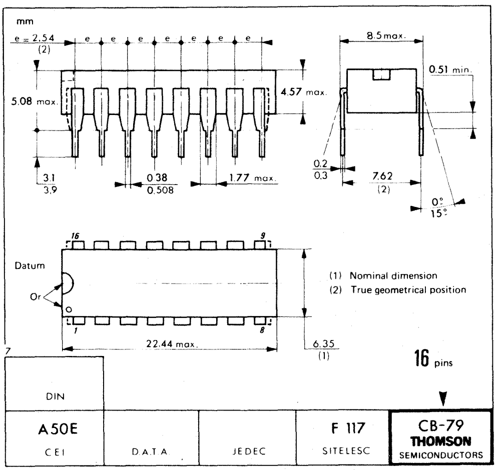
Conventions :

(ground plane symbol) : Ground plane connected to the incoming ground pin.

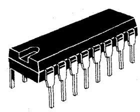
GND : Incoming ground pin.

TIMING DIAGRAM

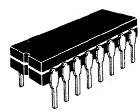




CB-79



P SUFFIX
PLASTIC PACKAGE



J SUFFIX
CERDIP PACKAGE

ALSO AVAILABLE

C SUFFIX
CERAMIC PACKAGE

This is advance information and specifications are subject to change without notice
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TS85XX

MASK - PROGRAMMABLE SWITCHED CAPACITOR FILTERS

The TS85XX circuits are HCMOS universal filters containing a mask programmable switched-capacitor cascadable structure and two uncommitted general purpose operational amplifiers.
The specifications of the internal filter are obtained during the last step of chip realization. The specialization method (Patented) used by THOMSON SEMICONDUCTORS is close to the one used for gate array integrated circuits.
For custom filters, the switched capacitors filter specialization is implemented by THOMSON SEMICONDUCTORS designers in accordance with the user gauge. Most filters can be realized. Samples are available 6 to 8 weeks after the filter gauge definition.
This technique has also been used to define THOMSON SEMICONDUCTORS family of general purpose filters.
Based on the switched-capacitor structure, these circuits exhibit all the advantages of this technique, namely precise gauge, high temperature and long-range stability, almost no external component, no adjustment, low consumption, high density, easy customization, low cost and high security of use.

- Available order : 2 to 8 (any type)
- Input signal frequency range : 0 to 50 KHz
- S/N ratio (depends on the internal structure) : 70 to 85 dB
- Gauge translation possible thru sampling clock tuning
- Power supply requirements : ± 5 V or 0-10 V
- Power consumption : adjustable from 0.5 mW to 20 mW per order.

AVAILABLE PRODUCTS :

- **Standard filters**

Low pass :
TS8510 : 5 th order Cauer (MIC)
TS8511 : 7 th order Cauer (50 dB)
TS8512 : 7 th order Cauer (75 dB)
TS8513 : 8 th order Tchebychev
TS8514 : 8 th order Butterworth.

High pass :
TS8530 : 3 rd order Cauer
TS8531 : 5 th order Cauer
TS8532 : 5 th Tchebychev

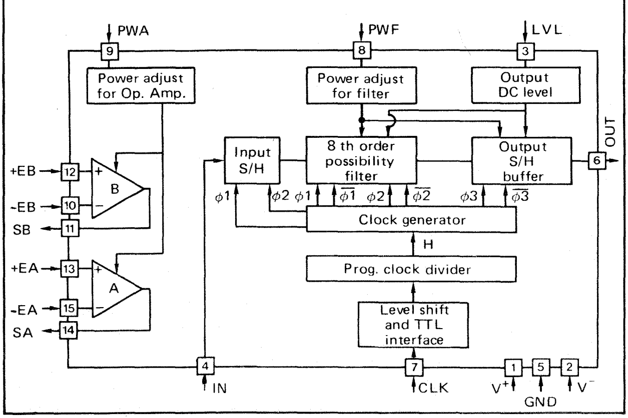
Band pass :
TS8550 : 8 th order Tchebychev

- **Custom filters**

EFG8508 / Customer identification : prototype delivery shorter than 8 weeks

Typical applications : telecommunications, data acquisition (filtering before A/D conversion and smoothing after D/A conversion) and of course classical action filter replacement.

BLOCK DIAGRAM



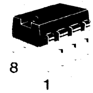
LINEAR

HCMOS 1

MASK - PROGRAMMABLE SWITCHED CAPACITOR FILTER

CASES

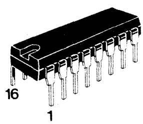
CB-98



P SUFFIX PLASTIC PACKAGE

J SUFFIX CERDIP PACKAGE

CB-79



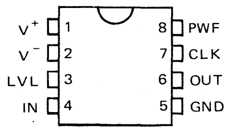
P SUFFIX PLASTIC PACKAGE

J SUFFIX CERDIP PACKAGE

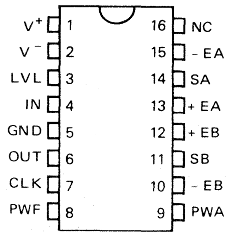
C SUFFIX CERAMIC PACKAGE

Hi-REL versions available - See Chapter 14

PIN ASSIGNMENTS



8 pins: FILTER ONLY



16 pins: FILTER+2 OP-AMPs

Ref. 00640-R1

THOMSON SEMICONDUCTORS
Sales headquarters
45, av. de l'Europe - 78140 VELIZY - FRANCE
Tel. : (3) 946 97 19 / Telex : 204780 F

THOMSON COMPONENTS

NOTES

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

UAC1005
UAB1005

PRODUCT PREVIEW

HIGH SPEED 4-BIT A/D CONVERTERS

The UAB1005 and UAC1005 are 4-bits fully parallel (flash) cascadable A/D converters. They are accurately sample and directly encode (without an external sample and hold circuit) input signals with frequency components up to 3 MHz. The circuits consist of an array of 16 comparators, a resistive voltage divider and ECL compatible binary encoder. Multiple UAB1005, UAC1005's may be connected together to form higher resolution systems.

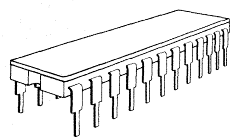
The 16-input comparators do not have sampling latches so the circuit permanently converts input signal with an input ouput progression delay of 30 ns. Conversion can be stopped and output states latched any time with the EM signal command.

- Direct A/D conversion (no clocking) 4 bits : $-5\ V < V_I < +5\ V$ ($\Delta V_I \leqslant 5\ V$).
- Min. quantization level : 30 mV.
- Memorization frequency : 30 MHz max.
- Binary direct or complemented outputs (TTL-LS).
- 24-pin, ceramic DIP.
- Power dissipation : 0.8 W.

Applications :
- Radar data conversion.
- Video data conversion with input sample and hold.
- High speed multiplexed data acquisition.

HIGH SPEED 4-BIT A/D CONVERTERS

CASE CB-68



DC SUFFIX
CERAMIC PACKAGE

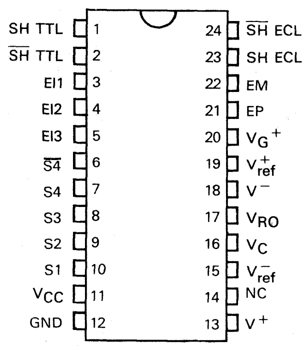
ORDERING INFORMATION

Hi-Rel versions available - See chapter 14

PART NUMBER	TEMPERATURE RANGE	PACKAGE DC
UAC1005	−55°C to +125°C	•
UAB1005	0°C to + 70°C	•
Example : UAC1005DC		

PIN ASSIGNMENT

(Top view)

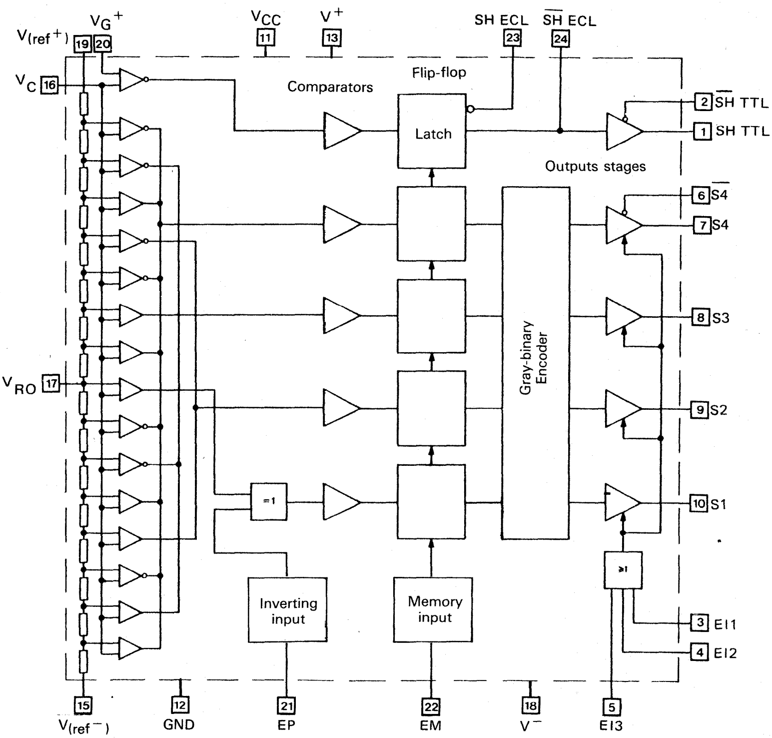


Réf. 00375

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Supply voltage		V_{CC}	7	V
Positive voltage		V^+	9	V
Negative voltage		V^-	−9	V
Positive reference voltage		$V_{(ref^+)}$	+5 to −4.52	V
Negative reference voltage		$V_{(ref^-)}$	+4.52 to −5	V
Positive reference voltage - Negative reference voltage		$V_{(ref^+)}-V_{(ref^-)}$	5	V
Operating temperature range	UAC1005 UAB1005	T_{oper}	−55 to +125 0 to + 70	°C
Storage temperature range		T_{stg}	−65 to +150	°C

BLOCK DIAGRAM



PIN OUT CONFIGURATION

V_G+ — Overrange detect level
V_C — Analog input voltage
$V_{(ref^-)}$, $V_{(ref^+)}$ — Set input voltage dynamic range
V_{RO} — Center tap of resistive ladder network
S1, S2, S3, $\overline{S4}$ — TTL-LS digital output
SH, $\overline{SH}$ — Overrange output TTL-LS, ECL
EM — Memorization input
EP — Output code select
EI — Three-state output control for output data

ELECTRICAL CHARACTERISTICS

UAC1005 : −55°C to +125°C
UAB1005 : 0°C to + 70°C
(Unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply currents					
$V_{CC} = +5.5$ V	I_{CC}	—	42	—	mA
$V^+ = +8.8$ V	I^+	—	13	—	mA
$V^- = -8.8$ V	I^-	—	65	—	mA
Analog section - Input signal V_C					
Input current, $V_{C(max)}$	I_I	—	36	200	μA
Input capacitance	C_I	—	—	25	pF
Voltage reference					
Input current ($V_{(ref+)} = +4.8$ V)	$I_{(ref+)}$	+4	+8	+9.6	mA
Output current ($V_{(ref-)} = 0$ V)	$I_{(ref-)}$	−9.6	−8	−4	mA
Digital section					
High level input voltage	V_{IH}	2	—	—	V
Low level input voltage	V_{IL}	—	—	0.8	V
EM, EP ($V_{CC} = +5.5$ V) - Note 4					
$V_{IH} = +2.7$ V	I_{IH}	—	—	75	μA
$V_{IL} = +0.5$ V	I_{IL}	—	—	2	mA
Other inputs ($V_{CC} = +5.5$ V, $V_{IL} = +0.5$ V)	I_{IL}	—	—	1	mA
Input clamp voltage ($V_{CC} = +4.5$ V, $I_I = -12$ mA)	V_I	—	−0.8	−1.5	V
TTL outputs, ($V_{CC} = +4.5$ V)					
$I_{OH} = -0.4$ mA	V_{OH}	2.5	—	—	V
$I_{OL} = +8$ mA	V_{OL}	—	—	0.5	V
Off state output current, $V_{OH} = +2.5$ V	—	—	—	50	μA
$V_{OL} = +0.5$ V	—	—	—	50	
Short-circuit current ($V_{CC} = +5.5$ V)	I_{SC}	20	43	100	mA
ECL outputs ($I_O = -10$ mA)	V_{OH}	−1.3	—	−0.7	V
	V_{OL}	−2.5	—	−1.7	

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltages	V_{CC}	+4.5	+5	+5.5	V
	V^+	+7.2	+8	+8.8	
	V^-	−8.8	−8	−7.2	
Reference inputs	$V_{(ref+)}$	−4.52	—	+5	V
	$V_{(ref-)}$	−5	—	+4.52	
Reference input range	$V_{(ref+)}$ - $V_{(ref-)}$	0.48	—	5	V
EM pulse width	—	20	—	—	ns

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Memorization max. frequency - (Note 1)	$f_{(mem)}$	20	—	—	MHz
Conversion time - (Note 2)	$t_{(conv)}$	—	30	—	ns
Propagation time V_C to S1	$T_{PHL} = T_{PLH}$	—	30	45	ns
Propagation time EM to S1 - (Note 3)	EMHL	—	20	40	ns
	EMLH	—	25	40	

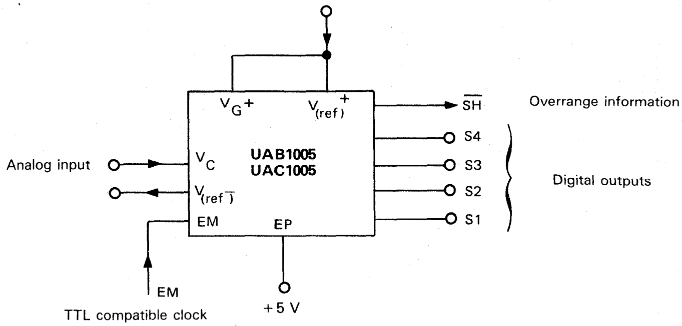
Note 1 : The input comparators do not have latches nor are they clocked. So, the memorization frequency is the frequency at which the circuit can sense and retain each output binary data variation corresponding to an input analog signal variation of lower frequency ($f_I < 1/2\, f_{(mem)}$).

Note 2 : It is the output settling time of the coded binary value corresponding to the application of an analog signal at the intput V_C.

Note 3 : Time delays from memorization control EM
EMHL : propagation time from memorization to outputs.
EMLH : propagation time to transparency to outputs.

Note 4 : Logic functions EM : EM = 0 Memorization
EM = 1 Input-output transparent
EP : EP = 0 Complemented binary
EP = 1 Direct binary
EI : EI = 1 High impedance state

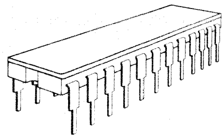
4-BIT A/D CONVERTER APPLICATION DATA



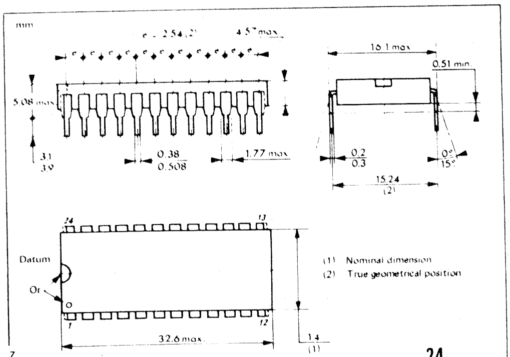
Memorization on the negative going edge of the clock pulse.

$V_{(ref+)}$, $V_{(ref-)}$	Coding range	0	to	+2.5 V
		0		−2.5 V
		0		−5 V
		−2.5 V		+2.5 V

CASE CB-68



DC SUFFIX
CERAMIC PACKAGE



24 pins

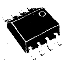
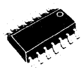
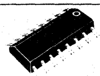
DIN				
A51D CEI	D.A.T.A.	JEDEC	F 118 SITELESC	CB-68 THOMSON SEMICONDUCTORS

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

NOTES

Plastic micropackages

BIPOLAR OP-AMPs

		 SO8	 SO14	 SO16	Page
Single	LM301A	★			63
	LM318	★			87
	UA741	★			271
	UA748	★			279
	UA776	★			287
Dual	LM358	★			131
	LM1458	★			143
	LM2904	★			131
	MC4558	★			159
	TEB1033	★			189
Quad	LM324		★		99
	LM346			★	111
	LM348		★		123
	LM2902		★		99
	MC3403		★		151

J-FET OP-AMPs

		SO8	SO14	SO16	Page
Single	TL061C	★			193
	TL071C	★			217
	TL081C	★			243
Dual	TL062C	★			201
	TL072C	★			225
	TL082C	★			251
Quad	TL064C		★		209
	TL074C		★		233
	TL084C		★		261

9

VOLTAGE COMPARATORS

		SO8	SO14	SO16	Page
Single	LM311	★			303
Dual	LM319	★			311
	LM393	★			329
	LM2903	★			329
Quad	LM339		★		319
	LM2901		★		319

VOLTAGE REGULATORS

		SO8	SO14	SO16	Page
	UA723C		★		421

RELAY & LAMP DRIVERS

		SO8	SO14	SO16	Page
	TDE1607		★		475
	TDE1647		★		475
	TDE1737		★		487

PROXIMITY DETECTORS

		SO8	SO14	SO16	Page
	TDA0161	★			651
	TDA0162	★			651
	TDE0160		★		657

TIMERS

		SO8	SO14	SO16	Page
Single	NE555	★			707
Dual	NE556		★		715

SURFACE MOUNTED DEVICES: today's solution for state-of-the-art system designs.

Today's trend toward light weight system designs with high component density allows Surface Mounting Technology to revolutionize manufacturing in the Electronics industry.

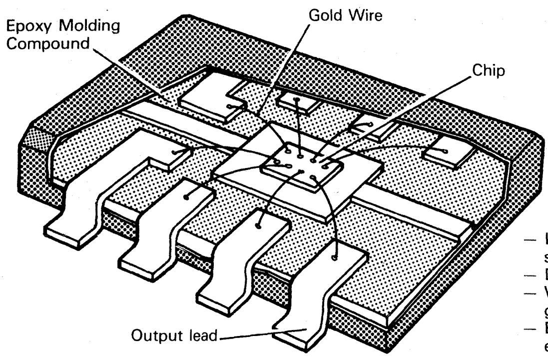
Reduction in board assembly cost by as much as 40% and in board size by as much as 50% is a goal that can be reached through the utilization of Surface Mounted Devices:
Active Semiconductors (SO IC's) - SO Discretes and Chip carriers as well as passive resistors and capacitor chips.

Today system designers can select package outlines that meet state-of-the-art weight/space ratio requirements while enhancing electrical performance.

By 1990, through widely accepted data, one can foresee about 50% of the world wide demand to be Surface Mounted Devices.

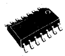
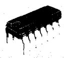
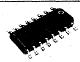
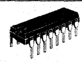
Included in the THOMSON SEMICONDUCTORS family of Surface Mounted Devices are integrated circuits (SO8 - SO28) Plastic Chip Carriers (44 - 84 leads) and discrete diodes and transistors in SOT 23 (TO-236).

Capacitor chips are also available in THOMSON LCC.
Compared to conventional types THOMSON SC's SMD have the following features:
• Compact design enabling high packing density and significant reduction in board size and weight, for instance in consumer electronics, telecommunications and automotives.
• Easy and low cost handling through automated high speed pick and place machinery.
• Mounting capability on both sides of all types of substrates (Ceramic or PC boards) using all current methods, such as wave soldering reflow and vapor phase technics.
• Same electrical characteristics (same dice) as conventional packages, with improved high frequency, high speed switching performances due to lower lead inductance and capacitance.
• Optimized way to package VLSI circuits by utilizing plastic chip carrier along with SO packages, leading to a major advantage over chip and wire assembly processes.



- Lead frame: spot plated FeNi42 alloy for SO8 spot plated copper for SO14, SO16
- Die attach: silver filled compound
- Wire bonding: Thermosonic ball bonding of golf wires
- Encapsulation: high performances non inflammable epoxy
- Lead coating: Pb-Sn plating (10% Pb typical)

COMPARISON BETWEEN SO (SMALL OUTLINE) AND DIL (DUAL-IN-LINE) PACKAGES

	8 PINS		14 PINS		16 PINS	
	SO	DIL	SO	DIL	SO	DIL
						
Weight (mg)	66	600	133	1000	160	1200
Overall thickness (mm)	1.75	5.1	1.75	5.1	1.75	5.1
Package body thickness (mm)	1.65	4.6	1.65	4.6	1.65	4.6
Package body area (mm^2)	20	70	35	126	44	140
Overall area (mm^2)	31	83	54	165	62	175
Total surface ratio SO/DIL	0.37		0.33		0.35	

THERMAL RESISTANCE

Junction ceramic - substrate (25 × 50) mm^2 (Case glued to substrate)	SO8	160°C/W
	SO14-SO16	90°C/W
Junction ceramic - substrate (25 × 50) mm^2 (Case glued to substrate. Substrate temperature maintained constant)	SO8	90°C/W
	SO14-SO16	65°C/W

QUALITY RESULTS FOR SO8-SO14-SO16

Test	AQL	PPM level
Electrical test Non functional	0.10	400
Parametric (including non functional)	0.25	1100
Solderability 235°C - 2 seconds (After storage 16 H - 150°C)	1.5	400

PERIODIC TEST FOR SO8-SO14-SO16

Test	NB OF PIECES	DEFECTS
Soldering: 260°C - 10 s Temperature cycling: 5 cycles/ −55°C to +125°C Moisture resistance (Accelerated stress testing)	240	0
Moisture resistance (56 days @ +40°C - 93% RH)	240	2
Salt atmosphere: 96 H	260	1

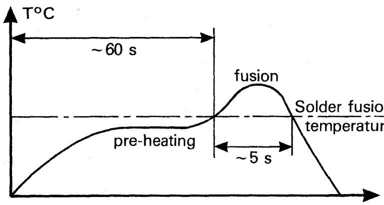
Test	λ60%	NB OF PIECES	DEFECTS
High temperature storage (T_{amb} = +150°C)	4.1×10^{-7} 0.04%/1000 H	520 2.06×10^6 H × C	0
Life test (T_{amb} = +125°C, V_{CC} = ±15 V)	2×10^{-6} 0.2%/1000 H	420 0.96×10^6 H × C	1
Biased moisture life test (T_{amb} = +85°C - RH = 85%, V_{CC} = ±15 V)	5×10^{-6} 0.5%/1000 H	908 0.97×10^6 H × C	4

* 1984 status

Mounting methods

SO8, SO14 and SO16 micropackages may be mounted on either PC boards or substrates, employing different soldering methods.

Reflow process
• This method permits the soldering of all components in a single operation. In this case, solder cream is used either by screen printing or employing a pneumatic gun. After the application of solder cream the components are mounted and the circuit is guided through an infra-red or convection oven which allows the solder to melt. In order to avoid solder spreading risks and to position the components, the board should be pre-screen printed with an insulating material.



• An other way to solder coat the board is to dip it into a soldering bath or through wave soldering. Then, flux is applied by a brush or immersion and the components are placed.

The soldering is done by reflow through an oven as above.
The result obtained by both methods is identical. However, in this case, a complete tinning of the circuit is necessary.

Wave soldering process
The components are glued to the substrate by means of an insulated glue. The board is dipped in flux and then goes through the wave soldering process.

Hot air soldering
In this system, the soldering iron must be replaced by a hot air nozzle. Employing this method, an improvement in solder temperature control is achieved.
It is also easy to correct some soldering failures with this method.

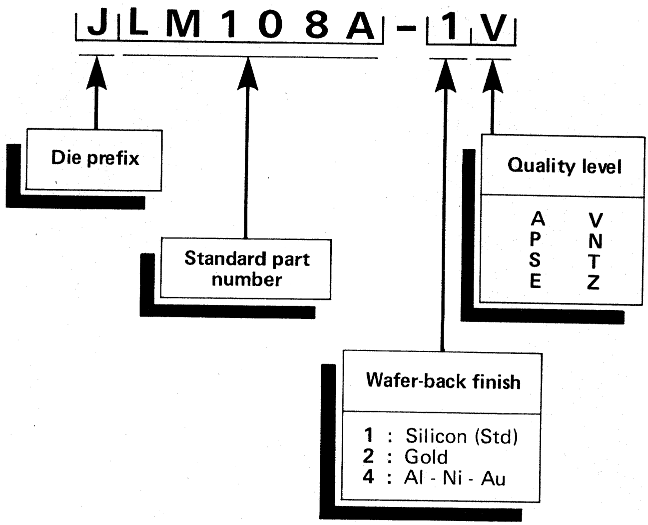
Heated collet
This method is used for rework and soldering PCC on the versus side of the board after wave solder.

Vapor phase soldering (VPS)
This method uses the heat of the vapor of a boiling inert fluorinated fluid. Soldering is accomplished by either screening tin layers or by electroplating solder paste.
Components are then mounted in appropriate locations and soldered to the circuit by dipping it into the vapor of boiling inert fluorinated fluid.
The main advantages of this method are:
• Uniform workpiece temperature whatever the difference in size of the components involved
• Accurate temperature without any elaborate control (temperature of boiling inert fluid)
• Dipping time may be very short and as a consequence better soldering results are obtained
• Soldering takes place in an oxygen-free atmosphere which permits:
– to use less active soldering flux, and
– to avoid soldering flux oxidation (easy cleaning of remaining flux)

Remarks
Various types of high speed automatic mounting equipments for passive and active devices are available contributing to considerable reduction in production costs.

10

Chips



Each THOMSON SEMICONDUCTORS linear circuit supplied in chip or wafer form has a special ordering code divided as follows :

MAIN CODE (Device specification)

- beginning with **J** (Common to all devices)
- followed by the part number of the equivalent packaged device

COMPLEMENTARY CODE (Wafer-back finish and quality level)

After a dash, two characters are used
- a figure indicating the choice of wafer-back finish
- a letter to specify the quality level

A : Wafer
P : Scribed wafer
S : Wafer on adhesive tape with separated chips
E : Chips in waffle pack without visual inspection
V : Chips in waffle pack with 100 % visual inspection according to MIL - STD - 883 / Method 2010
N : V level plus sampling batch of 55 packaged ICs
T : N level plus burn-in on sampling batch of 55 packaged ICs
Z : T level plus 1000 H life test on sampling batch of 55 packaged ICs

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Bipolar operational amplifiers selection guide	768
J-FET operational amplifiers selection guide	769
Voltage comparators selection guide	809
Voltage regulators selection guide	819
Autoprotected control selection guide	839
Proximity detectors selection guide	845
Miscellaneous selection guide	851

Eight different quality levels are available for dice (*)

LEVEL A

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL P

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Partial scribing
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

(*) Please inquire with our sales offices for the availability of the product you are interested in.

LEVEL S

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL E

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Waffle packing of good dice
- Final acceptance (AQL: 2.5 - level 2)
- Shipment

LEVEL V

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%) according to MIL-STD-883/Method 2010
- Waffle pack
- Visual inspection (sampling) MIL-STD-883/Method 2010 - 2/condition B
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL N

- Wafer selection
- Wafer selection at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condidion B (AQL: 1% - level 2)
- Packing
  - Sampling batch (55 dice)
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements
  - Measurement report
- Final acceptance
- Shipment

LEVEL T

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condition B (AQL: 1% - level 2)
  - Sampling batch (55 dice)
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements 1
  - Burn-in
  - Electrical measurements 2
  - Measurement report
- Packing
- Final acceptance
- Shipment

LEVEL Z

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condition B (AQL: 1% - level 2)
  - Sampling batch (55 dice)
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements 1
  - Burn-in
  - Electrical measurements 2
  - 1000-H life test
  - Electrical measurements 3
  - Measurement report
- Packing
- Final acceptance
- Shipment

SINGLE OP-AMPs

Internal compensation

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J LM118/J LM318	Ultra fast				●	Ultra fast	777
J UA741	General purpose			●		$I_{IB}<500$ mA	805
J UA776	Programmable	●		●			807

External compensation

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J LM101A/J LM301A	General purpose			●		$I_{IB}<100$ nA	773
J LM108,A/J LM308,A	Precision	●				High gain	775

DUAL OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J LM158/J LM358	Low power	●	●			$I_{IB}<100$ nA*	785
J LM1458/J LM1558	General purpose					$I_{IB}<500$ nA*	787
J MC4558	Wide band				●	$I_{IB}<500$ nA*	791

QUAD OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J LM124/J LM324	Low power	●	●			$I_{IB}<100$ nA*	779
J LM146/J LM346	Programmable	●					781
J LM148/J LM348	Differential input	●				$I_{IB}<100$ nA*	783
J MC3403/J MC3503	Differential input		●			Low distortion	789

* Each amplifier

SINGLE OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J LF155/J LF355	General purpose			●	2.5 MHz typ	$I_{IB}<200$ pA	771
J LF156/J LF356	General purpose			●	5 MHz typ	$I_{IB}<200$ pA	771
J LF157/J LF357	General purpose			●	20 MHz typ	$I_{IB}<200$ pA	771
J TL061	Low power	●		●		$I_{CC}<250$ μA	793
J TL081	General purpose			●			799

DUAL OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J TL062	Low power	●				$I_{CC}<250$ μA*	795
J TL082	General purpose				●		801

QUAD OP-AMPs

Part number	Function	Low power <1 mA	Single supply	Adjustable offset	Bandwidth >2 MHz	Other charac.	Page
J TL064	Low power	●				$I_{CC}<250$ μA*	797
J TL084	General purpose				●		803

* Each amplifier

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THOMSON SEMICONDUCTORS

J LF155/355
J LF156/356
J LF157/357

J-FET INPUT SINGLE OPERATIONAL AMPLIFIERS

These circuits are monolithic J-FET input operational amplifiers incorporating well matched high voltage J-FETs on the same chip with standard bipolar transistors.

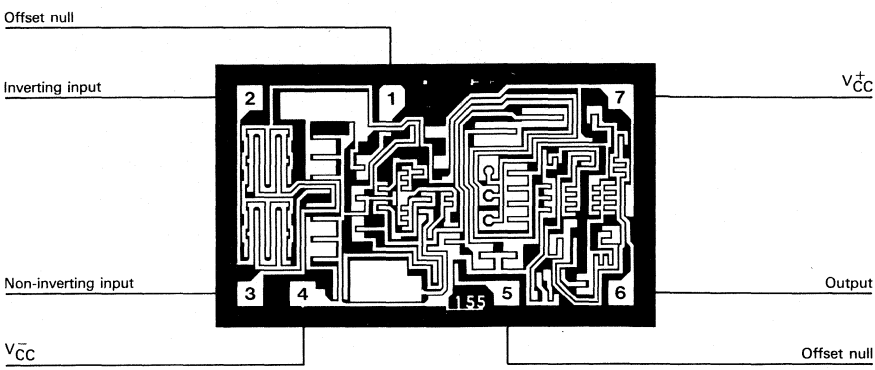
These amplifiers feature low input bias currents, low input offset voltage and input offset voltage drift, coupled with offset adjust which does not degrade drift or common-mode rejection.

The devices are also designed for high slew rate, wide bandwidth, extremely fast settling time, low voltage and current noise and a low I/f noise corner.

- Precision high speed integrators.
- Fast D/A and A/D converters.
- High impedance buffers.
- Wideband, low noise, low drift amplifiers.
- Logarithmic amplifiers.
- Photocell amplifiers.
- Sample and hold circuits.

J-FET INPUT SINGLE OPERATIONAL AMPLIFIERS

DIMENSIONS: 2.00 × 1.20 mm



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Ref. 04600

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LF355 J LF356 J LF357	J LF155 J LF156 J LF157	Unit
Supply voltage	V_{CC}	±18	±22	V
Differential input voltage	V_{ID}	±30	±40	V
Input voltage - (Note 1)	V_I	±16	±20	V
Operating free-air temperature range	T_{oper}	0 to + 70	−55 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC} = ±15 V (Unless otherwise specified)

Characteristic	Symbol	J LF155, J LF156, J LF157			J LF355, J LF356, J LF357			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage (R_S = 50 Ω)	V_{IO}	–	3	5	–	3	10	mV
Input offset current	I_{IO}	–	3	20	–	3	50	pA
Input bias current	I_{IB}	–	30	100	–	30	200	pA
Large signal voltage gain (V_{OPP} = ±10 V, R_L = 2 kΩ)	A_{VD}	50	200	–	25	200	–	V/mV
Supply voltage rejection ratio - (Note 2)	SVR	85	100	–	85	100	–	dB
Supply current	I_{CC}							mA
J LF155, J LF355		–	2	4	–	2	4	
J LF156, J LF356		–	5	7	–	5	10	
J LF157, J LF357		–	5	7	–	5	10	
Input voltage range	V_I	±11	+15.1 −12	–	±11	+15.1 −12	–	V
Common-mode rejection ratio	CMR	85	100	–	85	100	–	dB
Output voltage swing	V_{OPP}							V
R_L = 10 kΩ		±12	±13	–	±12	±13	–	
R_L = 2 kΩ		±10	±12	–	±10	±12	–	
Gain-bandwidth product	GB_p							MHz
J LF155, J LF355		–	2.5	–	–	2.5	–	
J LF156, J LF356		–	5	–	–	5	–	
J LF157, J LF357		–	20	–	–	20	–	
Slew rate	S_{VO}							V/μs
A_V = 1 J LF155, J LF355		–	5	–	–	5	–	
J LF156, J LF356		–	12	–	–	12	–	
A_V = 5 J LF157, J LF357		–	50	–	–	50	–	

Note 1 : Unless otherwise specified the absolute maximum negative input voltage is equal to the negative power supply voltage.

Note 2 : Supply voltage rejection is measured for both supply magnitudes increasing or decreasing simultaneously in accordance with common practice.

THOMSON SEMICONDUCTORS

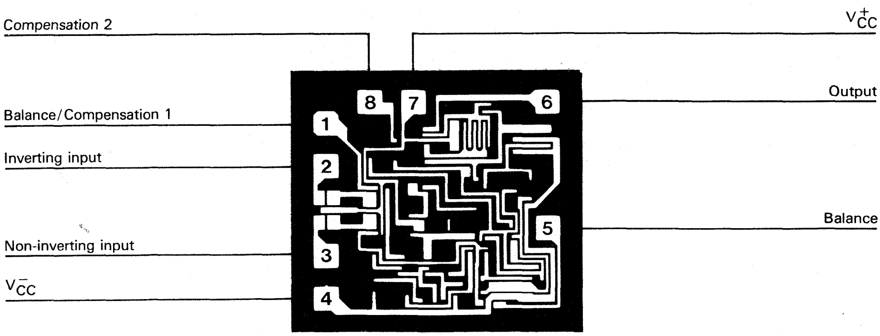
J LM101A
J LM301A

SINGLE OPERATIONAL AMPLIFIERS

The LM101A is a general-purpose operational amplifier. This amplifier offers many features : supply voltages from ±5 V to ±20 V, low current drain, overload protection on the input and output, no latch-up when the common mode range is exceeded, freedom from oscillations and compensation with a single 30 pF capacitors. It has advantages over internally compensated amplifiers in that the compensation can be tailored to the particular application : slew rates of 10 V/µs and bandwidths of 3.5 MHz can be easily achieved. In addition, the circuit can be used as a comparator with differential inputs up to ±30 V. The output can be clamped at any desired level to make it compatible with logic circuits.

SINGLE OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.2 × 1.3 mm



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Ref. 04605

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	LM101A	LM301A	Unit
Supply voltage	V_{CC}	±22	±18	V
Differential input voltage	V_{ID}	±30	±30	V
Input voltage	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$,
J LM101A : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$, C1 = 30 pF
J LM301A : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 15\ V$, C1 = 30 pF
(Unless otherwise specified)

Characteristic	Symbol	J LM101A			J LM301A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}	–	0.7	2	–	2	7.5	mV
Input offset current	I_{IO}	–	1.5	10	–	3	50	nA
Input bias current	I_{IB}	–	30	75	–	70	250	nA
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L = 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}	50	160	–	25	160	–	V/mV
Supply voltage rejection ratio ($R_S = 50\ k\Omega$)	SVR	80	96	–	70	96	–	dB
Supply current ($V_{CC} = +15$ V)	I_{CC}^+, I_{CC}^-	–	1.8	3	–	1.8	3	mA
Input voltage range ($V_{CC} = V_{CC(max)}$)	V_I	±15	–	–	±12	–	–	V
Common-mode rejection ratio ($R_S \leqslant 50\ k\Omega$)	CMR	80	96	–	70	90	–	dB
Output voltage swing ($V_{CC} = \pm 15$ V) $R_L = 2\ k\Omega$ $R_L = 10\ k\Omega$	V_{OPP}	 ±10 ±12	 ±13 ±14	 – –	 ±10 ±12	 ±13 ±14	 – –	V

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM108,A
J LM308,A

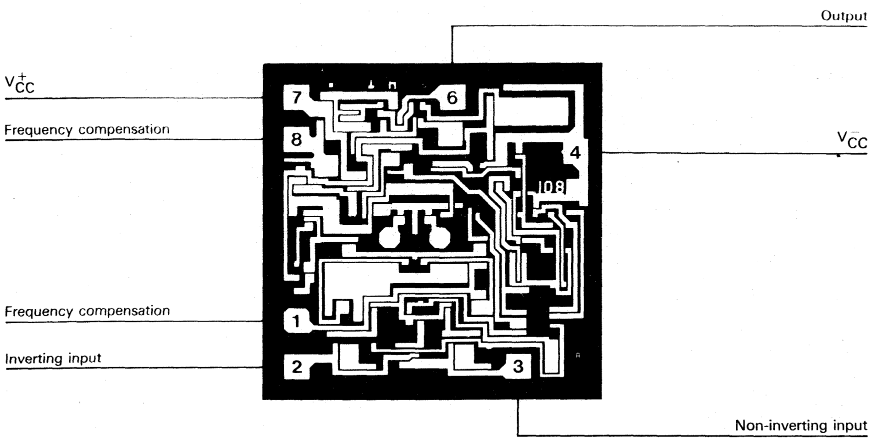
PRECISION SINGLE OPERATIONAL AMPLIFIERS

The LM108,A is a precision operational amplifier having specifications a factor ten better than FET amplifiers over a −55°C to +125°C temperature range. Selected units are available with offset voltages less than 1 mV and drifts less than 5μV/°C. This makes it possible to eliminate offset adjustments, in most cases.

The device operates with supply voltages from ±2 V to ±20 V (LM308 : ±2 V to ±15 V) and has sufficient supply rejection to use unregulated supplies. Although the circuit is interchangeable with and uses the same compensation as the LM101A, an alternate compensation scheme can be used to make it particularly insensitive to power supply noise and to make supply bypass capacitors unnecessary.

PRECISION SINGLE OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.56 × 1.56 mm



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Ref. 04610

MAXIMUM RATINGS

Rating	Symbol	J LM108,A	LM308,A	Unit
Supply voltage	V_{CC}	±20	±18	V
Input voltage - (Note 2)	V_I	±15	±15	V
Input offset current - (Note 1)	I_{IO}	±10	±10	mA
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−55 to +125	°C

Note 1 : The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used.

Note 2 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, (Unless otherwise specified)
J LM108A : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$
J LM308A : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 15\ V$

Characteristic	Symbol	J LM108A			J LM308A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	0.3	0.5	–	0.3	0.5	mV
Input offset current	I_{IO}	–	0.05	0.2	–	0.2	1	nA
Input bias current	I_{IB}	–	0.8	2	–	1.5	7	nA
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L \geqslant 10$ kΩ, $V_O = \pm 10$ V)	A_{VD}	80	300	–	80	300	–	V/mV
Supply voltage rejection ratio	SVR	96	110	–	96	110	–	dB
Supply current	I^+_{CC}, I^-_{CC}	–	0.3	0.6	–	0.3	0.8	mA
Input voltage range ($V_{CC} = \pm 15$ V)	V_I	±13.5	–	–	±14	–	–	V
Common-mode rejection ratio	CMR	96	110	–	96	110	–	dB
Output voltage swing ($V_{CC} = \pm 15$ V, $R_L = 10$ kΩ)	V_{OPP}	±13	±14	–	±13	±14	–	V

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, (Unless otherwise specified)
J LM108 : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$
J LM308 : $\pm 5\ V \leqslant V_{CC} \leqslant \pm 15\ V$

Characteristic	Symbol	J LM108			J LM308			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	0.7	2	–	2	7.5	mV
Input offset current	I_{IO}	–	0.05	0.2	–	0.2	1	nA
Input bias current	I_{IB}	–	0.8	2	–	1.5	7	nA
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L \geqslant 10$ kΩ, $V_O = \pm 10$ V)	A_{VD}	50	300	–	25	300	–	V/mV
Supply voltage rejection ratio	SVR	80	96	–	80	96	–	dB
Supply current	I^+_{CC}, I^-_{CC}	–	0.3	0.6	–	0.3	0.8	mA
Input voltage range ($V_{CC} = \pm 15$ V)	V_I	±13.5	–	–	±14	–	–	V
Common-mode rejection ratio	CMR	85	100	–	80	100	–	dB
Output voltage swing ($V_{CC} = \pm 15$ V, $R_L = 10$ kΩ)	V_{OPP}	±13	±14	–	±13	±14	–	V

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM118
J LM318

SINGLE OPERATIONAL AMPLIFIERS

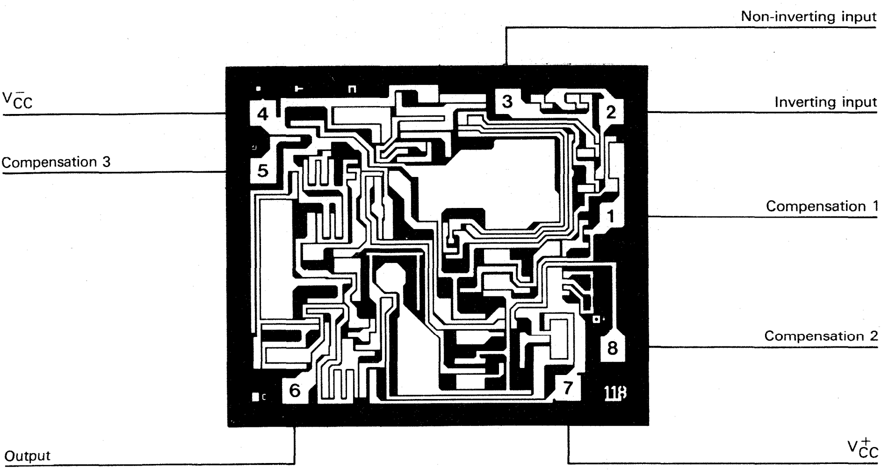
The LM118, and LM318 are precision high speed operational amplifiers designed for applications requiring wide bandwidth and high slew rate. They feature internal frequency compensation and a factor of ten increase in speed over general purpose devices.

Although, no external frequency compensation components are needed for operation, feedforward compensation may be used to further increase the speed. For inverting applications, feedforward compensation will boost the slew rate to over 150 V/µs and almost double the bandwidth. However, for non-inverting or differential applications feedforward cannot be used.

The high speed and fast settling time of these op amps make them useful in A/D converters, oscillators, active filters, sample and hold circuits, or general purpose amplifiers.

SINGLE OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.65 × 1.9 mm



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Ref. 04615

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM118	J LM318	Unit
Supply voltage	V_{CC}	±20	±20	V
Input voltage - (Note 1)	V_I	±15	±15	V
Differential input current - (Note 2)	I_{ID}	±10	±10	mA
Operating free-air temperature range - (Note 3)	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : For supply voltage less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

Note 2 : The inputs are shunted with shunt diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used.

Note 3 : $T_{j(max)} = +150°C$ for all categories.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $\pm 5\ V \leqslant V_{CC} \leqslant \pm 20\ V$, (Unless otherwise specified)

Characteristic	Symbol	J LM118			J LM318			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	4	–	4	10	mV
Input offset current	I_{IO}	–	6	50	–	30	200	nA
Input bias current	I_{IB}	–	120	250	–	150	500	nA
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L \geqslant 2$ kΩ, $V_O = \pm 10$ V)	A_{VD}	50	200	–	25	200	–	V/mV
Supply voltage rejection ratio	SVR	70	80	–	65	80	–	dB
Supply current	I_{CC}^+, I_{CC}^-	–	5	8	–	5	10	mA
Input voltage range ($V_{CC} = \pm 15$ V)	V_I	±11.5	–	–	±11.5	–	–	V
Common-mode rejection ratio	CMR	80	100	–	70	100	–	dB
Output voltage swing ($V_{CC} = \pm 15$ V, $R_L = 2$ kΩ)	V_{OPP}	±12	±13	–	±12	±13	–	V
Slew rate ($V_{CC} = \pm 15$ V, $A_V = 1$) - Note 4	S_{VO}	50	70	–	50	70	–	V/µs

Note 4 : May be improved up to 150 V/µs in inverting amplifier configuration.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

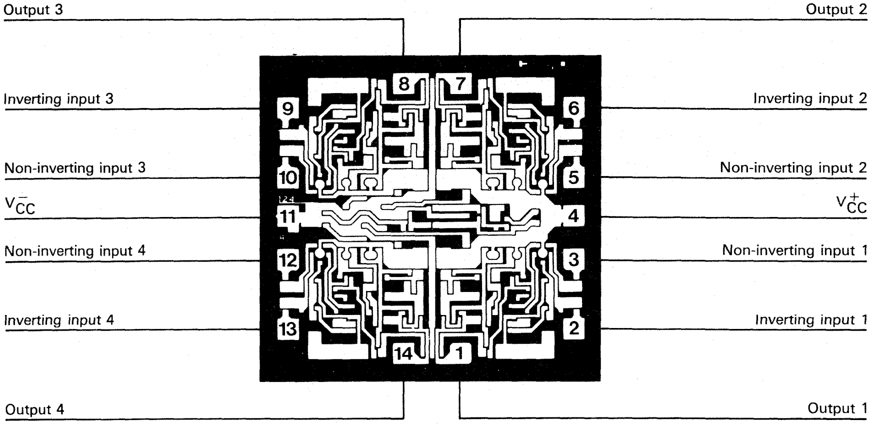
J LM124
J LM324

LOW POWER QUAD OPERATIONAL AMPLIFIERS

These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

LOW POWER QUAD OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.53 × 1.59 mm



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Ref. 04620

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM124	J LM324	Unit
Supply voltage	V_{CC}	± 16 or 32	± 16 or 32	V
Differential input voltage	V_{ID}	32	32	V
Input voltage	V_I	− 0.3 to + 32	− 0.3 to + 32	V
Operating free-air temperature range	T_{oper}	− 55 to + 125	0 to + 70	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC}^{+} = +5$ V, $V_{CC}^{-} = GND$
(Unless otherwise specified)

Characteristic	Symbol	J LM124			J LM324			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 0\ \Omega$) - Note 1	V_{IO}	—	2	5	—	2	7	mV
Input offset current	I_{IO}	—	3	30	—	5	50	nA
Input bias current - (Note 2)	I_{IB}	—	45	100	—	45	250	nA
Large signal voltage gain ($V_{CC} = \pm 15$ V, $R_L = 2$ kΩ)	A_{VD}	50	100	—	25	100	—	V/mV
Supply voltage rejection ratio	SVR	65	100	—	65	100	—	dB
Supply current ($R_L = \infty$ for all amplifiers) $V_{CC} = +5$ V $V_{CC} = +30$ V	I_{CC}^{+}, I_{CC}^{-}	 — —	 0.7 1.5	 1.2 3	 — —	 0.8 1.5	 1.2 3	mA
Input voltage range ($V_{CC}^{+} = +30$ V) - Note 3	V_I	0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	V
Common-mode rejection ratio	CMR	70	85	—	65	70	—	dB
Output short-circuit current	I_{OS}	—	40	60	—	40	60	mA
Output current ($V_{CC}^{+} = +15$ V, $V_I^{+} = +1$ V, $V_I^{-} = 0$ V)	I_O	20	40	—	20	40	—	mA
Output current sink ($V_I^{+} = 0$ V, $V_I^{-} = +1$ V) $V_{CC}^{+} = +15$ V $V_O = +200$ mV	$I_{O(sink)}$	 10 0.012	 20 0.05	 — —	 10 0.012	 20 0.05	 — —	mA
Output voltage swing ($V_{CC}^{+} = +5$ V, $R_L \geqslant 2$ kΩ)	V_{OPP}	0	—	$V_{CC}^{+} - 1.5$	0	—	$V_{CC}^{+} - 1.5$	V
High level output voltage ($V_{CC}^{+} = +30$ V, $R_L = 2$ kΩ)	V_{OH}	26	—	—	26	—	—	V
Low level output voltage ($R_L \leqslant 10$ kΩ)	V_{OL}	—	5	20	—	5	20	mV

Note 1 : $V_O = +1.4$ V, $R_S = 0\ \Omega$, $+5\ V \leqslant V_{CC}^{+} \leqslant +30$ V, V_{CC}^{-} = Ground, $0 \leqslant V_I \leqslant (V_{CC}^{+} - 1.5\ V)$

Note 2 : The direction of the output current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 3 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC}^{+} - 1.5$ V, but either or both inputs can go to +32 V without damage.

J LM146
J LM346

PROGRAMMABLE QUAD OPERATIONAL AMPLIFIERS

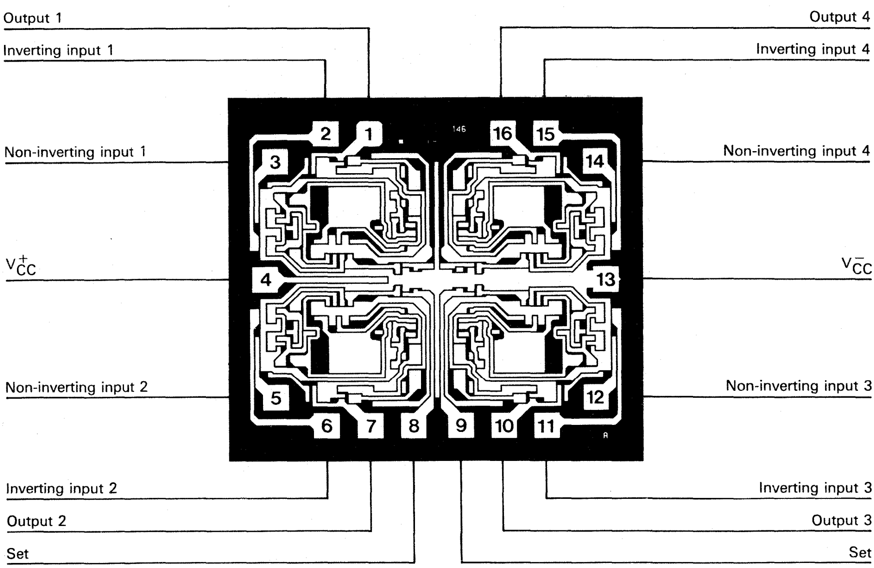
The LM346 consists of four independent, high gain, internally compensated, low power programmable amplifiers. Two external resistors (R_{set}) allow the user to program the gain-bandwith product, slew rate, supply current, input bias current, input offset current and input noise. For example the user can trade-off supply current for bandwidth or optimize noise figure for a given source resistance. In a similar way other amplifier characteristics can be tailored to the application.

