Seagate

MICROELECTRONICS LIMITED

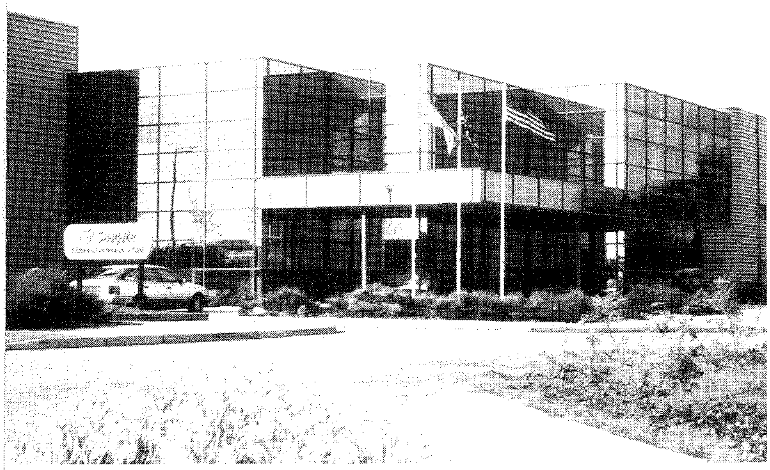
LINEAR
INTEGRATED CIRCUITS
1989 DATA BOOK

SEAGATE MICROELECTRONICS

Seagate Microelectronics Ltd. is part of the Seagate Technology Corporation, the world's leading manufacturer of hard disc drives for small computer systems.

The company provides advanced integrated circuit solutions for power management applications. This technology combines elements such as power, precision analogue and digital control into a single monolithic chip.

Seagate Microelectronics production facility is constructed to the highest specifications incorporating the latest cleanroom architecture equipment and services. Statistical process control (S.P.C.) techniques are employed throughout the manufacturing cycle ensuring quality and reliability are inherent to every Seagate Microelectronics device.



As a result Seagate Microelectronics is able to participate in Hi-Rel programmes worldwide and currently holds BS9000/CECC factory and product approvals, is a supplier of MIL STD 883C and class S devices, in addition to the list of approvals for D.E.S.C. "MIL DRAWING" system.

Seagate Microelectronics Limited
MacIntosh Road, Kirkton Campus,
Livingston EH54 7BW, SCOTLAND
Telephone: (0506) 416416
Telex: 727360 INTPOW G
Fax: (0506) 413526

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GENERAL INFORMATION

1

Proprietary Device Marking

IP # X ### X /BSS2 /883B

- Screening to BS 9400 or MIL STD 883 Rev C
- Package
- Product Part Number
- Product Family Designator
- Temperature Range Indicator
- Designated Seagate Microelectronics Proprietary Device

Product Family Designator	Description
D	Driver
M	Motor Control
P	Pulse Width Modulator
R	Regulator

Package Suffix	Description
D	Surface Mount Integrated Circuit (SOIC)
G	TO-257 Hermetic (TO-220 Style)
H	TO-39 Metal Can
J	Ceramic DIP
K	TO-3 Metal Can
N	Plastic DIP & Batwing
R	TO-66 Metal Can
T	TO-220 Molded
V	TO-218 Molded
W	Single In-line Power Tab

Temp Range Indicator	Temperature Range (Ambient)
1	Military Temperature Range (−55°C to +125°C)
2	Industrial Temperature Range (−25°C to +85°C) or (−40°C to +85°C)
3	Commercial Temperature Range (0°C to +70°C)

Alternate Source Device Marking

XXX #### X X /BSS2 /883B

- Screening to BS 9400 or MIL STD 883 Rev. C
- Package
- Letter Indicates Improved Electrical Specification
- Product Part Number
- Designator: LM, are Second-Source Devices, IP indicates Improved or Proprietary Devices

Devices are listed in the table of contents alphanumerically by product family and then by device number. Most of Seagate Microelectronics linear circuits employ a 1-2-3 numbering system. The 1 denotes a Military temperature range device (−55°C to +125°C), the 2 denotes an Industrial temperature range device (−25°C to +85°C), and the 3 denotes a Commercial temperature range device (0°C to +70°C), i.e., IP117A/IP317A.

Parts are generally listed in the table of contents by military part numbers first, i.e., IP117A/IP317A. Where only one temperature range exists, the part will be listed in its proper order, i.e., IP293.

GENERAL INFORMATION

VOLTAGE REGULATOR SELECTION GUIDE

Output Current	Output Votage	1% Output Tolerance		4% Output Tolerance		Packages
0.5A	Fixed +5V	IP78M05A IP140MA-5		IP78M05 IP140M-5		TO-39 TO-116 (8 pin)
	Fixed +12V	IP78M12A IP140MA-12		IP78M12 IP140M-12		
	Fixed +15V	IP78M15A IP140MA-15		IP78M15 IP140M-15		
	Fixed -5V	IP79M05A IP120MA-5		IP79M05 IP120M-5		
	Fixed -12V	IP79M12A IP120MA-12		IP79M12 IP120M-12		
	Fixed -15V	IP79M15A IP120MA-15		IP79M15 IP120M-15		
	Adj. +1.2V to +40V	IP117MA		IP117M		TO-39
	Adj. +1.2V to +60V	IP117MAHV		IP117MHV		
	Adj. −1.2V to −40V	IP137MA		IP137M		
	Adj. −1.2V to −50V	IP137MAHV		IP137MHV		
1.5A	Fixed +5V	IP7805A IP140A-5		IP7805 IP140-5		TO-3 TO-39
	Fixed +12V	IP7812A IP7815A		IP7812 IP7815		TO-66
	Fixed +15V	IP7815A IP140A-15		IP7815 IP140-15		TO-257
	Adj. +1.2V to +40V	IP117A		IP117		
	Adj. +1.2V to +60V	IP117AHV	IP317AHV	IP117HV	IP317HV	
	Fixed -5V	IP7905A IP120A-5		IP7905 IP120-5		
	Fixed -12V	IP7912A IP120A-12		IP7912 IP120-12		
	Fixed -15V	IP7915A IP120A-15		IP7915 IP120-15		
	Adj. -1.2V to -40V	IP137A		IP137		
	Adj. -1.2V to -50V	IP137AHV	IP337AHV	IP137HV	IP337HV	
3.0A	Fixed +5V	IP123A-5	IP323A-5	IP123-5		TO-3
	Fixed +12V	IP123A-12	IP323A-12	IP123-12		TO-218
	Fixed +15V	IP123A-15	IP323A-15	IP123-15		TO-220
	Fixed -5V	IP1R17A-5	IP3R17A-5	IP1R17-5	IP3R17-5	
	Fixed -5.2V	IP1R17A-5.2	IP3R17A-5.2	IP1R17-5.2	IP3R17-5.2	TO-257
	Fixed -12V	IP1R17A-12	IP3R17A-12	IP1R17-12	IP3R17-12	
	Fixed -15V	IP1R17A-15	IP3R17A-15	IP1R17-15	IP3R17-15	
	Adj. +1.2V to +35V	IP150A	IP350A	IP150		
	Adj. +1.2V to +35V Low Dropout	IP1R07A	IP3R07A	IP1R07	IP3R07	
5.0A	Fixed +5V	IP1R18A-5	IP3R18A-5	IP1R18-5	IP3R18-5	TO-3
	Fixed +12V	IP1R18A-12	IP3R18A-12	IP1R18-12	IP3R18-12	TO-218
	Fixed +15V	IP1R18A-15	IP3R18A-15	IP1R18-15	IP3R18-15	
	Fixed -5V	IP1R19A-5	IP3R19A-5	IP1R19-5	IP3R19-5	
	Fixed -5.2V	IP1R19A-5.2	IP3R19A-5.2	IP1R19-5.2	IP3R19-5.2	
	Fixed -12V	IP1R19A-12	IP3R19A-12	IP1R19-12	IP3R19-12	
	Fixed -15V	IP1R19A-15	IP3R19A-15	IP1R19-15	IP3R19-15	
	Adj. +1.2V to +35V	IP138A	IP338A	IP138	IP338	

GENERAL INFORMATION

PWM CIRCUIT SELECTION GUIDE

Part Number	Outputs	Output Type	Reference Precision	Output Transistor Rating	Under Voltage Lockout	Soft Start
IP1P125	2	Totem Pole	1%	35V/100mA	Yes	Yes
IP1524	2	Uncommitted	1%	40V/50mA	No	Ext.
IP1524B	2	Uncommitted	1%	60V/200mA	Yes	Ext.
IP1525A	2	Totem Pole	1%	35V/100mA	Yes	Yes
IP1526	2	Totem Pole	1%	35V/100mA	Yes	Yes
IP1526A	2	Totem Pole	1%	35V/100mA	Yes	Yes
IP1527A	2	Totem Pole	1%	35V/100mA	Yes	Yes
IP1842	1	Totem Pole	1%	30V/200mA	Yes	Yes
IP1843	1	Totem Pole	1%	30V/200mA	Yes	Yes
IP1844	1	Totem Pole	1%	30V/200mA	Yes	Yes
IP1845	1	Totem Pole	1%	80V/200mA	Yes	Yes
IP5560/1060	1	Uncommitted	1.6%	18V/40mA	Yes	Ext.
IP5561	1	Open Collector	2%	18V/40mA	Yes	Ext.
IP35063	1	Uncommitted	5%	40V/1.5A	N/A	Ext.

MOTOR/POWER DRIVER SELECTION GUIDE

Function	Part Number	Volts	Amps	Logic	Logic Supply Volts	Internal Clamp Diodes	Current Feedback Sense Resistor	Split Supply	Package
H Bridge	IP1D03	50	5.0	Yes		No	Ext.	No	8 Pin TO-3
	IP3D03	50	5.0	Yes		No	Ext.	No	8 Pin Power SIP*
Dual Bridge	IM10	40	±200m	Yes	5	Yes	Ext.	Option	14 Pin CERDIP
	3M10	40	±200m	Yes	5	Yes	Ext.	Option	14 Pin DIP
	IM12	40	±200m	Yes	7min	Yes	Ext.	Option	14 Pin CERDIP
	3M12	40	±200m	Yes	7min	Yes	Ext.	Option	14 Pin DIP
Universal Quad Driver	IP3D08	50	2.0	Yes		Yes			Pwr 16 Pin DIP
	IP3D09	50	2.0	Yes		Yes	Ext.		Pwr 20 Pin DIP

* FUTURE

POWER/SUPPLY MONITOR CIRCUIT SELECTION GUIDE

Part Number	Function	Fault Condition	Voltages Monitored	Reference Accuracy
IP1543	Voltage Sense	OV/UV/CL	2.5V to 40V	1%

GENERAL INFORMATION

Double Pulse Suppression	Current Limit CM Range	Dead Time Adjust	Error Amp CM Range	Shutdown	*Package TO-116 Style	No. of Pins
Yes	N/A	No	1.8 to V_{CC}-2	Yes, Dig	J.N.D.	16
No	-1 to 1V	No	1.8 to 3.4	Yes	J.N.D.	16
Yes	0 to V_{CC}-2	No	2.3 to 5.2	Yes, Dig.	J.N.D.	16
Yes	N/A	Yes	1.8 to V_{CC}-2	Yes, Dig.	J.N.D.	16
Yes	0 to V_{CC}-3	Yes	0 to V_{CC}-2	Yes, Dig.	J.N.D.	18
Yes	0 to V_{CC}-2	Yes	0 to V_{CC}-2	Yes, Dig.	J.N.D.	18
Yes	N/A	Yes	1.8 to V_{CC}-2	Yes, Dig.	J.N.D.	16
N/A	0 to 1V	Yes	N/A	N/A	J.N.D.	**8
N/A	0 to 1V	Yes	N/A	N/A	J.N.D.	**8
N/A	0 to1V	Yes	N/A	N/A	J.N.D.	**8
N/A	0 to1V	Yes	N/A	N/A	J.N.D.	**8
N/A	N/A	Yes	N/A	Yes	J.N.D.	16
N/A	N/A	No	N/A	Yes	J.N.D.	8
N/A	N/A	No	N/A	No	J.N.D.	8

*J — CERAMIC N — PLASTIC D — PLASTIC **SURFACE MOUNT PACKAGE CAN BE SUPPLIED 8 PIN OR 14 PIN

PWM APPLICATION GUIDE

Family	Direct MOS Drive	I Limit	House-keeping	High Freq.	Current Mode	Specific Features	Family Applications
Single-ended							
IP5560/1060		●	●				Forward Converter
IP5561		●					Fly-back Converter
IP1842/43/44/45	●	●		●	●		
Push-Pull							
1524/1524B		●					Push-Pull Converter
1525A/27A	●						Full Bridge Converter
1526/26A	●	●	●	●			1/2 Bridge Converter
IP1P125	●			●		●	
DC-DC Converter							
IP34063		●					DC-DC Converter

	Seagate Microelectronics	Fairchild	Linear Technology	Motorola	National	SGS	Signetics	Silicon General	Sprague	Texas Instruments	Unitrode
TO-3	**K**	K	K	K, KS	K, KC	K	—	K	V	K	K
TO-39	**H**	H	H	G	H	—	H	T	—	LA	—
TO-66	**R**	—	—	—	—	—	—	R	—	—	—
TO-116 Plastic	**N**	T, P	N, N8	P	N	B, N, P	N	M, N	A, M, B	P, N	N
TO-116 Ceramic	**J**	D, R	J, J8	U	J	—	F	J, Y	R	J, JG	J
TO-218	**V**	—	—	—	—	—	—	—	—	—	—
TO-220 Plastic	**T**	U	T	T	T	V	—	P	Z	KC	T
TO-257 Hermetic (TO-220)	**G**	—	—	—	—	—	—	—	—	—	—
Power SIP	**W**	—	—	—	T	Multi Watt	—	S	W	—	V
SOIC	**D**	S		D	M		D	D	L	D, DW	—

GENERAL INFORMATION

SEAGATE Standard	SEAGATE Improved	Linear Tech	Motorola	National	SGS	Signetics	Silicon General	Sprague	T1	Unitrode
IP117HV	IP117AHV			LM117AHV		LM117HV				
IP117	IP117A	LT117	LM117	LM117	LM117		SG117		LM117	UC117
IP120.5	IP120A.5			LM120.5			SG120.5		LM120.5	
IP120.12	IP120A.12			LM120.12			SG120.12		LM120.12	
IP120.15	IP120A.15			LM120.15			SG120.15		LM12015	
IP123	IP123A	LT123A	LM123/MC78T05	LM123			SG123/SG153.5		SN55123	
IP123.12	IP123A.12		MC78T12				SG153.12			
IP123.15	IP123A.15		MC78T15				SG153.15			
IP137HV	IP137AHV	LT137AHV		LM137HV						
IP137	IP137A	LT137A	LM137	LM137				LM137	UC137	
IP138	IP138A	LT138A		LM138			SG138			
IP140.5	IP140A.5			LM140.5			SG140.5		LM140.5	
IP140.12	IP140A.12			LM140.12			SG140.12		LM140.12	
IP140.15	IP140A.15			LM140.15			SG140.15		LM140.15	
IP150	IP150A	LT150A	LM150	LM150			SG150			UC150
IP1R17	IP1R17A			LM145						
IP317HV	IP317AHV	LT317AHV		LM317HV						
IP337HV	IP337AHV		LM337HV							
IP338	IP338A	LT338A		LM338			SG338			
IP3R17	IP3R17A			LM345						
IP1060						TDA1060				
IP1524		LT1524		LM1524		SG1524	SG1524	ULS8124	SG1524	UC1524
IP1524B							SG1524B			UC1524A
IP1525A		SG1525A	SG1525A				SG1525A	SG1525A		UC1525A
IP1526	IP1526A		SG1526			SG1526A	SG1526	ULS8126		UC1526
IP1543							SG1543			UC1543
IP1842	IP1842A									UC1842
IP1843	IP1843A									UC1843
IP1844	IP1844A									UC1844
IP1845	IP1845A									UC1845
IP1526A							SG1526A			UC1526A
IP33063			MC33063							
IP34063	IP34063A		MC34063A							
IP35063			MC35063							
IP2842										UC2842
IP2843										UC2843
IP2844										UC2844
IP2845										UC2845
IP3524B							SG3524B			UC3524A
IP3525A		SG3525A	SG3525A				SG3525A		SG3525A	UC3525A
IP3526	IP3526A		SG3526			SG3526A	SG3526	ULN8126		UC3526
IP3543							SG3543			UC3543
IP3842										UC3842
IP3843										UC3843
IP3844										UC3844
IP3845										UC3845
IP5560						SE5560		ULS8160		
IP5560C						NE5560		ULN8160		
IP5561						SE5561		ULS8161		
IP5561C						NE5561		ULN8161		
IP7805	IP7805A		MC7805	LM7805	L7805		SG7805		μA7805	UC7805
IP7812	IP7812A		MC7812	LM7812	L7812		SG7812		μA7812	UC7812
IP7815	IP7815A		MC7815	LM7815	L7815		SG7815		μA7815	UC7815
IP7905	IP7905A		MC7905	LM7905			SG7905		μA7905	UC7905
IP7912	IP7912A		MC7912	LM7912			SG7912		μA7912	UC7912
IP7915	IP7915A		MC7915	LM7915			SG7915		μA7915	UC7915

QUALITY AND RELIABILITY

Seagate Microelectronics produce a wide range of standard and custom linear power devices for power management purposes such as motor control, power supplies, power drives, power interfaces and power regulation.

Complex logic linear interface and power elements are combined providing unique and cost effective solutions in the areas of power to electronics interface.

Research and development is directed to the special requirements of power management in integrated circuits from a package and process technology concept. Through these facilities Seagate Microelectronics is uniquely placed to offer their customers comprehensive assistance in the development, manufacture and production of linear power and custom circuits and is committed to manufacturing a product with the maximum quality and reliability.

The quality and reliability of integrated circuits is determined by many facets. Design, fabrication manufacturing, packaging and testing are all interlinked and each part may impact the device reliability over a period of time.

Seagate Microelectronics is fully aware of these facts. A systematic approach is taken to assure the manufacturing of superior analog circuits. Our standard manufacturing flow chart is shown on pages 16 and 17.

Quality Assurance

Seagate Microelectronics is determined that no defective material shall be shipped to their customers.

Statistical process control techniques are employed throughout the operation to ensure that all manufacturing processes are defined and controlled.

Quality is the responsibility of each and every employee.

Maximum effort is placed on operator training certification and quality awareness.

A strict checks and balances system is maintained.

Each critical process is monitored through quality control, acceptance procedures and quality audits.

Electrical quality is guaranteed by not only guardbanding the measured limits but also the associated forcing functions.

All lots are submitted to a lot acceptance procedure stipulating a 0.1% AQL for all parameters at 25°C and temperature extremes as well as visual mechanical criteria for standard and military product.

Handling procedures are optimized to eliminate the mixing of parts.

Outgoing shipments are verified by quality assurance personnel against the original customer orders.

Outgoing quality levels are monitored by measuring the average outgoing quality.

Data is collected monthly and discussed with Seagate Microelectronics management in order to identify corrective actions.

Seagate Microelectronics actively seeks customer feedback and participation.

Design

Reliability starts at design. High voltage techniques are used for all Seagate Microelectronics products. Only bandgap or subsurface zener references are implemented to minimize drift and noise problems.

Metallization thickness is defined to minimize current density and so avoid metal migration problems. Power transistors and bonding pads are carefully laid out to minimize current densities in high current carrying tracks.

Seagate Microelectronics current density specification is one of the lowest in the industry.

Bonding pads are positioned in such a manner that there is no overhanging of the bond and bond tail into active areas or tracks. They are of sufficient size to accommodate the wire size employed in power devices.

All voltage regulators are properly short circuit protected and have thermal limiting included to effect shutdown and safeguard against catastrophic failure.

Motor control circuits employ inductive clamping on chips to prevent damage to the circuit.

All Seagate Microelectronics products are designed to operate over the military temperature range.

These examples demonstrate the commitment of Seagate Microelectronic's design philosophy towards providing "Bullet Proof" products for their customers.

Wafer Fabrication

Seagate Microelectronic's wafer manufacturing facility incorporates the most up to date wafer processing equipment.

Maximum effort has been placed on minimizing operator induced errors and handling procedures.

Photomasking processes are greatly enhanced by the employment of proximity mask aligners.

Critical dimensions, mask registration, resist adhesion and etch rates are all carefully monitored.

At the diffusion stages extensive steps are taken to minimize the impact of ionic contamination and defect densities.

Seagate Microelectronic's processes incorporate a dual passivation process to minimize the ingress of moisture and the effects of ionic contamination.

All diffusion tubes and depositioning equipment are regularly monitored using CV measuring techniques.

Extensive statistical process control assures that the process is fully understood.

Raw Material

All purchased materials such as raw silicon, chemicals, lead frames and headers are specified in procurement specifications and products are inspected at incoming prior to issuance to the manufacturing line. The performance of suppliers to Seagate Microelectronics are continuously monitored for quality and delivery.

Assembly and Packaging

In addition to the wafer and die manufacturing process the assembly packaging method can have a serious impact on the overall reliability performance of the final product.

Selection of the best available packaging materials and methods of assembly are therefore of prime importance.

The wafer/die separation utilizes a saw through method eliminating the cracking, chipping and mechanical stresses associated with earlier processes such as diamond scribe and break.

Internal visual inspection of all Seagate Microelectronics products is performed per MIL-STD-883 Method 2010 and BS9400 para. 1.2.10.

Die attach techniques are receiving special attention due to the special heat dissipation requirements for linear power products. Many rigorous checks are made such as die shear, thermal resistance and die attach coverage using scanning acoustical microscope and infrared scanning techniques.

The Research and Development programme includes package development particularly related to the power handling capability of Seagate Microelectronics products.

Semi automatic bonding equipment improves lead bond consistency and integrity.

Low temperature sealing glasses in ceramic packages minimize the effects of the sealing temperature on the final product, while for molded packages, the molding components specified have a very low sodium and chlorine content.

Sealing processes are continuously monitored for fine/gross leak and moisture content.

Electrical Test

Seagate Microelectronics invested heavily in the most up to date linear computer controlled test equipment and temperature handlers such as LTX, Symtek, Spartan Exatron and MCT.

The test philosophy includes proper guardbanding, not only to the measured limits but also the forcing functions.

Thermal regulation tests for voltage regulators are closely related to die attach quality.

Reliability

Seagate Microelectronics relies on accelerated life testing and purpose designed tests to determine the reliability performance of its product.

Data from these tests is used to predict infant mortality, wear out and other failure mechanisms.

Through appropriate failure analysis techniques and interpretation of the data, product improvement programmes are accomplished.

Accelerated life tests are also employed as an ongoing assessment of process capability.

It should be noted that a relationship exists between accelerated stress test conditions and actual normal conditions of use.

1, 2. Incoming Material. Raw silicon and chemicals are received from approved vendors and accepted through an incoming inspection prior to use in the manufacture of wafers.

3. Seagate Microelectronics Waferfabrication. Using photolithography, high temperature diffusion, and oxidation depositing techniques integrated circuits are manufactured in wafer form.

4. QC In-Process Audit. Consistency and control are regularly verified using control charting and statistical process controls. CV plotting checks for contamination. Scanning electron microscope techniques identify integrity of step coverage. Misalignment and metalization, resistivity, oxide thickness, pinhole density, and critical dimension are also verified.

5. Wafersort. Each individual chip on the finished wafer is electronically tested to determine the yield and process distribution using probing equipment linked to sophisticated electrical testers.

6. QC Wafersort. Each wafersort operation is inspected for probe quality, such as deep probing, dragging probes, inking quality and consistency.

7. Wafersaw Die Separation. The die on the wafer are separated using sawthrough methods. Good die are separated from reject die.

8. 100% Die Visual Inspection. Each die is submitted to a full visual inspection per MIL STD 883C, Method 2010 and BS9400.1.2.10.

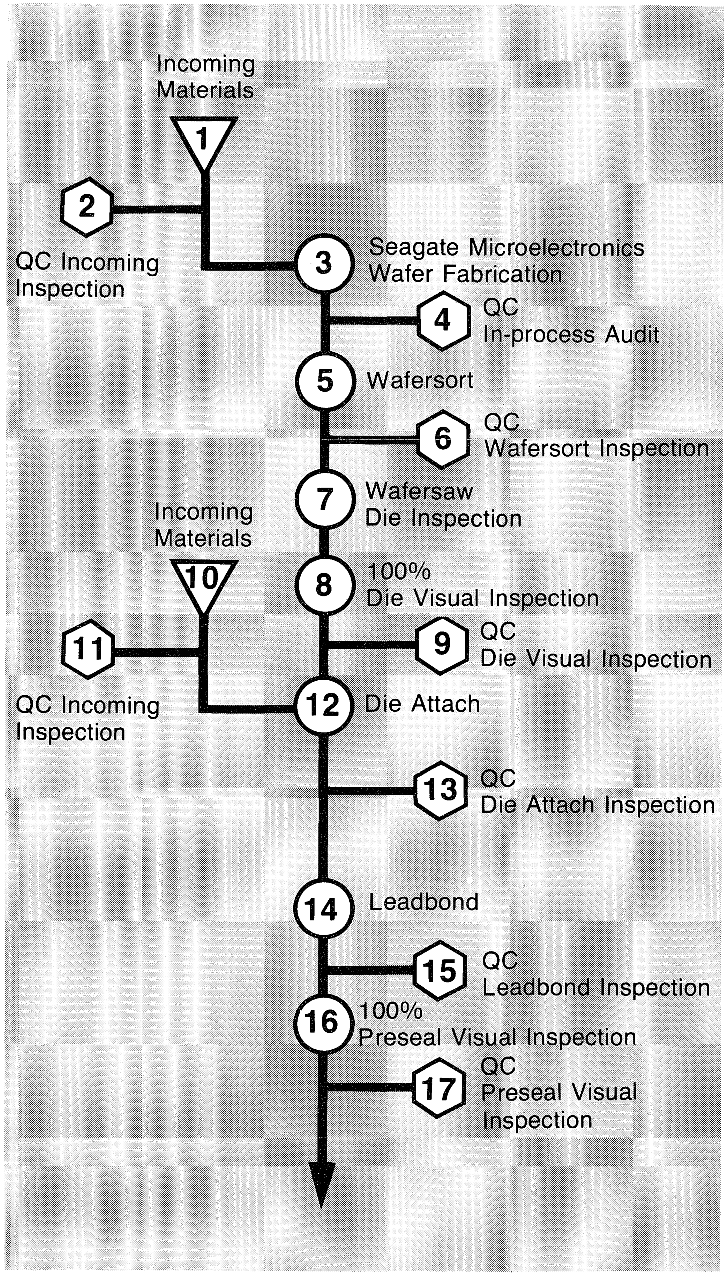
9. QC Die Visual Inspection. Each visual inspection is verified.

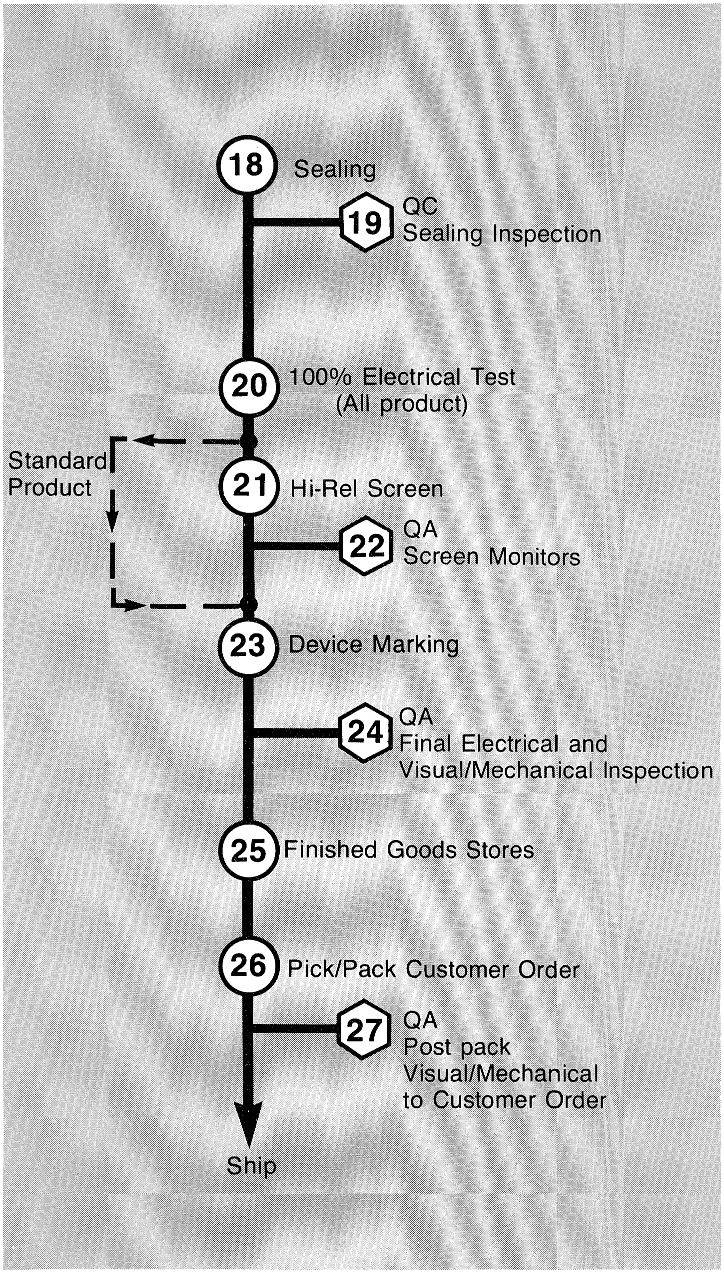
10, 11. Incoming Material. Raw materials such as headers, cans, leadframes, moulding compound, bondwire and die attach materials are purchased from approved vendors and inspected prior to submitting to assembly.

12. Die Attach. Die are mounted on the headers and leadframes using gold silicon eutectic, softsolder and other methods. For power devices, extreme care is taken to assure low thermal resistance.

13. QC Die Attach. Each die attach operation is monitored using die shear, die removal, and visual methods.

14. Leadbond. Die is connected to the leads with wire using ultrasonic, thermosonic, and thermocompression bonding techniques.





15. **QC Leadbond.** Leadbond quality is verified using bondpull tests. Each operation is measured using control charts.

16. **100% Preseal Visual Inspection (3rd Optical Inspection).** Prior to sealing, each device is inspected for workmanship, bonding quality, and contaminants per MIL STD 883C, Method 2010 and BS9400 para. 1, 2. 10.

17. **QC Preseal Visual Inspection.** Each preseal operation is checked for correctness and compliance.

18. **Sealing.** Each device is sealed hermetically or molded in epoxy-type molding compounds.

19. **QC Seal Visual.** The sealing operation is monitored for fine/gross leak, moisture content, and visual (placing of lids, cans, etc.)

20. **100% Final Electrical Test @ 25°C and Temperature Extremes.** After burn-in, all integrated circuits are tested fully and at the temperature extremes if required.

21. **High Rel Screening.** Screening procedures as per section 5 of this data book.

22. **QA Screen Monitors** To ensure compliance with screening procedures.

23. **Bottom Marking, Top Marking.** All devices receive a bottom mark to identify the device type, lot number for traceability purposes, and a sealing datecode. Seagate Microelectronics logo, device type, and datecode are marked on the top.

24. **QA Final Electrical and Visual/Mechanical Test.** Final quality inspection for compliance to Seagate Microelectronics visual, mechanical and electrical standards.

25. **Finished Goods Stores.** Product is stored in Finished Goods.

26. **Pick/Pack Customer Order.** Customer orders are made up from finished goods inventory.

27. **QA Post-pack Visual/Mechanical to Customer Order.** Final outgoing QA verification of shipment against customer order.

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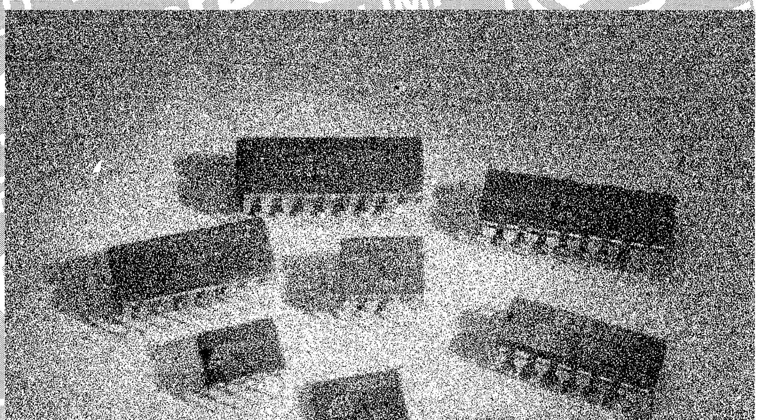
PULSE WIDTH MODULATORS

2



Seagate Microelectronics Limited

REGULATING PULSE WIDTH MODULATORS

IP1P125, IP3P125

2

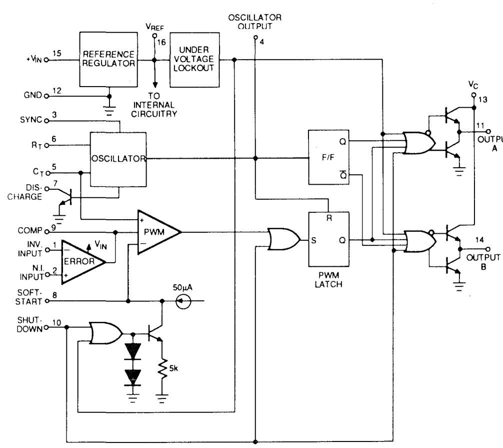
DESCRIPTION

The IP1P125 series of pulse width modulator integrated circuits offers high speed performance optimized for MOSFET drive. Pin compatible with the SG1525A, the IP1P125 features low crossover current through the output transistors as well as 95% total usable output pulse width up to 500KHz. High speed latched shutdown is included as well as a precision 5.1 volt reference, error amp, oscillator, latched PWM comparator, totem-pole output drivers, soft-start and undervoltage lockout.

FEATURES

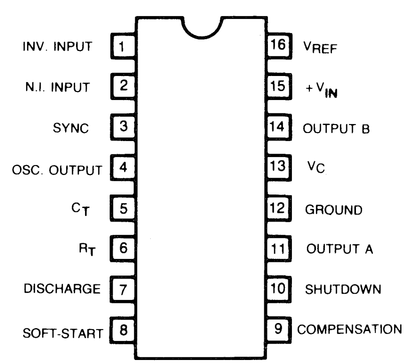
- Pin compatible with 1525A series
- Low output crossover current
- Fixed 100ns deadtime
- 100ns response latched shutdown
- 100Hz to 500KHz operating frequency
- 5.1 volt ± 1% reference
- Oscillator sync. terminal
- Soft-start
- Undervoltage lockout
- Latching PWM

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (300) Package

REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage ($+V_{IN}$)	+40V
Collector Supply Voltage ($+V_C$)	+40V
Logic Iputs	+0.3V to +5.5V
Analog Inputs	−0.3V to $+V_{IN}$
Output Current, Source or Sink	500mA
Reference Output Load Current	Internally Limited
Oscillator Charging Current	5mA
Power Dissipation at	
T_A = +25°C (Note 1)	1000mW
T_C = +25°C (Note 2)	2000mW
Operating Junction Temperature	−55°C to +150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage	+8V to +35V
Collector Supply Voltage	+4.5V to +35V
Sink/Source Load Current (steady state)	0 to 100mA
Sink/Source Load Current (peak)	0 to 400mA
Oscillator Frequency Range	100Hz to 500kHz
Oscillator Timing Resistor	1.5kΩ to 200kΩ
Oscillator Timing Capacitor	470pF to 0.1μF
Operating Ambient Temperature Range:	
IP1525A/IP1527A	−55°C to +125°C
IP2525A/IP2527A	−25°C to +85°C
IP3525A/IP3527A	0°C to +70°C

Note 1. Derate at 10 mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 16 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1P125J	−55°C to +125°C	16 Pin Ceramic DIP
IP3P125D	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3P125J	0°C to + 70°C	16 Pin Ceramic DIP
IP3P125N	0°C to + 70°C	16 Pin Plastic DIP

REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (Note 4)

2

Parameter	Test Conditions		IP1P125 Min	IP1P125 Typ	IP1P125 Max	IP3P125 Min	IP3P125 Typ	IP3P125 Max	Units
Turn-on Characteristics									
Undervoltage Threshold, V_{IN}	V_{IN} Rising	●	5.0	6.5	8.0	5.0	6.5	8.0	V
Turn-on Hysteresis		●	0.2	0.5	0.9	0.2	0.5	0.9	V
Operating Current	V_{IN} = 8 to 35V	●		10	20		10	20	mA
Reference Section									
Output Voltage			5.05	5.10	5.15	5.00	5.10	5.20	V
Output Voltage	V_{IN} = 8 to 35V, I_L = 0 to 20mA	●	5.00		5.20	4.95		5.25	V
Line Regulation	V_{IN} = 8 to 35V	●		1	10		1	15	mV
Load Regulation	I_L = 0 to 20 mA	●		5	15		5	25	mV
Temperature Stability (Note 5)	Over Operating Range	●		15	50		15	50	mV
Short Circuit Current	V_{REF} = 0 Volts	●	25	70	120	25	70	120	mA
Output Noise Voltage (Note 5)	10Hz $\leqslant$ f $\leqslant$ 10kHz			40	200		40	200	μVrms
Long term Stability (Note 5)	T_j = 125°C			1	10		1	50	mV/kHr
Oscillator Section (Note 6)									
Initial Accuracy			37.6	40	42.4	37.6	40	42.4	kHz
Voltage Stability	V_{IN} = 8 to 35V	●		0.1	0.5		0.1	2	%
Temperature Stability (Note 5)	Over Operating Range	●		1	4		1	6	%
Minimum Frequency	R_T = 200k Ω, C_T = 0.1 μF	●		80	120		80	120	Hz
Maximum Frequency	R_T=1.5k Ω, C_T=470pF, R_D=0Ω			900			900		kHz
Current Mirror	I_{RT} = 2.0 mA	●	1.7	2.0	2.2	1.7	2.0	2.2	mA
Clock Amplitude	Output, PIN 4, C_T = 0.01 μF	●	3.0	4.0		3.0	4.0		V
Clock Pulse Width	Output, PIN 4, C_T = 0.01 μF	●	0.3	0.5	1.3	0.3	0.5	1.3	μs
Sync Threshold		●	1.2	2.0	2.8	1.2	2.0	2.8	V
Sync Input Current	Sync Voltage = 3.5V	●		1.0	2.5		1.0	2.5	mA
Error Amplifier Section									
Input Offset Voltage	V_{cm} = 1.5 to 5.2V	●		0.1	5		2	10	mV
Input Bias Current	V_{cm} = 1.5 to 2.5V	●		1	5		1	10	μA
Input Offset Current	V_{cm} = 1.5 to 5.2V	●		0.1	1		0.1	1	μA
DC Open Loop Gain	ΔV_0 = 1 to 3V, $R_L \geqslant$ 10 MΩ	●	60	80		60	80		dB
Common Mode Rejection	V_{cm} = 1.5 to 5.2V	●	60	90		60	90		dB
Supply Voltage Rejection	V_{IN} = 8 to 35V	●	50	90		50	90		dB
Output Low Level		●		0.2	0.5		0.2	0.5	V
Output High Level		●	3.8	5.6	7.0	3.8	5.6	7.0	V
Gain-Bandwidth Product (Note 5)			1	3.5		1	3.5		MHz
PWM Comparator									
Minimum Duty Cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geqslant$ 150mV	●			0			0	%
Maximum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geqslant$ 150mV	●	45	49		45	49		%
Input Threshold Low	Zero Duty Cycle	●	0.6	0.9		0.6	0.9		V
Input Threshold High	Max. Duty Cycle	●		3.3	3.6		3.3	3.6	V
Input Bias Current				.05			.05		μA

REGULATING PULSE WIDTH MODULATORS

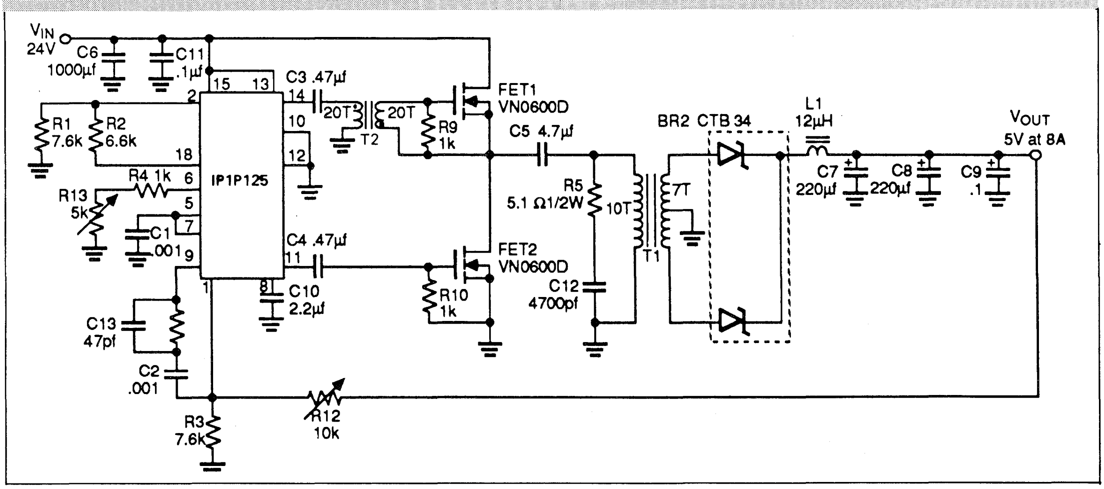
ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1P125 Min	IP1P125 Typ	IP1P125 Max	IP3P125 Min	IP3P125 Typ	IP3P125 Max	Units
Shutdown Section									
Soft Start Current	$V_{SHUTDOWN}$ = 0V	●	25	50	80	25	50	100	μA
Soft Start Low Level	$V_{SHUTDOWN}$ = 2V	●		0.4	0.6		0.4	0.6	V
Shutdown Threshold	To Outputs	●	0.6	1.3	2.0	0.6	1.3	2.0	V
Shutdown Input Current	$V_{SHUTDOWN}$ = 2.5V	●		0.1	1.0		0.1	1.0	mA
Shutdown Delay (Note 5)	T_j = 25°C, PIN 10 to Output			50	300		50	300	ns
Output Section (Each Transistor)									
Collector Leakage Current	V_C = 35 Volt	●			200			200	μA
Output Low Level	I_{SINK} = 20mA	●		0.2	0.4		0.2	0.4	V
	I_{SINK} = 100mA	●		1.0	2.5		1.0	2.5	V
Output High Level	I_{SOURCE} = 20mA	●	18	19		18	19		V
	I_{SOURCE} = 100mA	●	17	18		17	18		V
Rise Time	C_l = 1nF, T_j = 25°C			100	300		100	300	ns
Fall Time	C_L = 1nF, T_j = 25°C			50	150		50	150	ns
Dead Time	C_L = 1nF, T_j = 25°C			100			100		ns

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 4: V_{IN} = 20V, I_{REF} = 0mA unless otherwise specified.
Note 5: These parameters, although guaranteed over the recommended conditions, are not 100% tested in production.
Note 6: R_T = 3.6kΩ, C_T = 0.01 μF unless otherwise specified.

TYPICAL APPLICATION



Seagate Microelectronics Limited

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

IP1060B, IP1060, IP1060A

2

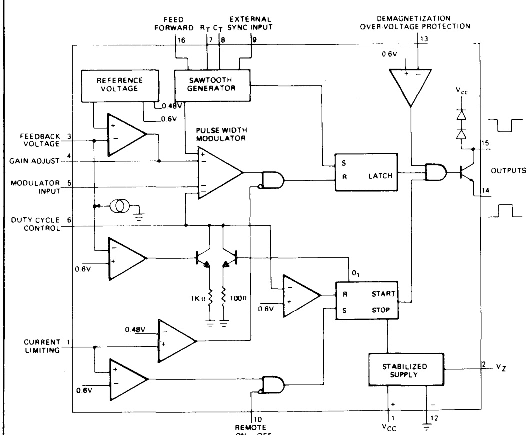
DESCRIPTION

The IP1060 is a control circuit for use in switched mode power supplies. This single monolithic chip incorporates all the control and supervisory (protection) functions required in switched mode power supplies, including an internal temperature compensated reference source, sawtooth generator, pulse width modulator, output stage and various protection circuits.