PROGRAMMING EQUATIONS :
Total supply current = 1.4 mA (I_{set} = 10 μA)
Gain-bandwith product = 1 MHz (I_{set} = 10 μA)
Slew rate = 0.4 V/μs (I_{set} = 10 μA)
Input bias current ≃ 50 nA (I_{set} = 10 μA)
I_{set} = current into terminals 8 and 9

$$I_{set} = \frac{V_{CC}^{+} - V_{CC}^{-} - 0.6V}{R_{set}}$$

PROGRAMMABLE QUAD OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.88 × 1.67 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM146	J LM346	Unit
Supply voltage	V_{CC}	± 22	± 18	V
Input voltage - (Note 1)	V_I	± 15	± 15	V
Differential input voltage	V_{ID}	± 30	± 30	V
Operating free-air temperature range	T_{oper}	– 55 to + 125	0 to + 70	°C
Storage temperature range	T_{stg}	– 65 to + 150	– 65 to + 150	°C

Note 1 : For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS

T_{amb} = + 25°C, V_{CC} = ± 15 V, I_{set} = 10 μA, (Unless otherwise specified)

Characteristic	Symbol	J LM146			J LM346			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 50\ \Omega$)	V_{IO}	–	0.5	5	–	0.5	6	mV
Input offset current	I_{IO}	–	2	20	–	2	100	nA
Input bias current	I_{IB}	–	50	100	–	50	250	nA
Large signal voltage gain ($\Delta V_O = \pm 10$ V, $R_L = 10$ kΩ)	A_{VD}	100	1000	–	50	1000	–	V/mV
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	80	100	–	74	100	–	dB
Supply current	I_{CC}	–	1.4	2	–	1.4	2.5	mA
Input voltage range	V_I	± 13.5	± 14	–	± 13.5	± 14	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	80	100	–	70	100	–	dB
Output short-circuit current	I_{OS}	5	20	30	5	20	30	mA
Output voltage swing ($R_L \geqslant 10$ kΩ)	V_{OPP}	± 12	± 14	–	± 12	± 14	–	V

THOMSON SEMICONDUCTORS

J LM148
J LM348

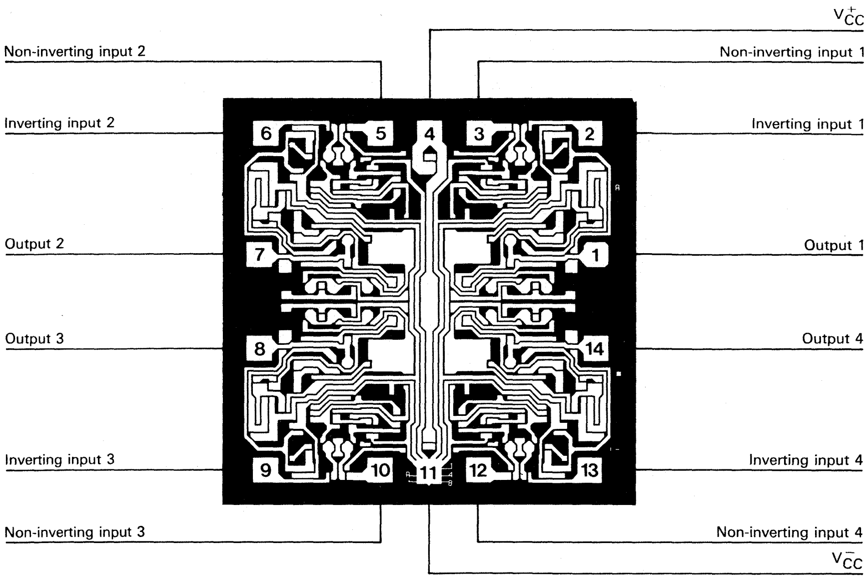
DIFFERENTIAL INPUT QUAD OP-AMPs

The LM148 consists of four independent, high gain internally compensated, low power operational amplifiers which have been designed to provide functional characteristics identical to those of the familiar UA741 operational amplifier. In addition the total supply current for all four amplifiers is comparable to the supply current of a single UA741 type op amp. Other features include input offset currents and input bias current which are much less than those of a standard UA741. Also, excellent isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling.

The LM148 can be used anywhere multiple UA741 type amplifiers are being used and in applications where amplifier matching or high packing density is required.

DIFFERENTIAL INPUT QUAD OP-AMPs

DIMENSIONS: 1.90 × 1.88 mm



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THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM148	J LM348	Unit
Supply voltage	V_{CC}	±22	±18	V
Differential input voltage	V_{ID}	±44	±36	V
Input voltage	V_I	±22	±18	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)

Characteristic	Symbol	J LM148			J LM348			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}	–	1	5	–	1	6	mV
Input offset current	I_{IO}	–	4	25	–	4	50	nA
Input bias current	I_{IB}	–	30	100	–	30	200	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geqslant 2$ kΩ)	A_{VD}	50	160	–	25	160	–	V/mV
Supply current (4 amplifiers)	I_{CC}	–	2.4	3.6	–	2.4	4.5	mA
Input voltage range	V_I	±12	–	–	±12	–	–	V
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	77	96	–	77	96	–	dB
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output voltage swing	V_{OPP}							V
$R_L = 2$ kΩ		±10	±12	–	±10	±12	–	
$R_L = 10$ kΩ		±12	±13	–	±12	±13	–	

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM158
J LM358

LOW POWER DUAL OPERATIONAL AMPLIFIERS

These circuits consist of two independent, high gain, internally frequency compensated amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, these circuits can be directly operated off the standard +5 V power supply voltage which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

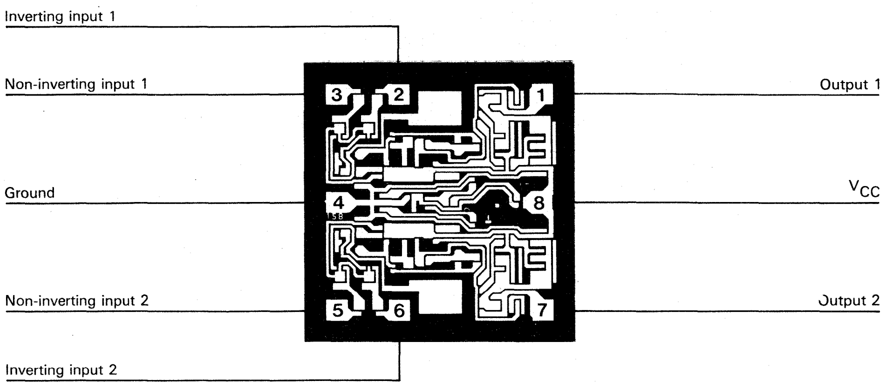
In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The gain-bandwidth product is temperature compensated.

The input bias current is temperature compensated.

LOW POWER DUAL OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.27 × 1.21 mm



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THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM158	J LM358	Unit
Supply voltage	V_{CC}	+32	+32	V
Differential input voltage	V_{ID}	+32	+32	V
Input voltage	V_I	−0.3 to +32	−0.3 to +32	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC} = +5 V, (Unless otherwise specified)

Characteristic	Symbol	J LM158			J LM358			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - Note 1	V_{IO}	—	±2	±5	—	±2	±7	mV
Input offset current	I_{IO}	—	±3	±30	—	±5	±50	nA
Input bias current - Note 2	I_{IB}^+, I_{IB}^-	—	45	150	—	45	250	nA
Large signal voltage gain (V_{CC} = +15 V, $R_L \geqslant 2$ kΩ)	A_{VD}	50	100	—	25	100	—	V/mV
Supply voltage rejection ratio	SVR	65	100	—	65	100	—	dB
Supply current ($R_L = \infty$)	I_{CC}	—	0.7	1.2	—	0.7	1.2	mA
Input voltage range (V_{CC} = +30 V) - Note 3	V_I	0	—	V_{CC}−1.5	0	—	V_{CC}−1.5	V
Common-mode rejection ratio	CMR	70	85	—	65	70	—	dB
Output current (V_{CC} = +15 V. V_I^+ = +1 V, V_I^- = 0 V)	I_O	20	40	—	20	40	—	mA
Output current sink (V_I^- = −1 V, V_I^+ = 0 V)	$I_{O(sink)}$							
V_{CC} = +15 V		10	20	—	10	20	—	mA
V_O = +0.2 V		12	50	—	12	50	—	μA
Output voltage swing ($R_L \neq 2$ kΩ)	V_{OPP}	0	—	V_{CC}−1.5	0	—	V_{CC}−1.5	V

Note 1 : $V_O \approx 1.4$ V, $R_S = 0$, +5 V ⩽ V_{CC} ⩽ +30 V, 0 ⩽ V_I ⩽ V_{CC} − 1,5 V

Note 2 : The direction of the input current is out of the chip. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 3 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC} − 1.5 V. But either or both inputs can go to +32 V without damage.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM1458
J LM1558

DUAL OPERATIONAL AMPLIFIERS

The LM1458 and LM1558 are high performance monolithic dual operational amplifiers constructed on a single silicon chip. They are intended for a wide range of analog applications.

- Summing amplifier
- Voltage follower
- Integrator
- Active filter
- Function generator

The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feed back applications. The internal compensation network (6 dB/octave) insures stability in closed loop applications.

DUAL OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.14 × 1.59 mm

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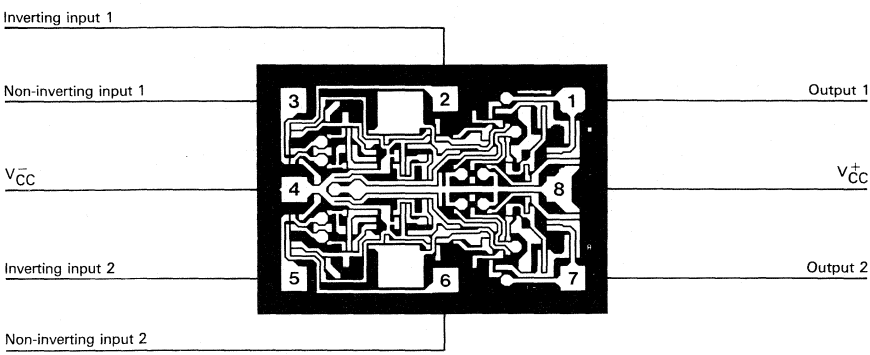

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Supply voltage		V_{CC}		V
	J LM1458		±18	
	J LM1558		±22	
Input voltage		V_I	±15	V
Differential input voltage		V_{ID}	±30	V
Operating free-air temperature range		T_{oper}		°C
	J LM1558		−55 to +125	
	J LM1458		0 to + 70	
Storage temperature range		T_{stg}		°C
	J LM1558		−65 to +150	
	J LM1458		−55 to +125	

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)

Characteristic	Symbol	J LM1558			J LM1458			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}	–	1	5	–	1	6	V
Input offset current	I_{IO}	–	20	200	–	20	200	nA
Input bias current	I_{IB}	–	80	500	–	80	500	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geqslant 2$ kΩ)	A_{VD}	50	200	–	20	200	–	V/mV
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	–	30	150	–	30	150	μV/V
Supply current	I_{CC}^+, I_{CC}^-	–	2.3	5	–	2.3	5.6	mA
Input voltage range	V_I	±12	±13	–	±12	±13	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output voltage swing	V_{OPP}							V
$R_L \geqslant 10$ kΩ		±12	±14	–	±12	±14	–	
$R_L \geqslant 2$ kΩ		±10	±13	–	±10	±13	–	

These specifications are subject to change without notice.

J MC3403
J MC3503

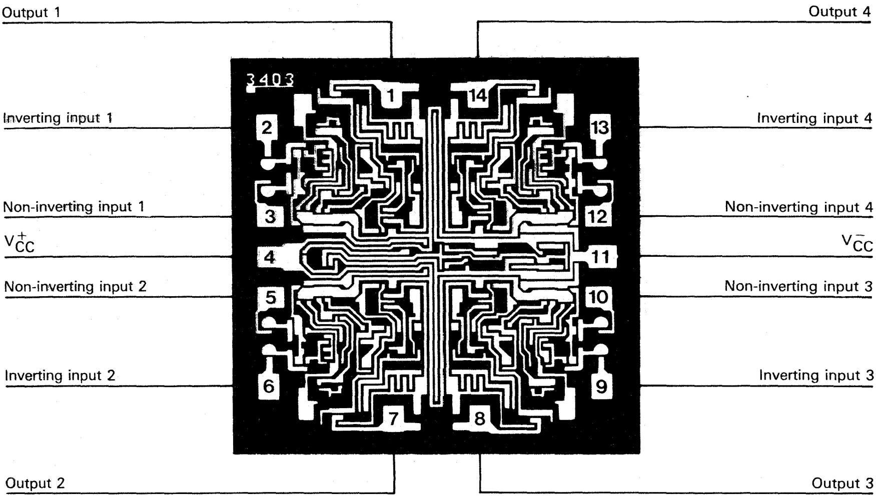
LOW POWER DIFFERENTIAL INPUT QUAD OP-AMPs

The MC3403 is a low-cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular UA741. However the MC3403, has several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 volts or as high as 36 volts with quiescent currents about one third of those associated with the UA741 (on a per amplifier basis). The common-mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

- Short-circuit protected outputs.
- Class AB output stage for minimal crossover distortion.
- Single supply operation : +3 V to +36 V.
- Dual supplies : ±1.5 V to ±18 V.
- Low input bias current : 500 nA max.
- Internally compensated.
- Similar performance to popular UA741.

LOW POWER DIFFERENTIAL INPUT QUAD OP-AMPs

DIMENSIONS: 2.00 × 1.90 mm



Ref. 04645

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J MC3503	J MC3403	Unit
Supply voltage	V_{CC}	±18	±18	V
Differential input voltage	V_{ID}	±36	±36	V
Input voltage - (Note 1)	V_I	±18	±18	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC}^+ = +15$ V, $V_{CC}^- = -15$ V,
(Unless otherwise specified)

Characteristic	Symbol	J MC3503			J MC3403			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	5	–	2	10	mV
Input offset current	I_{IO}	–	30	50	–	30	70	nA
Input bias current	I_{IB}	–	−200	−500	–	−200	−500	nA
Large signal open loop voltage gain ($V_O = \pm 10$ V, $R_L = 2$ kΩ)	A_{VD}	50	200	–	20	200	–	V/mV
Supply rejection ratio	SVR	–	30	150	–	30	150	μV/V
Supply current ($V_O = 0$ V, $R_L = \infty$)	I_{CC}	–	2.8	4	–	2.8	7	mA
Input common-mode voltage range (to V_{CC}^-)	V_I	+13	+13.5	–	+13	+13.5	–	V
Common-mode rejection ratio	CMR	70	90	–	70	90	–	dB
Individual output short-circuit current - (Note 2)	I_{OS}	±10	±30	±45	±10	±20	±45	mA
Small signal bandwidth ($A_V = 1$, $R_L = 10$ kΩ, $V_O = 50$ mV)	GW_R	–	1	–	–	1	–	MHz
Output voltage range	V_O							V
$R_L = 10$ kΩ		±12	±13.5	–	±12	±13.5	–	
$R_L = 2$ kΩ		±10	±13	–	±10	±13	–	

Note 2: Not to exceed maximum power dissipation.

ELECTRICAL CHARACTERISTICS (continued)

$V_{CC}^+ = +5$ V, V_{CC}^- =Ground, $T_{amb} = +25°C$
(Unless otherwise specified)

Characteristic	Symbol	MC3503			MC3403			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	5	–	2	10	mV
Input offset current	I_{IO}	–	30	50	–	30	50	nA
Input bias current	I_{IB}	–	−200	−500	–	−200	−500	nA
Large signal open loop voltage gain ($R_L = 2$ kΩ)	A_{VD}	10	200	–	10	200	–	V/mV
Power supply rejection ratio	SVR	–	–	150	–	–	150	μV/V
Supply current	I_{CC}	–	2.5	4	–	2.5	7	mA
Output voltage range ($R_L = 10$ kΩ) - Note 3	V_O							V
$V_{CC}^+ = +5$ V		3.3	3.5	–	3.3	3.5	–	
$+5\text{ V} \leq V_{CC}^+ \leq +30$ V		$V_{CC}^+ - 1.7$	$V_{CC}^+ - 1.5$	–	$V_{CC}^+ - 1.7$	$V_{CC}^+ - 1.5$	–	

Note 3 : Output will swing to ground.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J MC4558

DUAL WIDEBAND OPERATIONAL AMPLIFIERS

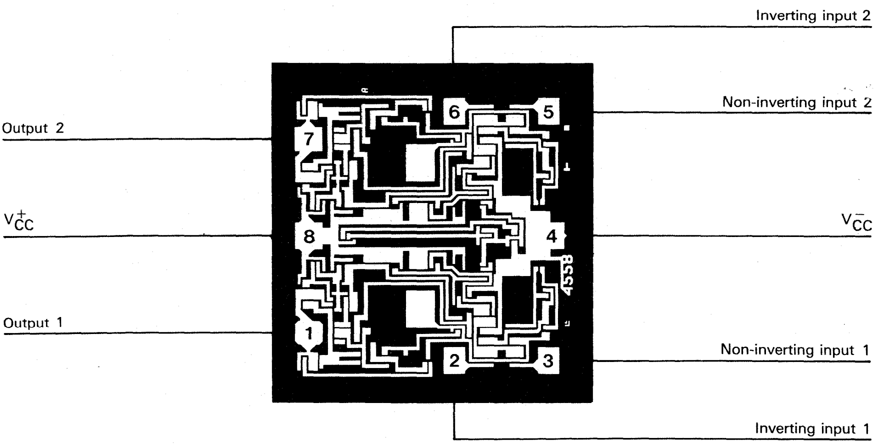
The MC4558 is a high performance monolithic dual operational amplifier constructed on a single silicon chip.

The circuit combines all the outstanding features of the LM1458 and, in addition, possesses three times the unity gain bandwidth of the industry standard.

- Internally compensated.
- Short-circuit protection.
- Gain and phase match between amplifiers.
- Low power consumption.

DUAL WIDEBAND OPERATIONAL AMPLIFIERS

DIMENSIONS: 1.45 × 1.51 mm



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THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J MC4558C	J MC4558M	Unit
Supply voltage	V_{CC}	±18	±22	V
Differential input voltage	V_{ID}	±30	±30	V
Input voltage	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	0 to + 70	−55 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC}^{+} = +15$ V, $V_{CC}^{-} = -15$ V, (Unless otherwise specified)

Characteristic	Symbol	J MC4558C			J MC4558M			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}	–	2	6	–	1	5	mV
Input offset current	I_{IO}	–	20	200	–	20	200	nA
Input bias current	I_{IB}	–	80	500	–	80	500	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L = 2$ kΩ)	A_{VD}	20	200	–	50	200	–	V/mV
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	–	30	150	–	30	150	μV/V
Input voltage range	V_I	±12	±13	–	±12	±13	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output short-circuit current	I_{OS}	10	20	40	10	20	40	mA
Output voltage swing	V_{OPP}							V
$R_L \geqslant 10$ kΩ		±12	±14	–	±12	±14	–	
$R_L \geqslant 2$ kΩ		±10	±13	–	±10	±13	–	
Slew rate ($V_I = +20$ mV, $R_L \geqslant 2$ kΩ, $C_L \leqslant 100$ pF)	S_{VO}	–	1.6	–	–	1.6		V/μs
Unity gain bandwidth	B	2	2.8	–	2.5	2.8	–	MHz

These specifications are subject to change without notice.

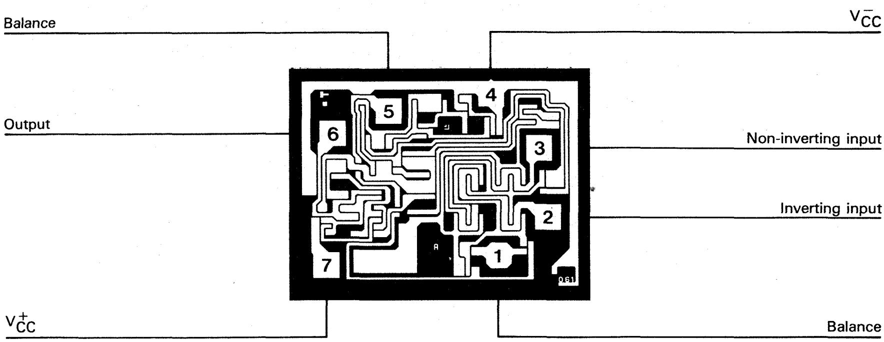
LOW POWER J-FET INPUT SINGLE OP-AMP

The TL061 is low power J-FET input single operational amplifier. This J-FET input operational amplifier incorporates well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

LOW POWER J-FET INPUT SINGLE OP-AMP

DIMENSIONS: 1.35 × 1.05 mm



Ref. 04655

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J TL061M	J TL061C	Unit
Supply voltage - (Note 1)	V_{CC}	±18	±18	V
Differential input voltage - (Note 2)	V_{ID}	±30	±30	V
Input voltage - (Note 3)	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL061M			J TL061C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}	–	3	6	–	5	15	mV
Input offset current*	I_{IO}	–	–	10	–	–	12	nA
Input bias current*	I_{IB}	–	–	12	–	–	16	nA
Input common-mode voltage range	V_I	±11	±12	–	±10	±11	–	V
Output voltage swing ($R_L = 10\ k\Omega$)	V_{OPP}	20	27	–	20	27	–	V
Large signal voltage gain ($R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}	4	6	–	3	6	–	V/mV
Small signal bandwidth ($R_L = 10\ k\Omega$)	GW_R	–	1	–	–	1	–	MHz
Common-mode rejection ratio ($R_S \leq 10\ k\Omega$)	CMR	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$, $R_S \leq 10\ k\Omega$)	SVR	80	95	–	70	95	–	dB
Supply current (no load, no signal)	I_{CC}	–	200	250	–	200	250	µA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J TL062

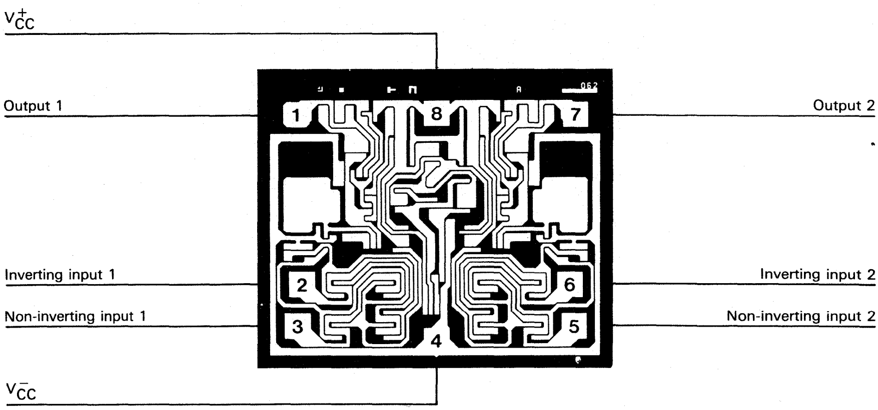
LOW POWER J-FET INPUT DUAL OP-AMP

The TL062 is a low power J-FET input dual operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rate, low input bias and offset currents, and low offset voltage temperature coefficient.

LOW POWER J-FET INPUT DUAL OP-AMP

DIMENSIONS: 1.61 × 1.37 mm



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Ref. 04660

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J TL062M	J TL062C	Unit
Supply voltage - (Note 1)	V_{CC}	± 18	± 18	V
Differential input voltage - (Note 2)	V_{ID}	± 30	± 30	V
Input voltage - (Note 3)	V_I	± 15	± 15	V
Operating free-air temperature range	T_{oper}	− 55 to + 125	0 to + 70	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	°C

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

T_{amb} = + 25°C, V_{CC} = ± 15 V, (Unless otherwise specified)
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL062M			J TL062C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage (R_S = 50 Ω)	V_{IO}	–	3	6	–	3	15	mV
Input offset current*	I_{IO}	–	–	10	–	–	12	nA
Input bias current*	I_{IB}	–	–	12	–	–	16	nA
Input voltage range	V_I	± 11	± 12	–	± 10	± 11	–	V
Output voltage swing (R_L = 10 kΩ)	V_{OPP}	20	27	–	20	27	–	V
Large signal voltage gain ($R_L \geqslant$ 10 kΩ, V_O = ± 10 V)	A_{VD}	4	6	–	3	6	–	V/mV
Small signal bandwidth (R_L = 10 kΩ)	GW_R	–	1	–	–	1	–	MHz
Common-mode rejection ratio ($R_S \leqslant$ 10 kΩ)	CMR	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($R_S \leqslant$ 10 kΩ)	SVR	80	95	–	70	95	–	dB
Supply current (per amplifier) - (no load, no signal)	I_{CC}	–	200	250	–	200	250	μA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

THOMSON SEMICONDUCTORS

J TL064

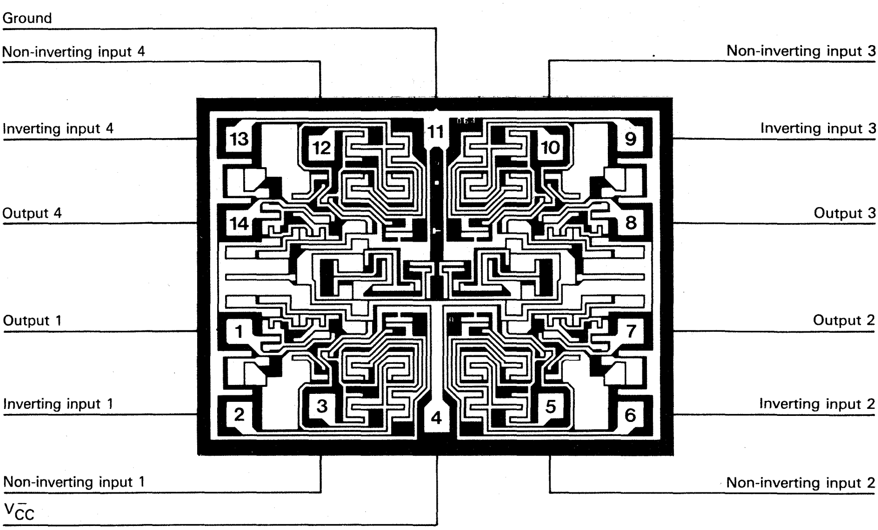
LOW POWER J-FET INPUT QUAD OP-AMP

The TL064 is a low power J-FET input quad operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

LOW POWER J-FET INPUT QUAD OP-AMP

DIMENSIONS: 2.16 × 1.64 mm



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Ref. 04665

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J TL064M	J TL064C	Unit
Supply voltage - (Note 1)	V_{CC}	±18	±18	V
Differential input voltage - (Note 2)	V_{ID}	±30	±30	V
Input voltage - (Note 3)	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)
All characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL064M			J TL064C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}	–	3	6	–	3	15	mV
Input offset current*	I_{IO}	–	–	10	–	–	12	nA
Input bias current*	I_{IB}	–	–	12	–	–	16	nA
Input common-mode voltage range	V_I	±11	±12	–	±10	±11	–	V
Output voltage swing ($R_L = 10\ k\Omega$)	V_{OPP}	20	27	–	20	27	–	V
Large signal voltage gain ($R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}	4	6	–	3	6	–	V/mV
Small signal bandwidth ($R_L = 10\ k\Omega$)	GW_R	–	1	–	–	1	–	MHz
Common-mode rejection ratio ($R_S \leq 10\ k\Omega$)	CMR	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$, $R_S \leq 10\ k\Omega$)	SVR	80	95	–	70	95	–	dB
Supply current (per amplifier) - (no load, no signal)	I_{CC}	–	200	250	–	200	250	µA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

THOMSON SEMICONDUCTORS

J TL081

J-FET INPUT SINGLE OP-AMPs

The TL081 is a high speed J-FET input single operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

J-FET INPUT SINGLE OP-AMPs

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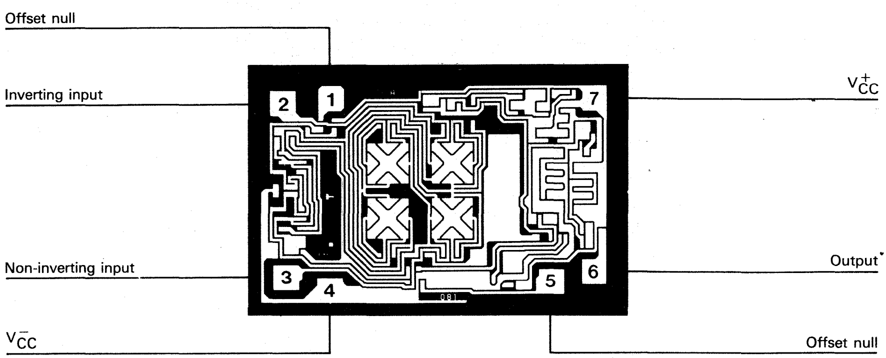
DIMENSIONS: 1.72 × 1.14 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage - (Note 1)	V_{CC}	± 18	V
Differential input voltage - (Note 2)	V_{ID}	± 30	V
Input voltage - (Note 3)	V_I	± 15	V
Operating free-air temperature range J TL081C J TL081M	T_{oper}	 0 to + 70 − 55 to + 125	°C
Storage temperature	T_{stg}	− 65 to + 150	°C

Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

Note 2 : Differential voltage are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

T_{amb} = + 25°C, V_{CC} = ± 15 V, (Unless otherwise specified)
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL081M			J TL081C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage (R_S = 50 Ω)	V_{IO}	–	3	6	–	5	15	mV
Input offset current*	I_{IO}	–	–	10	–	–	12	nA
Input bias current*	I_{IB}	–	–	12	–	–	16	nA
Input common-mode voltage range	V_I	± 11	± 12	–	± 10	± 11	–	V
Output voltage swing (R_L ≥ 10 kΩ)	V_{OPP}	24	27	–	24	27	–	V
Large signal voltage gain (R_L ≥ 2 kΩ, V_O = ± 10 V)	A_{VD}	50	200	–	25	200	–	V/mV
Small signal bandwidth	GW_R	–	3	–	–	3	–	MHz
Common-mode rejection ratio (R_S ≥ 10 kΩ)	CMR	80	86	–	70	76	–	dB
Supply voltage rejection ratio (R_S ≥ 10 kΩ)	SVR	80	86	–	70	76	–	dB
Supply current (per amplifier)	I_{CC}	–	1.4	2.8	–	1.4	2.8	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

THOMSON SEMICONDUCTORS

J TL082

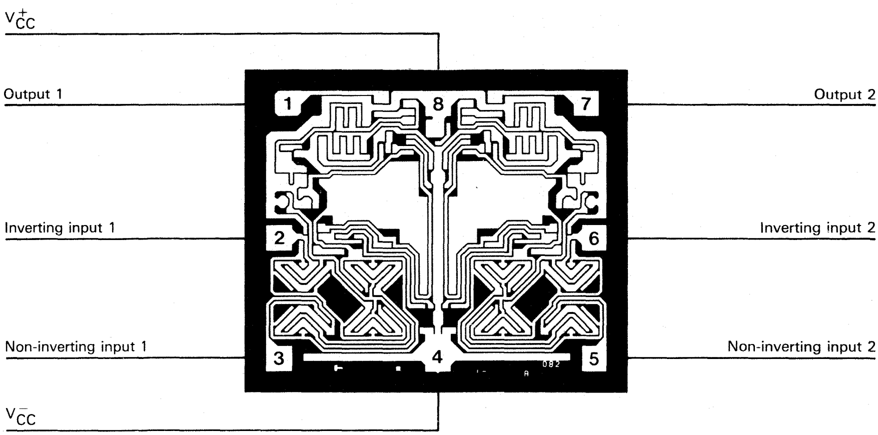
J-FET INPUT DUAL OP-AMP

The TL082 is a high speed J-FET input dual operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

J-FET INPUT
DUAL OP-AMP

DIMENSIONS: 1.74 × 1.48 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage - (Note 1)	V_{CC}	±18	V
Differential input voltage - (Note 2)	V_{ID}	±30	V
Input voltage - (Note 3)	V_I	±15	V
Operating free-air temperature range J TL082C J TL082M	T_{oper}	 0 to + 70 −55 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^-.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL082M			J TL082C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}	–	3	6	–	5	15	mV
Input offset current*	I_{IO}	–	–	10	–	–	12	nA
Input bias current*	I_{IB}	–	–	12	–	–	16	nA
Input voltage range	V_I	±11	±12	–	±10	±11	–	V
Output voltage swing ($R_L \geq 10\ k\Omega$)	V_{OPP}	24	27	–	24	27	–	V
Large signal voltage gain ($R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V)	A_{VD}	50	200	–	25	200	–	V/mV
Small signal bandwidth	GW_R	–	3	–	–	3	–	MHz
Common-mode rejection ratio ($R_S \geq 10\ k\Omega$)	CMR	80	86	–	70	76	–	dB
Supply voltage rejection ratio ($R_S \geq 10\ k\Omega$)	SVR	80	86	–	70	76	–	dB
Supply current (per amplifier)	I_{CC}	–	1.4	2.8	–	1.4	2.8	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

THOMSON SEMICONDUCTORS

J TL084

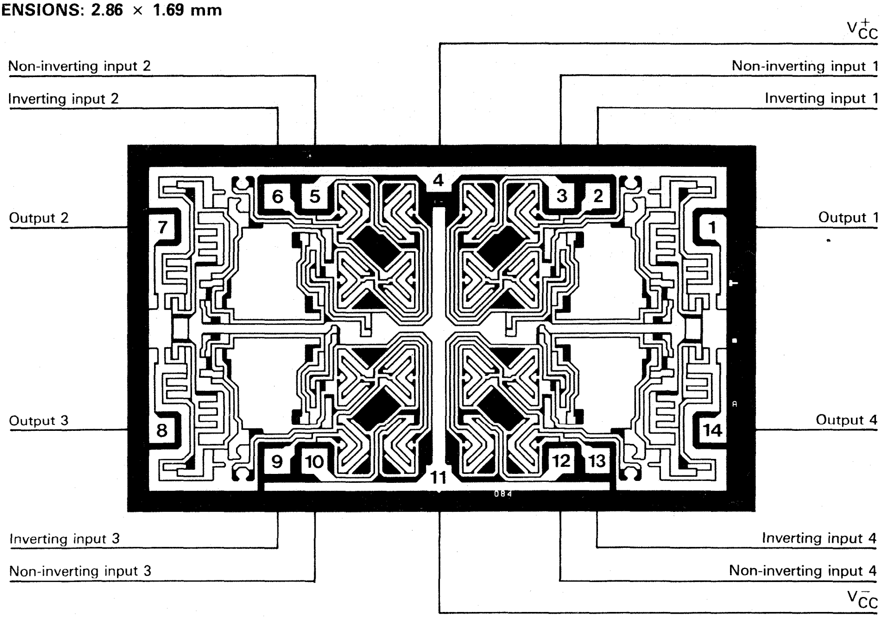
J-FET INPUT QUAD OP-AMP

The TL084 is a high speed J-FET input quad operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.

J-FET INPUT QUAD OP-AMP

DIMENSIONS: 2.86 × 1.69 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage - (Note 1)	V_{CC}	±18	V
Differential input voltage - (Note 2)	V_{ID}	±30	V
Input voltage - (Note 3)	V_I	±15	V
Operating free-air temperature range J TL084C J TL084M	T_{oper}	 0 to + 70 −55 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

Note 1 : All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^{+} and V_{CC}^{-}.

Note 2 : Differential voltages are at the non-inverting input terminal with respect to the inverting input terminal.

Note 3 : The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)
Test conditions : all characteristics are specified under open-loop conditions unless otherwise specified.

Characteristic	Symbol	J TL084M			J TL084C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S = 50\ \Omega$)	V_{IO}	—	3	6	—	5	15	mV
Input offset current*	I_{IO}	—	—	10	—	—	12	nA
Input bias current*	I_{IB}	—	—	12	—	—	16	nA
Input voltage range	V_I	±11	±12	—	±10	±11	—	V
Output voltage swing ($R_L \geqslant 10$ kΩ)	V_{OPP}	24	27	—	24	27	—	V
Large signal voltage gain ($R_L \geqslant 2$ kΩ, $V_O = \pm 10$ V)	A_{VD}	50	200	—	25	200	—	V/mV
Small signal bandwidth	GW_R	—	3	—	—	3	—	MHz
Common-mode rejection ratio ($R_S \geqslant 10$ kΩ)	CM_R	80	86	—	70	76	—	dB
Supply voltage rejection ratio ($R_S \geqslant 10$ kΩ)	SVR	80	86	—	70	76	—	dB
Supply current (per amplifier)	I_{CC}	—	1.4	2.8	—	1.4	2.8	mA

* Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

THOMSON SEMICONDUCTORS

J UA741

GENERAL-PURPOSE SINGLE OP-AMPs

The UA741 is a high performance monolithic operational amplifier. It is intended for a wide range of analog applications.

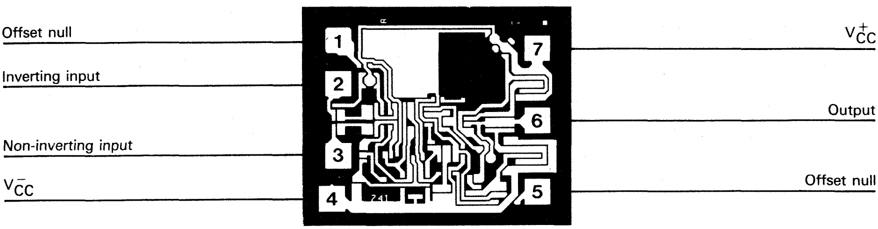
- Summing amplifier.
- Voltage follower.
- Integrator.
- Active filter.
- Function generator.

The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feedback applications. The internal compensation network (6 dB/octave) insures stability in closed loop applications.

- Large input voltage range.
- No latch-up.
- High gain.
- Short-circuit protection.
- No frequency compensation required.

GENERAL-PURPOSE
SINGLE OP-AMPs

DIMENSIONS: 1.20 × 1.00 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J UA741M	J UA741C	Unit
Supply voltage	V_{CC}	±22	±18	V
Differential input voltage	V_{ID}	±30	±30	V
Input voltage	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified)

Characteristic	Symbol	J UA741M			J UA741C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 10$ kΩ)	V_{IO}	—	1	5	—	2	6	mV
Input offset current	I_{IO}	—	20	200	—	20	200	nA
Input bias current	I_{IB}	—	80	500	—	80	500	nA
Large signal voltage gain ($V_O = \pm 10$ V, $R_L \geqslant 2$ kΩ)	A_{VD}	50	200	—	20	200	—	V/mV
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	—	30	150	—	30	150	µV/V
Supply current	I^+_{CC}, I^-_{CC}	—	1.7	2.8	—	1.7	2.8	mA
Input voltage range	V_I	±12	±13	—	±12	±13	—	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	—	70	90	—	dB
Output voltage swing	V_{OPP}							V
$R_L \geqslant 10$ kΩ		±12	±14	—	±12	±14	—	
$R_L \geqslant 2$ kΩ		±10	±13	—	±10	±13	—	

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J UA776

PROGRAMMABLE SINGLE OP-AMPs

The UA776 programmable operational amplifier is characterized by high input impedance, low supply currents and low input noise over a wide range of operating supply voltages.

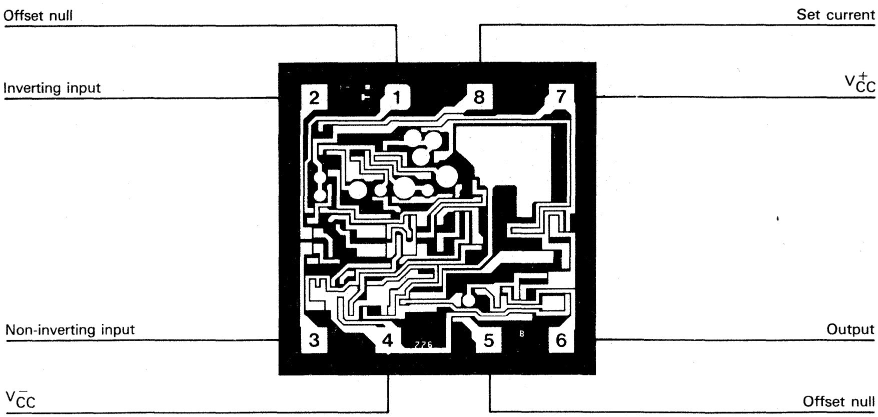
Coupled with programmable electrical characteristics it is an extremely versatile amplifier for use in high accuracy, low power consumption analog applications.

Input noise voltage and current, power consumption, and input current can be optimized by a single resistor or current source that sets the chip quiescent current for nano-watt power consumption or for characteristics similar to the UA741.

Internal frequency compensation, absence of latch up, high slew rate and short-circuit protection assure ease of use in long time integrators, active filters, and sample and hold circuits.

PROGRAMMABLE SINGLE OP-AMPs

DIMENSIONS: 1.43 × 1.43 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		J UA776M	J UA776C	
Supply voltage	V_{CC}	±18	±18	V
Differential input voltage	V_{ID}	±30	±30	V
Input voltage - (Note 1)	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC} = ±15 V, I_{set} = 15 μA, (Unless otherwise specified)

Characteristic	Symbol	J UA776M			J UA776C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage	V_{IO}	–	2	5	–	2	6	mV
Input offset current	I_{IO}	–	2	15	–	2	25	nA
Input bias current	I_{IB}	–	15	50	–	15	50	nA
Large signal voltage gain (V_O = ±10 V, $R_L \geqslant 5$ kΩ)	A_{VD}	10^5	4.10^5	–	5.10^4	4.10^5	–	V/V
Supply voltage rejection ratio ($R_S \leqslant 10$ kΩ)	SVR	–	25	150	–	25	200	μV/V
Supply current	I_{CC}	–	160	180	–	160	190	μA
Input voltage range	V_I	±10	–	–	±10	–	–	V
Common-mode rejection ratio ($R_S \leqslant 10$ kΩ)	CMR	70	90	–	70	90	–	dB
Output voltage swing ($R_L \geqslant 5$ kΩ)	V_{OPP}	±10	±13	–	±10	±13	–	V

These specifications are subject to change without notice.

SINGLE

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
J LM111/J LM311	Voltage comparator			●	●	811

DUAL

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
J LM119/J LM319	High speed dual comparator			●		813
J LM193,A/J LM393,A	Single supply low power, low offset	●	●			817

QUAD

Part number	Function	Low power <1 mA	Single power supply	$t_r < 0.3\ \mu s$	Adjustable offset	Page
J LM139,A/J LM339,A	Single supply low power, low offset	●	●			815

THOMSON SEMICONDUCTORS

J LM111
J LM311

SINGLE VOLTAGE COMPARATORS

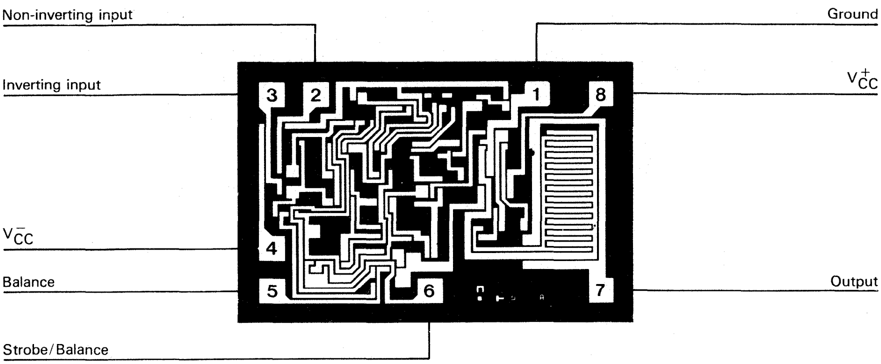
The LM111, and LM311 are voltage comparators that have extremely low input currents.

They are also designed to operate over a wide range of supply voltages : from standard ±15 V operational amplifier supplies down to the single +5 V supply used for IC logic.

Their output is compatible with RTL-DTL and TTL as well as MOS circuits and can switch voltages up to +50 V at output currents as high as 50mA.

SINGLE VOLTAGE COMPARATORS

DIMENSIONS: 1.18 × 1.78 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM111	J LM311	Unit
Supply voltage	V_{CC}	36	36	V
Differential input voltage	V_{ID}	±30	±30	V
Input voltage - (Note 1)	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C
Ground to negative supply voltage	$V_{(1-4)}$	30	30	V
Output to negative supply voltage	$V_{(7-4)}$	50	40	V

Voltage at strobe pin : $V_{CC}^{+} - 5$ V

Note 1 : This rating applies for ±15 V supplies. The positive input voltage limit is 30 V above the negative. The negative input voltage limit is equal to the negative supply voltage or 30 V below the positive supply, whichever is less.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = \pm 15$ V, (Unless otherwise specified) (Note 2)

Characteristic	Symbol	J LM111			J LM311			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leqslant 50$ kΩ) - (Note 3)	V_{IO}	–	0.7	3	–	2	7.5	mV
Input offset current - (Note 3)	I_{IO}	–	4	10	–	6	50	nA
Input bias current	I_{IB}	–	60	100	–	100	250	nA
Large signal voltage gain	A_{VD}	40	200	–	40	200	–	V/mV
Supply currents								mA
Positive	I_{CC}^{+}	–	5.1	6	–	5.1	7.5	
Negative	I_{CC}^{-}	–	4.1	5	–	4.1	5	
Input voltage range	V_I	–	±14	–	–	±14	–	V
Low level output voltage	V_{OL}							V
$I_O = 50$ mA, $V_I \leqslant -5$ mV		–	0.75	1.5	–	–	–	
$V_I \leqslant -10$ mV		–	–	–	–	0.75	1.5	
High level output current	I_{OH}							nA
$V_I \geqslant +5$ mV, $V_O = +35$ V		–	0.2	10	–	–	–	
$V_I \geqslant +10$ mV, $V_O = +25$ V		–	–	–	–	0.2	50	

Note 2 : The offset voltage, offset current and bias current specifications apply for any supply voltage from a single +5 V supply up to ±15 V supplies.

Note 3 : The offset voltage and offset currents given are the maximum values required to drive the output down to +1 V or up to +14 V with a 1 mA load. Thus, these parameters define an error band and take into account the worst-case of voltage gain and input impedance.

THOMSON SEMICONDUCTORS

J LM119
J LM319

HIGH SPEED DUAL COMPARATORS

The LM119, LM319 are precision high speed dual comparators fabricated on a single monolithic chip. They are designed to operate over a wide range of supply voltages down to a single 5 V logic supply and ground and have extremely low input currents and high gains.

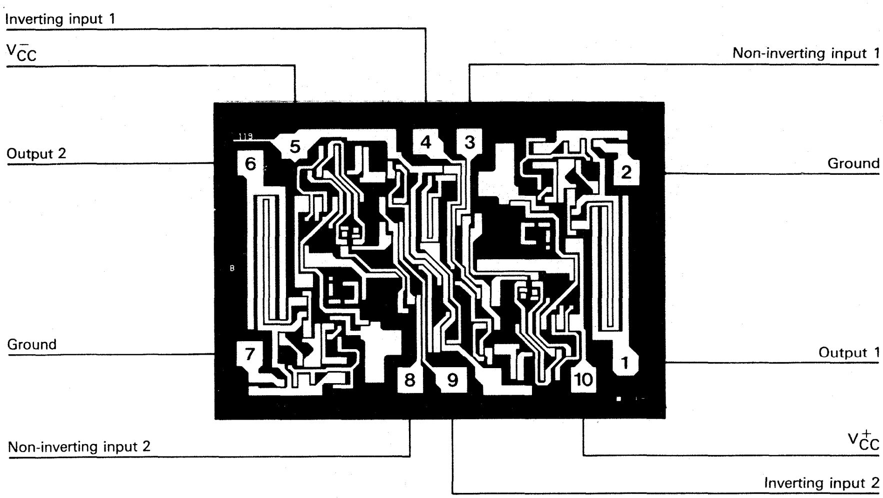
The open collector of the output stage makes the LM119, LM319 compatible with RTL, DTL and TTL as well as capable of driving lamps and relays at currents up to 25 mA.

Although designed primarily for applications requiring operation from digital logic supplies, the LM119, LM319 are fully specified for power supplies up to ± 15 V.

They feature faster response than the LM111 at the expense of higher power dissipation. However, the high speed, wide operating voltage range make the LM119, LM319 much more versatile.

HIGH SPEED DUAL COMPARATORS

DIMENSIONS: 2.03 × 1.43 mm



MAXIMUM RATINGS

Rating	Symbol	J LM119	J LM319	Unit
Negative supply voltage	V_{CC}^-	25	25	V
Positive supply voltage	V_{CC}^+	18	18	V
Differential input voltage	V_{ID}	±5	±5	V
Input voltage - (Note 1)	V_I	±15	±15	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

Note 1 : For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS (Note 2)

T_{amb} = +25°C, V_{CC} = ±15 V, (Unless otherwise specified)

Characteristic	Symbol	J LM119			J LM319			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage ($R_S \leq 5$ kΩ) - (Note 3)	V_{IO}	–	0.7	4	–	2	8	mV
Input offset current - (Note 3)	I_{IO}	–	30	75	–	80	200	nA
Input bias current	I_{IB}	–	150	500	–	250	1000	nA
Large signal voltage gain	A_{VD}	10	40	–	8	40	–	V/mV
Positive supply current V_{CC}^+ = +5 V, V_{CC}^- = 0 V	I_{CC}^+	– –	8 4.3	11.5 –	– –	8 4.3	12.5 –	mA
Negative supply current	I_{CC}^-	–	3	4.5	–	3	5	mA
Input voltage range (V_{CC}^+ = +5 V, V_{CC}^- = 0 V)	V_I	– 1	±13 –	– 3	– 1	±13 –	– 3	V
Low level output voltage, (I_O = 25 mA) V_I < − 5 mV V_I < −10 mV V_{CC}^+ > +4.5 V, V_{CC}^- = 0 V, V_I < − 6 mV, $I_{O(sink)}$ < 3.2 mA V_{CC}^+ > +4.5 V, V_{CC}^- = 0 V, V_I < −10 mV, $I_{O(sink)}$ < 3.2 mA	V_{OL}	 – – – –	 0.75 – 0.23 –	 1.5 – 0.4 –	 – – – –	 – 0.75 – 0.3	 – 1.5 – 0.4	V
High level output current (V_O = +35 V) V_I > + 5 mV V_I > +10 mV	I_{OH}	 – –	 0.2 –	 2 –	 – –	 – 0.2	 – 10	μA

Note 2 : These specifications apply for V_{CC} = ±15 V, unless otherwise stated. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single +5 V supply up to ±15 V supplies.

Note 3 : The offset voltages and offset current given are the maximum values required to drive the output down to 1 V or up 14 V with a 1 mA load current.
Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM139,A
J LM339,A

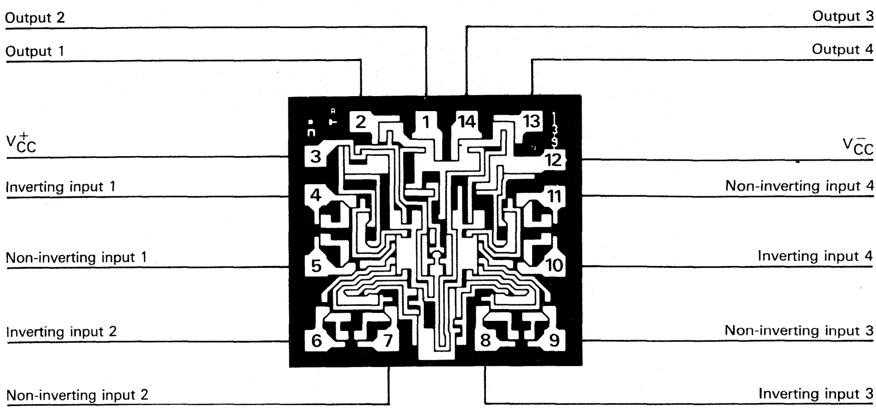
LOW POWER LOW OFFSET VOLTAGE QUAD COMPARATORS

These devices consist of four independent precision voltage comparators with an offset specifications as low as 2 mV max for LM339A and LM139A. All these comparators were designed specifically to operate from a single power supply over a wide range of voltages. Operation form split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

LOW POWER
LOW OFFSET VOLTAGE
QUAD COMPARATORS

DIMENSIONS: 1.4 × 1.3 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM139,A	J LM339,A	Unit
Supply voltage	V_{CC}	± 18 to 36	± 18 to 36	V
Differential input voltage	V_{ID}	36	36	V
Input voltage	V_I	− 0.3 to + 36	− 0.3 to + 36	V
Operating free-air temperature range	T_{oper}	− 55 to + 125	0 to + 70	°C
Storage temperature range	T_{stg}	− 65 to + 150	− 65 to + 150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC}^{+} = +5$ V, $V_{CC}^{-} = GND$, (Unless otherwise specified)

Characteristic	Symbol	J LM139,A			J LM339,A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - Note 1	V_{IO}							mV
J LM139, J LM339		—	± 2	± 5	—	± 2	± 5	
J LM139A		—	± 1	± 2	—	—	—	
J LM339A		—	—	—	—	± 1	± 2	
Input offset current	I_{IO}	—	± 3	± 25	—	± 5	± 50	nA
Input bias current (I_I^+ or I_I^-) - (Note 2)	I_{IB}	—	25	100	—	25	250	nA
Large signal voltage gain $V_{CC}^{+} = +15$ V, $R_L \geq 15$ kΩ	A_{VD}	—	200	—	—	200	—	V/mV
J LM139A		50	200	—	—	—	—	
J LM339A		—	—	—	50	200	—	
Supply current, $R_L = \infty$ (all comparators)	I_{CC}	—	0.8	2	—	0.8	2	mA
Input common-mode voltage range - (Note 3)	V_I	0	—	$V_{CC}^{+}-1.5$	0	—	$V_{CC}^{+}-1.5$	V
Low level output voltage ($V_I^- \geq 1$ V, $V_I^+ = 0$ V, $I_{sink} \leq 4$ mA)	V_{OL}	—	250	—	—	250	400	V
High level output current ($V_I^+ \geq 1$ V, $V_I^- = 0$ V, $V_O = +5$ V)	I_{OH}	—	0.1	—	—	0.1	—	nA
Output sink current ($V_I^- \geq 1$ V, $V_I^+ = 0$ V, $V_O \leq +1.5$ V)	$I_{O(sink)}$	6	16	—	6	16	—	mA

Note 1 : At output switch point, $V_O \cong 1.4$ V, $R_S = 0$ with $V_{CC}^{+} = 5$ V, and over the full input common-mode range (0 V to V_{CC}^{+} − 1.5 V).

Note 2 : The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference or input lines.

Note 3 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC}^{+} − 1.5 V, but either or both inputs can go to + 30 V without damage.

THOMSON SEMICONDUCTORS

J LM193,A
J LM393,A

DUAL VOLTAGE COMPARATORS

These devices consist of two independent precision voltage comparators with an offset voltage specification as low as 2 mV max for J LM393 A and J LM193A.

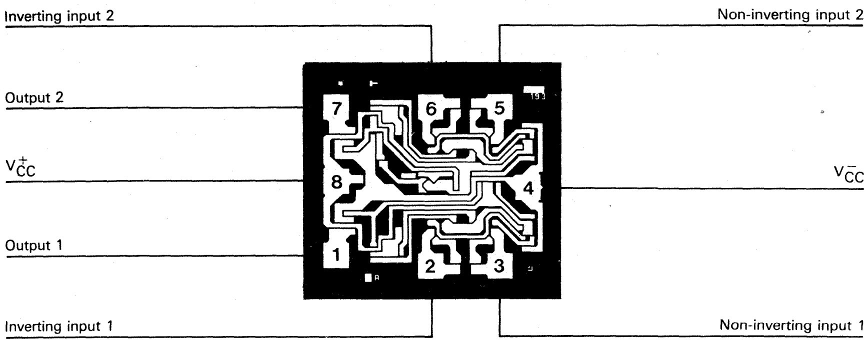
All these comparators were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

- TTL, DTL, ECL, MOS, CMOS compatible outputs.

DUAL VOLTAGE COMPARATORS

DIMENSIONS: 1.18 × 1.08 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM193,A	J LM393,A	Unit
Supply voltage	V_{CC}	±18 to 36	±18 to 36	V
Differential input voltage	V_{ID}	36	36	V
Input voltage range	V_I	−0.3 to +36	−0.3 to +36	V
Operating free-air temperature range	T_{oper}	−55 to +125	0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC}^{+} = +5$ V, V_{CC}^{-} = Ground,
(Unless otherwise specified)

Characteristic	Symbol	J LM193,A			J LM393,A			Unit
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage - (Note 1)	V_{IO}	—	±1	±5	—	±1	±5	mV
J LM193A, J LM393A		—	±1	±2	—	±1	±2	
Input offset current	I_{IO}	—	±3	±25	—	±5	±50	nA
Input bias current - (Note 2)	I_{IB}	—	25	100	—	25	250	nA
Large signal voltage gain ($R_L \geq 15$ kΩ, $V_{CC}^{+} = +15$ V)	A_{VD}	—	50	200	—	50	200	V/mV
Supply current ($R_L = \infty$) - (all comparators)	I_{CC}	—	0.4	1	—	0.4	1	mA
Input common-mode voltage range - (Note 3)	V_I	0	—	$V_{CC}^{+}-1.5$	0	—	$V_{CC}^{+}-1.5$	V
Saturation voltage ($V_I^{-} \geq 1$ V, $V_I^{+} = 0$ V, $I_{O(sink)} \leq 4$ mA)	V_{OL}	—	250	400	—	250	400	mV
High level output current ($V_I^{+} \geq 1$ V, $V_I^{-} = 0$ V, $V_O = +30$ V)	I_{OH}	—	—	1	—	—	1	μA
Output sink current ($V_I^{+} = 0$ V, $V_I^{-} \geq 1$ V, $V_O \leq +1.5$ V)	$I_{O(sink)}$	6	16	—	6	16	—	mA

Note 1 : At output switch point, $V_O \cong 1.4$ V, $R_S = 0$ with V_{CC}^{+} from 5 V to 30 V the full input common-mode range (0 V to V_{CC}^{+} − 1.5 V).

Note 2 : The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference or input lines.

Note 3 : The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC}^{+} − 1.5 V, but either or both inputs can go to +30 V without damage.

THREE-TERMINAL

Fixed

Part number	Function		Page
J UA7800 Series	Positive voltage regulators	1 A	831
J UA7900 Series	Negative voltage regulators	1 A	835

Adjustable

Part number	Function		Page
J LM117/J LM317	Positive voltage regulators	1 A	823
J LM137/J LM337	Negative voltage regulators	1 A	825
J LM138/J LM338	Positive voltage regulators	5 A	827

MULTI-TERMINAL

Part number	Function	Page
J LM105/J LM305	Positive voltage regulators	821
J UA723	Precision voltage regulators	829

THOMSON SEMICONDUCTORS

J LM105
J LM305

ADJUSTABLE POSITIVE VOLTAGE REGULATORS

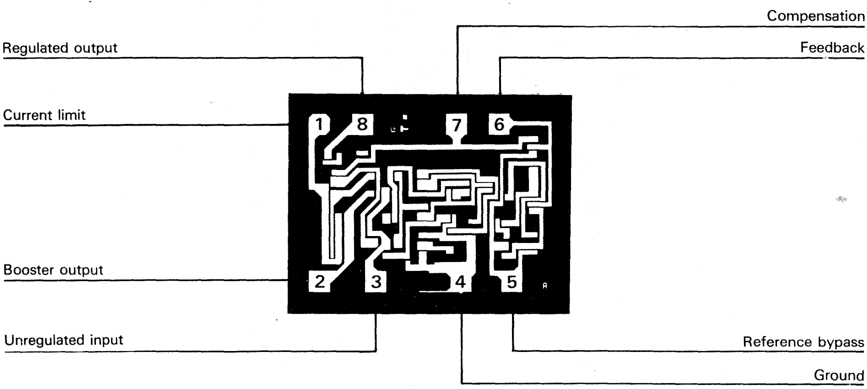
The LM105, LM305 are positive voltage regulators designed for a wide range of applications from digital power supplies to precision regulators for analog circuitry.

Important characteristics of these circuits are :
- Output voltage adjustable from 4.5 V to 40 V
- Output current in excess of 10 A possible by adding external transistors.
- Load regulation better than 0.1%, full load with current limiting.
- DC line regulation guaranteed at 0.03%.
- Ripple rejection of 0.01%/V

Additional features are : fast response to both load an line transients, freedom from oscillation with varying resistive or reactive loads and the ability to start reliably on any load within rating.

ADJUSTABLE POSITIVE VOLTAGE REGULATORS

DIMENSIONS: 1.02 × 1.32 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Input voltage	J LM105 J LM305	V_I	50 40	V
Input-output voltage differential		$V_I - V_O$	40	V
Short-circuit output current		I_{OS}	25	mA
Operating junction temperature range	J LM105 J LM305	T_j	−55 to +125 0 to + 70	°C
Storage temperature range		T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (Note 1)

$T_j = +25°C$, (Unless otherwise specified)

Characteristic	Symbol	J LM105			J LM305			Unit
		Min	Typ	Max	Min	Typ	Max	
Input voltage range	V_I	8.5	–	50	8.5	–	40	V
Output voltage range	V_O	4.5	–	40	4.5	–	30	V
Input-output voltage differential	$V_I - V_O$	3	–	30	3	–	30	V
Line regulation $V_I - V_O \leqslant +5$ V $V_I - V_O \geqslant +5$ V	K_{VI}	 – –	 0.025 0.015	 0.06 0.03	 – –	 0.025 0.015	 0.06 0.03	%/V
Load regulation ($0 \leqslant I_O \leqslant 12$ mA, $R_{sc} = 10\ \Omega$)	K_{VO}	–	0.02	0.05	–	0.02	0.05	%
Standby current drain $V_I = +50$ V $V_I = +40$ V	I_{IB}	 – –	 0.8 –	 2 –	 – –	 – 0.8	 – 2	mA
Reference voltage	V_{ref}	1.63	1.7	1.81	1.63	1.7	1.81	V
Current limit sense voltage ($R_{SC} = 10\ \Omega$, $V_O = 0$)	V_{sense}	225	300	375	225	300	375	mV

Note 1 : These specifications apply for a junction temperature $T_j = +25°C$, for input and output voltages within the ranges given, and for a divider impedance seen by the feedback terminal of 2 kΩ, unless otherwise specified. The load and line regulation specifications are for constant junction temperature. Temperature drift effects must be taken into account separately when the unit is operating under conditions of high dissipation.

THOMSON SEMICONDUCTORS

J LM117
J LM317

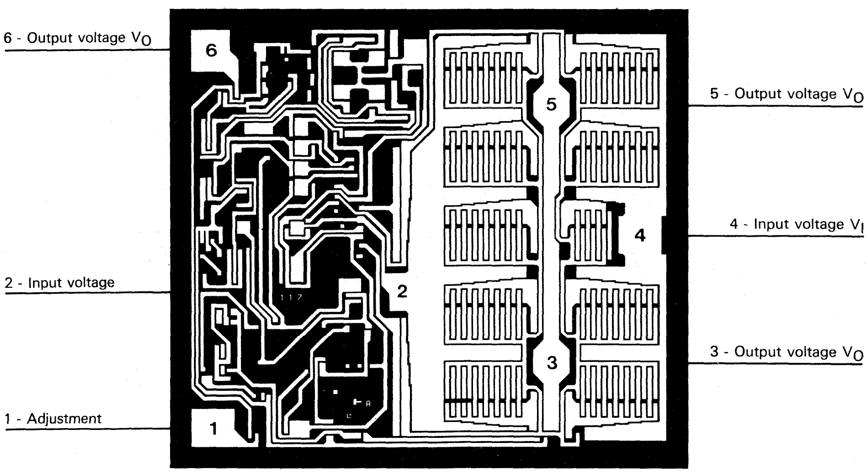
ADJUSTABLE POSITIVE VOLTAGE REGULATORS

The LM117 series are adjustable positive voltage regulators capable of supplying in excess of 1.5 A over a 1.2 to 37 V output voltage range. They are exceptionnally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators.

In addition to higher performance than fixed regulators, the LM117 series offer full overload protection available only in integrated circuits. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

ADJUSTABLE POSITIVE VOLTAGE REGULATORS

DIMENSIONS : 2.38 × 2.13



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input - Output voltage differential	$V_I - V_O$	40	V
Output current	I_O	1.5	A
Operating junction temperature range J LM117 J LM317	T_j	 −55 to +150 0 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I - V_O = 5$ V, $I_O = 0.5$ A
(Unless otherwise specified)

Characteristic	Symbol	J LM117			J LM317			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference voltage (10 mA ≤ I_O ≤ 0.5 A, 3 V ≤ $V_I - V_O$ ≤ 40 V) - Note 1	$V_{(ref)}$	1.20	1.25	1.30	1.20	1.25	1.30	V
Line regulation (I_O = 0.1 A, 3 V ≤ $V_I - V_O$ ≤ 40 V) - Note 1	K_{VI}	–	0.01	0.02	–	0.01	0.04	%/V
Load regulation, (10 mA ≤ I_O ≤ 0.5 A) - Note 1 V_O ≤ +5 V V_O ≥ +5 V	K_{VO}	 – –	 5 0.1	 15 0.3	 – –	 5 0.1	 25 0.5	 mV %
Adjustment pin current	I_{adj}	–	50	100	–	50	100	μA
Adjustment pin current change (10 mA ≤ I_O ≤ 0.5 A, 3 V ≤ $V_I - V_O$ ≤ 40 V)	ΔI_{adj}	–	0.2	5	–	0.2	5	μA
Minimum load current ($V_I - V_O$ = 40 V)	$I_{O(min)}$	–	3.5	5	–	3.5	10	mA

Note 1 : Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

THOMSON SEMICONDUCTORS

J LM137
J LM337

ADJUSTABLE NEGATIVE VOLTAGE REGULATORS

The LM137 series are adjustable negative voltage regulators capable of supplying in excess of − 1.5 A over a − 1.2 to − 37 V output voltage range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. In addition to higher performance than fixed regulators, the LM137 series offer full overload protection available only in integrated circuits. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

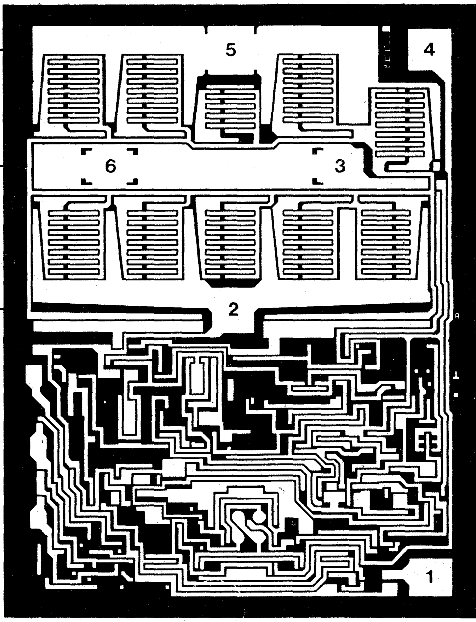
ADJUSTABLE NEGATIVE VOLTAGE REGULATORS

DIMENSIONS: 2.18 × 2.87 mm

Output voltage V_O

Input voltage V_I

Output voltage V_O



Output voltage V_O

Input voltage V_I

Adjustment

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input - Output voltage differential	$V_I - V_O$	40	V
Output current	I_O	1.5	A
Operating junction temperature range J LM137 J LM337	T_j	 −55 to +150 0 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $|V_I - V_O| = 5$ V, $I_O = 0.5$ A
(Unless otherwise specified)

Characteristic	Symbol	J LM137			J LM337			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference voltage (3 V ≤ $\|V_I - V_O\|$ ≤ 40 V, 10 mA < $\|I_O\|$ < 0.5 A)	V_{ref}	−1.20	−1.25	−1.30	−1.20	−1.25	−1.30	V
Line regulation (3 V ≤ $\|V_I - V_O\|$ ≤ 40 V) - Note 1	K_{VI}	—	0.01	0.02	—	0.01	0.04	%/V
Load regulation (10 mA ≤ $\|I_O\|$ ≤ 0.5 A) - Note 1 $\|V_O\|$ ≤ 5 V $\|V_O\|$ ≥ 5 V	K_{VO}	 — —	 15 0.3	 25 0.5	 — —	 15 0.3	 50 1	 mV %
Adjustment pin current	I_{adj}	—	65	100	—	65	100	μA
Adjustment pin current change (10 mA ≤ $\|I_O\|$ ≤ 0.5 A, 3 V ≤ $\|V_I - V_O\|$ ≤ 40 V)	ΔI_{adj}	—	2	5	—	2	5	μA
Minimum load current ($\|V_I - V_O\|$ ≤ 40 V)	$\|I_{O(min)}\|$	—	2.5	5	—	2.5	10	mA

Note 1 : Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

THOMSON SEMICONDUCTORS

J LM138
J LM338

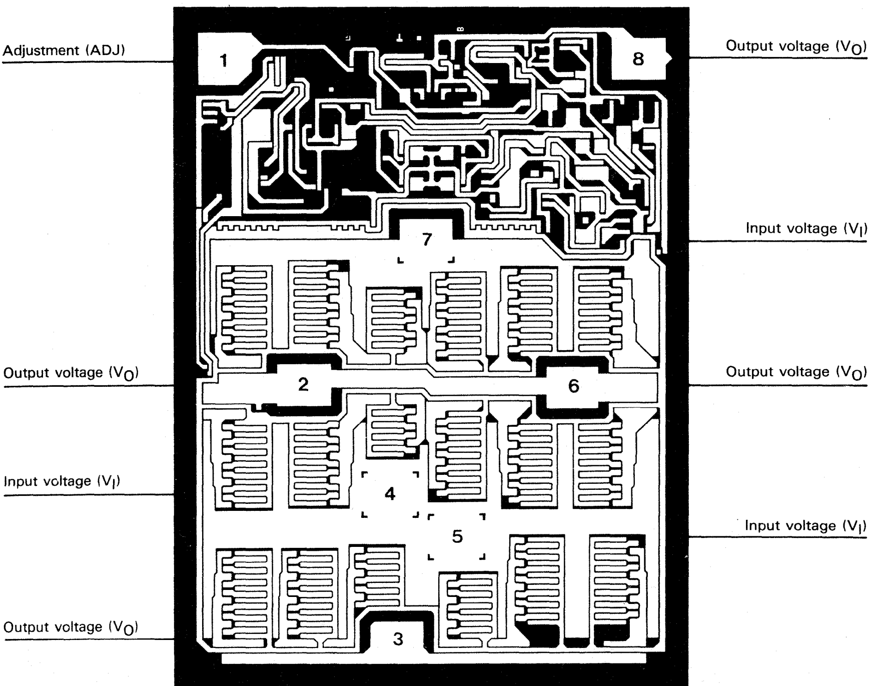
5-A ADJUSTABLE VOLTAGE REGULATORS

The LM138/LM338 are adjustable positive voltage regulators capable of supplying in excess of 5 A over a 1.2 V to 32 V output range. They are exceptionally easy to use and require only 2 resistors to set the output voltage.

Also included on the chip are thermal overload protection and safe area protection for the power transistor. Overload protection remains functional even if the adjustment terminal is accidentally disconnected.

5-A ADJUSTABLE VOLTAGE REGULATORS

DIMENSIONS: 2.38 × 3.2 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Output voltage range	V_O	1.2 to 32	V
Input/Output voltage differential	$V_I - V_O$	35	V
Operating junction temperature range J LM138 J LM338	T_j	 −55 to +150 0 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, (Unless otherwise specified)

Characteristic	Symbol	J LM138			J LM338			Unit
		Min	Typ	Max	Min	Typ	Max	
Line regulation ($+3\ V \leqslant (V_I - V_O) \leqslant +35\ V$) - Note 1	K_{VI}	–	0.005	0.01	–	0.005	0.03	%/V
Load regulation ($10\ mA \leqslant I_O \leqslant 3\ A$) - Note 1 $V_O \leqslant +5\ V$ $V_O \geqslant +5\ V$	K_{VO}	 – –	 5 0.1	 15 0.3	 – –	 5 0.1	 25 0.5	 mV %
Adjustment pin current	I_{adj}	–	45	100	–	45	100	μA
Adjustment pin current change $10\ mA \leqslant I_L \leqslant 3\ A$; $+3\ V \leqslant (V_I - V_O) \leqslant +35\ V$	ΔI_{adj}	 –	 0.2	 5	 –	 0.2	 5	μA
Reference voltage ($+3\ V \leqslant (V_I - V_O) \leqslant +35\ V$, $10\ mA \leqslant I_O \leqslant 3\ A$)	$V_{(ref)}$	1.19	1.24	1.29	1.19	1.24	1.29	V
Minimum load current ($V_I - V_O = +35\ V$)	$I_{O(min)}$	–	3.5	5	–	3.5	10	mA

Note 1 : Regulation is measured at constant junction temperature. Change in output voltage due to heating effects are taken into account separately by thermal regulation.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

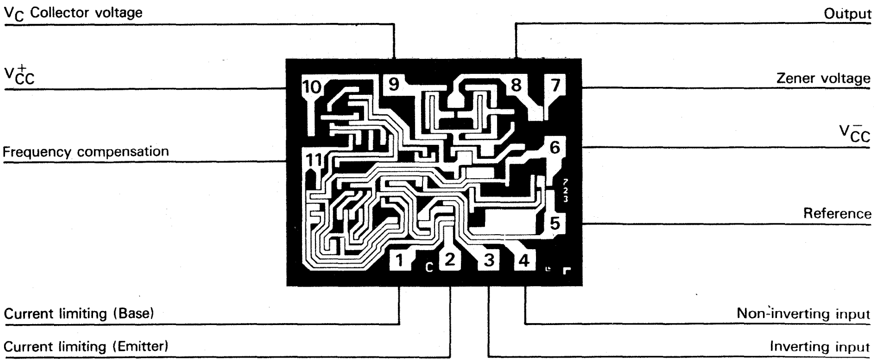
J UA723

PRECISION ADJUSTABLE VOLTAGE REGULATOR

The UA723 is a monolithic voltage regulator constructed on single silicon chip. The device consists of a temperature compensated reference amplifier, error amplifier, power series pass transistor and current limit circuitry. Additional NPN or PNP pass elements may be used when output currents exceeding 150 mA are required. Provisions are made for adjustable current limiting and remote shut down. In addition to the above the device features low standby current drain, low temperature drift and high ripple rejection. Applications include laboratory power supplies, airborne systems and other power supplies for digital and linear circuits.

PRECISION ADJUSTABLE VOLTAGE REGULATOR

DIMENSIONS: 1.1 × 1.4 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage (Both inputs)	V_I	40	V
Pulse voltage from V_{CC}^+ to V_{CC}^- (50 ms)	$V_{I(pulse)}$	50	V
Input-output voltage differential	$V_I - V_O$	38	V
Output current	I_O	150	mA
Operating junction temperature range J UA723C J UA723M	T_j	 0 to + 70 − 55 to + 125	°C
Storage temperature range	T_{stg}	− 65 to + 150	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, $T_j = +25°C$, $V_I = V_{CC}^+ = V_C = +12$ V, $V_{CC}^- = 0$, $V_O = +5$ V, $I_C = 1$ mA, $R_{SC} = 0$, C_1 (compensation) = 100 pF and divider impedance as seen by error amplifier ⩽ 10 kΩ.

Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.

Characteristic	Symbol	J UA723M			J UA723C			Unit
		Min	Typ	Max	Min	Typ	Max	
Input voltage range	V_I	9.5	–	40	9.5	–	40	V
Output voltage range	V_O	2	–	37	2	–	37	V
Input-output voltage differential	$V_I - V_O$	3	–	38	3	–	38	V
Line regulation + 12 V ⩽ V_I ⩽ + 15 V + 12 V ⩽ V_I ⩽ + 40 V	K_{VI}	 – –	 0.01 0.02	 0.1 0.2	 – –	 0.01 0.1	 0.1 0.5	%/V_O
Load regulation (1 mA ⩽ I_O ⩽ 50 mA)	K_{VO}	–	0.03	0.15	–	0.03	0.2	%/V_O
Standby current drain ($I_O = 0$, $V_I = +30$ V)	I_{IB}	–	2.3	3.5	–	2.3	4	mA
Reference voltage	$V_{(ref)}$	6.95	7.15	7.35	6.8	7.15	7.5	V
Short-circuit current ($R_{SC} = 10$ Ω, $V_O = 0$)	I_{SC}	–	65	–	–	65	–	mA

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J UA7805
J UA7812
J UA7815

FIXED POSITIVE VOLTAGE REGULATORS

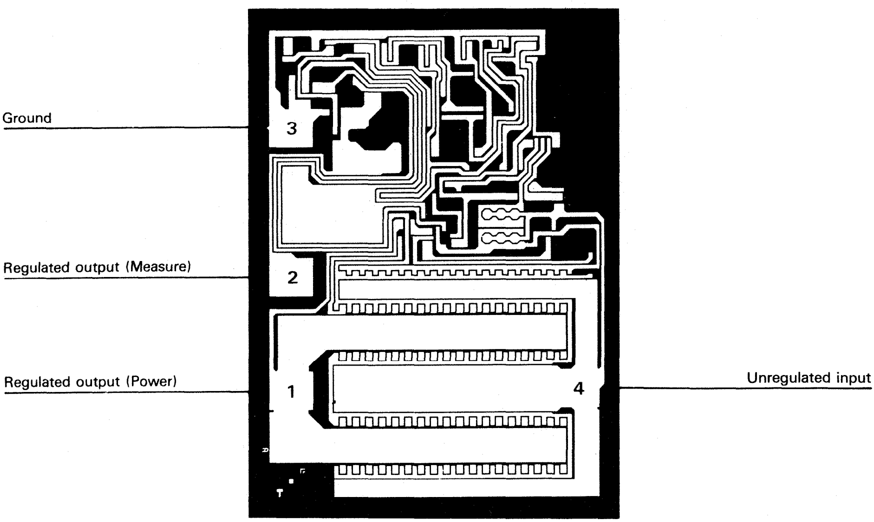
This series of regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If power dissipation becomes too high, the thermal shutdown circuit takes over preventing the chip form over-heating.

Considerable effort was expended to make this series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

FIXED POSITIVE VOLTAGE REGULATORS

DIMENSIONS: 1.7 × 2.4 mm



THOMSON SEMICONDUCTORS
Sales headquarters
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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage	V_I	35	V
Output current	I_O	Internally limited	A
Junction temperature	T_j	+150	°C
Operating temperature range J UA7805/12/15C J UA7805/12/15M	T_{oper}	 0 to +150 −55 to +150	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = +10$ V, $I_O = 0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7805C			J UA7805M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range (5 mA $\leqslant I_O \leqslant$ 0.5 A)	V_O	4.8	5.0	5.2	4.8	5.0	5.2	V
Line regulation - Note 1 +8 V $\leqslant V_I \leqslant$ +12 V +7 V $\leqslant V_I \leqslant$ +25 V	K_{VI}	 – –	 – –	 50 100	 – –	 – –	 25 50	mV
Load regulation (5 mA $\leqslant I_O \leqslant$ 0.5 A) - Note 1	K_{VO}	–	–	100	–	–	50	mV
Quiescent current	I_{IB}	–	6	10	–	5.5	8	mA
Quiescent current change +8 V $\leqslant V_I \leqslant$ +25 V +7 V $\leqslant V_I \leqslant$ +25 V 5 mA $\leqslant I_O \leqslant$ 0.5 A	ΔI_{IB}	 – – –	 – – –	 – 1.3 0.5	 – – –	 – – –	 0.8 – 0.5	mA

Note 1 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = +19$ V, $I_O = 0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7812C			J UA7812M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range (5 mA $\leqslant I_O \leqslant$ 0.5 A)	V_O	11.5	12	12.5	11.5	12	12.5	V
Line regulation - Note 2	K_{VI}							mV
+16 V $\leqslant V_I \leqslant$ +22 V		—	—	120	—	—	60	
+14.5 V $\leqslant V_I \leqslant$ +30 V		—	—	240	—	—	120	
Load regulation (5 mA $\leqslant I_O \leqslant$ 0.5 A) - Note 2	K_{VO}	—	—	240	—	—	120	mV
Quiescent current	I_{IB}	—	6	10	—	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+15 V $\leqslant V_I \leqslant$ +30 V, $I_O = 0.5$ A		—	—	—	—	—	0.8	
+14.5 V $\leqslant V_I \leqslant$ +30 V, $I_O = 0.5$ A		—	—	1.3	—	—	—	
5 mA $\leqslant I_O \leqslant$ 0.5 A		—	—	0.5	—	—	0.5	

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = +23$ V, $I_O = 0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7815C			J UA7815M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range (5 mA $\leqslant I_O \leqslant$ 0.5 A)	V_O	14.4	15	15.6	14.4	15	15.6	V
Line regulation - Note 2	K_{VI}							mV
+20 V $\leqslant V_I \leqslant$ +26 V		—	—	150	—	—	75	
+17.5 V $\leqslant V_I \leqslant$ +30 V		—	—	300	—	—	150	
Load regulation (5 mA $\leqslant I_O \leqslant$ 0.5 A) - Note 2	K_{VO}	—	—	300	—	—	150	mV
Quiescent current	I_{IB}	—	6	10	—	5.5	8	mA
Quiescent current change	ΔI_{IB}							mA
+18.5 V $\leqslant V_I \leqslant$ +30 V		—	—	—	—	—	0.8	
+17.5 V $\leqslant V_I \leqslant$ +30 V		—	—	1	—	—	—	
5 mA $\leqslant I_O \leqslant$ 0.5 A		—	—	0.5	—	—	0.5	

Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

NOTES

THOMSON SEMICONDUCTORS

J UA7905
J UA7912
J UA7915

FIXED NEGATIVE VOLTAGE REGULATORS

The UA7900M and UA7900C series are negative regulators with a fixed output voltage of −5 V, −12 V and −15 V and up to 1.5 A load current capability.

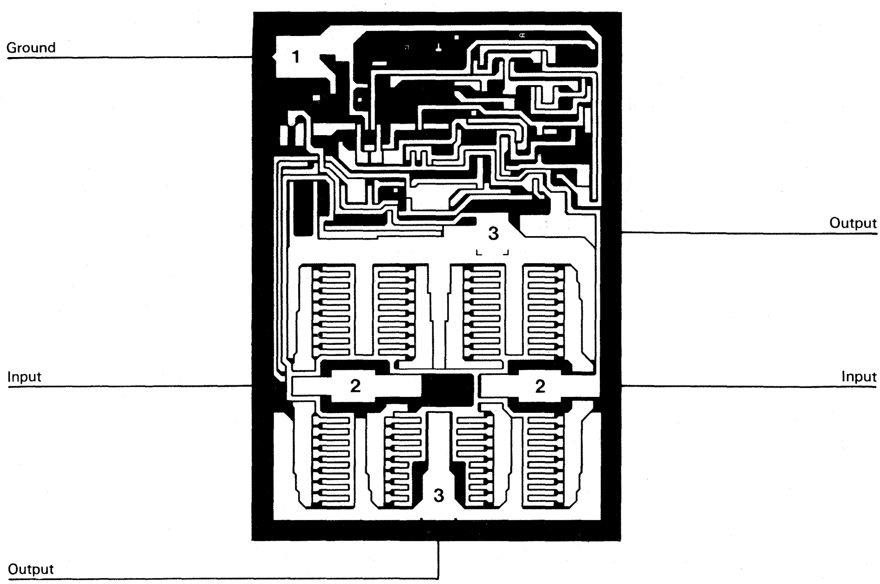
The UA7900M and UA7900C series have current limiting which is independent of temperature, combined with thermal overload protection. Internal current limit protection against momentary faults while thermal shut down prevents junction temperature exceeding safe limits during prolonged overloads.

Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heatsink provided, the thermal shutdown circuit takes over preventing the IC form overheating.

These devices need only one external component : a compensation capacitor at the output, making them easy to apply.

FIXED NEGATIVE VOLTAGE REGULATORS

DIMENSIONS: 2.4 × 1.7 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage J UA7915 J UA7905 - J UA7912	V_I	 −40 −35	V
Input-output voltage differential J UA7905 J UA7912/7915	$\|V_I - V_O\|$	 25 30	V
Output current	I_O	Internally limited	A
Operating junction temperature range J UA7905/12/15C J UA7905/12/15M	T_j	 0 to +125 −55 to +125	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = -10$ V, $I_O = -0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7905C			J UA7905M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O	−5.2	−5	−4.8	−5.1	−5	−4.9	V
Line regulation (-25 V$\leqslant V_I \leqslant -7$ V) - Note 1	K_{VI}	–	10	50	–	10	25	mV
Load regulation (-5 mA$\leqslant I_O \leqslant 0.5$ A) - Note 1	K_{VO}	–	30	80	–	30	80	mV
Quiescent current (-25 V$\leqslant V_I \leqslant -7$ V)	I_{IB}	–	2	4	–	2	4	mA
Quiescent current change (-25 V$\leqslant V_I \leqslant -7$ V, -5 mA$\leqslant I_O \leqslant -0.5$ A)	ΔI_{IB}	–	0.1	0.4	–	0.1	0.4	mA

Note 1 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = -17$ V, $I_O = -0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7912C			J UA7912M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O	−12.4	−12	−11.6	−12.3	−12	−11.7	V
Line regulation (-32 V $\leqslant V_I \leqslant -14$ V) - Note 2	K_{VI}	—	4	20	—	4	10	mV
Load regulation (-5 mA $\leqslant I_O \leqslant -0.5$ A) - Note 2	K_{VO}	—	30	80	—	30	80	mV
Quiescent current (-32 V $\leqslant V_I \leqslant -14$ V)	I_{IB}	—	2	4	—	2	4	mA
Quiescent current change (-32 V $\leqslant V_I \leqslant -14$ V, -5 mA $\leqslant I_O \leqslant -0.5$ A)	ΔI_{IB}	—	0.1	0.4	—	0.1	0.4	mA

Note 2 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

ELECTRICAL CHARACTERISTICS

$T_j = +25°C$, $V_I = -20$ V, $I_O = -0.5$ A, (Unless otherwise specified)

Characteristic	Symbol	J UA7915C			J UA7915M			Unit
		Min	Typ	Max	Min	Typ	Max	
Output voltage range	V_O	−15.4	−15	−14.6	−15.3	−15	−14.7	V
Line regulation (-35 V $\leqslant V_I \leqslant -17$ V) - Note 3	K_{VI}	—	5	20	—	5	10	mV
Load regulation (-5 mA $\leqslant I_O \leqslant -0.5$ A) - Note 3	K_{VO}	—	30	80	—	30	80	mV
Quiescent current (-35 V $\leqslant V_I \leqslant -17$ V)	I_{IB}	—	2	4	—	2	4	mA
Quiescent current change (-35 V $\leqslant V_I \leqslant -17$ V, -5 mA $\leqslant I_O \leqslant -0.5$ A)	ΔI_{IB}	—	0.1	0.4	—	0.1	0.4	mA

Note 3 : Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, pulse testing with a low duty cycle is used.

NOTES

Part number	Load	Short-circuit current programmable by external resistor	Auto Reset	Page
J TDE1607	Grounded	●	●	841
J TDE1647	Grounded	●	●	841
J TDE1737	V_{CC}	●	●	843

THOMSON SEMICONDUCTORS

J TDE1607
J TDE1647

RELAY AND LAMP DRIVER

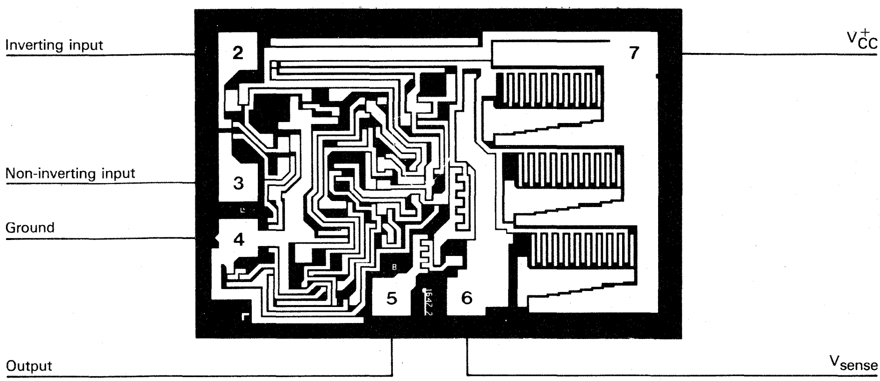
The TDE1647, TDE1607 are monolithic amplifiers designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

These devices are essentially blow-out proof. Current limiting is available to limit the peak output current to safe values, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the chip from overheating. If dissipation becomes too great, the driver will shut down to prevent excessive heating.

The output is also protected from short-circuit with the positive power supply. The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 V used for industrial electronic systems.

RELAY AND LAMP DRIVER

DIMENSIONS: 1.52 × 2.22 mm



Ref. 04685

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J TDE1647	J TDE1607	Unit
Supply voltage	V_{CC}	50	36	V
Differential input voltage	V_{ID}	50	36	V
Input voltage	V_I	50	36	V
Output current	I_O	1000	500	mA
Operating ambient temperature range	T_{oper}	−25 to + 85		°C
Storage temperature range	T_{stg}	−65 to +150		°C

ELECTRICAL CHARACTERISTICS (Note 1)

$T_j \leqslant +150°C$, (Unless otherwise specified)
J TDE1647 : $T_{amb} = +25°C$, $+8\ V \leqslant V_{CC} \leqslant +45\ V$, $I_O = 100$ mA
J TDE1607 : $T_{amb} = +25°C$, $+8\ V \leqslant V_{CC} \leqslant +30\ V$, $I_O = 100$ mA

Characteristic	Symbol	J TDE1647 • J TDE1607			Unit
		Min	Typ	Max	
Input offset voltage - (Note 2)	V_{IO}	–	2	50	mV
Input bias current	I_{IB}	–	0.1	1.5	μA
Supply current ($V_{CC} = +24$ V, $I_O = 0$)	I_{CC}				mA
High level		–	4	6	
Low level		–	2	4	
Common-mode input voltage range	V_{CM}	2	–	$V_{CC}-2$	V
Output saturation voltage (output high) ($R_{SC}=0$, $V_I^+ - V_I^- \geqslant 50$ mV, $I_O = 300$ mA)	$V_{CC}-V_O$	–	1.15	1.5	V
Low level output current ($V_O = 0$, $V_{CC} = +24$ V)	I_{OL}	–	0.01	10	μA

Note 1 : For operating at high temperature, the TDE1607, TDE1647, must be derated based on a +150°C maximum junction temperature.

Note 2 : The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

THOMSON SEMICONDUCTORS

J TDE1737

INTERFACE CIRCUIT (RELAY AND LAMP-DRIVER)

The TDE1737 is a monolithic amplifier designed for high current and high voltage applications, specifically to drive lamps, relays and control of stepper motors.

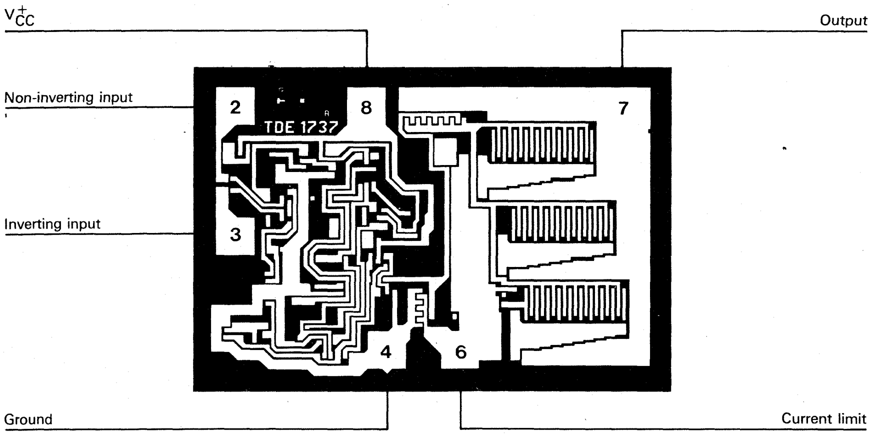
This device is essentially blow-out proof. Current limiting is available to limit the peak output current to a safe value, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the chip from overheating. If dissipation becomes too great, the driver will shut down to prevent excessive heating.

The output is also protected against short-circuits with the positive power supply.

The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 V used for industrial electronic systems.

INTERFACE CIRCUIT (RELAY AND LAMP DRIVER)

DIMENSIONS: 1.52 × 2.22 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	50	V
Input voltage	V_I	50	V
Differential input voltage	V_{ID}	50	V
Output current*	I_O	1000	mA
Operating free-air temperature range	T_{oper}	− 25 to + 85	°C
Storage temperature range	T_{stg}	− 65 to + 150	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply for :
$-25°C \leqslant T_{amb} \leqslant +85°C$, $+8\ V \leqslant V_{CC} \leqslant +45\ V$, $I_O \leqslant 100$ mA, $T_j \leqslant +150°C$

Characteristic	Symbol	Value			Unit
		Min	Typ	Max	
Input offset voltage (Note 1)	V_{IO}	–	2	50	mV
Input bias current	I_{IB}	–	0.1	1.5	µA
Supply current ($V_{CC} = +24$ V, $I_O = 0$)	I_{CC}	–	3	5	mA
Common-mode input voltage range	V_{CM}	2	–	$V_{CC} - 2$	V
Short-circuit current limit ($R_{SC} = 1.5\ \Omega$)	I_{SC}	–	500	–	mA
Output saturation voltage (output low) ($V_I^+ - V_I^- \geqslant 50$ mA, $I_O = 100$ mA, $R_{SC} = 0$)	$V_{CC} - V_O$	–	1	1.5	V
Output leakage current (output high) ($V_O = V_{CC} = +24$ V)	I_{OL}	–	–	10	µA

Note 1 : The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

Part number	Characteristic	Page
J TDA0161	Output current signal	847
J TDA0162	Output current signal - Built-in peak limiter	847
J TDE0160	Output current signal - Adjustable hysteresis	849

THOMSON SEMICONDUCTORS

J TDA 0161
J TDA 0162

PROXIMITY DETECTORS

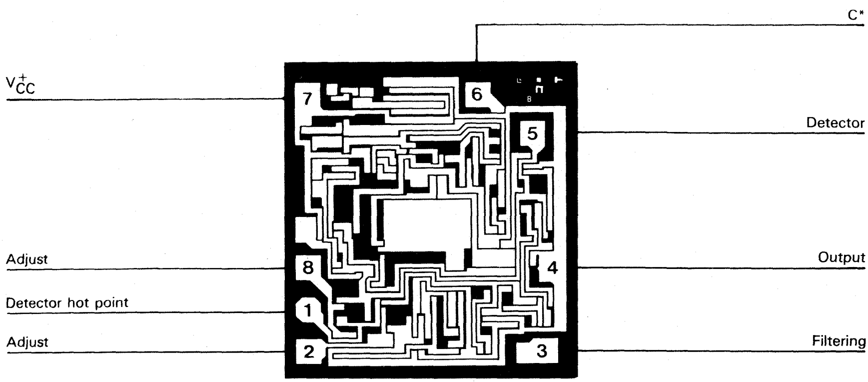
These monolithic integrated circuits are designed for metallic body detection by detecting the variations in high frequency Eddy current losses. With an external tuned circuit they act as oscillators. Output signal level is altered by an approaching metallic object.

Output signal is determined by supply current changes. Independent of supply voltage, this current is high or low according to the presence or the absence of a close metallic object.

TDA 0162 supply voltage is internally limited to 22 V by a built-in peak limiter.

PROXIMITY DETECTORS

DIMENSIONS: 1.4 × 1.5 mm



* 22 V Built-in peak limiter (J TDA 0162 only)

Ref. 04695

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J TDA 0161	J TDA 0162	Unit
Supply voltage	V_{CC}	35	22*	V
Junction temperature	T_j	+150	+150	°C
Storage temperature range	T_{stg}	−55 to +150		°C

* V_{CC} max. limited by internal zener diode.

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, (Unless otherwise specified)

Characteristic		Symbol	Value			Unit
			Min	Typ	Max	
Supply voltage	J TDA 0161 J TDA 0162	V_{CC}	4 4	– –	35 20	V
Supply current, close target $+4\ V < V_{CC} < +35\ V$ $+4\ V < V_{CC} < +20\ V$	 J TDA 0161 J TDA 0162	I_{CC}	 8 8	 10 10	 12 12	mA
Supply current, remote target $+4\ V < V_{CC} < +35\ V$ $+4\ V < V_{CC} < +20\ V$	 J TDA 0161 J TDA 0162	I_{CC}	 – –	 – –	 1 1	mA
Oscillator tuning frequency		f_{osc}	–	–	10	MHz
Output frequency (C3 = 0)		f_O	0	–	10	kHz
Output current ripple - C3 = 0, C2 (pF) > 150/f_{osc} (MHz)		ΔI_{CC}	–	–	20	μA
Negative resistance on terminals A and E (4 kΩ < R1 < 50 kΩ, f_{osc} < 3 MHz)		R_n	0.9 R1	R1	1.1 R1	–
Hysteresis at detection point C2 (pF) > 150/f_{osc} (MHz)		H_{yst}	0.5	–	5	%

If the circuit is used at a frequency higher than 3 MHz, it is recommended to connect a capacitor of 100 pF between terminals E and D.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J TDE0160

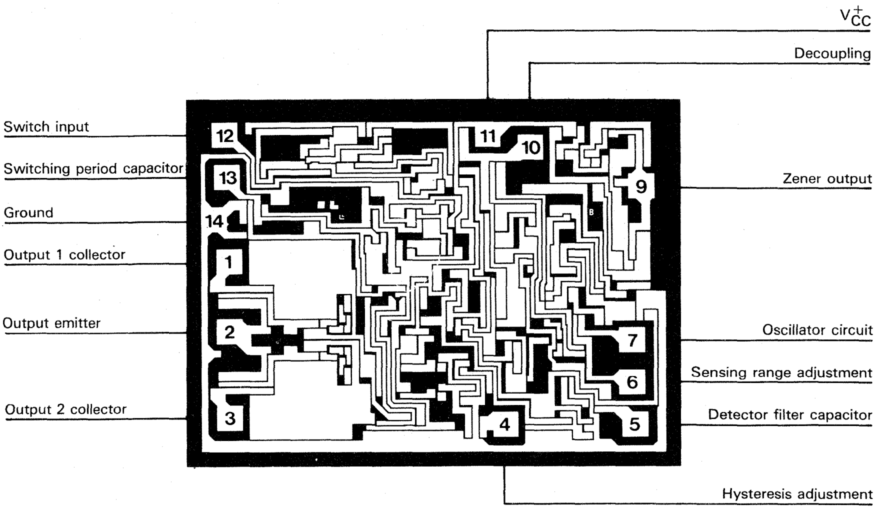
PROXIMITY DETECTOR

The TDE0160 is designed to detect metal bodies by the effect of Eddy currents on the HF losses of a coil. It has two complementary open collector outputs with peak limiting. Hysteresis is adjustable, and an electronic switching circuit is incorporated for disabling both outputs.

An internal zener diode maintains the supply voltage to the circuit in "dipole" operation.

PROXIMITY DETECTOR

DIMENSIONS: 1.7 × 2.2 mm



Ref. 04700

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply voltage	V_{CC}	36	V
Output voltage*	V_{O*}	36	V
Output current (I_1 – I_3)	I_O (I_1 – I_3)	40	mA
Junction temperature	T_j	+150	°C
Operating free-air temperature range	T_{oper}	–25 to +85	°C
Storage temperature range	T_{stg}	–65 to +150	°C

* Internal peak limiting to protect against transient voltage surges.

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC} = +25 V, (Unless otherwise specified)

Characteristic	Symbol	Value			Unit
		Min	Typ	Max	
Supply voltage	V_{CC}	4	–	36	V
Zener voltage (I_Z = +20 mA)	V_Z	3	–	4	V
Supply current	I_{CC}	–	–	1.2	mA
Limiting (I = 0.1 mA)	–	37	–	46	V
Output transistor saturation voltage (I = +20 mA)	–	–	–	1.1	V
Output transistor leakage current (V = +30 V)	–	–	–	2	μA
Switching threshold	–	90	110	130*	mV
Negative resistance (5 kΩ < R_H < 50 kΩ ; f = 100 kHz ; R_S = 0)	R_n	–	$R_n = R_H$	–	–
Inherent hysteresis	–	–	2	–	%
Programmed hysteresis (H < 15%)	–	–	$\frac{R_S}{R_S + R_H}$	–	%
Oscillation frequency	f_{osc}	0.015	–	1	MHz
Switching time-delay	–	–	0.5 C_d (μF)	–	s
Communication frequency (f = 1 MHz)		5	–	–	kHz

Note : This product is also available in packaged form (part number : TDE0160).
For further information and explanation of terms used in the above table, refer to the relevant data sheet.

Part number	Function	Page
J LM135/J LM335,A	Precision temperature sensors	853
J LM334	Adjustable current sources	855
J LM336,A	2.5 V voltage references	857
J NE555/J SE555	Single timer circuit	859
J NE556/J SE556	Dual timer circuit	861
J UCA4532	Thermal printhead driver	863
J UCA4632	Diode arrays	867

THOMSON SEMICONDUCTORS

J LM135
J LM335,A

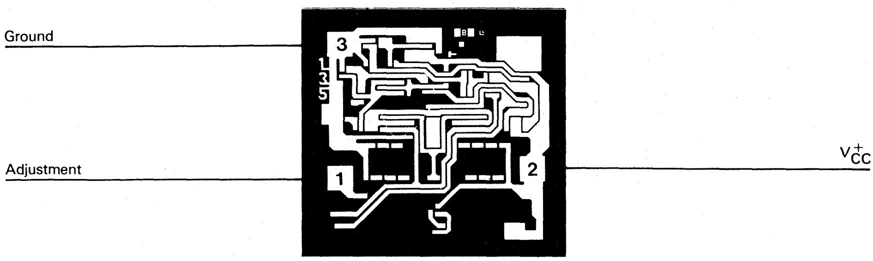
PRECISION TEMPERATURE SENSORS

The LM 135, LM335 are precision temperature sensors which can be easily calibrated. They operate as a 2-terminal Zener and the breakdown voltage is directly proportional to the absolute temperature at 10 mV/°K. The circuit has a dynamic impedance of less than 1 Ω and operates within a range of current from 400 μA to 5 mA without alteration of its characteristics. Calibrated at +25°C, the LM135, LM335 have a typical error of less than 1°C over a 100°C temperature range. Unlike other sensors, the LM135, LM335 have a linear output.

- Directly calibrated in °K
- 1°C initial accuracy
- Operates from 400 μA to 5 mA
- Less than 1 Ω dynamic impedance.