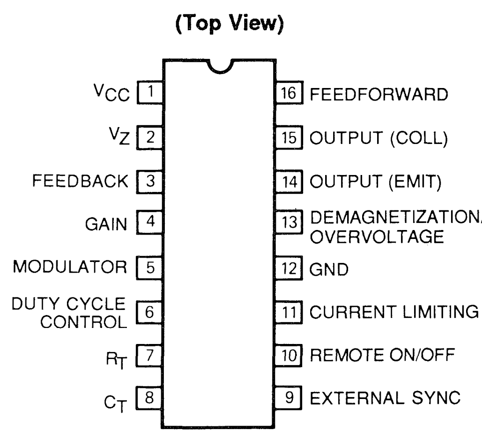
FEATURES

- Stabilized power supply
- Temperature compensated reference source
- Sawtooth generator
- Pulse width modulator
- Remote on/off switching
- Current limiting
- Low supply voltage protection
- Loop fault protection
- Demagnetization/overvoltage protection
- Maximum duty cycle clamp
- Feed forward control
- External synchronization

BLOCK DIAGRAM



CONNECTIONS



N, J and D (150) Package

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ABSOLUTE MAXIMUM RATINGS

Supply
- Voltage Sourced — 18V
- Current Sourced — 30mA

Output Transistor
- Output Current — 40mA
- Collector Voltage (Pin 15) — 18V

Max. Emitter Voltage (Pin 14) — 5V

Operating Temperature (Ambient)
- IP1060B — −55°C to +125°C
- IP1060 — −25°C to +85°C
- IP1060A — 0°C to 70°C

Storage Temperature Range — −65°C to +150°C

Operating Junction Temperature Range — 150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

V_{CC} = 12V unless otherwise specified

Parameter	Test Conditions		IP1060B/IP1060 Min	IP1060B/IP1060 Typ	IP1060B/IP1060 Max	IP1060A Min	IP1060A Typ	IP1060A Max	Unit
Reference Sections									
Internal Reference Voltage (V_{ref})			3.69	3.72	3.81	3.57	3.72	3.95	V
		•	3.42		4.03	3.42		4.03	V
Temperature Coefficient of V_{ref}				±100			±100		ppm/C
Internal Reference (V_Z)	I_L = .7mA		7.9	8.4	9.0	7.8	8.4	9.0	V
Temperature Coefficient of V_Z				±200			±200		ppm/C
Oscillator Section									
Frequency Range		•	50		100k	50		100k	Hz
Initial Accuracy Oscillator	R = 5 kΩ			5			5		%
Duty Cycle range	f_o = 20 KHz		0-90	0-98		0-90	0-98		%
Modulator									
Modulator Input Current	Voltage, at Pin 5 = 2V	•		-0.2	-5.0		-0.2	-5.0	µA
Supervisory Functions									
Pin 6, Input Current	At 2V O	•		-0.2	-6.0		-0.2	-6.0	µA
Pin 6, Duty Cycle Limit Control	(For 50% Max. Duty Cycle) 15 kHz to 50 kHz, $V_6 = 0.4\,V_Z$		40	50	60	40	50	60	% Duty Cycle
Pin 1, Low Supply Voltage Protection Thresholds			8.85	9.0	10.8	8.85	9.0	10.8	V
Pin 3, Feedback Loop Protection Trip Thresholds			460	600	720	460	600	720	mV
Pin 3, Pull Up Current	At 2V	•	-7	-15	-35	-7	-15	-35	µA
Pin 13, Demag./O.V. Prot. Threshold			470	600	720	470	600	720	mV
Pin 13, Input Current	At 0.25V			-0.6	-7.0		-0.6	-7.0	µA
		•			-20			-20	µA
Pin 16, Feed Forward Duty Cycle Control	Voltage at Pin 16 = $2V_Z$		30	40	50	30	40	50	% Orig Duty Cycle
Pin 16, Feed Forward Input Current	At 16V, V_{CC} = 18V			0.2	50		0.2	50	µA

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1060B/IP1060			IP1060A			Unit
			Min	Typ	Max	Min	Typ	Max	
External Synchronization									
Pin 9 Off			0		0.8	0		0.8	V
Pin 9 On			2		V_Z	2		V_Z	V
Pin 9, Sink Current	Voltage at Pin 9 = 0V			-85	-120		-85	-120	µA
Remote On/Off									
Pin 10 Off			0		0.8	0		0.8	V
Pin 10 On			2		V_Z	2		V_Z	V
Pin 10 Sink Current Pin 9 = 0V	Voltage at Pin 9 = 0V			-85	-120		-85	-120	µA
to Pin 10 = 0V									
Current Limiting									
Pin 11, I_{IN}	Voltage at Pin 11 = 250mV			-2	-10		-2	-10	µA
Single Pulse Inhibit Delay	Inhibit Delay Time for 20% Overdrive at 30mA I_{OUT}			0.7	0.8		0.7	0.8	Δs
Trip Levels: Shut Down, Slow Start			560	600	700	560	600	700	mV
Trip Levels: Current Limit			400	480	560	400	480	560	mV
Error Amplifier									
Output Voltage Swing (V_{OH})			6.2		9.5	6.2		9.5	V
Output Voltage Swing (V_{OL})					0.7			0.7	V
Open Loop gain			54	60		54	60		dB
Feedback Resistor			10k			10k			Ω
Small Signal Bandwidth				3			3		MHz
Output Stage									
$V_{CE(SAT)}$	I_C = 40mA				0.4			0.4	V
Output Current	(Pin 15)				40			40	mA
Max Emitter Voltage	(Pin 14)		5			5			V
Supply Voltage/Current									
I_{CC}	I_Z = 0 Voltage Feed V6 = 5V				10			10	mA
	R7 = 25kΩ	•			15			15	mA
V_{CC}	I_{CC} = 10mA, Current Feed		20		24	19		24	V
V_{CC}	I_{CC} = 30mA, Current Feed		20		30	20		30	V

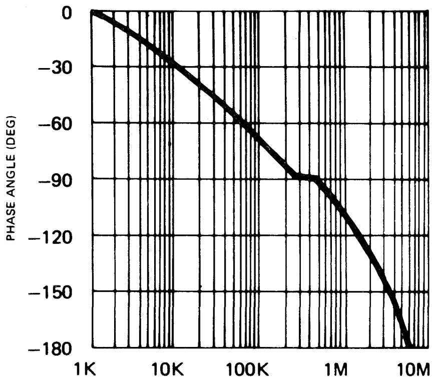
The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

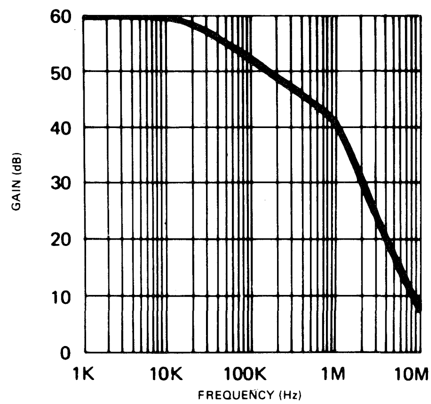
TYPICAL PERFORMANCE CHARACTERISTICS

ERROR AMPLIFIER

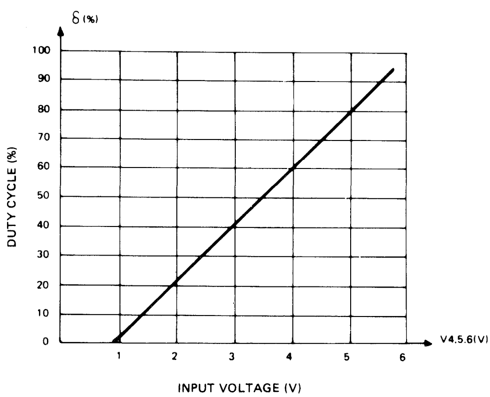
OPEN LOOP PHASE



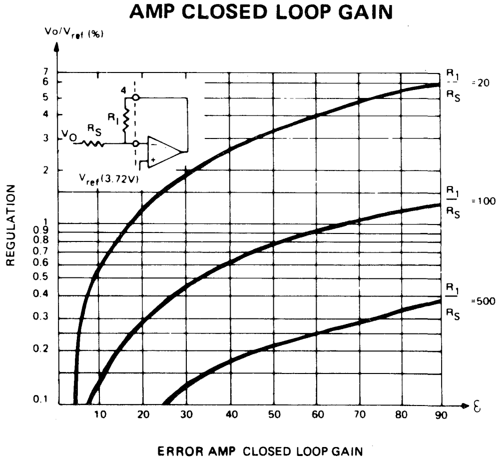
OPEN LOOP GAIN



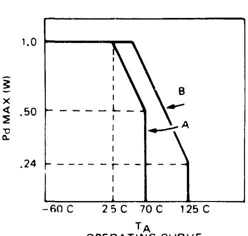
TRANSFER CURVE OF PULSE WIDTH MODULATOR DUTY CYCLE vs INPUT VOLTAGE



REGULATION vs ERROR AMP CLOSED LOOP GAIN

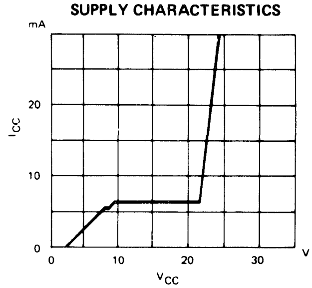


POWER DERATING CURVE

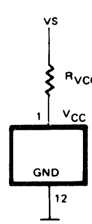


$P_d = V_{CC}\, I_{CC} + (V_{CC} - V_z) I_Z + [(V_{15} - V_{14})\, I_{15} \times \text{DUTY CYCLE}]$

VOLTAGE/CURRENT FED SUPPLY CHARACTERISTICS



CURRENT FED DROPPING RESISTOR



$R_{VCC} = \frac{V_S - V_{CC}}{(10 \text{ to } 20 \text{ mA})}$

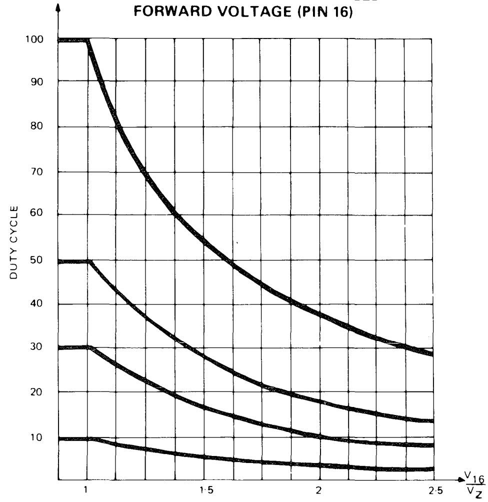
SEE DC ELECTRICAL CHARACTERISTICS FOR CURRENT FEED V_{CC} RANGE.

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

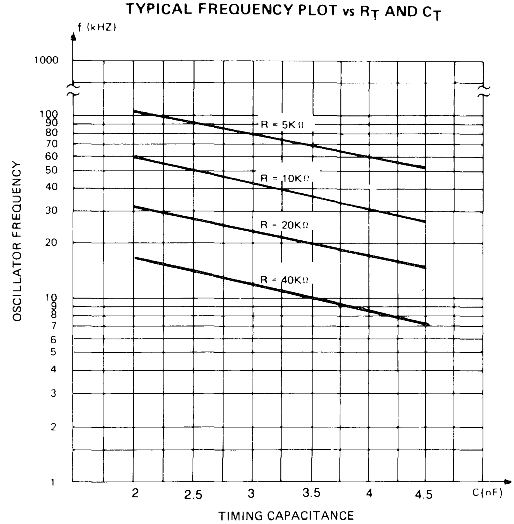
TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

ERROR AMPLIFIER (Cont.)

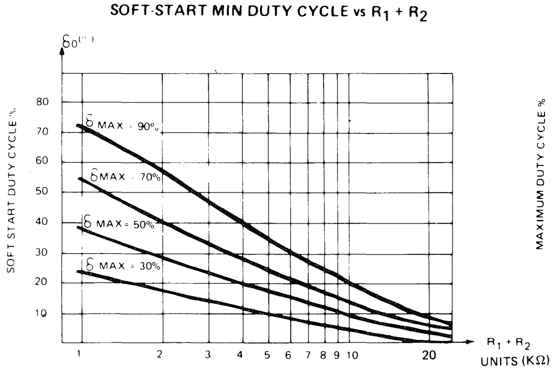
DUTY CYCLE SENSITIVITY TO FEED FORWARD VOLTAGE (PIN 16)



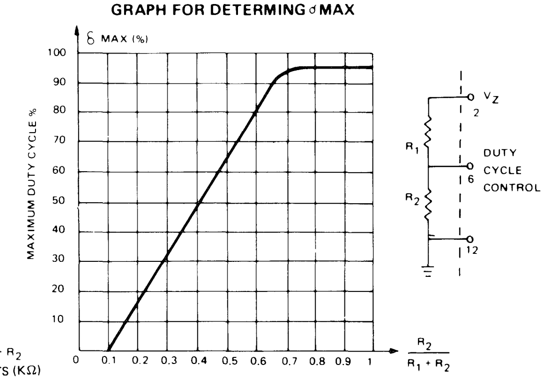
TYPICAL FREQUENCY PLOT vs R_T AND C_T



SOFT-START MIN DUTY CYCLE vs $R_1 + R_2$



GRAPH FOR DETERMING δ MAX



ORDER INFORMATION

Part Number	Temperature Range	Package
IP1060BJ	−55°C to +125°C	16 Pin Ceramic DIP
IP1060D	−25°C to + 85°C	16 Pin Plastic (150) SOIC
IP1060J	−25°C to + 85°C	16 Pin Ceramic DIP
IP1060N	−25°C to + 85°C	16 Pin Plastic DIP
IP1060AD	0°C to + 70°C	16 Pin Plastic (150) SOIC
IP1060AJ	0°C to + 70°C	16 Pin Ceramic DIP
IP1060AN	0°C to + 70°C	16 Pin Plastic DIP

REGULATING PULSE WIDTH MODULATOR

IP1524, IP3524

DESCRIPTION

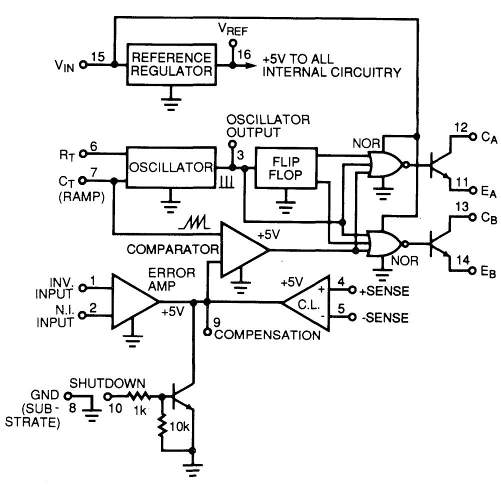
The IP1524 series of PWM switching regulator control circuits contains all the functions required to implement single-ended or push-pull switching regulators. Included are voltage reference, error amplifer, oscillator, PWM comparator, output drivers, current limiting and shutdown circuitry.

Although functionally indentical to the SG1524 series, Seagate Microelectronics has incorporated several improvements to the IP1524 allowing tighter and more complete specification of electrical performance.

FEATURES

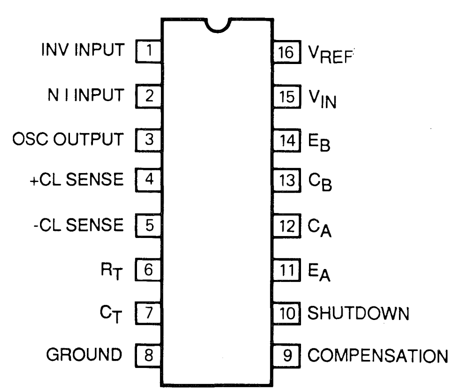
- Guaranteed ± 2% reference tolerance
- Guaranteed ± 6% oscillator tolerance
- Fully specified temperature performance
- Guaranteed 10 mV/1000 hours long term stability
- Interchangeable with SG1524 series

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (150) Package

REGULATING PULSE WIDTH MODULATOR

ABSOLUTE MAXIMUM RATINGS

Input Voltage (+V_{IN})	+40V
Collector Voltage	+40V
Output Current (each transistor)	100mA
Reference Load Current	Internally Limited
Oscillator Charging Current	5mA
Shut Down Pin Voltage	+5.5V
Current Limit Sense Common Mode Range	−1.0V to +1.0V
Power Dissipation at	
T_A = +25°C (Note 1)	1000mW
T_C = +25°C (Note2)	2000mW
Operating Junction Temperature	−55°C to +150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage (V_{IN})	+8V to +40V
Collector Voltage	0V to +40V
Error Amp Common Mode Range	+1.8V to +3.4V
Output Current (each transistor)	0 to 100mA
Reference Load Current	0 to 20mA
Oscillator Charging Current	30μA to 2.0mA
Oscillator Frequency Range	50Hz to 500kHz
Oscillator Timing Resistor (R_T)	1.8kΩ to 100kΩ
Oscillator Timing Capacitor (C_T)	1nF to 0.1μF
Operating Ambient Temperature Range	
IP1524	−55°C to +125°C
IP3524	−0°C to + 70°C

Note 1. Derate at 10mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 16mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

+V_{IN} = 20V, I_{REF} = 0mA unless otherwise specified

Parameter	Test Conditions		IP1524 Min	IP1524 Typ	IP1524 Max	IP3524 Min	IP3524 Typ	IP3524 Max	Units
Reference Section									
Output Voltage		•	4.90	5.00	5.10	4.60	5.00	5.40	V
Line Regulation	+V_{IN} = 8 to 40 Volts	•		1	10		10	30	mV
Load Regulation	I_L = 0 to 20 mA	•		5	20		20	50	mV
Ripple Rejection	f = 120 Hz			80			66		dB
Short Circuit Current	V_{REF} = 0 Volts	•	25	50	120		100		mA
Temperature Stability (Note 6)	Over Operating Range	•		0.3	1		0.3	1	%
Long Term Stability (Note 6)	T_j = 125°C			1	10		20		mV/khr
Oscillator Section									
Initial Accuracy	R_T = 2.7kΩ, C_T = 0.01 μF				6		5		%
Voltage Stability	+V_{IN} = 8 to 40 Volts			0.1	1		0.5	1	%
Temperature Stability (Note 6)	Over Operating Range	•		1	2			2	%

REGULATING PULSE WIDTH MODULATOR

ELECTRICAL CHARACTERISTICS (CONTINUED)

2

Parameter	Test Conditions		IP1524			IP3524			
			Min	Typ	Max	Min	Typ	Max	Units
Minimum Frequency	$R_T = 100K\Omega, C_T = 0.1\mu F$	•		120	240		120		Hz
Maximum Frequency	$R_T = 2k\Omega, C_T = 0.001\ \mu F$	•	200	300			300		kHz
Sawtooth Peak Voltage	$C_T = 0.01\mu F$			3.6			3.6		V
Sawtooth Valley Voltage	$C_T = 0.01\mu F$		0.6	1			1		V
Clock Amplitude	Output, Pin 3, $C_T = 0.01\mu F$	•	3.0	4.0			3.5		V
Clock Pulse Width	Output, Pin 3, $C_T = 0.01\mu F$		0.3	0.5	1.0		0.5		µs
Error Amplifier Section (Note 4)									
Input Offset Voltage		•		0.1	5		2	10	mV
Inputr Bias Current		•		1	2		1	10	µA
Input Offset Current		•			0.5			1	µA
DC Open Loop Gain		•	72	80		60	80		dB
Output Low Level	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150mV$				0.5			0.5	V
Output High Level	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150mV$		3.8			3.8			V
Common Mode Rejection			70	90			70		dB
Supply Voltage Rejection	$+V_{IN} = 8$ to 40 Volts		70	100			70		dB
Gain Bandwidth Product Note 6				3			3		MHz
PWM Comparator									
Minimum Duty Cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150mV$	•			0			0	%
Maximum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150mV$	•	45	49		45	49		%
Current Limit Amplifier (Note 5)									
Sense Voltage	$V_{CM} = 0V$		190	200	210	180	200	220	mV
Sense Voltage	$V_{CM} = 0V$	•	170	200	230		200		mV
Shutdown Input									
High Input Voltage	$V_{PIN\ 9} \leq 0.6V$	•	1.2			1.2			V
High Input Current	$V_{SHUTDOWN} = +5.0$ Volts	•		4	8		4		mA
Low Input Voltage	$V_{PIN\ 9} \geq 3.5V$	•			0.3			0.3	V
Output Section (Each Transistor)									
Collector-Emitter Voltage	$I_C = 50\mu A$	•	40			40			V
Collector Leakage Current	$V_{CE} = 40$ Volts	•		0.1	50		0.1	50	µA
Collector Saturation Voltage	$I_C = 50mA$	•		1	2		1	2	V
Emitter Output Voltage	$V_{IN} = 20V$	•	17	18		17	18		V
Emitter Voltage Rise Time	$R_E = 2k$			0.2	0.4		0.2		µs
Collector Voltage Fall Time	$R_C = 2k$			0.1	0.2		0.1		µs
Power Consumption									
Standby Current	$+V_{IN} = 40$ Volts	•		5	10		5	10	mA

The • denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.

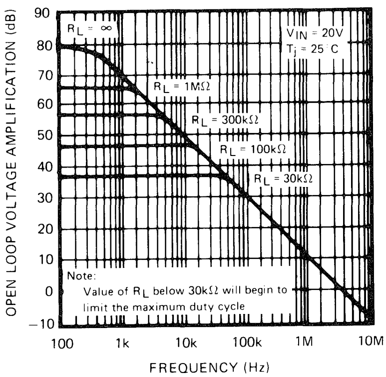
Note 4: $V_{CM} = +1.8$ to $+3.4V$
Note 5: $V_{CM} = -1$ to $+1V$
Note 6: These parameters, although guaranteed conditions, are not 100% tested in production.

REGULATING PULSE WIDTH MODULATOR

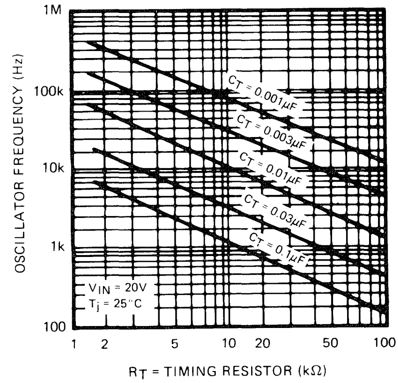
TYPICAL PERFORMANCE CHARACTERISTICS

2

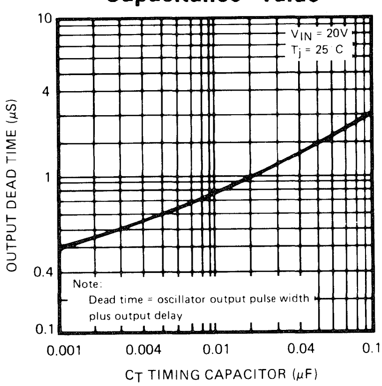
Open-Loop Voltage Amplification of Error Amplifier vs. Frequency



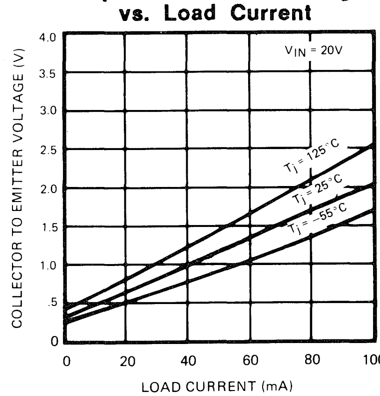
Oscillator Frequency vs. Timing Components



Output Dead Time vs. Timing Capacitance Value



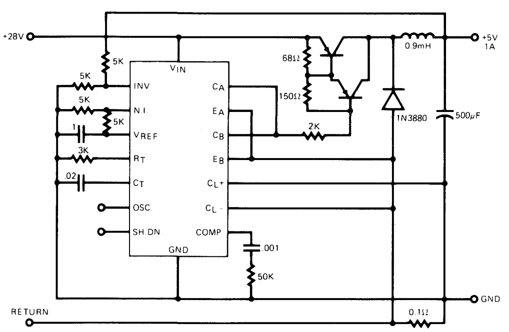
Output Saturation Voltage vs. Load Current



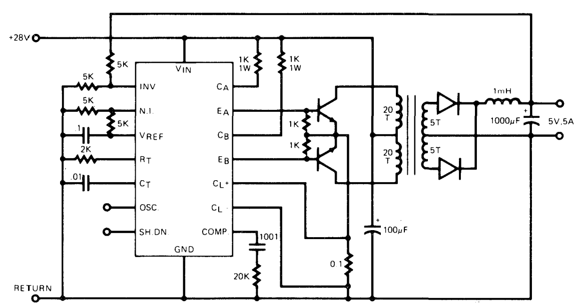
REGULATING PULSE WIDTH MODULATOR

APPLICATIONS INFORMATION

The IP1524 is a fixed-frequency pulse-width modulation voltage regulator control circuit. The regulator operates at a frequency that is programmed by one timing resistor (R_T) and one timing capacitor (C_T). R_T establishes a constant charging current for C_T, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. The IP1524 contains an on-board 5V regulator that serves as a reference as well as powering the IP1524's internal control circuitry and is also useful in supplying external support functions. This reference voltage is lowered externally by a resistor divider to provide a reference within the common-mode range of the error amplifier or an external reference may be used. The power supply output is sensed by a second resistor divider network to generate a feedback signal to the error amplifier. The amplifier output voltage is then compared to the linear voltage ramp at C_T. The resulting modulated pulse out of the high-gain comparator is then steered to the appropriate output pass transistor (Q_1 or Q_2) by the pulse-steering flip-flop, which is synchronously toggled by the oscillator output. The oscillator output pulse also serves as a blanking pulse to assure both outputs are never on simultaneously during the transition times. The width of the blanking pulse is controlled by the value of the C_T. The outputs may be applied in a push-pull configuration in which their frequency is half that of the base oscillator, or paralled for single-ended applications in which the frequency is equal to that of the oscillator. The output of the error amplifier shares a common input to the comparator with the current limiting and shutdown circuitry and can be overridden by signals from either of these inputs. This common point is also available externally and may be employed to control the gain of, or to compensate, the error amplifier, or to provide additional control to the regulator.



In this conventional single-ended regulator circuit, the two outputs of the IP1524 are connected in parallel for effective .0-90% duty cycle modulation. The use of an output inductor requires an R-C phase compensation network for loop stability.



Push-pull outputs are used in this transformer-coupled DC-DC regulating converter. Note that the oscillator must be set at twice the desired output frequency as the IP1524's internal flip-flop divides the frequency by 2 as it switches the PWM signal from one output to the other. Current limiting is done in the primary so that the pulse width will be reduced should transformer saturation occur.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1524J	−55°C to +125°C	16 Pin Ceramic DIP
IP3524D	0°C to + 70°C	16 Pin Plastic (150) SOIC
IP3524J	0°C to + 70°C	16 Pin Ceramic DIP
IP3524N	0°C to + 70°C	16 Pin Plastic DIP

ADVANCED REGULATING PULSE WIDTH MODULATOR

IP1524B, IP3524B

2

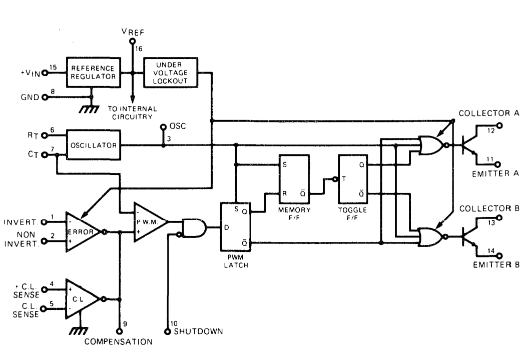
DESCRIPTION

The IP1524B is a pulse width modulator for switching power supplies which features improved performance over industry standards like the SG1524. A direct pin-for-pin replacement for the earlier device, it combines advanced processing techniques and circuit design to provide improved reference accuracy, and extended common mode range at the error amplifier and current limit inputs. A DC-coupled flip-flop eliminates triggering and glitch problems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response, while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the shutdown pin is used for pulse-by-pulse current limiting.

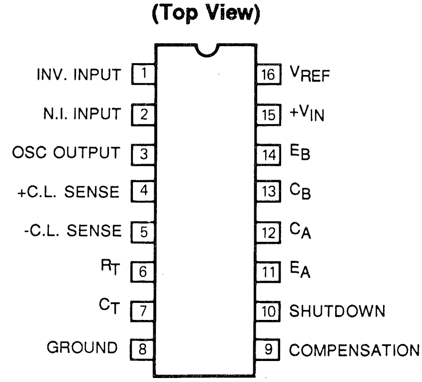
FEATURES

- Pin compatible with 1524 series
- 7 to 40 volt operation
- 5 volt reference trimmed to ± 1%
- Undervoltage lockout
- Excellent external sync capability
- Wide current limit common mode range
- +5V error amplifier common mode
- PWM data latch
- Full double-pulse suppression logic
- 50ns shutdown function
- Dual 200mA, 60 volt output transistors
- Fully specified over temperature

BLOCK DIAGRAM



CONNECTIONS



N, J and D (300) Package

ADVANCED REGULATING PULSE WIDTH MODULATOR

ABSOLUTE MAXIMUM RATINGS

Input Voltage (+V_{IN}) +40V
Collector Voltage +60V
Logic Inputs −0.3V to +5.5V
Current Limit Sense Inputs −0.3V to +V_{IN}
Oscillator Charging Current 5mA

Power Dissipation at
T_A = +25°C (Note 1) 1000mW
T_C = +25°C (Note 2) 2000mW
Operating Junction Temperature −55°C to +150°C
Storage Temperature Range −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage (V_{IN}) +7V to +40V
Collector Voltage 0V to +60V
Error Amp Common Mode Range +2.3V to V_{REF}
Current Limit Sense Common Mode Range 0V to V_{IN} −2.5V
Output Current (each transistor) 0 to 200mA
Reference Load Current 0 to 20mA

Oscillator Charging Current 25 µ to 1.8mA
Oscillator Frequency Range 50Hz to 500kHz
Oscillator Timing Resistor (R_T) 2kΩ to 150kΩ
Oscillator Timing Capacitor (C_T) 1nF to 0.1µF
Operating Ambient Temperature Range
IP1524B −55°C to +125°C
IP3524B 0°C to +70°C

Note 1. Derate at 10mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 16 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 20V, I_{REF} = 0mA unless otherwise specified)

Parameter	Conditions		IP1524B Min	IP1524B Typ	IP1524B Max	IP3524B Min	IP3524B Typ	IP3524B Max	Units
Turn-on Characteristics									
V_{IN} Undervoltage Threshold	V_{IN} Rising	•	4.3	5.2	6.5	4.3	5.2	6.5	V
Turn-on Hysteresis		•	0.1	0.3	0.6	0.1	0.3	0.6	V
Operating Current	V_{IN} = 7 to 40V	•		7	10		7	10	mA
Reference Section									
Output Voltage			4.95	5.00	5.05	4.90	5.00	5.10	V
Output Voltage	V_{IN} = 7 to 40V, I_L = 0 to 20mA	•	4.90		5.10	4.85		5.15	V
Line Regulation	V_{IN} = 7 to 40V	•		1	10		1	15	mV
Load Regulation	I_L = 0 to 20 mA	•		5	15		5	25	mV
Temperature Stability (Note 4, Note 6)	Over Operating Range	•		40	75		40	75	mV
Short Circuit Current	V_{REF} = 0V	•	25	70	120	25	70	120	mA
Long Term Stability (Note 4)				1	10		1		mV/khr
Oscillator Section (Note 5)									
Initial Accuracy			41	43	45	39	43	47	kHz
Voltage Stability	V_{IN} = 7 to 40 V	•		0.1	1		0.1	1	%
Temperature Stability (Note 4)	Over Operating Range	•		1	2		1	2	%

ADVANCED REGULATING PULSE WIDTH MODULATOR

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Conditions		IP1524B Min	IP1524B Typ	IP1524B Max	IP3524B Min	IP3524B Typ	IP3524B Max	Units
Minimum Frequency	R_T = 150 kΩ, C_T = 0.1 µF	•		80	140		80	140	Hz
Maximum Frequency	R_T = 2 kΩ, C_T = 470 pF	•	400	700		400	700		kHz
Clock Amplitude	Output, Pin 3 C_T = 0.01 µF	•	3.0	4.0		3.0	4.0		V
Clock Pulse Width	Output, Pin 3 C_T = 0.01 µF	•	0.4	0.5	1.2	0.4	0.5	1.2	µs
Sawtooth Peak Voltage	C_T = 0.01µF	•		3.7	4.0		3.7	4.0	V
Sawtooth Valley Voltage	C_T = 0.01 µF	•	0.6	1	1.1	0.6	1	1.1	V
Sawtooth Valley T.C.				-1.0			-1.0		mV/°C
Error Amplifier Section									
Input Offset Voltage	V_{CM} = 2.3 V to V_{REF}	•		0.1	5		2	10	mV
Input Bias Current	V_{CM} = 2.3 V to V_{REF}	•		1	5		1	10	µA
Input Offset Current	V_{CM} = 2.3 V to V_{REF}	•		0.1	1		0.1	1	µA
DC Open Loop Gain	ΔV_O = 1 to 3 V, $R_L \geq$ 10 MΩ	•	60	75		60	75		dB
Common Mode Rejection	V_{CM} = 2.3 V to V_{REF}	•	70	90		70	90		dB
Supply Voltage Rejection	V_{IN} = 7 to 40 V	•	76	120		76	120		dB
Output Low Level	I_{SINK} = 100 µA	•		0.2	0.5		0.2	0.5	V
Output High Level	I_{SOURCE} = 100 µA	•	3.8	4.2		3.8	4.2		V
Gain Bandwidth Product (Note 4)			1	2		1	2		MHz
PWM Comparator									
Minimum Duty Cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geq$ 150 mV	•			0			0	%
Maximum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geq$ 150 mV	•	45	49		45	49		%
Current Limit Amplifier									
Sense Voltage	V_{CM} = 0 to 17.5V V_{IN} = 7 to 40V	•	180	200	220	180	200	220	mV
Input Bias Current	V_{CM} = 0 to 17.5V, V_{IN} = 7 to 40 V	•		-1	-10		-1	-10	µA
Shutdown Input									
High Input Voltage		•	2.0			2.0			V
High Input Current	$V_{SHUTDOWN}$ = 5.0V	•		0.1	1		0.1	1	mA
Low Input Voltage		•			0.6			0.6	V
Shutdown Delay	Pin 10 to Output			50			50		ns
Output Section (Each Transistor)									
Collector Leakage Current	V_{CE} = 60V	•		0.1	20		0.1	20	µA
Collector Saturation Voltage	I_C = 20 mA	•		0.2	0.4		0.2	0.4	V
	I_C = 200 mA	•		1.0	2.2		1.0	2.2	V
Emitter Output Voltage	I_E = 50 mA	•	17	19		17	19		V
	I_E = 200 mA	•	16.5	18		16.5	18		V
Emitter Voltage Rise Time	R_E = 2k			0.2	0.4		0.2		µs
Collector Voltage Fall Time	R_C = 2k			0.1	0.2		0.1		µs

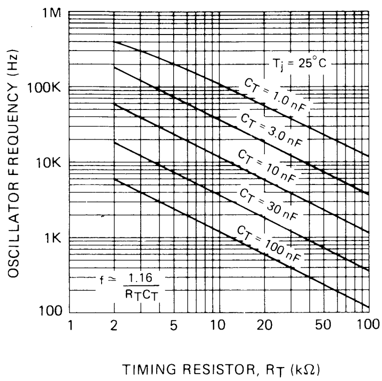
The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 4. These parameters, although guaranteed over the recommended conditions, are not 100% tested in production.
Note 5. R_T = 2.7KΩ, C_T = 0.01µF unless otherwide specified.

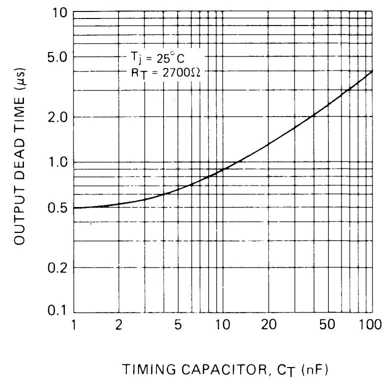
ADVANCED REGULATING PULSE WIDTH MODULATOR

TYPICAL PERFORMANCE CHARACTERISTICS

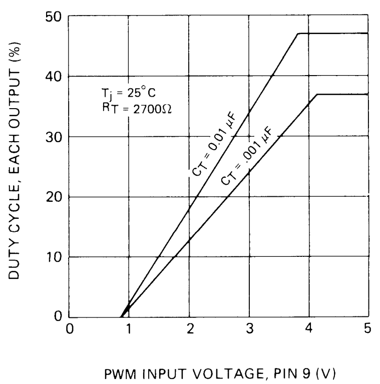
Oscillator Frequency vs. Timing Components



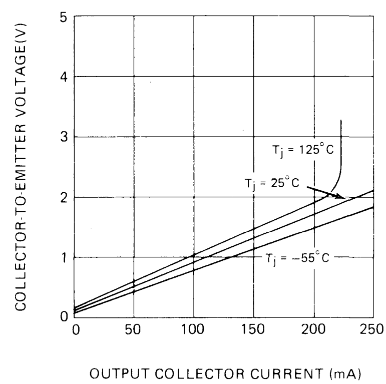
Output Dead Time vs. Timing Capacitor Value



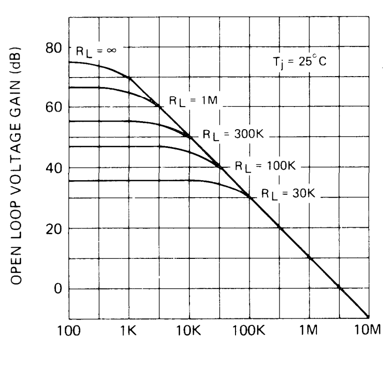
Pulse Width Modulator Transfer Function



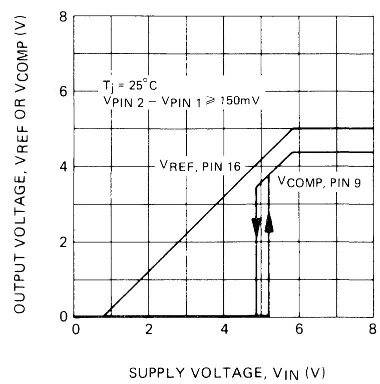
Output Saturation Voltage



Error Amplifier Voltage Gain vs. Frequency

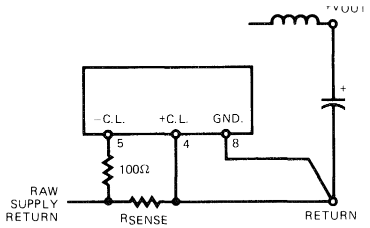


Undervoltage Lockout Characteristic

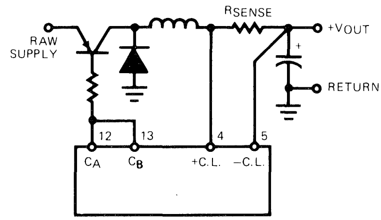


ADVANCED REGULATING PULSE WIDTH MODULATOR

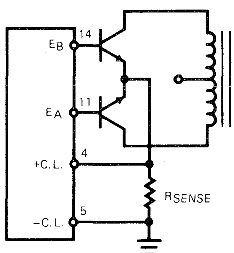
APPLICATIONS INFORMATION



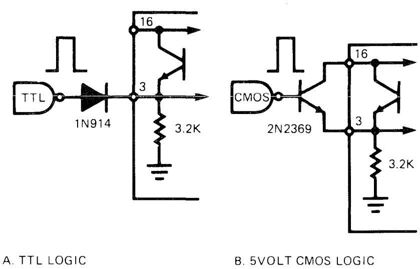
Current Sensing in the Ground Line



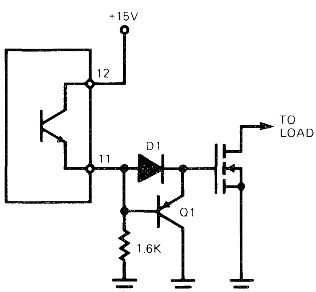
Current Sensing in the Output Line



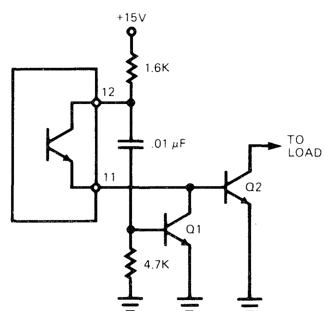
Sensing Primary Current with an Emitter Resistor



Oscillator Sync to an External Clock



Driving Power MOSFETS



Driving Power Bipolar Transistors

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1524BJ	−55°C to +125°C	16 Pin Ceramic DIP
IP3524BD	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3524BJ	0°C to + 70°C	16 Pin Ceramic DIP
IP3524BN	0°C to + 70°C	16 Pin Plastic DIP

REGULATING PULSE WIDTH MODULATORS

IP1525A, IP3525A, IP1527A, IP3527A

DESCRIPTION

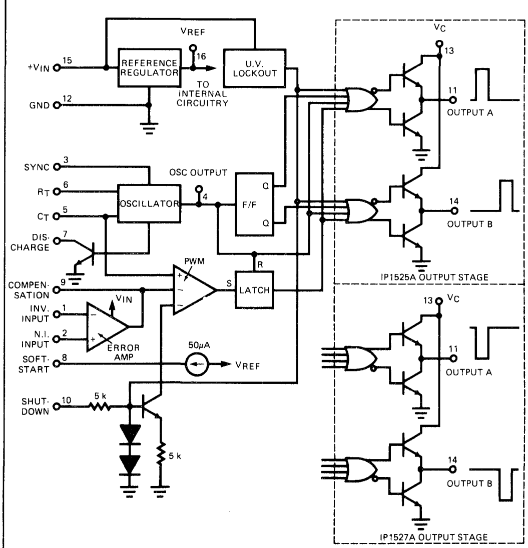
The IP1525A and IP1527A families of PWM switching regulator control circuits offer improved performance and lower parts count when used in designing switching power supplies. Included are 5.1 volt reference, error amplifier, adjustable dead-time oscillator with synchronization capability, latched PWM comparator, totem-pole output drivers, shutdown, soft start, and undervoltage lockout.

The IP1525A and IP1527A differ only in output phasing. The IP1525A output is low when "off", while the IP1527A output is high when "off".

FEATURES

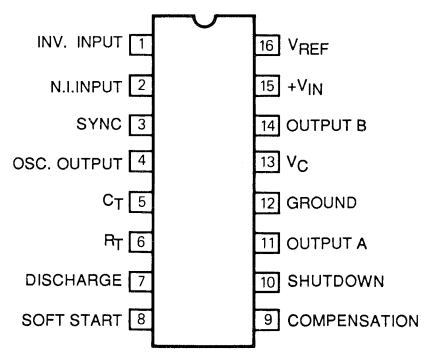
- 8 to 35 volt operation
- 5.1 volt reference trimmed to ±1%
- 100Hz to 500kHz oscillator range
- Separate oscillator sync terminal
- Adjustable deadtime control
- Internal soft-start
- Input undervoltage lockout
- Latching PWM to prevent multiple pulses
- Dual source/sink output drivers

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (300) Package

REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (+V_{IN}) +40V
Collector Voltage +40V
Logic Inputs −0.3V to +5.5V
Analog Inputs −0.3V to +V_{IN}
Output Current, Source or Sink 500mA
Reference Output Load Current Internally Limited
Oscillator Charging Current 5mA

Power Dissipation at
T_A = +25°C (Note 1) 1000mW
T_C = +25°C (Note 2) 2000mW
Operating Junction Temperature −55°C to +150°C
Storage Temperature Range −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage (V_{IN}) +8V to +35V
Collector Voltage +4.5V to +35V
Sink/Source Load Current (steady state) 0 to 100mA
Sink/Source Load Current (peak) 0 to 400mA
Reference Load Current 0 to 20mA
Oscillator Frequency Range 100Hz to 400kHz

Oscillator Timing Resistor 2kΩ to 200kΩ
Oscillator Timing Capacitor 470pF to 0.1μF
Deadtime Resistor Range 0 to 500Ω
Operating Ambient Temperature Range
IP1525A/IP1527A −55°C to +125°C
IP3525A/IP3527A 0°C to +70°C

Note 1. Derate at 10 mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 16 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

(+V_{IN} = 20V, unless otherwise specified)

Parameter	Test Conditions		IP1525A IP1527A Min	Typ	Max	IP3525A IP3527A Min	Typ	Max	Units
Reference Section									
Output Voltage			5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	V_{IN} = 8 to 35 V	•		2	10		2	20	mV
Load Regulation	I_L = 0 to 20 mA	•		5	50		5	50	mV
Temperature Stability (Note 4)	Over Operating Range	•		20	50		20	50	mV
Total Output Variation	Over Line, Load and Temp.	•	5.00		5.20	4.95		5.25	V
Short Circuit Current	V_{REF} = 0			80	100		80	100	mA
Output Noise Voltage (Note 4)	10 Hz ≤ f ≤ 10 kHz			40	200		40	200	μVrms
Long Term Stability (Note 4)				1	10		1	50	mV/kHr
Oscillator Section (Note 5)									
Initial Accuracy				2	6		2	6	%
Voltage Stability	V_{IN} = 8 to 35 V	•		0.3	1		1	2	%
Temperature Stability (Note 4)	Over Operating Range	•		3	6		3	6	%
Minimum Frequency	R_T = 200 kΩ, C_T = 0.1 μF	•		90	120		90	120	Hz
Maximum Frequency	R_T = 2 kΩ, C_T = 470pf	•	400	600		400	600		kHz

REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1525A IP1527A Min	Typ	Max	IP3525A IP3527A Min	Typ	Max	Units
Current Mirror	I_{RT} = 2mA	•	1.7	2.0	2.2	1.7	2.0	2.2	mA
Clock Amplitude		•	3.0	3.5		3.0	3.5		V
Clock Width			0.3	0.5	1.0	0.3	0.5	1.0	µs
Sync Threshold		•	1.2	2.0	2.8	1.2	2.0	2.8	V
Sync Input Current	Sync Voltage = 3.5 V	•		1.0	2.5		1.0	2.5	mA
Error Amplifier Section (V_{CM} = 5.1 V)									
Input Offset Voltage		•		0.5	5		2	10	mV
Input Bias Current		•		1	10		1	10	µA
Input Offset Current		•			1			1	µA
DC Open Loop Gain	$R_L \geq 10\ M\Omega$	•	60	75		60	75		dB
Gain-Bandwidth Product (Note 4)			1	2		1	2		MHz
Output Low Level		•		0.2	0.5		0.2	0.5	V
Output High Level		•	3.8	5.6		3.8	5.6		V
Common Mode Rejection	V_{CM} = 1.5 to 5.2 V	•	60	75		60	75		dB
Supply Voltage Rejection	V_{IN} = 8 to 35 V	•	50	60		50	60		dB
PWM Comparator									
Minimum Duty Cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geq$ 150 mV	•			0			0	%
Maximum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geq$ 150 mV	•	45	49		45	49		%
Input Threshold (Note 5)	Zero Duty Cycle	•	0.6	0.9		0.6	0.9		V
Input Threshold (Note 5)	Max Duty Cycle	•		3.3	3.6		3.3	3.6	V
Input Bias Current (Note 4)		•		.05	1.0		.05	1.0	µA
Shutdown Section									
Soft Start Current	$V_{SHUTDOWN}$ = 0 V	•	25	50	80	25	50	80	µA
Soft Start Low Level	$V_{SHUTDOWN}$ = 2 V	•		0.4	0.6		0.4	0.6	V
Shutdown Threshold	To Outputs	•	0.6	1.3	2.0	0.6	1.3	2.0	V
Shutdown Input Current	$V_{SHUTDOWN}$ = 2.5 V	•		0.1	1.0		0.1	1.0	mA
Shutdown Delay	$V_{SHUTDOWN}$ = 2.5 V			0.2	0.5		0.2	0.5	µs
Output Drivers (Each Output) (V_C = 20 Volts)									
Output Low Level	I_{SINK} = 20 mA	•		0.2	0.4		0.2	0.4	V
	I_{SINK} = 100 mA	•		1.0	2.0		1.0	2.0	V
Output High Level	I_{SOURCE} = 20 mA	•	18	19		18	19		V
	I_{SOURCE} = 100 mA	•	17	18		17	18		V
Undervoltage Lockout	V_{COMP} = High	•	5.0	7	8.0	5.0	7	8.0	V
Output Leakage	V_C = 35 V	•			200			200	µA
Rise Time	C_L = 1 nF			100	600		100	600	ns
Fall Time	C_L = 1nF			50	300		50	300	ns
Total Standby Current									
Supply Current	V_{IN} = 35 V	•		10	20		10	20	mA

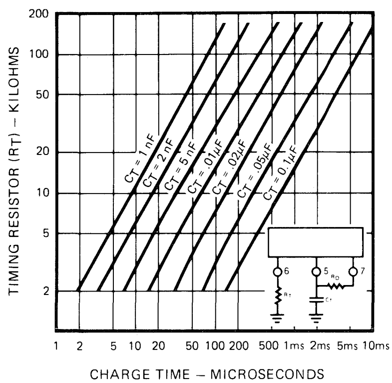
The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.
Note 4. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
Note 5. Tested at f_{OSC} = 40 kHz (R_T = 3.6 KΩ, C_T = 0.01 µF, R_D = 0Ω).