PRECISION TEMPERATURE SENSORS

DIMENSIONS: 1.17 × 1.22 mm



Ref. 04705

MAXIMUM RATINGS

Rating	Symbol	J LM135	J LM335,A	Unit
Current Reverse Forward	 I_R I_F	 15 10	 15 10	mA
Operating free-air temperature range Continuous Intermittent	T_{oper}	 – 55 to + 150 + 150 to + 200	 – 10 to + 100 + 100 to + 125	°C
Storage temperature range	T_{stg}	– 60 to + 180	– 60 to + 180	°C

TEMPERATURE ACCURACY

$T_j = +25°C$, (Unless otherwise specified)

Characteristic	J LM135 - J LM335A			J LM335			Unit
	Min	Typ	Max	Min	Typ	Max	
Operating output voltage ($I_R = 1$ mA)	2.95	2.98	3.01	2.92	2.98	3.04	V
Uncalibrated temperature error ($I_R = 1$ mA) $T_j = +25°C$ $T_{(min)} < T_j < T_{(max)}$	 – –	 1 2	 – –	 – –	 2 4	 – –	°C
Temperature error with 25°C calibration ($T_{(min)} < T_j < T_{(max)}$, $I_R = 1$ mA)	–	0.5	–	–	1	–	°C
Calibrated error at extended temperature $T_j = T_{(max)}$ (intermittent)	–	2	–	–	2	–	°C
Non-linearity ($I_R = 1$ mA)	–	0.3	–	–	0.3	–	°C

ELECTRICAL CHARACTERISTICS (Note 1)

Characteristic	J LM135			J LM335,A			Unit
	Min	Typ	Max	Min	Typ	Max	
Operating output voltage change with current (400 μA < I_R < 5 mA at constant temperature)	–	2.5	10	–	3	14	mV
Dynamic impedance ($I_R = 1$ mA)	–	0.5	–	–	0.6	–	Ω
Output voltage temperature drift	–	+ 10	–	–	+ 10	–	mV/°C
Time constant Still air Air 0.5 m/s Stirred oil	 – – –	 80 10 1	 – – –	 – – –	 80 10 1	 – – –	s
Time stability ($T_j = +125°C$)	–	0.2	–	–	0.2	–	°C/kh

Note 1 : Accuracy measurements are made in a well-stirred oil bath. For other conditions, self heating must be considered.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J LM334

ADJUSTABLE CURRENT SOURCE

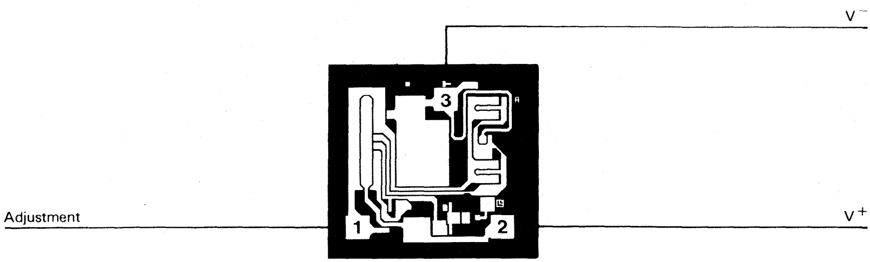
The LM334 is adjustable current source characterized by :
— an operating current range of 10000 : 1
— an excellent current regulation
— a wide dynamic voltage range of 1 V to 40 V
The current is determined by an external resistor without requiring other external components.

Reverse voltages of up to 20 V will only draw a current of several microamperes. This enables the circuit to operate as a rectifier and as a source of current in a.c. applications

- Operates from 1 V to 40 V.
- 0.02% V current regulation.
- Programmable from 1 μA to 10 mA.
- $\pm$3% initial accuraty.

ADJUSTABLE CURRENT SOURCE

DIMENSIONS: 0.97 × 0.9 mm



Ref. 04710

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	J LM334	Unit
Voltage V^+ to V^- Forward Reverse	 30 20	V
ADJ pin to V^- voltage	5	V
Set current	10	mA
Storage temperature range	− 65 to + 150	°C
Operating free-air temperature range	0 to + 70	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise stated, these specifications apply for $T_j = +25°C$ with pulse testing so that junction temperature does not change during testing.

Characteristic	J LM334			Unit
	Min	Typ	Max	
Set current error ($V^+ = +25$ V) - (Note 1) 10 μA ≤ I_{set} ≤ 1 mA 1 mA ≤ I_{set} ≤ 5 mA 2 μA ≤ I_{set} ≤ 10 μA	 — — —	 — 2 2	 6 — —	%
Ratio of set current to V^- current 10 μA ≤ I_{set} ≤ 1 mA 1 mA ≤ I_{set} ≤ 5 mA 2 μA ≤ I_{set} ≤ 10 μA	 14 — —	 18 14 18	 26 — —	—
Minimum operating voltage 2 μA ≤ I_{set} ≤ 100 μA 100 μA ≤ I_{set} ≤ 1 mA 1 mA ≤ I_{set} ≤ 5 mA	 — — —	 0.8 0.9 1	 — — —	V
Average change in set current with input voltage 10 μA ≤ I_{set} ≤ 1 mA + 1.5 V ≤ V^+ ≤ + 5 V + 5 V ≤ V^+ ≤ + 40 V 1 mA ≤ I_{set} ≤ 5 mA + 1.5 V ≤ V^+ ≤ + 5 V + 5 V ≤ V^+ ≤ + 40 V	 — — — —	 0.02 0.01 0.03 0.02	 0.1 0.05 — —	%/V
Temperature dependence of set current (25 μA ≤ I_{set} ≤ 1 mA) - Note 2	—	T	—	—
Effective shunt capacitance	—	15	—	pF

Note 1 : Set current is the current flowing into the V^+ terminal. It is determined by the following formula : $I_{set} = 67.7\ mV/R_{set} (T_j = +25°C)$. Set current error is expressed as a percent deviation from this amount.

Note 2 : I_{set} is directly proportional to absolute temperature (°K). I_{set} at any temperature can be calculated from $I_{set} = I_O(T/T_O)$ where I_O is I_{set} measured at T_O (°K).

THOMSON SEMICONDUCTORS

J LM336,A

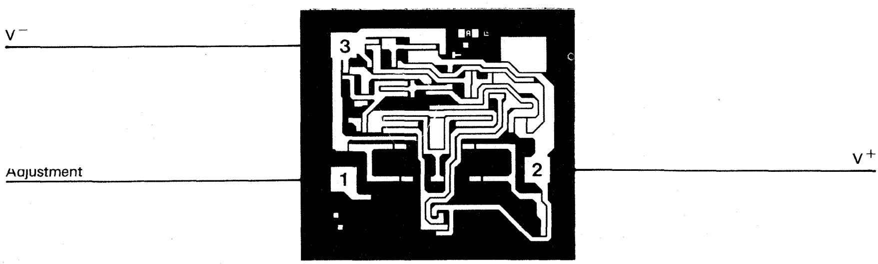
2.5 V VOLTAGE REFERENCES

The LM336 is a precision 2.5 V regulator diode. This voltage reference monolithic chip operates like 2.5 V zener diode with a low temperature coefficient and a dynamic impedance of 0.2 Ω. A third terminal enables adjusting the reference voltage and the temperature coefficient.

- Low temperature coefficient.
- Wide operating current of 300 μA to 10 mA.
- 0.2 Ω dynamic impedance.
- Guaranteed temperature stability.
- Fast turn-on.

2.5 V
VOLTAGE REFERENCES

DIMENSIONS: 1.12 × 1.17 mm



Ref. 04715

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	J LM336,A	Unit
Current Reverse Forward	 I_R I_F	 15 10	mA
Operating free-air temperature range	T_{oper}	0 to + 70	°C
Storage temperature range	T_{stg}	−60 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, (Unless otherwise specified)

Characteristic	Symbol	J LM336,A			Unit
		Min	Typ	Max	
Reverse breakdown voltage ($I_R = 1$ mA) J LM336 J LM336A	V_R	 2.39 2.44	 2.49 2.49	 2.59 2.54	V
Reverse breakdown change with current (400 $\mu A \leqslant I_R \leqslant 10$ mA)	ΔV_R	–	2.6	10	mV
Reverse dynamic impedance ($I_R = 1$ mA)	Z_D	–	0.2	–	Ω
Temperature stability ($V_R = 2.49$ V, $I_R = 1$ mA)	K_{VT}	–	1.8	–	mV
Long term stability ($T_{amb} = +25°C$ ±0.1°C, $I_R = 1$ mA)	K_{VH}	–	20	–	ppm

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J NE555
J SE555

TIMER CIRCUIT

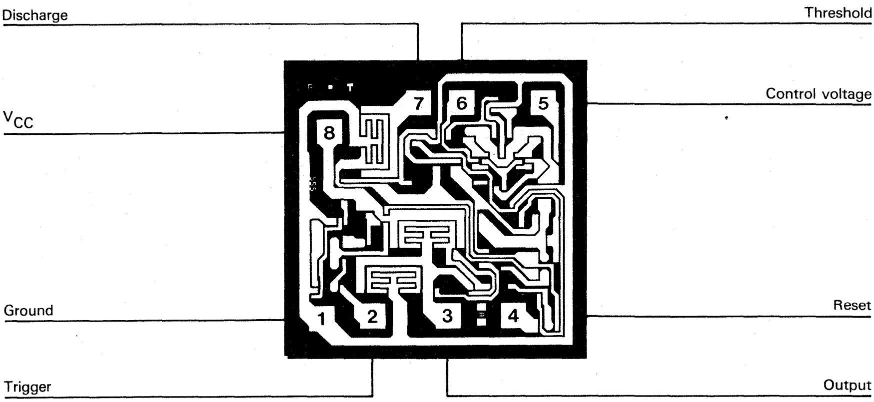
The NE555/SE555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillations.
Additionnal terminals are provided for triggering or resetting if desired.
In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor.

For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor.

The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive TTL circuits.

TIMER CIRCUIT

DIMENSIONS: 1.4 × 1.4 mm



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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	18	V
Output current	I_O	200	mA
Operating free-air temperature range J SE555 J NE555	T_{oper}	 −55 to +125 0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25°C$, $V_{CC} = +5$ V to $+15$ V, (Unless otherwise specified)

Characteristic	Symbol	J SE555			J NE555			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply voltage	V_{CC}	4.5	–	18	4.5	–	16	V
Supply current (low state) - (Note 1) $V_{CC} = +5$ V, $R_L = \infty$ $V_{CC} = +15$ V, $R_L = \infty$ (high state) $V_{CC} = +5$ V, $R_L = \infty$	I_{CC}	 – – –	 3 10 2	 5 12 –	 – – –	 3 10 2	 6 15 –	mA
Control voltage level $V_{CC} = +15$ V $V_{CC} = +5$ V	V_{CL}	 9.6 2.9	 10 3.33	 10.4 3.8	 9 2.6	 10 3.33	 11 4	V
Threshold voltage $V_{CC} = +15$ V $V_{CC} = +5$ V	V_{th}	 – –	 10 3.33	 – –	 – –	 10 3.33	 – –	V
Threshold current - (Note 2)	I_{th}	–	0.1	0.25	–	0.1	0.25	μA
Trigger voltage $V_{CC} = +15$ V $V_{CC} = +5$ V	V_{trig}	 – –	 5 1.67	 – –	 – –	 5 1.67	 – –	V
Trigger current ($V_{trig} = 0$ V)	I_{trig}	–	0.5	–	–	0.5	–	μA
Reset voltage - (Note 3)	V_{reset}	0.4	0.7	1	0.4	0.7	1	V
Reset current $V_{reset} = +0.4$ V	I_{reset}	 –	 0.1	 –	 –	 0.1	 –	mA
Low level output voltage • $V_{CC} = +15$ V, $I_{O(sink)} = 10$ mA $I_{O(sink)} = 50$ mA $I_{O(sink)} = 100$ mA $I_{O(sink)} = 200$ mA • $V_{CC} = +5$ V, $I_{O(sink)} = 5$ mA	V_{OL}	 – – – – –	 0.1 0.4 2.0 2.5 0.05	 0.15 0.5 2.2 – 0.2	 – – – – –	 0.1 0.4 2.0 2.5 0.25	 0.25 0.75 2.5 – 0.35	V
High level output voltage $V_{CC} = +15$ V, $I_{O(source)} = 200$ mA $I_{O(source)} = 100$ mA $V_{CC} = +5$ V, $I_{O(source)} = 100$ mA	V_{OH}	 – 13.0 3	 12.5 13.3 3.3	 – – –	 – 12.75 2.75	 12.5 13.3 3.3	 – – –	V

Note 1 : Supply current when output is high is typically 1 mA less.

Note 2 : This will determine the maximum value of $R_A + R_B$ for +15 V operation, the max total is R = 20 MΩ

Note 3 : Specified with trigger input high.

THOMSON SEMICONDUCTORS

J NE556
J SE556

DUAL TIMERS

The NE556/SE556 dual timing circuits are highly stable controllers capable of producing accurate time delays, or oscillation.

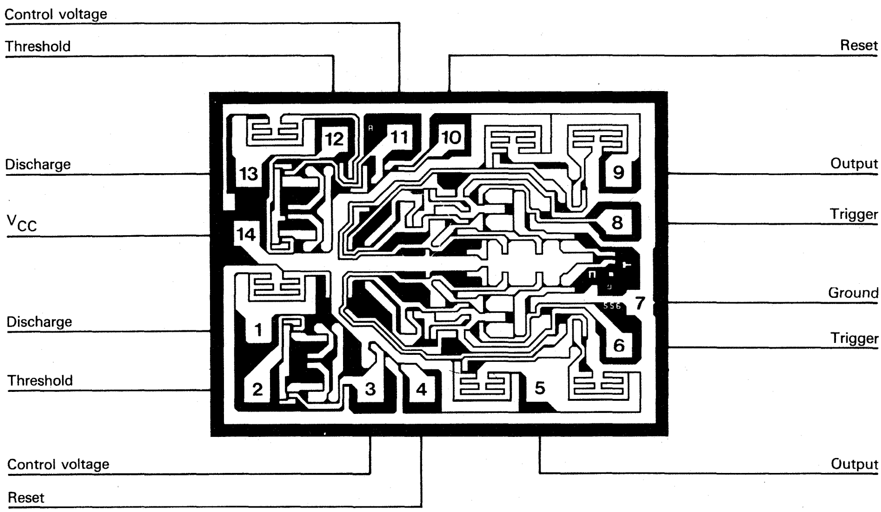
The NE556/SE556 are dual 555. The two timers operate independently of each other sharing only V_{CC} and ground.

For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor.

The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive TTL circuits.

DUAL TIMERS

DIMENSIONS: 1.6 × 2.16 mm



Ref. 04725

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THOMSON COMPONENTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	+18	V
Output current	I_O	200	mA
Operating free-air temperature range J SE556 J NE556	T_{oper}	 −55 to +125 0 to + 70	°C
Storage temperature range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC} = +5 V to +15 V, (Unless otherwise specified)

Characteristic	Symbol	J SE556			J NE556			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply voltage	V_{CC}	4.5	–	18	4.5	–	16	V
Supply current - (Note 1) Low state, $R_L = \infty$, V_{CC} = +5 V V_{CC} = +15 V High state, V_{CC} = +5 V, $R_L = \infty$	I_{CC}	 – – –	 6 20 4	 10 24 –	 – – –	 6 20 4	 12 30 –	mA
Control voltage level V_{CC} = +15 V V_{CC} = +5 V	V_{CL}	 9.6 2.9	 10 3.33	 10.4 3.8	 9 2.6	 10 3.33	 11 4	V
Threshold voltage V_{CC} = +15 V V_{CC} = +5 V	V_{th}	 – –	 10 3.33	 – –	 – –	 10 3.33	 – –	V
Threshold current - (Note 2)	I_{th}	–	0.1	0.25	–	0.1	0.25	μA
Trigger voltage V_{CC} = +15 V V_{CC} = +5 V	V_{trig}	 – –	 5 1.67	 – –	 – –	 5 1.67	 – –	V
Trigger current	I_{trig}	–	0.5	–	–	0.5	–	μA
Reset voltage - (Note 3)	V_{reset}	0.4	0.7	1	0.4	0.7	1	V
Reset current V_{reset} = 0.4 V	I_{reset}	 –	 0.1	 –	 –	 0.1	 –	mA
Low level output voltage V_{CC} = +15 V, $I_{O(sink)}$ = 10 mA $I_{O(sink)}$ = 50 mA $I_{O(sink)}$ = 100 mA $I_{O(sink)}$ = 200 mA V_{CC} = + 5 V, $I_{O(sink)}$ = 8 mA $I_{O(sink)}$ = 5 mA	V_{OL}	 – – – – – –	 0.1 0.4 2.0 2.5 0.1 –	 0.15 0.5 2.25 – 0.25 –	 – – – – – –	 0.1 0.4 2.0 2.5 – 0.25	 0.25 0.75 2.75 – – 0.35	V
Output voltage drop (high state) V_{CC} = +15 V, $I_{O(source)}$ = 200 mA $I_{O(source)}$ = 100 mA V_{CC} = + 5 V, $I_{O(source)}$ = 100 mA	V_{OH}	 – 13 3	 12.5 13.3 3.3	 – – –	 – 12.75 2.75	 12.5 13.3 3.3	 – – –	V
Discharge leakage current	$I_{dis(off)}$	–	20	100	–	20	100	nA

Note 1 : Supply current when output high typically 1 mA less at V_{CC} = +5 V.

Note 2 : This will determine the maximum value of $R_A + R_B$ for +15 V operation. The maximum total is R = 20 MΩ

Note 3 : Specified with trigger input high.

These specifications are subject to change without notice.

THOMSON SEMICONDUCTORS

J UCA4532

ADVANCE INFORMATION

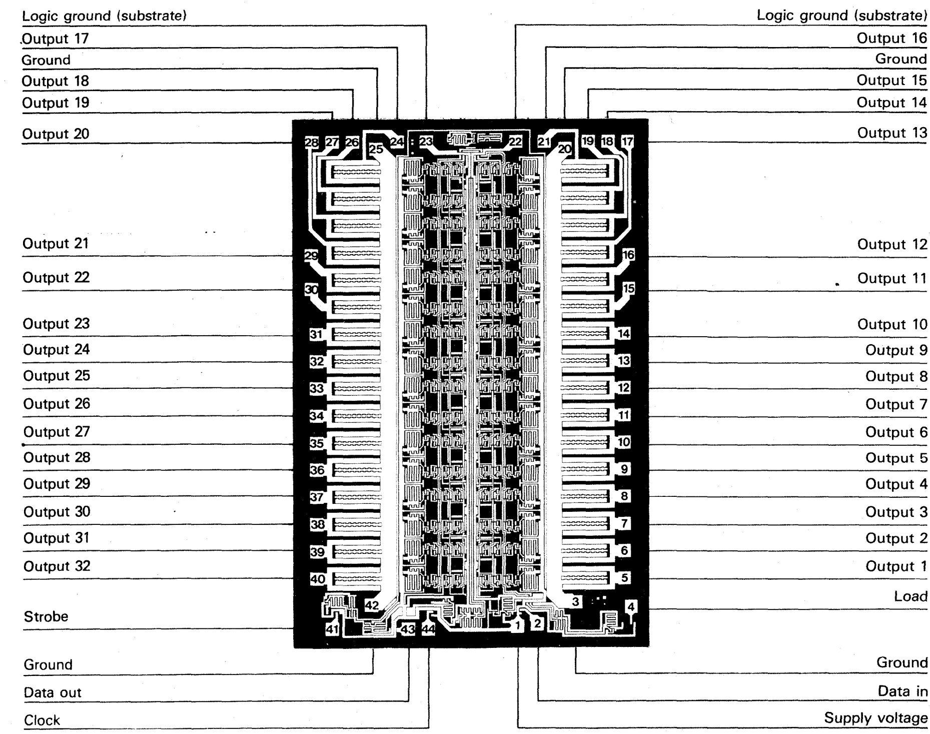
THERMAL PRINTHEAD DRIVER

The J UCA4532 is a monolithic integrated circuit, consisting of a 32-bit shift register, a 32-bit latch and 32 power outputs (N transistor, open collector)

- BIMOS technology
- Data inputs to the shift register, one positive pulse shifts data one step
- On high level on load pin, data is copied paralell from the shift-register
- Strobe input controls power outputs, outputs are activated on high level
- The device will be available as passivated, bare back chip, in the usual packaging types (tray pack).

THERMAL
PRINTHEAD
DRIVER

DIMENSIONS : 4.81 × 3.19mm



Ref.00805

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

MAXIMUM RATINGS

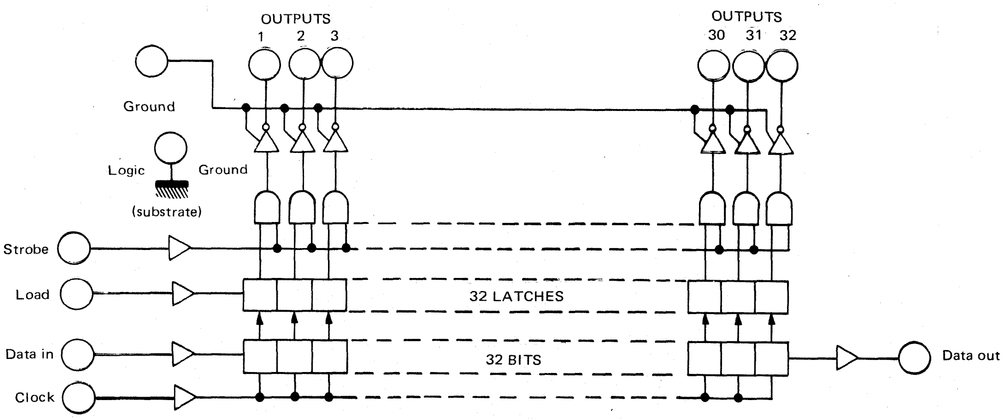
Rating	Symbol	Value	Unit
Output voltage	V_O	40	V
Input voltage (logic)	V_I	7	V
Output current	I_O	160	mA
Maximum junction temperature	T_j	150	°C

ELECTRICAL CHARACTERISTICS

T_{amb} + 25°C to + 85°C, V_{CC} = + 5V ± 5 % (unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
Output leakage current (V_O = + 40 V, V_{CC} = + 5 V)	I_{CEX}	–	–	100	μA
Collector-emitter saturation voltage (I_O = 100 mA, V_{CC} = + 5 V)	$V_{CE\ (sat)}$	0.25	–	0.55	V
Low level input voltage	V_{IL}	-0.3	–	0.8	V
High level input voltage	V_{IH}	2.4	–	V_{CC}	V
Low level input current (V_{IL} = + 0.8 V)	I_{IL}	–	–	400	μA
High level input current (V_{IH} = + 2.4 V)	I_{IH}	–	–	20	μA
Supply current (V_{CC} = + 5 V)	I_{CC}				mA
All drivers ON	–	–	–	160	
All drivers OFF	–	–	–	1	
Clock frequency	f_{CLK}	3.5	–	–	MHz
Output voltage turn-off time (I_{CC} = 100 mA, V_{CC} = + 5 V, 10 to 90 % of current)	$t_{out\ (on)}$	–	–	2	μs
	$t_{out\ (off)}$	–	–	2	

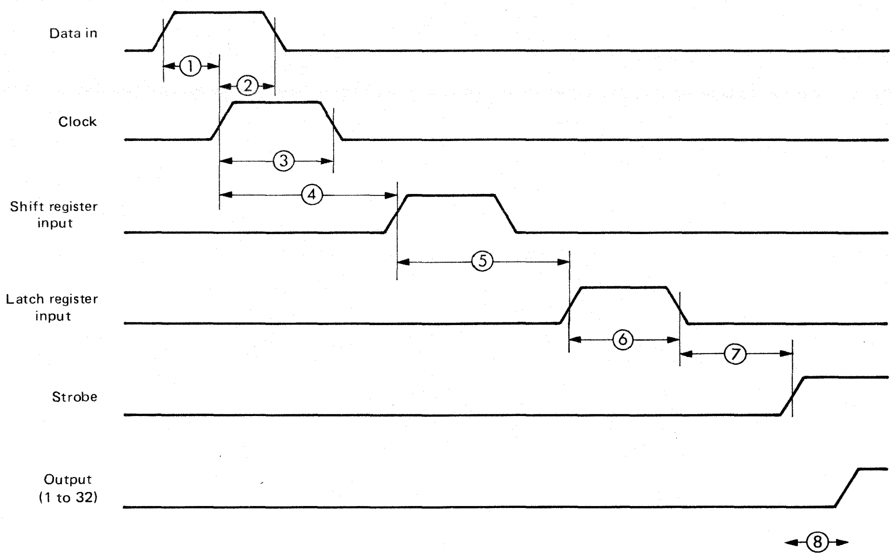
FUNCTIONAL BLOCK DIAGRAM



FUNCTIONAL CHARACTERISTICS

FUNCTION	PIN NUMBER	ACTIVE STATE OR LEVEL
Clock	44	Rise Time
Load (latch)	4	High Level
Strobe	41	Low Level

TIMING DIAGRAMS



Ident. number	Characteristic	Symbol	Min	Typ	Max	Unit
1	Data valid time	–	75	–	–	ns
2	Data hold time	–	75	–	–	ns
3	Clock pulse width	–	150	–	–	ns
4 + 5	Time between last clock pulse and load	–	150	–	–	ns
6	Load pulse width	–	100	–	–	ns
6 + 7	Time between load and strobe	–	1	–	–	µs
8	Data through time	–	–	2	–	µs

These specifications are subject to change without notice.

NOTES

Printed in France

THOMSON SEMICONDUCTORS

J UCA4632

PRODUCT PREVIEW

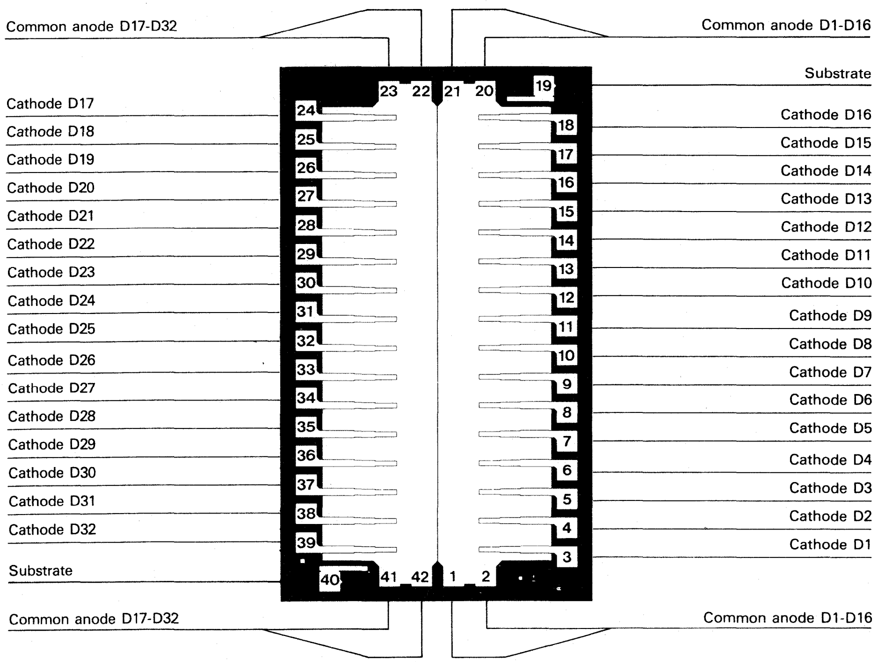
COMMON ANODE DIODE ARRAY

The J UCA4632 is a diode array arranged in 2 groups of 16 common anode diodes.
Although designed primarily for thermal printhead drivers, the J UCA4632 can be used in multiplexing applications where currents of several hundred mA and inverse voltages higher than 30V are required.

- Low forward voltage drop : 1.1V @ 100 mA
- Reverse voltage in excess of 30V
- Low substrate leakage current

COMMON ANODE DIODE ARRAY

DIMENSIONS : 2.10 × 3.68 mm



Ref.00800

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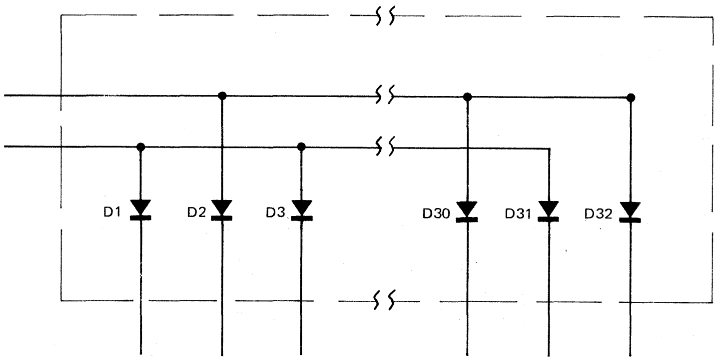
THOMSON COMPONENTS

ELECTRICAL CHARACTERISTICS

$-25°C \leqslant T_{amb} \leqslant +85°C$
Wafer probe test @ $T_{amb} = +25°C$

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse voltage (one diode) $I_R = 10\ \mu A$	V_R	30	—	—	V
Forward voltage (all diodes in conduction) $I_F = 110$ mA	V_F	—	1.15	1.3	V
Substrate current (one diode) Anode to substrate voltage = +30V	I_S	—	—	100	μA

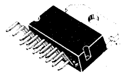
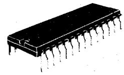
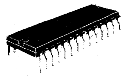
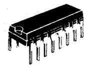
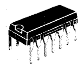
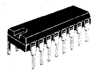
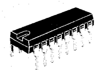
FUNCTIONAL DIAGRAM



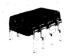
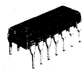
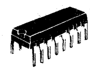
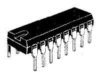
These specifications are subject to change without notice.

Consumer ICs

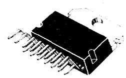
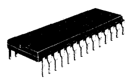
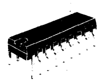
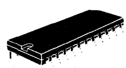
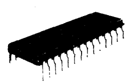
DEFLECTION CIRCUITS

Function	Part number	Characteristic	Package	
Horizontal and vertical	**TEA2017**	Complete horizontal and vertical deflection circuit for black and white TV sets. Direct drive of frame yoke (maximum output current: ±1.5 A), direct drive of line darlington, muting output.	SIL15	
	TEA2026	TV scanning and power supply digital processor includes 50-60 Hz identification, security and start-up systems.	DIL28	
	TEA2029	TV scanning and power supply digital processor includes 50-60 Hz identification, security and start-up systems. In conjunction with TEA2162, it provides SMPS secondary regulation.	DIL28	
	TEA2037	Low cost horizontal and vertical deflection circuit for black and white TV sets and monochrome displays. Direct drive of frame yoke (maximum output current: ±1 A), direct drive of line darlington.	Batwing DIL16	
Vertical	**TEA2116**	Vertical power stage with fly-back generator for 110° screen	SIL7	
	TEA2134	Vertical power stage with fly-back generator for 90° screen	Batwing DIL14	
Horizontal	**TBA920,S**	Line oscillator, sync. separator, phase comparator for monochrome TV sets.	DIL16	
	TDA2593	Line oscillator combination, burst, blanking and frame pulse separation for color TV sets.	DIL16	
Parabolic correction	**TEA2031**	Ensures the vertical rate, parabolic and keystone correction for 110° screens.	DIL8	

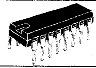
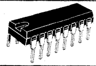
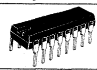
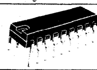
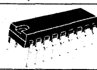
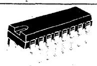
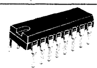
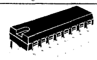
POWER SUPPLIES (SMPS FLY-BACK MODE)

Function	Part number	Characteristic	Package	
Switch mode power supply	TEA2018A	Power supply control circuit for fixed frequency fly-back power supplies up to 80 W. Direct drive of the switching transistor. Output current $I_B = KI_C$. Total protection from overload, short-circuit and temperature. Low rest current.	DIL8	
	TEA2019	Power supply control circuit for fixed frequency fly-back power supplies up to 80 W. Direct drive of the switching transistor. Output current $I_B = KI_C$. Total protection from overload, short-circuit and temperature. – Low rest current. – Sync. capability with internal PLL.	DIL14	
	TEA2162	Control IC for fixed frequency fly-back power supplies up to 200 W. In conjunction with TEA2029, this IC provides full secondary regulation for color TV applications (Master/Slave). Optimized power stage drive current. Over-voltage / current protections. Soft-start procedure.	Batwing DIL16	
	UAA4006A	Control circuit for fixed frequency fly-back power supplies up to 200 W. Direct drive of switching transistor with self regulated base current. Reduced storage time. Total protection from overload, short-circuit and temperature. Very low rest current.	DIL16	

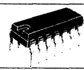
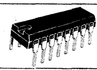
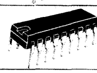
CHROMA CIRCUITS

Function	Part number	Characteristic	Package	
High voltage video amplifier	TEA5101	Drives directly R-G-B cathodes and gives measure of cut-off currents.	SIL15	
Video processor	TEA5031	In conjunction with PAL and/or SECAM decoder, this circuit constitutes a complete and flexible color TV chroma system featuring: on screen display inputs, electronic control of contrast, brightness and saturation, automatic cut-off adjustment, low dissipation, and positive color difference inputs.	DIL28	
PAL decoder	TEA5620	Complete PAL decoding system.	DIL18	
SECAM decoder	TEA5630	Complete SECAM decoding system. Can be combined with PAL decoder for PAL/SECAM applications. (automatic PAL/SECAM switching).	DIL24	
PAL/SECAM/ NTSC1/2 decoder	TEA5640	Automatic PAL/SECAM/NTSC1/NTSC2 decoder. Suppresses all adjustments. No crystal required. Operates with an external frequency reference of 62.5 kHz.	DIL28	

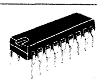
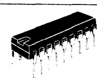
VIDEO AND SOUND IF CIRCUITS

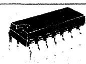
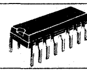
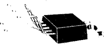
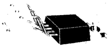
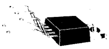
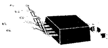
Function	Part number	Characteristic	Package	
Video IF	**TDA2540**	IF amplifier with demodulator and AFC (CCIR standard) for NPN tuner.	DIL16	
	TDA2541	IF amplifier with demodulator and AFC (CCIR standard) for PNP tuner.	DIL16	
	TDA2542	IF amplifier with demodulator and AFC (French standard).	DIL16	
	TDA4426	Very stable IF amplifier with demodulator and AFC for PNP tuner.	DIL18	
	TDA4427	Very stable IF amplifier with demodulator and AFC for PNP tuner and inverted AFC.	DIL18	
	TDA4443	IF amplifier with demodulator for multistandard applications. High input sensitivity. Large AGC capabilities.	DIL16	
Sound IF	**TDA4445A**	Quasi parallel sound processing with quadrature inter-carrier demodulator. Very high input sensitivity. Good AM suppression.	DIL16	
	TDA4445B	AM/FM sound demodulator. Low AM distortion. Very high input sensitivity. No adjustment for the AM demodulator.	DIL16	

PERITELEVISION INTERFACE CIRCUIT

Function	Part number	Characteristic	Package	
Video and AF switch	**TEA1014**	For monosound TV sets. Follows the SCART specification n° 108.	DIL14	
Video switch	**TEA2014**	Switched 2 Vpp video output. Not switched 75 Ω, 1 Vpp video output.	DIL8	
R-G-B switch	**TEA5114**	3-channel high frequency switch (20 MHz), designed for R-G-B and video applications. Low output impedance (75 Ω).	DIL16	
	TEA5115	5-switch (R-G-B, Fast blanking, Sync.) video signal selector. 25 MHz bandwidth for R-G-B signals.	DIL18	

REMOTE CONTROL AND CHANNEL SELECTOR CIRCUITS

Function	Part number	Characteristic	Package	
Transmitter	**UAA4000**	For ultra-sonic or infra-red transmission. 32 command capability. Pulse position modulation provides excellent noise immunity.	DIL18	
Receiver	**UAA4009**	Complete circuit for PPM demodulation. 12 channel tuning voltage switch (remote and keyboard), one DC voltage output for volume adjustment, standby information.	DIL18	

Application	Part number	MAX. VALUES V_{CC} (V)	MAX. VALUES I_O (A)	NOMINAL CONDITIONS V_{CC} (V)	NOMINAL CONDITIONS R_L (Ω)	NOMINAL CONDITIONS P_O (W)	Note	Package
Radio and portable recorders	TBA820	16	1.5	9	8	1.2	—	DIL14 
	TBA820M	16	1.5	9	8	1.2	—	DIL8 
	TCA830SM	20	2	9	4	2	—	DIL8 
Portable radio dual AF amplifier	TEA2025	15	1.5	9	4	2.3*	Fully protected	Batwing DIL16 
Car radio	TDA2003	18/40**	3.5	14.4	2	10	Fully protected	SIL5 
TV and record players	TDA2006	30	3	24	4	12	Fully protected	SIL5 
	TDA2030	36/42**	3.5	28	4	18	Fully protected	SIL5 
Hi-Fi/Stereo TV receivers	TDA2040	40	4	32	4	22 d = 0.5%	Fully protected	SIL5 

* P_O (W) Output per channel except bridge applications (both amplifiers)
** Peak voltage (50 ms)

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Telecommunication ICs

MODEMs

Part number	Function	Package	Suffix	Page
EF7910	FSK modem - V21/V23/BELL202/BELL103	Cerdip DIL 28	J	879
EFB7510	FSK modem - V23/BELL202	DIL18	C, J	881
EFB7513	FSK modem - V23	Plastic DIL 22	P	883
EFG7515	DPSK modem - V22/BELL212A	DIL 28	C, P	885

SWITCHING

Part number	Function	Package	Suffix	Page
ETC5040,A	PCM monolithic filter	Cerdip DIL 16	J	889
ETC5051/ETC5056	Monolithic parallel data interface CODEC/FILTERS	Cerdip DIL 20	J	891
ETC5054/ETC5057	Monolithic serial interface CODEC/FILTERS	Cerdip DIL 16	J	893
ETC5064/ETC5067	Monolithic serial interface CODEC/FILTERS	Cerdip DIL 20	J	895

TELEPHONE SET

Part number	Function	Package	Suffix	Page
EFG7189	DTMF generator	Plastic DIL 8 Plastic DIL 14	P P	897
TEA3046	Monochip transmission & DTMF circuit	Plastic DIL 28	DP	899
TEA7031	Loud speaker amplifier	Plastic DIL 28	DP	901
TEA7036	Monochip transmission & DTMF circuit	Plastic DIL 28	DP	903

THOMSON SEMICONDUCTORS

EF7910

FSK MODEM

The EF7910 is a single-chip asynchronous Frequency Shift Keying (FSK) voiceband modem. It is pin selectable for baud rates of 300, 600 or 1200 bits per second and is compatible with the applicable Bell and CCITT recommended standards for 103/113/108, 202, V.21 and V.23 type modems. Five mode control lines select a desired modem configuration.

Digital signal processing techniques are employed in the EF7910 to perform all major functions such as modulation, demodulation and filtering. The EF7910 contains on-chip analog-to-digital and digital-to-analog converter circuits to minimize the external components in a system. This device includes the essential RS-232/CCITT V.24 terminal control signals with TTL levels.

Clocking can be generated by attaching a crystal to drive the internal crystal oscillator or by applying an external clock signal.

A data access arrangement (DAA) or acoustic coupler must provide the phone line interface externally.

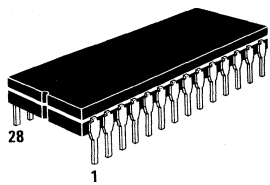
The EF7910 is fabricated using HMOS technology in a 28-pin package. All the digital input and output signals (except the external clock signal) are TTL compatible. Power supply requirements are ± 5 volts.

- Complete FSK MODEM in a 28-pin package - just add line interface
- Compatible with Bell 103/113/108, Bell 202, CCITT V.21, CCITT V.23 specifications
- No external filtering required
- All digital signal processing, digital filters and ADC/DAC included on-chip
- Includes essential RS-232/CCITT V.24 handshake signals
- Auto-answer capability
- Local copy/test modes
- 1200 bps full duplex on 4-wire line
- Pin-programmable mode section.

HMOS

FSK MODEM

CASE CB-132



J SUFFIX
CERDIP PACKAGE

PIN ASSIGNMENT

$\overline{RING}$	1	28	BTD
V_{CC}	2	27	$\overline{BCD}$ →
$\overline{RESET}$	3	26	RD →
V_{BB}	4	25	$\overline{CD}$ →
RC	5	24	$XTAL_1$/CLK
CAP_1	6	23	$XTAL_2$
CAP_2	7	22	DGND
← TC	8	21	MC_4
AGND	9	20	MC_3
TD	10	19	MC_2
$\overline{BRTS}$	11	18	MC_1
$\overline{RTS}$	12	17	MC_0
← $\overline{CTS}$	13	16	$\overline{DTR}$
← $\overline{BCTS}$	14	15	BRD →

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Ref.01930

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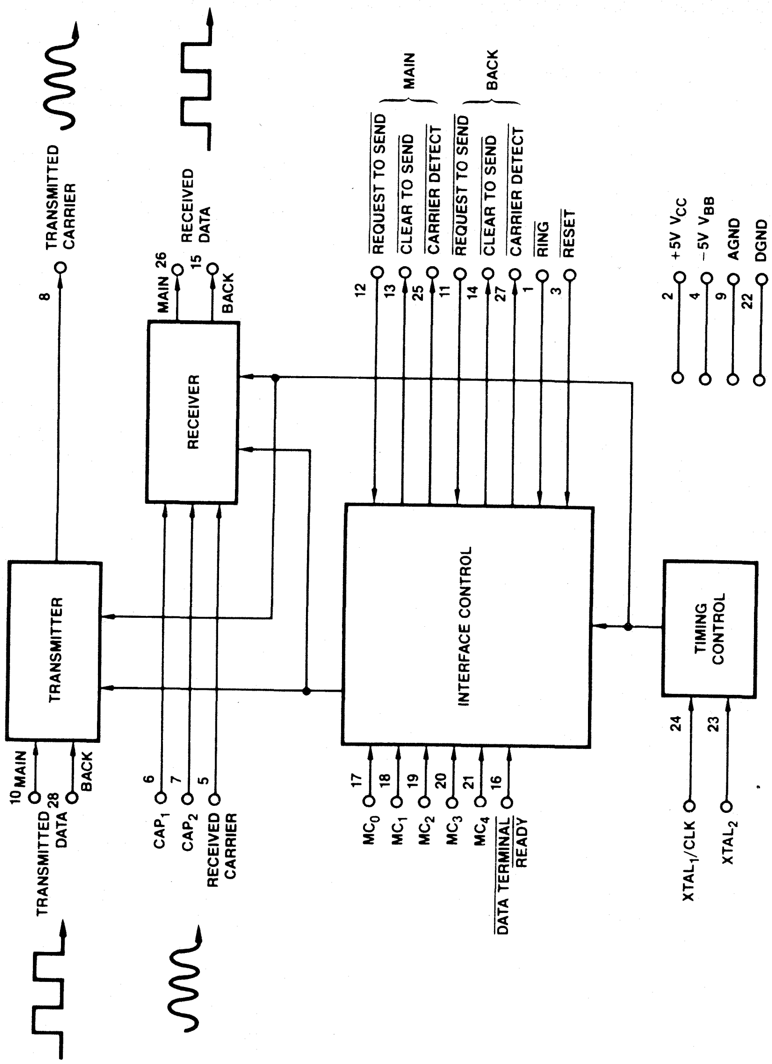
THOMSON COMPONENTS

BLOCK DIAGRAM



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTEURS

EFB7510

SINGLE CHIP ASYNCHRONOUS FSK MODEM

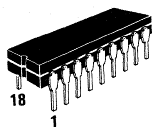
The EFB7510 is a single-chip asynchronous Frequency Shift Keying (FSK) voiceband modem.
Operating at rates up to 75, 150 or 1200 bits per second, it is compatible with the applicable Bell and CCITT recommended standards for 202 and V23 type modems.
This device provides the essential RS-232/CCITT V.24, V.25 and V.54 terminal control signal at TTL levels.

- Monolithic device includes both transmit and receive filters
- Standard low cost crystal (3.579 MHz)
- ± 5 % power supplies : + 5 V, – 5 V
- Separate analog and digital ground pins reduce system noise problems
- Available clock for UART (19.200 Hz)
- Reference voltage internally generated, to avoid noise and supply drift
- Back channel included
- 1.200 bauds, half-duplex two-wire operation or full-duplex four-wire operation
- Fixed compromise line equalizer
- No external precision component needed
- Low power consumption : 100 mW typical
- Direct interface to the THOMSON SEMICONDUCTORS EF6850, UART.

CMOS

SINGLE CHIP
ASYNCHRONOUS
FSK MODEM

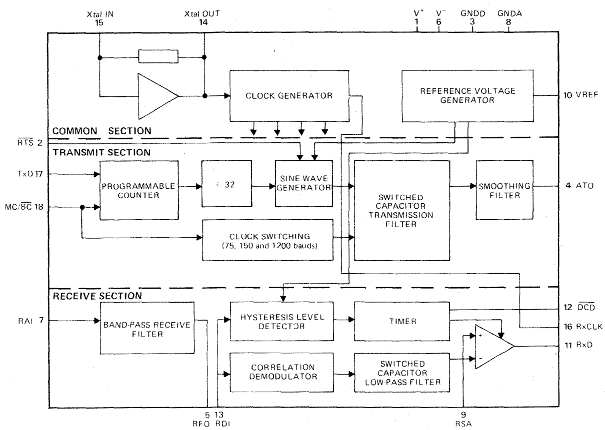
CASE CB-181



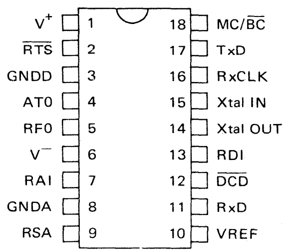
J SUFFIX
CERDIP PACKAGE

C SUFFIX
CERAMIC PACKAGE

BLOCK DIAGRAM



PIN ASSIGNMENT



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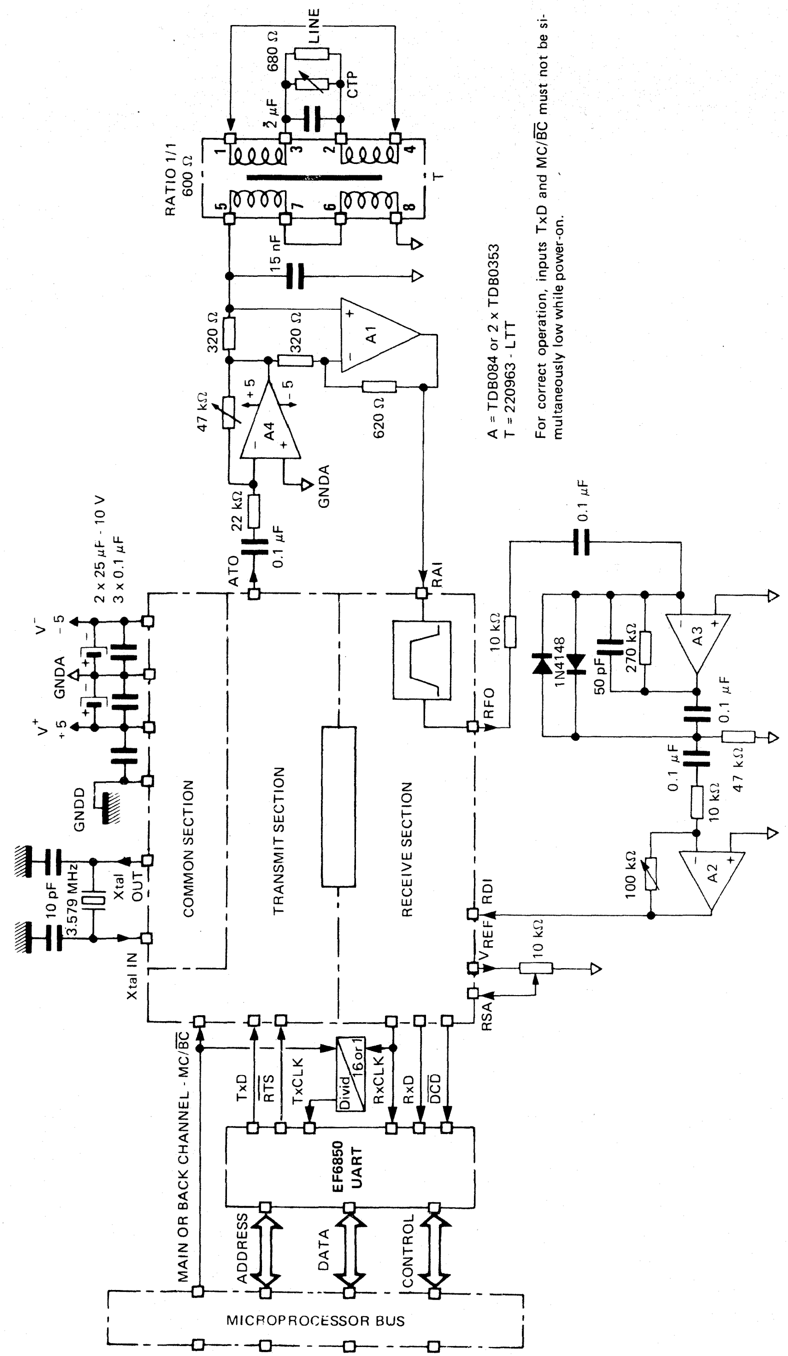
THOMSON COMPONENTS

ANNEX II : TYPICAL APPLICATION OF EFB7510



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

EFB7513

SINGLE CHIP ASYNCHRONOUS FSK MODEM

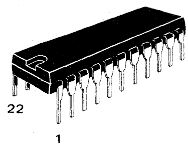
The EFB7513 is a single chip asynchronous frequency shift keying voice-band modem. Operating at rates up to 75, 1200 bit per second, it is compatible with the applicable CCITT recommended standards for V23 type modems. This device provides the essential CCITT 24, V25 and V54 terminal control signals at TTL levels.

- Monolithic device includes both transmit and receive filter
- Programmable modes :
  - 75 bds transmit / 1200 bds receive
  - 1200 bds transmit / 75 bds receive
  - 1200 bds full duplex on 4 wire line
  - Analog loopback.
- Fixed compromise line equalizer
- Receive and transmit clocks for UART (EF6850)
- Standard low cost crystal (3.579 MHz)
- ± 5 % power supplies (+ 5 V, −5 V)
- DTMF filter and tax rejection notch-filter (kit with EFG7189 DTMF)
- 3.579 MHz clock output available.