REGULATING PULSE WIDTH MODULATORS

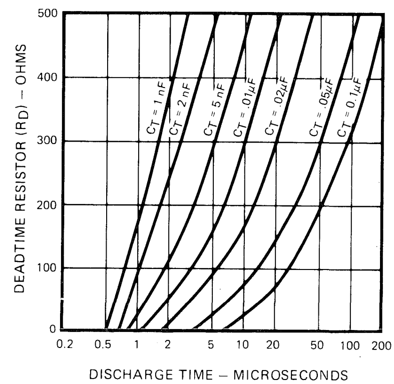
TYPICAL PERFORMANCE CHARACTERISTICS

2

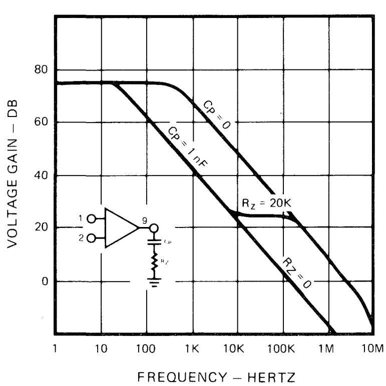
Oscillator Charge Time vs. R_T and C_T



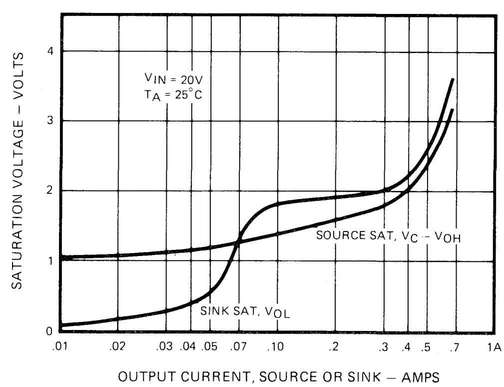
Oscillator Discharge Time vs. R_D and C_T



Error Amplifier Open-loop Frequency Response



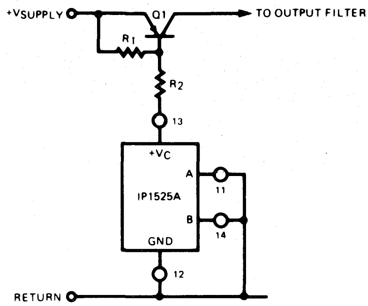
IP1525A Output Saturation Characteristics



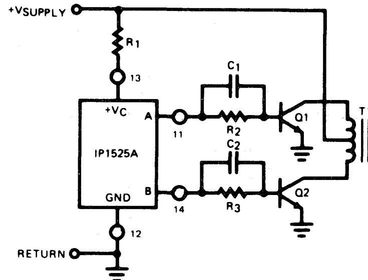
IP1525A, IP3525A, IP1527A, IP3527A

REGULATING PULSE WIDTH MODULATORS

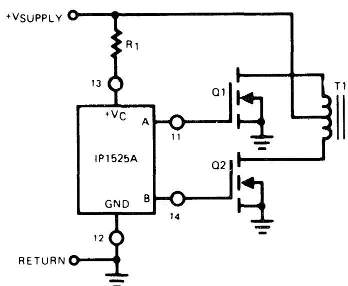
APPLICATIONS INFORMATION



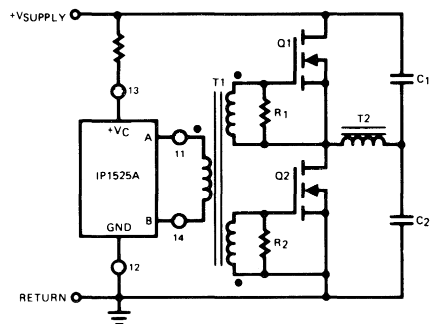
For single-ended supplies, the driver outputs are grounded. The V_C terminal is switched to ground by the totem-pole source transistors on alternate oscillator cycle.



In conventional push-pull bipolar designs, forward base drive is controlled by R_1-R_3. Rapid turn-off times for the power devices are achieved with speed-up capacitors C_1 and C_2.



The low source impedance of the output drivers provides rapid charging of power FET input capacitance while minimizing external components.



Low power transformers can be driven directly by the IP1525A. Automatic reset occurs during deadtime, when both ends of the primary winding are switched to ground.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1525AJ	−55°C to +125°C	16 Pin Ceramic DIP
IP3525AD	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3525AJ	0°C to + 70°C	16 Pin Ceramic DIP
IP3525AN	0°C to + 70°C	16 Pin Plastic DIP
IP1527AJ	−55°C to +125°C	16 Pin Ceramic DIP
IP3527AD	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3527AJ	0°C to + 70°C	16 Pin Ceramic DIP
IP3527AN	0°C to + 70°C	16 Pin Plastic DIP

Seagate Microelectronics Limited

REGULATING PULSE WIDTH MODULATORS

IP1526, IP3526

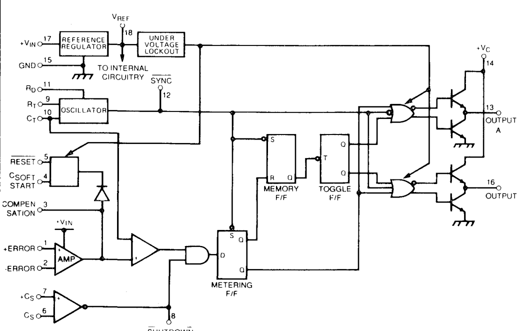
DESCRIPTION

The IP1526 and IP3526 high performance monolithic pulse width modulator circuits are designed for fixed-frequency switching regulators and other power control applications. Included in an 18-pin dual-in-line package are a temperature compensated voltage reference, sawtooth oscillator, error amplifier, pulse width modulator, pulse metering and steering logic, and two low impedence power drivers. Also included are protective features such as soft-start and under-voltage lockout, digital current limiting, double pulse inhibit, a data latch for single pulse metering, adjustable deadtime, and provision for symmetry correction inputs. For ease of interface, all digital control ports are TTL and B-series CMOS compatible. Active LOW logic design allows wired-OR connections for maximum flexibility. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformerless and transformer coupled.

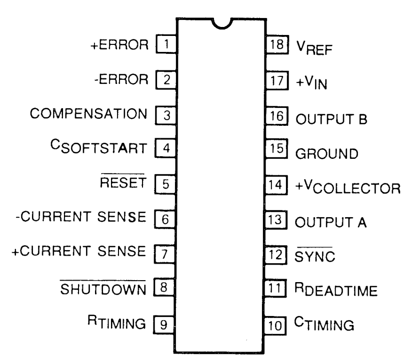
FEATURES

- 8 to 35 volt operation
- 5 volt reference trimmed to ±1%
- 1Hz to 400kHz oscillator range
- Dual 100 mA source/sink outputs
- Digital current limiting
- Double pulse suppression
- Programmable deadtime
- Undervoltage lockout
- Single pulse metering
- Programmable soft-start
- Wide current limit common mode range
- TTL/CMOS compatible logic ports
- Symmetry correction capability
- Guaranteed 6 unit synchronization

BLOCK DIAGRAM



CONNECTIONS



N, J and D (300) Package

REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (+V_{IN}) +40V
Collector Supply Voltage +40V
Logic Inputs −0.3V to +5.5V
Analog Inputs −0.3V to $+V_{IN}$
Source/Sink Load Current 200mA
Reference Load Current Internally Limited
Logic Sink Current 15mA
Power Dissipation at
T_A = +25°C (Note 1) 1000mW
T_C = +25°C (Note 2) 3000mW
Operating Junction Temperature −55°C to +150°C
Storage Temperature Range −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage +8V to +35V
Collector Voltage +4.5V to +35V
Sink/Source Load Current (each output) 0 to 100mA
Reference Load Current 0 to 20mA
Oscillator Frequency Range 1Hz to 400kHz
Oscillator Timing Resistor 2kΩ to 150kΩ
Oscillator Timing Capacitor 470pF to 20μF
Available Deadtime Range at 40kHz 3% to 50%
Operating Ambient Temperature Range
IP1526 −55°C to +125°C
IP3526 0°C to +70°C

Note 1. Derate at 10 mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 24 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

(+V_{IN} = 15V, unless otherwise specified)

Parameter	Conditions		IP1526 Min	IP1526 Typ	IP1526 Max	IP3526 Min	IP3526 Typ	IP3526 Max	Units
Reference Section									
Output Voltage			4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	$+V_{IN}$ = 8 to 35V	•		2	20		2	30	mV
Load Regulation	I_L = 0 to 20 mA	•		5	30		5	50	mV
Temperature Stability (Note 4)	Over Operating Range	•		15	50		15	50	mV
Total Output Voltage Range		•	4.90	5.00	5.10	4.85	5.00	5.15	V
Short Circuit Current	V_{REF} = 0 V	•	25	80	140	25	80	140	mA
Undervoltage Lockout									
$\overline{RESET}$ Output Voltage	V_{REF} = 3.8 V	•		0.2	0.4		0.2	0.4	V
$\overline{RESET}$ Output Voltage	V_{REF} = 4.8 V	•	2.4	4.8		2.4	4.8		V
Oscillator Section (Note 5)									
Initial Accuracy				±3	±8		±3	±8	%
Voltage Stability	$+V_{IN}$ = 8 to 35 V	•		0.5	1		0.5	1	%
Temperature Stability (Note 4)	Over Operating Range	•		3	10		7	10	%
Minimum Frequency	R_T = 150 kΩ, C_T = 0.2 μF	•			100			100	Hz
Maximum Frequency	R_T = 2 kΩ, C_T = 470 pF	•	400			400			kHz

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Conditions		IP1526 Min	IP1526 Typ	IP1526 Max	IP3526 Min	IP3526 Typ	IP3526 Max	Units
Sawtooth Peak Voltage	$+V_{IN} = 35$ V	•		3.0	3.5		3.0	3.5	V
Sawtooth Valley Voltage	$+V_{IN} = 8$V		0.5	1.0			1.0		V
Error Amplifier Section (Note 6)									
Input Offset Volltage	$R_S \leq 2$ kΩ	•		2	5		2	10	mV
Input Bias Current		•		-350	-1000		-350	-2000	nA
Input Offset Current		•		35	100		35	200	nA
DC Open Loop Gain	$R_L \geq 10$ MΩ	•	64	72		60	72		dB
High Output Voltage	$V_{PIN\,1} - V_{PIN\,2} \geq 150$ mV, $I_{SOURCE} = 100$ µA	•	3.6	4.2		3.6	4.2		V
Low Output Voltage	$V_{PIN\,2} - V_{PIN\,1} \geq 150$ mV, $I_{SINK} = 100$ µA	•		0.2	0.4		0.2	0.4	V
Common Mode Rejection	$R_S \leq 2$ kΩ	•	70	94		70	94		dB
Supply Voltage Rejection	$+V_{IN} = 12$ to 18 V	•	66	80		66	80		dB
PWM Comparator (Note 5)									
Minimum Duty Cycle	$V_{PIN\,2} - V_{PIN\,1} \geq 150$mV	•			0			0	%
Maximum Duty cycle	$V_{PIN\,1} - V_{PIN\,2} \geq 150$mV	•	45	49		45	49		%
Digital Ports (SYNC, SHUTDOWN and RESET)									
HIGH Output Voltage	$I_{SOURCE} = 40$ µA	•	2.4	4.0		2.4	4.0		V
LOW Output Voltage	$I_{SINK} = 3.6$ mA	•		0.2	0.4		0.2	0.4	V
HIGH Input Current	$V_{IH} = +2.4$ V	•		-125	-200		-125	-300	µA
LOW Input Current	$V_{IL} = +0.4$ V	•		-225	-360		-225	-500	µA
Current Limit Comparator (Note 7)									
Sense Voltage	$R_S \leq 50$ Ω	•	90	100	110	80	100	120	mV
Input Bias Current		•		-3	-10		-3	-10	µA
Soft-Start Section									
Error Clamp Voltage	$\overline{RESET} = +0.4$ V	•		0.1	0.4		0.1	0.4	V
C_S Charging Current	$\overline{RESET} = +2.4$ V	•	50	100	150	50	100	150	µA
Output Drivers (Each Output) (Note 8)									
HIGH Output Voltage	$I_{SOURCE} = 20$ mA	•	12.5	13.5		12.5	13.5		V
	$I_{SOURCE} = 100$ mA	•	12	13		12	13		V
LOW Output Voltage	$I_{SINK} = 20$ mA	•		0.2	0.3		0.2	0.3	V
	$I_{SINK} = 100$ mA	•		1.2	2.0		1.2	2.0	V
Collector Leakage	$V_C = 40$ V	•		50	150		50	150	µA
Rise Time	$C_L = 1000$ pF	•		0.3	0.6		0.3	0.6	µsec
Fall Time	$C_L = 1000$ pF	•		0.1	0.2		0.1	0.2	µsec
Power Consumption (Note 9)									
Standby Current	$\overline{SHUTDOWN} = +0.4$ V	•		18	30		18	30	mA

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 4. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.

Note 5. F_{OSC} = 40 kHz (R_T = 4.12 kΩ ± 1%, C_T = 0.01µ ± 1%, R_D = 0Ω).

Note 6. V_{CM} = 0 to + 5.2V.

Note 7. V_{CM} = 0 to + 12V.

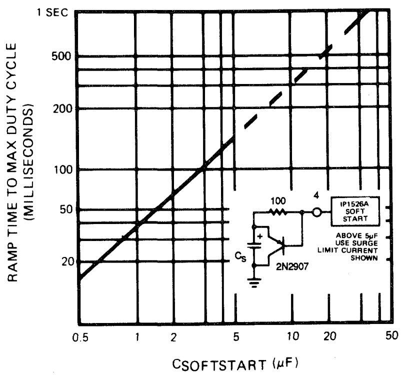
Note 8. V_C = + 15V.

Note 9. $+V_{IN}$ = + 35V, R_T = 4.12 kΩ.

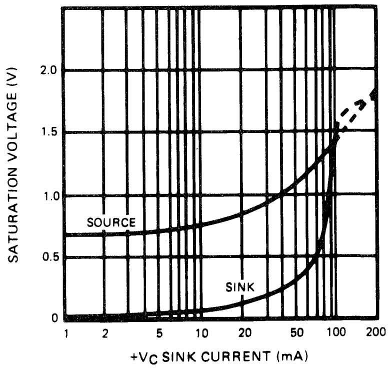
REGULATING PULSE WIDTH MODULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

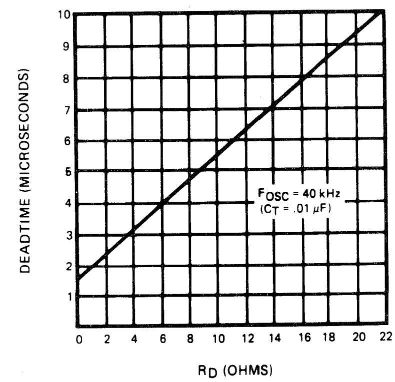
Soft-start Time vs. C_S



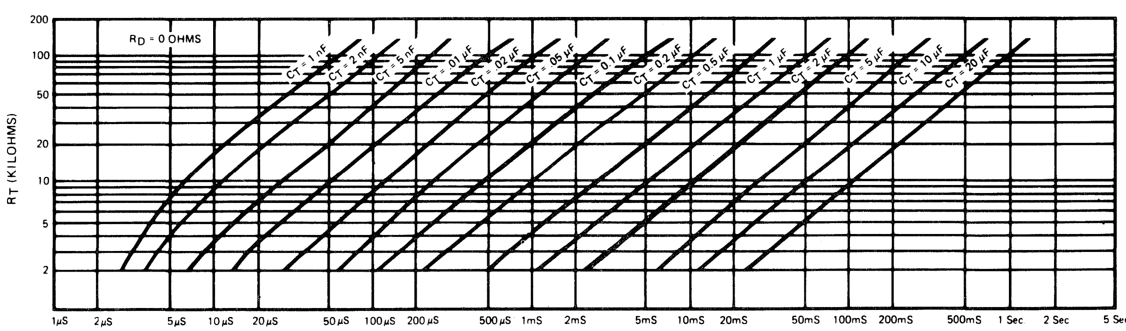
Output Driver Saturation Voltage



Output Driver Deadtime vs. R_D Value

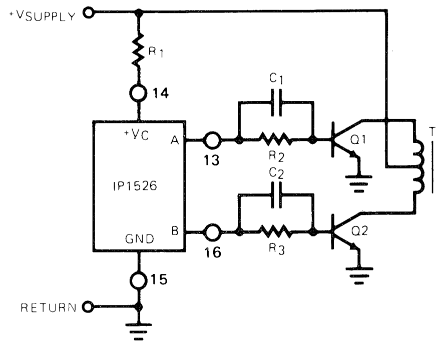


Oscillator Period vs. R_T and C_T

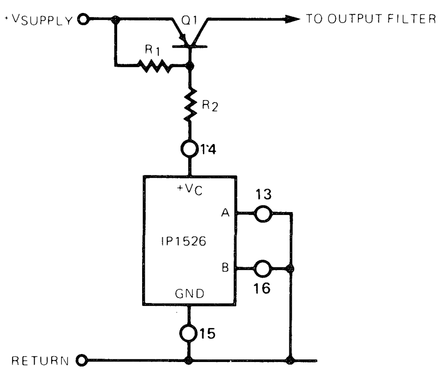


REGULATING PULSE WIDTH MODULATORS

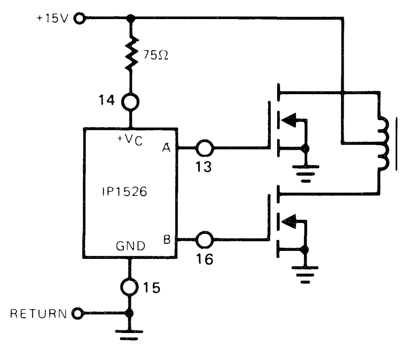
APPLICATIONS INFORMATION



Push-Pull Configuration



Single-Ended Configuration



Driving N-Channel Power MOSFETS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1526J	−55°C to +125°C	18 Pin Ceramic DIP
IP3526D	0°C to + 70°C	18 Pin Plastic (300) SOIC
IP3526J	0°C to + 70°C	18 Pin Ceramic DIP
IP3526N	0°C to + 70°C	18 Pin Plastic DIP

Seagate Microelectronics Limited

ADVANCED REGULATING PULSE WIDTH MODULATORS

IP1526A, IP3526A

2

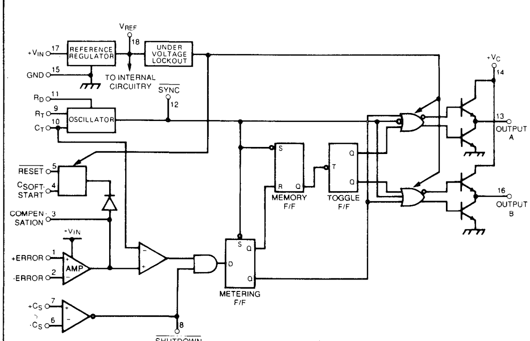
DESCRIPTION

The IP1526A series of high performance pulse width modulator circuits is a direct replacement for the IP1526 series in all applications and features improved performance in several key areas. Functions included are a temperature compensated voltage reference, sawtooth oscillator, error amplifier, PWM comparator, pulse metering and steering logic, and two low impedance power drivers. Also included are protective features such as soft-start, undervoltage lockout, digital current limiting, double pulse inhibit, a data latch for single pulse metering, adjustable dead-time and provision for symmetry correction inputs. For ease of interface, all digital control ports are TTL and B-series CMOS compatible. Active LOW logic design allows wired-OR connections for maximum flexibility. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformerless and transformer coupled.

FEATURES

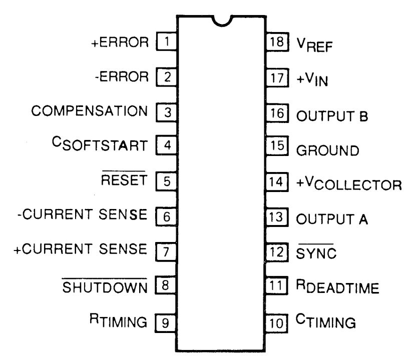
- Low drain current
- 8 to 35 volt operation
- High performance 5V ±1% reference
- Low t.c. 1Hz to 400kHz oscillator
- Dual 100 mA source/sink outputs
- Digital current limiting
- Double pulse suppression
- Programmable deadtime
- Accurate current limit sense voltage
- Undervoltage lockout
- Single pulse metering
- Programmable soft-start
- Wide current limit common mode range
- TTL/CMOS compatible logic ports
- Symmetry correction capability
- Guaranteed 6 unit synchronization

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (300) Package

ADVANCED REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage ($+V_{IN}$)	+40V
Collector Supply Voltage ($+V_C$)	+40V
Logic Inputs	−0.3V to +5.5V
Analog Inputs	−0.3V to $+V_{IN}$
Source/Sink Load Current (Each output, continuous)	200mA
Reference Load Current	Internally Limited
Logic Sink Current	15mA
Power Dissipation at T_A = +25°C (Note 1)	1000mW
T_C = +25°C (Note 2)	3000mW
Operating Junction Temperature	−55°C to +150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage	+8V to +35V
Collector Voltage	+4.5V to +35V
Sink/Source Load Current (each output)	0 to 100mA
Reference Load Current	−5mA to 20mA
Oscillator Frequency Range	1Hz to 400kHz
Oscillator Timing Resistor	2kΩ to 150kΩ
Oscillator Timing Capacitor	470pF to 20µF
Available Deadtime Range at 40kHz	3% to 50%
Operating Ambient Temperature Range	
IP1526A	−55°C to +125°C
IP3526A	0°C to +70°C

Note 1. Derate at 10 mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 24 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

($+V_{IN}$ = 15V, unless otherwise specified)

Parameter	Conditions		IP1526A Min	IP1526A Typ	IP1526A Max	IP3526A Min	IP3526A Typ	IP3526A Max	Units
Reference Section									
Output Voltage			4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation	$+V_{IN}$ = 8 to 35V	•		2	10		2	15	mV
Load Regulation	I_L = -5 to +20 mA	•		5	10		5	20	mV
Temperature Stability (Note 4)	Over Operating Range	•		15	50		15	50	mV
Total Output Voltage Range		•	4.90	5.00	5.10	4.85	5.00	5.15	V
Short Circuit Current	V_{REF} = 0 V	•	30	80	140	30	80	140	mA
Undervoltage Lockout									
$\overline{RESET}$ Output Voltage	V_{REF} = 3.8 V	•		0.2	0.4		0.2	0.4	V
$\overline{RESET}$ Output Voltage	V_{REF} = 4.8 V	•	2.4	4.8		2.4	4.8		V
Oscillator Section (Note 5)									
Initial Accuracy				±3	±8		±3	±8	%
Voltage Stability	$+V_{IN}$ = 8 to 35 V	•		0.5	1		0.5	1	%
Temperature Stability (Note 4)	Over Operating Range	•		1	3		1	6	%
Minimum Frequency	R_T = 150 kΩ, C_T = 0.2 µF	•			100			100	Hz
Maximum Frequency	R_T = 2 kΩ, C_T = 470 pF	•	400	700		400	700		kHz

ADVANCED REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Conditions		IP1526A Min	IP1526A Typ	IP1526A Max	IP3526A Min	IP3526A Typ	IP3526A Max	Units
Sawtooth Peak Voltage	$+V_{IN} = 35\ V$	•		3.0	3.5		3.0	3.5	V
Sawtooth Valley Voltage	$+V_{IN} = 8V$	•	0.3	1.0		0.3	1.0		V
Error Amplifier Section (Note 6)									
Input Offset Voltage	$R_S \leq 2\ k\Omega$	•		2	5		2	10	mV
Input Bias Current		•		-350	-1000		-350	-2000	nA
Input Offset Current		•		35	100		35	200	nA
DC Open Loop Gain	$R_L \geq 10\ M\Omega$	•	64	72		60	72		dB
High Output Voltage	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150\ mV$, $I_{SOURCE} = 100\ \mu A$	•	3.6	4.2		3.6	4.2		V
Low Output Voltage	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150\ mV$, $I_{SINK} = 100\ \mu A$	•		0.2	0.4		0.2	0.4	V
Common Mode Rejection	$R_S \leq 2\ k\Omega$	•	70	94		70	94		dB
Supply Voltage Rejection	$+V_{IN} = 12$ to $18\ V$	•	66	80		66	80		dB
PWM Comparator (Note 5)									
Minimum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150mV$	•			0			0	%
Maximum Duty cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150mV$	•	45	49		45	49		%
Digital Ports (SYNC, SHUTDOWN and RESET)									
HIGH Output Voltage	$I_{SOURCE} = 40\ \mu A$	•	2.4	4.0		2.4	4.0		V
LOW Output Voltage	$I_{SINK} = 3.6\ mA$	•		0.2	0.4		0.2	0.4	V
HIGH Input Current	$V_{IH} = +2.4\ V$	•		-125	-200		-125	-200	µA
LOW Input Current	$V_{IL} = +0.4\ V$	•		-225	-360		-225	-360	µA
Current Limit Comparator (Note 7)									
Sense Voltage	$R_S \leq 50\ \Omega$	•	90	100	110	80	100	120	mV
Input Bias Current		•		-3	-10		-3	-10	µA
Soft-Start Section									
Error Clamp Voltage	$\overline{RESET} = +0.4\ V$	•		0.1	0.4		0.1	0.4	V
C_S Charging Current	$\overline{RESET} = +2.4\ V$	•	50	100	150	50	100	150	µA
Output Drivers (Each Output) (Note 8)									
HIGH Output Voltage	$I_{SOURCE} = 20\ mA$	•	12.5	13.5		12.5	13.5		V
	$I_{SOURCE} = 100\ mA$	•	12	13		12	13		V
LOW Output Voltage	$I_{SINK} = 20\ mA$	•		0.2	0.3		0.2	0.3	V
	$I_{SINK} = 100\ mA$	•		1.2	2.0		1.2	2.0	V
Collector Leakage	$V_C = 40\ V$	•		50	150		50	150	µA
Rise Time	$C_L = 1000\ pF$	•		0.3	0.6		0.3	0.6	µs
Fall Time	$C_L = 1000\ pF$	•		0.1	0.2		0.1	0.2	µs
Power Consumption (Note 9)									
Standby Current	$\overline{SHUTDOWN} = +0.4\ V$, $V_{IN} = 35\ V$	•		14	20		14	20	mA

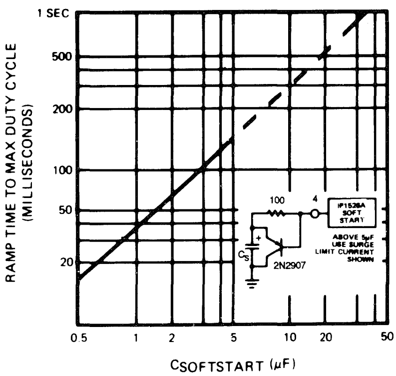
The • denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.

Note 4. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.
Note 5. $F_{OSC} = 40\ kHz$ ($R_T = 4.12\ k\Omega \pm 1\%$, $C_T = 0.01\mu \pm 1\%$, $R_D = 0\Omega$).
Note 6. $V_{CM} = 0$ to $+5.2V$.
Note 7. $V_{CM} = 0$ to $+12V$.
Note 8. $V_C = +15V$.
Note 9. $+V_{IN} = +35V$, $R_T = 4.12\ k\Omega$.

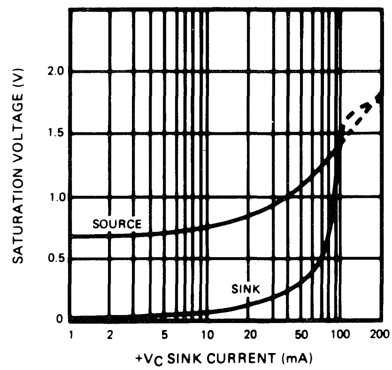
ADVANCED REGULATING PULSE WIDTH MODULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

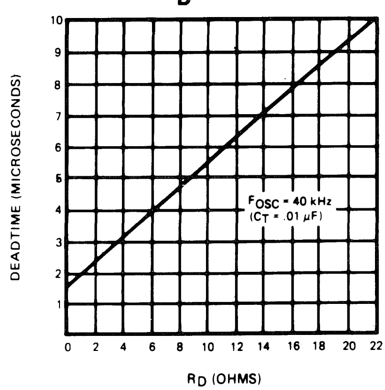
Soft-start Time vs. C_S



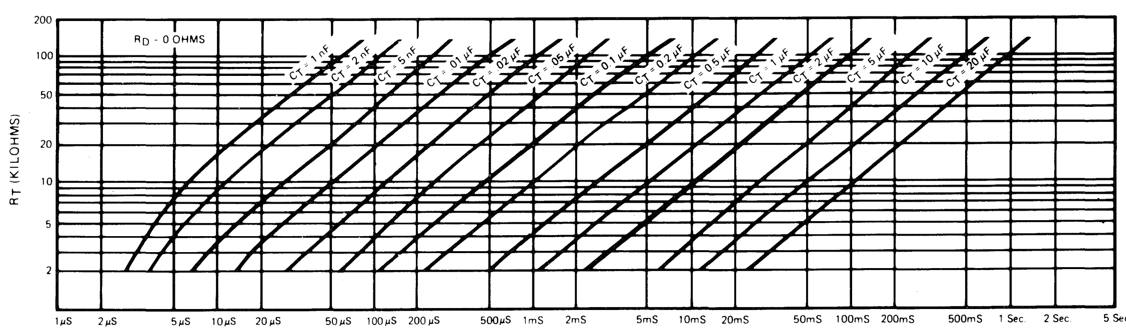
Output Driver Saturation Voltage



Output Driver Deadtime vs. R_D Value

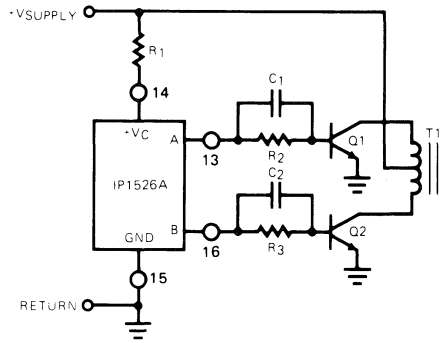


Oscillator Period vs. R_T and C_T

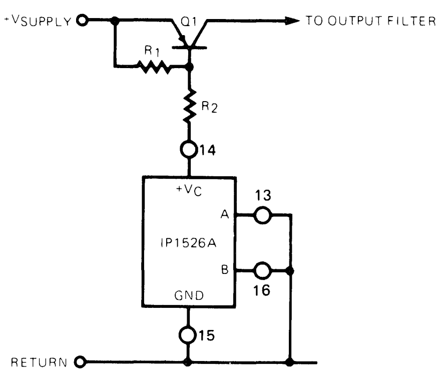


ADVANCED REGULATING PULSE WIDTH MODULATORS

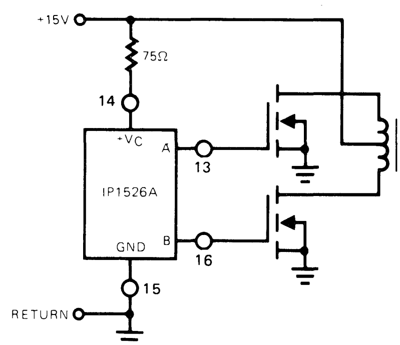
APPLICATIONS INFORMATION



Push-Pull Configuration



Single-Ended Configuration



Driving N-Channel Power MOSFETS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1526AJ	−55°C to +125°C	16 Pin Ceramic DIP
IP3526AD	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3526AJ	0°C to + 70°C	16 Pin Ceramic DIP
IP3526AN	0°C to + 70°C	16 Pin Plastic DIP

Seagate Microelectronics Limited

POWER SUPPLY SUPERVISORY CIRCUITS

IP1543, IP3543

2

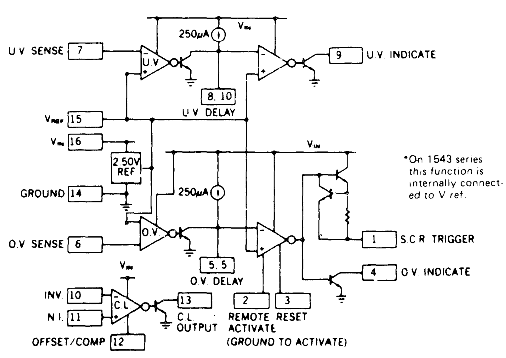
DESCRIPTION

The IP1543 and IP3543 power supply supervisory circuits contain all the functions necessary to monitor and control the output of a sophisticated power supply system. Included on the chip are over-voltage (O.V.) sensing with externally programmable delay used to trigger an external SCR "Crowbar", under-voltage (U.V.) sensing with externally programmable delay used to sense either the power supply output or the line input voltage, a third op-amp/comparator with provision for external compensation and/or offset programming used for either current limiting or as an additional voltage monitor, and a voltage reference trimmed to ±1%.

FEATURES

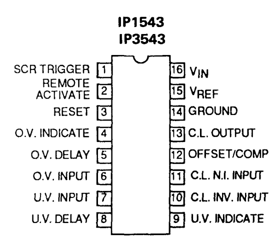
- 4.5 to 40V operation over full temperature range
- Reference voltage trimmed to 1% accuracy
- Includes over-voltage, under-voltage and current sensing
- Programmable time delays
- SCR "Crowbar" drive of 300mA
- Remote activation capability
- Optional over-voltage latch capability

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (300) Package

POWER SUPPLY SUPERVISORY CIRCUITS

ABSOLUTE MAXIMUM RATINGS

Sense Inputs V_{IN}

SCR Trigger Current (Note 1) Internally Limited

Indicator Output Voltage +40V

Indicator Output Sink Current 50mA

T_C = +25°C (Note 3) 2000mW

Operating Junction Temperature +150°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 seconds) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

Note 1. At higher input voltages, a dissipation limiting resistor, R_G, is required.
Note 2. Derate at 10mW/°C for ambient temperatures above +50°C.
Note 3. Derate at 16mW/°C for case temperatures above +25°C.

RECOMMENDED OPERATING CONDITIONS (Note 4)

Input Supply Voltage (V_{IN}) +4.5V to +40V

Current Limit Common Mode Range

Input Voltage Range 0 to V_{IN} −3V

Reference Load Current 0 to 10mA

Indicate Output Current 0 to 10mA

Operating Ambient Temperature Range
IP1543 −55°C to +125°C
IP3543 0°C to +70°C

Note 4. Range over which the device is functional and parameter limits guaranteed.

ELECTRICAL CHARACTERISTICS

$+V_{IN} = +10V$

Parameter	Test Conditions		IP1543 Min	IP1543 Typ	IP1543 Max	IP3543 Min	IP3543 Typ	IP3543 Max	Units
Input Voltage Range		•	4.5		40	4.5		40	V
Supply Current	V_{IN} = 40V	•		7	10		7	10	mA
Reference Section									
Output Voltage			2.48	2.50	2.52	2.45	2.50	2.55	V
		•	2.45		2.55	2.40		2.60	V
Line Regulation	V_{IN} = 4.5 to 30V	•		1	5		1	5	mV
Load Regulation	I_{REF} = 0 to 10 mA	•		1	10		1	10	mV
Short Circuit Current	V_{REF} = 0	•	12	25	40	12	25	40	mA
Temperature Stability	Over Operating Range			50			50		ppm/°C
SCR Trigger Section									
Peak Output Current	V_{IN} = 5v, R_G = 0, V_O = 0	•	100	200	400	100	200	400	mA
Peak Output Voltage	V_{IN} = 15V, I_O = 100 mA	•	12	13		12	13		V
Output Off Voltage	V_{IN} = 40V	•		0	0.1		0	0.1	V
Remote Activate Current	Pin 2 = Gnd	•		-.1	-.8		-.1	-.8	mA
Remote Activate Voltage	Pin 2 = Open	•		1.5	6		1.5	6	V

POWER SUPPLY SUPERVISORY CIRCUITS

2

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1543 Min	IP1543 Typ	IP1543 Max	IP3543 Min	IP3543 Typ	IP3543 Max	Units
Reset Current	Pin 3 = Gnd, Pin 2 = Gnd	•		-.1	-.8		-.1	-.8	mA
Reset Voltage	Pin 3 = Open, Pin 2 = Gnd	•		1.5	6		1.5	6	V
Output Current Rise Time	$R_L = 50\Omega$			400			400		mA/µS
Prop. Delay from Pin 2	$C_D = 0$ $V_{(Pin\ 2)} = 0.4V$			300			300		ns
Prop. Delay from Pin 6	$V_{(Pin\ 6)} = 2.7V$			500			500		ns
Comparator Sections									
Input threshold (Input Voltage Rising			2.45	2.50	2.55	2.40	2.50	2.60	V
on Pin 6, falling on Pin 7)		•	2.40		2.60	2.35		2.65	V
Input Hysteresis				25			25		mV
Input Bias Current	Sense Input = 0V	•		-0.3	-1.0		-0.3	-1.0	µA
Delay Saturation		•		0.2	0.5		0.2	0.5	V
Delay High Level		•		6	8		6	8	V
Delay Charging Current	$V_D = 0V$	•	200	250	300	200	250	300	µA
Indicate Saturation	$I_L = -10$ mA	•		0.2	0.5		0.2	0.5	V
Indicate Leakage	$V_{IND} = 40V$	•		.01	1.0		.01	1.0	µA
Propagation Delay	$V_{(Pin\ 6)} = 2.7V$, $C_D = 0$			400			400		ns
	$V_{(Pin\ 7)} = 2.3V$, $C_D = 1\mu F$			10			10		ms
Current Limit Section									
Input Voltage Range		•	0		V_{IN}-3	0		V_{IN}-3	V
Input Bias Current	Pin 12 = Open, $V_{CM} = 0V$	•		-0.3	-1.0		-0.3	-1.0	µA
Input Offset Voltage	Pin 12 = Open, $V_{CM} = 0V$	•		0	10		0	15	mV
	10kΩ from Pin 12 to Gnd	•	70	100	130	70	100	130	mV
CMRR	$0 \leq V_{CM} \leq 12V$, $V_{IN} = 15V$	•	60	70		60	70		dB
AVOL	Pin 12 = Open, $V_{CM} = 0V$	•	72	80		72	80		dB
Output Saturation	$I_L = -10$ mA	•		0.2	0.5		0.2	0.5	V
Output Leakage	$V_{IND} = 40V$	•		.01	1.0		.01	1.0	µA
Small Signal Bandwidth	$A_V = 0$ dB			5			5		MHz
Propagation Delay	$V_{overdrive} = 100$ mV			200			200		ns

The • denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.

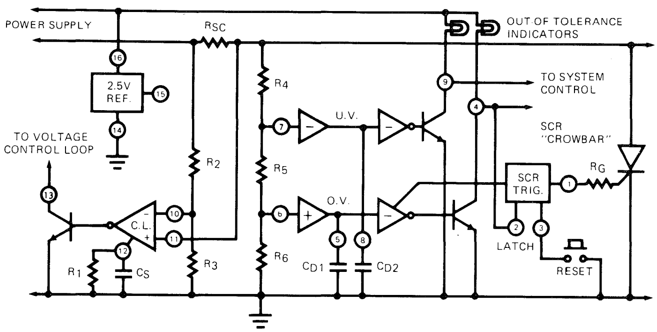
ORDER INFORMATION

Part Number	Temperature Range	Package
IP1543J	−55°C to +125°C	16 Pin Ceramic DIP
IP3543D	0°C to + 70°C	16 Pin Plastic (300) SOIC
IP3543J	0°C to + 70°C	16 Pin Ceramic DIP
IP3543N	0°C to + 70°C	16 Pin Plastic DIP

POWER SUPPLY SUPERVISORY CIRCUITS

APPLICATIONS INFORMATION

Typical Application



The values for the external components are determined as follows:

Current limit input threshold, $Vth \approx \frac{1000}{R1}$

Cs is determined by the current loop dynamics

Peak current to load, $Ip \cong \frac{Vth}{Rsc} + \frac{Vo}{Rsc}\left(\frac{R2}{R2 + R3}\right)$

Short circuit current, $Isc = \frac{Vth}{Rsc}$

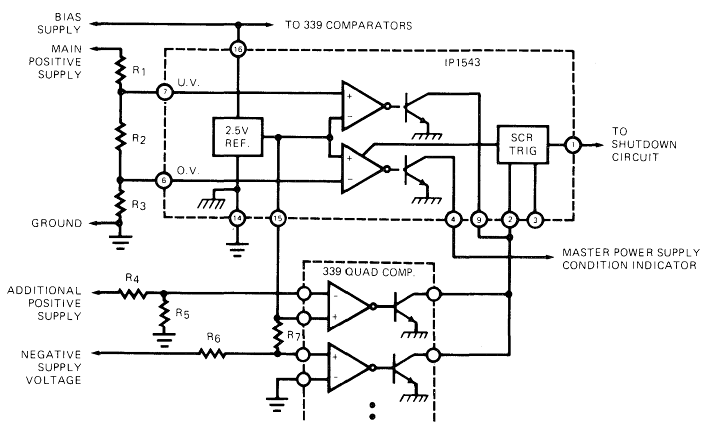
Low output voltage limit, $Vo\,(Low) = \frac{2.5\,(R4 + R5 + R6)}{R5 + R6}$

High output voltage limit, $Vo\,(High) = \frac{2.5\,(R4 + R5 + R6)}{R6}$

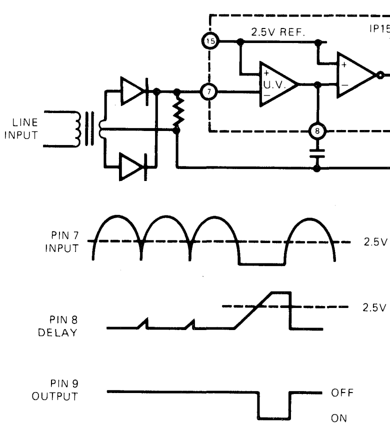
Voltage sensing delay, $td = 10{,}000\ Cd$

SCR trigger power limiting resistor, $Rg > \frac{Vin - 5}{0.2}$

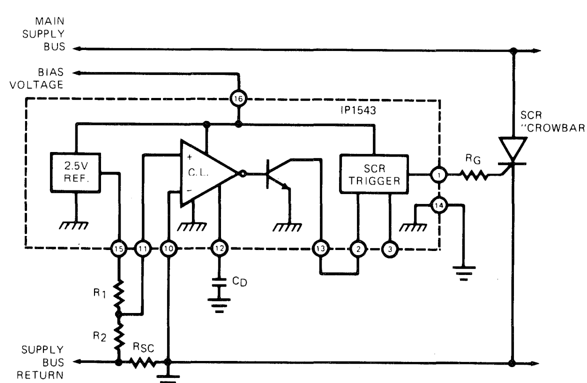
Sensing Multiple Supply Voltages



Input Line Monitor



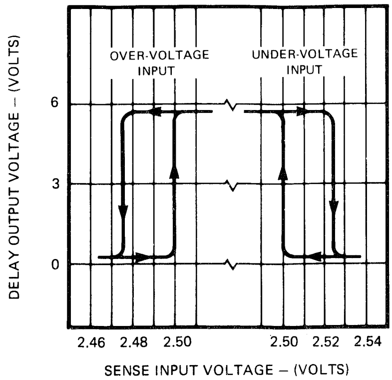
Overcurrent Shutdown



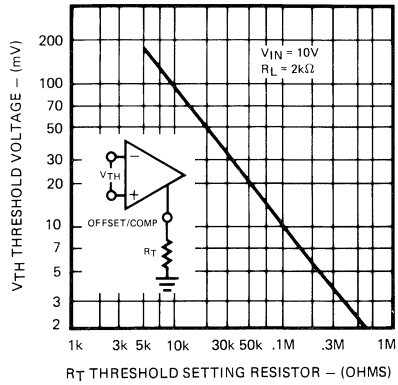
POWER SUPPLY SUPERVISORY CIRCUITS

TYPICAL PERFORMANCE CHARACTERISTICS

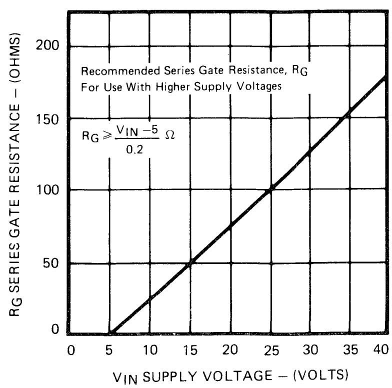
Comparator Input Hysteresis



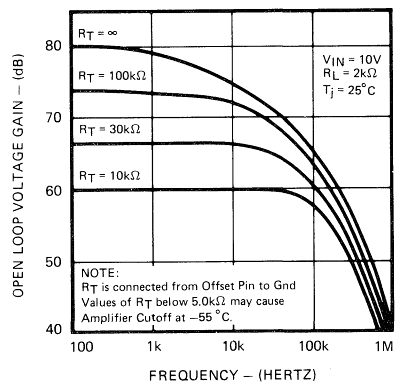
Current Limit Input Threshold



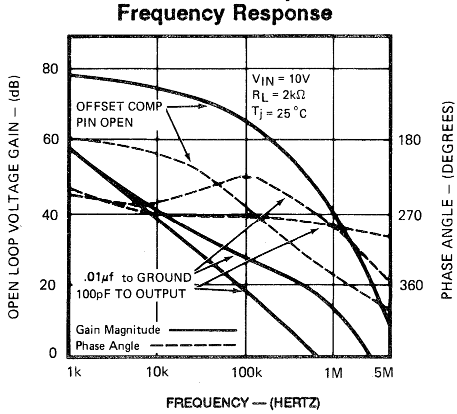
SCR Trigger Power Limiting



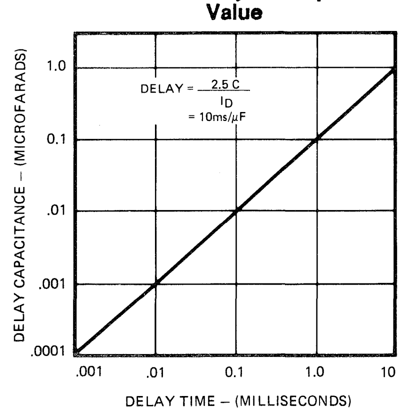
Current Limit Amplifier Gain



Current Limit Amplifier Frequency Response



Activation Delay vs. Capacitor Value



Seagate Microelectronics Limited

REGULATING PULSE WIDTH MODULATORS

CURRENT MODE IP1842, IP2842, IP3842, IP1843, IP2843, IP3843

2

DESCRIPTION

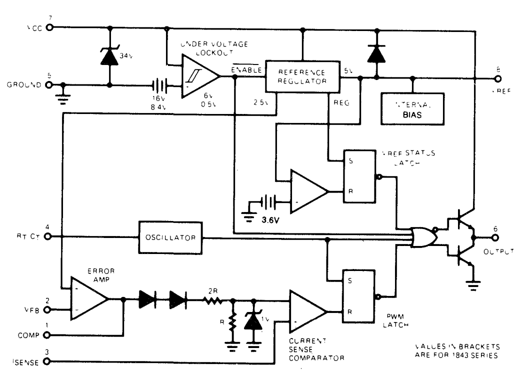
The IP1842 and IP1843 series of switching regulator control circuits contain all the functions necessary to implement off-line, current mode switching regulators, using a minimum number of external parts. Functions included are voltage reference, error amplifier, current sense comparator, oscillator, totem-pole output driver and under-voltage lockout circuitry.

Although pin compatible with the UC1842 and UC1843 series, Seagate Microelectronics has incorporated several improvements in the IP1842 and IP1843 series allowing tighter and more complete specification of electrical performance.