CMOS

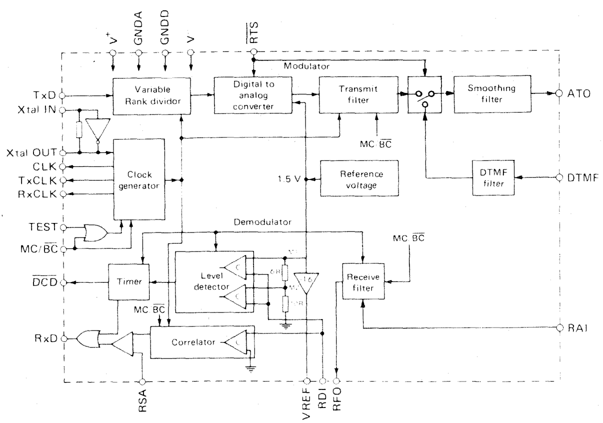
SINGLE CHIP ASYNCHRONOUS FSK MODEM

CASE CB-180

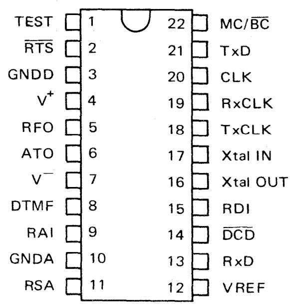


P SUFFIX
PLASTIC PACKAGE

BLOCK DIAGRAM



PIN ASSIGNMENT



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Ref.00460

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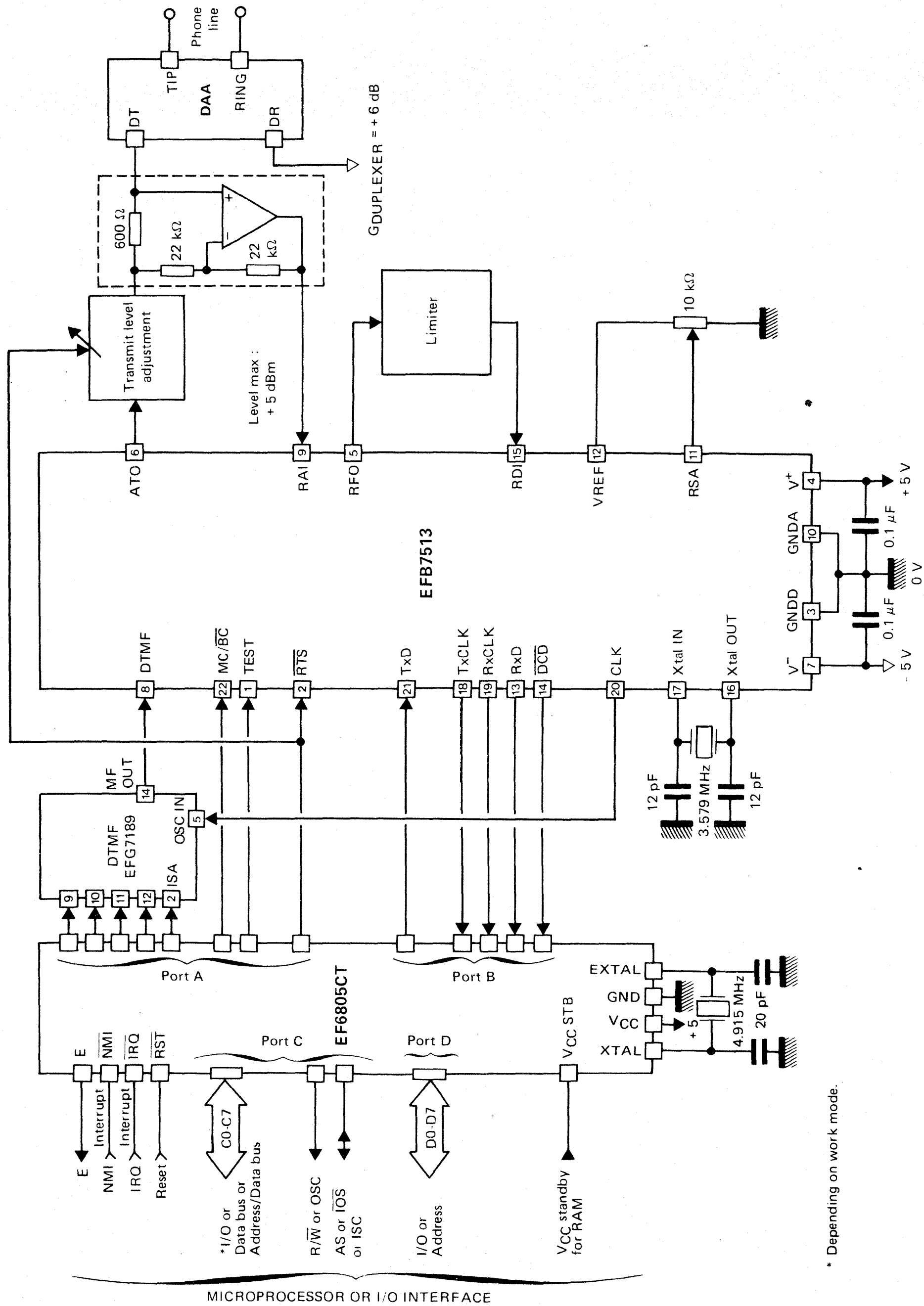
THOMSON COMPONENTS



* Depending on work mode.

EFB7513 - TYPICAL APPLICATION

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

EFG7515

ADVANCE INFORMATION

CMOS

SINGLE CHIP DPSK AND FSK MODEM

SINGLE CHIP DPSK AND FSK MODEM (BELL 212A - BELL 103 - V22 A/B)

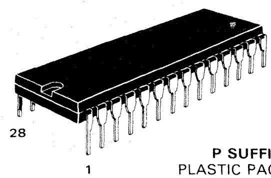
The EFG7515 is a single chip DPSK and FSK voiceband modem, compatible with the applicable BELL and CCITT recommended standards for 212A sets including BELL 103 and V22 A-B type modems.

- Monolithic device includes both transmit and receive filters.
- Mixing analog and digital technics.
- Standard low cost crystal (4.9152 MHz).
- Available clock for microprocessor at 4.9152 MHz.
- Low power consumption - CMOS technology.
- Sharp adjacent channel rejection.
- Fixed equalization in transmitter and receiver.
- Test loops.
- Carrier detect output.
- CCITT and BELL signaling tone.
- 1200 bps and 600 bps bit synchronous format in DPSK.
- 1200 bps and 600 bps +1%, −2.5% or +2.3%, −2.5% character asynchronous format (8, 9, 10 or 11 bits) in DPSK.
- 0 to 300 bps in FSK.
- Break signal supervision.
- External voice band tone filtering available (i.e. 550 Hz or DTMF).
- CMOS and TTL compatible.
- Direct interface to THOMSON SEMICONDUCTORS microprocessor family.

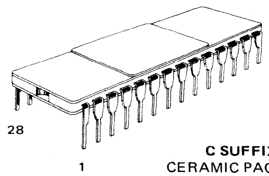
MAIN OPERATING MODES

- Standard selection (BELL 212A/BELL 103/V22).
- Answer tone selection.
- Low speed mode selection.
- Channel selection (Answer/Originate).
- Synchronous/Asynchronous mode selection.
- 8 bits to 11 bits word length selection in character asynchronous format mode.
- Overspeed selection in character asynchronous format mode.
- Scrambler selection.
- 1800 Hz guard tone selection in V22.
- Test loop selection (Digital/Analog).

CASE CB-132

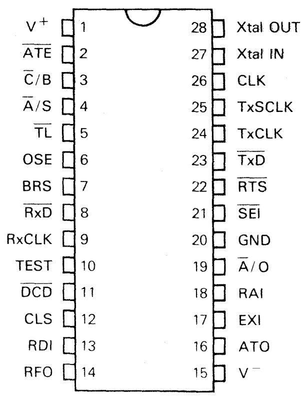


P SUFFIX
PLASTIC PACKAGE



C SUFFIX
CERAMIC PACKAGE

PIN ASSIGNMENT



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Ref.00400-R1

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THOMSON COMPONENTS

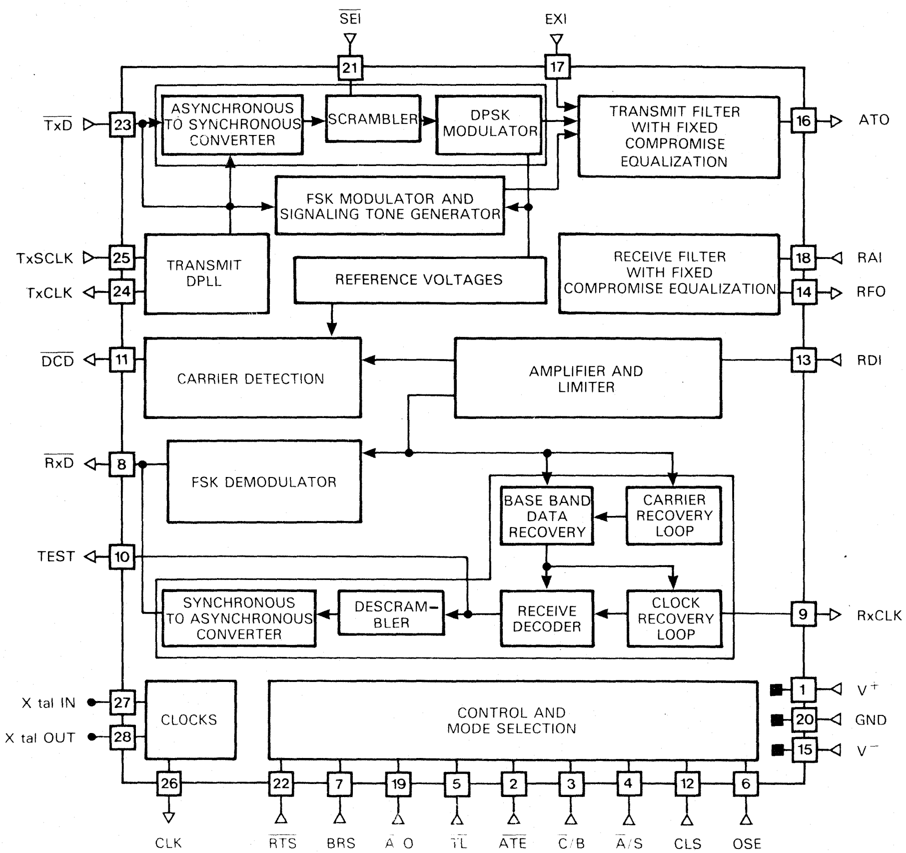
GENERAL DESCRIPTION

The EFG7515 is a general purpose monolithic DPSK and FSK modem implemented with double poly CMOS process. It is capable of generating and receiving phase modulated signals at data rates of 1200 bps or 600 bps as well as frequency modulated signals at data rates up to 300 bps on voice-grade telephone lines. It is offered in a 28 pin package capable of operating full-duplex according to three pin selectable standards :

- CCITT V22 A-B.
- Bell 212A with its low speed mode.
- Bell 103.

All filtering functions required for frequency generation, out-of-band noise rejection and demodulation are performed by on-chip switched capacitor filters. In phase modulation the modem provides all data buffering and scrambling functions necessary for bit synchronous format and asynchronous character format modes of operation. Internal frequencies are generated from a 4.9152 MHz crystal reference.

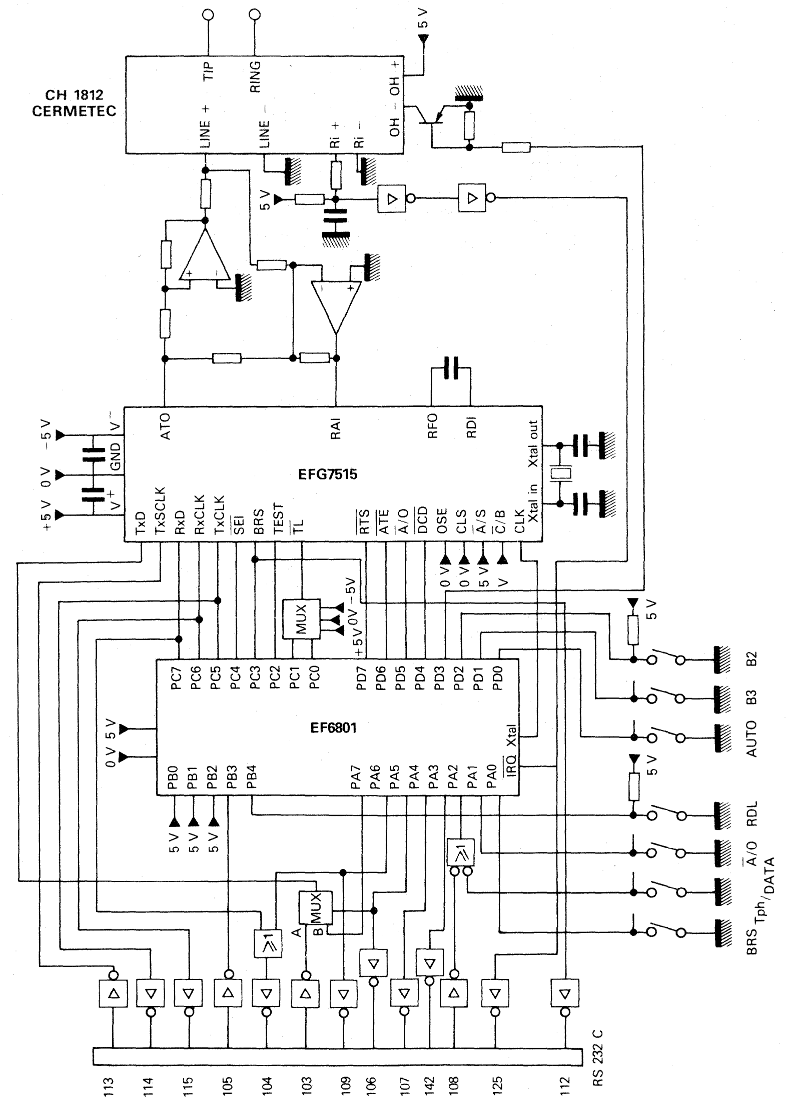
BLOCK DIAGRAM



APPLICATIONS INFORMATION

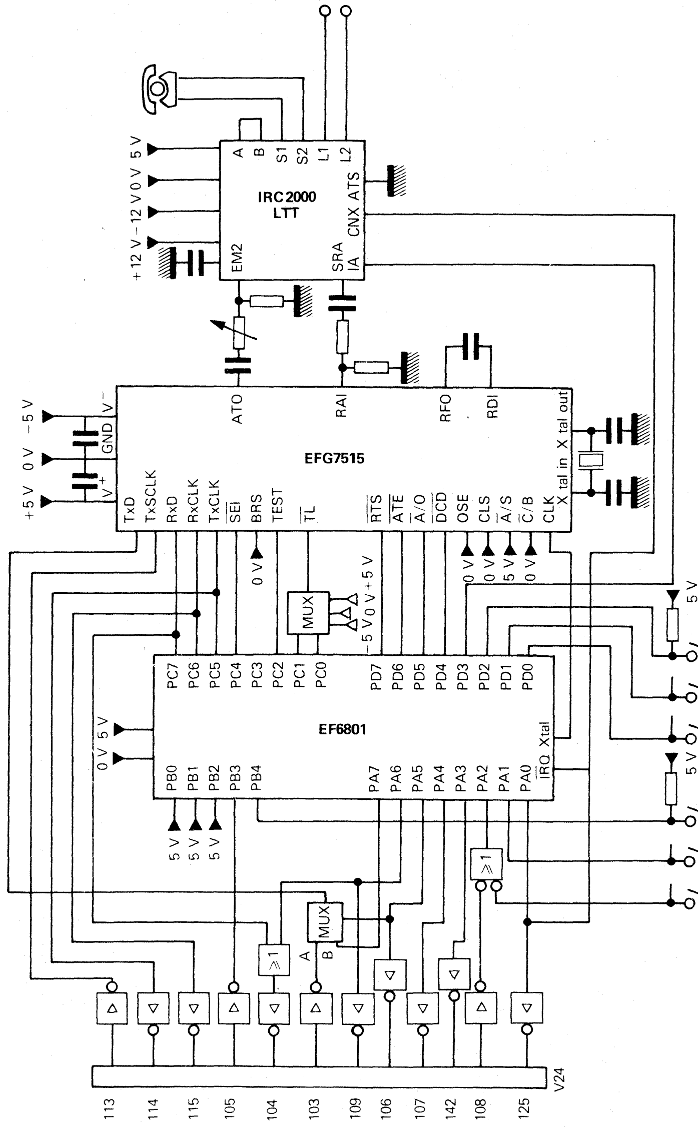
In a typical application a microcontroller provides control and interface to the Data Terminal Equipment (DTE), and a Direct Access Arrangement provides connection to the telephone line. Then the EFG7515 can communicate with the most popular modems (BELL 103 and BELL 212A) in countries under BELL standards and popular modems (V22) in countries under CCITT recommendations.

BELL 212A application :



On this typical application bit synchronous format is selected in high speed mode.

V22 application :



V22A with 1800 Hz and 1200 bps only

ETC5040
ETC5040A

PCM MONOLITHIC FILTER

The ETC5040/ETC5040A filter is a monolithic circuit containing both transmit and receive filters specifically designed for PCM CODEC filtering applications in 8 kHz sampled systems.

The filter is manufactured using double-poly silicon gate CMOS technology. Switched capacitor integrators are used to simulate classical LC ladder filters which exhibit low component sensitivity.

TRANSMIT FILTER STAGE

The transmit filter is a fifth order elliptic low pass filter in series with a fourth order Chebyshev high pass filter. It provides a flat response in the passband and rejection of signals below 200 Hz and above 3.4 kHz.

RECEIVE FILTER STAGE

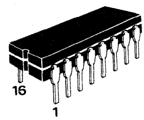
The receive filter is a fifth order elliptic low pass filter designed to reconstruct the voice signal from the decoded/demultiplexed signal which, as a result of the sampling process, is a stair-step signal having the inherent sin x/x frequency response. The receive filter approximates the function required to compensate for the degraded frequency response and restore the flat pass-band response.

- Exceeds all D3/D4 and CCITT specifications
- + 5V, –5V power supplies
- Low power consumption :
  - 45 mW (600Ω 0 dBm load)
  - 30 mW (power amps disabled)
- Power down mode : 0.5 mW
- 20 dB gain adjust range
- No external anti-aliasing components
- Sin x/x correction in receive filter
- 50/60 Hz rejection in transmit filter
- TTL and CMOS compatible logic
- All inputs protected against static discharge due to handling

CMOS

PCM MONOLITHIC FILTER

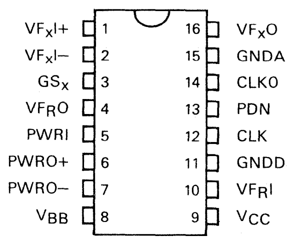
CASE



J SUFFIX

CERDIP PACKAGE

PIN ASSIGNMENT



12

Ref.00030

THOMSON SEMICONDUCTORS
Sales headquarters
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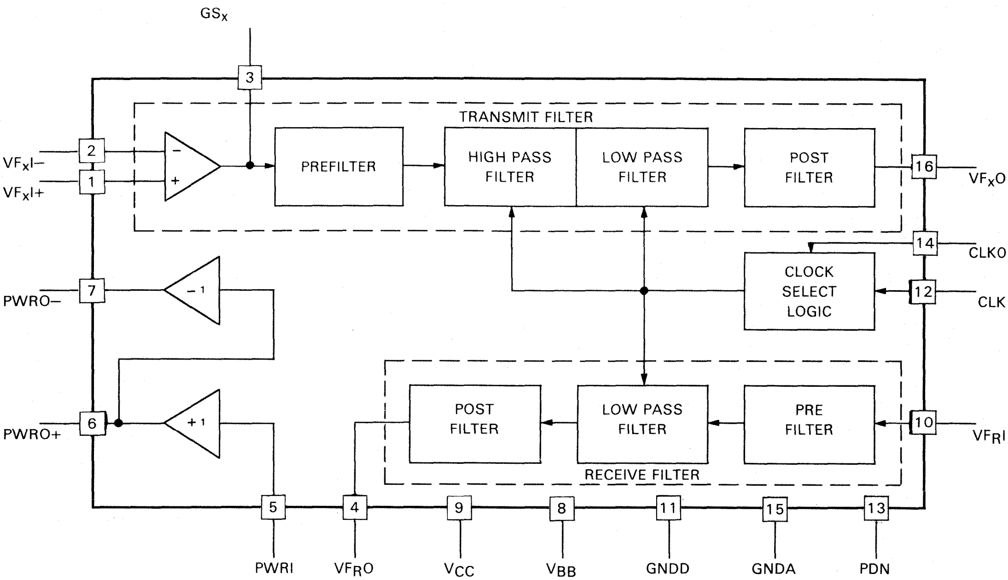
THOMSON COMPONENTS

BLOCK DIAGRAM



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

ETC5051
ETC5056

MONOLITHIC PARALLEL INTERFACE CODEC/FILTER

The ETC5051/ETC5056 family consists of A-law and μ-law monolithic PCM CODEC/filters utilizing the A/D and D/A conversion architecture shown in Figure 1, parallel I/O data bus interface. The devices are fabricated using double-poly CMOS process.

The encode portion for each device consists of an input gain adjust amplifier, an active RC pre-filter which eliminates very high frequency noise prior to entering a switched-capacitor band-pass filter that rejects signals below 200 Hz and above 3400 Hz. Also-included are auto-zero circuitry and a companding coder which samples the filtered signal and encodes it in the companded A-law or μ-law PCM format.

The decode portion of each device consists of an expanding decoder, which reconstructs the analog signal from the companded A-law or μ-law code, a low-pass filter which corrects for the sin x/x response of the decoder output and rejects signals above 3400 Hz and is followed by a single-ended power amplifier capable of driving low impedance loads.

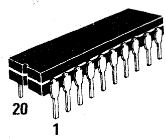
The ETC5051, ETC5056 are especially designed to be used with a line interface controller providing local time and space switching in a distributed control switching system.

- Complete CODEC and filtering system including :
  - Transmit high pass and low pass filtering.
  - Receive low pass filter with sin x/x correction.
  - Receive power amplifier.
  - Active RC noise filters.
  - μ-255 law COder and DECoder - ETC5051
  - A-law COder and DECoder - ETC5056
  - Internal precision voltage reference.
  - Internal auto-zero circuitry.
- Meets or exceeds all D3/D4 and CCITT specifications.
- ±5 V operation.
- Low operating power - typically 60 mW.
- Power-down standby mode - typically 3 mW.
- High speed TRI-STATE® data bus.
- 2 loopback test modes.
- Second source of TP3051, TP3056.

CMOS

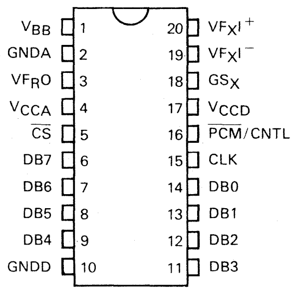
MONOLITHIC PARALLEL DATA INTERFACE CODEC/FILTER

CASE J20A



20 Lead Cavity
J SUFFIX
CERDIP PACKAGE

PIN ASSIGNMENT



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Ref.00035R1

THOMSON SEMICONDUCTORS
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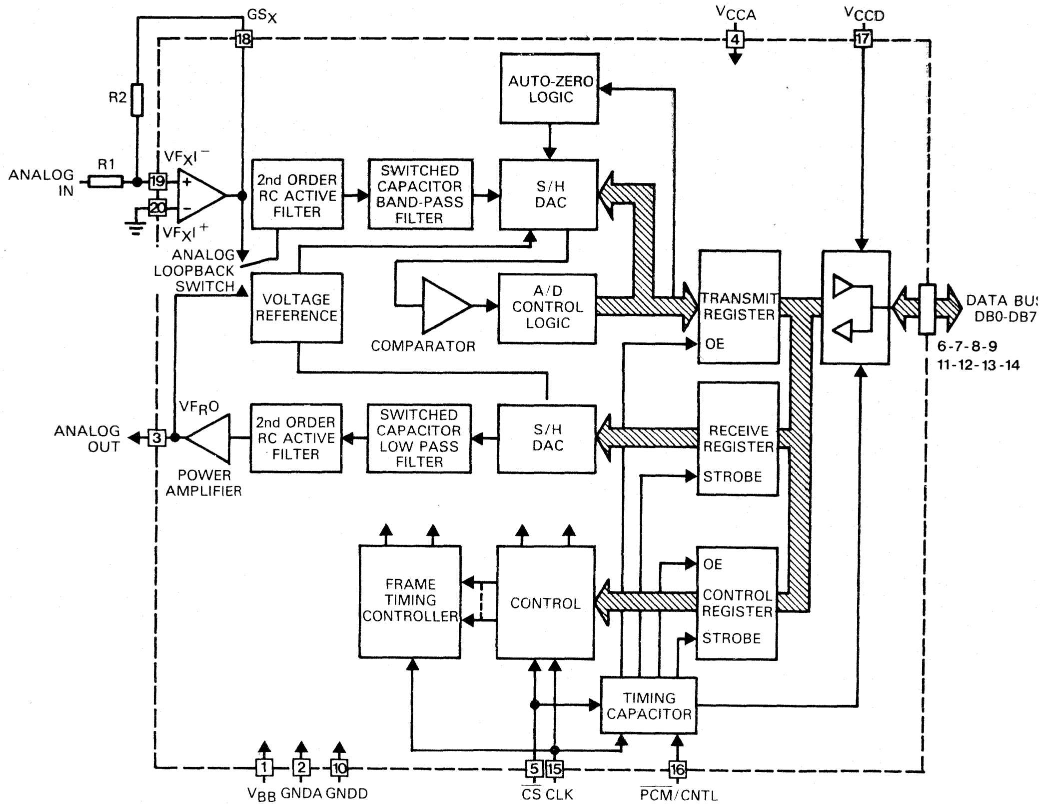
THOMSON COMPONENTS

BLOCK DIAGRAM



Parallel CODEC/FILTER

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

ETC5057
ETC5054

MONOLITHIC SERIAL INTERFACE CODEC/FILTER

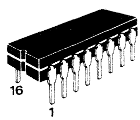
The ETC5057/ETC5054 family consists of A-law and μ-law monolithic PCM CODEC/filters utilizing the A/D and D/A conversion architecture shown in Figure 1, and a serial PCM interface. The devices are fabricated using double-poly CMOS process.

The encode portion of each device consists of an input gain adjust amplifier, an active RC pre-filter which eliminates very high frequency noise prior to entering a switched-capacitor band-pass filter that rejects signals below 200 Hz and above 3400 Hz. Also included are auto-zero circuitry and a companding coder which samples the filtered signal and encodes it in the companded A-law or μ-law PCM format. The decode portion of each device consists of an expanding decoder, which reconstructs the analog signal from the companded A-law or μ- law code, a low-pass filter which corrects for the sin x/x response of the decoder output and rejects signals above 3400 Hz and is followed by a single-ended power amplifier capable of driving low impedance loads. The devices require two 1.536 MHz, 1.544 MHz, or 2.048 MHz transmit and receive master clocks, which may be asynchronous, transmit and receive bit clocks which may vary from 64 kHz to 2.048 MHz, and transmit and receive frame sync pulses. The timing of the frame sync pulses and PCM data is compatible with both indrustry standard formats.

- Complete CODEC and filtering system (COMBO) including:
  - Transmit high-pass and low-pass filtering
  - Receive low-pass filter with sin x/x correction
  - Active RC noise filters
  - A-law or μ-law compatible COder and DECoder
  - Internal precision voltage reference
  - Serial I/O interface
  - Internal auto-zero circuitry
- A-law, 16-pins - ETC5057
- μ-law without signaling, 16-pins - ETC5054
- Meets or exceeds all D3/D4 and CCITT specifications
- ± 5V operation
- Low operating power - typically 60 mW
- Power-down standby - typically 3 mW
- TTL or CMOS compatible digital interfaces
- Maximizes line interface card circuit density
- Second source of TP3057, TP3054.

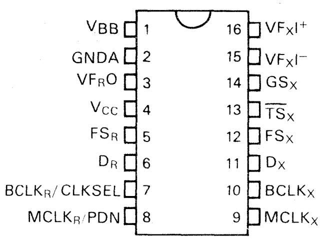
CMOS

MONOLITHIC SERIAL INTERFACE CODEC/FILTER



J SUFFIX
CERDIP PACKAGE

PIN ASSIGNMENT



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Ref.00040

THOMSON SEMICONDUCTORS
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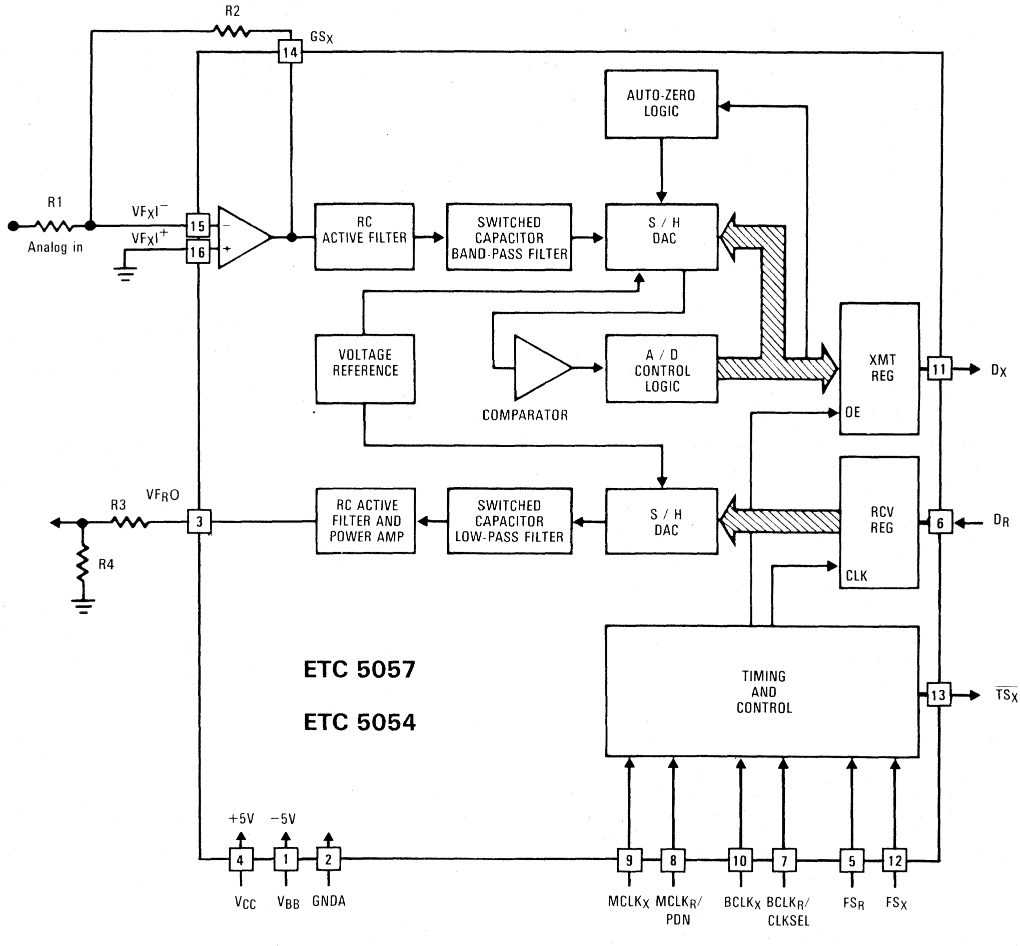
THOMSON COMPONENTS

BLOCK DIAGRAM



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

ETC5067 ETC5064

ADVANCE INFORMATION

MONOLITHIC SERIAL INTERFACE CODEC/FILTER WITH RECEIVE POWER AMPLIFIER

The ETC5064 (μ-law) and ETC5067 (A-law) are monolithic PCM CODEC/FILTERS utilizing the A/D and D/A conversion architecture shown in Figure 1, and a serial PCM interface. The devices are fabricated using National's advanced double-poly CMOS process (microCMOS).

Similar to the ETC5050 family, these devices feature an additional Receive Power Amplifier to provide push-pull balanced output drive capacity. The receive gain can be adjusted by means of two external resistors for an output level of up to ± 6.6 V across a balanced 600 Ω load.

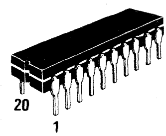
Also included is an Analog Loopback switch and $\overline{TS}_X$ output.

- Complete CODEC and filtering system including :
  - Transmit high-pass and low-pass filtering.
  - Receive low-pass filter with sin x/x correction.
  - Active RC noise filters.
  - μ-law or A-law compatible COder and DECoder.
  - Internal precision voltage reference.
  - Serial I/O interface.
  - Internal auto-zero circuitry.
  - Receive push-pull power amplifiers.
- μ-law ETC5064
- A-law ETC5067
- Meets or exceeds all D3/D4 and CCITT specifications.
- ± 5 V operation.
- Low operating power - typically 70 mW
- Power-down standby mode - typically 3 mW
- Automatic power-down.
- TTL or CMOS compatible digital interfaces.
- Maximizes line interface card circuit density.

CMOS

MONOLITHIC SERIAL INTERFACE CODEC/FILTER WITH RECEIVE POWER AMPLIFIER

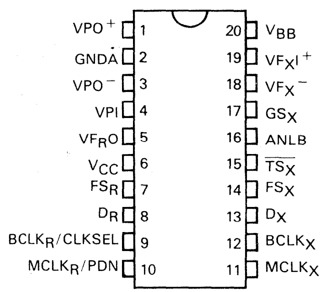
CASE J20A



20 Lead Cavity
J SUFFIX
CERDIP PACKAGE

PIN ASSIGNMENT

12



Ref.04465

THOMSON SEMICONDUCTORS
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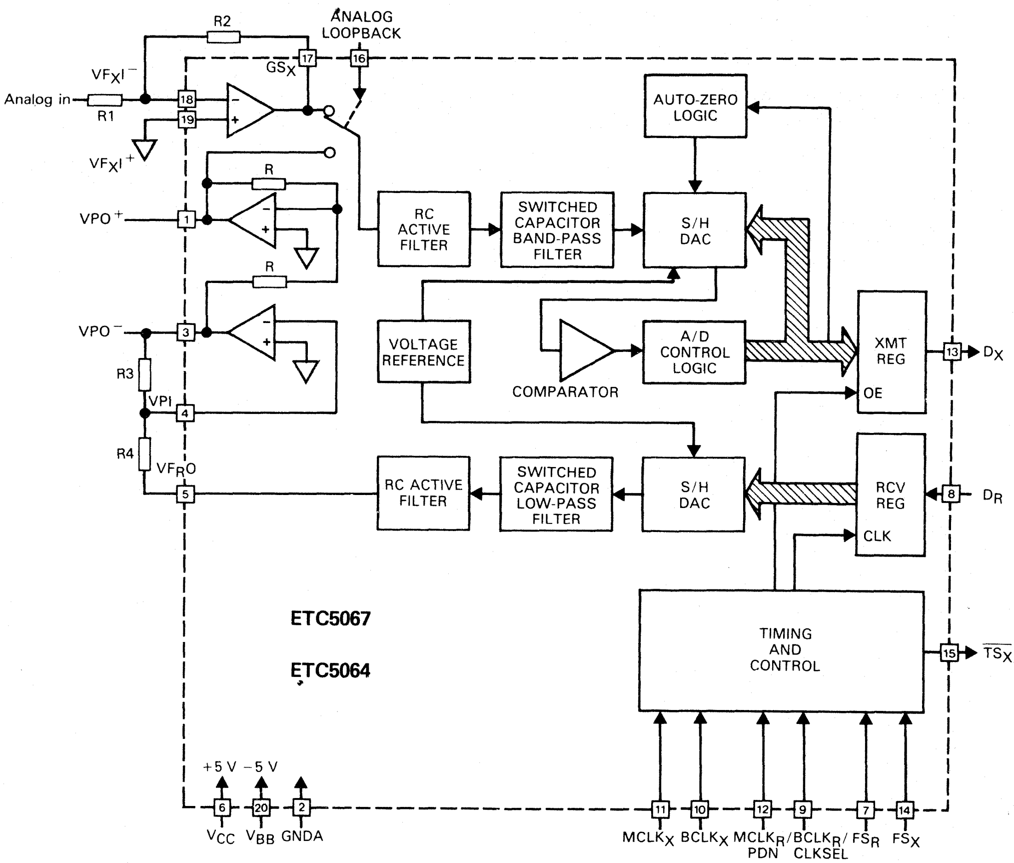
THOMSON COMPONENTS

BLOCK DIAGRAM



These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

EFG7189

DTMF GENERATOR FOR BINARY CODED HEXADECIMAL DATA

This CMOS circuit is designed specifically to provide, with a minimum number of external components, a low cost DTMF dialer for microprocessor-controlled telephone sets operating in accordance with existing standards. The 4 bits identifying the frequency pair to be generated may be supplied via either 5 connections between the EFG7189 and the microprocessor in parallel format or in serial format through 3 connections linking the EFG7189 to the microprocessor. This feature eliminates the necessity to simulate keyboard-type inputs normally required by standard DTMF generators. Input data is stored on trailing edge of ISA signal. The tone pair selected by this code is generated while ISA remains low. With ISA high, the oscillator is inhibited and the device is in standby mode. SA pin is connected to V^- while device is outputting any tone pair.

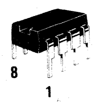
- Generates 16 standard DTMF tone pairs
- Uses low cost 3,579 MHz crystal
- Direct microprocessor interface
- Accepts 4-bit data in serial or parallel format
- Data is stored during transmission period
- Low harmonic distortion
- High group pre-emphasis
- Low power consumption in standby mode
- Pull-up to V^+ on all logic inputs.

CMOS

DTMF GENERATOR FOR BINARY CODED HEXADECIMAL DATA

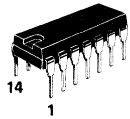
CASES

CB-98



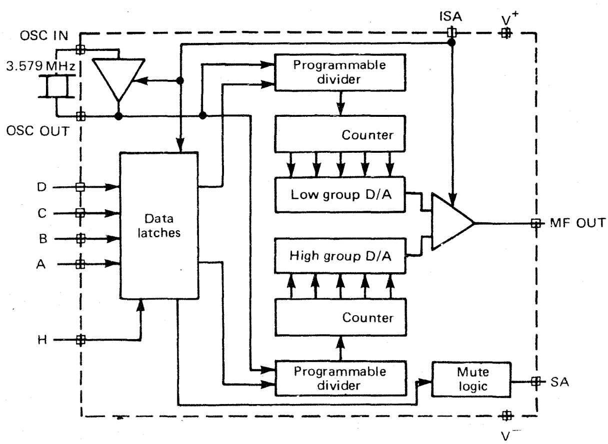
P SUFFIX
PLASTIC PACKAGE

TO-116
(CB-2)



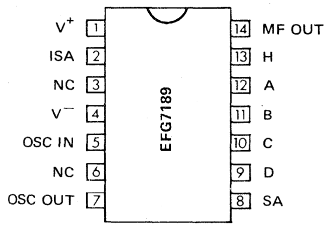
P SUFFIX
PLASTIC PACKAGE

BLOCK DIAGRAM

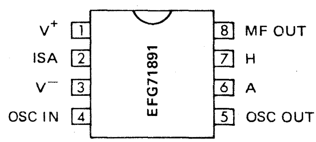


PIN ASSIGNMENTS

TO-116
(CB-2)



CB-98



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Ref.01915

THOMSON SEMICONDUCTORS
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THOMSON COMPONENTS

NOTES

THOMSON SEMICONDUCTORS

TEA3046

PRODUCT PREVIEW

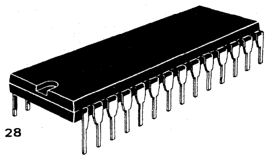
TELEPHONE LOW-COST MONOCHIP

Specially designed for a basic low cost telephone set application, this 28-pin IC provides transmission and line adaptation, DTMF generation and power supply for peripheral circuits. Interface is also possible with a micro-computer for a more sophisticated set.

- Low working voltage
- Wide operation current range
- Adjustable automatic line length receiving and sending gain control
- Adjustable automatic line length tracking anti-sidetone system
- Adjustable dynamic impedance
- Microphone preamplifier compatible with both symmetrical and asymmetrical inputs
- Adjustable microphone amplifier gain
- Adjustable earphone amplifier gain
- Low send and receive noise
- Click-free switch-over from speech mode to dialling mode & vice-versa
- Silent position facility
- Single-tone facility
- Two keys roll over provided
- Switch bounce elimination
- Microcomputer interface available
- Adjustable output tone level
- Temperature independent output level
- Inputs protected against electrostatic discharge
- Power supply for peripheral circuits.

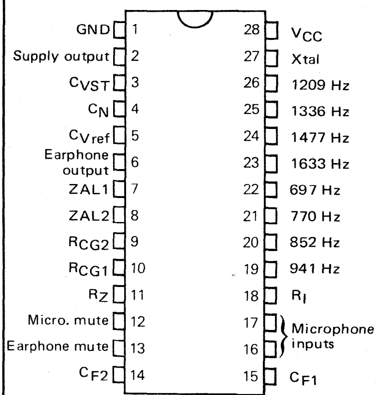
TELEPHONE LOW-COST MONOCHIP

CASE CB-132



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT



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Ref.00625

THOMSON SEMICONDUCTORS
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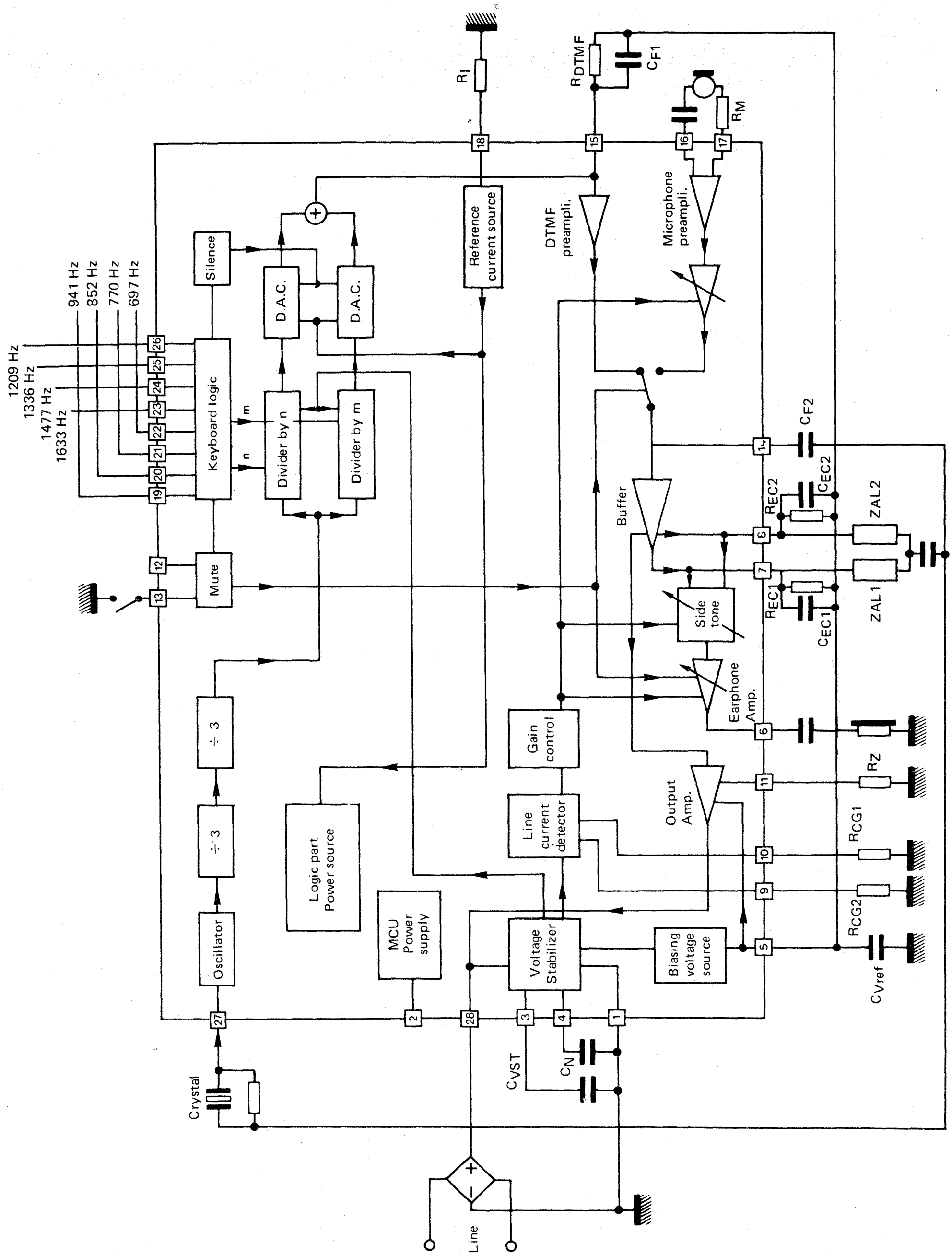
THOMSON COMPONENTS

BLOCK DIAGRAM



This is advance information and specifications are subject to change without notice
Please inquire with our sales offices about the availability of the different packages.

THOMSON SEMICONDUCTORS

TEA7031

PRODUCT PREVIEW

LOUDSPEAKER AMPLIFIER

The TEA7031 is a 28-pin DIL integrated circuit especially designed to be used as loudspeaker amplifier.
Functions implemented on the chip include :

- Loudspeaker amplifier,
- Anti-acoustic feed-back system (anti-larsen),
- Direct microcomputer supply,
- Switching regulator.

These functions are electrically separated and may-be used individually.
One of the main applications is the telephone set with loudspeaker.
In this configuration, the circuit is used in conjunction with TEA7030.

Loudspeaker amplifier

- DC voltage : from 2.5 V to 7 V
- Supply current : less than 1.5 mA without output current
- High output voltage swing : 3 Vpp on a 50 Ω loudspeaker with only 3 Vdc supply.
- The gain of the amplifier is programmable linearly or in steps of 6 dB
- When the required output energy becomes higher than the energy available by the power supply, an automatic gain control system will reduce the gain to avoid distortion.

High efficiency anti-acoustic feed-back system

- Adjustable as a function of the mechanical feed-back
- An original system will distinguish between voice and other signals thus preventing the amplifier to switch off in the presence of background room noise signals.

Microcomputer supply

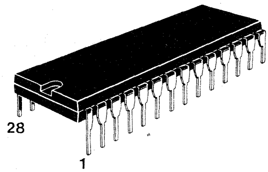
- DC voltage : from 2 V to 5 V
- Reset and halt signals available
- A Ring Detection Signal (RDS) is available to allow the circuit to be used as a ringer fo telephone set.

Switching regulator

- Low operating supply voltage
- If the circuit is supplied by a high voltage energy source, e.g. 24, (which is normally the case while ringing signal is being received), due to high impedance characteristic of the circuit, the available current will be insufficient for satisfactory circuit operation. Under this condition, the on-chip SWITCHING REGULATOR will convert the available high voltage into a low voltage (e.g. 3 V) and will provide the required amount of current for high efficiency circuit operation.

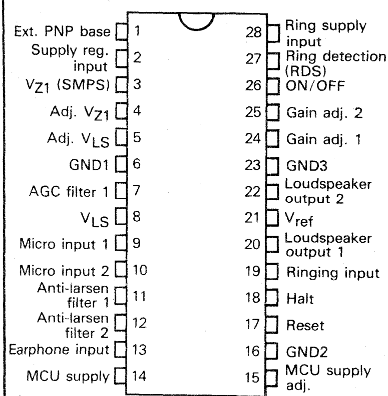
LOUDSPEAKER AMPLIFIER

CASE CB-132



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT



12

Ref.00645

THOMSON SEMICONDUCTORS
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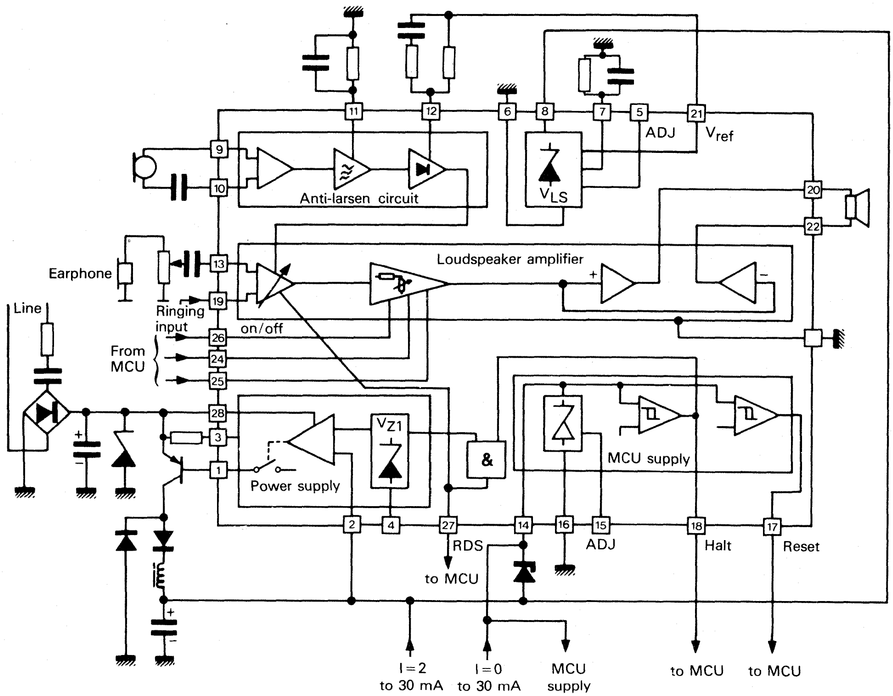
THOMSON COMPONENTS

SWITCHING SUPPLY

- This supply allows the circuit to be used for a ringer.
- It converts the high voltage to high current on the loudspeaker and powers the IC. So the same circuit can be used both as voice amplifier and ringer amplifier.
- When the switching regulator is operating properly and the microcomputer power supply is satisfactory, the circuit will send and active "RDS" signal to the microcomputer to instruct it to generate a melody signal. Conversely, the microcomputer will return the melody signal which is then processed internally by the TEA7031 and applied to the loudspeaker.

APPLICATION FOR TELEPHONE SET



THOMSON SEMICONDUCTORS

TEA7036

PRODUCT PREVIEW

TRANSMISSION AND DTMF MONOCHIP

Specially designed for a basic low cost telephone set application, this 28 pin Integrated Circuit provides transmission and line adaptation, DTMF generation, flash function and a stabilized power supply for peripheral circuits. Interface is also possible with a microprocessor for a more sophisticated set.

- Designed to meet French standard requirements
- Low power consumption
- Low operating voltage
- Automatic line length detection and gain compensation for transmission, reception and anti-sidetone

Transmission

The transmit and receive gains as well as the 2-wire to 4-wire conversion are automatically adjusted according to line length.

The microphone preamplifier performs a high CMRR, thereby minimizing crosstalk and RF effects and resulting in excellent noise characteristics. Its architecture permits symmetrical and asymmetrical inputs. External adjustment of gain to fit different microphone capsules is also provided. A single pole filter limits the amplifier bandwidth thus achieving an excellent high frequency response.

The gain of the earphone amplifier can be externally adjusted. An automatic line impedance tracking anti-sidetone system performs an excellent sidetone efficiency for any line length. The dynamic impedance of the circuit is fixed by an external resistor so as to provide impedance matching with different lines.

DTMF signal generation

Tones are obtained from a crystal-controlled oscillator followed by two independent programmable dividers and two sinewave synthesizers. The crystal is an inexpensive 3.58 MHz TV model oscillator. Distortion reduction is achieved by two successive single pole filters. Spread of tone levels and pre-emphasis are in accordance with CCITT standards. The amplitude of multi-frequency signal is set by an external resistor.

The required tone frequencies may be selected by either an inexpensive 4 X 4 single contact keyboard or directly by a microprocessor. Single-tone operation for testing purposes is also possible.

Power supply

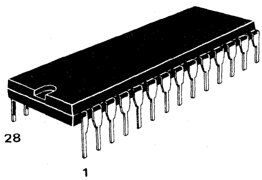
This is a 3 mA current source with a typical voltage compliance of 3.2 V. It can power either an electret microphone or a microprocessor.

Flash function

It begins operating as soon as the appropriate key is released. Its duration is externally adjustable.