FEATURES

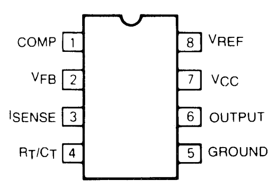
- Guaranteed ±1% reference voltage tolerance
- Guaranteed ±10% frequency tolerance
- Low start-up current (<500 μA)
- Under voltage lockout with hysteresis
- Output state completely defined for all supply and input conditions
- Interchangeable with UC1842 and UC1843 series for improved operation
- 500 kHz operation

BLOCK DIAGRAM

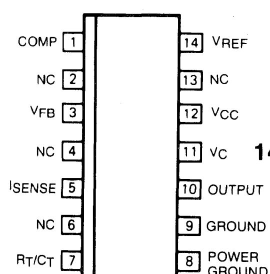


CONNECTIONS

(Top View)



N and J Package
8 Pin D (150) Package



14 Pin D (150) Package

CURRENT MODE IP1842, IP2842, IP3842, IP1843, IP2843, IP3843

REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (+V_{CC}) (low impedance source)	+30V
Supply Voltage (V_{CC}) (I_{CC} <30mA)	Self limiting
Output Current	±1A
Output Energy (capacitive load)	µJ
Analog Inputs (pins 2 and 3)	−0.3V to +V_{CC}
Error Amp Output Sink Current	10mA
Power Dissipation at	
T_A = +25°C (Note 1)	1000mW
T_C = +25°C (Note 2)	2000mW
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Supply Voltage (+V_{CC}) (Note 4)	≤30V
Output Current	0 to ±200mA
Analog Inputs (pins 2 and 3)	−0.3 to 3 V
Error Amp Output Sink Current	0 to 2mA
Operating Ambient Temperature Range:	
IP1842, IP1843	−55°C to +125°C
IP2842, IP2843	−25°C to +85°C
IP3842, IP3843	0°C to +70°C

Note 1. Derate at 10 mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 24 mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.
Note 4. Lower limit set by under voltage lockout specification.

ELECTRICAL CHARACTERISTICS

V_{CC} = 15V, f = 52kHz, R_T = 10k, C_T = 3.3nF unless otherwise specified (Note 6)

Parameter	Test Conditions		IP1842/IP1843 IP2842/IP2843			IP3842/IP3843			Units
			Min	Typ	Max	Min	Typ	Max	
Reference Section									
Output Voltage	I_O = 1mA		4.95	5.00	5.05	4.90	5.00	5.10	V
Input Regulation	V_{CC} = 12 to 25V	●		6	20		6	20	mV
Output Regulation	I_O = 1 to 20mA	●		6	25		6	25	mV
Temperature Stability	(Note 5)	●		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation	Line, Load, Temp	●	4.90		5.10	4.82		5.18	V
Output Noise Voltage	f = 10Hz to 10kHz (Note 5)			50			50		µV
Long Term Stability	T_j = 125°C 1000 Hrs (Note 5)			5	25		5	25	mV
Output Short Circuit Current	V_{REF} = 0	●	30	80	160	30	80	160	mA
Oscillator Section									
Frequency			47	52	57	47	52	57	kHz
Voltage Stability	V_{CC} = 12 to 25V	●		0.2	1		0.2	1	%
Temperature Stability	ΔT_A = Min to Max (Note 5)	●		5			5		%
Amplitude	$V_{PIN\ 4}$ Peak to Peak	●		1.7			1.7		V
Discharge Current				8.3			8.3		mA
	ΔT_A = Min to Max (Note 5)			8			8		%

CURRENT MODE IP1842, IP2842, IP3842, IP1843, IP2843, IP3843

REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

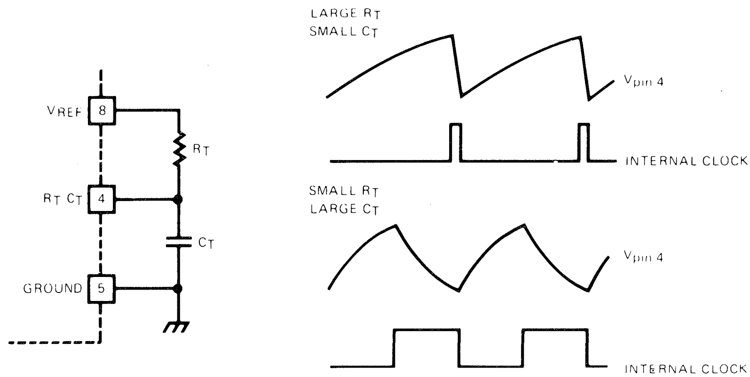
2

Parameter	Test Conditions		IP1842/IP1843 IP2842/IP2843 Min	Typ	Max	IP3842/IP3843 Min	Typ	Max	Units
Error Amp Section									
Input Voltage	$V_{PIN\ 1} = 2.5V$	●	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current		●		-0.3	-1		-0.3	-2	μA
Open Loop Voltage Gain	$V_O = 2$ to $4V$	●	65	90		65	90		dB
Unity Gain Bandwith	(Note 5)	●	0.7	1		0.7	1		MHz
Supply Voltage Rejection	$V_{CC} = 12$ to $25V$	●	60	70		60	70		dB
Output Sink Current	$V_{PIN\ 2} = 2.7V$, $V_{PIN\ 1} = 1.1V$	●	2	6		2	6		mA
Output Source Current	$V_{PIN\ 2} = 2.3V$, $V_{PIN\ 1} = 4.6V$	●	-0.5	-0.8		-0.5	-0.8		mA
V_{OUT} High	$V_{PIN\ 2} = 2.3V$, $R_L = 15k$	●	4.6	4.8		4.6	4.8		V
V_{OUT} Low	$V_{PIN\ 2} = 2.7V$, $R_L = 15k$	●		0.7	1.1		0.7	1.1	V
Current Sense Section									
Gain	(Notes 7 and 8)	●	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal	$V_{PIN\ 1} = 4.6V$ (Note 7)	●	0.9	1	1.1	0.9	1.0	1.1	V
Supply Voltage Rejection	$V_C = 12$ to $25V$	●	60	70		60	70		dB
Input Bias Current		●		-2	-10		-2	-10	μA
Delay to Output		●		200	400		200	400	ns
Output Section									
Output Low Level	$I_{SINK} = 20mA$	●		0.1	0.4		0.1	0.4	V
	$I_{SINK} = 200mA$	●		1.5	2.2		1.5	2.2	V
Output High Level	$I_{SOURCE} = 20mA$	●	13	13.5		13	13.5		V
	$I_{SOURCE} = 200mA$	●	12	13.5		12	13.5		V
Rise Time	$C_L = 1nF$			50	150		50	150	ns
Fall Time	$C_L = 1nF$			50	150		50	150	ns
UVLO Saturation	$V_{CC} = 6V$, $I_L = 1mA$	●		0.7	1.1		0.7	1.1	V
Under-voltage Lockout Section									
Upper Threshold	1842 Series	●	15	16	17	14.5	16	17.5	V
(V_{CC})	1843 Series	●	7.8	8.4	9	7.8	8.4	9	V
Lower Threshold	1842 Series	●	9	10	11	8.5	10	11.5	V
(V_{CC})	1843 Series	●	7	7.6	8.2	7	7.6	8.2	V
Total Standby Current									
Start-Up Current		●		0.3	0.5		0.3	0.5	mA
Operating Supply Current	$V_{PIN\ 2} = 0V$ — 1842 Series	●		11	15		11	15	mA
	$V_{PIN\ 3} = 0V$ — 1843 Series	●		14	17		14	17	mA
V_{CC} Zener Voltage	$I_{CC} = 25mA$	●	30	34	40	30	34	40	V

The ● denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.
Note 5. These parameters, although guaranteed over the recommended conditions,are not 100% tested in production.
Note 6. Adjust V_{CC} above start threshold before setting at required level.
Note 7. Parameter measured at trip point of latch with $V_{PIN\ 2} = 0V$.
Note 8. Gain defined as

$$A = \frac{\Delta V_{PIN\ 1}}{\Delta V_{PIN\ 3}} ; 0 \leqslant V_{PIN\ 3} \leqslant 0.8$$

Oscillator Waveforms and Maximum Duty Cycle



Oscillator timing capacitor, C_T is charged by V_{REF} through R_T and discharged by an internal current source. During the discharge time, the internal clock signal blanks the output to the low state. Selection of R_T and C_T therefore determines both oscillator frequency and maximum duty cycle. Charge and discharge times are determined by the formulas:

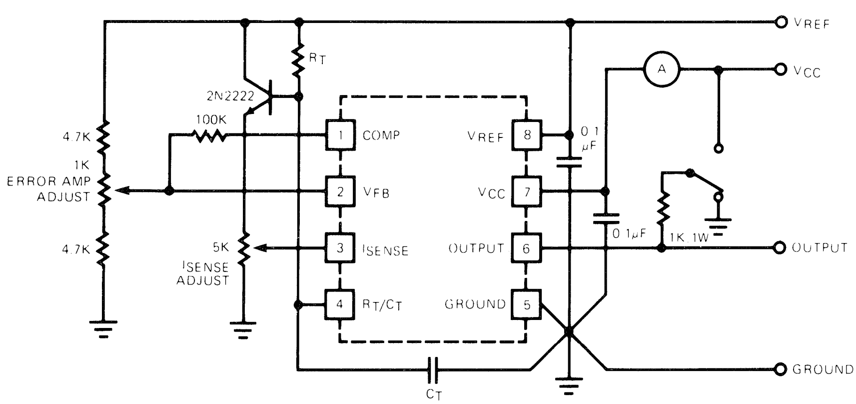
$$t_c \approx 0.55\, R_T C_T$$

$$t_d \approx R_T C_T \,\ell n \left(\frac{.0063\, R_T - 2.3}{.0063 - 4} \right)$$

Frequency, then is: $f = (t_c + t_d)^{-1}$

For $R_T > 5k$, $f \approx \dfrac{1.8}{R_T C_T}$

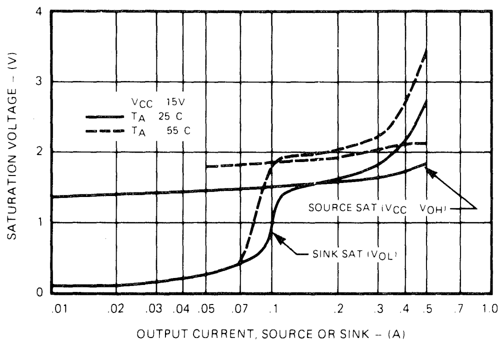
Open-Loop Laboratory Test Fixture



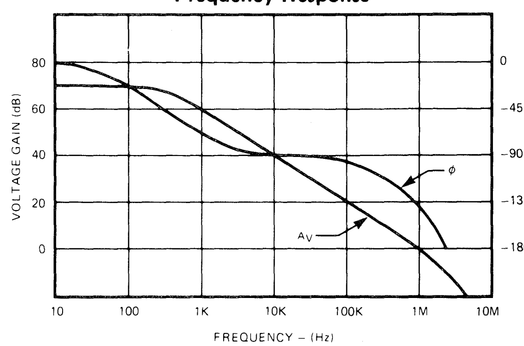
High peak current associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to pin 5 in a single point ground. The transistor and 5K potentiometer are used to sample the oscillator wave form and apply an adjustable ramp to pin 3

TYPICAL PERFORMANCE CHARACTERISTICS

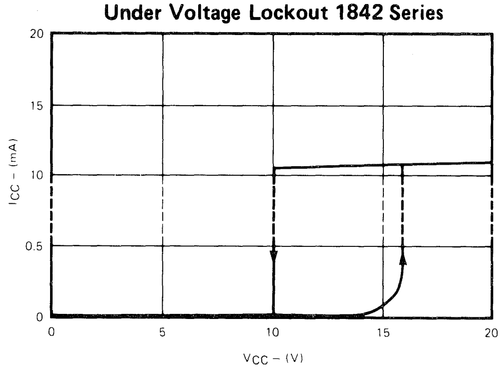
Output Saturation Characteristics



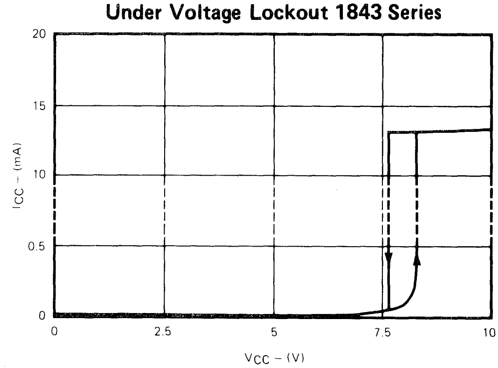
Error Amplifier Open-Loop Frequency Response



Under Voltage Lockout 1842 Series



Under Voltage Lockout 1843 Series



ORDER INFORMATION

Part Number	Temperature Range	Package
IP1842J	−55°C to +125°C	8 Pin Ceramic DIP
IP2842J	−25°C to + 85°C	8 Pin Ceramic DIP
IP2842N	−25°C to + 85°C	8 Pin Plastic DIP
IP2842D	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2842D-14	−25°C to + 85°C	14 Pin Plastic (150)SOIC
IP3842J	0°C to + 70°C	8 Pin Ceramic DIP
IP3842N	0°C to + 70°C	8 Pin Plastic DIP
IP3842D	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3842D-14	0°C to + 70°C	14 Pin Plastic (150) SOIC
IP1843J	−55°C to +125°C	8 Pin Ceramic DIP
IP2843J	−25°C to + 85°C	8 Pin Ceramic DIP
IP2843N	−25°C to + 85°C	8 Pin Plastic DIP
IP2843D	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2843D-14	−25°C to + 85°C	14 Pin Plastic (150) SOIC
IP3843J	0°C to + 70°C	8 Pin Ceramic DIP
IP3843N	0°C to + 70°C	8 Pin Plastic DIP
IP3843D	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3843D-14	0°C to + 70°C	14 Pin Plastic (150) SOIC

Seagate Microelectronics Limited

REGULATING PULSE WIDTH MODULATORS

CURRENT MODE IP1844, IP2844, IP3844, IP1845, IP2845, IP3845

DESCRIPTION

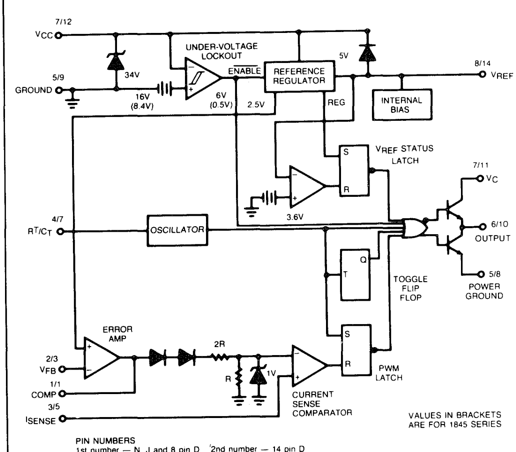
The IP1844 and IP1845 series of switching regulator control circuits contain all the functions necessary to implement off-line, current mode switching regulators, using a minimum number of external parts. Functions included are voltage reference, error amplifier, current sense comparator, oscillator, totem-pole output driver and under-voltage lockout circuitry. In addition there is a toggle flip-flop which blanks the output on every second clock pulse, thereby ensuring that the duty cycle never exceeds 50%.

Although pin compatible with the UC1844 and UC1845 series, Seagate Microelectronics has incorporated several improvements in the IP1844 and IP1845 series allowing tighter and more complete specification of electrical performance.

FEATURES

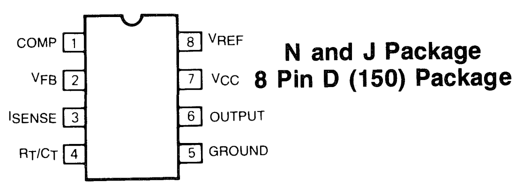
- Guaranteed ±1% reference voltage tolerance
- Guaranteed ±10% frequency tolerance
- Low start-up current (<500 μA)
- Under voltage lockout with hysteresis
- Output state completely defined for all supply and input conditions
- Interchangeable with UC1844 and UC1845 series for improved operation
- 500 kHz Oscillator operation
  250 kHz Output operation

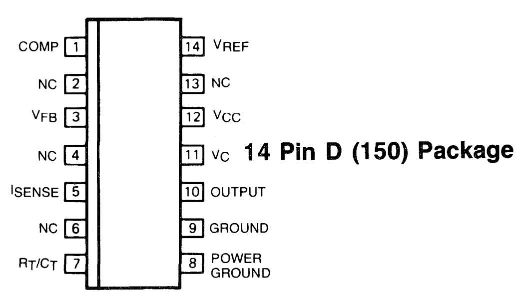
BLOCK DIAGRAM



CONNECTIONS

(Top View)





REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (+V_{CC}) (low impedance source)	+30V
Supply Voltage (V_{CC}) (I_{CC} <30mA)	Self limiting
Output Current	±1A
Output Energy (capacitive load)	5μJ
Analog Inputs (pins 2 and 3)	−0.3V to +V_{CC}
Error Amp Output Sink Current	10mA

Power Dissipation at

T_A = +25°C (Note 1) N and J Packages	1000mW
T_C = +25°C (Note 2) D Packages	725mW
T_C = +25°C (Note 3) N and J Packages	2000mW
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 4)

Supply Voltage (+V_{CC})	⩽30V
Output Current	0 to ±200mA
Analog Inputs (pins 2 and 3)	−0.3V to 3V
Error Amp Output Sink Current	0 to 2mA

Operating Ambient Temperature Range:

IP1844, IP1845	−55°C to +125°C
IP2844, IP2845	−25°C to +85°C
IP3844, IP3845	0°C to +70°C

Note 1. Derate at 10 mW/°C, for N and J packages, for ambient temperatures above +50°C.
Note 2. Derate at 7.25 mW/°C for D packages, for ambient temperatures above +50°C.
Note 3. Derate at 16 mW/°C for case temperatures above +25°C.
Note 4. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

V_{CC} = 15V, f = 52kHz, R_T = 10k, C_T = 3.3nF unless otherwise specified (Note 6)

Parameter	Test Conditions		IP1844/IP1845 IP2844/IP2845 Min	Typ	Max	IP3844/IP3845 Min	Typ	Max	Units
Reference Section									
Output Voltage	I_O = 1mA		4.95	5.00	5.05	4.90	5.00	5.10	V
Input Regulation	V_{CC} = 12 to 25V	●		6	20		6	20	mV
Output Regulation	I_O = 1 to 20mA	●		6	25		6	25	mV
Temperature Stability	(Note 5)	●		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation	Line, Load, Temp	●	4.90		5.10	4.82		5.18	V
Output Noise Voltage	f = 10Hz to 10kHz (Note 5)			50			50		μV
Long Term Stability	T_j = 125°C 1000 Hrs (Note 5)			5	25		5	25	mV
Output Short Circuit Current	V_{REF} = 0	●	30	80	160	30	80	160	mA
Oscillator Section									
Frequency	Note 10		47	52	57	47	52	57	kHz
Voltage Stability	V_{CC} = 12 to 25V	●		0.2	1		0.2	1	%
Temperature Stability	ΔT_A = Min to Max (Note 5)	●		5			5		%
Amplitude	$V_{PIN\ 4}$ Peak to Peak	●		1.7			1.7		V
Discharge Current				8.3			8.3		mA
	ΔT_A = Min to Max (Note 5)			8			8		%

REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1844/IP1845 IP2844/IP2845			IP3844/IP3845			Units
			Min	Typ	Max	Min	Typ	Max	
Error Amp Section									
Input Voltage	$V_{PIN\ 1} = 2.5V$	●	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current		●		-0.3	-1		-0.3	-2	μA
Open Loop Voltage Gain	$V_O = 2$ to $4V$	●	65	90		65	90		dB
Unity Gain Bandwith	(Note 5)	●	0.7	1		0.7	1		MHz
Supply Voltage Rejection	$V_{CC} = 12$ to $25V$	●	60	70		60	70		dB
Output Sink Current	$V_{PIN\ 2} = 2.7V$, $V_{PIN\ 1} = 1.1V$	●	2	6		2	6		mA
Output Source Current	$V_{PIN\ 2} = 2.3V$, $V_{PIN\ 1} = 5.0V$	●	-0.5	-0.8		-0.5	-0.8		mA
V_{OUT}High	$V_{PIN\ 2} = 2.3V$, $R_L = 15k$	●	5.0	6.0		5.0	6.0		V
V_{OUT}Low	$V_{PIN\ 2} = 2.7V$, $R_L = 15k$	●		0.7	1.1		0.7	1.1	V
Current Sense Section									
Gain	(Notes 7 and 8)	●	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal	$V_{PIN\ 1} = 5.0$ (Note 7)	●	0.9	1	1.1	0.9	1.0	1.1	V
Supply Voltage Rejection	$V_C = 12$ to $25V$	●	60	70		60	70		dB
Input Bias Current		●		-2	-10		-2	-10	μA
Delay to Output		●		150	300		150	300	ns
Output Section									
Output Low Level	$I_{SINK} = 20mA$	●		0.1	0.4		0.1	0.4	V
	$I_{SINK} = 200mA$	●		1.5	2.2		1.5	2.2	V
Output High Level	$I_{SOURCE} = 20mA$	●	13	13.5		13	13.5		V
	$I_{SOURCE} = 200mA$	●	12	13.5		12	13.5		V
Rise Time	$C_L = 1nF$	●		50	150		50	150	ns
Fall Time	$C_L = 1nF$	●		50	150		50	150	ns
UVLO Saturation	$V_{CC} = 6V$, $I_L = 1mA$	●		0.7	1.1		0.7	1.1	V
Under-voltage Lockout Section									
Upper Threshold	1844 Series	●	15	16	17	14.5	16	17.5	V
(V_{CC})	1845 Series	●	7.8	8.4	9	7.8	8.4	9	V
Lower Threshold	1844 Series	●	9	10	11	8.5	10	11.5	V
(V_{CC})	1845 Series	●	7	7.6	8.2	7	7.6	8.2	V
Total Standby Current									
Start-Up Current		●		0.3	0.5		0.3	0.5	mA
Operating Supply Current	$V_{PIN\ 2} = 0V$ 1844 Series	●		11	15		11	15	mA
	$V_{PIN\ 3} = 0V$ 1845 Series	●		14	17		14	17	mA
V_{CC} Zener Voltage	$I_{CC} = 25mA$	●	30	34	40	30	34	40	V

The ● denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.
Note 5. These parameters, although guaranteed over the recommended conditions,are not 100% tested in production.
Note 6. Adjust V_{CC} above start threshold before setting at required level.
Note 7. Parameter measured at trip point of latch with $V_{PIN\ 2} = 0V$.
Note 8. Gain defined as

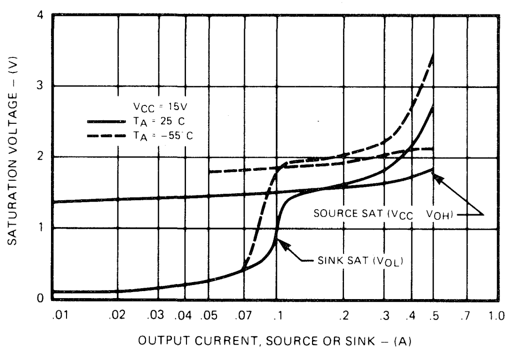
$$A = \frac{\triangle V_{PIN\ 1}}{\triangle V_{PIN\ 3}} ;0 \leqslant V_{PIN\ 3} \leqslant 0.8$$

ELECTRICAL CHARACTERISTICS (CONTINUED)

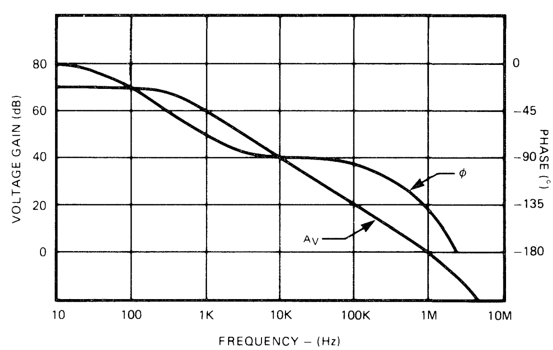
Parameter	Test Conditions		IP1844/IP1845 IP2844/IP2845 Min	Typ	Max	IP3844/IP3845 Min	Typ	Max	Units
PWM Section									
Maximum Duty Cycle		●	47	48	50	46	48	50	%
Minimum Duty Cycle		●			0			0	%

TYPICAL PERFORMANCE CHARACTERISTICS

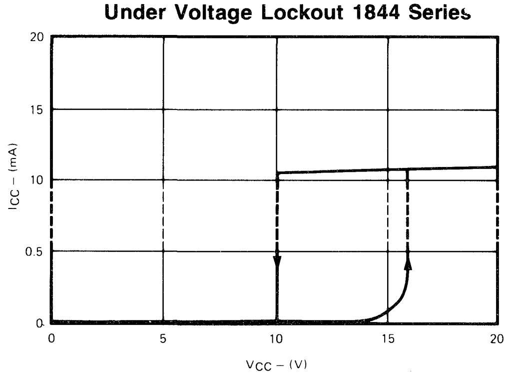
Output Saturation Characteristics



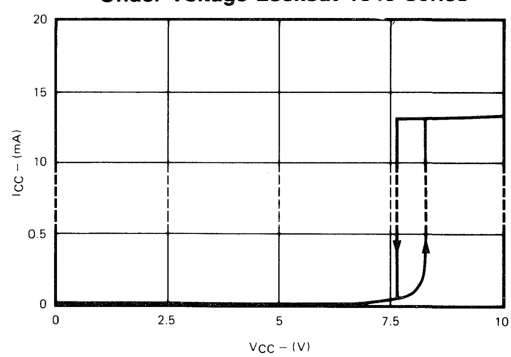
Error Amplifier Open-Loop Frequency Response



Under Voltage Lockout 1844 Series



Under Voltage Lockout 1845 Series



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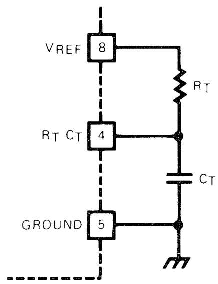
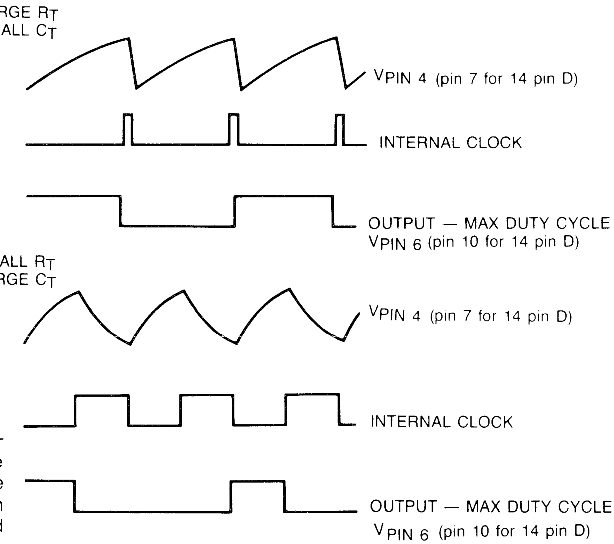
Oscillator Waveforms and Maximum Duty Cycle





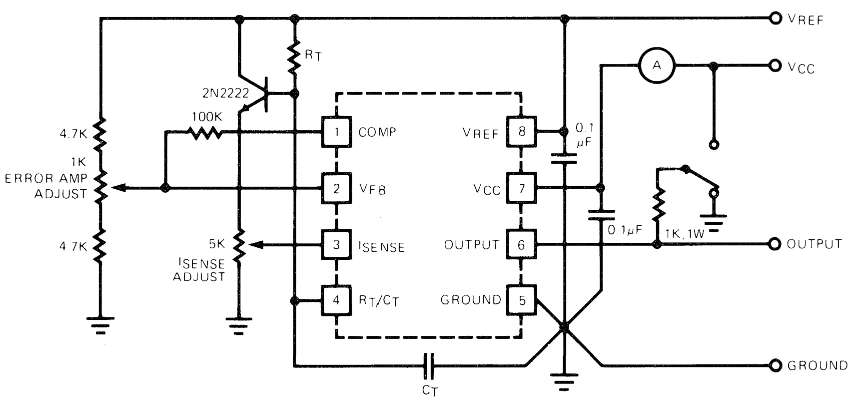
Oscillator timing capacitor, C_T is charged by V_{REF} through R_T and discharged by an internal current source. During the discharge time, the internal clock signal blanks the output to the low state. Selection of R_T and C_T therefore determines both oscillator frequency and maximum duty cycle. Charge and discharge times are determined by the formulas:

$$t_c \approx 0.55\, R_T C_T$$

$$t_d \approx R_T C_T \ln\left(\frac{.0063\, R_T - 2.3}{.0063 - 4}\right)$$

Frequency, then is: $f = (t_c + t_d)^{-1}$ For $R_T > 5k$, $f \approx \frac{1.8}{R_T C_T}$

Open-Loop Laboratory Test Fixture



High peak current associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to pin 5 in a single point ground. The transistor and 5K potentiometer are used to sample the oscillator wave form and apply an adjustable ramp to pin 3.

REGULATING PULSE WIDTH MODULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1844J	−55°C to +125°C	8 Pin Ceramic DIP
IP2844J	−25°C to + 85°C	8 Pin Ceramic DIP
IP2844N	−25°C to + 85°C	8 Pin Plastic DIP
IP2844D	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2844D-14	−25°C to + 85°C	14 Pin Plastic (150) SOIC
IP3844J	0°C to + 70°C	8 Pin Ceramic DIP
IP3844N	0°C to + 70°C	8 Pin Plastic DIP
IP3844D	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3844D-14	0°C to + 70°C	14 Pin (150) SOIC
IP1845J	−55°C to +125°C	8 Pin Ceramic DIP
IP2845J	−25°C to + 85°C	8 Pin Ceramic DIP
IP2845N	−25°C to + 85°C	8 Pin Plastic DIP
IP2845D	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2845D-14	−25°C to + 85°C	14 Pin(150) SOIC
IP3845J	0°C to + 70°C	8 Pin Ceramic DIP
IP3845N	0°C to + 70°C	8 Pin Plastic DIP
IP3845D	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3845D-14	0°C to + 70°C	14 Pin (150) SOIC

Seagate Microelectronics Limited

REGULATING PULSE WIDTH MODULATORS

CURRENT MODE — IPX842A, IPX843A, IPX844A, IPX845A

2

DESCRIPTION

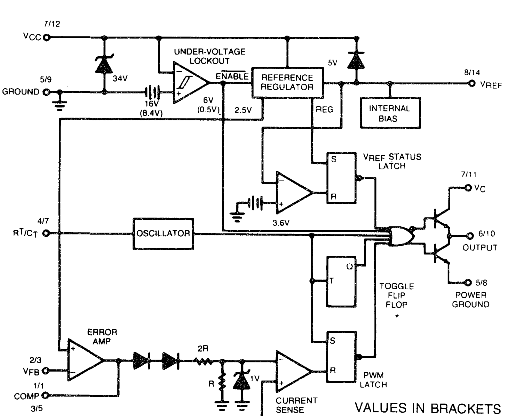
The IPX84XA series of switching regulator control circuits contains all the functions necessary to implement off-line, current mode switching regulators, using a minimum number of external parts. Functions included are voltage reference, error amplifier, current sense comparator, oscillator, totem-pole output driver and under-voltage lockout circuitry. In addition the IPX844A and IPX845A have a toggle flip-flop which blanks the output on every second clock pulse, thereby ensuring that the duty cycle never exceeds 50%. For applications requiring more flexible control all devices feature an on-chip trimmed oscillator discharge current, allowing accurate control to maximum-duty-cycle by selection of timing components. This can be beneficial even if using the IPX844A or IPX845A series, as it allows optimum safety margins to be designed into the application.

Although pin compatible with the 'non A' parts, these devices offer improved performance in several areas. They also offer tighter specification and improved performance over the UCX84X series, whilst retaining complete compatability.

FEATURES

- Guaranteed ± 1% reference voltage tolerance
- Accurate oscillator discharge current
- Guaranteed ± 10% frequency tolerance
- Low start-up current (<500 μA)
- Under voltage lockout with hysteresis
- Output state completely defined for all supply and input conditions
- Interchangeable with UC1842/43/44/45 series for improved operation
- 500 kHz Oscillator operation
  250 kHz Output operation (IPX844A & IPX845A)

BLOCK DIAGRAM



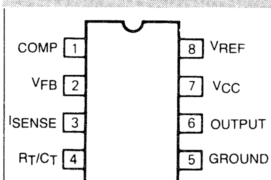
PIN NUMBERS
1st number — N, J and 8 pin D 2nd number — 14 pin D

VALUES IN BRACKETS ARE FOR X843A & X845A Series

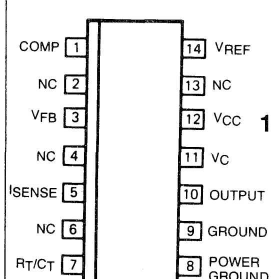
* X844A & X845A SERIES

CONNECTIONS

(Top View)



N and J Package
8 Pin D (150) Package



14 Pin D (150) Package
14 Pin J Package
14 Pin N Package

REGULATING PULSE WIDTH MODULATORS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (+V_{CC}) (low impedance source)	+30V
Supply Voltage (V_{CC}) (I_{CC} <30mA)	Self limiting
Output Current	±1A
Output Energy (capacitive load)	5μJ
Analog Inputs (pins 2 and 3)	−0.3V to +V_{CC}
Error Amp Output Sink Current	10mA
Power Dissipation at	
T_A = +25°C (Note 1) N and J Packages	1000mW
T_C = +25°C (Note 2) D Packages	725mW
T_C = +25°C (Note 3) N and J Packages	2000mW
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 4)

Supply Voltage (+V_{CC}) (Note 5)	≤30V
Output Current	0 to ±200mA
Analog Inputs (pins 2 and 3)	−0.3V to 3V
Error Amp Output Sink Current	0 to 2mA
Operating Ambient Temperature Range:	
IP184XA	−55°C to +125°C
IP284XA	−25°C to +85°C
IP384XA	0°C to +70°C

Note 1. Derate at 10 mW/°C, for N and J packages, for ambient temperatures above +50°C.
Note 2. Derate at 7.25 mW/°C for D packages, for ambient temperatures above +50°C.
Note 3. Derate at 16 mW/°C for case temperatures above +25°C.
Note 4. Range over which the device is functional and parameter limits are guaranteed.
Note 5. Lower limit set by under voltage lockout specification.

ELECTRICAL CHARACTERISTICS

V_{CC} = 15V, f = 52kHz, R_T = 10k, C_T = 3.3nF unless otherwise specified (Note 7)

Parameter	Test Conditions		IP184XA IP284XA Min	Typ	Max	IP384XA Min	Typ	Max	Units
Reference Section									
Output Voltage	I_O = 1mA		4.95	5.00	5.05	4.90	5.00	5.10	V
Input Regulation	V_{CC} = 12 to 25V	●		6	20		6	20	mV
Output Regulation	I_O = 1 to 20mA	●		6	25		6	25	mV
Temperature Stability	(Note 6)	●		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation	Line, Load, Temp	●	4.90		5.10	4.82		5.18	V
Output Noise Voltage	f = 10Hz to 10kHz (Note 6)			50			50		μV
Long Term Stability	T_j = 125°C 1000 Hrs (Note 6)			5	25		5	25	mV
Output Short Circuit Current	V_{REF} = 0	●	30	80	160	30	80	160	mA
Oscillator Section									
Frequency	Note 10		47	52	57	47	52	57	kHz
Voltage Stability	V_{CC} = 12 to 25V	●		0.2	1		0.2	1	%
Temperature Stability	ΔT_A = Min to Max (Note 6)	●		5			5		%
Amplitude	$V_{PIN\ 4}$ Peak to Peak	●		1.7			1.7		V
Discharge Current			7.8	8.3	8.8	7.8	8.3	8.8	mA
	ΔT_A = Min to Max (Note 6)		7.0		9.0	7.0		9.0	mA

REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

2

Parameter	Test Conditions		IP184XA IP284XA			IP384XA			Units
			Min	Typ	Max	Min	Typ	Max	
Error Amp Section									
Input Voltage	$V_{PIN\,1}$ = 2.5V	●	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current		●		-0.3	-1		-0.3	-2	μA
Open Loop Voltage Gain	V_O = 2 to 4V	●	65	90		65	90		dB
Unity Gain Bandwith	(Note 6)	●	0.7	1		0.7	1		MHz
Supply Voltage Rejection	V_{CC} = 12 to 25V	●	60	70		60	70		dB
Output Sink Current	$V_{PIN\,2}$ = 2.7V, $V_{PIN\,1}$ = 1.1V	●	2	6		2	6		mA
Output Source Current	$V_{PIN\,2}$ = 2.3V, $V_{PIN\,1}$ = 5.0V	●	-0.5	-0.8		-0.5	-0.8		mA
V_{OUT}High (See Note 11)	$V_{PIN\,2}$ = 2.3V, R_L = 15k	●	5.0	6.0		5.0	6.0		V
V_{OUT}Low	$V_{PIN\,2}$ = 2.7V, R_L = 15k	●		0.7	1.1		0.7	1.1	V
Current Sense Section									
Gain	(Notes 8 and 9)	●	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal	$V_{PIN\,1}$ = 5.0 (Note 8)	●	0.9	1	1.1	0.9	1.0	1.1	V
Supply Voltage Rejection	V_C = 12 to 25V	●	60	70		60	70		dB
Input Bias Current		●		-2	-10		-2	-10	μA
Delay to Output		●		150	300		150	300	ns
Output Section									
Output Low Level	I_{SINK} = 20mA	●		0.1	0.4		0.1	0.4	V
	I_{SINK} = 200mA	●		1.5	2.2		1.5	2.2	V
Output High Level	I_{SOURCE} = 20mA	●	13	13.5		13	13.5		V
	I_{SOURCE} = 200mA	●	12	13.5		12	13.5		V
Rise Time	C_L = 1nF	●		50	150		50	150	ns
Fall Time	C_L = 1nF	●		50	150		50	150	ns
UVLO Saturation	V_{CC} = 6V, I_L = 1mA	●		0.7	1.1		0.7	1.1	V
Under-voltage Lockout Section									
Upper Threshold	IPX842A/IPX844A Series	●	15	16	17	14.5	16	17.5	V
(V_{CC})	IPX843A/IPX845A Series	●	7.8	8.4	9	7.8	8.4	9	V
Lower Threshold	IPX842A/IPX844A Series	●	9	10	11	8.5	10	11.5	V
(V_{CC})	IPX843A/IPX845A Series	●	7	7.6	8.2	7	7.6	8.2	V
Total Standby Current									
Start-Up Current		●		0.3	0.5		0.3	0.5	mA
Operating Supply Current	$V_{PIN\,2}$ = 0V 42/44 Series	●		11	15		11	15	mA
	$V_{PIN\,3}$ = 0V 43/45 Series	●		14	17		14	17	mA
V_{CC} Zener Voltage	I_{CC} = 25mA	●	30	34	40	30	34	40	V

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 6. These parameters, although guaranteed over the recommended conditions,are not 100% tested in production.

Note 7. Adjust V_{CC} above start threshold before setting at required level.

Note 8. Parameter measured at trip point of latch with $V_{PIN\,2}$ = 0V.

Note 9. Gain defined as

$$A = \frac{\triangle V_{PIN\,1}}{\triangle V_{PIN\,3}} \quad ; 0 \leqslant V_{PIN\,3} \leqslant 0.8$$

Note 10. The output frequency is half the oscillator frequency for IPX844A and IPX845A Series.

Note 11. V_{OH} MIN 4.6V for 42A, 43A.

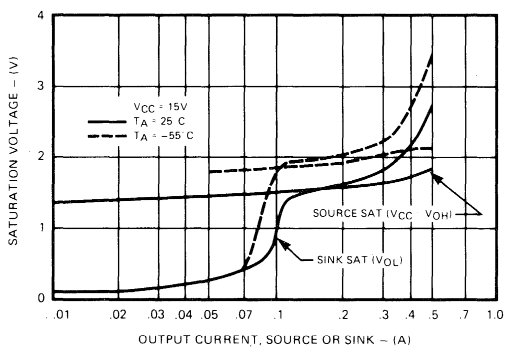
REGULATING PULSE WIDTH MODULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

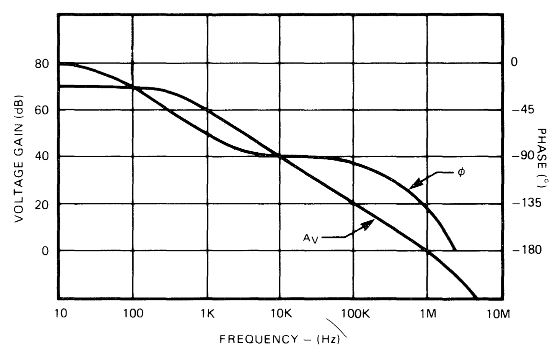
Parameter	Test Conditions		IP184XA IP284XA			IP384XA			Units
			Min	Typ	Max	Min	Typ	Max	
PWM Section									
Maximum Duty Cycle	IPX844A/IPX845A Series	●	47	48	50	46	48	50	%
Maximum Duty Cycle	IPX842A/IPX843A Series	●	95	97	100	95	97	100	%
Minimum Duty Cycle		●			0			0	%

TYPICAL PERFORMANCE CHARACTERISTICS

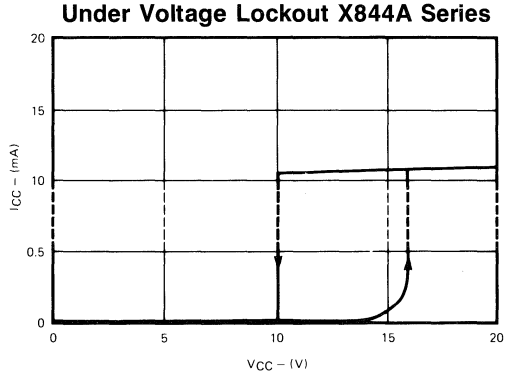
Output Saturation Characteristics



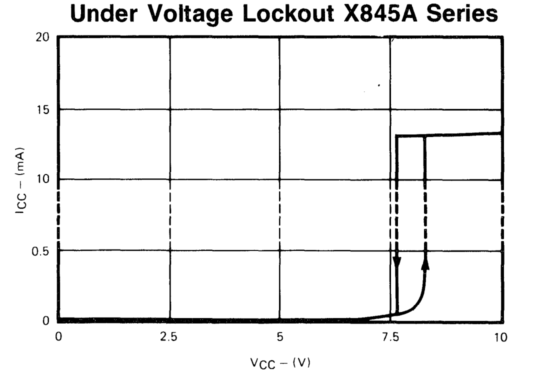
Error Amplifier Open-Loop Frequency Response



Under Voltage Lockout X844A Series

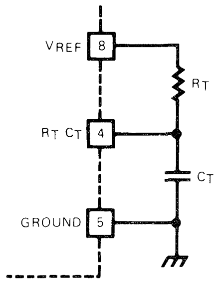


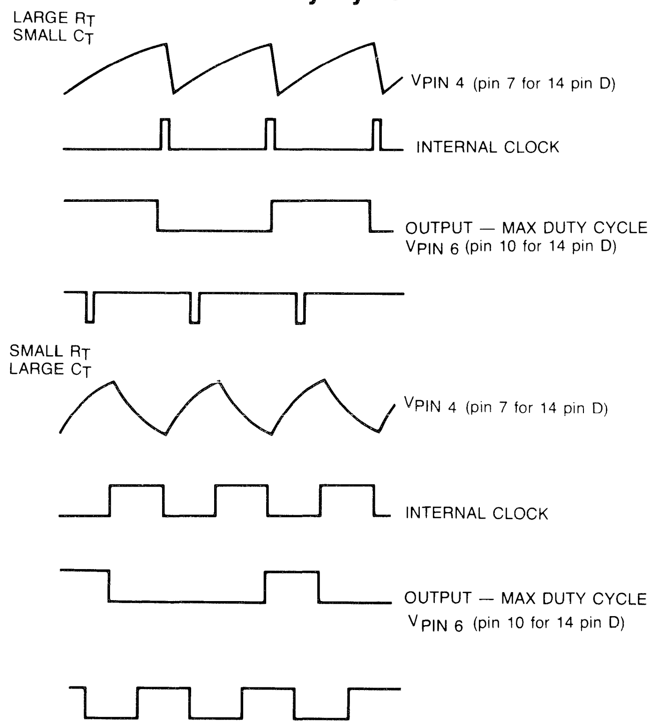
Under Voltage Lockout X845A Series



APPLICATIONS INFORMATION

Oscillator Waveforms and Maximum Duty Cycle





Oscillator timing capacitor, C_T is charged by V_{REF} through R_T and discharged by an internal current source. During the discharge time, the internal clock signal blanks the output to the low state. Selection of R_T and C_T therefore determines both oscillator frequency and maximum duty cycle. Charge and discharge times are determined by the formulas.

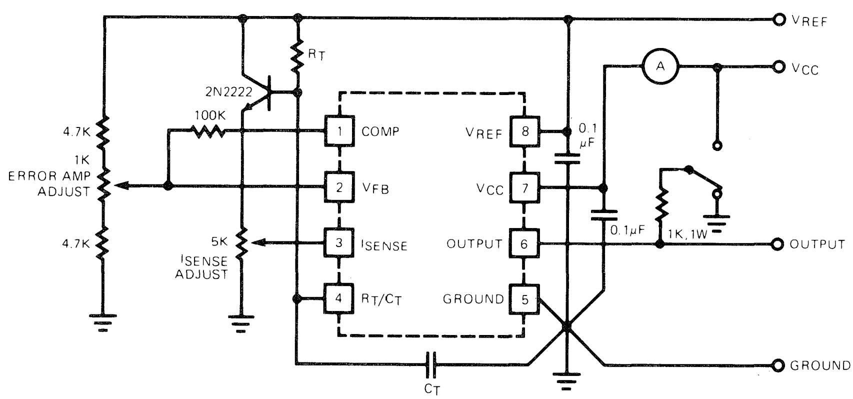
$$t_c \approx 0.55\, R_T C_T$$

$$t_d \approx R_T C_T \, \ln\left(\frac{.0063\, R_T - 2.3}{.0063\, R_T - 4}\right)$$

Frequency, then is: $f = (t_c + t_d)^{-1}$

For $R_T > 5k$, $f \approx \dfrac{1.8}{R_T C_T}$

Open-Loop Laboratory Test Fixture



High peak current associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to pin 5 in a single point ground. The transistor and 5K potentiometer are used to sample the oscillator wave form and apply an adjustable ramp to pin 3.