TRANSMISSION AND DTMF MONOCHIP

CASE CB-132



DP SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT

GND	1	28	V_{CC}
C_{VST}	2	27	C_N
Flash input	3	26	Xtal
Flash adj.	4	25	1633 Hz
High voltage control	5	24	1477 Hz
Earphone output	6	23	1336 Hz
Supply output	7	22	1209 Hz
ZAL1	8	21	697 Hz
ZAL2	9	20	770 Hz
AGC inhibit	10	19	852 Hz
R_Z	11	18	941 Hz
C_{F2}	12	17	$I_{(ref)}$
C_{F1}	13	16	$V_{(ref)}$
Microphone input	14	15	Microphone input

12

Ref. 04550

THOMSON SEMICONDUCTORS
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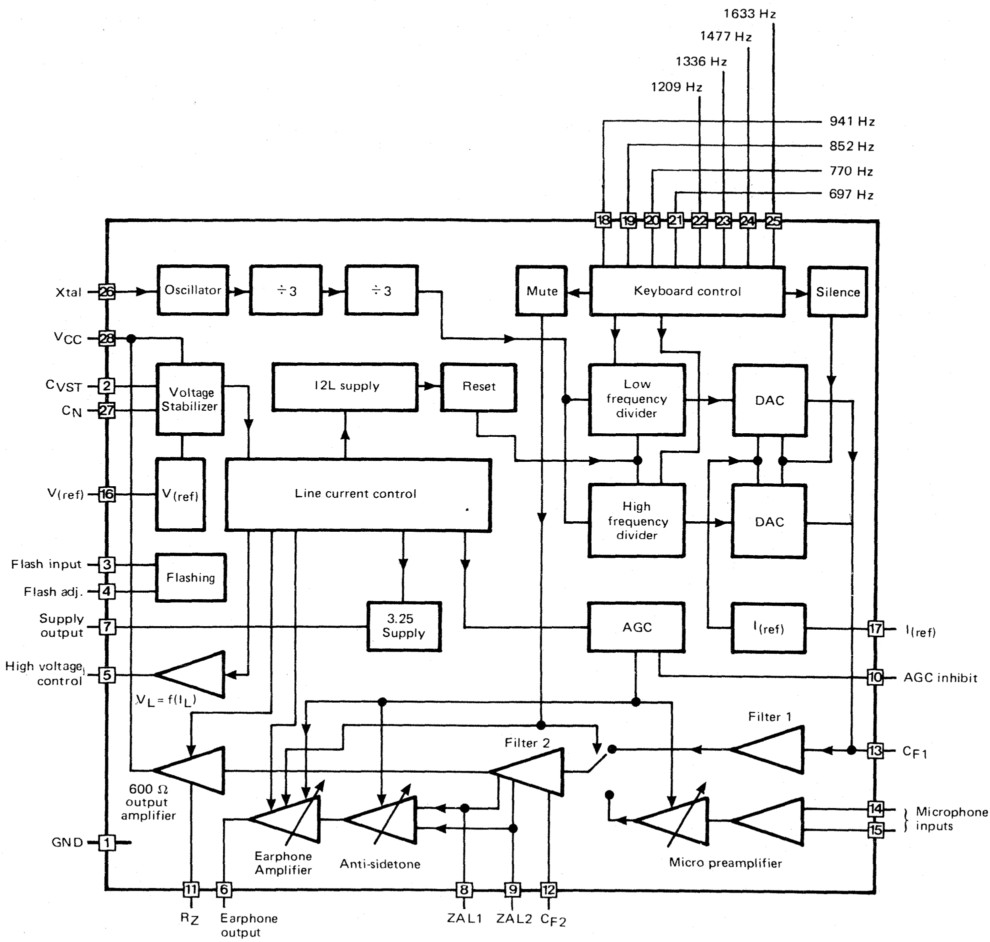
THOMSON COMPONENTS

BLOCK DIAGRAM



This is advance information and specifications are subject to change without notice
Please inquire with our sales offices about the availability of the different packages.

Semi-custom ICs

Page

POLY-USE A 400 components analog bipolar array 907
POLY-USE G 800 components analog bipolar array 907
POLY-USE K High speed analog array 915
TS8505/Cust. ID Semi-custom switched capacitor filters 917

	Number of pads	Transistors NPN	PNP	f_T (MHz)	Package
POLY-USE A	24	71	35	550	Plastic DIL 14/16/18/24
POLY-USE G	40	142	70	550	Plastic DIL 24/28/40
POLY-USE K	28	188	28	3000	Plastic DIL 8/14/16/18/24/28 Plastic SO 14/16

THOMSON SEMICONDUCTORS

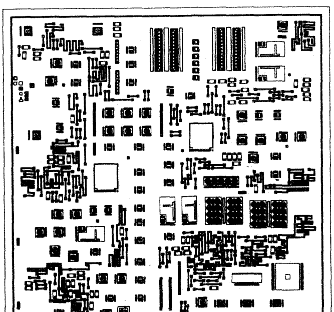
POLY-USE A
POLY-USE G

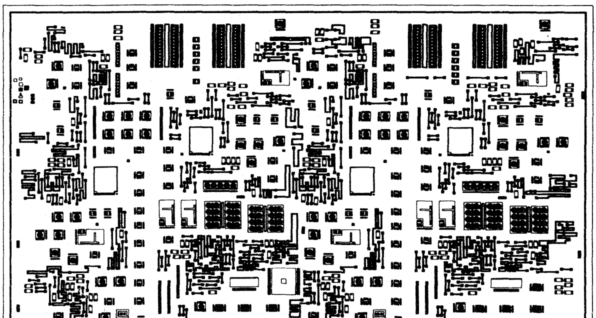
LINEAR COMPONENT ARRAYS

The THOMSON SEMICONDUCTORS **linear component arrays** are semicustom bipolar integrated circuits that contain an array of uncommitted discrete transistors, resistors and capacitors. A user can interconnect these individual components on second level metal to form a custom linear integrated circuit.

- 20 volt (max) supply operation
- Standard NPN f_T = 550 MHz typ.
- Wide variety of NPN and PNP transistor types on each array
- Base, pinched-base, and emitter resistors (10 ohm to 100K ohm)
- MOS and junction capacitors
- 2 layer metalization for ease of interconnect
- Digitized customer layout sheet for computer-aided routing

A unique feature of the POLY-USE A and G array is the two level metalization which simplifies routing, increases the percent utilization of the components on the array and provides improved electrical characteristics. First level metal is a standard, predefined pattern that provides low resistance distribution of the positive and negative supply voltages across the chip. All custom interconnection and routing is done on second level metal along a predefined routing grid which automatically maintains the proper metal pitch. All contact vias to the individual components and to the first level metal supply voltages lie on intersection points of this grid. This two layer system reduces layout time by a factor of 3 over single layer arrays and up to 90% of the components on the array may be utilized. Computer assisted layout, available as an option, further simplifies and speeds up layout and reduces the risk of errors.





POLY-USE A
- 150 X 106 mil die size (3.8 x 2.7mm)
- 424 components
- 24 pins max
- ≤20 Volt supply max
- 14,16,24 pin plastic or ceramic DIP

POLY-USE G
- 192 X 152 mil die size (4.88 x 3.85mm)
- 835 components
- 40 pins max
- ≤20 Volt supply max
- 22,24,28,40 pin plastic or ceramic DIP

Ref. 00695

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TABLE I — Summary of Components on POLY-USE A and G

CIRCUIT COMPONENTS	DESCRIPTION		A	G
NPN Transistors	QN1 — Standard 10 mA NPN		46	92
	QN2 — High frequency NPN (rbb' = 150 ohm)		12	23
	QN3 — Low noise NPN (rbb' = 70 ohm)		2	4
	QN4 — 100 mA NPN		2	4
	QN5 — Standard 10 mA NPN with merged PN junction capacitor (C2)		7	12
	Total NPN Transistors		69	135
PNP Transistors	QP6 — Standard lateral PNP (1 mA)		32	60
	QP7 — Multiple lateral PNP (5X)		1	2
	QP8 — Multiple lateral PNP (16X)		2	4
	QP9 — Substrate PNP (1 mA)		1	2
	QP10 — High Current Substrate PNP (5 mA)		2	4
	Total PNP Transistors		38	72
DIODES	D1 — P+N+ Zener		3	0
CAPACITORS	C1 — MOS Capacitor (8 pf)		2	4
	C2 — PN junction (merged with QN5)		7	12
	C3 — P+N+ isolated junction		1	2
	C4 — P+N+ junction (P+ connected to substrate)		1	1
	Total Capacitors		11	19
RESISTORS	P Base	100 ohm	24	45
		220 ohm	34	65
		470 ohm	41	83
		1 K ohm	70	142
		2.2K ohm	62	128
		4.7K ohm	30	59
		10 K ohm	26	53
	Pinched Base	40 K ohm	6	12
		100 K ohm	5	10
	N+Emitter	10 ohm	12	24
	Total Resistors		310	621
TOTAL COMPONENTS			431	847

THE LINEAR COMPONENTS

The POLY-USE A and G use the same family of NPN and PNP transistors, capacitors and resistors. These components are completely characterized in the **linear component array** Design Manual. A brief description of these components and their features follows.

NPN Transistors: There are five basic NPN transistor types on the arrays. QN1 is a standard NPN vertical structure designed for 10 mA nominal and 30 mA maximum collector current. QN2 is a higher frequency version NPN with two base contacts which reduce the series base resistance (rbb') to 150 ohm typ. QN3 is a low noise NPN that has a rbb' of only 70 ohm typ. The high current NPN, QN4 will handle 100 mA nominal and 300 mA maximum collector current. This transistor contains an extra deep collector diffusion which lowers the VCE(sat) to 250 mV at 100 mA. Finally, QN5 is a standard NPN transistor with an additional P diffusion in the collector which forms a merged PN junction capacitor (C2) off the collector. This is a convenient structure for use in designs requiring Miller capacitance.

PNP Transistors: The arrays have both lateral and substrate PNP transistors. QP6 is a standard lateral PNP designed to handle 1 mA nominal collector current. QP7 is a 5X multiple lateral PNP and QP8 is a 16X lateral PNP. These two PNP transistors contain multiple emitter-collector structures diffused into the same base for higher current handling capability. QP9 is a standard substrate PNP transistor that can handle 1 mA collector current. QP10 is a higher current substrate PNP designed for 5mA nominal collector current.

Diodes: The POLY-USE A also contains 3P+N+ zener diodes with a nominal voltage of 5.5 volts. Additionally, all NPN transistors can be used as zener diodes by connecting the emitter to the collector and using the emitter base junction breakdown for the zener voltage.

Resistors: Three types of resistor construction are used on the arrays; base, pinched-base and emitter. The resulting resistors are arranged in strings of 2 or 3 each in a wide range of standard discrete values. The majority of the resistors on the array are base diffused resistors of either 30 μm or 8 μm width with the values from 100 ohm to 10K ohm. For higher resistance, pinched-base resistors are available in 40K ohm and 100K ohm values. A maximum voltage of 5 volts can be applied to the pinched-base resistors. There are several low value emitter resistors on the arrays of 10 ohm each. Although the initial tolerance on these diffused resistors is not as close as with discrete components, the resistance matching of identical value resistors is superior to discrete versions.

Capacitors: The arrays contain both junction and MOS capacitors which may be used in ac coupling, Miller capacitance or compensation applications. The MOS capacitors are made with a layer of aluminum isolated from an N+ emitter diffusion by a thin layer of oxide. These capacitors have a nominal value of 8 pf which is voltage independent. They also exhibit very low series resistance (high Q). The junction capacitors C3 and C4 have voltage dependent capacitance and may be biased to several hundred picofarads. However, depending on the application, use of these junction capacitors may be limited due to non-negligible leakage currents. The P+N+ junction capacitor (C4) merged with a standard NPN transistor (QN5) provides Miller capacitance capability.

TABLE II — Typical Electrical Characteristics (T_{amb} = + 25°C)

Transistors	NPN (QN1, 2, 3, 4, 5)	Lateral PNP (QP6, 7, 8)	Substrate PNP (QP9, 10)
BVcbo	45 V	45 V	45 V
BVceo	20 V	40 V	45 V
BVebo	6.1 V	30 V	25 V
h_{FE}	140	35	60
f_T	550 MHz	3.5 MHz	14 MHz

Capacitors	MOS (C1)	Junction (C2)	Junction (C3)	Junction (C4)
Nominal value	8 pf	$\frac{5\ pf}{(1 + Vc/0.5)^{0.4}}$	$\frac{30\ pf}{(1 + Vc/0.75)^{0.33}}$	$\frac{100\ pf}{(1 + Vc/0.75)^{0.33}}$
Max. Voltage	±20 V	20 V	2.0 V	2.0 V

Resistors	Base	Pinched Base	Emitter
Initial tolerance	±30%	+100% – 50%	+40% – 30%
Matching (Same value pairs)	±2%	±5%	±10%
Temperature coefficient (typ.)	+0.1%/°C	+0.5%/°C	+0.15%/°C

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KIT PARTS

Successful **linear component array** design may require a bread board analysis of the custom circuit prior to committing to layout. A complete set of array components is available in kit part form for this purpose. In addition to kit parts for the various transistors and capacitors on the POLY USE A and G there are also several "linear functions" which have been built and characterized using the array components including a wide band differential amplifier, an active load differential amplifier, a 1.3 volt band gap reference voltage source, a temperature dependent current source and an NPN mixer configuration. All kit parts are packaged in standard 16 pin ceramic DIPs.

TABLE III — Available Breadboard Kit Parts

Kit Part #	Description
KP01	5 standard NPN transistor array (QN1)
KP02	4 standard lateral PNPs (QP6) 1 substrate PNP (QP9)
KP06	1 standard NPN (QN1) 1 standard PNP (PQ6) 1 high current NPN (QN4) 1 high current lateral PNP, 16x (QP8) 1 high current substrate PNP (QP10)
KP054	2 mixer configurations of standard NPNs (QN1)
KP121A	2 low noise NPNs (QN3) 1 wide band differential amplifier circuit
KP122	5 high frequency NPN transistor array (QN2)
KP124A	1 high current lateral PNP (QP8) 1 MOS capacitor (C1) 1 P+N+ capacitor (C4) 1 active load differential amplifier circuit
KP128A	1 P+N+ capacitor (C3) 1 temperature dependent current source circuit 1 wide band differential amplifier circuit 1 band gap 1.3 V voltage source

CIRCUIT MODELING AND SIMULATION

Instead of, or in addition to, bread board evaluation, the customer may want to perform computer analysis of the circuit to verify correct operation over a range of environmental and process variations. To assist with this analysis, a complete set of modeling parameters is available in the **linear component array** Design Manual for each component type on the POLY-USE A and G. The parameters are given for Ebers-Moll and Gummel-Poon bipolar transistor models which are used in simulation programs such as SPICE.

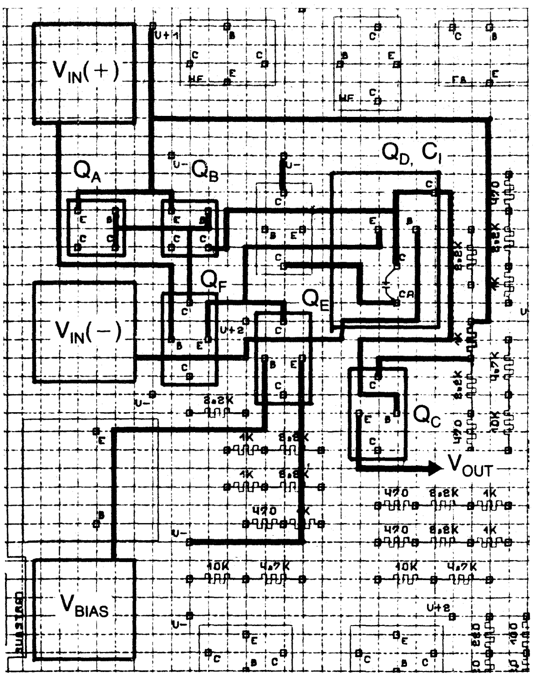
LAYOUT TECHNIQUES

The **linear component arrays** may be routed manually by the customer on routing sheets provided by THOMSON SEMICONDUCTORS. The POLY-USE A and G arrays have been designed to be much easier for the customer to manually interconnect and route than competing single level metal linear arrays. All of the customization of each array is done on second metal. The first level metal pattern is standard on each array, and it provides low resistance distribution of the power and ground buses throughout the array. The POLY-USE G has two separate power buses (+5, +12 volts, for example) and one ground bus. This simplifies the required interconnection on second metal as all supply routing is already provided on first metal. Contact to any of the power supply buses is made by simply routing the interconnect to one of the many V− and V+ contact vias (V−, V+1, V+2 on the POLY-USE G located throughout the array.

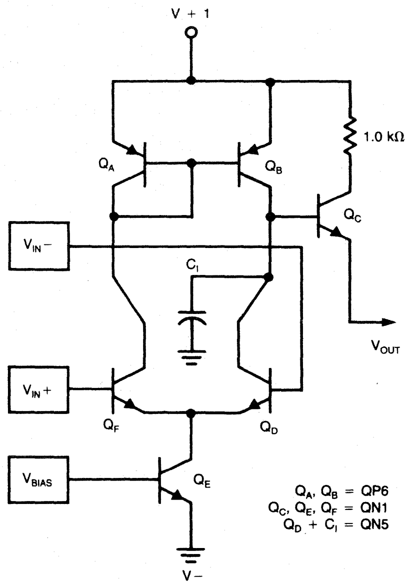
Another feature that simplifies the manual layout is the grid on which all interconnect metal is placed. The grid pitch is 31 μm and by specifying the routing along the grid, proper metal spacing and metal width, (16 μm line width is standard), are automatically maintained. Where higher current handling is required (>40 mA) the line width may be drawn wider to indicate the necessary metal width.

All contact vias to the individual component terminals as well as all power and ground contacts are located on intersection points on the grid, further simplifying routing. All NPN transistors have two collector contacts which can be used as crossunder connections. There are also contacts to a number of first level metal crossunders throughout the array which are strategically located so as to simplify connections from the center of the array to the bonding pads on the periphery of the chip. These features reduce the average manual layout time by a factor of 3 over similar complexity single level metal arrays. A high percentage of component utilization is also possible on the POLY-USE A and G, typically 80 to 90 percent, and better electrical characteristics should be expected.

LAYOUT EXAMPLE: Differential Amplifier Circuit on the POLY-USE G



Completed Manual Layout on Routing Sheet

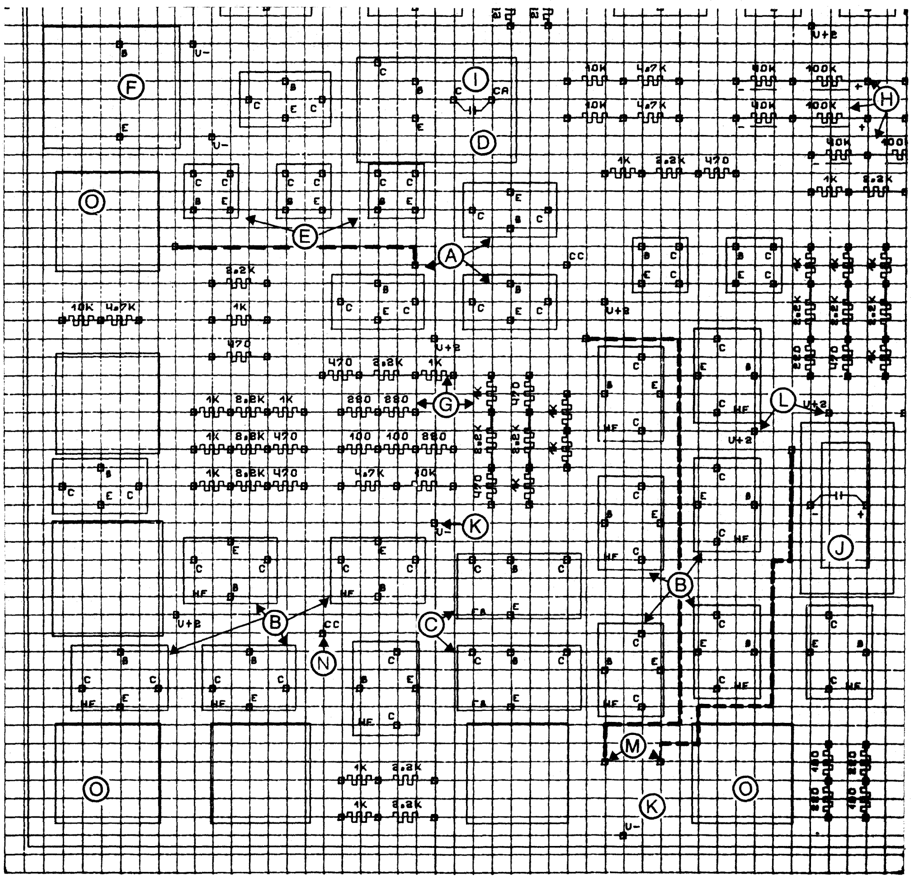


Circuit Schematic

The layout example demonstrates some of the "user-friendly" features of the VSI routing sheets:

- Conveniently located supply and ground contacts (V + 1 and V−) simplify bias connections.
- Collector contacts of the unused NPN transistor form a handy crossunder connection.
- Both C_I and Q_D of the circuit schematic are implemented with the QN5, merged capacitor transistor.

POLY-USE G ROUTING SHEET DETAIL



LEGEND

TRANSISTORS

- Ⓐ — Standard NPN — QN1
- Ⓑ — High Frequency NPN — QN2
- Ⓒ — Low Noise NPN — QN3
- Ⓓ — Standard NPN with Merged PN Junction Capacitor — QN5
- Ⓔ — Standard Lateral PNP — QP6
- Ⓕ — High Current Substrate PNP — QP10

RESISTORS

- Ⓖ — Base Resistor Strings
- Ⓗ — Pinched-base Resistor Strings

CAPACITORS

- Ⓘ — PN Junction Merged with QN5 — C2
- Ⓙ — P^+N^+ Isolated Junction — C3

OTHER CONTACTS

- Ⓚ — Negative Supply Voltage or Ground Contacts
- Ⓛ — Positive Supply Voltage Contacts
- Ⓜ — First Level Metal Crossunder Connections
- Ⓝ — Resistor Tub Biasing Contact
- Ⓞ — Bonding Pad Location.

DESIGN MANUAL

The starting point in developing a custom linear circuit on the POLY-USE A and G is a review of the LINEAR COMPONENT ARRAY DESIGN MANUAL. The Manual contains all the information necessary for a customer to design and layout a custom linear circuit on the POLY-USE A and G arrays including:

- Description of the bipolar processing technology used
- Description of the basic linear component structures and their topology
- Electrical characteristics of the components
- Modeling parameters of the components for computer simulation
- Data sheets for the breadboard Kit Parts
- Explanation of layout and routing procedures
- Manual routing sheets for both the POLY-USE A and G

DESIGN DEVELOPMENT PROCEDURE

The development of a custom linear circuit is a joint effort involving THOMSON SEMICONDUCTORS and the customer. Typical development work is divided as follows:

The CUSTOMER Tasks:

- Review the Design Manual
- Generate a circuit schematic using POLY-USE A and G components
- Perform breadboard evaluation and/or computer simulation of the circuit
- Layout circuit on routing sheet
- Submit complete Design Package including: completed routing sheet, circuit schematic, breadboard schematic (if applicable), description of circuit operation, application, circuit performance and test specifications

THOMSON SEMICONDUCTORS Tasks:

- Review the Design Package
- Convert the completed routing sheet to custom metalization mask
- Process wafers and probe to basic process test patterns
- Assemble die into packages
- Test functional prototypes and ship to customer

THOMSON SEMICONDUCTORS will normally ship the prototypes within 6 to 10 weeks after receiving the customer's Design Package. The testing of the prototypes will be sufficient to ensure proper circuit functionality. After the customer completes evaluation and characterization of the prototypes, THOMSON SEMICONDUCTORS will work closely with the customer to finalize the test programs and procedures for use in volume production.

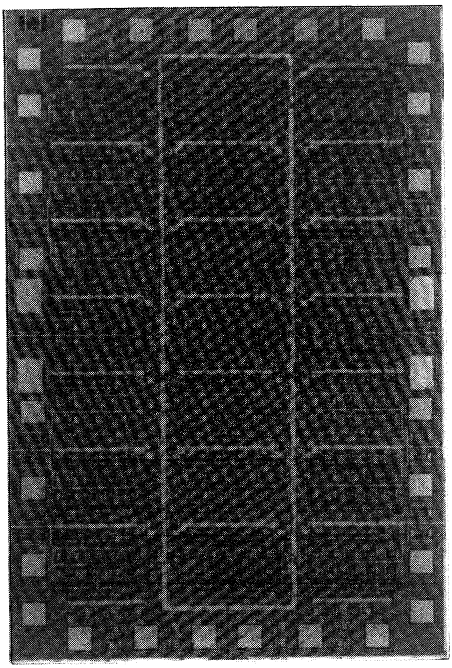
13

NOTES

THOMSON SEMICONDUCTORS

POLY-USE K

PRODUCT PREVIEW



BIPOLAR LINEAR ARRAY

The POLY-USE linear arrays are semi-custom bipolar ICs containing an array of uncommitted discrete transistors, resistors and capacitors.
These individual components may be interconnected by the user on the second metal layer to form a custom linear IC.

- **NPN f_T = 3 GHz**
- Two metal layers for ease of interconnection
- Number of components : 906
- Chip size : 7.66 mm^2
- Available in plastic DIL from 8 to 28-pin package
- **Mountable in SO package (14 or 16-pin)**

Ref.04215

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THOMSON COMPONENTS

TYPICAL ELECTRICAL CHARACTERISTICS (T_{amb} = + 25 °C)

TRANSISTORS

Characteristic	Symbol	Value		Unit
		NPN	PNP	
Collector-base breakdown voltage	$V_{(BR)CBO}$	>25	>25	V
Collector-emitter breakdown voltage	$V_{(BR)CEO}$	>15	>20	V
Early voltage	V_{EA}	>30	>30	V
Current gain	h_{FE}	100	>20	–
Cut-off frequency (unity gain)	f_T	3	–	GHz

RESISTORS

Characteristic	Symbol	Value	Unit
Extrinsic base resistance	R□ Bex	350	Ω/□
P^+ resistance	R□ P^+	60	Ω/□

NUMBER OF COMPONENTS

Number of pads	Transistors		Capacitors	Resistors
	NPN	PNP		
28	188	28	4	686

AVAILABLE COMPONENTS

126	NPN	transistors - Small signal
42	NPN	transistors - 2 emitters connected
10	NPN	transistors - Low noise, high current
28	PNP	transistors - Lateral
4		capacitors - Oxide - Nitrate - 6 pF
364	P^+	resistors - 100 Ω, 200 Ω, 400 Ω, 800 Ω
322		Base resistors - 1 kΩ to 16 kΩ

- The two-layers system reduces lay-out time by a factor of 3 compared to single layer arrays and up to 90 % of components on the array may be used.
- Successful linear component array design may require a bread board of the circuit prior to committing the design lay-out.
- A complete set of array components is available in kit parts for this purpose.

THOMSON SEMICONDUCTORS

TS85XX

MASK - PROGRAMMABLE SWITCHED CAPACITOR FILTERS

The TS85XX circuits are HCMOS universal filters containing a mask programmable switched-capacitor cascadable structure and two uncommitted general purpose operational amplifiers.
The specifications of the internal filter are obtained during the last step of chip realization. The specialization method (Patented) used by THOMSON SEMICONDUCTORS is close to the one used for gate array integrated circuits.
For custom filters, the switched capacitors filter specialization is implemented by THOMSON SEMICONDUCTORS designers in accordance with the user gauge. Most filters can be realized. Samples are available 6 to 8 weeks after the filter gauge definition.
This technique has also been used to define THOMSON SEMICONDUCTORS family of general purpose filters.
Based on the switched-capacitor structure, these circuits exhibit all the advantages of this technique, namely precise gauge, high temperature and long-range stability, almost no external component, no adjustment, low consumption, high density, easy customization, low cost and high security of use.

- Available order : 2 to 8 (any type)
- Input signal frequency range : 0 to 50 KHz
- S/N ratio (depends on the internal structure) : 70 to 85 dB
- Gauge translation possible thru sampling clock tuning
- Power supply requirements : ± 5 V or 0-10 V
- Power consumption : adjustable from 0.5 mW to 20 mW per order.

AVAILABLE PRODUCTS :

• Standard filters

Low pass :
TS8510 : 5 th order Cauer (MIC)
TS8511 : 7 th order Cauer (50 dB)
TS8512 : 7 th order Cauer (75 dB)
TS8513 : 8 th order Tchebychev
TS8514 : 8 th order Butterworth.

High pass :
TS8530 : 3 rd order Cauer
TS8531 : 5 th order Cauer
TS8532 : 5 th Tchebychev

Band pass :
TS8550 : 8 th order Tchebychev

• Custom filters

EFG8508 / Customer identification : prototype delivery shorter than 8 weeks

Typical applications : telecommunications, data acquisition (filtering before A/D conversion and smoothing after D/A conversion) and of course classical action filter replacement.

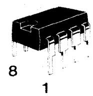
LINEAR

HCMOS 1

MASK - PROGRAMMABLE SWITCHED CAPACITOR FILTER

CASES

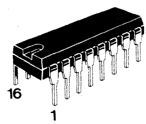
CB-98



P SUFFIX
PLASTIC PACKAGE

J SUFFIX
CERDIP PACKAGE

CB-79



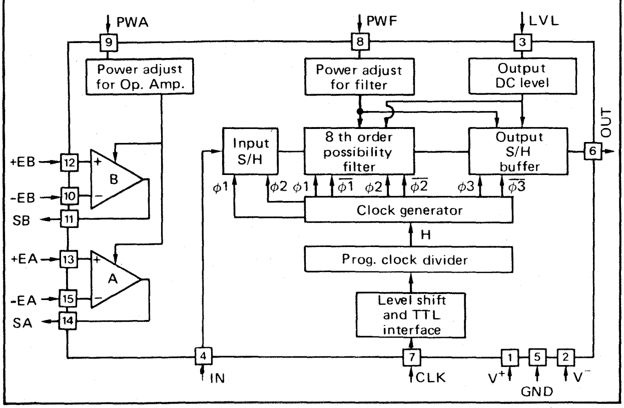
P SUFFIX
PLASTIC PACKAGE

J SUFFIX
CERDIP PACKAGE

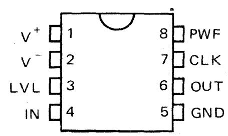
C SUFFIX
CERAMIC PACKAGE

Hi-REL versions available - See Chapter 14

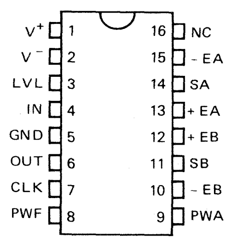
BLOCK DIAGRAM



PIN ASSIGNMENTS



8 pins: FILTER ONLY



16 pins: FILTER+2 OP-AMPs

Ref. 00640-R1

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THOMSON COMPONENTS

NOTES

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.

High reliability ICs

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J-FET INPUT DUAL OP-AMPs 936
J-FET INPUT QUAD OP-AMPs 936

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DUAL COMPARATORS 937
QUAD COMPARATORS 937

THREE-TERMINAL FIXED VOLTAGE REGULATORS 938
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MULTI-TERMINAL VOLTAGE REGULATORS 939

MISCELLANEOUS ICs 940

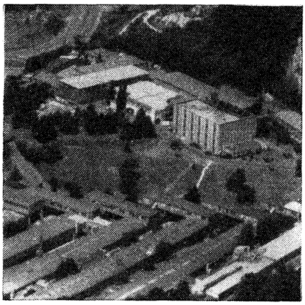
14

MILITARY AND SPACE PROGRAM

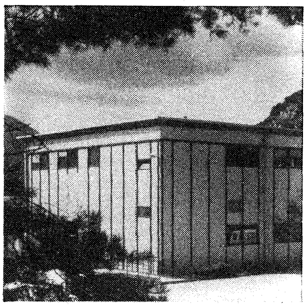
To meet increasing worldwide demand for high-quality high-reliability semiconductors, THOMSON SEMICONDUCTORS has created a Military and Space Division specialized in these products.

The division is wholly responsible for strategy, design and manufacture of semiconductor products for military and space applications, and has the expertise and the resources to satisfy the most demanding requirements:

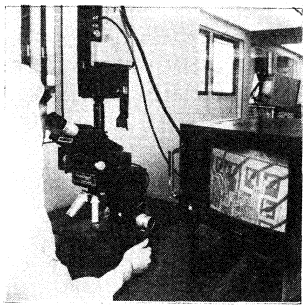
- a 3,000 m^2 plant exclusively assigned to the design and manufacture of military and space products,
- equipment carefully selected to guarantee the highest possible standards in terms of quality,
- staff fully trained in the strictest possible quality assurance and reliability procedures,
- large known-bow based on active participation in outstanding programs including ARIANE, AIRBUS, MIRAGE 2000, METEOSAT, etc.



THOMSON SEMICONDUCTORS Military and Space Division is located at the company's and manufacturing facility in Grenoble.



3,000 m^2 Military and Space Division plant on the St Egreve complex.



The most sophisticated quality control and reliability methods and resources are employed by expert staff who ensure that quality assurance procedures are strictly complied with.

SEMICONDUCTORS FOR A VARIED RANGE OF PRESTIGE PROGRAMS

THOMSON SEMICONDUCTORS has been involved in components development for weapons and avionics systems, space vehicles and ballistic missiles for nearly 20 years. A selection of examples is listed below:

Military

- RITA telecommunication network
- EXOCET missile
- CROTALE missile
- SHAHINE missile

Civil and military aviation

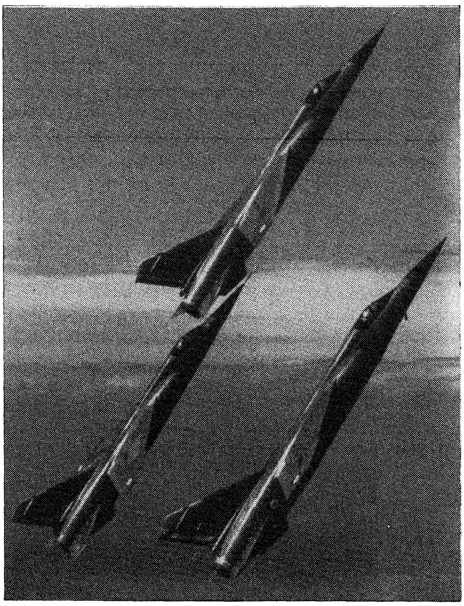
- AIRBUS aircraft
- MIRAGE 2000 air-fighter
- Airport guidance systems

Space

- ARIANE launch vehicle
- METEOSAT satellite
- TV-SAT satellite

Other

- TGV (High-speed inter-urbain transport)



QUALITY CONTROL: a tailored service

The market for high-reliability components is characterized by its highly individual requirements, with which THOMSON SEMICONDUCTORS is more than able to cope:

● By offering quality levels compatible with the leading international standards:

— MIL-STD-883/class B,
— ESA/SCC 9000, classes B and C, LA1, 2 and 3,
— CECC 90000, selection classes B or D and quality assurance level Y,
— NFC 96883, selection classes B, G or D,
— NFC 96020, Quality Assessment Standard, level Y.

● By ensuring that its semiconductor products appear on as many Preferential Product Lists (GAMT1, MUAHAG, etc.) and Qualified Product Lists as possible.

● By deploying the most advanced technology: in the ongoing search for improved performance (speed, power consumption, integration, immunity to radiation, etc.), military equipment design demands the use of the most modern technologies. These technologies are deployed by THOMSON SEMICONDUCTORS in respect of its standard products as well as its custom activities:

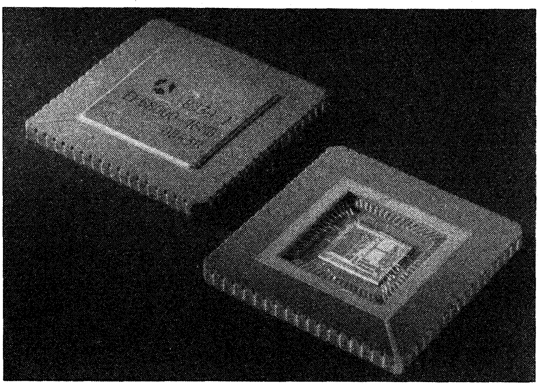
Processes

— HMOS1 (3μ) and HMOS2 (2μ),
— HCMOS (2μ) double-layer,
— HCMOS/SOS,
— High-speed linear bipolar (4 GHz),
— High-speed digital bipolar (ECL): HBIP2 (2μ).

Encapsulation technologies

— Metal can (linear),
— Cerdip,
— Ceramic,
— Chip-carrier,
— Pin grid array,
— Dice (for hybrids).

● By providing a tailor-made service: special requirements in respect of quality, product life and quantities are a characteristic feature of this market sector. In all these areas, THOMSON SEMICONDUCTORS offers the optimum cost/performance trade-off for the problem in hand.



FIVE SELECTION LEVELS

The THOMSON SEMICONDUCTORS Military and Space Division offers five selection classes compatible with international standards. For a more complete explanation of each class refer to the "Quality Information" section of this data book. The essential features of each class are outlined below:

Level S:

Space applications: the methods applied conform to specification ESA/SCC 9000/classes B and C, LAT1, 2 and 3.

Level B/B and G/B:

Class B/B conforms strictly to MIL-STD-883/class B.
The classes are schematically represented in the flowchart (next page), illustrating the differences between them. The selection methods for classes B/B and G/B are those of MIL-STD-883, class B, which are in turn identical to those of standards NFC 96883/class B and CECC 90,000/class B.

Level G/B, offered by very few manufacturers, is an alternative particularly appreciated by users for its quality/price trade-off.

Levels D and Standard:

In the "Standard" class, the Military and Space Division offers a range of products in ceramic, cerdip and metal packages, for operation in the following temperature ranges:

- Extended: −40°C to +85°C,
- Military: −55°C to +125°C.

The **"D"** level is the standard level with additional burn-in only.

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B/B AND G/B CLASS QUALITY ASSURANCE AND SCREENING PROCEDURES

B/B specifications	Step	G/B specifications
	WAFER ELECTRICAL TEST (100%)	
MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)	**VISUAL INPECTION AFTER DIE SEPARATION** (100%)	Internal norm (*)
Internal norms (*)	**PACKAGE VISUAL INSPECTION AFTER CLEANING** (Sampling by lot)	Internal norms (*)
Sampling by lot MIL-STD-883/Method 2019	**DIE ATTACH TEST**	2 sampling by shift MIL-STD-883/Method 2019
100% Internal norms (*)	**VISUAL INSPECTION AFTER WIRE BONDING** (100%)	2 sampling by shift Internal norms (*)
Sampling by lot MIL-STD-883/Method 2011	**WIRE BONDING STRENGTH TEST**	1 sampling by lot MIL-STD-883/Method 2011
MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)	**PRECAP INTERNAL VISUAL INSPECTION** (100%)	MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)
Internal norm (*)	**VISUAL INSPECTION OF INCOMING PARTS BEFORE SEALING** (Sampling by lot)	Internal norm (*)
Internal norm to meet MIL-STD-883/Method 5004	**SEALING**	Internal norm to meet MIL-STD-883/Method 5004
MIL-STD-883/Method 1008 (NFC 20602)	**STABILIZATION BAKE AFTER ENCAPSULATION** (100% - 24 H +150°C)	MIL-STD-883/Method 1008 (NFC 20602)
100% - 10 cycles −65°C, +150°C MIL-STD-883/Method 1010 (NFC 20605)	**TEMPERATURE CYCLING**	100% - 10 cycles −65°C, +150°C MIL-STD-883/Method 1010 (NFC 20605)
100% - 30,000 g Where applicable (**) MIL-STD-883/Method 2001 (NFC 20623)	**B/B: CONSTANT ACCELERATION** / **G/B: NONE**	

See next page

(*) Not specified in MIL-STD-883: THOMSON SEMICONDUCTORS norms.
(**) For TO-3 and large DIL: contact manufacturing.

B/B and G/B SCREENINGS(continued)

B/B specifications	Screening step	G/B specifications
MIL-STD-883/Method 1014 (NFC 20631)	**SEAL TEST GROSS/FINE LEAKS** (100%) 5×10^{-8} atm/cm^3/sec)	MIL-STD-883/Method 1014 (NFC 20631)
MIL-STD-883/Method 2015 (NFC 20627)	**INSPECTION AFTER MARKING** (Sampling by lot)	MIL-STD-883/Method 2015 (NFC 20627)
Device specifications	**25°C PRE BURN-IN ELECTRICAL TEST** (100%)	Device specifications
MIL-STD-883/Method 1015 (NFC 96883-E503)	**BURN-IN** (100% - 168 H - 125°C)	MIL-STD-883/Method 1015 (NFC 96883-E503)
PDA = 5% Device specifications (NFC 96883-P502)	**B/B: FINAL ELECTRICAL TEST AT 25°C AND HIGH/LOW TEMP.** (100%) — **G/B: FINAL ELECTRICAL TEST AT 25°C CORRELATION FOR HIGH/LOW TEMP.** (100%)	PDA = 5% Device specifications (NFC 96883-P502)
MIL-STD-883/Method 5005: (***) see page 952 (NFC 96020): see page 953	**QUALITY CONFORMANCE INSPECTION**	MIL-STD-883/Method 5005: (** see page 952 (NFC 96020): see page 953
MIL-STD-883 Conformity certificate test results (NFC 96883)	**DATA REPORT**	MIL-STD-883 Compliance certificate indicating value of PD (NFC 96883)
MIL-STD-883/Method 2009 (NFC 96883)	**PACKING CONTROL BEFORE SHIPPING** (100%)	MIL-STD-883/Method 2009 (NFC 96883)

(***) On customer requests selection between AQL (NFC 96883) and LTPD (MIL-STD-883/Method 5005) will be sent.

THE RESOURCES TO ENSURE RIGOROUS QUALITY CONTROL

The strictest possible quality control at all levels of the manufacturing process offers the user the best guarantee of reliability.

Wafer processing

The diffusion workshops are covered by extremely rigorous specifications in respect of cleanliness and the precision with which the various operations are carried out. Production is continuously sampled for the purpose of reliability testing. The most stringent requirements are imposed to wafers intended for military and space applications.

Assembly

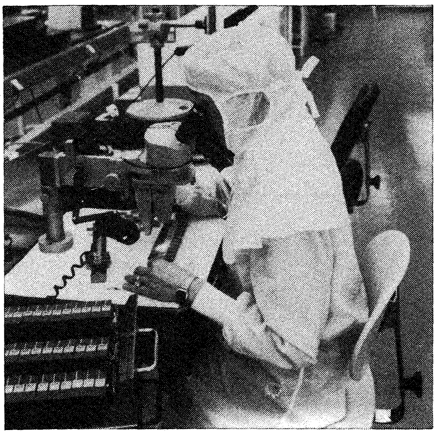
Assembly is carried out in a clean room environment by highly skilled staff using the most sophisticated automated equipment. There are a number of possible test and inspection levels:

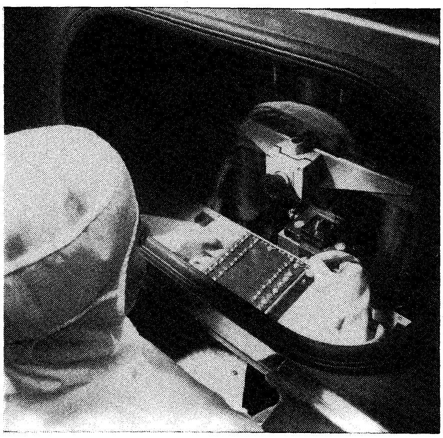
- 100% visual inspection (PRECAP),
- Wire bonding test,
- Die attach test,
- Stabilization bake,
- Temperature cycling,
- Constant acceleration,
- Particle impact noise detection test (Pind-test),
- Seal test.

Quality assurance and selection

Electrical tests are performed on 100% of devices after selection operations. Apart from sorting parts, this test is used to determine the proportion of circuits defective after burn-in . Application of the 5% PDA procedure enables the entire production to be rejected where lots show a potential for failures after shipping considered excessive.

Following the selection operations, the Quality Assurance staff applies standardized quality monitoring procedures in accordance with standard CECC 90,000, level Y.





SINGLE BIPOLAR OP-AMPs (Internal compensation)

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufac-turing status	Page
UA741MH-D	General purpose	TO-99 Metal can				●	Contact our sales offices		★	271
UA741MHG/B					●				★	
UA741MHB/B			●	●					★	
UA741MDG-D		Cerdip DIL 8				●			★	271
UA741MDGG/B					●				★	
UA741MDGB/B			●	●					★ ★ ★	
UA776MH-D	Programmable	TO-99 Metal can				●			★	287
UA776MHG/B					●				★	
UA776MHB/B			●	●					★ ★	
UA776MDG-D		Cerdip DIL 8				●			★ ★	287
UA776MDGG/B					●				★ ★	
UA776MDGB/B			●	●					★ ★ ★	
UA776MGC-D		20-pad LCC				●			★	287
UA776MGCG/B					●				★	
UA776MGCB/B			●	●					★ ★	
LM118H-D	High speed - Wide band	TO-99 Metal can				●			★	87
LM118HG/B					●				★	
LM118HB/B			●	●					★	
LM118H (ESA)								●	★	
LM118DG-D		Cerdip DIL 8				●			★ ★	87
LM118DGG/B					●				★ ★	
LM118DGB/B			●	●					★ ★ ★	
LM118GC-D		20-pad LCC				●			★	87
LM118GCG/B					●				★	
LM118GCB/B			●	●					★ ★	
LM11H-D	Very high accuracy	TO-99 Metal can				●			★ ★	49
LM11HG/B					●				★ ★	
LM11HB/B			●	●					★ ★	
LM11DG-D		Cerdip DIL 8				●			★ ★	49
LM11DGG/B					●				★ ★	
LM11DGB/B			●	●					★ ★ ★	

★ Available

★ ★ To be introduced

★ ★ ★ Contact our sales offices

SINGLE BIPOLAR OP-AMPs (External compensation)

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
UA748MH-D	General purpose	TO-99 Metal can				●	Contact our sales offices		★	279
UA748MHG/B					●				★	
UA748MHB/B			●	●					★★★	
UA748MDG-D		Cerdip DIL 8				●			★	279
UA748MDGG/B					●				★	
UA748MDGB/B			●	●					★★★	
TAA762MH-D	Open collector	TO-107 6-lead Metal can				●			★	165
TAA762MHG/B					●				★	
TAA762MHB/B			●	●					★★★	
LM101AH-D	Low offset	TO-99 Metal can				●			★	63
LM101AHG/B					●				★	
LM101AHB/B			●	●					★	
LM101AH (ESA)								●	★	
LM101ADG-D		Cerdip DIL 8				●			★	63
LM101ADGG/B					●				★★	
LM101ADGB/B			●	●					★★★	
LM101AGC-D		20-pad LCC				●			★★★	63
LM101AGCG/B					●				★★★	
LM101AGCB/B			●	●					★★★	
LM108H-D	High accuracy	TO-99 Metal can				●			★	73
LM108HG/B					●				★	
LM108HB/B			●	●					★	
LM108DG-D		Cerdip DIL 8				●			★★	73
LM108DGG/B					●				★★	
LM108DGB/B			●	●					★★★	
LM108GC-D		20-pad LCC				●			★★★	73
LM108GCG/B					●				★★★	
LM108GCB/B			●	●					★★★	
LM108AH-D	Very high accuracy	TO-99 Metal can				●			★	73
LM108AHG/B					●				★	
LM108AHB/B			●	●					★	
LM108AH (ESA)								●	★	
LM108ADG-D		Cerdip DIL 8				●			★★	73
LM108ADGG/B					●				★★	
LM108ADGB/B			●	●					★★★	
LM108AGC-D		20-pad LCC				●			★	73
LM108AGCG/B					●				★	
LM108AGCB/B			●	●					★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

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DUAL BIPOLAR OP-AMPs

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LM158H-D	Low supply current	TO-99 Metal can				●	Contact our sales offices		★	131
LM158HG/B					●				★	
LM158HB/B			●	●					★	
LM158DG-D		Cerdip DIL 8				●			★	131
LM158DGG/B					●				★★	
LM158DGB/B			●	●					★★★	
LM1558H-D	General purpose	TO-99 Metal can				●			★	143
LM1558HG/B					●				★	
LM1558HB/B			●	●					★★	
LM1558DG-D		Cerdip DIL 8				●			★	143
LM1558DGG/B					●				★★	
LM1558DGB/B			●	●					★★★	
MC4558MH-D	Wide band	TO-99 Metal can				●			★	159
MC4558MHG/B					●				★	
MC4558MHB/B			●	●					★★	
MC4558MDG-D		Cerdip DIL 8				●			★★	159
MC4558MDGG/B					●				★★	
MC4558MDGB/B			●	●					★★★	
TEC1033DG-D	General purpose	Cerdip DIL 8				●			★★	189
TEC1033DGG/B					●				★★	
TEC1033DGB/B			●	●					★★★	
TEC1033GC-D		20-pad LCC				●			★	189
TEC1033GCG/B					●				★	
TEC1033GCB/B			●	●					★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

QUAD BIPOLAR OP-AMPs

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LM124DG-D	Low supply current	Cerdip DIL 14				●	Contact our sales offices		★	99
LM124DGG/B					●				★	
LM124DGB/B			●	●					★★★	
LM124DC-D		Ceramic DIL 14				●			★	99
LM124DCG/B					●				★	
LM124DCB/B			●	●					★	
LM124DC (ESA)								●	★★★	
LM146DG-D	Programmable	Cerdip DIL 14				●			★	111
LM146DGG/B					●				★	
LM146DGB/B			●	●					★★★	
LM148DC-D	General purpose	Ceramic DIL 14				●			★	123
LM148DCG/B					●				★	
LM148DCB/B			●	●					★	
LM148DG-D		Cerdip DIL 14				●			★	123
LM148DGG/B					●				★	
LM148DGB/B			●	●					★★★	
LM148GC-D		20-pad LCC				●			★★★	123
LM148GCG/B					●				★★★	
LM148GCB/B			●	●					★★★	
TEC4033DG-D	General purpose	Cerdip DIL 14				●			★★	*
TEC4033DGG/B					●				★★	
TEC4033DGB/B			●	●					★★★	
TEC4033GC-D		20-pad LCC				●			★★★	*
TEC4033GCG/B					●				★★★	
TEC4033GCB/B			●	●					★★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

* Available as separate data sheet

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J-FET INPUT SINGLE OP-AMPs

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufac-turing status	Page
LF155DG-D	Low supply current	Cerdip DIL 8				●	Contact our sales offices		★★	35
LF155DGG/B					●				★★	
LF155DGB/B			●	●					★★★	
LF155H-D		TO-99 Metal can				●			★	35
LF155HG/B					●				★	
LF155HB/B			●	●					★	
LF155H (ESA)								●	★★★	
LF155ADG-D	Low supply current low drift	Cerdip DIL 8				●			★★	35
LF155ADGG/B					●				★★	
LF155ADGB/B			●	●					★★★	
LF155AH-D		TO-99 Metal can				●			★	35
LF155AHG/B					●				★	
LF155AHB/B			●	●					★	
LF155AH (ESA)								●	★★★	
LF156DG-D	High slew rate	Cerdip DIL 8				●			★★	35
LF156DGG/B					●				★★	
LF156DGB/B			●	●					★★★	
LF156H-D		TO-99 Metal can				●			★	35
LF156HG/B					●				★	
LF156HB/B			●	●					★	
LF156H (ESA)								●	★★★	
LF156ADG-D	High slew rate low drift	Cerdip DIL 8				●			★★	35
LF156ADGG/B					●				★★	
LF156ADGB/B			●	●					★★★	
LF156AH-D		TO-99 Metal can				●			★	35
LF156AHG/B					●				★	
LF156AHB/B			●	●					★	
LF156AH (ESA)								●	★★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

J-FET INPUT SINGLE OP-AMPs

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LF157DG-D	Wide band	Cerdip DIL 8				●	Contact our sales offices		★★	35
LF157DGG/B					●				★★	
LF157DGB/B			●	●					★★★	
LF157H-D		TO-99 Metal can				●			★	35
LF157HG/B					●				★	
LF157HB/B			●	●					★	
LF157ADG-D	Wide band, low drift	Cerdip DIL 8				●			★★	35
LF157ADGG/B					●				★★	
LF157ADGB/B			●	●					★★★	
LF157AH-D		TO-99 Metal can				●			★	35
LF157AHG/B					●				★	
LF157AHB/B			●	●					★	
TL061MH-D	Low supply current	TO-99 Metal can				●			★★	193
TL061MHG/B					●				★★	
TL061MHB/B			●	●					★★	
TL061MDG-D		Cerdip DIL 8				●			★★	193
TL061MDGG/B					●				★★	
TL061MDGB/B			●	●					★★★	
TL071MH-D	Low noise	TO-99 Metal can				●			★★	217
TL071MHG/B					●				★★	
TL071MHB/B			●	●					★★	
TL071MDG-D		Cerdip DIL 8				●			★★	217
TL071MDGG/B					●				★★	
TL071MDGB/B			●	●					★★★	
TL081MH-D	High slew rate	TO-99 Metal can				●			★★	243
TL081MHG/B					●				★★	
TL081MHB/B			●	●					★★	
TL081MDG-D		Cerdip DIL 8				●			★★	243
TL081MDGG/B					●				★★	
TL081MDGB/B			●	●					★★★	

★ Available
★★ To be introduced
★★★ Contact our sales offices

14

J-FET INPUT DUAL OP-AMPs

Part number	Characteristic	Package	MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
TL062MH-D	Low supply current	TO-99 Metal can				●	Contact our sales offices		★★	201
TL062MHG/B					●				★★	
TL062MHB/B			●	●					★★	
TL062MDG-D		Cerdip DIL 8				●			★★	201
TL062MDGG/B					●				★★	
TL062MDGB/B			●	●					★★★	
TL072MH-D	Low noise	TO-99 Metal can				●			★★	225
TL072MHG/B					●				★★	
TL072MHB/B			●	●					★★	
TL072MDG-D		Cerdip DIL 8				●			★★	225
TL072MDGG/B					●				★★	
TL072MDGB/B			●	●					★★★	
TL082MH-D	High slew rate	TO-99 Metal can				●			★★	251
TL082MHG/B					●				★★	
TL082MHB/B			●	●					★★	
TL082MDG-D		Cerdip DIL 8				●			★★	251
TL082MDGG/B					●				★★	
TL082MDGB/B			●	●					★★★	

J-FET INPUT QUAD OP-AMPs

Part number	Characteristic	Package	MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
TL064MDG-D	Low voltage supply	Cerdip DIL 14				●	Contact our sales offices		★★	209
TL064MDGG/B					●				★★	
TL064MDGB/B			●	●					★★★	
TL064MDC-D		Ceramic DIL 14				●			★★	209
TL064MDCG/B					●				★★	
TL064MDCB/B			●	●					★★	
TL074MDG-D	Low noise	Cerdip DIL 14				●			★★	233
TL074MDGG/B					●				★★	
TL074MDGB/B			●	●					★★★	
TL084MDG-D	High slew rate	Cerdip DIL 14				●			★	261
TL084MDGG/B					●				★	
TL084MDGB/B			●	●					★★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

SINGLE COMPARATORS

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufac-turing status	Page
LM111H-D	General purpose	TO-99 Metal can				●	Contact our sales offices		★	303
LM111HG/B					●				★	
LM111HB/B			●	●					★	
LM111 (ESA)								●	★ ★ ★	
LM111DG-D		Cerdip DIL 8				●			★ ★	303
LM111DGG/B					●				★ ★	
LM111DGB/B			●	●					★ ★ ★	

DUAL COMPARATORS

Part number	Characteristic	Package	MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufac-turing status	Page
LM119H-D	High speed	TO-100 Metal can				●	Contact our sales offices		★	311
LM119HG/B					●				★	
LM119HB/B			●	●					★ ★	
LM119DG-D		Cerdip DIL 14				●			★	311
LM119DGG/B					●				★	
LM119DGB/B			●	●					★ ★ ★	
LM193H-D	Low supply current Low offset	TO-99 Metal can				●			★	329
LM193HG/B					●				★	
LM193HB/B			●	●					★	

QUAD COMPARATORS

Part number	Characteristic	Package	MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufac-turing status	Page
LM139DG-D	Low supply current Low offset	Cerdip DIL 14				●	Contact our sales offices		★	319
LM319DGG/B					●				★	
LM319DGB/B			●	●					★ ★ ★	
LM139ADG-D		Cerdip DIL 14				●			★	319
LM139ADGG/B					●				★	
LM139ADGB/B			●	●					★ ★ ★	
LM139DC-D		Ceramic DIL 14				●			★	319
LM139DCG/B					●				★	
LM139DCB/B			●	●					★	
LM139DC (ESA)								●	★ ★ ★	

★ Available

★ ★ To be introduced

★ ★ ★ Contact our sales offices

THREE-TERMINAL FIXED VOLTAGE REGULATORS

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LM109H-D	+5 V/0.2 A	TO-39 Metal can				●	Contact our sales offices		★	357
LM109HG/B					●				★	
LM109HB/B			●	●					★	
LM109K-D	+5 V/1 A	TO-3 Metal can				●			★	357
LM109KG/B					●				★	
LM109KB/B			●	●					★	
LM123K-D	+5 V/3 A	TO-3 Metal can				●			★	375
LM123KG/B					●				★	
LM123KB/B			●	●					★★	
UA7805MK-D	+5 V/1.5 A	TO-3 Metal can				●			★	435
UA7805MKG/B					●				★	
UA7805MKB/B			●	●					★	
UA7808MK-D	+8 V/1.5 A	TO-3 Metal can				●			★	435
UA7808MKG/B					●				★	
UA7808MKB/B			●	●					★★★	
UA7812MK-D	+12 V/1.5 A	TO-3 Metal can				●			★	435
UA7812MKG/B					●				★	
UA7812MKB/B			●	●					★★	
UA7815MK-D	+15 V/1.5 A	TO-3 Metal can				●			★	435
UA7815MKG/B					●				★	
UA7815MKB/B			●	●					★	
UA7824MK-D	+24 V/1.5 A	TO-3 Metal can				●			★	435
UA7824MKG/B					●				★	
UA7824MKB/B			●	●					★★	
UA7905MK-D	−5 V/1.5 A	TO-3 Metal can				●			★	455
UA7905MKG/B					●				★	
UA7905MKB/B			●	●					★	
UA7912MK-D	−12 V/1.5 A	TO-3 Metal can				●			★	455
UA7912MKG/B					●				★	
UA7912MKB/B			●	●					★★	
UA7915MK-D	−15V/1.5 A	TO-3 Metal can				●			★	455
UA7915MKG/B					●				★	
UA7915MKB/B			●	●					★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

THREE-TERMINAL ADJUSTABLE VOLTAGE REGULATORS

Part number	Characteristic	Package	Processed or qualified according to: MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LM117H-D	+1.2 to +37 V/0.5 A	TO-39 Metal can				●	Contact our sales offices		★	365
LM117HG/B					●				★	
LM117HB/B			●	●					★	
LM117H (ESA)								●	★★★	
LM117K-D	+1.2 to +37 V/1.5 A	TO-3 Metal can				●			★	365
LM117KG/B					●				★	
LM117KB/B			●	●					★	
LM117K (ESA)								●	★★★	
LM137H-D	−1.2 to −37 V/0.5 A	TO-39 Metal can				●			★	383
LM137HG/B					●				★	
LM137HB/B			●	●					★	
LM137H (ESA)								●	★★★	
LM137K-D	−1.2 to −37 V/1.5 A	TO-3 Metal can				●			★	383
LM137KG/B					●				★	
LM137KB/B			●	●					★	
LM137K (ESA)								●	★★★	
LM138K-D	+1.2 to +32 V/5 A	TO-3 Metal can				●			★★★	393
LM138KG/B					●				★★★	
LM138KB/B			●	●					★★★	

MULTI-TERMINAL VOLTAGE REGULATORS

Part number	Characteristic	Package	MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000	Manufacturing status	Page
LM105H-D	Programmable: +4.5 V, +40 V/25 mA	TO-99 Metal can				●	Contact our sales offices		★	349
LM105HG/B					●				★	
LM105HB/B			●	●					★	
LM105 (ESA)								●	★★★	
UA723MH-D	Programmable: +2 V, +37 V/150 mA	TO-100 Metal can				●			★	421
UA723MHG/B					●				★	
UA723MHB/B			●	●					★	
UA723MDG-D		Cerdip DIL 14				●			★	421
UA723MDGG/B					●				★	
UA723MDGB/B			●	●					★★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

MISCELLANEOUS

Part number	Characteristic	Package	Processed or qualified according to:						Manufacturing status	Page
			MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000		
LM131H-D	V/F and F/V converter	TO-99 Metal can				●	Contact our sales offices		★★	*
LM131HG/B					●				★★★	
LM131HB/B			●	●					★★★	
LF198H-D	J-FET sample and hold circuit	TO-99 Metal can				●			★	667
LF198HG/B					●				★	
LF198HB/B			●	●					★	
SE555MH-G	Single timer circuit	TO-99 Metal can				●			★	707
SE555MHG/B					●				★	
SE555MHB/B			●	●					★★	
SE555MDG-D		Cerdip DIL 8				●			★★	707
SE555MDGG/B					●				★★	
SE555MDGB/B			●	●					★★★	
SE556MDG-D	Dual timer circuit	Cerdip DIL 14				●			★	715
SE556MDGG/B					●				★	
SE556MDGB/B			●	●					★★★	
UAC1005DC-D	High speed A/D converter 4 bit - 30 MHz compatible MPU	Ceramic DIL 14				●			★★★	749
UAC1005DCG/B					●				★★★	
UAC1005DCB/B			●	●					★★★	
TS8306MC-D	6-bit video speed flash A/D converter	Ceramic DIL 24				●			★★	733
TS8306MCG/B					●				★★	
TS8306MCB/B			●	●					★★★	
TS8308MC-D	8-bit video speed flash A/D converter	Ceramic DIL 24				●			★★	739
TS8308MCG/B					●				★★	
TS8308MCB/B			●	●					★★★	
TS8408MC-D	8-bit video speed voltage output D/A converter	Ceramic DIL 16				●			★★	743
TS8408MCG/B					●				★★	
TS8408MCB/B			●	●					★★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

* Available as separate data sheet

MISCELLANEOUS

Part number	Characteristic	Package	Processed or qualified according to:						Manufac-turing status	Page
			MIL-STD-883 level B	NFC 96883 level B	NFC 96883 level G	NFC 96883 level D	CECC 90000	ESA/SCC 9000		
TS8510MC-D	Low pass - 5th order Cauer	Ceramic DIL 16				●	Contact our sales offices		★★	747
TS8510MCG/B					●				★★	
TS8510MCB/B			●	●					★★	
TS8511MC-D	Low pass - 7th order Cauer	Ceramic DIL 16				●			★★	747
TS8511MCG/B					●				★★	
TS8511MCB/B			●	●					★★	
TS8512MC-D		Ceramic DIL 16				●			★★	747
TS8512MCG/B					●				★★	
TS8512MCB/B			●	●					★★	
TS8513MC-D	Low pass 8th order Tchebychev	Ceramic DIL 16				●			★★	747
TS8513MCG/B					●				★★	
TS8513MCB/B			●	●					★★	
TS8514MC-D	Low pass 8th oder Butterworth	Ceramic DIL 16				●			★★	747
TS8514MCG/B					●				★★	
TS8514MCB/B			●	●					★★	
TS8530MC-D	High pass - 3rd order Cauer	Ceramic DIL 16				●			★★	747
TS8530MCG/B					●				★★	
TS8530MCB/B			●	●					★★	
TS8531MC-D	High pass - 5th order Cauer	Ceramic DIL 16				●			★★	747
TS8531MCG/B					●				★★	
TS8531MCB/B			●	●					★★	
TS8532MC-D	High pass 5th order Tchebychev	Ceramic DIL 16				●			★★	747
TS8532MCG/B					●				★★	
TS8532MCB/B			●	●					★★	
TS8550MC-D	Band pass 8th order Tchebychev	Ceramic DIL 16				●			★★	747
TS8550MCG/B					●				★★	
TS8550MCB/B			●	●					★★	

★ Available

★★ To be introduced

★★★ Contact our sales offices

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Quality information

SCREENING CLASSES

Different screening classes are available from THOMSON SEMICONDUCTORS for customers desirous to use a same product in different environmental conditions. Consequently, screening classes choice is the customer's responsibility.
Screening classes for packaged circuits, and quality levels for dice are indicated below.

PACKAGED PRODUCTS

S space screening class:
In accordance with ESA/SCC 9000, B or C class with LA1, LA2 or LA3 on customer's resquest.

B/B screening class:
Strictly equivalent to the US MIL-STD-883 class B (or French NFC 96883/class B or European CECC 9000/class B). This is suitable for products used in severe environmental conditions and when low maintenance cost is required.

G/B screening class:
Same as B/B but:

- No constant acceleration test,
- Full range temperature test through +25°C correlated measurement.

Only available with THOMSON SEMICONDUCTORS, this screening class, which refers to the MIL-STD-883, is a cost effective alternative for customers wishing to buy HI-REL devices at lower cost. This screening is strictly conform to the French NFC 96883/class G.

D SCREENING CLASS:
In accordance with French NFC 96883/class D (and European CECC 9000/class D), this level corresponds to "standard screening" products submitted only to an additional burn-in.

STANDARD QUALITY CLASS:
Guaranteed level when no specific screening class is required by the customer.

S space screening

Specifications class B		Specifications class C
Internal norm (*) ESA/SCC 21400	**WAFER LOT ACCEPTANCE** (100%)	Internal norm (*)
Internal norm (*)	**WAFER ELECTRICAL TEST** (100%)	Internal norm (*)
MIL-STD-883/Method 2010 Cond. A	**VISUAL INSPECTION AFTER DIE SEPARATION** (100%)	MIL-STD-883/Method 2010 Cond. B
Internal norm (*)	**VISUAL INSPECTION OF PACKAGE AFTER CLEANING** (100%)	Internal norm (*)
MIL-STD-883/Method 2019	**DIE ATTACH TEST** (SAMPLING BY SHIFT & LOT)	MIL-STD-883/Method 2019
Internal norm (*)	**VISUAL INPECTION AFTER WIRE BONDING** (100%)	Internal norm (*)
MIL-STD-883/Method 2011	**WIRE BONDING STRENGTH TEST** (SAMPLING BY SHIFT & LOT)	MIL-STD-883/Method 2011
MIL-STD-883/Method 2010 Cond. A	**PRECAP INTERNAL VISUAL INSPECTION** (100%)	MIL-STD-883/Method 2010 Cond. B
Internal norm (*)	**VISUAL INSPECTION OF INCOMING PARTS BEFORE SEALING** (100%)	Internal norm (*)
MIL-STD-883/Method 1008	**STABILIZATION BAKE AFTER ENCAPSULATION** (100% - 48 H - 150°C)	MIL-STD-883/Method 1008
MIL-STD-883/Method 1010	**TEMPERATURE CYCLING** (100% - 10 cycles −65°C ; +150°C)	MIL-STD-883/Method 1010

See next page

(*) Not specified in ESA/SCC 9000: THOMSON SEMICONDUCTORS norms

S space screening (continued)

MIL-STD-883/Method 2001	**CONSTANT ACCELERATION** (100% - 30000 G - WHERE APPROPRIATE)	MIL-STD-883/Method 2001
MIL-STD-883/Method 2020	**PIND TEST** (100% - COND. A - WHEN APPLICABLE	MIL-STD-883/Method 2020
MIL-STD-883/Method 1014	**SEALING TEST** (FINE & GROSS LEAK) (100% - 5×10^{-8} atm/cm³/sec)	MIL-STD-883/Method 1014
DEVICE SPECIFICATIONS	**ELECTRICAL MEASUREMENT AT 25°C AND LOW/HIGH (OPTIONAL)** 100%	DEVICE SPECIFICATIONS
YES (serial.) MIL-STD-883/Method 2015	**SERIALIZATION INSPECTION AFTER MARKING** (SAMPLING BY LOT)	NO (serial.) MIL-STD-883/Method 2015
DEVICE SPECIFICATION	**PRE BURN-IN ELECTRICAL TEST AT 25°C** (100%)	SKIPED STEP
MIL-STD-883/Method 1015 240 H - +125°C	**BURN-IN** (100%)	MIL-STD-883/Method 1015 168 H - +125°C
DEVICE SPECIFICATION	**POST BURN-IN ELECTRICAL TEST AT 25°C WITH DELTAS** (100%)	SKIPED TEST
MIL-STD-883/Method 1014	**SEALING TEST (FINE & GROSS LEAK)** (100% - 5×10^{-8} atm/cm³/sec)	MIL-STD-883/Method 1014
DEVICE SPECIFICATION	**FINAL ELECTRICAL TEST AT 25°C** (100%)	DEVICE SPECIFICATION
DEVICE SPECIFICATION	**FINAL ELECTRICAL TEST HIGH & LOW TEMPERATURE** (100%)	DEVICE SPECIFICATION
< 10%	**PERCENT DEFECTIVE ALLOWABLE**	< 10%
ESA/SCC 20500	**EXTERNAL VISUAL INSPECTION**	ESA/SCC 20500
CERTIF. OF COMPLIANCE TESTS & MEASUREMENT RESULTS DATA LOGGED VALUES	**QUALITY CONFORM INSPECTION DATA REPORT**	CERTIF. OF COMPLIANCE TESTS & MEASUREMENT PASS/FAILED RESULTS
MIL-STD-883/Method 2009	**PACKING CONTROL BEFORE SHIPMENT** (100%)	MIL-STD-883/Method 2009

B/B AND G/B CLASS QUALITY ASSURANCE AND SCREENING PROCEDURES

B/B specifications	Procedure	G/B specifications
	WAFER ELECTRICAL TEST (100%)	
MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)	**VISUAL INPECTION AFTER DIE SEPARATION** (100%)	Internal norm (*)
Internal norms (*)	**PACKAGE VISUAL INSPECTION AFTER CLEANING** (Sampling by lot)	Internal norms (*)
Sampling by lot MIL-STD-883/Method 2019	**DIE ATTACH TEST**	2 sampling by shift MIL-STD-883/Method 2019
100% Internal norms (*)	**VISUAL INSPECTION AFTER WIRE BONDING** (100%)	2 sampling by shift Internal norms (*)
Sampling by lot MIL-STD-883/Method 2011	**WIRE BONDING STRENGTH TEST**	1 sampling by lot MIL-STD-883/Method 2011
MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)	**PRECAP INTERNAL VISUAL INSPECTION** (100%)	MIL-STD-883/Method 2010 Cond. B (NFC 96883-V501-Cond. B)
Internal norm (*)	**VISUAL INSPECTION OF INCOMING PARTS BEFORE SEALING** (Sampling by lot)	Internal norm (*)
Internal norm to meet MIL-STD-883/Method 5004	**SEALING**	Internal norm to meet MIL-STD-883/Method 5004
MIL-STD-883/Method 1008 (NFC 20602)	**STABILIZATION BAKE AFTER ENCAPSULATION** (100% - 24 H +150°C)	MIL-STD-883/Method 1008 (NFC 20602)
100% - 10 cycles −65°C, +150°C MIL-STD-883/Method 1010 (NFC 20605)	**TEMPERATURE CYCLING**	100% - 10 cycles −65°C, +150°C MIL-STD-883/Method 1010 (NFC 20605)
100% - 30,000 g Where applicable (**) MIL-STD-883/Method 2001 (NFC 20623)	**B/B: CONSTANT ACCELERATION** / **G/B: NONE**	

See next page

(*) Not specified in MIL-STD-883: THOMSON SEMICONDUCTORS norms.
(**) For TO-3 and large DIL: contact manufacturing.

B/B and G/B SCREENINGS (continued)

B/B specifications	Screening step	G/B specifications
MIL-STD-883/Method 1014 (NFC 20631)	**SEAL TEST GROSS/FINE LEAKS** (100%) 5×10^{-8} atm/cm^3/sec)	MIL-STD-883/Method 1014 (NFC 20631)
MIL-STD-883/Method 2015 (NFC 20627)	**INSPECTION AFTER MARKING** (Sampling by lot)	MIL-STD-883/Method 2015 (NFC 20627)
Device specifications	**25°C PRE BURN-IN ELECTRICAL TEST** (100%)	Device specifications
MIL-STD-883/Method 1015 (NFC 96883-E503)	**BURN-IN** (100% - 168 H - 125°C)	MIL-STD-883/Method 1015 (NFC 96883-E503)
PDA = 5% Device specifications (NFC 96883-P502)	**B/B: FINAL ELECTRICAL TEST AT 25°C AND HIGH/LOW TEMP.** (100%) — **G/B: FINAL ELECTRICAL TEST AT 25°C CORRELATION FOR HIGH/LOW TEMP.** (100%)	PDA = 5% Device specifications (NFC 96883-P502)
MIL-STD-883/Method 5005: (***) see page 952 (NFC 96020): see page 953	**QUALITY CONFORMANCE INSPECTION**	MIL-STD-883/Method 5005: (***) see page 952 (NFC 96020): see page 953
MIL-STD-883 Conformity certificate test results (NFC 96883)	**DATA REPORT**	MIL-STD-883 Compliance certificate indicating value of PD (NFC 96883)
MIL-STD-883/Method 2009 (NFC 96883)	**PACKING CONTROL BEFORE SHIPPING** (100%)	MIL-STD-883/Method 2009 (NFC 96883)

(***) On customer request selection between AQL (NFC 96883) and LTPD (MIL-STD-883/Method 5005) will be sent.

D and STANDARD SCREENINGS

	Specifications
DIE SEPARATION/CLEANING VISUAL INSPECTION (100%)	Internal norm (*)
PACKAGE INPECTION (by lot)	Internal norm (*)
DIE ATTACH (2 sampling by shift (1))	Internal norm (*)
BONDING WIRE INSPECTION (2 sampling by shift (1))	Internal norm (*)
WIRE BONDING BOND STRENGTH (2 sampling by shift (1))	Internal norm (*)
INTERNAL VISUAL INPECTION (100% + (2))	Internal norm (*)
INCOMING PARTS CLEANING 100% + (2)	Internal norm (*)
ENCAPSULATION STABILIZATION BAKE (100%)	Internal norm (*)
SEAL TEST (fine leak) (100%)	Internal norm (*)

See next page

D and STANDARD SCREENINGS (continued)

SEAL TEST (gross leak) (100%)	NFC 96883
MARKING (100%)	Internal norm
ELECTRICAL TEST AT 25°C (100%)	NFC 96883/P502 Device specification
"STANDARD" SCREENING STOPS HERE	
BURN-IN (100%)	168 H - 125°C NFC 96883/E503
POST BURN-IN ELECTRICAL TEST AT 25°C (100%)	NFC 96883/P502 Device specification
FINAL ELECTRICAL TEST	
QUALITY CONFORMANCE INPECTION	See page 954
DATA REPORT	NFC 96883
PACKING, CONTROL BEFORE SHIPPING (100%)	

(1) Minimum sample quantity by shift
(2) Lot sampling

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B/B QUALITY CONFORMANCE INSPECTION

GROUP A TESTS
(performed on each lot)

TESTS	DEVICES / CLASS / MIL-STD-883 Method	ANALOG B/B LEVEL MIL-STD-883 Method 5005 LTPD	Accept. number	LOGIC B/B LEVEL MIL-STD-883 Method 5005 LTPD	Accept. number
External visual inspection Marking conformance	2009	3	2	3	2
Mechanical inoperatives		3	1	3	1
Functional test at 25°C	Subgroups 4 and 7	2	0	2	0
Main static tests and complementary static tests at 25°C	Subgroup 1				
Functional and main static tests at maximum rated operating temperature	Subgroups 2, 5 and 8	3	1	3	1
Functional and main static tests at minimum rated operating temperature	Subgroups 3, 6 and 8	5	2	5	2
Switching tests at 25°C	Subgroup 9	2	0	2	0
Switching tests at maximum rated operating temperature	Subgroup 10	3	0	3	0
Switching tests at minimum rated operating temperature	Subgroup 11	5	0	5	0

GROUP B TESTS
(by lot or weekly by package type and by lead finish)
MIL-STD-883/Method 5005

Group B tests	Method	Quantity/(Accept. no.) or LTPD
Subgroup 1 (a) Physical dimensions	2016	2 devices (no failures)
Subgroup 2 (a) Resistance to solvents	2015	4 devices (no failures)
Subgroup 3 (a) Solderability	2003	15
Subgroup 4 (a) Internal visual and mechanical	2014	1 device (no failures)
Subgroup 5 (a) Bond strength	2011	15
Subgroup 6 (1) (a) Internal water-vapor content	1018	No test (Packages contain no dessicant)
Subgroup 7 (1) (a) Seal	1014	5
Subgroup 8 (a) Electrical parameters (b) Electrical discharge sensitivity classification (c) Electrical parameters	3015	No test (Performed for initial qualification and product redesign)

GROUP C TESTS
(Every 3 months)
MIL-STD-883/Method 5005

Group C tests	Method	Quantity/(Accept. no.) or LTPD
Subgroup 1 (a) Steady state life test (1000 H - 125°C) (b) End-point electrical parameters	1005	5
Subgroup 2 (a) Temperature cycling (b) Constant acceleration Y1 orientation (c) Seal (1) Fine (2) Gross (d) Visual examination (e) End-point electrical parameters	1010 2001 1014	15

GROUP D TESTS
(Every 6 months)
MIL-STD-883/Method 5005

Group D tests	Method	Quantity/(Accept. no.) or LTPD
Subgroup 1 (a) Physical dimensions	2016	15
Subgroup 2 (a) Lead integrity (b) Seal (1) (1) Fine (2) Gross	2004 1014	15
Subgroup 3 (a) Thermal shock (b) Temperature cycling (c) Moisture resistance (d) Seal (1) Fine (2) Gross (e) Visual examination (f) End-point electrical parameters	1011 1010 1004 1014	15
Subgroup 4 (1) (a) Mechanical shock (b) Vibration, variable frequency (c) Constant acceleration (d) Seal (1) Fine (2) Gross (e) Visual examination (f) End-point electrical parameters	2002 2007 2001 1014	15
Subgroup 5 (a) Salt atmosphere (2) (3) (b) Seal (1) (1) Fine (2) Gross (c) Visual examination	1009 1014	15
Subgroup 6 (1) (a) Internal water-vapor content	1018	3 devices (0) failures or 5 devices (1 failure)
Subgroup 7 (1) (a) Adhesion of lead finish (2)	2025	15
Subgroup 8 (a) Lid torque (2)	2024	5 (0)

(1) For cavity packages only
(2) No test for leadless chip carrier packages
(3) According to package.

G/B QUALITY CONFORMANCE INSPECTION

The following tables comply with the NFC 96020 norms. This norm is quite similar to the MIL-STD-883 quality conformance inspection from which it differs only on minor points.

Lot acceptance test
The group A and B tests are performed on each lot (NFC 96020-Y level)

Quality conformance inspection for assembly process and technologies
These tests are accomplished with a periodicity of 3 or 6 months.
We perform practically all the tests of group C, as defined in the French standard NFC 96020, adopting methods compatible with book VII of methodic documentation of the CCT (UTE C00-192).

Tests of groups A and B (Y level) of the French Standard NFC 96020 performed on each lot

		DEVICES	ANALOG		LOGIC	
		CLASS	G/B LEVEL		G/B LEVEL	
Sub-group	TESTS	NFC96020 reference §	Inspection level	AQL %	Inspection level	AQL %
A1a	External visual inspection Marking conformance	6.1 6.1.1	II	0.4	II	0.4
A1b	Mechanical inoperatives	6.2	II	0.15	II	0.15
A2	Functional test at 25°C or at T° max (*)		II	0.15		
A3a	Main static tests at 25°C		II	0.4	II	0.25
A3b	Complementary static tests at 25°C					
A4a	Functional and main static tests at maximum rated operating temperature	Device specification	S4	1		
A4b	Functional and main static tests at minimum rated operating temperature				S4	1
A5	Main dynamic tests at 25°C or at T° max (*)		S4	1.5	II	0.25

		DEVICES	ANALOG and LOGIC	
			G/B LEVEL	
Sub-group	TESTS	NFC96020 reference §	Sample sizes or inspection levels	Acceptance criteria or AQL %
B1	Physical dimensions	6.3	11	0/1
B2	Solderability	M302	32	1/2
B3	Seal test (For cavity packages)	M303	I	1 %

Periodical test table

Sub-group	Tests	NFC 96020 reference §	Sample sizes	Accep. criteria
C1	Secondary physical dimensions weight	6.3	11	0
C2	Marking resistance to solvents	M 306	18	1
C3	Terminal strength	M 304	18	1
C4	- Resistance to soldering heating - Thermal shocks	M 301 C 203	25	1
(1)	- Accelerated damp heat	C 205		
C5 (2)	- Mechanical shocks - Vibrations - bumps - Constant acceleration	M 307 M 308 M 305	18	1
C6	Damp heat (steady state) (3)	C 204	18	1
C8	Life test 1000 H at high temperature (4)	E 401 or E 403 and device spec.	25	1
C9	High temperature storage	E 402	18	1
C13	Salt atmosphere (5)	C 202	8	1

These tests are accomplished with a periodicity of 3 or 6 months.
They regroup practically all the tests of group C, as defined in the French standard NFC 96020, adopting methods compatible with book VII of the CCT methodic documentation (UTE C00-192).

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(1) For plastic packages
(2) For ceramic and metal glass packages
(3) 10 days for gold plated leads
56 days for tin plated leads or tin dipped leads
(4) Max junction temperature : 150°C for cavity packages
130°C for plastic packages
(5) According to package (once a year).

D and STANDARD QUALITY CONFORMANCE INSPECTIONS

The following tables comply with the NFC 96020 norms. This norm is quite similar to the MIL-STD-883 quality conformance inspection from which it differs only on minor points.

Lot acceptance test
The group A and B tests are performed on each lot (NFC 96020-Y level)

Quality conformance inspection for assembly process and technologies
These tests are accomplished with a periodicity of 3 or 6 months.
We perform practically all the tests of group C, as defined in the French standard NFC 96020, adopting methods compatible with book VII of methodic documentation of the CCT (UTE COO-192).

Tests of groups A and B (Y level) of the French Standard NFC 96020 performed on each lot

		DEVICES	ANALOG		LOGIC	
		CLASS	STANDARD & D LEVELS		STANDARD & D LEVELS	
Sub-group	TESTS	NFC96020 reference §	Inspection level	AQL %	LTPD	Accept. criteria
A1a	External visual inspection Marking conformance	6.1 6.1.1	II	0.4	3	2/3
A1b	Mechanical inoperatives	6.2	II	0.25	3	1/2
A2	Functional test at 25°C or at T° max (*)	Device specification	II	0.15	3(*) @ T°max.	1/2
A3a	Main static tests at 25°C		II	0.4		
A3b	Complementary static tests at 25°C					
A4a	Functional and main static tests at maximum rated operating temperature		S4	1		
A4b	Functional and main static tests at minimum rated operating temperature				No test	No test
A5	Main dynamic tests at 25°C or at T° max (*)		No test	No test	5(*) @ T°max.	3/4

		DEVICES	ANALOG and LOGIC	
			STANDARD/D LEVELS	
Sub-group	TESTS	NFC96020 reference §	Sample sizes or inspection levels	Acceptance criteria or AQL %
B1	Physical dimensions	6.3	11	0/1
B2	Solderability	M302	32	1/2
B3	Seal test (For cavity packages)	M303	I	1 %

Periodical test table

Sub-group	Tests	NFC 96020 reference §	Sample sizes	Accep. criteria
C1	Secondary physical dimensions weight	6.3	11	0
C2	Marking resistance to solvents	M 306	18	1
C3	Terminal strength	M 304	18	1
C4	- Resistance to soldering heating - Thermal shocks	M 301 C 203	25	1
(1)	- Accelerated damp heat	C 205		
C5 (2)	- Mechanical shocks - Vibrations - bumps - Constant acceleration	M 307 M 308 M 305	18	1
C6	Damp heat (steady state) (3)	C 204	18	1
C8	Life test 1000 H at high temperature (4)	E 401 or E 403 and device spec.	25	1
C9	High temperature storage	E 402	18	1
C13	Salt atmosphere (5)	C 202	8	1

These tests are accomplished with a periodicity of 3 or 6 months.
They regroup practically all the tests of group C, as defined in the French standard NFC 96020, adopting methods compatible with book VII of the CCT methodic documentation (UTE C00-192).

(1) For plastic packages
(2) For ceramic and metal glass packages
(3) 10 days for gold plated leads
56 days for tin plated leads or tin dipped leads
(4) Max junction temperature : 150°C for cavity packages
130°C for plastic packages
(5) According to package (once a year).

DICE QUALITY LEVELS

Eight different quality levels are available for dice (*)

LEVEL A

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL P

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Partial scribing
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

(*) Please inquire with our sales offices for the availability of the product you are interested in.

LEVEL S

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL E

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Waffle packing of good dice
- Final acceptance (AQL: 2.5 - level 2)
- Shipment

LEVEL V

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%) according to MIL-STD-883/Method 2010
- Waffle pack
- Visual inspection (sampling) MIL-STD-883/Method 2010 - 2/condition B
- Packing
- Final acceptance (AQL: 1.5 - level 2)
- Shipment

LEVEL N

- Wafer selection
- Wafer selection at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condidion B (AQL: 1% - level 2)
- Packing
  - Sampling batch (55 dice)
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements
  - Measurement report
- Final acceptance
- Shipment

LEVEL T

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condition B (AQL: 1% - level 2)
  - Sampling batch (55 dice)
- Packing
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements 1
  - Burn-in
  - Electrical measurements 2
  - Measurement report
- Final acceptance
- Shipment

LEVEL Z

- Wafer selection
- Wafer probe at room temperature
- Wafer inspection
- Scribing
- Dice visual screening (100%)
- Waffle pack
- Visual inspection MIL-STD-883/Method 2010 - 2/condition B (AQL: 1% - level 2)
  - Sampling batch (55 dice)
- Packing
  - Assembly
  - Precap inspection (100%)
  - Sealing
  - Electrical measurements 1
  - Burn-in
  - Electrical measurements 2
  - 1000-H life test
  - Electrical measurements 3
  - Measurement report
- Final acceptance
- Shipment

List of symbols

(A)

AGC : Automatic Gain Control
A_M : Gain margin
A_V : Voltage gain
A_{VC} : Common-mode voltage gain
A_{VD} : Large signal voltage gain
A_{VOL} : Open loop voltage gain

(B)

b* : Susceptance
B : Unity gain bandwidth
B_{OM} : Large signal bandwidth
BW : Bandwidth
BW_p : Power bandwidth

* y..... = g..... + jb.....

(C)

C : Capacitance
$C_{(adj)}$: Adjustment (pin) capacitor
C_{CB} : Collector-base capacitance
C_{CS} : Collector-substrate capacitance
C_{fb} : Feed back capacitor
C_I : Input capacitance
C_{ID} : Differential input capacitance
C_L : Load capacitance
CMR : Common-mode rejection ratio
C_O : Output capacitance
C_{reset} : Reset (pin) capacitor

Short-circuit input capacitance
C_{11b} b = common base
C_{11e} e = common emitter

Open-circuit reverse transfer capacitance
C_{12b} b = common base
C_{12e} e = common emitter

Open-circuit output capacitance
C_{22b} b = common base
C_{22e} e = common emitter

(D)

D : Crossover distortion

(E)

e_I : (Dynamic) input voltage
e_n : Equivalent input noise electromotive force
e_O : (Dynamic) output voltage

(F)

f : Frequency
F : Noise figure
f_c : Unity gain crossover frequency
f_{CLK} : Clock frequency
f_{fs} : Full-scale frequency

Cut-off frequency
f_{h21b} b = common base
f_{h21e} e = common emitter

f_{mod} : Modulation frequency
f_{osc} : Oscillator or Oscillation frequency
f_T : Transition frequency
f_{tun} : Tuning frequency

(G)

g* : Conductance
GB_p : Gain-bandwidth product
G_P : (Large signal) Power gain
G_p : (Small signal) Power gain
GW_R : Small signal bandwidth

* y..... = g..... + jb.....

(H)

h_{FE} : (D.C.) forward current gain (I_C and V_{CE} specified)
H_{yst} : Hysteresis

Short-circuit input impedance
h_{11b} b = common base
h_{11e} e = common emitter

Open-circuit reverse voltage transfer ratio
h_{12b} b = common base
h_{12e} e = common emitter

Short-circuit forward current transfer ratio
h_{21b} b = common base
h_{21e} e = common emitter

h_{21E} : Static value of the forward current transfer ratio (common emitter)

Open-circuit output admittance
h_{22b} b = common base
h_{22e} e = common emitter

(I)

I : Current
I_A : Alarm current
$I_{A(sink)}$: Alarm output sink current
$I_{A(source)}$: Alarm output source current
$I_{(adj)}$: Adjustment (pin) current
I_{AGC} : Automatic gain control stage input current
I_{ave} : Average current
I_B : Base (D.C.) current
I_{B1} : Base current during saturation
I_{B2} : Base current during desaturation
I_C : Collector (D.C.) current
$I_{C(off)}$: Collector off-state current
$I_{C(peak)}$: Collector peak current (repetitive)
I_{CBO} : Collector-base cut-off current ($I_E = 0$ and V_{CB} specified)
I_{CC} : Supply current (General term)
I_{CC}^{+} : Positive supply current
I_{CC}^{-} : Negative supply current
$I_{CC(sb)}$: Standby supply current
$I_{CC(av)}$: Average supply current
I_{CEO} : Collector-emitter cut-off current ($I_B = 0$ and V_{CE} specified)
I_{CEX} : Output leakage current (V_{CE} specified)
$I_{(dis)}$: Discharge (pin) current
$I_{dis(off)}$: Discharge pin leakage current
I_E : Emitter current
$I_{E(off)}$: Emitter off-state current
I_{fb} : Feed back current
I_{FL} : Full load current
I_I : Input current
I_{IB} : Input bias current
I_{IB}^{+} : Input bias current (Non-inverting input)
I_{IB}^{-} : Input bias current (Inverting input)
I_{ID} : Differential input current
I_{IH} : High level input current
I_{IL} : Low level input current
I_{IO} : Input offset current
I_{load} : Load current
$I_{L(min)}$: Minimum load current
I_n : Input equivalent noise current
I_{NL} : No load current
I_O : Output current
I_{OA} : Alarm output current
I_{off} : Cut-off leakage current
I_{OH} : High level output current
I_{OL} : Low level output current
$I_{O(peak)}$: Peak output current
$I_{O(sink)}$: Output sink current
$I_{O(source)}$: Output source current
I_Q : Quiescent current
I_R : Diode leakage current
$I_{(ref)}$: Reference current (General term)
$I_{(ref+)}$: Positive reference current
$I_{(ref-)}$: Negative reference current
I_{reset} : Reset current
I_{SC} : Short-circuit current
I_{sense} : Sense (pin/terminal) current
$I_{sense(off)}$: Sense (pin/terminal) leakage current
I_{sink} : Sink current
I_{source} : Source current
I_{start} : Starting current
I_{strobe} : Strobe current
I_Z : Zener current
I_{th} : Threshold current
$I_{(trig)}$: Trigger current

(K)

K_{OV} : Overshoot factor
K_{VH} : Long term stability
K_{VI} : Line regulation
K_{VO} : Load regulation
K_{VT} : Temperature stability

(P)

P : Internal power dissipation
P_D : Circuit power consumption
P_O : Output power (useful in load) with specified conditions
P_{tot} : Total power dissipation

(R)

R : Resistance
R_{fb} : Feed back resistance
R_G : External generator resistance
R_I : Input resistance
R_{ID} : Differential input resistance
R_L : Load resistance
R_n : Negative resistance
R_O : Output resistance
R_p : Parallel loss resistance of a tuned oscillatory circuit
R_S : Source resistance
R_{SC} : Sense current resistance
$R_{th(j-a)}$: Junction-ambient thermal resistance
$R_{th(j-c)}$: Junction-case thermal resistance
$R_{th(c-a)}$: Case-ambient thermal resistance
R_{vf} : Ripple rejection

16

(S)

S : Sensitivity (input signal voltage with output and operating conditions specified)
S_{VO} : Slew rate
SVR : Supply voltage rejection ratio (General term)
SVR^+ : Positive supply voltage rejection ratio
SVR^- : Negative supply voltage rejection ratio

(T)

t : Time
T : Temperature
t_{aut} : Autonomy time
$t_{(conv)}$: Conversion time
t_d : Delay time
t_f : Fall time
THD : Total harmonic distortion
t_{off} : Turn off time
t_{on} : Turn on time
t_{ost} : Strobe release time
t_{ov} : Overshoot time
t_p : Pulse time
t_r : Rise time
t_{re} : Response time
t_{rel} : Large signal response time
t_{reset} : Reset pulse duration
t_{rip} : Ripple time
t_s : Settling time
T_{amb} : Ambient temperature
T_{case} : Case temperature
T_j : Junction temperature
T_{lead} : Lead temperature (soldering duration specified)
T_{oper} : Operating temperature
T_{stg} : Storage temperature

(V)

V_A : Alarm voltage
$V_{(adj)}$: Adjustment (pin) voltage
V_{AGC} : Voltage applied to Automatic Gain Control stage
$V_{(aux)}$: Auxiliary voltage
V_{BE} : Base-emitter (D.C.) voltage
V_{CBO} : Collector-base (D.C.) voltage ($I_E = 0$ and I_C specified)
V_{CC} : Supply voltage (General term)
V_{CC}^+ : Positive supply voltage
V_{CC}^- : Negative supply voltage
$V_{CC(peak)}$: Peak supply voltage
$V_{CC(th)}$: Supply voltage threshold
$V_{CE(sat)}$: Collector-emitter saturation voltage (I_B and I_C specified)
$V_{CE(sust)}$: Collector-emitter (pulsed) sustaining voltage (I_C specified)
V_{CEO} : Collector-emitter (D.C.) voltage ($I_B = 0$ and I_C specified)
V_{CL} : Control voltage level
V_{CM} : Common-mode (input) voltage
V_{CSO} : Collector-substrate voltage
$V_{(dis)}$: Discharge (pin) voltage
$V_{dis(sat)}$: Discharge (pin) saturation voltage
V_{EBO} : Emitter-base (D.C.) voltage ($I_C = 0$ and I_E specified)
V_F : Forward voltage
$V_{H(reset)}$: Reset high voltage
V_I : Input voltage (General term)
V_I^+ : Positive input voltage / Non-inverting terminal input voltage
V_I^- : Negative input voltage / Inverting terminal input voltage
V_{ICR} : Common-mode input voltage range
V_{ID} : Differential input voltage
V_{IH} : High level input voltage
V_{IL} : Low level input voltage
V_{IM} : Input voltage range
$V_{I(max)}$: Maximum input voltage
V_{IO} : Input offset voltage
V_{IOR} : Offset voltage adjustment range
$V_{I(R)}$: Inverse input voltage
$V_{I(reset)}$: Reset input voltage
$V_{L(reset)}$: Reset low voltage
V_n : Equivalent (input) noise voltage
V_{NO} : Output noise voltage
V_O : Output voltage
V_O^+ : Positive output voltage
V_O^- : Negative output voltage
V_{OH} : High level output voltage
V_{OL} : Low level output voltage
$V_{O(max)}$: Maximum output voltage
V_{OPP} : Output voltage swing
$V_{O(sat)}$: Output saturation voltage
V_{O1}/V_{O2} : Channel separation
V_R : Inverse voltage
$V_{(ref)}$: Reference voltage
$V_{(ref+)}$: Positive reference voltage
$V_{(ref-)}$: Negative reference voltage
V_{reset} : Reset (pin) voltage
V_{sense} : Sense voltage
V_{strobe} : Strobe voltage
V_{th} : Threshold voltage
V_{thH} : Higher treshold voltage
$V_{thH(reset)}$: Reset higher threshold level
V_{thL} : Lower threshold voltage
$V_{thL(reset)}$: Reset lower threshold level
$V_{(trig)}$: Trigger voltage
V_Z : Zener voltage

(Y)

Short-circuit input admittance
y_{11b}* b = common base
y_{11e} e = common emitter

Short-circuit reverse transfer admittance
y_{12b}* b = common base
y_{12e} e = common emitter

Short-circuit forward transfer admittance
y_{21b}* b = common base
y_{21e} e = common emitter

Short-circuit output admittance
y_{22b}* b = common base
y_{22e} e = common emitter

* y..... = g..... + jb.....