REGULATING PULSE WIDTH MODULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1842AJ	−55°C to +125°C	8 Pin Ceramic DIP
IP2842AJ	−25°C to + 85°C	8 Pin Ceramic DIP
IP2842AN	−25°C to + 85°C	8 Pin Plastic DIP
IP2842AD	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2842AD-14	−25°C to + 85°C	14 Pin Plastic (150) SOIC
IP3842AJ	0°C to + 70°C	8 Pin Ceramic DIP
IP3842AN	0°C to + 70°C	8 Pin Plastic DIP
IP3842AD	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3842AD-14	0°C to + 70°C	14 Pin (150) SOIC
IP1843AJ	−55°C to +125°C	8 Pin Ceramic DIP
IP2843AJ	−25°C to + 85°C	8 Pin Ceramic DIP
IP2843AN	−25°C to + 85°C	8 Pin Plastic DIP
IP2843AD	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2843AD-14	−25°C to + 85°C	14 Pin(150) SOIC
IP3843AJ	0°C to + 70°C	8 Pin Ceramic DIP
IP3843AN	0°C to + 70°C	8 Pin Plastic DIP
IP3843AD	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3843AD-14	0°C to + 70°C	14 Pin (150) SOIC
IP1844AJ	−55°C to +125°C	8 Pin Ceramic DIP
IP2844AJ	−25°C to + 85°C	8 Pin Ceramic DIP
IP2844AN	−25°C to + 85°C	8 Pin Plastic DIP
IP2844AD	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2844AD-14	−25°C to + 85°C	14 Pin Plastic (150) SOIC
IP3844AJ	0°C to + 70°C	8 Pin Ceramic DIP
IP3844AN	0°C to + 70°C	8 Pin Plastic DIP
IP3844AD	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3844AD-14	0°C to + 70°C	14 Pin (150) SOIC
IP1845AJ	−55°C to +125°C	8 Pin Ceramic DIP
IP2845AJ	−25°C to + 85°C	8 Pin Ceramic DIP
IP2845AN	−25°C to + 85°C	8 Pin Plastic DIP
IP2845AD	−25°C to + 85°C	8 Pin Plastic (150) SOIC
IP2845AD-14	−25°C to + 85°C	14 Pin(150) SOIC
IP3845AJ	0°C to + 70°C	8 Pin Ceramic DIP
IP3845AN	0°C to + 70°C	8 Pin Plastic DIP
IP3845AD	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP3845AD-14	0°C to + 70°C	14 Pin (150) SOIC

Seagate Microelectronics Limited

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

IP5560, IP5560C

2

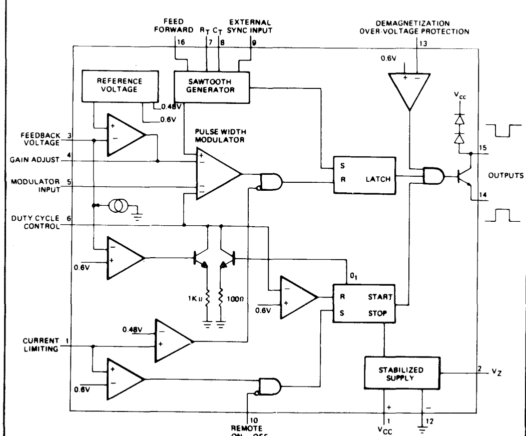
DESCRIPTION

The IP5560 is a control circuit for use in switched mode power supplies. This single monolithic chip incorporates all the control and supervisory (protection) functions required in switched mode power supplies, including an internal temperature compensated reference source, internal reference, sawtooth generator, pulse width modulator, output stage and various protection circuits.

FEATURES

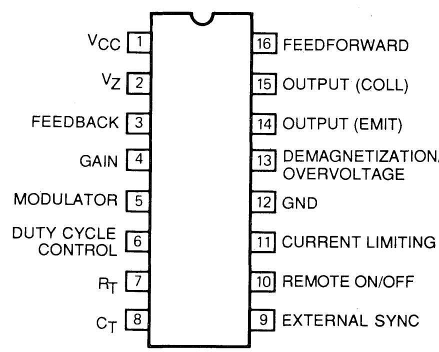
- Stabilized power supply
- Temperature compensated reference source
- Sawtooth generator
- Pulse width modulator
- Remote on/off switching
- Current limiting
- Low supply voltage protection
- Loop fault protection
- Demagnetization/overvoltage protection
- Maximum duty cycle clamp
- Feed forward control
- External synchronization

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (150) Package

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ABSOLUTE MAXIMUM RATINGS

Supply

Voltage Sourced	18V
Current Sourced	30mA

Output Transistor

Output Current	40mA
Collector Voltage (Pin 15)	18V
Max. Emitter Voltage (Pin 14)	5V

Operating Temperature (Ambient)

IP5560	−55°C to +125°C
IP5560C	−0°C to +70°C

Storage Temperature Range −65°C to +150°C

Operating Junction Temperature Range −55°c to +150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

V_{CC} = 12V unless otherwise specified

			IP5560			IP5560C			
Parameter	**Test Conditions**		**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
Reference Sections									
Internal Reference Voltage (V_{ref})			3.69	3.72	3.81	3.57	3.72	3.95	V
		•	3.65		3.85	3.53		4.00	V
Temperature Coefficient of V_{ref}				±100			±100		ppm/°C
Internal Reference (V_Z)	I_L = -7mA		7.8	8.4	8.8	7.8	8.4	8.8	V
Temperature Coefficient of V_Z				±200			±200		ppm/°C
Oscillator Section									
Frequency Range		•	50		100k	50		100k	Hz
Initial Accuracy Oscillator	R = 5 kΩ			5			5		%
Duty Cycle range	f_o = 20 KHz		0-90	0-98		0-90	0-98		%
Modulator									
Modulator Input Current	Voltage at Pin 5 = 2V	•		-0.2	-20		-0.2	-20	µA
Supervisory Functions									
Pin 6, Input Current	At 2V	•		-0.2	-20		-0.2	-20	µA
Pin 6, Duty Cycle Limit Control	(For 50% Max. Duty Cycle) 15 kHz to 50 kHz, V_6 = 0.4V_Z		40	50	60	40	50	60	% Duty Cycle
Pin 1, Low Supply Voltage Protection Thresholds			8	9.0	10.5	8	9.0	10.5	V
Pin 3, Feedback Loop Protection Trip Thresholds			400	600	720	400	600	720	mV
Pin 3, Pull Up Current	At 2V	•	-7	-15	-35	-7	-15	-35	µA
Pin 13, Demagnetization/ Over-voltage Protection Threshold			470	600	720	470	600	720	mV
Pin 13, Input Current	At 0.25V			-0.6	-10		-0.6	-10	µA
		•			-20			-20	µA
Pin 16, Feed Forward Duty Cycle Control	Voltage at Pin 16 = 2V_Z		30	40	50	30	40	50	%Orig Duty Cycle
Pin 16, Feed Forward Input Current	At 16V, V_{CC} = 18V			0.2	5		0.2	5	µA

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP5560			IP5560C			Units
			Min	Typ	Max	Min	Typ	Max	
External Synchronization									
Pin 9 Off			0		0.8	0		0.8	V
Pin 9 On			2		Vz	2		Vz	V
Pin 9, Sink Current	Voltage at Pin 9 = 0V	•		-85	-125		-85	-125	µA
Remote On/Off									
Pin 10 Off			0		0.8	0		0.8	V
Pin 10 On			2		Vz	2		Vz	V
Pin 10 Sink Current	Voltage at Pin 9 = 0V	•		-85	-125		-85	-125	µA
Current Limiting									
Pin 11, I_{IN}	Voltage at Pin 11 = 250mV			-2	-10		-2	-10	µA
Single Pulse Inhibit Delay	Inhibit Delay Time for 20% Overdrive at 30mA I_{OUT}			0.7	0.8		0.7	0.8	µs
Trip Levels: Shut Down, Slow Start			560	600	700	560	600	700	mV
Trip Levels: Current Limit			400	480	500	400	480	500	mV
Error Amplifier									
Output Voltage Swing (V_{OH})			6.2		9.5	6.2		9.5	V
Output Voltage Swing (V_{OL})					0.7			0.7	V
Open Loop Gain			54	60		54	60		dB
Feedback Resistor			10			10			kΩ
Small Signal Bandwidth				3			3		MHz
Output Stage									
$V_{CE}(SAT)$	I_C = 40mA				0.5			0.5	V
Output Current	(Pin 15)				40			40	mA
Max Emitter Voltage	(Pin 14)		5			5			V
Supply Voltage/Current									
I_{CC}	I_Z = 0, Voltage Fed, V_6 = .5V,				10			10	mA
	R_7 = 25kΩ	•			15			15	mA
V_{CC}	I_{CC} = 10mA, Current Feed		20		24	19		24	V
	I_{CC} = 30mA, Current Feed		20		30	20		30	V

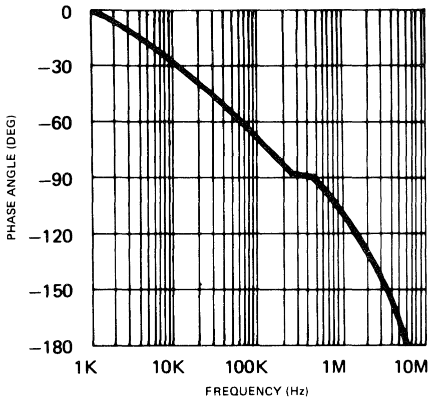
The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

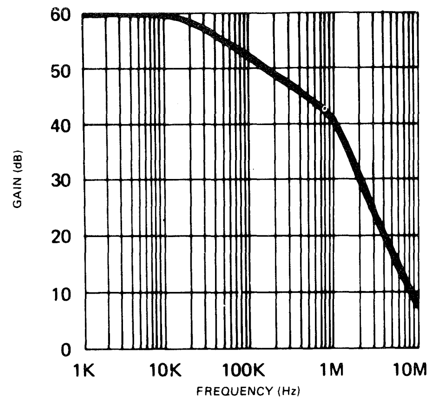
TYPICAL PERFORMANCE CHARACTERISTICS

ERROR AMPLIFIER

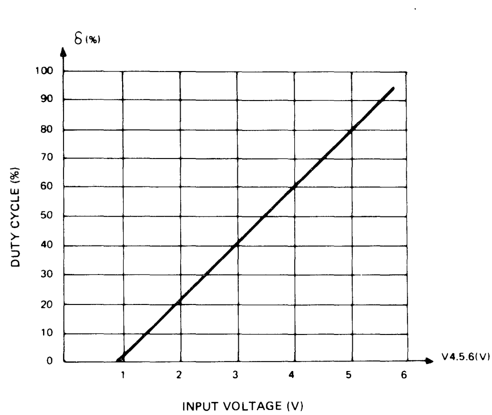
OPEN LOOP PHASE



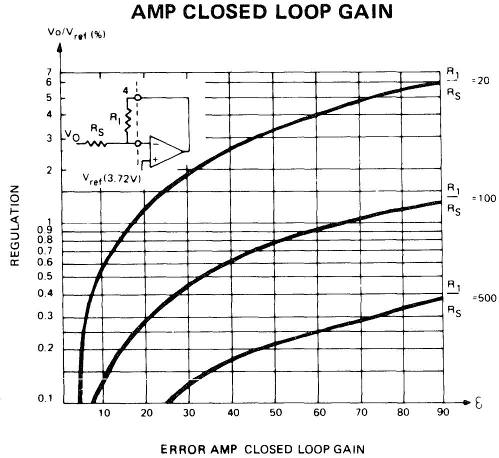
OPEN LOOP GAIN



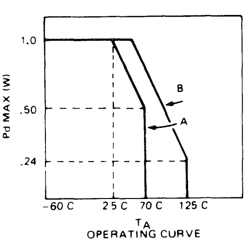
TRANSFER CURVE OF PULSE WIDTH MODULATOR DUTY CYCLE vs INPUT VOLTAGE



REGULATION vs ERROR AMP CLOSED LOOP GAIN

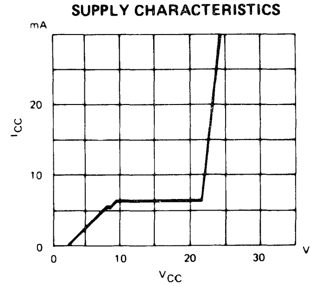


POWER DERATING CURVE

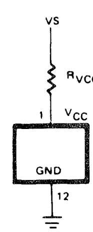


$P_d = V_{CC} I_{CC} + (V_{CC} - V_z) I_z + [(V_{15} - V_{14}) I_{15} \times \text{DUTY CYCLE}]$

VOLTAGE/CURRENT FED SUPPLY CHARACTERISTICS



CURRENT FED DROPPING RESISTOR



$R_{VCC} = \frac{V_S - V_{CC}}{(10 \text{ to } 20 \text{ mA})}$

SEE DC ELECTRICAL CHARACTERISTICS FOR CURRENT FEED V_{CC} RANGE.

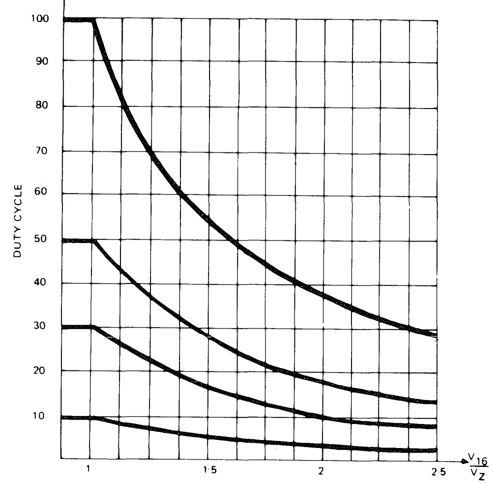
SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

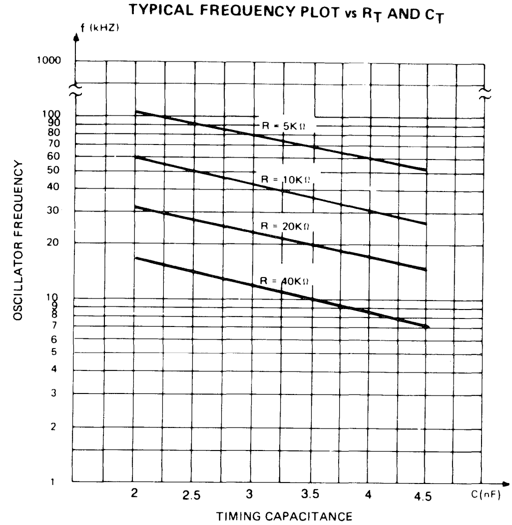
ERROR AMPLIFIER (Cont.)

2

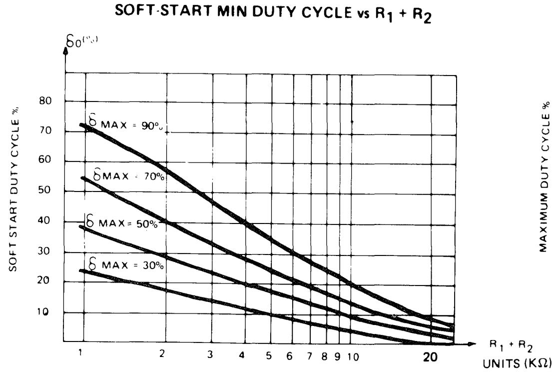
DUTY CYCLE SENSITIVITY TO FEED FORWARD VOLTAGE (PIN 16)



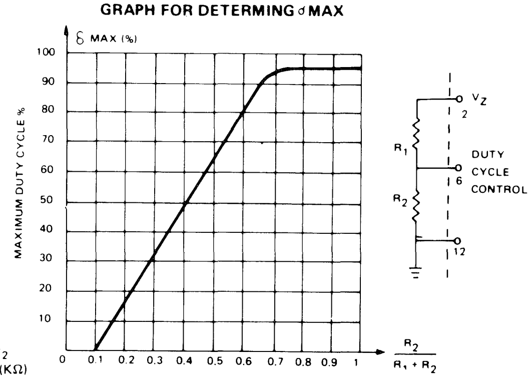
TYPICAL FREQUENCY PLOT vs R_T AND C_T



SOFT-START MIN DUTY CYCLE vs $R_1 + R_2$



GRAPH FOR DETERMING δ MAX



ORDER INFORMATION

Part Number	Temperature Range	Package
IP5560J	−55°C to +125°C	16 Pin Ceramic DIP
IP5560CD	−0°C to + 70°C	16 Pin Plastic (150) SOIC
IP5560CJ	−0°C to + 70°C	16 Pin Ceramic DIP
IP5560CN	−0°C to + 70°C	16 Pin Plastic DIP

Seagate Microelectronics Limited

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

IP5561, IP5561C

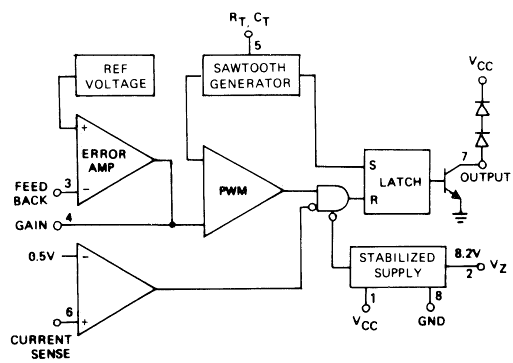
DESCRIPTION

The IP5561 is a control circuit for use in switched mode power supplies. This single monolithic chip incorporates the control and supervisory (protection) functions required in switched mode power supplies, including an internal temperature compensated reference source, internal zener reference, sawtooth generator, pulse width modulator, output stage and cycle by cycle current limit.

FEATURES

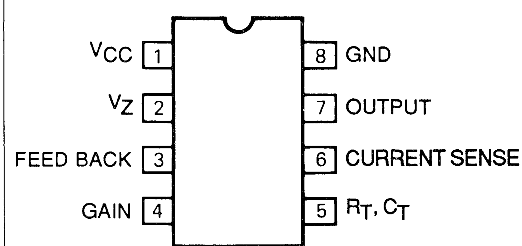
- Stabilized power supply
- Temperature compensated reference source.
- Sawtooth generator
- Pulse width modulator
- 8 Pin mini-DIP
- Current limiting

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (150) Package

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ABSOLUTE MAXIMUM RATINGS

Supply
- Voltage Sourced — 18V
- Current Sourced — 30mA

Output transistor
- Output Current — 40mA
- Collector Voltage (Pin 7) — 18V

Operating Temperature (Ambient)
- IP5561 — −55°C to +125°C
- IP5561C — 0°C to +70°C

Storage Temperature Range — −65°C to +150°C

Operating Junction Temperature Range — −55°C to +150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

V_{CC} = 12V unless otherwise specified.

Parameter	Test Conditions		IP5561 Min	IP5561 Typ	IP5561 Max	IP5561C Min	IP5561C Typ	IP5561C Max	Units
Reference Sections									
Internal Reference Voltage(V_{REF})			3.69	3.75	3.84	3.57	3.75	3.96	V
		•	3.65		3.88	3.55		3.98	V
Temperature Coeffecient of V_{REF}				±100			±100		ppm/°C
Internal Zener Reference (V_Z)	I_L = -7 mA		7.8	8.2	8.8	7.8	8.2	8.8	V
Temperature Coefficient of V_Z				±200			±200		ppm/°C
Oscillator Section									
Frequency Range		•	50		100k	50		100k	Hz
Initial Accuracy Oscillator	f_o = 20kHz			12			12		%
Duty Cycle Range			0-90	0-98		0-90	0-98		%
Current Limiting									
I_{IN}	Pin 6 = 250 mV			-2	-10		-2	-10	μA
		•			-20			-20	μA
Single Pulse Inhibit Delay	Inhibit Delay Time for 20% Overdrive at I_{OUT} = 20mA			0.88	1.10		0.88	1.10	μs
	Inhibit Delay Time for 20% Overdrive at I_{OUT} = 40mA			0.7	0.8		0.7	0.8	μs
Current Limit Trip Level			.400	.500	.600	.400	.500	.600	V
Error Amplifier									
Output Voltage Swing (V_{OH})			6.2			6.2			V
Output Voltage Swing (V_{OL})					0.7			0.7	V
Open Loop Gain				60			60		dB
Feedback Resistor			10k			10k			Ω
Small Signal Bandwidth				3			3		MHz
Output Stage									
$V_{CE\ (SAT)}$	I_C = 20 mA	•			0.4			0.4	V
Output Current		•	20			20			mA

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP5561			IP5561C			
			Min	Typ	Max	Min	Typ	Max	Units
Supply Voltage/Current									
I_{CC}	$I_Z = 0$ Voltage Fed				10			10	mA
		•			13			13	mA
V_{CC}	$I_{CC} = 10mA$, Current Fed		20	21.0	22	19.0	21.0	24.0	V
	$I_{CC} = 30mA$, Current Fed		20.0		30.0	20.0		30.0	V
Low Supply Protection									
Pin 1 Threshold			8	9	10.5	8	9	10.5	V

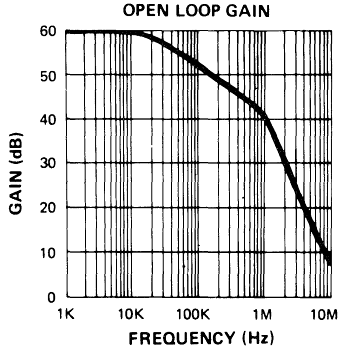
The • denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.

2

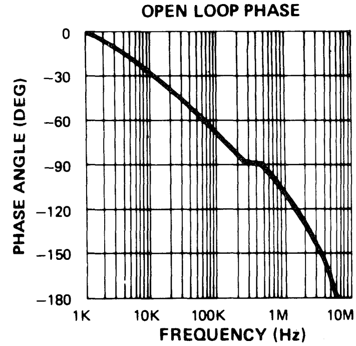
TYPICAL PERFORMANCE CHARACTERISTICS

ERROR AMPLIFIER

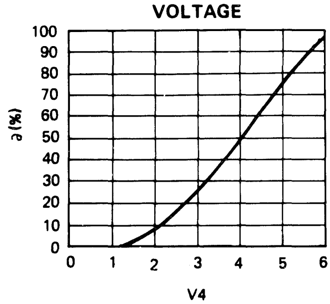
OPEN LOOP GAIN



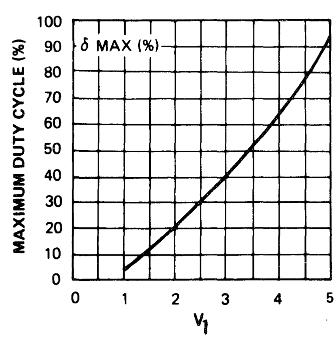
OPEN LOOP PHASE



TRANSFER CURVE OF PULSE–WIDTH MODULATOR DUTY CYCLE VS INPUT VOLTAGE



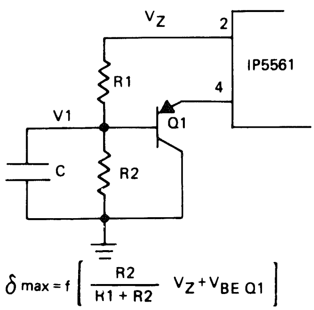
MAXIMUM DUTY CYCLE VS BASE VOLTAGE ON Q1



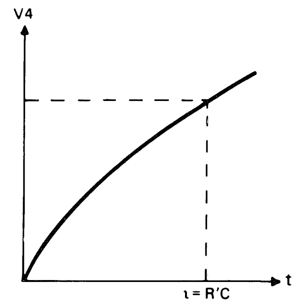
SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

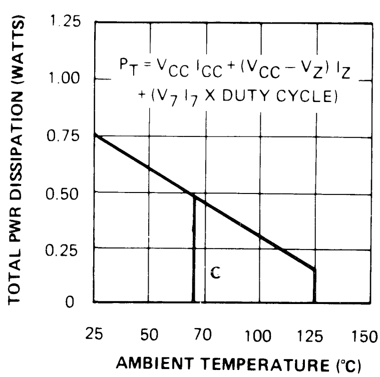
START–UP CIRCUIT (OPTIONAL)



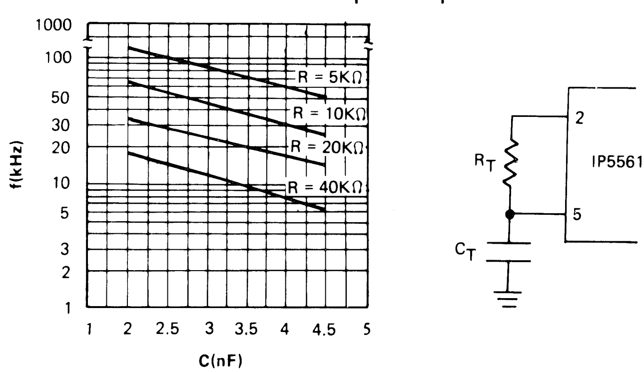
SLOW START VOLTAGE



POWER DERATING CURVE



TYPICAL FREQUENCY PLOT VS R_T AND C_T



ORDER INFORMATION

Part Number	Temperature Range	Package
IP5561J	−55°C to +125°C	8 Pin Ceramic DIP
IP5561CJ	0°C to + 70°C	8 Pin Ceramic DIP
IP5561CN	0°C to + 70°C	8 Pin Plastic DIP
IP5561CD	0°C to + 70°C	8 Pin Plastic (150) SOIC

Seagate Microelectronics Limited

DC-DC CONVERTER CONTROL CIRCUITS

IP35063, IP33063, IP34063

2

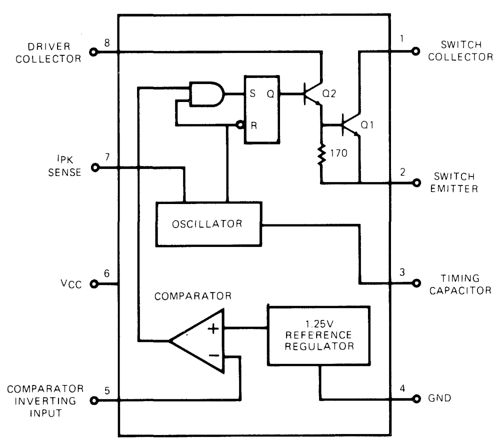
DESCRIPTION

The IP34063 series of control circuits contains all the functions required to implement DC-DC converters. Included are internal voltage reference, comparator, controlled duty cycle oscillator with current limit circuit, driver, and high current output switch. This series was specifically designed to be incorporated in Step-Down (Buck) and Step-Up (Boost) applications with a minimum number of external components.

FEATURES

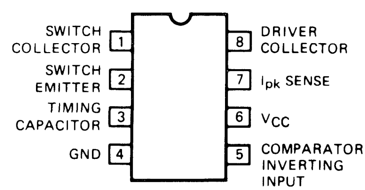
- Operation from 2.5 to 40V input
- Low standby current
- Current limiting
- Output switch current of 1.5A
- Output voltage adjustable from 1.25 to 40V
- Operating frequency from 100Hz to 100kHz
- Direct replacement for MC34063/ MC34063A series

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (150) Package

DC-DC CONVERTER CONTROL CIRCUITS

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage	+40V
Comparator Input Voltage Range	−0.3 to +40V
Switch Collector Voltage	40V
Switch Emitter Voltage	40V
Switch Collector to Emitter Voltage	40V
Driver Collector Voltage	40V
Switch Current	1.5A
Power Dissipation at T_A = +25°C (Note 1)	
Ceramic Package	1.25W
Plastic Package	1.0W
Operating Junction Temperature	
Ceramic Package	+150°C
Plastic Package	+125°C
Operating Ambient Temperature Range	
IP35063	−55°C to +125°C
IP33063	−40°C to +85°C
IP34063	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

Note 1. Derate at 10mW/°C for ambient temperatures above +25°C.

ELECTRICAL CHARACTERISTICS

(V_{CC} = 5.0V, unless otherwise specified)

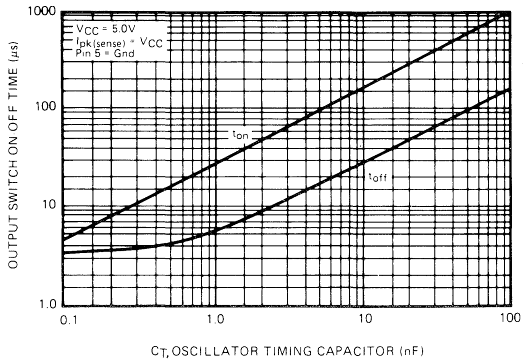
Parameters	Test Conditions		Min	Typ	Max	Units
Oscillator						
Charging Current	$5.0V \le V_{CC} \le 40V$		20	35	50	µA
Discharge Current	$5.0V \le V_{CC} \le 40V$		150	200	250	µA
Voltage Swing				0.5		Vpp
Discharge to Charge Current Ratio	$I_{pk\ (sense)} = V_{CC}$			6.0		
Current Limit Sense Voltage	$I_{chg} = I_{dischg}$		250	300	350	mV
Output Switch						
Saturation Voltage, Darlington Connection	I_{SW} = 1.0A	•		1.0	1.3	V
Saturation Voltage	I_{SW} = 1.0A; $I_{C\ (Driver)}$ = 50mA, (Forced ß = 20)	•		0.45	0.7	V
DC Current Gain	I_{SW} = 1.0A; V_{CE} = 5.0V		35	120		
Collector Off-State Current	V_{CE} = 40V			10		nA
Comparator						
Threshold Voltage		•	1.18	1.25	1.32	V
Threshold Voltage Line regulation	$3.0V \le V_{CC} \le 40V$	•		0.04	0.2	mV/V
Input Bias Current	V_{IN} = 0V	•		40	400	nA
Total Device						
Supply Current	$5.0V \le V_{CC} \le 40V$, C_T = 0.001 µF $I_{pk\ (Sense)} = V_{CC}$, $V_{PIN\ 5} > V_{th}$ PIN 2 = Gnd, Remaining Pins Open	•		2.4	3.5	mA

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

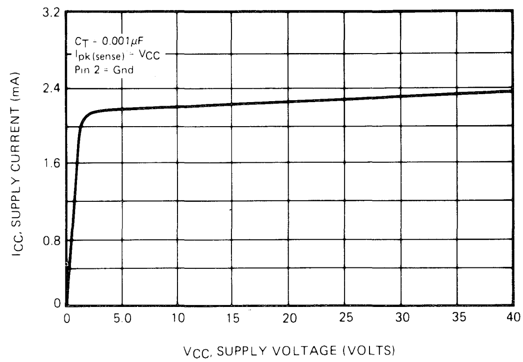
DC-DC CONVERTER CONTROL CIRCUITS

TYPICAL PERFORMANCE CHARACTERISTICS

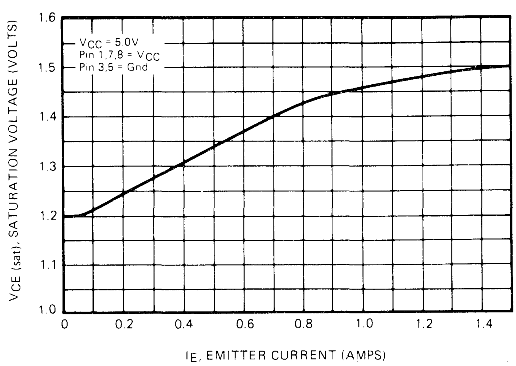
Output Switch On-Off Time vs. Oscillator Timing Capacitor



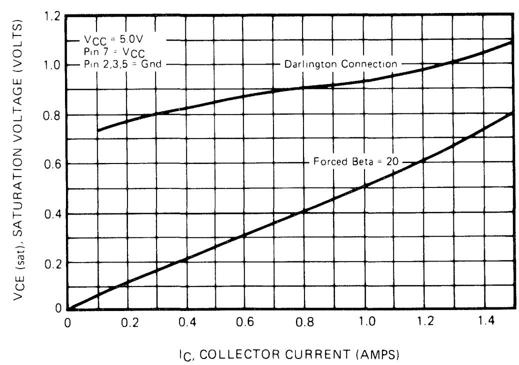
Standby Supply Current vs. Supply Voltage



Emitter-Follower Configuration Output Switch Saturation Voltage vs. Emitter Current



Common-Emitter Configuration Output Switch Saturation Voltage vs. Collector Current



DC-DC CONVERTER CONTROL CIRCUITS

DESIGN FORMULA TABLE

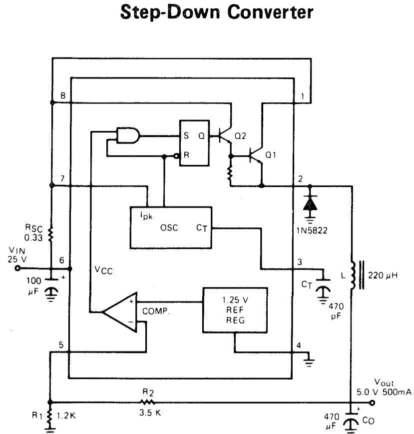
Calculation	Step-down	Step-up
$\frac{t_{ON}}{t_{OFF}}$	$\frac{V_{OUT} + V_F}{V_{IN(MAX)} - V_{SAT} - V_{OUT}}$	$\frac{V_{OUT} + V_F - V_{IN\ (MIN)}}{V_{IN(MIN)} - V_{SAT}}$
$(t_{ON} + t_{OFF})_{MAX}$	$\frac{1}{f_{MIN}}$	$\frac{1}{f_{MIN}}$
C_T	$4 \times 10^{-5} t_{ON}$	$4 \times 10^{-5} t_{ON}$
$I_{pk(switch)}$	$2 I_{OUT(MAX)}$	$2 I_{OUT(MAX)} \frac{t_{ON} + t_{OFF}}{t_{OFF}}$
R_{SC}	$0.33/I_{pk(switch)}$	$0.33/I_{pk(switch)}$
$L_{(MIN)}$	$\left(\frac{V_{IN(MAX)} - V_{SAT} - V_{OUT}}{I_{pk(switch)}}\right) t_{ON(MAX)}$	$\left(\frac{V_{IN(MIN)} - V_{SAT}}{I_{pk(switch)}}\right) t_{ON(MAX)}$
C_O	$\frac{I_{pk(switch)} (t_{ON} + t_{OFF})}{8 V_{ripple\ (p\text{-}p)}}$	$\frac{I_{OUT}\, t_{ON}}{V_{ripple}}$

V_{SAT} = Saturation voltage of the output switch.
V_F = Forward voltage drop of the ringback rectifier.
The following power supply characteristics must be choser.

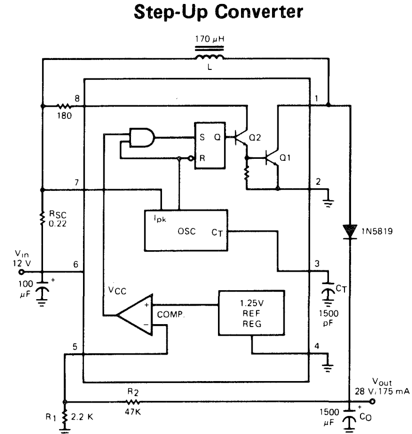
- V_{IN} — Nominal input voltage. If this voltage is not constant, then use $V_{IN(MAX)}$ for step-down and $V_{IN(MIN)}$ for step-up converter.
- V_{OUT} — Desired output voltage, $V_{OUT} = 1.25 \left(1 + \frac{R_2}{R_1}\right)$.
- I_{OUT} — Desired output current.
- f_{MIN} — Minimum desired output switching frequency at the selected values for V_{IN} and I_O.
- $V_{ripple(p\text{-}p)}$ — Desired peak-to-peak output ripple voltage. In practice, the calculated value will need to be increased due to the capacitor's equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly affect the line and load regulation.

APPLICATIONS INFORMATION

Step-Down Converter



Step-Up Converter

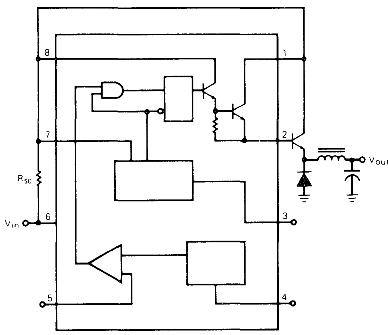


DC-DC CONVERTER CONTROL CIRCUITS

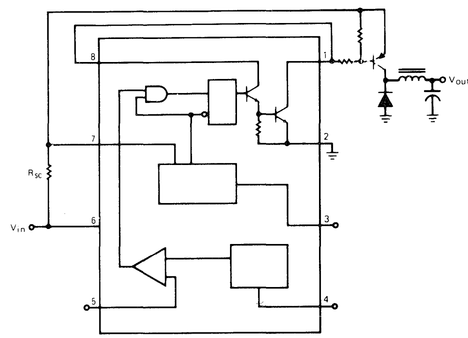
APPLICATIONS INFORMATION (CONTINUED)

External Current Boost Connections For I_C Peak Greater Than 1.5 A

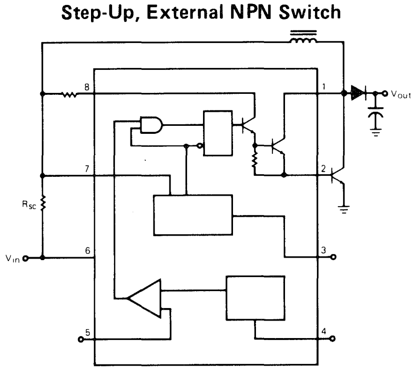
Step-Down, External NPN Switch



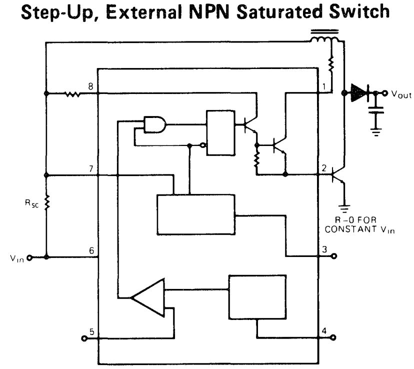
Step-Down, External PNP Saturated Switch



Step-Up, External NPN Switch



Step-Up, External NPN Saturated Switch



ORDER INFORMATION

Part Number	Temperature Range	Package
IP35063J	−55°C to +125°C	8 Pin Ceramic DIP
IP33063D	−40°C to + 85°C	8 Pin Plastic (150) SOIC
IP33063J	−40°C to + 85°C	8 Pin Ceramic DIP
IP33063N	−40°C to + 85°C	8 Pin Plastic DIP
IP34063D	0°C to + 70°C	8 Pin Plastic (150) SOIC
IP34063J	0°C to + 70°C	8 Pin Ceramic DIP
IP34063N	0°C to + 70°C	8 Pin Plastic DIP

2

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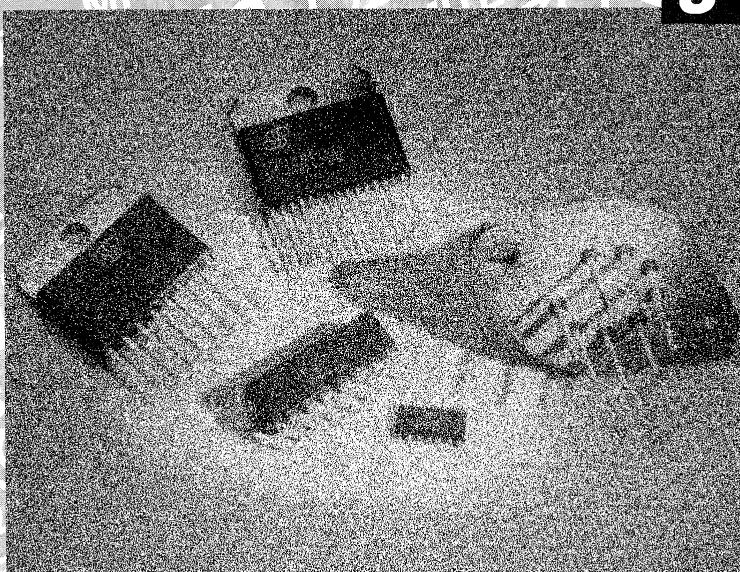
MOTOR CONTROLLERS/DRIVERS

3



5-AMP STEPPER MOTOR DRIVER

IP1D03, IP2D03, IP3D03

3

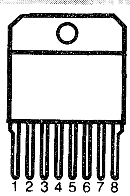
DESCRIPTION

The IP3D03W is a high voltage, high current monolithic integrated H-bridge driver designed to drive DC and stepper motors with up to 5 amps continuous current. TTL compatible control is provided by two INPUT pins to control the respective phase of each push-pull channel and an ENABLE pin for four-quadrant chopping applications. The entire circuit operates from a single supply with a maximum of 50 volts. Logic pins can be switched from −0.3 volts to supply making this device ideal for military applications. The IP1D03K is packaged in an 8 pin TO-3 for applications which require a hermetic power package. Other features include an external current sense pin, thermal shutdown protection with hysteresis, input hysteresis and internal crossover-current protection to avoid destructive current spikes through the device.

FEATURES

- 5A maximum continuous output current
- 50V maximum supply voltage
- External current sense capability
- Internal crossover-current protection
- Thermal shutdown protection with hysteresis
- TTL compatible inputs with hysteresis
- Power SIP package (Future)
- Hermetic 8 pin TO-3 package
- Parasitic protection from inductive transients

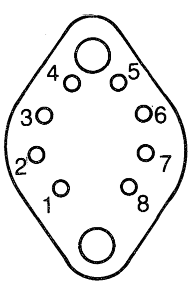
CONNECTIONS



Power SIP

IP3D03W (FUTURE)

1—SUPPLY
2—INPUT 1
3—OUTPUT 1
4—SENSE
5—OUTPUT 2
6—INPUT 2
7—ENABLE
8—GROUND

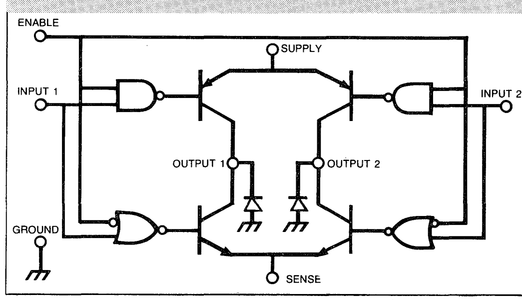


IP1D03K

1—SENSE
2—OUTPUT 1
3—INPUT 1
4—ENABLE
5—GROUND/CASE
6—SUPPLY
7—INPUT 2
8—OUTPUT 2

TO-3

BLOCK DIAGRAM



TRUTH TABLE

INPUT	ENABLE	OUTPUT
X	L	HIGH Z
L	H	SINK
H	H	SOURCE

5-AMP STEPPER MOTOR DRIVER

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_S 50V

Input Voltage, V_{IN} −0.3 to +50V

Output Voltage, V_O (Note 1)

Output Current, I_O 5A

Operating Junction Temperature, T_J 150°C

Storage Temperature, T_{STG} −60°C to 150°C

Package Thermal Resistance

Power SIP,	R_{JC}	1.5°C/W
	R_{JA}	25°C/W
TO-3	R_{JC}	1.0°C/W

Note 1: Voltage transients above supply must be limited by external suppression diodes. See application information for more details.

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

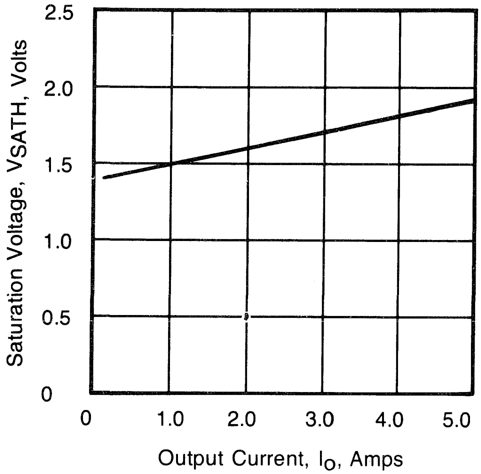
ELECTRICAL CHARACTERISTICS

Unless otherwise noted, these specifications apply over the full operating ambient temperature range. Typical values are given for V_S = 28V and T_A = 25°C.

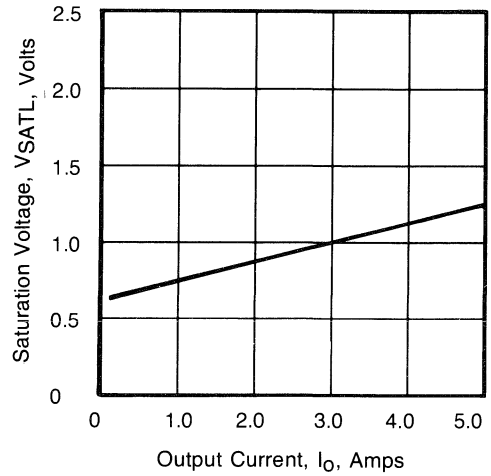
Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_S	Supply Voltage		4.5		48	V
I_S	Supply Current	EN = H, IN = H		19		mA
		EN = H, IN = L		37		mA
		EN = L		9		mA
V_{IL}	Input Low Voltage		-0.3		0.8	V
V_{IH}	Input High Voltage		2.4		VS	V
I_{IL}	Input Low Current	V_{IL} = 0V		−50		uA
I_{IH}	Input High Current	V_{IH} = 5V		10		uA
U_{th}	Upper Threshold			2.10		V
L_{th}	Lower Threshold			1.50		V
V_{CEsatH}	Source Saturation Voltage	1_O = −0.5A		1.45		V
		I_o = −5.0A		1.90		V
V_{CEsatL}	Sink Saturation Voltage	I_o = 0.5A		0.75		V
		I_o = 5.0A		1.1		V
V_{OD}	Output Voltage Differential	I_o = 0.5A		0	25	mV
		I_o = 5.0A		0	100	mV
V_F	Diode Forward Voltage	I_o = 0.5A		0.95		V
		I_o = 5.0A		1.55		V
T_{tsd}	Thermal Shutdown Threshold		150	175		C
T_{hys}	Thermal Shutdown Hysteresis			25		C

TYPICAL PERFORMANCE CHARACTERISTICS

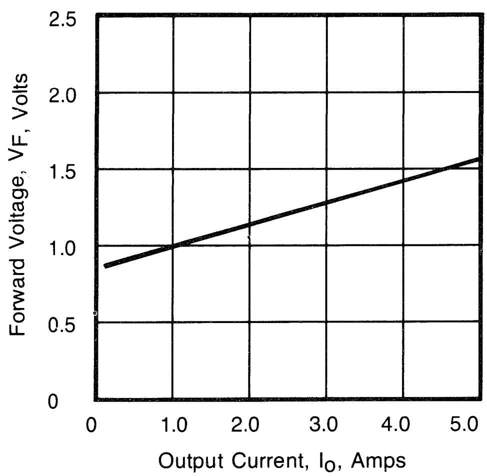
Source Saturation Voltage vs Output Current



Sink Saturation Voltage vs Output Current



Diode Forward Voltage vs Output Current



5-AMP STEPPER MOTOR DRIVER

SWITCHING CHARACTERISTICS

INPUT Switching (t1 - t4 Source, t5 - t8 Sink)			Min	Typ	Max	Units
t1	Turn-off delay	0.5Vi to 0.5Io		300		ns
t2	Fall time	0.9Io to 0.1Io		150		ns
t3	Turn-on delay	0.5Vi to 0.5Io		1500		ns
t4	Rise time	0.1Io to 0.9Io		200		ns
t5	Turn-off delay	0.5Vi to 0.5Io		400		ns
t6	Fall time	0.9Io to 0.1Io		300		ns
t7	Turn-on delay	0.5Vi to0.5Io		450		ns
t8	Rise time	0.1Io to 0.9Io		300		ns
ENABLE Switching (t9 - t12 Source, t13 - t16 Sink)						
t9	Turn-off delay	0.5Vi to 0.5Io		3400		ns
t10	Fall time	0.91o to 0.1Io		850		ns
t11	Turn-on delay	0.5Vi to 0.5Io		800		ns
t12	Rise time	0.1Io to 0.9Io		150		ns
t13	Turn-off delay	0.5Vi to 0.5Io		2900		ns
t14	Fall time	0.9Io to 0.1Io		800		ns
t15	Turn-on delay	0.5Vi to 0.5Io		500		ns
t16	Rise time	0.1Io to 0.9Io		100		ns
Cross-over Delays, INPUT Switching						
t17	Source to Sink delay			1600		ns
t18	Sink to Source delay			1600		ns

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1D03K	−55°C to +125°C	8 Pin TO-3
IP2D03W	−40°C to +105°C	8 Pin Power SIP (FUTURE)
IP3D03W	0°C to + 70°C	8 Pin Power SIP (FUTURE)
IP3D03K	0°C to + 70°C	8 pin TO-3

Seagate Microelectronics Limited

UNIVERSAL QUAD DRIVER

IP2D08, IP2D09, IP3D08, IP3D09

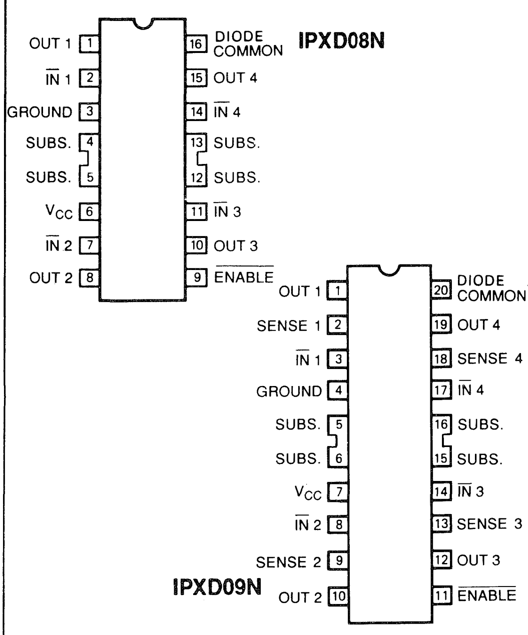
DESCRIPTION

This family of universal quad drivers are high voltage, high current, high gain integrated circuits that provide an interface between stepper motors and motor control circuitry. Both part types, the D08 and D09, allow split supply operation to both positive and negative rails. The D09 allows for external current sensing via an emitter sense pin. The D08/09 are capable of sinking up to 2.5A and can withstand output OFF voltages to 50V. All outputs offer voltage suppression capability with internal clamp diodes and all versions are supplied in dual-in-line packages with heat sink contact tabs for maximum power dissipation.