(Z)

Z : Impedance
Z_D : Reverse dynamic impedance
Z_I : Input impedance
Z_{IC} : Common-mode input impedance
Z_{ID} : Differential input impedance
Z_O : Output impedance
Z_{OD} : Differential output impedance

(α)

α : Temperature coefficient
α_I : Current temperature coefficient
α_V : Voltage temperature coefficient
$\alpha V_{IO}/V_{IO}$: Change in average temperature coefficient with V_{IO} adjust
αV_O : Average temperature coefficient of output voltage
$\alpha V_{(ref)}$: Reference voltage temperature coefficient

(δ)

δ : Duty cycle (of a pulse)

(η)

η : Efficiency

(φ)

φ : Phase angle

Phase angle of input admittance with output short-circuited
φy_{11b} b = common base
φy_{11e} e = common emitter

Phase angle of reverse transfer admittance with input short-circuited
φy_{12b} b = common base
φy_{12e} e = common emitter

Phase angle of forward transfer admittance with output short-circuited
φy_{21b} b = common base
φy_{21e} e = common emitter

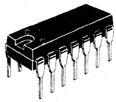
Phase angle of output admittance with input short-circuited
φy_{22b} b = common base
φy_{22e} e = common emitter

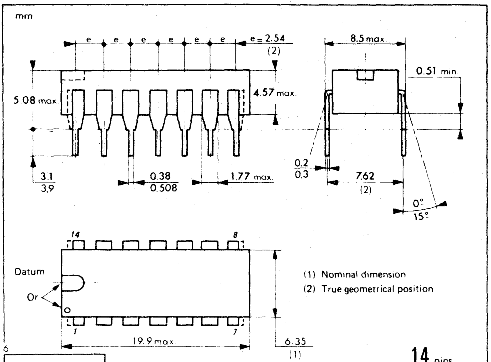
(ω)

ω : Angular frequency

16

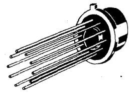
Package dimensions

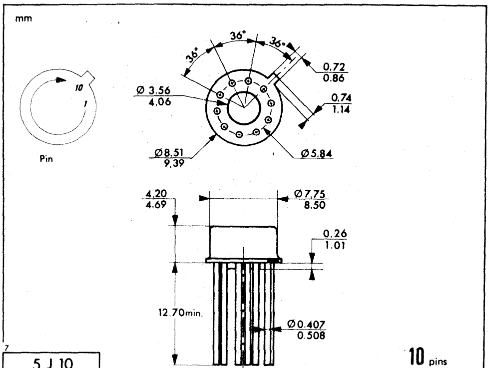




14 pins

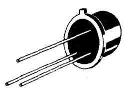
DIN				
A50B CEI	TO-116 D.A.T.A	TO-116 JEDEC	F 105 SITELESC	CB-2 THOMSON SEMICONDUCTORS

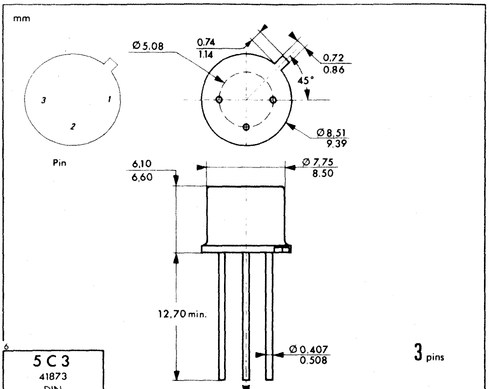




10 pins

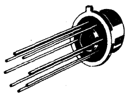
5 J 10 41873 DIN				
Case : C-23 Base : B-33 CEI	TO-100 D.A.T.A.	TO-100 JEDEC	F95 SITELESC	CB-3 THOMSON SEMICONDUCTORS

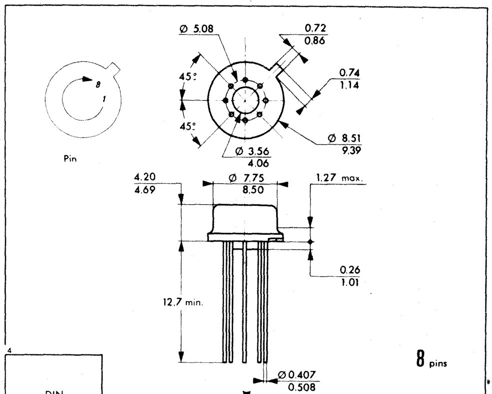




3 pins

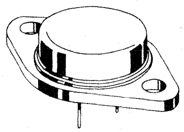
5 C 3 41873 DIN				
Case : C-4 Base : B-4C CEI	TO-39 D.A.T.A.	TO-39 JEDEC	F 59 SITELESC	CB-7 THOMSON SEMICONDUCTORS

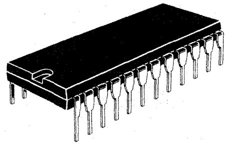


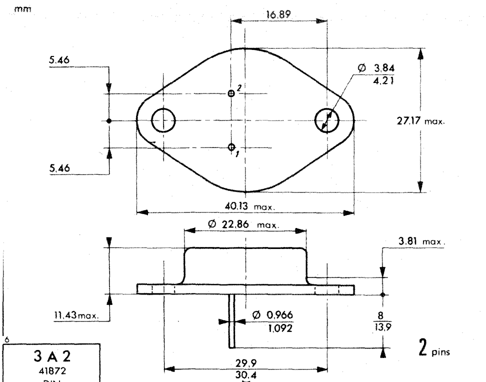


8 pins

DIN				
Case : C-23 Base : CEI	TO-99 D.A.T.A.	TO-99 JEDEC	F 101 SITELESC	CB-11 THOMSON SEMICONDUCTORS

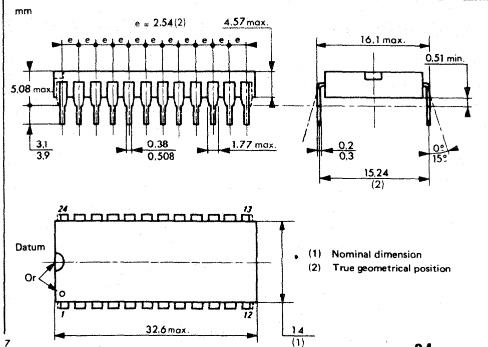






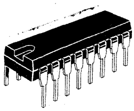
2 pins

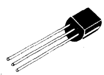
3 A 2 41872 DIN				
Case [C - 14 A] Base B - 18 CEI	TO - 3 D.A.T.A.	TO - 3 JEDEC	F 24 A SITELESC	CB - 19 THOMSON SEMICONDUCTORS

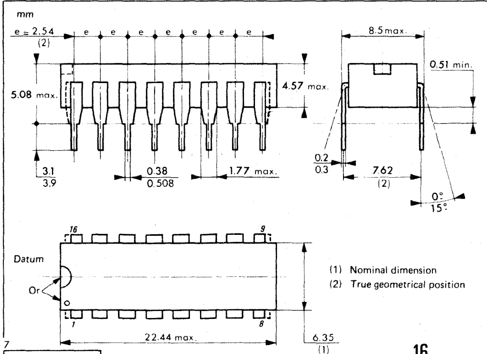


24 pins

DIN				
A51D CEI	D.A.T.A.	JEDEC	F 118 SITELESC	CB-68 THOMSON SEMICONDUCTORS

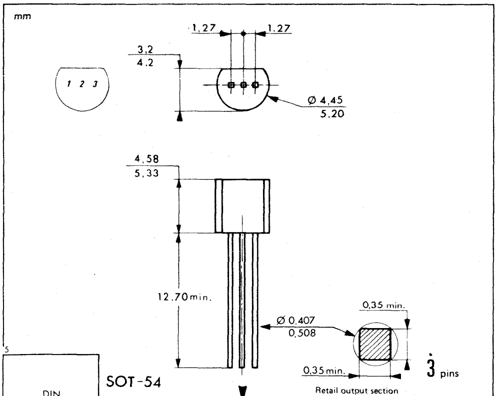






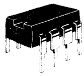
16 pins

DIN				
A50E CEI	D.A.T.A.	JEDEC	F 117 SITELESC	CB-79 THOMSON SEMICONDUCTORS

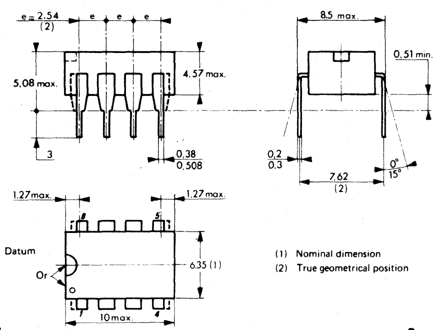


3 pins

DIN	SOT-54			
CEI	TO-92 D.A.T.A.	TO-92 JEDEC	F 129 B SITELESC	CB-97 THOMSON SEMICONDUCTORS



mm

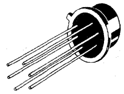


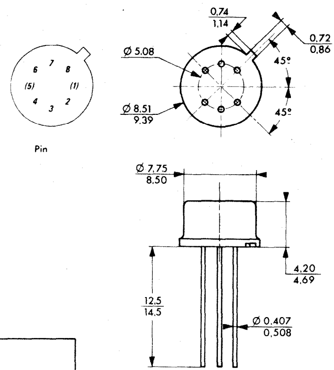
(1) Nominal dimension
(2) True geometrical position

6

8 pins

DIN				
A50D CEI	D.A.T.A.	JEDEC	F 116 A SITELESC	CB-98 THOMSON SEMICONDUCTORS

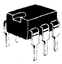




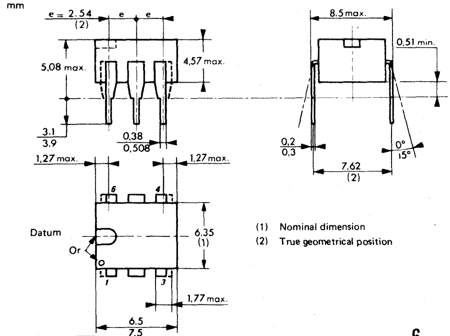
3

6 pins

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-107 THOMSON SEMICONDUCTORS



mm

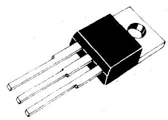


(1) Nominal dimension
(2) True geometrical position

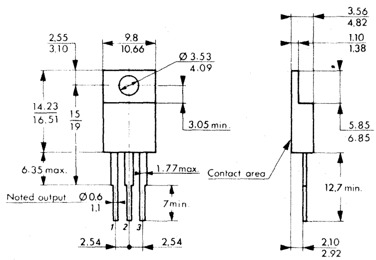
5

6 pins

DIN				
CEI	D.A.T.A.	JEDEC	F 124 A SITELESC	CB-116 THOMSON SEMICONDUCTORS



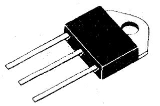
mm

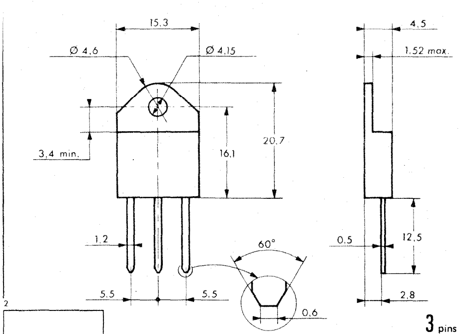


10

3 pins

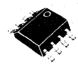
DIN				
CEI	X-75 D.A.T.A.	TO-220 AB JEDEC	(F 138) SITELESC	CB-117 THOMSON SEMICONDUCTORS

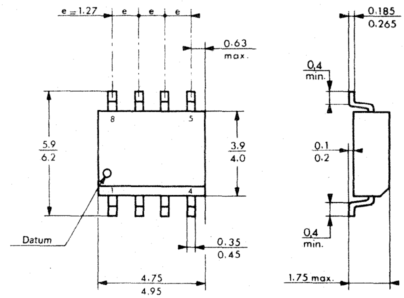




3 pins

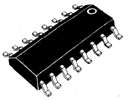
DIN				
CEI	D.A.T.A.	TO-218 JEDEC	SITELESC	CB-244 THOMSON SEMICONDUCTORS

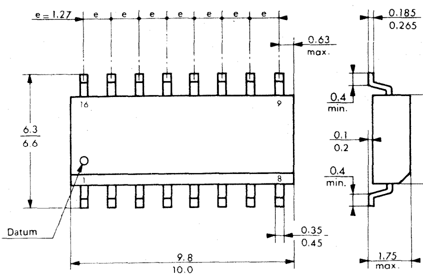




8 pins

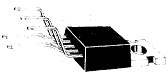
DIN	SO8			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-342 THOMSON SEMICONDUCTORS

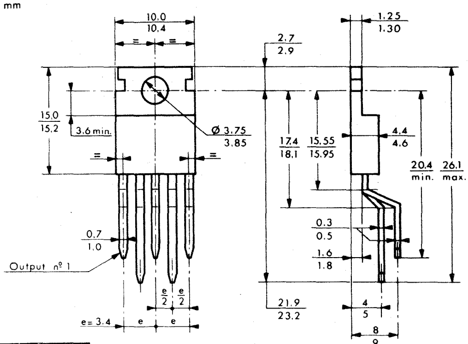




16 pins

DIN	SO16			
CEI	D.A.T.A.	JEDEC	SITELESC	CB-359 THOMSON SEMICONDUCTORS

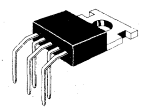


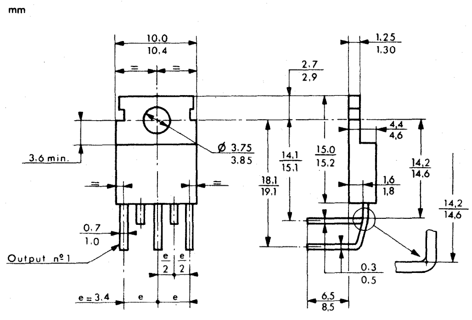


5 pins

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-360 THOMSON SEMICONDUCTORS

17

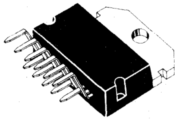


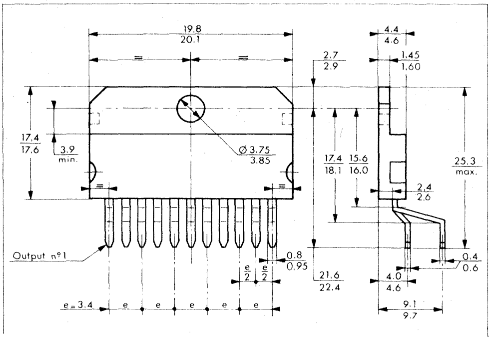


1

5 pins

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-367 THOMSON SEMICONDUCTORS

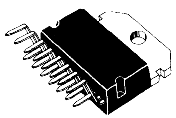


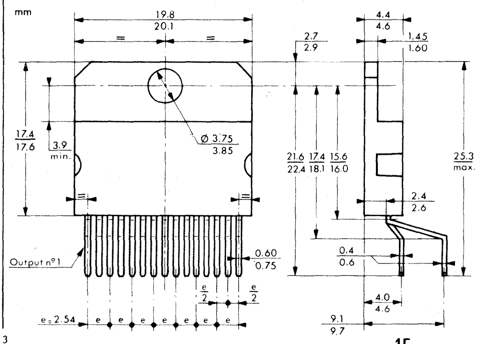


1

11 Outputs

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-500 THOMSON SEMICONDUCTORS

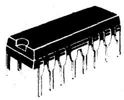


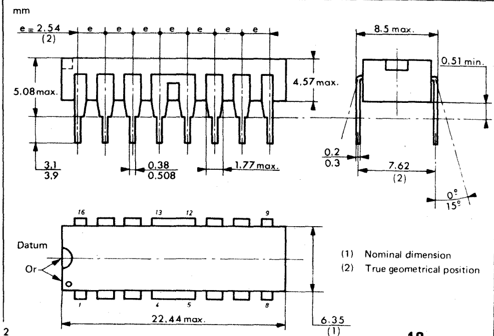


3

15 pins

DIN				
CEI	D.A.T.A.	JEDEC	SITELESC	CB-501 THOMSON SEMICONDUCTORS

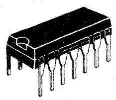


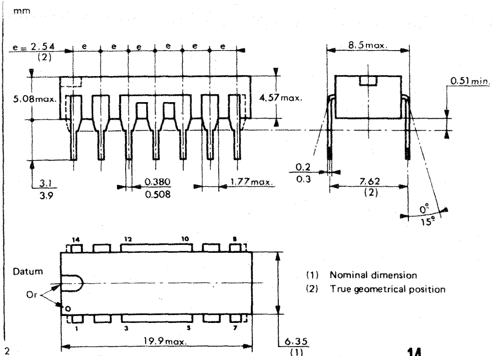


2

16 pins

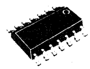
DIN				
[A50E] CEI	D.A.T.A.	JEDEC	(F117) SITELESC	CB-502 THOMSON SEMICONDUCTORS

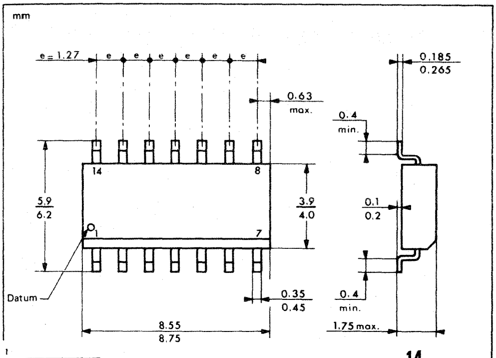




14 pins

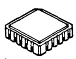
DIN				
[A50B]			(F105)	CB-504 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	

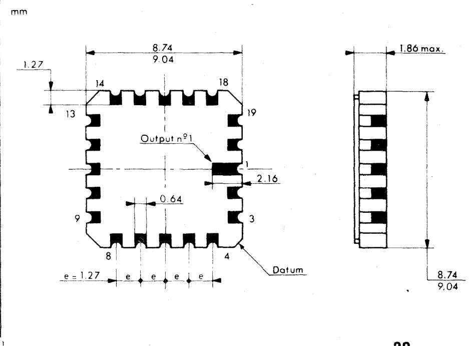




14 pins

DIN	SO14			
				CB-511 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	



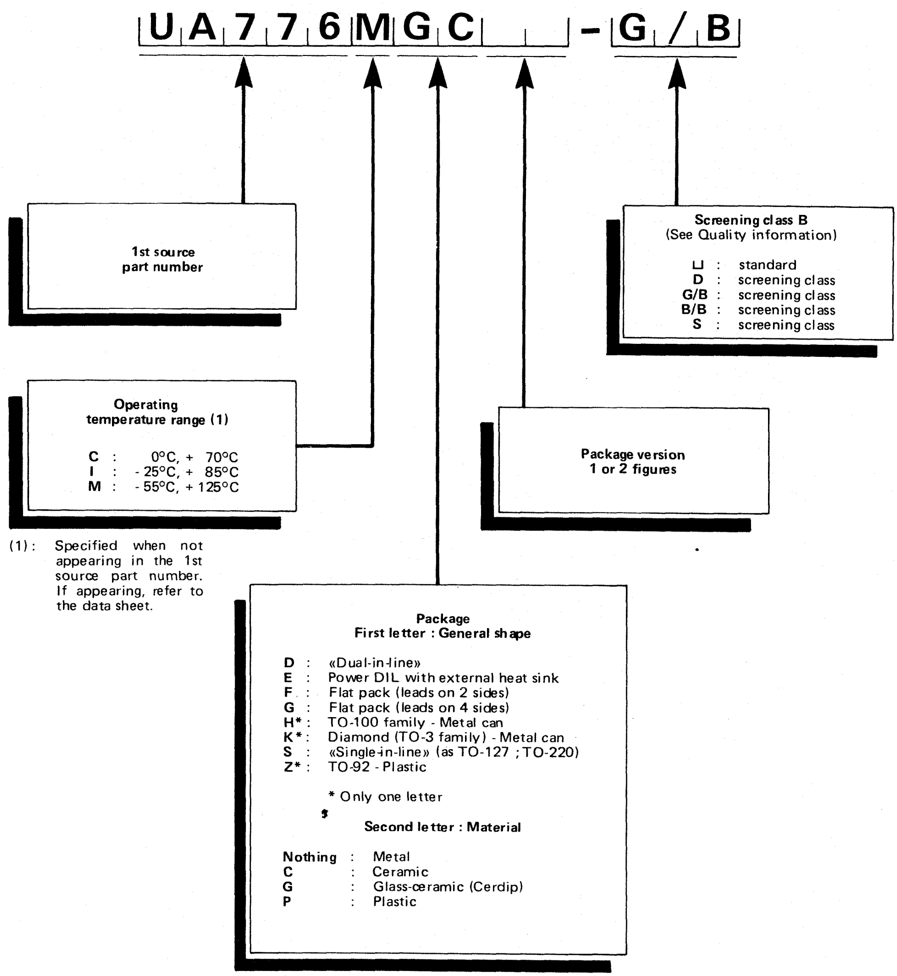


20 pins

DIN				
MS004 CB		TMS004 CB		CB-705 THOMSON SEMICONDUCTORS
CEI	D.A.T.A.	JEDEC	SITELESC	

17

Ordering information


UA776MGC -G/B
1st source part number
Operating temperature range (1)
C : 0°C, + 70°C
I : - 25°C, + 85°C
M : - 55°C, + 125°C
(1) : Specified when not appearing in the 1st source part number. If appearing, refer to the data sheet.
Package
First letter : General shape
D : «Dual-in-line»
E : Power DIL with external heat sink
F : Flat pack (leads on 2 sides)
G : Flat pack (leads on 4 sides)
H* : TO-100 family - Metal can
K* : Diamond (TO-3 family) - Metal can
S : «Single-in-line» (as TO-127 ; TO-220)
Z* : TO-92 - Plastic
* Only one letter
Second letter : Material
Nothing : Metal
C : Ceramic
G : Glass-ceramic (Cerdip)
P : Plastic
Package version
1 or 2 figures
Screening class B
(See Quality information)
⊔ : standard
D : screening class
G/B : screening class
B/B : screening class
S : screening class

PRO-ELECTRON

U A A 4 0 0 6 A D P _ _ - _ _ _

3 letter prefix

First : T Analog circuit
U Digital / analog circuit

Second : No special significance

Third : Operating temperature range

A	:	not specified		
B	:	0°C	+	70°C
C	:	−55°C	+	125°C
D	:	−25°C	+	70°C
E	:	−25°C	+	85°C
F	:	−40°C	+	85°C
G	:	−55°C	+	85°C

Four figures or letters allocated by Pro-Electron or recalling first source number.

Version letter : indicates a minor variant of the basic type.

First letter : General shape

- **C** : Cylindrical
- **D** : "Dual-in-line"
- **E** : Power DIL with external heat sink
- **F** : Flat pack (leads on 2 sides)
- **G** : Flat pack (leads on 4 sides)
- **K** : Diamond (TO-3 family)
- **M** : "Multiple-in-line" (> 4 output rows)
- **Q** : "Quadruple-in-line" (QUIL)
- **R** : Power QUIL with external heat sink
- **S** : "Single-in-line" (as TO-127 ;TO-220)
- **T** : "Triple-in-line".

Second letter : Material

- **C** : Ceramic
- **G** : Glass-ceramic (Cerdip)
- **M** : Metal
- **P** : Plastic

Package version
1 or 2 figures

Screening class B
(See Quality information)

- **⊔** : standard
- **D** : screening class
- **G/B** : screening class
- **B/B** : screening class
- **S** : screening class

TS 8351 M C - B / B

THOMSON SEMICONDUCTORS prefix (TS)

Device number allocated by THOMSON SEMICONDUCTORS or recalling the first source code (8351)

Operating temperature range (M)

C	:	0°C, + 70°C
I	:	- 25°C, + 85°C
M	:	- 55°C, + 125°C

Package (C)

C	:	Ceramic DIL
E	:	Ceramic LCC
EP	:	Plastic power DIL
FN	:	Plastic chip-carrier
FP	:	Plastic micropackage
FQ	:	UV window cerdip
H	:	Metal TO-100
J	:	Cerdip DIL
K	:	Metal diamond (TO-3)
P	:	Plastic DIL
R	:	Pin Grid Array
Z	:	Plastic TO-92 family

Screening class B (B/B)
(See Quality information)

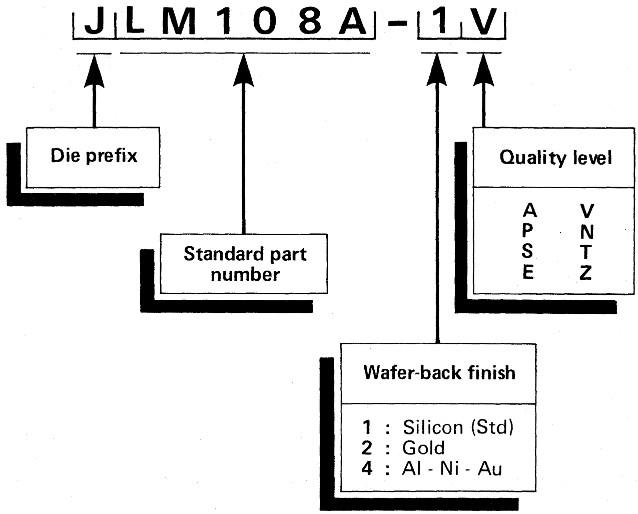
␣	:	standard
D	:	screening class
G/B	:	screening class
B/B	:	screening class
S	:	screening class

THOMSON SEMICONDUCTORS ICs
According to ESA/SCC 9000

LM 101 AH | 9 | 3 | Q | B | 2

- **LM 101 AH** — THOMSON SEMICONDUCTORS part number
- **9** : according to ESA/SCC 9000
- **3** —
  1 : according to ESA/SCC detail spec. issue 1
  2 : issue 2
  3 : issue 3... & so on
- **Q** —
  Q : THOMSON SEMICONDUCTORS product is ESA/SCC qualified
  N : not qualified but selected according to ESA/SCC specification
- **B** —
  B : customer order according to B level of ESA/SCC 9000
  C : customer order according to C level of ESA/SCC 9000
- **2** —
  L.A.T. according to ESA/SCC 9000
  0 : no L.A.T. requested
  1 : customer order with L.A.T. 1
  2 : L.A.T. 2
  3 : L.A.T. 3

DICE ORDERING INFORMATION



Each THOMSON SEMICONDUCTORS linear circuit supplied in chip or wafer form has a special ordering code divided as follows :

MAIN CODE (Device specification)

- beginning with **J** (Common to all devices)
- followed by the part number of the equivalent packaged device

COMPLEMENTARY CODE (Wafer-back finish and quality level)

After a dash, two characters are used
- a figure indicating the choice of wafer-back finish
- a letter to specify the quality level

A : Wafer
P : Scribed wafer
S : Wafer on adhesive tape with separated chips
E : Chips in waffle pack without visual inspection
V : Chips in waffle pack with 100 % visual inspection according to MIL - STD - 883 / Method 2010
N : V level plus sampling batch of 55 packaged ICs
T : N level plus burn-in on sampling batch of 55 packaged ICs
Z : T level plus 1000 H life test on sampling batch of 55 packaged ICs

Cross reference

LINEAR CROSS REFERENCE (BY MANUFACTURER)

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NEC 989
PMI 990
RCA 991
RIFA 991
SGS 991
SIGNETICS 992
SPRAGUE 993
TEXAS 994

PLASTIC MICROPACKAGES LINEAR CROSS REFERENCE (BY MANUFACTURER)

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JRC 996
MOTOROLA 996
NEC 996
ROHM 997
SGS 997
SIGNETICS 997
TEXAS 997

ADVANCED MICRO DEVICES

Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
Am101AH	LM101AH		63
Am101AD8	LM101ADG		63
Am105H	LM105H		349
Am108AD8	LM108ADG		73
Am108AH	LM108AH		73
Am108D8	LM108DG		73
Am108H	LM108H		73
Am111H	LM111H		303
Am118H	LM118H		87
Am119D	LM119DG		311
Am119H	LM119H		311
Am124D	LM124DG		99
Am139AD	LM139ADG		319
Am139D	LM139DG		319
Am1458H	LM1458H		143
Am148D	LM148DG		123
Am149D	LM149DG		123
LF155AH	LF155AH		35
LF155H	LF155H		35
LF156AH	LF156AH		35
LF156H	LF156H		35
LF157AH	LF157AH		35
LF157H	LF157H		35
LF198H	LF198H		667
Am201AD8	LM201ADG		63
Am201AH	LM201AH		63
Am205H	LM205H		349
Am208AD	LM208ADG		73
Am208AH	LM208AH		73
Am208D	LM208DG		73
Am208H	LM208H		73
Am211H	LM211H		303
Am218H	LM218H		87
Am219D	LM219DG		311
Am219H	LM219H		311
Am224D	LM224DG		99
Am239AD	LM239ADG		319
Am239D	LM239DG		319
Am248D	LM248DG		123
Am249D	LM249DG		123
LF255H	LF255H		35
LF256H	LF256H		35
LF257H	LF257H		35
LF298H	LF298H		667
Am301AD8	LM301ADG		63
Am301AH	LM301AH		63
Am301AN	LM301ADP		63
Am305H	LM305H		349
Am308AD	LM308ADG		73
Am308AH	LM308AH		73
Am308AN	LM308ADP		73
Am308D	LM308DG		73

ADVANCED MICRO DEVICES

Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
Am308H	LF308H		73
Am308N	LF308DP		73
Am311D	LM311DG		303
Am311H	LM311H		303
Am311N	LM311DP		303
Am318H	LM318H		87
Am319D	LM319DG		311
Am319H	LM319H		311
Am319N	LM319DP		311
LF355AH	LF355AH		35
LF355H	LF355H		35
LF355N	LF355DP		35
LF356AH	LF356AH		35
LF356H	LF356H		35
LF356N	LF356DP		35
LF357AH	LF357AH		35
LF357H	LF357H		35
LF357N	LF357DP		35
LF398H	LF398H		667
Am723DC	UA723CDG		421
Am723DM	UA723MDG		421
Am723HC	UA723CH		421
Am723HM	UA723MH		421
Am723PC	UA723CDP		421
Am741AHM	UA741AH		271
Am741HC	UA741CH		271
Am741HM	UA741MH		271
Am748HC	UA748CH		279
Am748HM	UA748MH		279
Am1458H	LM1458H		143
Am1558H	LM1558H		143

FAIRCHILD

Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
UA101AHM	LM101AH		63
UA105HM	LM105H		349
UA108AHM	LM108AH		73
UA108HM	LM108H		73
UA109KM	LM109K		357
UA111HM	LM111H		303
UA111RM	LM111DG		303
UA117KM	LM117K		365
UA124DM	LM124DG		99
UA139ADM	LM139ADG		319
UA139DM	LM139DG		319
UA148DM	LM148DG		123
UA198HM	LF198H		667
UA201AHM	LM201AH		63
UA201AT	LM201ADP		63
UA208AHM	LM208AH		73
UA208HM	LM208H		73
UA209KM	LM209K		357
UA217UV	LM217SP		365
UA224DV	LM224DG		99
UA224PV	LM224DP		99
UA239ADC	LM239ADG		319
UA239APC	LM239ADP		319
UA239DC	LM239DG		319
UA239PC	LM239DP		319
UA248DC	LM248DG		123
UA293ATC	LM293ADP		329
UA293TC	LM293DP		329
UA298HC	LF298H		667
UA298RC	LF298DP		667
UA301ATC	LM301ADP		63
UA301HC	LM301AH		63
UA311HC	LM311H		303
UA311RC	LM311DG		303
UA311TC	LM311DP		303
UA317KC	LM317K		365
UA317UC	LM317SP		365
UA318HC	LM318H		87
UA324DC	LM324DG		99
UA324PC	LM324DP		99
UA339ADC	LM339ADG		319
UA339APC	LM339ADP		319
UA339DC	LM339DG		319
UA339PC	LM339DP		319
UA348DC	LM348DG		123
UA348PC	LM348DP		123
UA393TC	LM393DP		329
UA398HC	LF398H		667
UA398RC	LF398DP		667
UA494DC	TL494DG		597
UA494DM		TL494IDG	597
UA494PC	TL494DP		597

FAIRCHILD

Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
UA555TC	NE555CDP		707
UA556PC	NE556CDP		715
UA723DC	UA723CDG		421
UA723DM	UA723MDG		421
UA723HC	UA723CH		421
UA723HM	UA723MH		421
UA723PC	UA723CDP		421
UA741HC	UA741CH		271
UA741HM	UA741MH		271
UA741RC	UA741CDG		271
UA741TC	UA741CDP8		271
UA748HC	UA748CH		279
UA748HM	UA748MH		279
UA748TC	UA748CDP		279
UA771ATC		TL081BCDP	243
UA771BTC		TL081ACDP	243
UA771LTC	TL081CDP		243
UA771TC		TL081CDP	243
UA772ATC		TL082BCDP	251
UA772BTC		TL082ACDP	251
UA772LTC	TL082CDP		251
UA772TC		TL082CDP	251
UA774LDC	TL084CDG		261
UA774LPC	TL084CDP		261
UA776HC	UA776CH		287
UA776HM	UA776MH		287
UA776TC	UA776CDP		287
UA791KC		TDB7910DP	185
UA1458CHC	LM1458H		143
UA1458CRC	LM1458DG		143
UA1458CTC	LM1458DP		143
UA1458HC	LM1458H		143
UA1558HM	LM1558H		143
UA1558RM	LM1558DG		143
UA2901PC	LM2901DP		319
UA2902PC	LM2902DP		99
UA2903TC	LM2903DP		329
UA2904TC	UA2904DP		131
UA3302PC	MC3302DP		319
UA3303PC	MC3303DP		151
UA3403DC	MC3403DG		151
UA3403PC	MC3403DP		151
UA7805KC	UA7805CK		435
UA7805KM	UA7805MK		435
UA7805UC	UA7805CSP		445
UA7806KC	UA7806CK		435
UA7806KM	UA7806MK		435
UA7806UC	UA7806CSP		445
UA7808KC	UA7808CK		435
UA7808KM	UA7808MK		435
UA7808UC	UA7808CSP		445
UA7812KC	UA7812CK		435

FAIRCHILD

Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
UA7812KM	UA7812MK		435
UA7812UC	UA7812CSP		445
UA7815KC	UA7815CK		435
UA7815KM	UA7815MK		435
UA7815UC	UA7815CSP		445
UA7818KC	UA7818CK		435
UA7818KM	UA7818MK		435
UA7818UC	UA7818CSP		445
UA7824KC	UA7824CK		435
UA7824KM	UA7824MK		435
UA7812UC	UA7824CSP		445
UA7905KC	UA7905CK		455
UA7905KM	UA7905MK		455
UA7905UC	UA7905CSP		463
UA7912KC	UA7912CK		455
UA7912KM	UA7912MK		455
UA7912UC	UA7912CSP		463
UA7915KC	UA7915CK		455
UA7915KM	UA7915MK		455
UA7915UC	UA7915CSP		463

MOTOROLA

LF155AH	LF155AH		35
LF155H	LF155H		35
LF156AH	LF156AH		35
LF156H	LF156H		35
LF157AH	LF157AH		35
LF157H	LF157H		35
LF255H	LF255H		35
LF255N	LF255DP		35
LF256H	LF256H		35
LF256N	LF256DP		35
LF257H	LF257H		35
LF257N	LF257DP		35
LF355AH	LF355AH		35
LF355BH	LF355AH		35
LF355BN	LF355ADP		35
LF355H	LF355H		35
LF355N	LF355DP		35
LF356AH	LF356AH		35
LF356BH	LF356AH		35
LF356BN	LF356ADP		35
LF356H	LF356H		35
LF356N	LF356DP		35
LF357AH	LF357AH		35
LF357BH	LF357AH		35
LF357BN	LF357ADP		35
LF357H	LF357H		35
LF357N	LF357DP		35
LM101AH	LM101AH		63
LM101AJ	LM101ADG		63

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
LM108AD	LM108ADG		73
LM108AH	LM108AH		73
LM108D	LM108DG		73
LM108H	LM108H		73
LM109H	LM109H		357
LM109K	LM109K		357
LM111H	LM111H		303
LM111J-8	LM111DG		303
LM117H	LM117H		365
LM117K	LM117K		365
LM124J	LM124DG		99
LM137H	LM137H		383
LM137K	LM137K		383
LM139AJ	LM139ADG		319
LM139J	LM139DG		319
LM140K-5.0		UA7805MK	435
LM140K-8.0		UA7806MK	435
LM140K-8.0		UA7808MK	435
LM140K-12		UA7812MK	435
LM140K-15		UA7815MK	435
LM140K-18		UA7818MK	435
LM140K-24		UA7824MK	435
LM148J	LM148DG		123
LM158H	LM158H		131
LM158J	LM158DG		131
LM193H	LM193H		329
LM201AH	LM201AH		63
LM201AJ	LM201ADG		63
LM201AN	LM201ADP		63
LM208AH	LM208AH		73
LM208H	LM208H		73
LM209H	LM209H		357
LM209K	LM209K		357
LM211H	LM211H		303
LM217H	LM217H		365
LM217K	LM217K		365
LM224J	LM224DG		99
LM224N	LM224DP		99
LM237H	LM237H		383
LM237K	LM237K		383
LM239AJ	LM239ADG		319
LM239AN	LM239ADP		319
LM239J	LM239DG		319
LM239N	LM239DP		319
LM248J	LM248DG		123
LM248N	LM248DP		123
LM258H	LM258H		131
LM258J	LM258DG		131
LM258N	LM258DP		131
LM293AH	LM293AH		329
LM293AN	LM293ADP		329
LM293H	LM293H		329

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Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
LM293N	LM293DP		329
LM301AH	LM301AH		63
LM301AD	LM301AFP		63
LM301AJ	LM301ADG		63
LM301AN	LM301ADP		63
LM308AH	LM308AH		73
LM308AD	LM308ADG		73
LM308D	LM308DG		77
LM308H	LM308H		73
LM308N	LM308DP		73
LM309H	LM309H		357
LM309K	LM309K		357
LM311D	LM311FP		303
LM311H	LM311H		303
LM311J-8	LM311DG		303
LM311N	LM311DP		303
LM317H	LM317H		365
LM317K	LM317K		365
LM317T	LM317SP		365
LM324D	LM324FP		99
LM324J	LM324DG		99
LM324N	LM324DP		99
LM339AJ	LM339ADG		319
LM339AN	LM339ADP		319
LM339D	LM339FP		319
LM339J	LM339DG		319
LM339N	LM339DP		319
LM340K-5.0		UA7805CK	435
LM340K-6.0		UA7806CK	435
LM340K-8.0		UA7808CK	435
LM340K-12		UA7812CK	435
LM340K-15		UA7815CK	435
LM340K-18		UA7818CK	435
LM340K-24		UA7824CK	435
LM348J	LM348DG		123
LM348N	LM348DP		133
LM358D	LM358FP		131
LM358H	LM358H		131
LM358J	LM358DG		131
LM358N	LM358DP		131
LM393D	LM393FP		329
LM393H	LM393H		329
LM393N	LM393DP		329
LM2901D	LM2901FP		319
LM2901N	LM2901DP		319
LM2902D	LM2902FP		99
LM2902N	LM2902DP		99
LM2903D	LM2903FP		329
LM2903N	LM2903DP		329
LM2904D	LM2904FP		131
LM2904N	LM2904DP		131
MC1455D	NE555CFP		707

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Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
MC1455G	NE555CH		707
MC1455P1	NE555CDP		707
MC1455U	NE555CDG		707
MC1458CD	LM1458FP		143
MC1458CG	LM1458H		143
MC1458CU	LM1458DG		143
MC1458CP1	LM1458DP		143
MC1458D	LM1458FP		143
MC1458G	LM1458H		143
MC1458P1	LM1458DP		143
MC1555G	SE555MH		707
MC1555U	SE555MDG		707
MC1558G	LM1558H		143
MC1558U	LM158DG		143
MC1723CD	UA723CFP		421
MC1723CG	UA723CH		421
MC1723CL	UA723CDG		421
MC1723CP	UA723CDP		421
MC1723G	UA723MH		421
MC1723L	UA723MDG		421
MC1741CD	UA741CFP		271
MC1741CG	UA741CH		271
MC1741CP1	UA741CDP8		271
MC1741CP2	UA741CDP14		271
MC1741CU	UA741CDG		271
MC1741G	UA741MH		271
MC1741U	UA741MDG		271
MC1748CG	UA748CH		279
MC1748CP1	UA748CDP		279
MC1748CU	UA748CDG		279
MC1748G	UA748MH		279
MC1748U	UA748MDG		279
MC1776CD	UA776CFP		287
MC1776CG	UA776CH		287
MC1776CP1	UA776CDP		287
MC1776G	UA776MH		287
MC3302P	MC3302DP		319
MC3303L	MC3303DG		151
MC3303P	MC3303DP		151
MC3346D	TDB2046FP		727
MC3403D	MC3403FP		151
MC3403L	MC3403DG		151
MC3403P	MC3403DP		151
MC3503L	MC3503DG		151
MC4558CD	MC4558CFP		159
MC4558CG	MC4558CH		159
MC4558CP1	MC4558CDP		159
MC4558CU	MC4558CDG		159
MC4558G	MC4558MH		159
MC4558U	MC4558MDG		159
MC4741CL		LM348DG	123
MC4741CP		LM348DP	123

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
MC4741L		LM148DG	123
MC78XXACT	UA78XXBISP		445
MC78XXCK	UA78XXCK		435
MC78XXCT	UA78XXCSP		445
MC78XXK	UA78XXMK		435
MC79XXCK	UA79XXCK		455
MC79XXCT	UA79XXCSP		463
MC79XXK	UA79XXMK		455
MC34001D		TL071CFP	217
MC34001AG		TL071ACH	217
MC34001AP		TL071ACDP	217
MC34001BG		TL071BCH	217
MC34001BP		TL071BCDP	217
MC34001G		TL071CH	217
MC34001P		TL071CDP	217
MC34002D		TL072CFP	225
MC34002AG		TL072ACH	225
MC34002AP		TL072ACDP	225
MC34002BG		TL072BCH	225
MC34002BP		TL072BCDP	225
MC34002G		TL072CH	225
MC34002P		TL072CDP	225
MC34004D		TL074CFP	233
MC34004AL		TL074ACDG	233
MC34004AP		TL074ACDP	233
MC34004BL		TL074BCDG	233
MC34004BP		TL074BCDP	233
MC34004L		TL074CDG	233
MC34004P		TL074CDP	233
MC34060P	MC34060DP		557

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
LF155AH	LF155AH		35
LF155H	LF155H		35
LF156AH	LF156AH		35
LF156H	LF156H		35
LF157AH	LF157AH		35
LF157H	LF157H		35
LF198H	LF198H		667
LF255H	LF255H		35
LF256H	LF256H		35
LF257H	LF257H		35
LF298H	LF298H		667
LF347BN		TL084ACDP	261
LF347N		TL084CDP	261
LF351H		TL081CH	243
LF351N		TL081CDP	243
LF353H		TL081CH	243
LF353N		TL082CDP	251
LF355AH	LF355AH		35
LF355H	LF355H		35
LF355N	LF355DP		35
LF356AH	LF356AH		35
LF356H	LF356H		35
LF356N	LF356DP		35
LF357AH	LF357AH		35
LF357H	LF357H		35
LF357N	LF357DP		35
LF398H	LF398H		667
LF398N	LF398DP		667
LF441ACN		TL061BCDP	193
LF441CN		TL061ACDP	193
LF442ACN		TL062BCDP	201
LF442CN		TL062ACDP	201
LF444CN		TL064ACDP	209
LM101AH	LM101AH		63
LM101AJ	LM101ADG		63
LM105H	LM105H		349
LM108AH	LM108AH		73
LM108AJ-8	LM108ADG		73
LM108H	LM108H		73
LM108J-8	LM108DG		73
LM109H	LM109H		357
LM109K STEEL	LM109K		357
LM111H	LM111H		303
LM111J-8	LM111DG		303
LM117H	LM117H		365
LM117K STEEL	LM117K		365
LM118H	LM118H		87
LM119H	LM119H		311
LM119J	LM119DG		311
LM11CH	LM11CH		49
LM11CLH	LM11LCH		49
LM11CLN	LM11LCDP		49

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Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
LM11CN	LM11CDP		49
LM120K-12		UA7912MK	455
LM120K-15		UA7915MK	455
LM120K-5.0		UA7905MK	455
LM123K STEEL	LM123K		375
LM124J	LM124DG		99
LM137H	LM137H		383
LM137K STEEL	LM137K		383
LM138K STEEL	LM138K		393
LM139AJ	LM139ADG		319
LM139J	LM139DG		319
LM140K-12		UA7812MK	435
LM140K-15		UA7815MK	435
LM140K-5.0		UA7805MK	435
LM146J	LM146DG		111
LM148J	LM148DG		123
LM149J	LM149DG		123
LM1458H	LM1458H		143
LM1458J	LM1458DG		143
LM1458N	LM1458DP		143
LM158H	LM158H		131
LM158J	LM158DG		131
LM1558H	LM1558H		143
LM1558J	LM1558DG		143
LM193AH	LM193AH		329
LM193H	LM193H		329
LM201AH	LM201AH		63
LM201AJ	LM201ADG		63
LM201AN	LM201ADP		63
LM205H	LM205H		348
LM208AH	LM208AH		73
LM208AJ-8	LM208ADG		73
LM208H	LM208H		73
LM208J-8	LM208DG		73
LM209H	LM209H		357
LM209K STEEL	LM209K		357
LM211H	LM211H		303
LM211J-8	LM211DG		303
LM217H	LM217H		365
LM217K STEEL	LM217K		365
LM218H	LM218H		87
LM219H	LM219H		311
LM219J	LM219DG		311
LM223K STEEL	LM223K		375
LM237H	LM237H		383
LM237K STEEL	LM237K		383
LM238K STEEL	LM238K		393
LM239AJ	LM239ADG		319
LM239J	LM239DG		319
LM246J	LM246DG		111
LM248J	LM248DG		123
LM249J	LM249DG		123

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Part number	THOMSON SC		Page
	Direct replacement	Similar replacement	
LM258H	LM258H		131
LM293AH	LM293AH		329
LM293H	LM293H		329
LM2901N	LM2901DP		319
LM2902N	LM2902DP		99
LM2903N	LM2903DP		329
LM2904N	LM2904DP		131
LM301AH	LM301AH		63
LM301AJ	LM301ADG		63
LM301AN	LM301ADP		63
LM305H	LM305H		349
LM308AH	LM308AH		73
LM308AJ-8	LM308ADG		73
LM308AN	LM308ADP		73
LM308H	LM308H		73
LM308J-8	LM308DG		73
LM308N	LM308DP		73
LM309H	LM309H		357
LM309K STEEL	LM309K		357
LM3046N	TDB2046DP		723
LM311H	LM311H		303
LM311J-8	LM311DG		303
LM311N	LM311DP		303
LM317H	LM317H		365
LM317K STEEL	LM317K		365
LM317T	LM317SP		365
LM318H	LM318H		87
LM318N	LM318DP		87
LM319H	LM319H		311
LM319J	LM319DG		311
LM319N	LM319DP		311
LM320K-12		UA7912CK	455
LM320K-15		UA7915CK	455
LM320K-5.0		UA7905CK	455
LM320T-12		UA7912CSP	463
LM320T-15		UA7915CSP	463
LM320T-5.0		UA7905CSP	463
LM323K STEEL	LM323K		375
LM324J	LM324DG		99
LM324N	LM324DP		99
LM334Z	LM334Z		679
LM335AZ	LM335AZ		689
LM335Z	LM335Z		689
LM336BZ-2.5	LM336AZ		699
LM336Z 2.5	LM336Z		699
LM337H	LM337H		383
LM337K STEEL	LM337K		383
LM337T	LM337SP		383
LM338K STEEL	LM338K		393
LM339AJ	LM339ADG		319
LM339AN	LM339ADP		319
LM339J	LM339DG		319

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
LM339N	LM339DP		319
LM3302N	LM3302DP		319
LM340K-12	UA7812CK		455
LM340K-15	UA7815CK		455
LM340K-5.0	UA7805CK		455
LM340T-12	UA7812CSP		455
LM340T-15	UA7815CSP		455
LM340T-5.0	UA7805CSP		455
LM346J	LM346DG		111
LM346N	LM346DP		111
LM358J	LM348DG		123
LM348N	LM348DP		123
LM349J	LM349DG		123
LM349N	LM349DP		123
LM3403N	MC3403DP		151
LM358H	LM358H		131
LM358J	LM358DG		131
LM358N	LM358DP		131
LM393AH	LM393AH		329
LM393AN	LM393ADP		329
LM393H	LM393H		329
LM393N	LM393DP		329
LM4250CH		UA776CH	287
LM4250CN		UA776CDP	287
LM4250H		UA776MH	287
LM555CH	NE555CH		707
LM555CJ	NE555CDG		707
LM555CN	NE555CDP		707
LM555H	SE555MH		707
LM555J	SE555MDG		707
LM556CJ	NE556CDG		715
LM556CN	NE556CDP		715
LM556J	SE556MDG		715
LM723CH	UA723CH		421
LM723CJ	UA723CDG		421
LM723CN	UA723CDP		421
LM723H	UA723MH		421
LM723J	UA723MDG		421
LM741CH	UA741CH		271
LM741CJ	UA741CDG		271
LM741CN	UA741CDP		271
LM741CN-14	UA741CDP14		271
LM741H	UA741MH		271
LM741J	UA741MDG		271
LM748CH	UA748CH		279
LM748CJ	UA748CDG		279
LM748CN	UA748CDP		279
LM748H	UA748MH		279
LM748J	UA749MDG		279
LM7805CK	UA7805CK		435
LM7805CT	UA7805CSP		445
LM7812CK	UA7812CK		435

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
LM7812CT	UA7812CSP		445
LM7815CK	UA7815CK		435
LM7815CT	UA7815CSP		445
LM7905CK	UA7905CK		455
LM7905CT	UA7905CSP		463
LM7905K	UA790MK		455
LM7912CK	UA7912CK		455
LM7912CT	UA7912CSP		463
LM7912K	UA7912MK		455
LM7915K	UA7915CK		455
LM7915CT	UA7915CSP		463
LM7915K	UA7915MK		455

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Part number	Direct replacement	Similar replacement	Page
μPC141A	LM205H		349
μPC151D	UA741IDG		271
μPC151C	UA7411IDP8		271
μPC151G		UA741CFP	271
μPC156D	LM208DP		73
μPC157D	LM201ADG		63
μPC157C	LM201ADP		63
μPC159D		LM318DP	87
μPC177C	LM239DP		319
μPC177ED	LM239DG		319
μPC177G		LM339FP	319
μPC251C	LM1458IDP		143
μPC251D	LM1458IDG		143
μPC251G		LM1458FP	143
μPC258D	MC4558IDG		159
μPC258C	MC4558IDP		159
μPC258G		MC4558CFP	159
μPC271C	LM211DP		303
μPC271ED	LM211DG		303
μPC271G		LM311FP	303
μPC272C	LM219DP		311
μPC272D	LM219G		311
μPC272G		LM319FP	311
μPC277C	LM239DP		319
μPC277D		LM293DP	329
μPC277G		LM393FP	329
μPC301AC	LM301ADP		63
μPC311C	LM311DP		303
μPC311G	LM311FP		303
μPC319C	LM319DP		311
μPC319G	LM319FP		311
μPC324C	LM324DP		99
μPC324G	LM324FP		99
μPC339C	LM339DP		319
μPC339G	LM339FP		319
μPC356C	LF356DP		35
μPC357C	LF357DP		35

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
μPC358C	LM358DP		131
μPC358G	LM358FP		131
μPC393C	LM393DP		329
μPC393G	LM393FP		329
μPC398C	LF398DP		667
μPC451D	LM224DG		99
μPC451C	LM224DP		99
μPC451G		LM324FP	99
μPC452C	MC3303DP		151
μPC452G		MC3403FP	151
μPC458C	LM248DP		123
μPC458D	LM248DG		123
μPC458G		LM348FP	123
μPC494C	TL494IDP		597
μPC617C		NE555CDP	707
μPC649C		LF398DP	667
μPC741C	UA741CDP8		271
μPC741G	UA741CFP		271
μPC801C	TL081IDP		243
μPC803C	TL082IDP		251
μPC803G		TL082CFP	251
μPC804D	TL084IDG		261
μPC804C	TL084IDP		261
μPC806C	LF256DP		35
μPC807C	LF257DP		35
μPC1251D	LM258DG		131
μPC1251C	LM258DP		131
μPC1251G		LM358FP	131
μPC1458C	LM1458DP		143
μPC1458G	LM1458FP		143
μPC1558C	NE555CDP		707
μPC3403C	MC3403DP		151
μPC3403G	MC3403FP		151
μPC4081C	TL081CDP		243
μPC4081G	TL081CFP		243
μPC4082C	TL082CDP		251
μPC4082G	TL082CFP		251
μPC4084C	TL084CDP		261
μPC4558C	MC4558CDP		159
μPC4558G	MC4558CFP		159
μPC4741C	LM348DP		123
μPC4741G	LM348FP		123
μPC78XXH	UA78XXCSP		445
μPC79XXH	UA79XXCSP		463

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
PM108AJ	LM108AH		73
PM108J	LM108H		73
PM111J	LM111H		303
PM155AJ	LF155AH		35
PM155J	LF155H		35
PM156AJ	LF156AH		35
PM156J	LF156H		35
PM157AJ	LF157AH		35
PM157J	LF157H		35
PM208AJ	LM208AH		73
PM208J	LM208H		73
PM211J	LM211H		303
PM225J	LF255H		35
PM256J	LF256H		35
PM257J	LF257H		35
PM308AJ	LM308AH		73
PM308J	LM308H		73
PM311J	LM311H		303
PM355AJ	LF355AH		35
PM355J	LF355H		35
PM356AJ	LF356AH		35
PM356J	LF356H		35
PM357AJ	LF257AH		35
PM357J	LF357H		35
PM741CJ	UA741CH		271
PM741CZ	UA741CDG		271
PM741J	UA741MH		271
PM741Z	UA741MDG		271
PM1458CJ	LM1458H		143
PM1458CZ	LM1458DG		143
PM1558J	LM1558H		143
PM1558Z	LM1558DG		143

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Part number	THOMSON SC Direct replacement	THOMSON SC Similar replacement	Page
CA081AE	TL081ACDP		243
CA081BE	TL081BCDP		243
CA081E	TL081CDP		243
CA081T	TL081MH		243
CA082AE	TL082ACDP		251
CA082BE	TL082BCDP		251
CA082E	TL082CDP		251
CA082T	TL082MH		251
CA084AE	TL084ACDP		261
CA084BE	TL084BCDP		261
CA084E	TL084CDP		261
CA101T	LM101AH		63
CA124E	LM124DP		99
CA139AE	LM139ADP		319
CA139E	LM139DP		319
CA158T	LM158H		131
CA201T	LM201AH		63
CA224E	LM224DP		99
CA239AE	LM239ADP		319
CA239E	LM239DP		319
CA258E	LM258DP		131
CA258T	LM258H		131
CA301AE	LM301ADP		63
CA301AT	LM301AH		63
CA311E	LM311DP		303
CA311T	LM311H		303
CA324E	LM324DP		99
CA339AE	LM339ADP		319
CA339E	LM339DP		319
CA358E	LM358DP		131
CA358T	LM358H		131
CA555CE	NE555CDP		707
CA555CT	NE555CH		707
CA555T	SE555MH		707
CA723CE	UA723CDP		421
CA723CT	UA723CH		421
CA723T	UA723MH		421
CA741CE	UA741CDP8		271
CA741CT	UA741CH		271
CA741T	UA741MH		271
CA748CE	UA748CDP		279
CA748CT	UA748CH		279
CA748T	UA748MH		279
CA1458E	LM1458DP		143
CA1458T	LM1458H		143
CA1558T	LM1558H		143
CA2904E	LM2904DP		131
CA3046	TDB2046DP		723
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L78XXCT	UA78XXCK		435
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L79XXCT	UA79XXCK		455
L79XXCV	UA79XXCSP		463
L79XXT	UA79XXMK		455
LM117K	LM117K		365
LM217K	LM217K		365
LM317K	LM317K		365
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LM324AN	LM324ADP		99
LM324CM	LM324FP		99
LM324N	LM324DP		99
LM339AN	LM339ADP		319
LM339CM	LM339FP		319
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LM2902CM	LM2902FP		99
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LS101AT	LM101AH		63
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LS141CB	UA741CDP		271
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HS0458D	LM1458FP		143
HS0555D	NE555CFP		707
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LF157AH	LF157AH		35
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LF198H	LF198H		667
LF255H	LF255H		35
LF256H	LF256H		35
LF257H	LF257H		35
LF298H	LF298H		667
LF355AH	LF355AH		35
LF355H	LF355H		35
LF355N	LF355DP		35
LF356AH	LF356AH		35
LF356H	LF356H		35
LF356N	LF356DP		35
LF357AH	LF357AH		35
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LM224N	LM224DP		99
LM239AF	LM239ADG		319
LM239AN	LM239ADP		319
LM239F	LM239DG		319
LM239N	LM239DP		319
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LM308AH	LM308AH		73
LM308AN	LM308ADP		73
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LM324AF	LM324ADG		99
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LM2901D	LM2901FP		319
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LM2902D	LM2902FP		99
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LM2903D	LM2903FP		329
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LM2904D	LM2904FP		131
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LM2903D	LM2903FP	329
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LM393D	LM393FP	329
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MC3403D	MC3403FP	151
NE532D	LM358FP	131
NE555D	NE555CFP	707
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