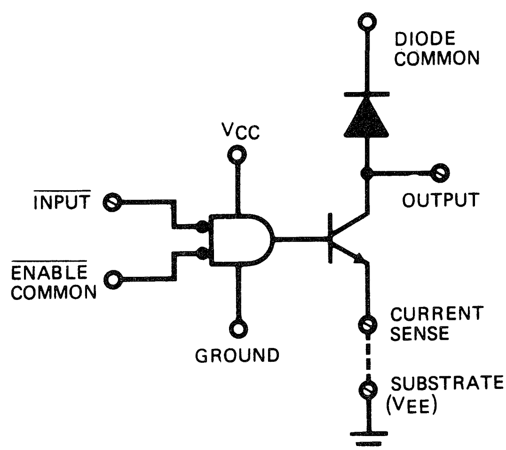
FEATURES

- Output currents to 2 amps
- Current sense on D09
- 50 volt output breakdown
- Low output saturation voltage
- Low diode forward voltage
- Split supply operation
- Clamp diodes for transient suppression
- Compatible with standard logic families
- Improved noise immunity and parasitic suppression
- 50 volt output sustaining voltage

CONNECTIONS



BLOCK DIAGRAM



One of Four Drivers

UNIVERSAL QUAD DRIVER

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C

Output Voltage, V_{CE}	
D08/D09	50V
Input Voltage, V_{IN}	−0.3V to +80V
Logic Supply Voltage, V_{CC}	
D08/D09	50V
Output Current, I_{OUT}	2.5A
Diode Reverse Voltage V_R	80V
Diode Forward Current, I_D	2.5A
Current Sense Voltage, V_S	
D09	1V
Power Dissipation	2.7W
Operating Junction Temperature	+150°C
Operating Ambient Temperature Range	
IP2D08/D09	−25°C to +85°C
IP3D08/D09	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature(Soldering, 10 sec.)	+300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

3

ELECTRICAL CHARACTERISTICS

(V_{CC} = 15V)

Parameter	Conditions		Min	Typ	Max	Unit
Supply Current, I_S	All Inputs = 0.8V	●		25	40	mA
	All Inputs = 5.0V	●		2	5	mA
Input Low Current, I_{IL}	V_{IL} = 0.8V	●		-50		uA
Input High Current, I_{IH}	V_{IH} = 2.0V	●			10	uA
Enable Low Current, I_{IL}	V_{IL} = 0.8V	●		-200	-400	uA
Enable High Current, I_{IH}	V_{IH} = 2.0V	●			10	uA
Logic Input Low Voltage, V_{IL}		●	-0.3		0.8	V
Logic Input High Voltage, V_{IH}		●	2.0		V_{CC}	V
Output Saturation Voltage, V_{CE} (SAT)	I_{OUT} = 2.0A	●			1.8	V
Output Leakage Current, I_{CEX}	V_{OUT} = $V_{CE\ MAX}$	●			50	uA
Output Sustaining Voltage, $V_{CE(SUS)}$	I_{OUT} = 100mA (Figure 2)	●	50			V
Diode Leakage Current, I_R	V_R = 80V	●			50	uA
Diode Foward Voltage, V_F	I_{OUT} = 2.0A	●			1.5	V

The ● denotes the specifications which apply over the full operating range, all others apply at T_A = 25°C unless otherwise specified.

(V_{CC} = 15V, f = 10KHz and T_A = 25°C)

Parameter	Conditions		Min	Typ	Max	Unit
Turn-on Delay, t_{on}	I_{OUT} = 2.0A			0.8		us
Turn-off Delay, t_{off}	I_{OUT} = 2.0A			0.8		us

Note: Switching times apply for resistive loads and are not tested in production.

UNIVERSAL QUAD DRIVER

TEST CONFIGURATION

Reverse Bias Safe Operating Area — Test Circuit & Waveforms

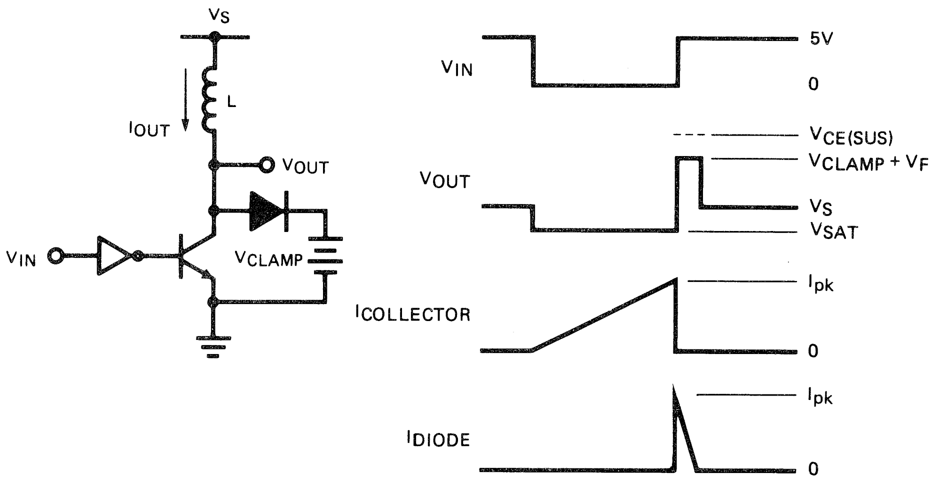


Figure 1.
Sustaining Voltage — Test Circuit & Waveforms

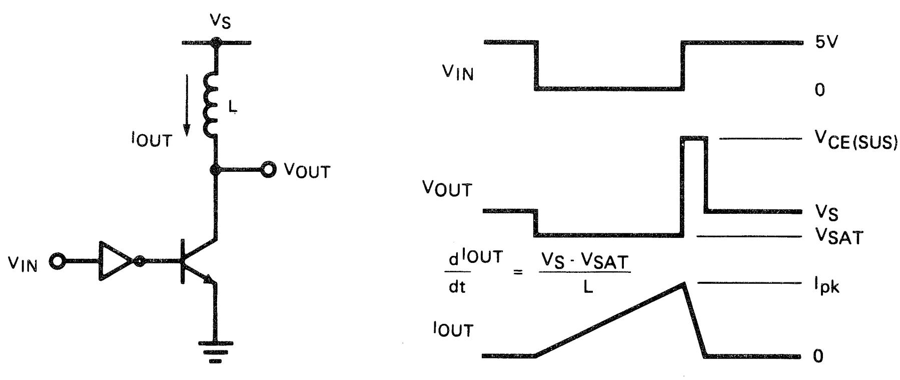


Figure 2.
For this test the internal flyback diode is disconnected.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP2D08N	−25°C to +85°C	16 pin power DIP
IP3D08N	0°C to +70°C	16 pin power DIP
IP2D09N	−25°C to +85°C	20 pin power DIP
IP3D09N	0°C to +70°C	20 pin power DIP

Seagate Microelectronics Limited

200mA DUAL H BRIDGE

IP1M10, IP2M10, IP3M10, IP1M12, IP2M12, IP3M12

DESCRIPTION

The IP1M10 and IP1M12 series each contain two full H-bridge power drivers capable of delivering 200 mA continuous output current per channel (100mA for IMXX/2MXX). Each bridge may be run from its own supply voltage of up to 36V and is controlled by 2 high voltage protected logic level inputs with internal hysteresis for noise immunity. Protection features include thermal shutdown, peak current limiting, crossover current blanking, and internal output clamp diodes. Logic supply current is provided by a separate pin so that standby power dissipation may be minimized. The IP1M10 series requires a +5V logic supply while the IP1M12 series requires a logic supply voltage of +7V or greater, and is typically used in single supply applications.

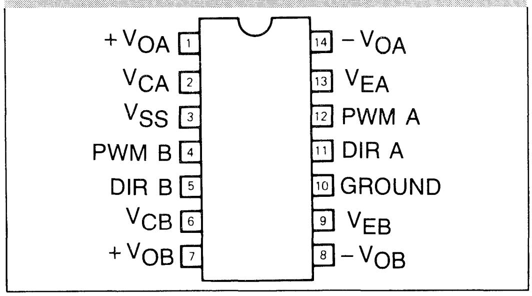
The IP1M10 and IP1M12 are available in a 14 lead ceramic DIP while the IP2M10, IP2M12, IP3M10, IP3M12 are available in the 14 lead ceramic DIP, 14 lead plastic DIP, and 14 lead plastic SOIC packages.

FEATURES

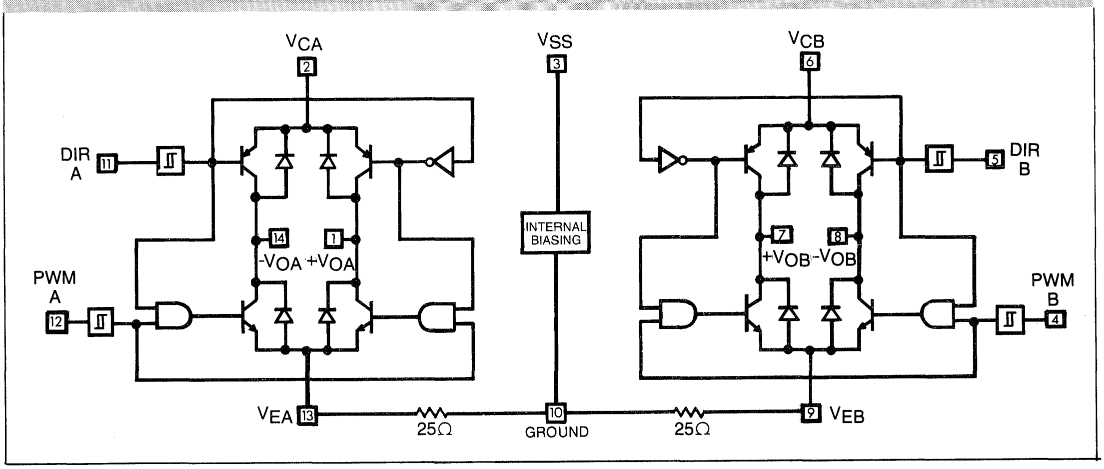
- 200mA continuous output current per bridge (100mA for IMXX/2MXX)
- Internal output clamp diodes
- Hysteretic logic inputs for noise immunity
- Thermal shutdown protection
- Peak current limit protection
- Crossover current blanking
- Separate +5V logic supply for minimum power dissipation (1M10 series only)
- Separate +7 to +36V logic supply (1M12 series only)

3

CONNECTIONS



BLOCK DIAGRAM



200mA DUAL H BRIDGE

ABSOLUTE MAXIMUM RATINGS

Logic Supply Voltage, Pin 3
(1M10, 2M10, 3M10) + 7V

Logic Supply Voltage, Pin 3
(1M12, 2M12, 3M12) +40V

Driver Supply Voltage, Pins 2 and 6 +40V

Logic Inputs −0.3V to +40V

Output Current, DC ±250mA

Output Current, Peak INTERNALLY LIMITED

Power Dissipation, T_A = +25°C 1000mW
(Note 1)

Power Dissipation, T_C = +25°C 2000mW
(Note 2)

Operating Junction Temperature +150°C

Storage Temperature Range −65°C to +150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (NOTE 3)

Logic Supply Voltage, Pin 3
(1M10, 2M10, 3M10) +4.75V to +5.25V

Logic Supply Voltage, Pin 3
(1M12, 2M12, 3M12) +7V to +36V

Driver Supply Voltage, Pins 2 and 6
+4.75V to +36V

Logic Inputs 0V to +36V

Output Current, DC
(3MXX) ±200mA
(1MXX/2MXX) ±100mA

Output Current, peak
(3MXX) ±250mA
(1MXX/2MXX) ±125mA

Operating Ambient Temperature Range
IP1M10/1M12 −55°C to +125°C
IP2M10/2M12 −40°C to + 85°C
IP3M10/3M12 0°C to + 70°C

Note 1 Derate at 10mW/°C for ambient temperature above + 50°C
Note 2 Derate at 16mW/°C for case temperature above + 25°C
Note 3 Range over which the device is functional and parameter limits are guaranteed

TRUTH TABLE

INPUTS		OUTPUTS	
DIR	PWM	$+V_O$	$-V_O$
L	L	Z*	H
L	H	L	H
H	L	H	Z*
H	H	H	L

* Z = High Impedance

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, specifications apply over the recommended operating conditions. (See Notes 1-3).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNITS
Logic Supply Current (Pin 3)	XM10	Vss = +5.25V, I_{LOADS} = 0mA	●		5	12	mA
		Vss = +5.25V, I_{LOADS} = 100mA	●		8	20	
		Vss = +5.25V, I_{LOADS} = 200mA	●		12	28	
	XM12	Vss = +36V, I_{LOADS} = 0mA	●		8	18	
		Vss = +36V, I_{LOADS} = 100mA	●		11	25	
		Vss = +20V, I_{LOADS} = 200mA	●		15	32	
Quiescent Bridge Current (Pin 2 or 6)		I_{LOAD} = 0mA	●		2.5	8	mA
PWM Input Threshold (Pins 4 and 12)	Falling		●	0.8	1.5	2.0	V
	Rising		●	1.2	2.5	3.0	
	Hysterisis		●	0.4	1.0		
PWM Input Current (Pins 4 and 12)	Low	V_{IN} = 0V	●		−20	−100	μA
	High	V_{IN} =36V	●		0.1	±10	
DIR Input Threshold (Pins 5 and 11)	Falling		●	0.8	1.5	2.0	V
	Rising		●	1.2	2.3	3.0	
	Hysterisis		●	0.2	0.8		
DIR Input Current (Pins 5 and 11)	Low	V_{IN} = 0V	●		−20	−100	μA
	High	V_{IN} = +36V	●		0.1	±10	
Total Saturation Voltage (VSAT (Sink) + VSAT (Source))		I_{LOAD} = 100 mA	●		1.8	2.25	V
	3M10/3M12 Only	I_{LOAD} = 200 mA	●		2.1	2.70	
Diode Forward Voltage		I_{DIODE} = 100 mA	●		1.1	1.4	V
		I_{DIODE} = 200 mA	●		1.2	1.6	
Output Leakage Current (Pins 1, 7, 8 and 14)	Low	Vo = 0V, Vc = 36V	●		1	100	μA
	High	Vo = Vc = 36V	●		1	100	

SWITCHING CHARACTERISTICS

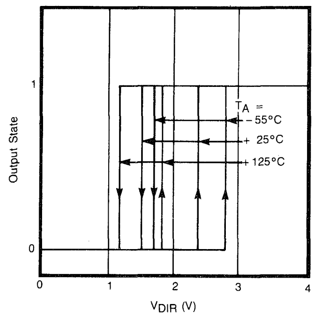
PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNITS
Sink Turn-on Delay	Δt: V_i = $V_{i(TH)}$ to V_O = Vs/2			1250		nS
Sink Current Rise Time	Δt: I_O = (0.1 to 0.9) I_{LOAD}			200		nS
Sink Turn-off Delay	Δt: V_i = $V_{i(TH)}$ to V_O = $V_{s/2}$			300		nS
Sink Current Fall Time	Δt: I_O = (0.9 to 0.1) I_{LOAD}load			200		nS
Source Turn-on Delay	Δt: V_i = $V_{i(TH)}$ to V_O = $V_{s/2}$			800		nS
Source Rise Time	Δt: I_O = (0.1 to 0.9) I_{LOAD}			400		nS
Source Turn-off Delay	Δt: V_i = $V_{i(TH)}$ to V_O = $V_{s/2}$			1000		nS
Source Fall Time	Δt: I_O = (0.9 to 0.1) I_{LOAD}			500		nS
Sink to Source Deadtime				500		nS
Source to Sink Deadtime				250		nS

The ● denotes specifications which apply over the full operating range, all others apply at T_A = 25°C unless otherwise specified.

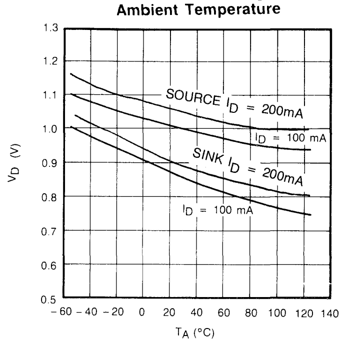
200mA DUAL H BRIDGE

TYPICAL PERFORMANCE CHARACTERISTICS

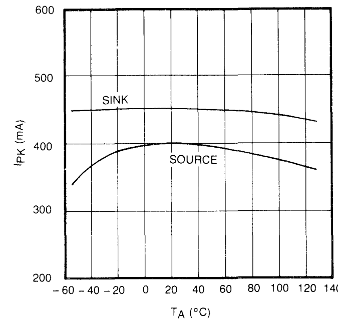
Output State vs DIR Input Voltage



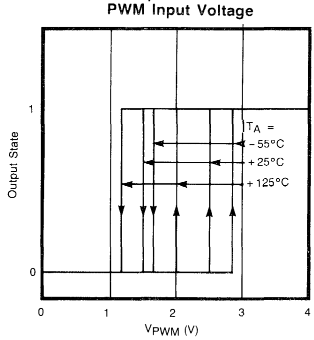
Diode Forward Voltage vs Ambient Temperature



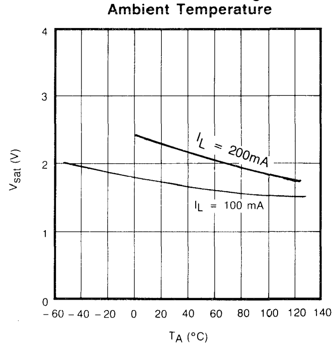
Peak Output Current vs Ambient Temperature



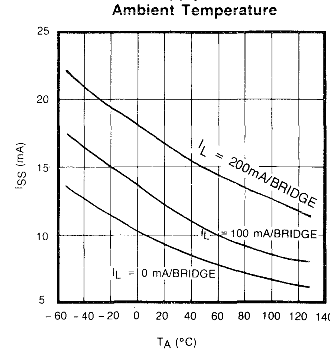
Output State vs PWM Input Voltage



Total Saturation Voltage vs Ambient Temperature



Logic Supply Current vs Ambient Temperature



ORDER INFORMATION

Part Number	Temperature Range	Package
IP1M10J	−55°C to +125°C	14 Pin Ceramic DIP
IP2M10J	−40°C to + 85°C	14 Pin Ceramic DIP
IP2M10N	−40°C to + 85°C	14 Pin Plastic DIP
IP2M10D	−40°C to + 85°C	14 Pin SOIC
IP3M10J	0°C to + 70°C	14 Pin Ceramic DIP
IP3M10N	0°C to + 70°C	14 Pin Plastic DIP
IP3M10D	0°C to + 70°C	14 Pin SOIC
IP1M12J	−55°C to +125°C	14 Pin Ceramic DIP
IP2M12J	−40°C to + 85°C	14 Pin Ceramic DIP
IP2M12N	−40°C to + 85°C	14 Pin Plastic DIP
IP2M12D	−40°C to + 85°C	14 Pin SOIC
IP3M12J	0°C to + 70°C	14 Pin Ceramic DIP
IP3M12N	0°C to + 70°C	14 Pin Plastic DIP
IP3M12D	0°C to + 70°C	14 Pin SOIC

PUSH-PULL FOUR CHANNEL DRIVER

IP293DML

DESCRIPTION

The IP293DML is a low voltage, low current version of the 293 quad push-pull driver with superior output impedance matching and parameters guaranteed over temperature. It is ideal for applications with 5V or 12V power rails and each channel is capable of delivering a continuous output current of 250 mA.

Each full bridge driver has an enable input for a high impedance output state. A separate supply input allows the logic to be operated at lower voltages to reduce power dissipation.

This device has an output differential voltage guaranteed to be less the 75mV at 100mA for accurate positioning in stepper motor applications.

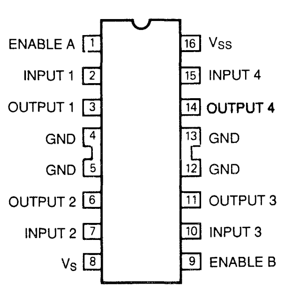
The IP293DML is packaged in a plastic power DIP which uses the four centre pins to conduct heat to the printed circuit board, or a plastic power SOIC which uses the eight centre pins.

FEATURES

- 250mA continuous output current
- 500mA peak non-repetitive output current per channel
- Enable facility for dual full-bridge configuration
- High noise immunity
- Seperate logic supply
- Thermal shutdown protection
- Cross-over current protection
- Internal output clamp diodes

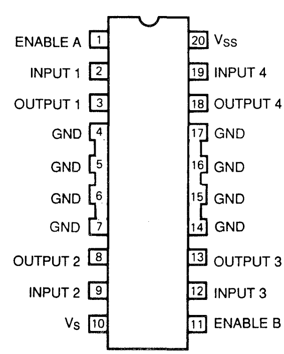
CONNECTIONS

Top View



IP293DML

N Package



IP293DML

D (300) Package

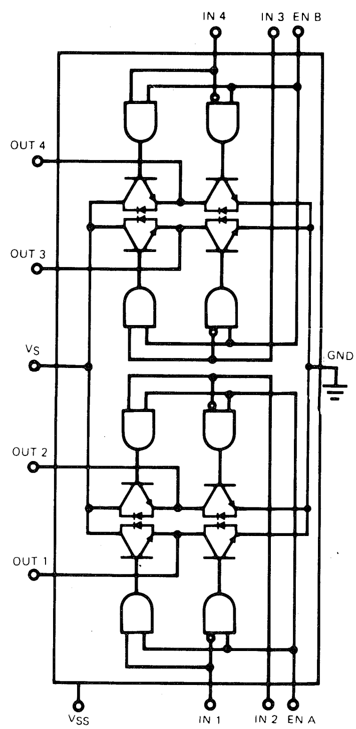
PUSH-PULL FOUR CHANNEL DRIVER

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	18V
Logic Supply Voltage	18V
Peak Non-repetitive Output Current (t ≤ 5ms)	0.5A
Operating Ambient Temperature	0°C to +70°C
Junction Temperature	150°C
Storage Temperature	−40°C to + 150°C
Continuous Output Current IP293DML	0.25A

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

BLOCK DIAGRAM



IP293DML

PUSH-PULL FOUR CHANNEL DRIVER

ELECTRICAL CHARACTERISTICS

V_S = 12V, V_{SS} = 5V unless otherwise stated

Parameter	Test Conditions		Min	Typ	Max	Units
Supply Voltage V_S		●	V_{SS}		15	V
Logic Supply Voltage V_{SS}		●	4.5		15	V
Quiscent Supply Current I_S (per channel)	V_{IN} = L, V_{EN} = H, I_O = 0	●		0.5	1.5	mA
	V_{IN} = H, V_{EN} = H, I_O = 0	●		5	8	mA
	V_{EN} = L	●			1	mA
Quiscent Logic Supply Current I_{SS} (per channel)	V_{IN} = L, V_{EN} = H, I_O = 0	●		11	15	mA
	V_{IN} = H, V_{EN} = H, I_O = 0	●		1.5	5.5	mA
	V_{EN} = L	●		1.5	6.0	mA
Input Low Voltage		●	−0.3		1.5	V
Input High Voltage		●	2.3		V_{SS}	V
Low Voltage Input Current	V_{IL} = 1.5V	●			−10	μA
High Voltage Input Current	V_{IN} = 2.3V	●		40	100	μA
Enable Low Voltage		●	−0.3		1.5	V
Enable High Voltage		●	2.3		V_{SS}	V
Low Voltage Enable Current	V_{ENL} = 1,5V	●		−40	−100	μA
High Voltage Enable Current	V_{ENH} = 2.3V	●			10	μA
Source Output Saturation Voltage	I_O = 250mA, V_S = 10.8V	●		0.9	1.8	V
Sink Output Saturation Voltage	I_O = 250mA, V_S = 10.8V	●		0.9	1.8	V
Output Differential Voltage	I_O = 100mA, V_S = 4.3V	●	−75	±25	+75	mV
Output Differential Voltage	I_O = 250mA, V_S = 10.8V	●	−150		+150	mV
Diode Forward Voltage	I_O = 250mA	●		1.3	1.8	V
Output Leakage Curent	V_S = 10.8V, V_{EN} = L	●	−200		+200	μA

The ● denotes the specifications which apply over the full operating ambient temperature range, all others apply T_A = 25°C unless otherwise specified.

PUSH-PULL FOUR CHANNEL DRIVER

SWITCHING CHARACTERISTICS

V_S = 12V, V_{SS} = 5V, f_C = 30 kHz, T_A = 25°C

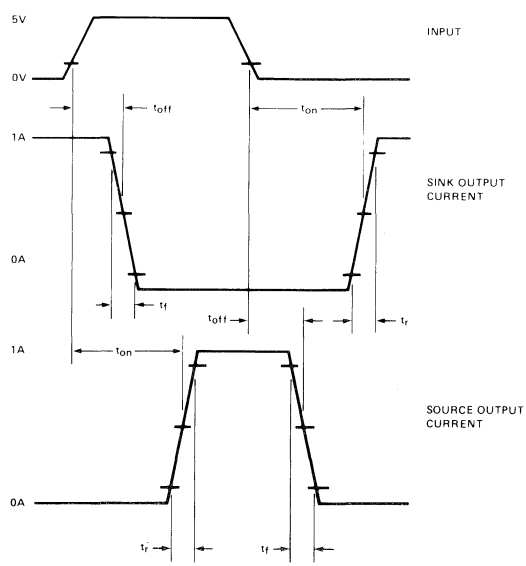
Parameter	Min	Typ	Max	Unit
Sink Current Turn-on Delay		600		ns
Sink Current Rise Time		100		ns
Sink Current Turn-off Delay		400		ns
Sink Current Fall Time		200		ns
Sink Current Turn-on Delay		1000		ns
Sink Current Rise Time		200		ns
Sink Current Turn-off Delay		200		ns
Sink Current Fall Time		100		ns
Sink to Source Deadtime	0	600		ns
Source to Sink Deadtime	0	400		ns

(Note; Switching times apply for resistive loads only)

(per channel)

INPUT	ENABLE*	OUTPUT
H	H	H
L	H	L
H	L	Z
L	L	Z

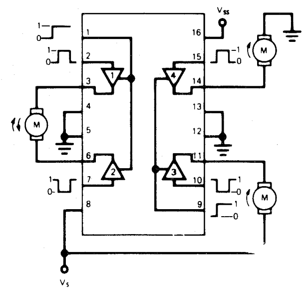
*relative to the considered channel
Z = High impedance



$$td1 = (t_{on} - t_r/2)_{source} - (t_{off} + t_f/2)_{sink}$$
$$td2 = (t_{on} - t_r/2)_{sink} - (t_{off} + t_f/2)_{source}$$

PUSH-PULL FOUR CHANNEL DRIVER

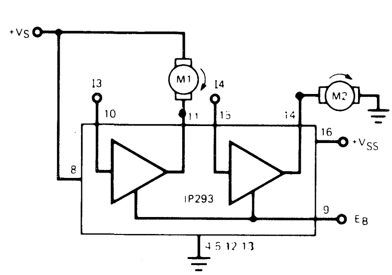
APPLICATIONS INFORMATION

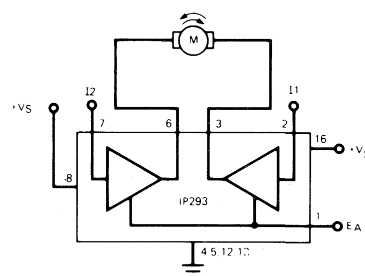


IP293DML

DC motor controls (with connection to ground and to the supply voltage)

Bidirectional DC motor control





EB	I3	M1	I4	M2
H	H	Fast Motor Stop	H	Run
H	L	Run	L	Fast Motor Stop
L	X	Free Running Motor Stop	X	Free Running Motor Stop

L = Low H = High X = Don't care

INPUTS		FUNCTION
E_A = H	I_2 = H; I_1 = L	Turn Right
	I_2 = L; I_1 = H	Turn Left
	I_1 = I_2	Fast Motor Stop
E_A = L	I_1 = X; I_2 = X	Free Running Motor Stop

L = Low H = High X = Don't care

PUSH-PULL FOUR CHANNEL DRIVER

MOUNTING INSTRUCTIONS

The $R_{\Theta JA}$ of the IP293DML can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board or to an external heatsink.

The diagram of Figure 3 shows the maximum package power P_{tot} and the Θ_{JA} as a function of the side "λ" of two equal square copper areas having a thickness of 35μ (see figure 1).

In addition, it is possible to use an external heatsink (see figure 2).

During soldering the pins' temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

Figure 1 - Example of P.C. Board Copper Area which is used as Heatsink

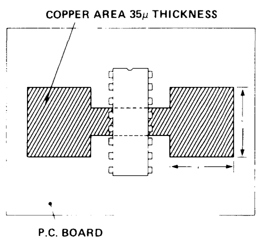


Figure 2 - External Heatsink Mounting Example (θ_{JA} = 25°C/W)

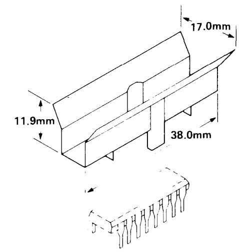


Figure 3 - Maximum Package Power and Junction to Ambient Thermal Resistance vs Size "ℓ"

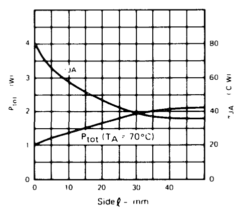
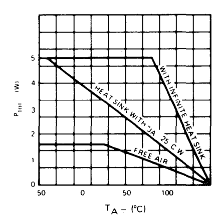


Figure 4 - Maximum Allowable Power Dissapation vs Ambient Temperature



THERMAL DATA IP2930MLN

$R_{\theta JC}$	**MAX 14° C/W**
$R_{\theta JA}$	**MAX 80° C/W**

ORDER INFORMATION

Part Number	**Temperature Range**	**Package**
IP293DMLN	0°C to +70°C	16 Pin Plastic DIP
IP293DMLD	0°C to +70°C	20 Pin Plastic (300) SOIC

VOLTAGE REGULATORS

4

Seagate Microelectronics Limited

LOW DROPOUT, 3 AMP POS. ADJUSTABLE REGULATORS

IP1R07A, IP1R07, IP3R07A, IP3R07 Series

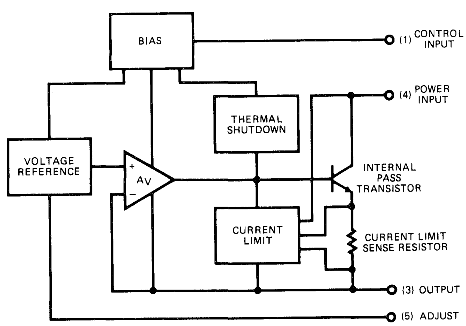
DESCRIPTION

The IP3R07A series of low dropout adjustable voltage regulators are capable of supplying 3A of output current with an input-to-output voltage of just 0.8V. In applications where high efficiency is necesary it is now possible to obtain a low cost, single chip solution. These regulators are exceptionally easy to use, requiring only two external resistors to set the output voltage. The IP3R07A exhibits an initial ±1% output voltage tolerance, and over all operating conditions the reference voltage is guaranteed not to vary more than ± 2%. These devices include internal current limiting, thermal overload protection, and power device safe operating area compensation.

FEATURES

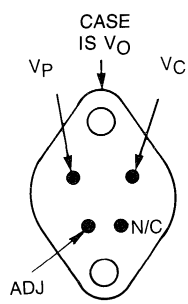
- 0.8V dropout voltage at 3A
- Guaranteed 1% output voltage tolerance
- Guaranteed 0.3% load regulation
- Guaranteed 0.01%/V line regulation
- Available in TO-218, TO-220, TO-3 and Hermetic TO-257 packages

BLOCK DIAGRAM

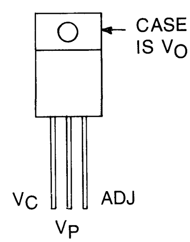


CONNECTIONS

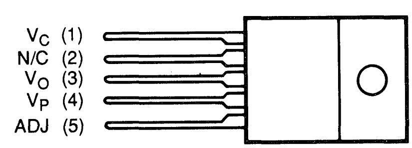
(Bottom View)
TO-3



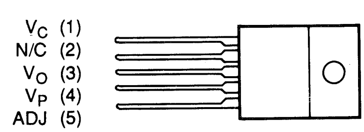
(Top View)
TO-257



(Top View)
TO-218



(Top View)
TO-220



LOW DROPOUT, 3 AMP POS. ADJUSTABLE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited

Control Input to Output Voltage 35V

Power Input to Output Voltage 15V

Operating Junction Temperature
IP1R07A, IP1R07 −55°C to +150°C
IP3R07A, IP3R07 0°C to +125°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

				IP1R07A/IP3R07A			IP1R07/IP3R07			
Parameter	Conditions (Note 1)			Min	Typ	Max	Min	Typ	Max	Units
Reference Voltage	$I_O = 10mA$			1.238	1.250	1.262				V
	$3V \le V_C - V_O \le 35V$ $1.5V \le V_P - V_O \le 7V$ $10mA \le I_O \le 3A$, $P \le 20W$		•	1.225	1.250	1.270	1.20	1.25	1.30	V
Line Regulation	$3V \le V_C - V_O \le 35V$				0.005	0.01		0.005	0.03	%/V
			•		0.02	0.05		0.02	0.07	%/V
Load Regulation	$10mA \le I_O \le 3A$				0.10	0.30		0.10	0.50	%
(% V_{OUT})			•		0.30	1.0		0.30	1.5	%
Thermal Regulation	20 msec Pulse				0.002	0.01		0.002	0.03	%/W
Ripple Rejection	$V_O = 10V$,	$C_{Adj} = 0$			65			65		dB
(Control Input)	$f = 120Hz$	$C_{Adj} = 10\mu F$	•	66	86		66	86		dB
Dropout Voltage (Power Input)	$\Delta V_O = 50mV$				0.8	1.0		0.8	1.0	V
Adjust Pin Current			•		50	100		50	100	µA
Adjust Pin Current Change	$3V \le V_C - V_O \le 35V$ $1.5V \le V_P - V_O \le 7V$ $10mA \le I_O \le 3A$		•		0.2	5		0.2	5	µA
Minimum Load Current	$V_C - V_O = 35V$		•		3.5	5		3.5	10	mA
Current Limit	$V_P - V_O \le 7V$		•	3	4.5		3	4.5		A
Thermal Resistance Junction-to-Case, θ_{JC}	V Pkg K Pkg	Power Transistor			1.2			1.2		°C/W
		Control Circuitry			0.5			0.5		°C/W
	T Pkg G Pkg	Power Transistor			2.3			2.3		°C/W
		Control Circuitry			0.7			0.7		°C/W

The ● denotes specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

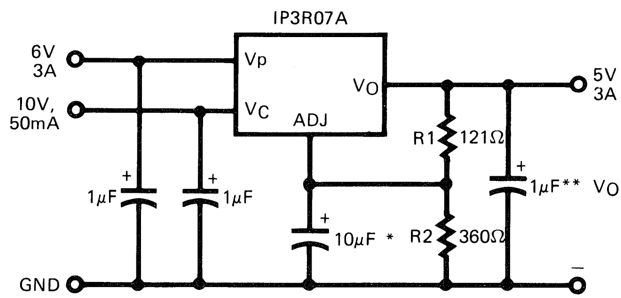
Note 1: Unless otherwise specified, V_C-V_O = 5V, V_P-V_O = 3V, I_O = 3A. Although power dissipation is internally limited, these specifications apply for dissipations up to 20W.

Note 2: Line and load regulation are electrically independent and are measured using pulsed testing techniques at low duty cycle, in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating see thermal regulation specification.

LOW DROPOUT, 3 AMP POS. ADJUSTABLE REGULATORS

TYPICAL APPLICATION

6 VOLT INPUT, 5 VOLT OUTPUT REGULATOR



*IMPROVES RIPPLE REJECTION
**IMPROVES TRANSIENT RESPONSE

NOTE: $V_O = 1.25V\ (1 + \frac{R2}{R1})$

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1R07AK, IP1R07K	−55°C to +150°C	TO-3
IP1R07AG, IP1R07G	−55°C to +150°C	TO-257
IP3R07AK	0°C to +125°C	TO-3
IP3R07K	0°C to +125°C	TO-3
IP3R07AV	0°C to +125°C	TO-218
IP3R07V	0°C to +125°C	TO-218
IP3R07AT	0°C to +125°C	TO-220
IP3R07T	0°C to +125°C	TO-220

Seagate Microelectronics Limited

1.5 AMP POSITIVE ADJUSTABLE REGULATORS

IP117A, IP117, LM117, IP117AHV, IP317AHV, IP117HV, LM117HV, IP317HV

DESCRIPTION

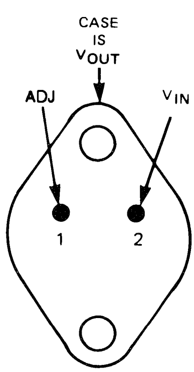
The IP117A Series are three terminal positive adjustable voltage regulators capable of supplying in excess of 1.5A over a 1.25V to 60V output range. These regulators are exceptionally easy to use and require only two external resistors to set the output voltage. In addition to improved line and load regulation, a major feature of the "A" series is the initial output voltage tolerance, which is guaranteed to be less than 1%. Over full operating conditions, including load, line, and power dissipation, the reference voltage is guaranteed not to vary more than 2%. These devices exhibit current limit, thermal overload protection, and improved power device safe operating area protection, making them essentially indestructible.

FEATURES

- Guaranteed 1% output voltage tolerance
- Guaranteed 0.3% load regulation
- Guaranteed 0.01%/V line regulation
- Internal current limiting constant with temperature
- Internal thermal overload protection
- Improved output transistor safe operating area compensation
- Output adjustable between 1.25V and 60V

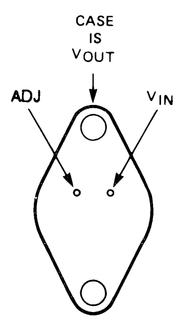
CONNECTIONS

(Bottom View)



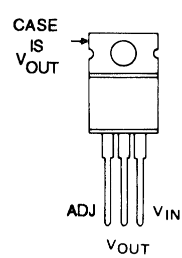
TO-3

(Bottom View)



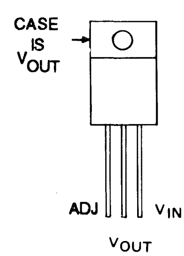
TO-66

(Top View)



TO-220

(Top View)



TO-257

1.5 AMP POSITIVE ADJUSTABLE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited

Operating Junction Temperature Range
117AHV/117A/117HV/117 −55°C to +150°C
317AHV/317HV 0°C to +125°C

Input to Output Voltage Differential
Non-HV 40V
HV Series 60V

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS *(NOTES 1 and 3)*

4

Parameter	Test Conditions			IP117AHV IP117A Min	IP117AHV IP117A Typ	IP117AHV IP117A Max	LM117HV IP117HV LM117 IP117 Min	LM117HV IP117HV LM117 IP117 Typ	LM117HV IP117HV LM117 IP117 Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			-1.238	-1.250	-1.262				V
	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX} 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}		●	-1.225	-1.250	-1.270	-1.200	-1.250	-1.300	V
Line Regulation, $\Delta V_{OUT}/\Delta I_{OUT}$	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX}				0.005	0.010		0.010	0.020	%/V
	(See Note 2)		●		0.010	0.020		0.020	0.050	%/V
Load Regulation, $\Delta V_{OUT}/\Delta I_{OUT}$	10 mA ≤ I_{OUT} ≤ I_{MAX}	(V_{OUT}) ≤ 5V			5	15		5	15	mV
	(See Note 2)	(V_{OUT}) ≤ 5V			0.1	0.3		0.1	0.3	%
		(V_{OUT}) ≤ 5V	●		15	50		20	50	mV
		(V_{OUT}) ≤ 5V	●		0.3	1.0		0.3	1.0	%
Thermal Regulation	20 msec Pulse				0.002	0.020		0.030	0.070	%/W
Ripple Rejection	V_{OUT} = -10V,	C_{ADJ} = 0			65			65		dB
	f = 120Hz	C_{ADJ} = 10 μF	●	66	80		66	80		dB
Adjust Pin Current, I_{ADJ}			●		50	100		50	100	μA
Adjust Pin Current Change, ΔI_{ADJ}	10 mA ≤ I_{OUT} ≤ I_{MAX} 2.5V ≤ (V_{IN} - V_{OUT}) ≤ V_{MAX}		●		0.2	5		0.2	5	μA
Minimum Load Current, I_{MIN}	(V_{IN} - V_{OUT}) = 40V		●		3.5	5		3.5	5	mA
	(V_{IN} - V_{OUT}) = 60V, HV Series		●		3.5	7		3.5	7	mA
Current Limit, I_{CL}	(V_{IN} - V_{OUT}) ≤ 15V		●	1.5	2.2		1.5	2.2		A
	(V_{IN} - V_{OUT}) = 40V			0.30	0.50		0.30	0.50		A
	(V_{IN} - V_{OUT}) = 60V HV Series				0.10			0.10		A
Temperature Stability, $\Delta V_{OUT}/\Delta TEMP$			●		1	2		1		%
Long Term Stability, $\Delta V_{OUT}/\Delta V_{TIME}$	T_A = 125°C, 1000 Hrs.				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	10Hz ≤ f ≤ 10kHz				0.001			0.001		%
Thermal Resistance	K Package				2.3	3		2.3	3	°C/W
Junction to Case, Θ_{jc}	R Package				5	7		5	7	°C/W
	G Package, T Package				3	5		3	5	°C/W

1.5 AMP POSITIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS

Parameter	Test Conditions			IP317AHV IP317A Min	Typ	Max	IP317HV IP317 Min	Typ	Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			1.238	1.250	1.262				V
	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX} 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}		●	1.225	1.250	1.270	1.200	1.250	1.300	V
Line Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX}				0.005	0.010		0.010	0.040	%/V
	(See Note 2)		●		0.010	0.020		0.020	0.070	%/V
Load Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	10 mA ≤ I_{OUT} ≤ I_{MAX}	(V_{OUT}) ≤ 5V			5	25		5	25	mV
	(See Note 2)	(V_{OUT}) ≤ 5V			0.1	0.5		0.1	0.5	%
		(V_{OUT}) ≤ 5V	●		15	50		20	70	mV
		(V_{OUT}) ≤ 5V	●		0.3	1.0		0.3	1.5	%
Thermal Regulation	20 msec Pulse				0.002	0.020		0.030	0.070	%/W
Ripple Rejection	V_{OUT} = -10V,	C_{ADJ} = 0			65			65		dB
	f = 120Hz	C_{ADJ} = 10 µF	●	66	80		66	80		dB
Adjust Pin Current, I_{ADJ}			●		50	100		50	100	µA
Adjust Pin Current Change, ΔI_{ADJ}	10 mA ≤ I_{OUT} ≤ I_{MAX} 2.5V ≤ (V_{IN} - V_{OUT}) ≤ V_{MAX}		●		0.2	5		0.2	5	µA
Minimum Load Current, I_{MIN}	(V_{IN} - V_{OUT}) = 40V		●		3.5	10		3.5	10	mA
	(V_{IN} - V_{OUT}) = 60V, HV Series		●		3.5	12		3.5	12	mA
Current Limit, I_{CL}	(V_{IN} - V_{OUT}) ≤ 15V		●	1.5	2.2		1.5	2.2		A
	(V_{IN} - V_{OUT}) = 40V			0.15	0.40		0.15	0.40		A
	(V_{IN} - V_{OUT}) = 60V HV Series				0.10			0.10		A
Temperature Stability, $\frac{\Delta V_{OUT}}{\Delta TEMP}$			●		1	2		1		%
Long Term Stability, $\frac{\Delta V_{OUT}}{\Delta V_{TIME}}$	1000 Hrs.				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	10Hz ≤ f ≤ 10kHz				0.003			0.003		%
Thermal Resistance	K Package				2.3	3		2.3	3	°C/W
Junction to Case, Θ_{jc}	R Package				5	7		5	7	°C/W
	T Package				4	5		4	5	°C/W
	G Package				3	5		3	5	°C/W

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, (V_{IN}-V_{OUT}) = 5V, I_{OUT} = 0.5A for the TO-3 (K), TO-257 (G), TO-66 (R) and TO-220 (T) Packages. Although power dissipation is internally limited, these specifications apply for dissipations up to 20W for the TO-3, TO-257, TO-66 and TO-220. I_{MAX} = 1.5A for the TO-3, TO-66, TO-220 and TO-257.

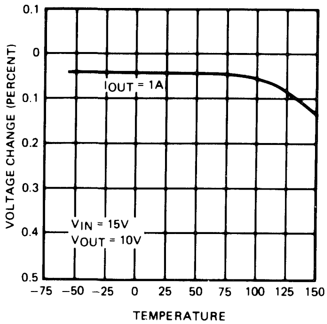
Note 2: Regulation is measured at constant junction temperature, using pulse testing at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured from the bottom of the package for the TO-3, and TO-66, and at the junction of the wide and narrow portion of the output lead for the TO-220, and 1/8″ below the base of the package on the output pin of the TO-257.

Note 3: V_{MAX} = 40V for IP117A, IP117, LM117.
V_{MAX} = 60V for IP117AHV, IP117HV, LM117HV, IP317HV, IP317AHV.

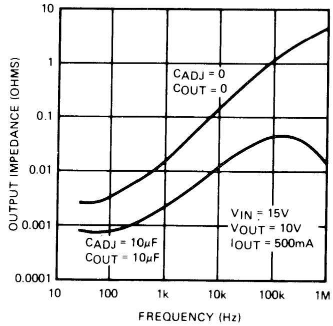
1.5 AMP POSITIVE ADJUSTABLE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

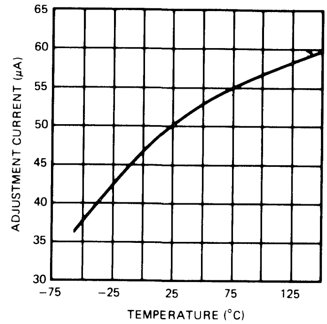
Load Regulation



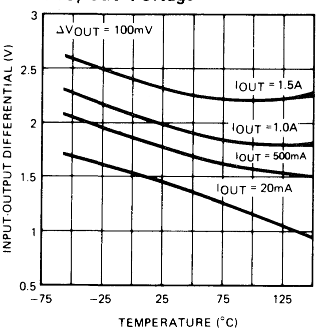
Output Impedance



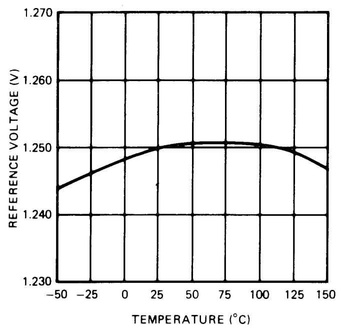
Adjustment Current



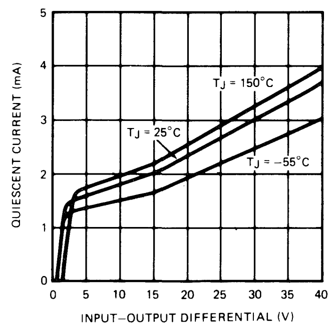
Dropout Voltage



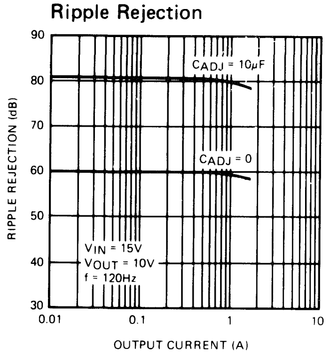
Temperature Stability



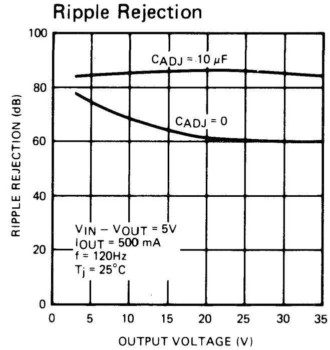
Minimum Operating Current



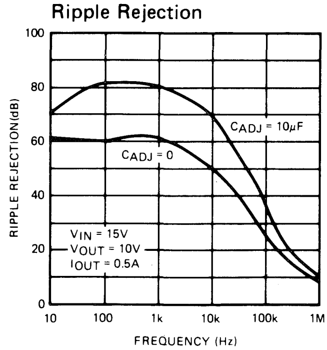
Ripple Rejection



Ripple Rejection



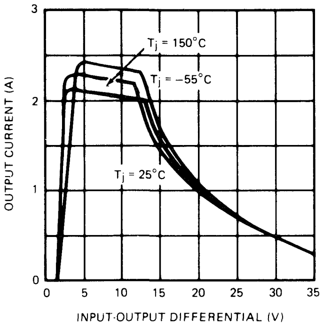
Ripple Rejection



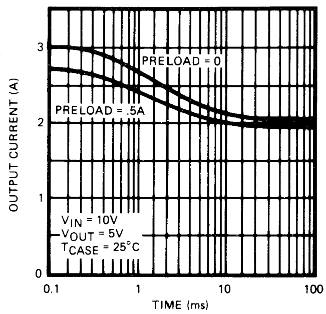
1.5 AMP POSITIVE ADJUSTABLE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

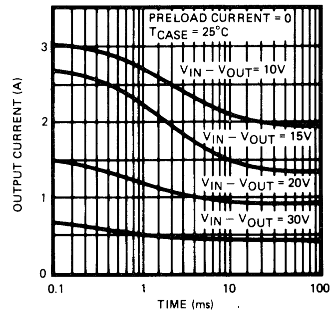
Current Limit
TO-3, TO-66, TO-220 and TO-257



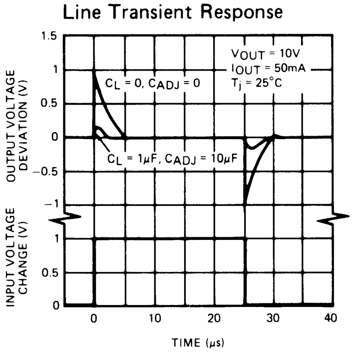
Current Limit
TO-3, TO-66, TO-220 and TO-257



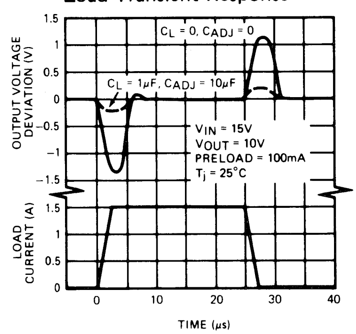
Current Limit
TO-3, TO-66, TO-220 and TO-257



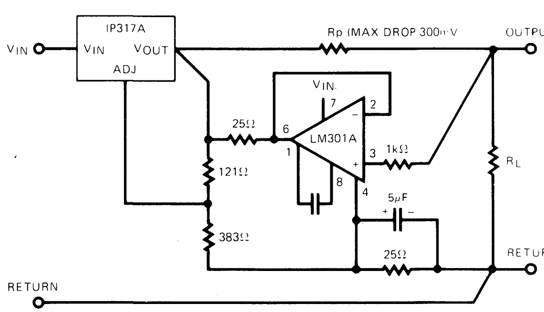
Line Transient Response



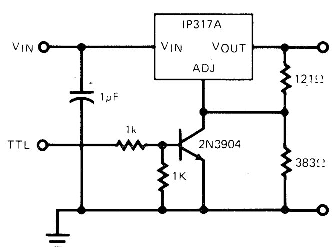
Load Transient Response



APPLICATIONS INFORMATION

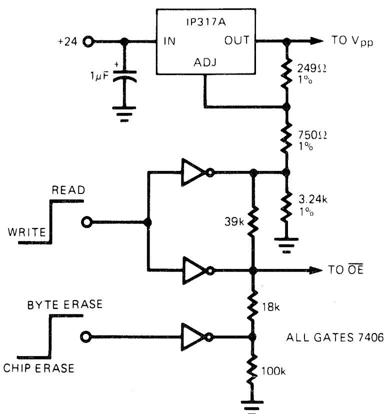


Remote Sensing



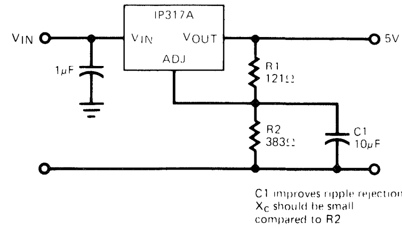
5V Regulator with Shut Down

APPLICATIONS INFORMATION (CONTINUED)

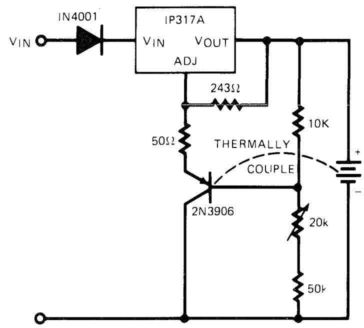


	$\overline{OE}$	V_{pp}
READ	0V	5V
WRITE		
BYTE	5V	21V
CHIP ERASE	12V	21V

2816 EEPROM Supply Programmer for Read/Write Control



Improving Ripple Rejection



Temperature Compensated Lead Acid Battery Charger

ORDER INFORMATION

Part Number	Temperature Range	Package
IP117K/IP117AK/IP117AHVK/IP117HVK LM117K/LM117HVK	−55°C to +150°C	TO-3
IP117AR/IP117AHVR/IP117R/IP117HVR	−55°C to +150°C	TO-66
IP117AG/IP117AHVG/IP117G/IP117HVG	−55°C to +150°C	TO-257 (Hermetic TO-220 style)
IP317AHVK/IP317HVK	0°C to +125°C	TO-3
IP317AHVT/IP317HVT	0°C to +125°C	TO-220

Seagate Microelectronics Limited

0.5 AMP POSITIVE ADJUSTABLE REGULATORS

IP117MA, IP117M, IP117MAHV, IP117MHV

DESCRIPTION

The IP117M Series are three terminal positive adjustable voltage regulators capable of supplying in excess of 0.5A over a 1.25V to 60V output range. These regulators are exceptionally easy to use and require only two external resistors to set the output voltage. In addition to improved line and load regulation, a major feature of the "A" series is the initial output voltage tolerance, which is guaranteed to be less than 1%. Over full operating conditions, including load, line, and power dissipation, the reference voltage is guaranteed not to vary more than 2%. These devices exhibit current limit, thermal overload protection, and improved power device safe operating area protection, making them essentially indestructible.

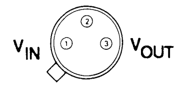
FEATURES

- Guaranteed 1% output voltage tolerance
- Guaranteed 0.3% load regulation
- Guaranteed 0.01%/V line regulation
- Internal current limiting constant with temperature
- Internal thermal overload protection
- Improved output transistor safe operating area compensation
- Output adjustable between 1.25V and 60V

4

CONNECTIONS

(Bottom View)



TO-39

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited

Operating Junction Temperature Range
117MAHV/117MHV/117MA/117M −55°C to +150°C

Input to Output Voltage Differential
Non-HV 40V
HV Series 60V

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP117MAHVH/IP117MHVH/ IP117MAH/IP117MH	−55°C to +150°C	TO-39
LM117HVH/LM117H	−55°C to +150°C	TO-39

0.5 AMP POSITIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS (NOTES 1 and 3)

Parameter	Test Conditions			IP117MAHV IP117MA Min	Typ	Max	IP117MHV IP117M LM117HV LM117 Min	Typ	Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			-1.238	-1.250	-1.262				V
	$3V \leq (V_{IN}-V_{OUT}) \leq V_{MAX}$ $10\ mA \leq I_{OUT} \leq I_{MAX}$, $P \leq P_{MAX}$		●	-1.220	-1.250	-1.270	-1.200	-1.250	-1.300	V
Line Regulation, $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	$3V \leq (V_{IN}-V_{OUT}) \leq V_{MAX}$				0.005	0.010		0.010	0.020	%/V
	(See Note 2)		●		0.010	0.020		0.020	0.050	%/V
Load Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	$10\ mA \leq I_{OUT} \leq I_{MAX}$	$(V_{OUT}) \leq 5V$			5	15		5	15	mV
	(See Note 2)	$(V_{OUT}) \leq 5V$			0.1	0.3		0.1	0.3	%
		$(V_{OUT}) \leq 5V$	●		15	50		20	50	mV
		$(V_{OUT}) \leq 5V$	●		0.3	1.0		0.3	1.0	%
Thermal Regulation	20 msec Pulse				0.002	0.020		0.030	0.070	%/W
Ripple Rejection	V_{OUT} = -10V,	C_{ADJ} = 0			65			65		dB
	f = 120Hz	C_{ADJ} = 10 μF	●	66	80		66	80		dB
Adjust Pin Current, I_{ADJ}			●		50	100		50	100	μA
Adjust Pin Current Change, ΔI_{ADJ}	$10\ mA \leq I_{OUT} \leq I_{MAX}$ $2.5V \leq (V_{IN} - V_{OUT}) \leq V_{MAX}$		●		0.2	5		0.2	5	μA
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT})$ = 40V		●		3.5	5		3.5	5	mA
	$(V_{IN} - V_{OUT})$ = 60V, HV Series		●		3.5	7		3.5	7	mA
Current Limit, I_{CL}	$(V_{IN} - V_{OUT}) \leq 15V$		●	0.50	0.80		0.50	0.80		A
	$(V_{IN} - V_{OUT})$ = 40V			0.15	0.20		0.15	0.20		A
	$(V_{IN} - V_{OUT})$ = 60V HV Series				0.30			0.30		A
Temperature Stability, $\frac{\Delta V_{OUT}}{\Delta TEMP}$			●		1	2		1		%
Long Term Stability, $\frac{\Delta V_{OUT}}{\Delta V_{TIME}}$	T_A = 125°C, 1000 Hrs.				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	10Hz $\leq$ f $\leq$ 10kHz				0.001			0.001		%
Thermal Resistance Junction to Case, θ_{jc}	H Package				12	15		12	15	°C/W

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, $(V_{IN}-V_{OUT})$ = 5V, I_{OUT} = 0.1A for the TO-39 (H) Package. Although power dissipation is internally limited, these specifications apply for dissipations up to 2W for the TO-39 I_{MAX} = 0.5A for the TO-39.

Note 2: Regulation is measured at constant junction temperature, using pulse testing at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured ⅛″ below the base of the package on the output pin of the TO-39.

Note 3: V_{MAX} = 40V for IP117MA, IP117M, LM117
V_{MAX} = 50V for IP117MAHV, IP117MHV, LM117HV

Seagate Microelectronics Limited

1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

IP120A, IP120, LM120, IP7900A Series, IP7900 Series

DESCRIPTION

The IP120A/IP7900A/IP7900 series of three-terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The A-suffix devices provide 0.01%/V line regulation, 0.3%/A load regulation, and ±1% output voltage tolerance at room temperature. Protection features include safe operating area current limiting and thermal shutdown. The entire series of regulators is available in the metal TO-3 and TO-66 power packages. The IP120A/LM120/IP7900A/IP7900 series is now available in a new TO-257 (hermetic TO-220 style) power package.

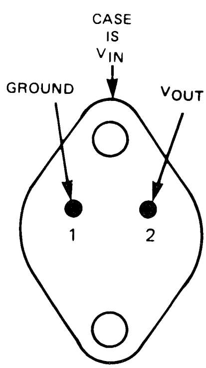
FEATURES

- 1% Tolerance
- −5, −12 and −15V fixed output voltages available
- 0.01%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe area protection
- Start-up with positive voltage (± supplies) on output

4

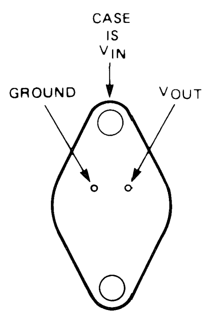
CONNECTIONS

(Bottom View)



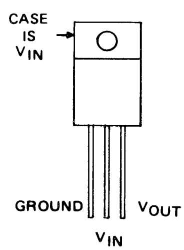
TO-3

(Bottom View)



TO-66

(Top View)



TO-257

1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_O = −5V, −12V, −15V) 35V

Internal Power Dissipation (Note 1) Internally Limited

Operating Temperature Range (T_j)
IP120A, IP120, LM120 −55°C to +150°C
IP7900A, IP7900 −55°C to +150°C

Maximum Junction Temperature
TO-3 Package K 150°C
TO-66 Package R 150°C
TO-257 (Hermetic TO-220 style) G 150°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

Note 1. Although power dissipation is internally limited, these specifications are applicable for maximum power dissipation P_{MAX} of 20W for the TO-3, TO-66 and TO-257. I_{MAX} is 1.0A for the TO-3, TO-66 and TO-257 package.

APPLICATION INFORMATION

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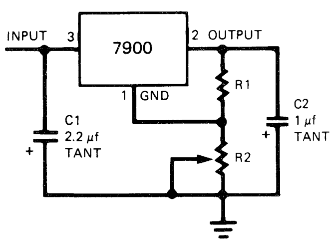
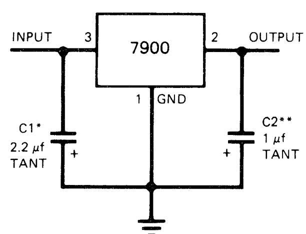
Adjustable Output Regulator



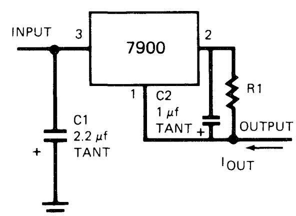
$$V_{out} \approx V_{reg} \frac{(R_1 + R_2)}{R_1}$$

Fixed Output Regulator



*Required if the regulator is located far from the power supply filter.
**Required for stability. 25 µf electrolytic may be substituted.

Current Regulator



$$I_{out} = \frac{V_{reg}}{R1} + I_Q$$

ORDER INFORMATION

Part Number	Temperature Range	Package
IP120AK-XX/IP120K-XX/LM120K-XX	−55°C to +150°C	TO-3
IP7900AK/IP7900K	−55°C to +150°C	TO-3
IP120AR-XX/IP120R-XX	−55°C to +150°C	TO-66
IP7900AR/IP7900R	−55°C to +150°C	TO-66
IP120AG-XX/IP120G-XX	−55°C to +150°C	TO-257 (Hermetic TO-220 style)
IP7900AG/IP7900G	−55°C to +150°C	TO-257 (Hermetic TO-220 style)

1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ELECTRICAL CHARACTERISTICS (NOTE 2)

Parameter	Test Conditions		IP7905A IP120A-5			IP7905 IP120-5 LM120-5			Units
			Min	Typ	Max	Min	Typ	Max	
Output Voltage, V_O	I_O = 500 mA, V_{IN} = -10V		-4.95	-5	-5.05	-4.9	-5	-5.1	V
	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ -7.5V $\leq V_{IN} \leq$ -20V	●	-4.85		-5.15	-4.8		-5.2	V
Low Supply, V_O	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ -7V $\leq V_{IN} \leq$ -20V		-4.75		-5.15	-4.75		-5.25	V
Line Regulation, $\triangle V_O$	I_O = 0.5 I_{MAX}, -7V $\leq V_{IN} \leq$ -25V			3	10		3	25	mV
	-7.5V $\leq V_{IN} \leq$ -20V	●		3	10		3	50	mV
	$I_O \leq I_{MAX}$, -8V $\leq V_{IN} \leq$ -12V			1	4		1	25	mV
		●		1	12		2	50	mV
Load Regulation, $\triangle V_O$	V_{IN} = −10V, 5 mA $\leq I_O \leq$ 1.5A			10	25		10	75	mV
	250mA $\leq I_O \leq$ 750mA			4	15		4	25	mV
	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = -10V	●		7	25		7	50	mV
Quiescent Current, I_Q	$I_O \leq$ 0.5 I_{MAX}			1	1.9		1	1.9	mA
	V_{IN} = -10V	●		1	2		1	2	mA
Quiescent Current Change, $\triangle I_Q$	5 mA $\leq I_O \leq I_{MAX}$			0.2	0.4		0.2	0.4	mA
	V_{IN} = -10V	●		0.2	0.5		0.2	0.5	mA
	$I_O \leq$ 0.5 I_{MAX}, -7V $\leq V_{IN} \leq$ -25V			0.1	0.4		0.1	0.4	mA
	$I_O \leq$ 0.5 I_{MAX}, -8V $\leq V_{IN} \leq$ -25V	●		0.1	0.5		0.1	1.0	mA
Output Noise Voltage, V_N	10 Hz $\leq$ f $\leq$ 100 kHz, V_{IN} = -10V			40	400		40	400	μV
Ripple Rejection, $\triangle V_{IN}/\triangle V_{OUT}$	f = 120 Hz, $I_O \leq I_{MAX}$		66	80		54	80		dB
	-8 V $\leq V_{IN} \leq$ -18V, $I_O \leq$ 0.5 I_{MAX}	●	66	80		54	80		dB
Dropout Voltage	I_{OUT} = I_{MAX}			1.1	2.3		1.1	2.3	V
Output Resistance, R_O	f = 1 kHz			5			5		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = -35V			0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = -10V			2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA			0.2	2.0		0.2	2.0	mV/°C
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leq I_{MAX}$		-7.3			-7.3			V

4

1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONT.)

Parameter	Test Conditions			IP7912A IP120A-12 Min	Typ	Max	IP7912 IP120-12 LM120-12 Min	Typ	Max	Units
Output Voltage, V_O	I_O = 500 mA, V_{IN} = -19V			-11.88	-12	-12.12	-11.76	-12	-12.24	V
	$P_D \leqslant P_{MAX}$, 5mA $\leqslant I_O \leqslant I_{MAX}$ -14.8V $\leqslant V_{IN} \leqslant$ -27V		•	-11.64		-12.36	-11.52		-12.48	V
Low Supply, V_O	$P_D \leqslant P_{MAX}$, 5mA $\leqslant I_O \leqslant I_{MAX}$ -14.5V $\leqslant V_{IN} \leqslant$ -27V			-11.40		-12.36	-11.4		-12.6	V
Line Regulation, $\triangle V_O$	I_O = 0.5 I_{MAX}	-14.5V $\leqslant V_{IN} \leqslant$ -30V			4	18		4	120	mV
		-14.8V $\leqslant V_{IN} \leqslant$ -27V	•		4	18		4	200	mV
	$I_O \leqslant I_{MAX}$	-16V $\leqslant V_{IN} \leqslant$ -22V			1	4		1	25	mV
			•		2	9		2	60	mV
Load Regulation, $\triangle V_O$	V_{IN} = − 19V	5 mA $\leqslant I_O \leqslant$ 1.5A			12	32		12	80	mV
		250mA $\leqslant I_O \leqslant$ 750mA			4	19		4	60	mV
	5 mA $\leqslant I_O \leqslant I_{MAX}$, V_{IN} = -19V		•		8	60		8	120	mV
Quiescent Current, I_Q	$I_O \leqslant$ 0.5 I_{MAX}				0.2	0.4		0.2	0.4	mA
	V_{IN} = -19V		•		1	2		1	2.0	mA
Quiescent Current Change, $\triangle I_Q$	5 mA $\leqslant I_O \leqslant I_{MAX}$				0.2	0.4		0.2	0.4	mA
	V_{IN} = -19V		•		0.2	0.5		0.2	0.5	mA
	$I_O \leqslant$ 0.5 I_{MAX}, -14.5V $\leqslant V_{IN} \leqslant$ -30V				0.1	0.4		0.1	0.4	mA
	$I_O \leqslant$ 0.5 I_{MAX}, -15V $\leqslant V_{IN} \leqslant$ -30V		•		0.1	0.5		0.1	1.0	mA
Output Noise Voltage, V_N	10 Hz $\leqslant$ f $\leqslant$ 100 kHz, V_{IN} = -19V				75	960		75	960	μV
Ripple Rejection, $\triangle V_{IN}/\triangle V_{OUT}$	f = 120 Hz	$I_O \leqslant I_{MAX}$		58	72		56	72		dB
	-15V $\leqslant V_{IN} \leqslant$ -25V	$I_O \leqslant$ 0.5 I_{MAX}	•	58	72		56	72		dB
Dropout Voltage	I_{OUT} = I_{MAX}				1.1	2.3		1.1	2.3	V
Output Resistance, R_O	f = 1 kHz				8			8		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = -35V				0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = -19V				2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA				0.5	4.8	0.5	4.8	mV/°C	
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leqslant I_{MAX}$			-14.5			-14.5			V

1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONT.)

Parameter	Test Conditions			IP7915A IP120A-15 Min	Typ	Max	IP7915 IP120-15 LM120-15 Min	Typ	Max	Units
Output Voltage, V_O	I_O = 500 mA, V_{IN} = -23V			-14.85	-15	-15.15	-14.7	-15	-15.3	V
	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ -17.9V $\leq V_{IN} \leq$ -30V		•	-14.55		-15.45	-14.4		-15.6	V
Low Supply, V_O	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ -17.5V $\leq V_{IN} \leq$ -30V			-14.25		-15.45	-14.25		-15.75	V
Line Regulation, $\triangle V_O$	I_O = 0.5 I_{MAX}	-17.5V $\leq V_{IN} \leq$ -30V			4	22		4	150	mV
		-17.9V $\leq V_{IN} \leq$ -30V	•		4	22		4	250	mV
	$I_O \leq I_{MAX}$	-20V $\leq V_{IN} \leq$ -26V			2	10		2	75	mV
			•		5	30		5	150	mV
Load Regulation, $\triangle V_O$	V_{IN} = −23V	5 mA $\leq I_O \leq$ 1.5A			12	35		12	80	mV
		250mA $\leq I_O \leq$ 750mA			4	21		4	75	mV
	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = -23V		•		9	75		9	150	mV
Quiescent Current, I_Q	$I_O \leq$ 0.5 I_{MAX}				1	1.9		1	1.9	mA
	V_{IN} = -23V		•		1	2		1	2.0	mA
Quiescent Current Change, $\triangle I_Q$	5 mA $\leq I_O \leq I_{MAX}$				0.2	0.4		0.2	0.4	mA
	V_{IN} = -23V		•		0.2	0.5		0.2	0.5	mA
	$I_O \leq$ 0.5 I_{MAX}, -17.5V $\leq V_{IN} \leq$ -30V				0.1	0.4		0.1	0.4	mA
	$I_O \leq$ 0.5 I_{MAX}, -18.5V $\leq V_{IN} \leq$ -30V		•		0.1	0.5		0.1	1.0	mA
Output Noise Voltage, V_N	10 Hz $\leq$ f $\leq$ 100 kHz, V_{IN} = -23V				90	1200		90	1200	μV
Ripple Rejection, $\triangle V_{IN}/\triangle V_{OUT}$	f = 120 Hz	$I_O \leq I_{MAX}$		56	70		54	70		dB
	-18.5V $\leq V_{IN} \leq$ -28.5V	$I_O \leq$ 0.5 I_{MAX}	•	56	70		54	70		dB
Dropout Voltage	I_{OUT} = I_{MAX}				1.1	2.3		1.1	2.3	V
Output Resistance, R_O	f = 1 kHz				9			9		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = -35V				0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = -23V				2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA				0.6	6.0		0.6	6.0	mV/°C
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leq I_{MAX}$			-17.5			-17.5			V

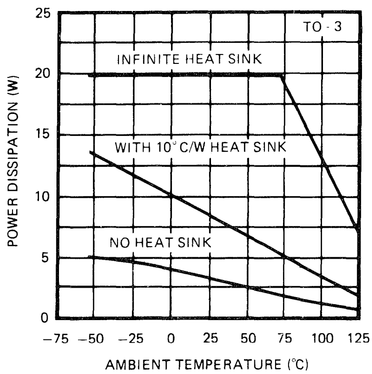
The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 2. All characteristics are measured with a capacitor across the input of 2.2 μF and a capacitor across the output of 0.1 μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_W \leq$ 10 ms, duty cycle $\leq$ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

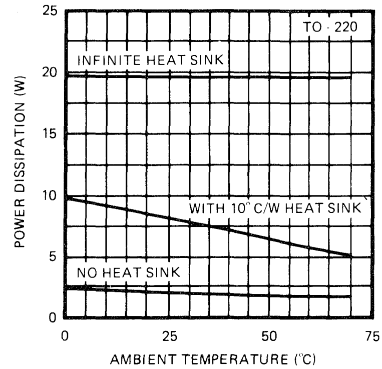
1.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

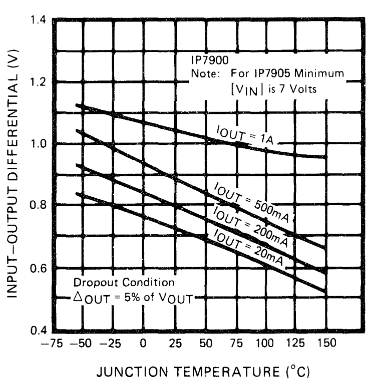
Maximum Average Power Dissipation



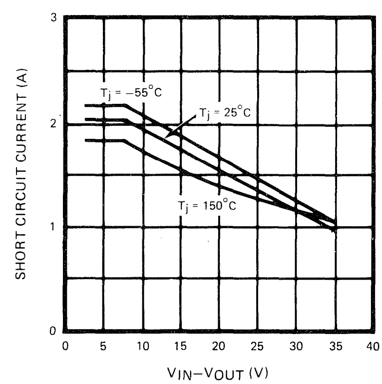
Maximum Average Power Dissipation



Dropout Voltage



Peak Output Current



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Seagate Microelectronics Limited

0.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

IP79M00 Series, IP79M00A Series, IP120M Series, IP120MA Series

DESCRIPTION

The IP79M00/A series of voltage regulators are fixed output regulators intended for local, on-card voltage regulation. These devices are available in −5, −12, and −15 volt options and are capable of delivering in excess of 500 mA over temperature. The A-suffix devices are fully specified at 0.5A, provide 0.01%/V line regulation, 0.3%/A load regulation, and ±1% output voltage tolerance at room temperature. Protection features include safe operating area, current limiting and thermal shutdown. This series of regulators is available in TO-39 and Ceramic DIP packages.

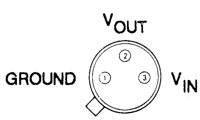
FEATURES

- 1% output voltage tolerance
- −5, −12 and −15V fixed output voltages available
- 0.01%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe operating area protection
- Start-up with negative voltage (± supplies) on output

4

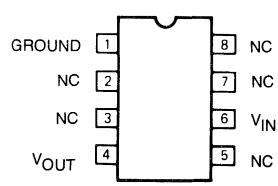
CONNECTIONS

(Bottom View)



TO-39

(Top View)



8 Pin J Package

0.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_O = −5V, −12V, −15V) −35V

Internal Power Dissipation
(Note 1) Internally Limited

Operating Temperature Range (T_j)
IP79M00A, IP79M00 −55°C to +150°C
IP120MA, IP120M −55°C to +150°C

Maximum Junction Temperature
H Package TO-39 150°C
8 Pin Ceramic DIP Package J 150°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) 300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS (NOTE 2)

Parameter	Test Conditions		IP79M05A IP120MA-5 Min	Typ	Max	IP79M05 IP120M-5 Min	Typ	Max	Units
Output Voltage, V_O	I_O = 100mA, V_{IN} = -10V		-4.95	-5	-5.05	-4.80	-5	-5.20	V
	$P_D \le P_{MAX}$, 5mA ≤ I_O ≤ 350mA -25V ≤ V_{IN} ≤ -7V	•	-4.85		-5.15	-4.75		-5.25	V
Line Regulation, ΔV_O	I_O = 350mA, -25V ≤ V_{IN} ≤ -7V			3	10			50	mV
	-18V ≤ V_{IN} < -8V	•		3	10			30	mV
Load Regulation, ΔV_O	5mA ≤ I_O ≤ 500mA, V_{IN} = -10V	•		5	50			100	mV
Quiescent Current, I_Q	I_O = 350mA, V_{IN} = -10V	•		1	2		1	2	mA
Quiescent Current Change, ΔI_Q	5mA ≤ I_O ≤ 500mA, V_{IN} = -10V	•		0.1	0.4			0.4	mA
	-25V ≤ V_{IN} ≤ -8V, I_O = 200mA	•		0.1	0.4			0.4	mA
Output Noise Voltage, V_n	10Hz ≤ f ≤ 100kHz			40	400			400	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	I_O = 300mA, f = 120Hz -18V ≤ V_{IN} ≤ -8V		65	80		54			dB
	I_O = 100mA, f = 120Hz -18V ≤ V_{IN} ≤ -8V	•	65	80		54			dB
Dropout Voltage	I_O = 350mA			1.1	2.3			2.3	V
Short Circuit Current, I_{SC}	V_{IN} = -35V			300	600		300	600	mA
Peak Output Current, I_{PK}	V_{IN} = -10V		0.5	1.0	1.4	0.5	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	I_O = 5mA			0.5	2.0		0.5		mV/°C

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Thermal resistance of the TO-39 package (H) is typically 20°C/W junction to case and 120°C/W case to ambient. Although power dissipation is internally limited, these specifications apply for up to 2W for the TO-39 package, and 1.05W for the J package. Thermal resistance of the J package is typically 119°C/W junction to ambient. (Derate at 8.4mW/°C for ambient temperatures above 25°C).

Note 2: All characteristics are measured with a capacitor across the input of 0.22µF and a capacitor across the output of 0.1µF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_W ⩽ 10ms, duty cycle ⩽ 5%. Output voltage changes due to changes in internal temperature must be taken into account separately.

0.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP79M12A/IP120MA-12 Min	Typ	Max	IP79M12/IP120M-12 Min	Typ	Max	Units
Output Voltage, V_O	$I_O = 100mA$, $V_{IN} = -19V$		-11.88	-12	-12.12	-11.50	-12	-12.50	V
	$P_D \le P_{MAX}$, $5mA \le I_O \le 350mA$, $-30V \le V_{IN} \le -14.5V$	•	-11.64		-12.36	-11.40		-12.60	V
Line Regulation, ΔV_O	$I_O = 350mA$, $-30V \le V_{IN} \le -14.5V$			4	18			80	mV
	$I_O = 350mA$, $-25V \le V_{IN} \le -15V$	•		4	18			50	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 500mA$, $V_{IN} = -19V$	•		10	60			240	mV
Quiescent Current, I_Q	$I_O = 350mA$, $V_{IN} = -19V$	•		1.5	3		1.5	3	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 500mA$, $V_{IN} = -19V$	•		0.1	0.4			0.4	mA
	$-30V \le V_{IN} \le -14.5V$, $I_O = 200mA$	•		0.1	0.4			0.4	mA
Output Noise Voltage, V_n	$10Hz \le f \le 100kHz$			96	960			960	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$I_O = 300mA$, $f = 120Hz$, $-25V \le V_N \le -15V$		58	72		54			dB
	$I_O = 100mA$, $f = 120Hz$, $-25V \le V_{IN} \le -15V$	•	58	72		54			dB
Dropout Voltage	$I_O = 350mA$			1.1	2.3			2.3	V
Short Circuit Current, I_{SC}	$V_{IN} = -35V$			300	600		300	600	mA
Peak Output Current, I_{PK}	$V_{IN} = -19V$		0.5	1.0	1.4	0.5	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	$I_O = 5mA$			1.2	4.8		1.2		mV/°C

Parameter	Test Conditions		IP79M15A/IP120MA-15 Min	Typ	Max	IP79M15/IP120M-15 Min	Typ	Max	Units
Output Voltage, V_O	$I_O = 100mA$, $V_{IN} = -23V$		-14.85	-15	-15.15	-14.40	-15	-15.60	V
	$P_D \le P_{MAX}$, $5mA \le I_O \le 350mA$, $-30V \le V_{IN} \le -17.5V$	•	-14.55		-15.45	-14.25		-15.75	V
Line Regulation, ΔV_O	$I_O = 350mA$, $-30V \le V_{IN} \le -17.5V$			4	22			80	mV
	$I_O = 350mA$, $-28V \le V_{IN} \le -18V$	•		4	22			50	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 500mA$, $V_{IN} = -23V$	•		12	75			240	mV
Quiescent Current, I_Q	$I_O = 350mA$, $V_{IN} = -23V$	•		1.5	3		1.5	3	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 500mA$, $V_{IN} = -23V$	•		0.1	0.4			0.4	mA
	$-30V \le V_{IN} \le -17.5V$, $I_O = 200mA$	•		0.1	0.4			0.4	mA
Output Noise Voltage, V_n	$10Hz \le f \le 100kHz$			120	1200			1200	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$I_O = 300mA$, $f = 120Hz$, $-28.5V \le V_{IN} \le -18.5V$		57	70		54			dB
	$I_O = 100mA$, $f = 120Hz$, $-28.5V \le V_{IN} \le -18.5V$	•	57	70		54			dB
Dropout Voltage	$I_O = 350mA$			1.1	2.3			2.3	V
Short Circuit Current, I_{SC}	$V_{IN} = -35V$			300	600		300	600	mA
Peak Output Current, I_{PK}	$V_{IN} = -23V$		0.5	1.0	1.4	0.5	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	$I_O = 5mA$			1.5	6.0		1.5		mV/°C

0.5 AMP, 3-TERMINAL NEGATIVE REGULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP79M05AH	−55°C to +150°C	TO-39
IP79M05H	−55°C to +150°C	TO-39
IP79M12AH	−55°C to +150°C	TO-39
IP79M12H	−55°C to +150°C	TO-39
IP79M15AH	−55°C to +150°C	TO-39
IP79M15H	−55°C to +150°C	TO-39
IP79M05AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP79M05J	−55°C to +150°C	8 Pin Ceramic DIP
IP79M12AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP79M12J	−55°C to +150°C	8 Pin Ceramic DIP
IP79M15AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP79M15J	−55°C to +150°C	8 Pin Ceramic DIP
IP120MAH-5	−55°C to +150°C	TO-39
IP120MH-5	−55°C to +150°C	TO-39
IP120MAH-12	−55°C to +150°C	TO-39
IP120MH-12	−55°C to +150°C	TO-39
IP120MAH-15	−55°C to +150°C	TO-39
IP120MH-15	−55°C to +150°C	TO-39

3 AMP, 3-TERMINAL POSITIVE REGULATORS

IP123A, IP323A, IP123, LM123

DESCRIPTION

The IP123A/IP323A/LM123/IP123 series of three terminal, three amp regulators is available with several fixed output voltages and three package options, greatly expanding the versatility of this product line. The A-suffix devices are trimmed to ±1% tolerance and provide 0.04%/V line regulation and 0.3%/A load regulation. Protection features include safe operating area current limiting and thermal shutdown. The entire series of regulators is available in the metal TO-3 power package and the IP123A series is also available in the TO-257 hermetic power package.

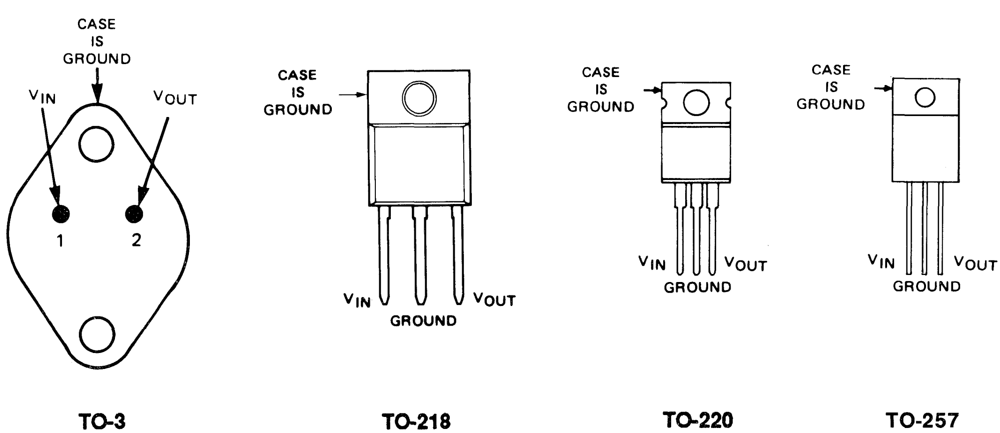
FEATURES

- 1% Tolerance
- 5, 12 and 15V fixed output voltages available
- 0.04%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe operating area protection
- Start-up with negative voltage (± supplies) on output
- Selection of TO-3, TO-218, TO-220 or TO-257 packages

4

CONNECTIONS

(Bottom View) (Top Views)



3 AMP, 3-TERMINAL POSITIVE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_O = 5V, 12V, 15V) 35V

Internal Power Dissipation Internally Limited

Operating Temperature Range (T_j)
IP123A, LM123, IP123 −55°C to +150°C
IP323A 0°C to +125°C

Storage Temperature Range −65°C to 150°C

Lead Temperature (Soldering, 10 sec.) 300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

P_{MAX} = 30W for K (TO-3), V (TO-218) and G (TO-257) Packages
P_{MAX} = 25W for T (TO-220) Packages

Parameter	Test Conditions		IP123A-5 IP323A-5			LM123-5 IP123-5			Units
			Min	Typ	Max	Min	Typ	Max	
Output Voltage, V_O	I_O = 1A, V_{IN} = 7.5V		4.95	5	5.05	4.8	5	5.2	V
	5mA ≤ I_O ≤ 3A, P_{OUT} ≤ P_{MAX} 8V ≤ V_{IN} ≤ 15V	•	4.85		5.15	4.75		5.25	V
Line Regulation, ΔV_O	I_O = 1A, 7.5V ≤ V_{IN} ≤ 15V	•			15			25	mV
Load Regulation, ΔV_O	5mA ≤ I_O ≤ 3A, V_{IN} = 8V	•			50			100	mV
Quiescent Current, I_Q	5mA ≤ I_O ≤ 3A, V_{IN} = 8V	•			10			14	mA
Quiescent Current Change, ΔI_Q	5mA ≤ I_O ≤ 3A, V_{IN} = 8V	•			1.5			3.0	mA
	I_O = 1A, 7.5V ≤ V_{IN} ≤ 15V	•			1.5			3.0	mA
Output Noise Voltage, V_N	10Hz ≤ f ≤ 100kHz			40			40		μV_{rms}
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	f = 120Hz, I_O = 1A		66	80		60	80		dB
	8V ≤ V_{IN} ≤ 18V	•	60			56			dB
Short-Circuit Current, I_{SC}	V_{IN} = 15V			3			3		A
	V_{IN} = 7.5V			4			4		A
Long-Term Stability					35			35	mV
Thermal Resistance,	K, V Package			1.5	2.5		2		°C/W
Junction to Case, Θ_{JC}	G, T Package			3	4		4		°C/W

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note: All characteristics are measured with a capacitor across the input of 0.22 μF and a capacitor across the output of 0.1 μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_W ≤ 10ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

3 AMP, 3-TERMINAL POSITIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONT.)

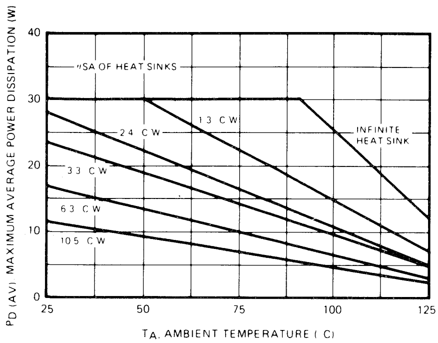
Parameter	Test Conditions		IP123A-12 IP323A-12			LM123-12 IP123-12			Units
			Min	Typ	Max	Min	Typ	Max	
Output Voltage, V_O	$I_O = 1A$, $V_{IN} = 14.8V$		11.88	12	12.12	11.5	12	12.5	V
	$5mA \le I_O \le 3A$, $P_{OUT} \le P_{MAX}$ $15.4V \le V_{IN} \le 22V$	•	11.64		12.36	11.4		12.6	V
Line Regulation, ΔV_O	$I_O = 1A$, $14.8V \le V_{IN} \le 22V$	•			36			60	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 3A$, $V_{IN} = 15.4V$	•			75			150	mV
Quiescent Current, I_Q	$5mA \le I_O \le 3A$, $V_{IN} = 15.4V$	•			10			14	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 3A$, $V_{IN} = 15.4V$	•			1.5			3.0	mA
	$I_O = 1A$, $14.8V \le V_{IN} \le 22V$	•			1.5			3.0	mA
Output Noise Voltage, V_N	$10Hz \le f \le 100kHz$			75			75		μV_{rms}
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120Hz$, $I_O = 1A$,		58	72		52	72		dB
	$15.4V \le V_{IN} \le 25.4V$	•	52			48			dB
Short-Circuit Current, I_{SC}	$V_{IN} = 15.4V$			3			3		A
Peak Output Current, I_{pk}	$V_{IN} = 15.4V$			4			4		A
Long -Term Stability					84			84	mV
Thermal Resistance,	K, V Package			1.5	2.5		2		°C/W
Junction to Case, Θ_{JC}	G, T Package			3	4		4		°C/W

Parameter	Test Conditions		IP123A-15 IP323A-15			LM123-15 IP123-15			Units
			Min	Typ	Max	Min	Typ	Max	
Output Voltage, V_O	$I_O = 1A$, $V_{IN} = 17.9V$		14.85	15	15.15	14.4	15	15.6	V
	$5mA \le I_O \le 3A$, $P_{OUT} \le P_{MAX}$ $18.5V \le V_{IN} \le 25V$	•	14.55		15.45	14.25		15.75	V
Line Regulation, ΔV_O	$I_O = 1A$, $17.9V \le V_{IN} \le 25V$	•			45			75	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 3A$, $V_{IN} = 18.5V$	•			75			150	mV
Quiescent Current, I_Q	$5mA \le I_O \le 3A$, $V_{IN} = 18.5V$	•			10			14	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 3A$, $V_{IN} = 18.5V$	•			1.5			3.0	mA
	$I_O = 1A$, $17.9V \le V_{IN} \le 25V$	•			1.5			3.0	mA
Output Noise Voltage, V_N	$10Hz \le f \le 100kHz$			90			90		μV_{rms}
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120Hz$, $I_O = 1A$		56	70		50	70		dB
	$18.5V \le V_{IN} \le 28.5V$	•	50			46			dB
Short-Circuit Current, I_{SC}	$V_{IN} = 18.5V$			2.5			2.5		A
Peak Output Current, I_{pk}	$V_{IN} = 18.5V$			4			4		A
Long -Term Stability					105			105	mV
Thermal Resistance,	K, V Package			1.5	2.5		2		°C/W
Junction to Case, Θ_{JC}	G, T Package			3	4		4		°C/W

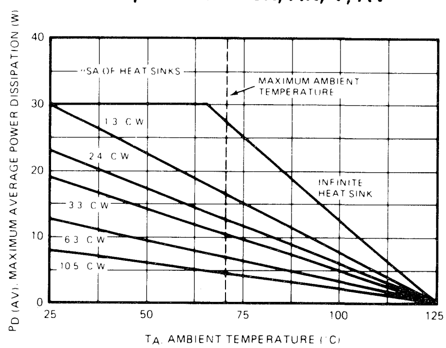
3 AMP, 3-TERMINAL POSITIVE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

Maximum Average Power Dissipation for IP123K, AK, G, AG



Maximum Average Power Dissipation for 323K, AK, V, AV



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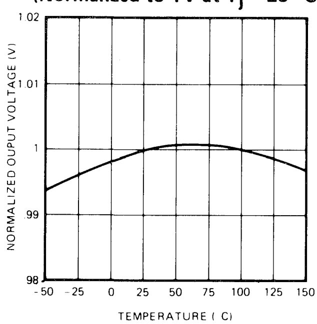
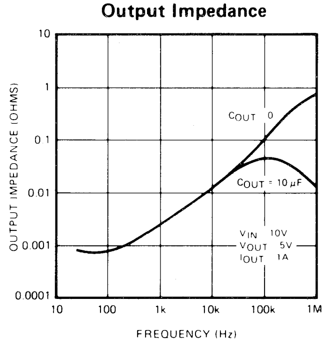
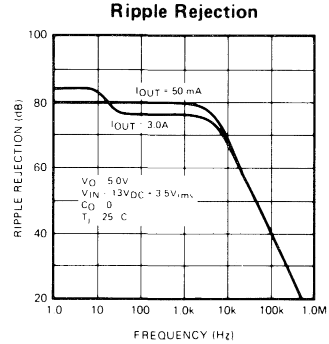
Output Voltage (Normalized to 1V at T_j = 25 °C)



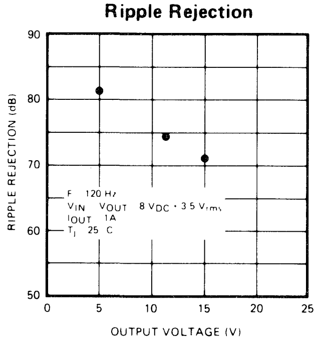
Output Impedance



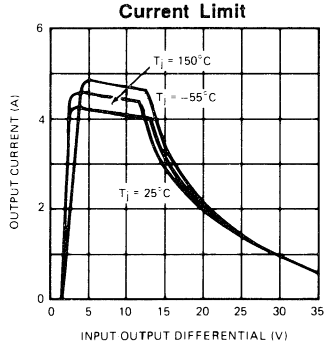
Ripple Rejection



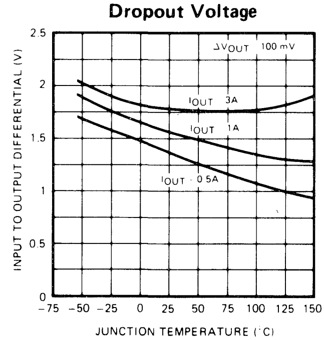
Ripple Rejection



Current Limit



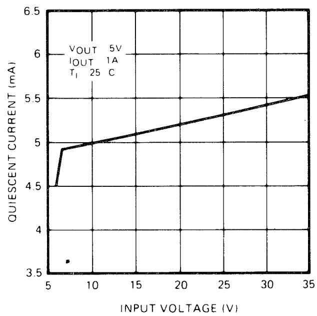
Dropout Voltage



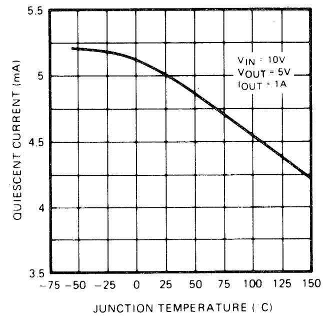
3 AMP, 3-TERMINAL POSITIVE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

Quiescent Current

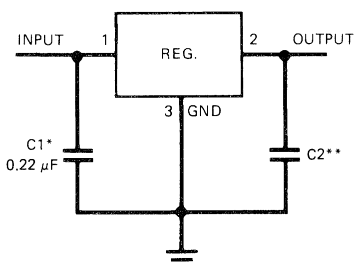


Quiescent Current



APPLICATIONS INFORMATION

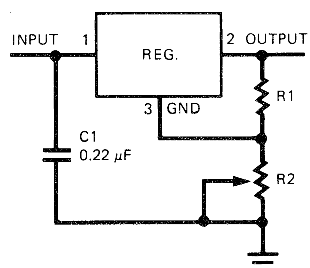
Fixed Output Regulator



* Required if the regulator is located far from the power supply filter.

** Although no output capacitor is needed for stability, it does help transient response. (If needed, use 0.1 μF, ceramic disc)

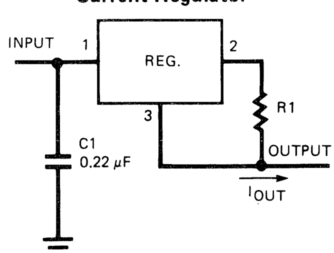
Adjustable Output Regulator



$V_{OUT} = V_{REG} + (V_{REG}/R_1 + I_Q)\,R_2$

$V_{REG}/R_1 > 3\,I_Q$, load regulation $(L_r) \approx \left[\dfrac{(R_1 + R_2)}{R_1}\right]$ (L_R of Regulator)

Current Regulator



$$I_{OUT} = \frac{V_{REG}}{R_1} + I_Q$$

ΔI_Q = 3.0 mA over line and load changes

1.5 AMP POSITIVE ADJUSTABLE REGULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP123AK-5	−55°C to +150°C	TO-3
LM123K	−55°C to +150°C	TO-3
IP123K-5	−55°C to +150°C	TO-3
IP323AK-5	0°C to +125°C	TO-3
IP123AK-12	−55°c to +150°C	TO-3
IP123K-12	−55°C to +150°C	TO-3
IP323AK-12	0°C to +125°C	TO-3
IP123AK-15	−55°C to +150°C	TO-3
IP123K-15	−55°C to +150°C	TO-3
IP323AK-15	0°C to +125°C	TO-3
IP323AV-5	0°C to +125°C	TP-218
IP323AV-12	0°C to +125°C	TO-218
IP323AV-15	0°C to +125°C	TO-218
IP323AT-5	0°C to +125°C	TO-220
IP232AT-12	0°C to +125°C	TO-220
IP323AT-15	0°C to +125°C	TO-220
IP123G-05	−55°C to +150°C	TO-257
IP123AG-05	−55°C to +150°C	TO-257
IP123G-12	−55°C to +150°C	TO-257
IP123AG-12	−55°C to +150°C	TO-257
IP123G-15	−55°C to +150°C	TO-257
IP123AG-15	−55°C to +150°C	TO-257

Seagate Microelectronics Limited

1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

IP137A, IP137, LM137, IP137AHV, IP137HV, LM137HV, IP337AHV, IP337HV, LM337HV

DESCRIPTION

The IP137A family of negative adjustable regulators will deliver up to 1.5 amps output current over an output voltage range of −1.2V to −47V. Seagate Microelectronics has made significant improvements in these regulators compared to previous devices, such as better line and load regulation, and a maximum output voltage error of 1%.

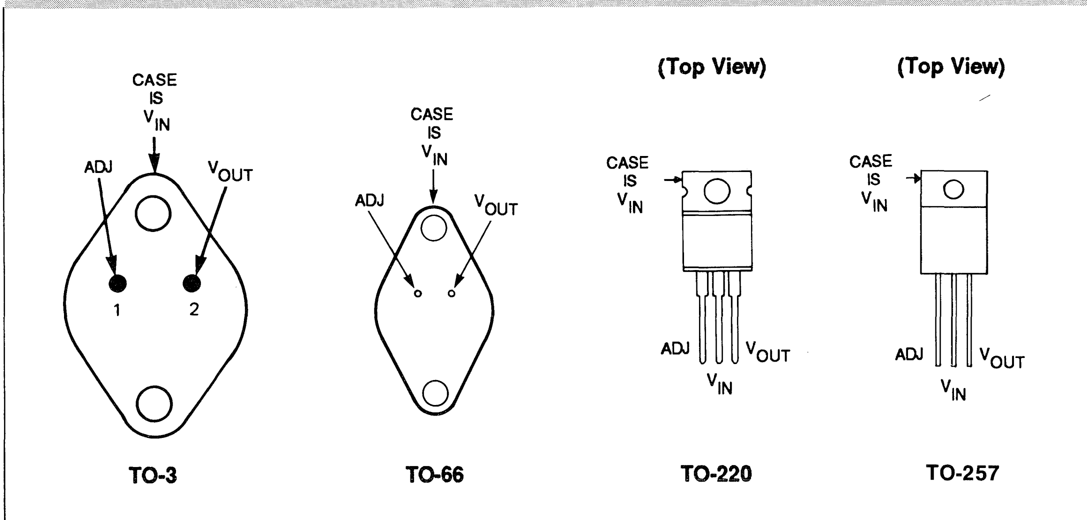
Internal current and power limiting coupled with true thermal limiting prevents device damage due to overloads or shorts, even if the regulator is not fastened to a heat sink.

FEATURES

- 1% Initial voltage tolerance
- 0.01%/V line regulation
- 0.5%/A load regulation
- 0.02%/W thermal regulation

4

CONNECTIONS



1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited
Input to output voltage differential 40V
Input to output voltage differential (HV) 50V

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Operating Junction Temperature Range
IP137AHV, IP137A, IP137 −55°C to +150°C
LM137HV, LM137 −55°C to +150°C
IP337AHV, IP337HV 0°C to +125°C
LM337HV 0°C to +125°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS (NOTES 1 AND 3)

Parameter	Test Conditions		IP137A IP137AHV Min	Typ	Max	LM137 IP137 LM137HV IP137HV Min	Typ	Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA		-1.238	-1.250	-1.262	-1.225	-1.250	-1.275	V
	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX} 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}	●	-1.220	-1.250	-1.280	-1.200	-1.250	-1.300	V
Line Regulation, $\Delta V_{OUT}/\Delta V_{IN}$	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX}			0.005	0.010		0.010	0.020	%/V
	(See Note 2)	●		0.010	0.030		0.020	0.050	%/V
Load Regulation, $\Delta V_{OUT}/\Delta I_{OUT}$	10 mA ≤ I_{OUT} ≤ I_{MAX} (See Note 2 and 3) — (V_O) ≤ 5V			5	25		15	25	mV
	(V_O) ≤ 5V			0.1	0.5		0.3	0.5	%
	(V_O) ≤ 5V	●		10	50		20	50	mV
	(V_O) ≤ 5V	●		0.2	1.0		0.3	1.0	%
Thermal Regulation	T_A = 25°C, 10 msec Pulse			0.002	0.02		0.002	0.02	%/W
Ripple Rejection	V_{OUT} = -10V, f = 120Hz — C_{ADJ} = 0		60	66			60		dB
	C_{ADJ} = 10 µF	●	70	80		66	77		dB
Adjust Pin Current, I_{ADJ}		●		65	100		65	100	µA
Adjust Pin Current Change, ΔI_{ADJ}	10 mA ≤ I_{OUT} ≤ I_{MAX}	●		0.2	2		0.5	5	µA
	3V ≤ (V_{IN} - V_{OUT}) ≤ 40V	●		1.0	5		2	5	µA
	3V ≤ (V_{IN} - V_{OUT}) ≤ 50V, HV series	●		2.0	6		3	6	µA
Minimum Load Current, I_{MIN}	(V_{IN} - V_{OUT}) ≤ 40V	●		2.5	5.0		2.5	5.0	mA
	(V_{IN} - V_{OUT}) ≤ 10V	●		1.2	3.0		1.2	3.0	mA
Current Limit, I_{CL}	(V_{IN} - V_{OUT}) ≤ 15V	●	1.5	2.2	3.2	1.5	2.2	3.2	A
	(V_{IN} - V_{OUT}) = 40V	●	0.24	0.4	1.0	0.24	0.4		A
	(V_{IN} - V_{OUT}) = 50V HV Series	●	0.2	0.4	0.8	0.2	0.4	0.8	A
Temperature Stability, $\Delta V_{OUT}/\Delta TEMP$		●		0.6	1.5		0.6		%
Long Term Stability, $\Delta V_{OUT}/\Delta TIME$	T_A = 125°C, 1000 Hrs.			0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	T_A = 25°C, 10Hz ≤ f ≤ 10kHz			0.003			0.003		%
Thermal Resistance Junction to Case, Θ_{jc}	K Package			2.3	3		2.3	3	°C/W
	R Package			5	7		5	7	°C/W
	G Package			3	5		3	5	°C/W

1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions			IP337AHV Min	IP337AHV Typ	IP337AHV Max	IP337HV LM337HV Min	IP337HV LM337HV Typ	IP337HV LM337HV Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			-1.238	-1.250	-1.262	-1.213	-1.250	-1.287	V
	3V ⩽ $(V_{IN}\text{-}V_{OUT})$ ⩽ V_{MAX} 10 mA ⩽ I_{OUT} ⩽ I_{MAX}, P ⩽P_{MAX}		●	-1.220	-1.250	-1.280	-1.200	-1.250	-1.300	V
Line Regulation, $\Delta V_{OUT}/\Delta V_{IN}$	3V ⩽ $(V_{IN}\text{-}V_{OUT})$ ⩽ V_{MAX}				0.005	0.010		0.010	0.040	%/V
	(See Note 2)		●		0.010	0.03		0.020	0.070	%/V
Load Regulation, $\Delta V_{OUT}/\Delta I_{OUT}$	10 mA ⩽I_{OUT} ⩽I_{MAX}	(V_O) ⩽ 5V			5	25		15	50	mV
	(See Note 2 and 3)	(V_O) ⩽ 5V			0.1	0.5		0.3	1.0	%
		(V_O) ⩽ 5V	●		10	50		20	70	mV
		(V_O) ⩽ 5V	●		0.2	1.0		0.3	1.5	%
Thermal Regulation	T_A = 25°C, 10 msec Pulse				0.002	0.020		0.003	0.04	%/W
Ripple Rejection	V_{OUT} = -10V,	C_{ADJ} = 0		60	66			60		dB
	f = 120Hz	C_{ADJ} = 10 µF	●	70	80		66	77		dB
Adjust Pin Current, I_{ADJ}			●		65	100		65	100	µA
Adjust Pin Current Change, ΔI_{ADJ}	10 mA ⩽ I_{OUT} ⩽ I_{MAX} 3V ⩽ $(V_{IN} - V_{OUT})$ ⩽ 40V 3V ⩽ $(V_{IN} - V_{OUT})$ ⩽ 50V, HV series		● ● ●		0.2 1.0 2.0	2 5 6		0.5 2 3	5 5 6	µA µA µA
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT})$ ⩽ 40V $(V_{IN} - V_{OUT})$ ⩽ 10V		● ●		2.5 1.2	5 3.0		2.5 1	10 6	mA mA
Current Limit, I_{CL}	$(V_{IN} - V_{OUT})$ ⩽ 15V		●	1.5	2.2	3.5	1.5	2.2	3.5	A
	$(V_{IN} - V_{OUT})$ = 40V		●	0.24	0.4	1.0	0.15	0.4		A
	$(V_{IN} - V_{OUT})$ = 50V HV Series		●	0.2	0.4	0.8	0.1	0.4	0.8	A
Temperature Stability, $\Delta V_{OUT}/\Delta TEMP$			●		0.6	1.5		0.6		%
Long Term Stability, $\Delta V_{OUT}/\Delta TIME$	T_A = 125°C, 1000 Hrs.				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	T_A = 25°C, 10Hz ⩽ f ⩽ 10kHz				0.003			0.003		%
Thermal Resistance	K Package				2.3	3		2.3	3	°C/W
Junction to Case, θ_{jc}	R Package				5	7		5	7	°C/W
	T Package				4	5		4		
	G Package				3	5		3	5	°C/W

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, $(V_{IN} - V_{OUT})$ = 5V, and I_{OUT} = 0.5A for the TO-3 (K), TO-257 (G), TO-66 (R), and TO-220 (T) Packages. Although power dissipation is internally limited, these specifications apply for dissipations up to 20W for the TO-3, TO-66, TO-220 and TO-257. I_{Max} = 1.5A for the TO-3, TO-66 TO-220 and TO-257.

Note 2: Regulation is measured at constant junction temperature, using pulse testing at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured at a point ⅛" from the bottom of the package for the TO-3 and TO-66, at the junction of the wide and narrow portion of the output lead for the TO-220, and ⅛" below the base of the package on the output pin of the TO-257.

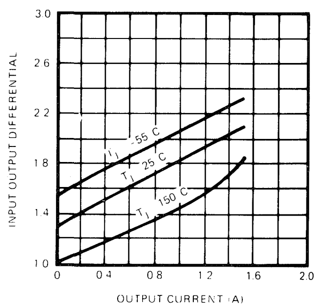
Note 3: V_{MAX} = 40V, IP137A, IP337A, LM137, LM337, IP137, IP337.
V_{MAX} = 50V for IP137AHV, IP337AHV, LM137HV, LM337HV, IP137HV, IP337HV.

1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

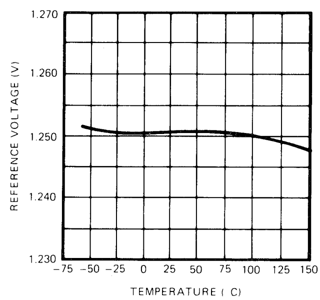
TYPICAL PERFORMANCE CHARACTERISTICS

4

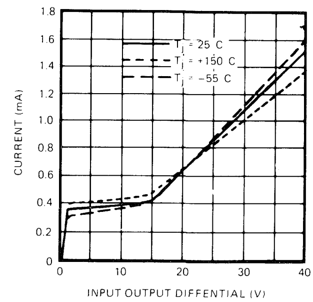
Dropout Voltage



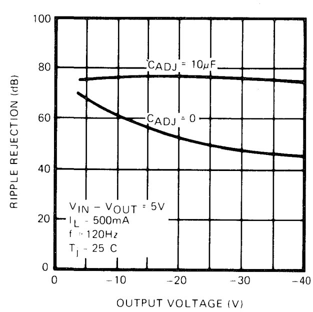
Temperature Stability



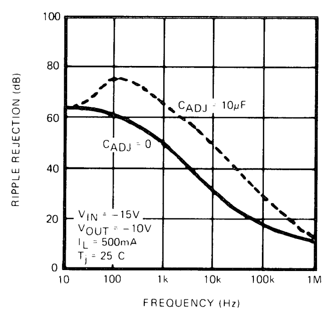
Minimum Load Current



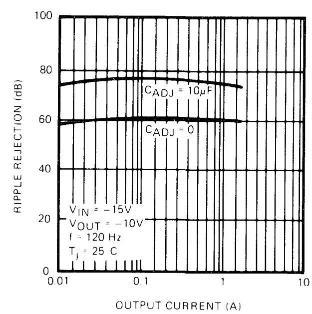
Ripple Rejection



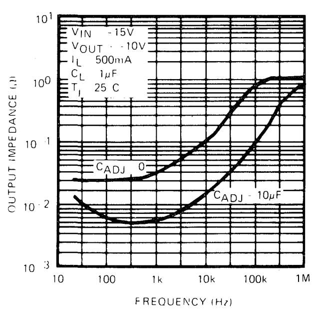
Ripple Rejection



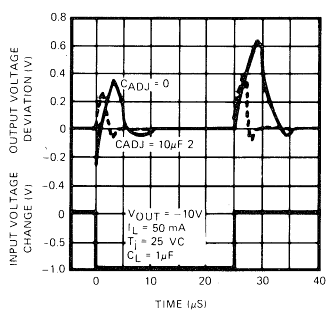
Ripple Rejection



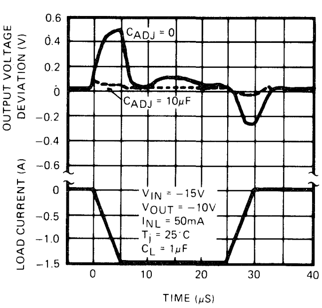
Output Impedance



Line Transient Response



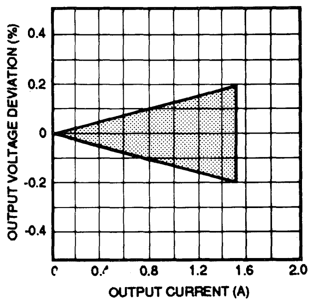
Load Transient Response



1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

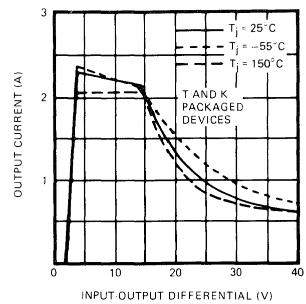
TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

Load Regulation*

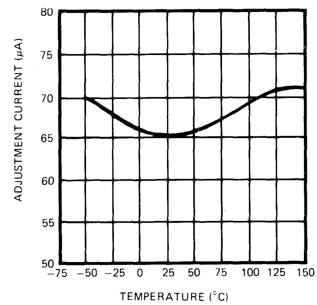


*The IP137A/AHV, IP337A/AHV series has load compensation which makes the typical unit read close to zero. This band represents the typical production spread.

Current Limit

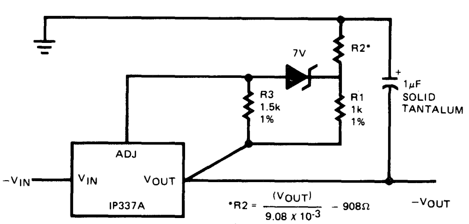


Adjustment Current

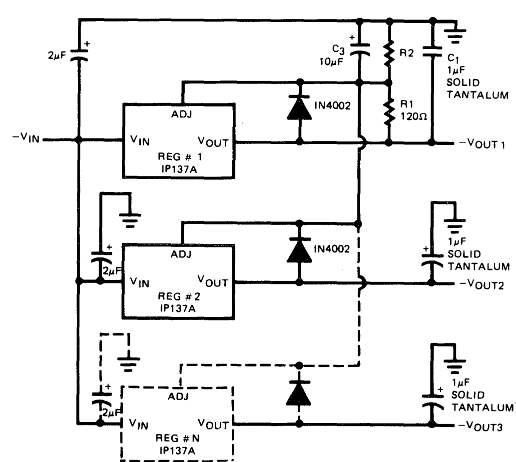


APPLICATIONS INFORMATION

High Stability Regulator:
The output stability, load regulation, line regulation, thermal regulation, temperature drift, long term drift, and noise, can be improved by a factor of 6.6 over the standard regulator configuration. This assumes a zener has 20PPM/°C maximum drift and about 10 times lower noise than the regulator.

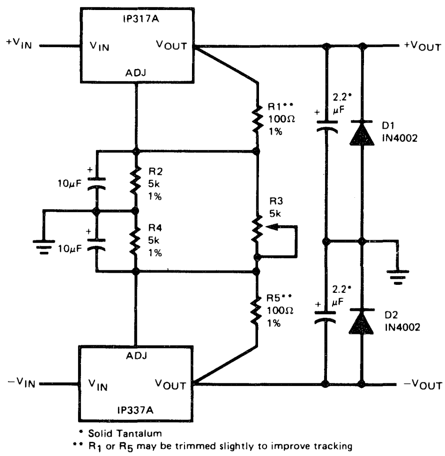


Multiple Tracking Regulators:
In the application shown below, regulator #2 to "N" will track regulator #1 to within ±24mV initially, and to ±60mV over all load, line, and temperature conditions. If any regulator output is shorted to ground, all other outputs will drop to −2V. Load regulation of regulators 2 to "N" will be improved by V_{OUT}/1.25V compared to a standard regulator, so regulator #1 should be the one which has the lowest load current.

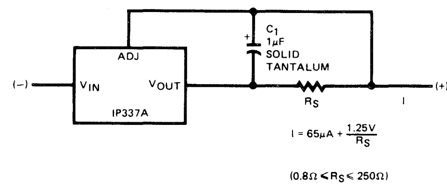


1.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

APPLICATION INFORMATION (CONTINUED)



Dual Tracking Supply ±1.25V to ±20V



Current Regulator

ORDER INFORMATION

Part Number	Temperature Range	Package
IP137AK/IP137AHVK/LM137K/LM137HVK/ IP137K/IP137HVK	−55°C to +150°C	TO-3
IP137AR/IP137AHVR/IP137R/IP137HVR	−55°C to +150°C	TO-66
IP137AG/IP137AHVG/IP137G/IP137HVG	−55°C to +150°C	TO-257 (Hermetic TO-220 style)
IP337AHVK/LM337HVK	0°C to +125°C	TO-3
IP337AHVT/LM337HVT	0°C to +125°C	TO-220

Seagate Microelectronics Limited

0.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

IP137MAHV, IP137MHV, IP137MA, IP137M

DESCRIPTION

The IP137M family of negative adjustable regulators will deliver up to 0.5 amps output current over an output voltage range of −1.2V to −47V. Seagate Microelectronics has made significant improvements in these regulators compared to previous devices, such as better line and load regulation, and a maximum output voltage error of 1%.

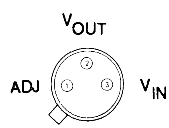
Internal current and power limiting coupled with true thermal limiting prevents device damage due to overloads or shorts, even if the regulator is not fastened to a heat sink.

FEATURES

- 1% Initial voltage tolerance
- 0.01%/V line regulation
- 0.5%/A load regulation
- 0.02%/W thermal regulation

CONNECTIONS

(Bottom View)



TO-39

4

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited
Input to output voltage differential 40V
Input to output voltage differential (HV) 50V

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) +300°C

Operating Junction Temperature Range

IP137MAHV, IP137MHV	−55°C to +150°C
IP137MA, IP137M	−55°C to +150°C
LM137, LM137HVH	−55°C to +150°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP137MAHVH, IP137MHVH,		
IP137MAH, IP137MH	−55°C to +150°C	TO-39
LM137HVH, LM137H	−55°C to +150°C	TO-39

0.5A, 3-TERMINAL NEGATIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS (NOTES 1 AND 3)

Parameter	Test Conditions			IP137MAHV IP137MA			IP137MHV IP137M LM137HV LM137			Units
				Min	Typ	Max	Min	Typ	Max	
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			-1.238	-1.250	-1.262	-1.225	-1.250	-1.275	V
	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX} 10 mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}		●	-1.220	-1.250	-1.280	-1.200	-1.250	-1.300	V
Line Regulation, $\triangle V_{OUT}/\triangle V_{IN}$	3V ≤ (V_{IN}-V_{OUT}) ≤ V_{MAX}				0.005	0.010		0.010	0.020	%/V
	(See Note 2)		●		0.010	0.030		0.020	0.050	%/V
Load Regulation, $\triangle V_{OUT}/\triangle I_{OUT}$	10 mA ≤ I_{OUT} ≤ I_{MAX} (See Note 2 and 3)	(V_O) ≤ 5V			5	25		15	25	mV
		(V_O) ≤ 5V			0.1	0.5		0.3	0.5	%
		(V_O) ≤ 5V	●		10	50		20	50	mV
		(V_O) ≤ 5V	●		0.2	1.0		0.3	1.0	%
Thermal Regulation	T_A = 25°C, 10 msec Pulse				0.002	0.02		0.002	0.02	%/W
Ripple Rejection	V_{OUT} = -10V,	C_{ADJ} = 0		60	66			60		dB
	f = 120Hz	C_{ADJ} = 10 µF	●	70	80		66	77		dB
Adjust Pin Current, I_{ADJ}			●		65	100		65	100	µA
Adjust Pin Current Change, $\triangle I_{ADJ}$	10 mA ≤ I_{OUT} ≤ I_{MAX}		●		0.2	2		0.5	5	µA
	3V ≤ (V_{IN} - V_{OUT}) ≤ 40V		●		1.0	5		2	5	µA
	3V ≤ (V_{IN} - V_{OUT}) ≤ 50V, HV series		●		2.0	6		3	6	µA
Minimum Load Current, I_{MIN}	(V_{IN} - V_{OUT}) ≤ 40V		●		2.5	5.0		2.5	5.0	mA
	(V_{IN} - V_{OUT}) ≤ 10V		●		1.2	3.0		1.2	3.0	mA
Current Limit, I_{CL}	(V_{IN} - V_{OUT}) ≤ 15V		●	0.5	0.8	1.5	0.5	0.8	1.5	A
	(V_{IN} - V_{OUT}) = 40V		●	0.15	0.17		0.15	0.17		A
	(V_{IN} - V_{OUT}) = 50V HV Series		●	0.1	0.17	0.5	0.1	0.17	0.5	A
Temperature Stability, $\triangle V_{OUT}/\triangle TEMP$			●		0.6	1.5		0.6		%
Long Term Stability, $\triangle V_{OUT}/\triangle TIME$	T_A = 125°C, 1000 Hrs.				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	T_A = 25°C, 10Hz ≤ f ≤ 10kHz				0.003			0.003		%
Thermal Resistance Junction to Case, Θ_{jc}	H Package				12	15		12	15	°C/W

The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, (V_{IN}-V_{OUT}) = 5V, I_{OUT} = 0.1A for the TO-39 (H) Package. Although power dissipation is internally limited, these specifications apply for dissipations up to 2W for the TO-39 I_{MAX} = 0.5A for the TO-39.

Note 2: Regulation is measured at constant junction temperature, using pulse testing at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured ⅛″ below the base of the package on the output pin of the TO-39.

Note 3: V_{MAX} = 40V for IP137MA, IP137M, LM137
V_{MAX} = 50V for IP137MAHV, IP137MHV, LM137HV

5 AMP POSITIVE ADJUSTABLE REGULATORS

IP138A, IP338A, IP138, LM138, IP338, LM338

DESCRIPTION

The IP138A series are 3-terminal positive adjustable voltage regulators capable of supplying in excess of 5A over a 1.25V to 35V output range. These regulators are exceptionally easy to use and require only two external resistors to set the output voltage. In addition to improved line and load regulation, a major feature of the "A" series is the initial output voltage tolerance, which is guaranteed to be less than 1%. Over full operating conditions, including load, line and lower dissipation, the reference voltage is guaranteed not to vary more than 2%. These devices exhibit current limit, thermal overload protection, and improved power device safe operating area protection, making them essentially indestructible.

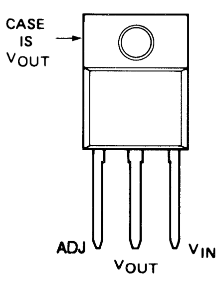
FEATURES

- Available in low cost TO-218
- Guaranteed 1% output voltage tolerance
- Guaranteed 0.3% load regulation
- Guaranteed 0.01%/V line regulation
- Internal current limiting constant with temperature
- Internal thermal overload protection
- Improved output transistor safe operating area compensation
- Output adjustable between 1.25V and 35V

4

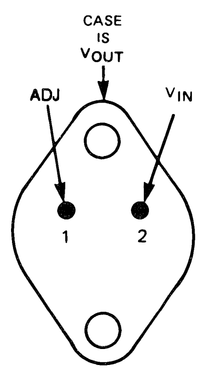
CONNECTIONS

(Top View)



TO-218 Plastic

(Bottom View)



TO-3 Metal Can

5 AMP POSITIVE ADJUSTABLE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited

Input to Output Voltage Differential 35V

Operating Junction Temperature Range
IP138A, LM138, IP138 −55°C to +150°C
IP338A, LM338, IP338 0°C to +125°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) 300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS (NOTE 1)

4

Parameter	Test Conditions			IP138A Min	IP138A Typ	IP138A Max	LM138/IP138 Min	LM138/IP138 Typ	LM138/IP138 Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			1.238	1.250	1.262				V
	$3V \le (V_{IN} - V_{OUT}) \le 35V$ $10mA \le I_{OUT} \le 5A$, $P \le 50W$		•	1.225	1.250	1.270	1.19	1.24	1.29	V
Line Regulation, $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	$3V \le (V_{IN} - V_{OUT}) \le 35V$				0.005	0.01		0.005	0.01	%/V
	(See Note 2)		•		0.020	0.04		0.020	0.04	%/V
Load Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	$10 mA \le I_{OUT} \le 5A$	$V_O \le 5V$			5	15		5	15	mV
	(See Note 2)	$V_O \ge 5V$			0.1	0.3		0.1	0.3	%
		$V_O \le 5V$	•		20	30		20	30	mV
		$V_O \ge 5V$	•		0.3	0.6		0.3	0.6	%
Thermal Regulation	20 msec Pulse				0.002	0.01		0.002	0.01	%/W
Ripple Rejection	V_{OUT} = 10V,	$C_{ADJ} = 0$	•		60			60		dB
	f = 120 Hz	$C_{ADJ} = 10\mu F$	•	60	75		60	75		dB
Adjust Pin Current, I_{ADJ}			•		45	100		45	100	μA
Adjust Pin Current Change, ΔI_{ADJ}	$10 mA \le I_{OUT} \le 5A$ $3V \le (V_{IN} - V_{OUT}) \le 35V$		•		0.2	5		0.2	5	μA
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT}) = 35V$		•		3.5	5		3.5	5	mA
Current Limit, I_{SC}	$(V_{IN} - V_{OUT}) \le 10V$	DC	•	5	8		5	8		A
		0.5ms peak	•	7	12		7	12		A
	$(V_{IN} - V_{OUT}) = 30V$				1			1		A
Temperature Stability, $\frac{\Delta V_{OUT}}{\Delta TEMP}$			•		1	2		1		%
Long Term Stability, $\frac{\Delta V_{OUT}}{\Delta TIME}$	T_A = 125°C, 1000 Hrs				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	$10Hz \le f \le 10khz$				0.001			0.001		%
Thermal Resistance Junction to Case, θ_{jc}	K Package					1			1	°C/W

5 AMP POSITIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS (NOTE 1)

Parameter	Test Conditions			IP338A			LM338/IP338			Units
				Min	Typ	Max	Min	Typ	Max	
Reference Voltage, V_{REF}	$I_{OUT} = 10$ mA			1.238	1.250	1.262				V
	$3V \le (V_{IN} - V_{OUT}) \le 35V$		•	1.225	1.250	1.270	1.19	1.24	1.29	V
	$10mA \le I_{OUT} \le 5A$, $P \le 50W$									
Line Regulation, $\Delta V_{OUT} / \Delta V_{IN}$	$3V \le (V_{IN} - V_{OUT} \le 35V$				0.005	0.01		0.005	0.03	%/V
	(See Note 2)		•		0.02	0.04		0.020	0.06	%/V
Load Regulation, $\Delta V_{OUT} / \Delta I_{OUT}$	$10 mA \le I_{OUT} \le 5A$	$V_O \le 5V$			5	15		5	25	mV
	(See Note 2)	$V_O \ge 5V$			0.1	0.3		0.1	0.5	%
		$V_O \le 5V$	•		20	30		20	50	mV
		$V_O \ge 5V$	•		0.3	0.6		0.3	1	%
Thermal Regulation	20 msec Pulse				0.002	0.02		0.002	0.02	%/W
Ripple Rejection	$V_{OUT} = 10V$,	$C_{ADJ} = 0$	•		60			60		dB
	f = 120 Hz	$C_{ADJ} = 10\mu F$	•	60	75		60	75		dB
Adjust Pin Current, I_{ADJ}			•		45	100		45	100	μA
Adjust Pin Current Change, ΔI_{ADJ}	$10 mA \le I_{OUT} \le 5A$,		•		0.2	5		0.2	5	μA
	$3V \le (V_{IN} - V_{OUT}) \le 35V$									
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT}) = 35V$		•		3.5	10		3.5	10	mA
Current Limit, I_{SC}	$(V_{IN} - V_{OUT}) \le 10V$	DC	•	5	8		5	8		A
		0.5ms peak	•	6	12		6	12		A
	$(V_{IN} - V_{OUT}) = 30V$				1			1		A
Temperature Stability, $\Delta V_{OUT} / \Delta TEMP$			•		1	2		1		%
Long Term Stability, $\Delta V_{OUT} / \Delta TIME$	$T_A = 125°C$, 1000 hrs				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	$10Hz \le f \le 10khz$				0.001			0.003		%
Thermal Resistance Junction	K Package					1			1	°C/W
to Case, θ_{jc}	V Package					1			1	°C/W

The • denotes the specifications which apply over the full operating temperature range, all others apply at $T_j = 25°C$ unless otherwise specified.

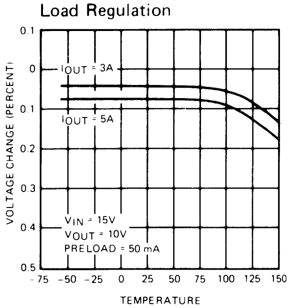
Note 1. Unless otherwise specified, these specifications apply for $V_{IN} - V_{OUT} = 5V$, $I_{OUT} = 2.5A$. Although power dissipation is internally limited, these specifications apply for dissipations of 50W and $I_{MAX} = 5A$.

Note 2. Regulation is measured at constant junction temperature, using pulse testing at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured from the bottom of the package for the TO-3, and at the junction of the wide and narrow portion of the output lead for the TO-218.

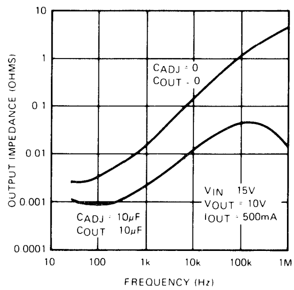
5 AMP POSITIVE ADJUSTABLE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

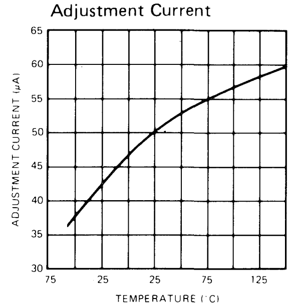
Load Regulation



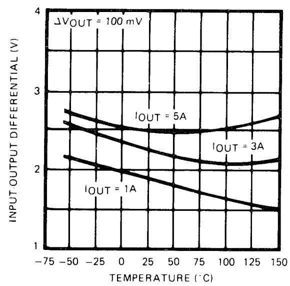
Output Impedance



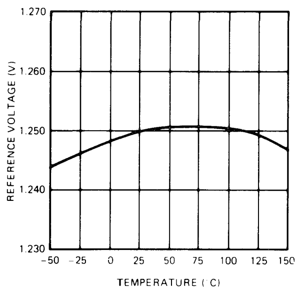
Adjustment Current



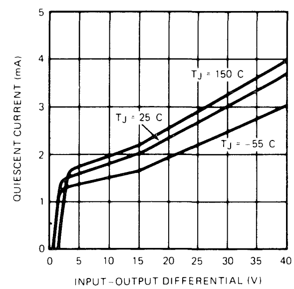
Dropout Voltage



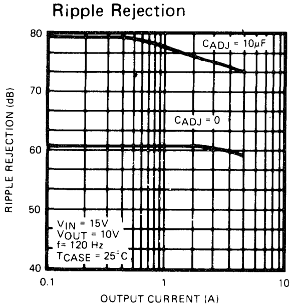
Temperature Stability



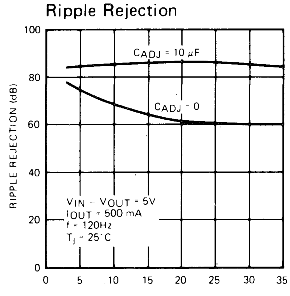
Minimum Operating Current



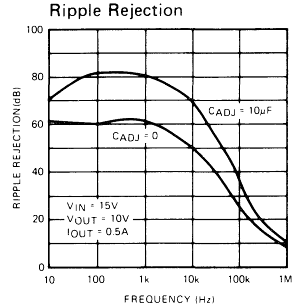
Ripple Rejection



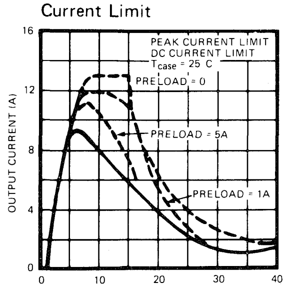
Ripple Rejection



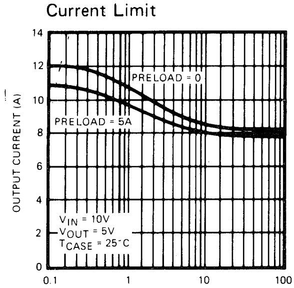
Ripple Rejection



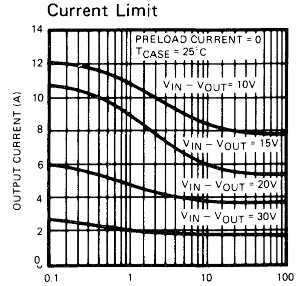
Current Limit



Current Limit



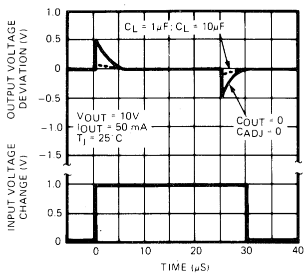
Current Limit



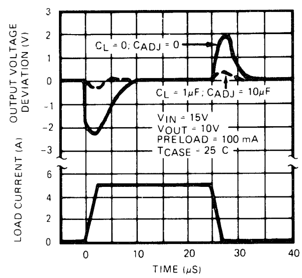
5 AMP POSITIVE ADJUSTABLE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

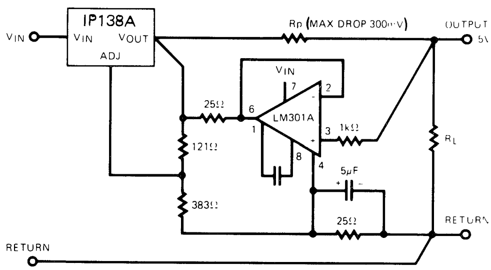
Line Transient Response



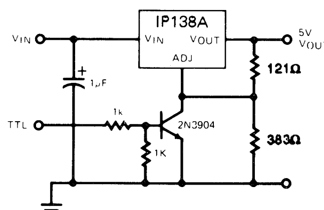
Load Transient Response



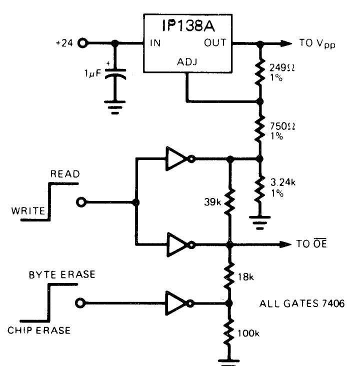
TYPICAL APPLICATIONS



Remote Sensing

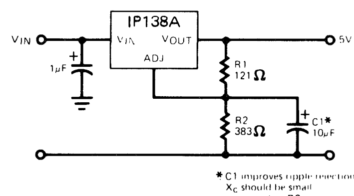


5V Regulator with Shut Down

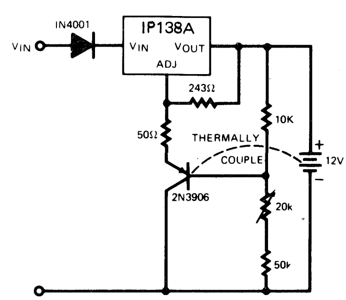


	$\overline{OE}$	V_{PP}
READ	0V	5V
WRITE		
BYTE	5V	21V
CHIP ERASE	12V	21V

2816 EEPROM Supply Programmer for Read/Write Control



Improving Ripple Rejection



Temperature Compensated Lead Acid Battery Charger

5 AMP POSITIVE ADJUSTABLE REGULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP138AK	−55°C to +150°C	TO-3
IP138K	−55°C to +150°C	TO-3
LM138K	−55°C to +150°C	TO-3
IP338AK	0°C to +125°C	TO-3
IP338K	0°C to +125°C	TO-3
LM338K	0°C to +125°C	TO-3
IP338AV	0°C to +125°C	TO-218
IP338V	0°C to +125°C	TO-218

Seagate Microelectronics Limited

1 AMP, 3-TERMINAL POSITIVE REGULATORS

IP140A, IP140, LM140, IP7800A Series, IP7800 Series

DESCRIPTION

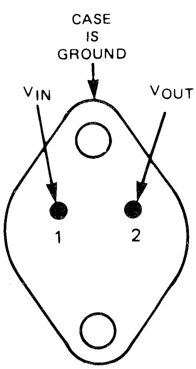
The IP140A/ LM140/ IP7800A/ IP7800 series of three-terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The A-suffix devices are fully specified at 1.0A, provide 0.01%/V line regulation, 0.3%/A load regulation, and ±1% output voltage tolerance at room temperature. Protection features include safe operating area current limiting and thermal shutdown. The entire series of regulators is available in the metal TO-3 and TO-66 power packages. The IP140A/ LM140/ IP7800A/IP7800 series is now available in a new TO-257 (Hermetic TO-220 style) power package.

FEATURES

- 1% Tolerance
- 5, 12 and 15V fixed output voltages available
- 0.01%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe operating area protection
- Start-up with negative voltage (± supplies) on output

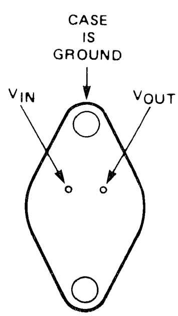
CONNECTIONS

(Bottom View)



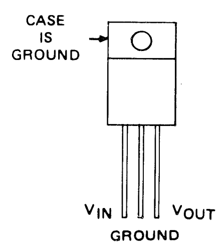
TO-3

(Bottom View)



TO-66

(Top View)



TO-257

1 AMP, 3-TERMINAL POSITIVE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_O = 5V, 12V, 15V) 35V

Internal Power Dissipation
(Note 1) Internally Limited

Operating Temperature Range (T_j)
IP140A, LM140, IP140 −55°C to +150°C
IP7800A, IP7800 −55°C to +150°C

Maximum Junction Temperature
TO-3 Package K 150°C
TO-66 Package R 150°C
TO-257 (Hermetic TO-220 style) Package G150°C

Storage Temperature Range −65°C to 150°C

Lead Temperature (Soldering, 10 sec.) 300°C

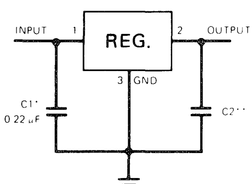
Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

Note 1. Although power dissipation is internally limited, these specifications are applicable for maximum power dissipation P_{MAX} of 20W for the TO-3, TO-66 and TO-257. I_{MAX} is 1.0A for the TO-3, TO-66, TO-257.

APPLICATIONS INFORMATION

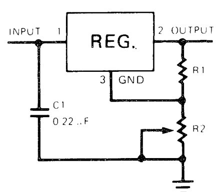
4

Fixed Output Regulator



*Required if the regulator is located far from the power supply filter.
**Although no output capacitor is needed for stability, it does help transient response. (If needed, use 0.1 μF, ceramic disc)

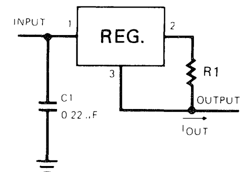
Adjustable Output Regulator



$V_{OUT} = 5V + (5V/R1 + I_Q)R2$

$5V/R1 > 3\ I_Q$, load regulation $(L_r) \approx \left[\frac{(R1+R2)}{R1}\right]$ (L_R of Regulator)

Current Regulator



$I_{OUT} = \frac{V_2 - V_3}{R1} + I_Q$

ΔI_Q = 1.3 mA over line and load changes.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP140AK-XX	−55°C to +150°C	TO-3
IP140K/LM140K	−55°C to +150°C	TO-3
IP7800AK/IP7800K	−55°C to +150°C	TO-3
IP140AR-XX/IP140R-XX	−55°C to +150°C	TO-66
IP7800AR/IP7800R	−55°C to +150°C	TO-66
IP140AG-XX/IP140G-XX	−55°C to +150°C	TO-257 (Hermetic TO-220 style)
IP7800AG/IP7800G	−55°C to +150°C	TO-257 (Hermetic TO-220 style)

1 AMP, 3-TERMINAL POSITIVE REGULATORS

ELECTRICAL CHARACTERISTICS (SEE NOTE 2)

Parameter	Test Conditions			IP7805A IP140A-5			IP7805 LM140-5		
				Min	Typ	Max	Min	Typ	Max	Units
Output Voltage, V_O	K, R, G Pkg., I_O = 1A, V_{IN} = 10V			4.95	5	5.05	4.8	5	5.2	V
	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 7.5V $\leq V_{IN} \leq$ 20V		•	4.85		5.15	4.75		5.25	V
Low Supply, V_O	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 7V $\leq V_{IN} \leq$ 20V			4.75		5.15	4.75		5.25	V
Line Regulation, $\triangle V_O$	I_O = 0.5 I_{MAX}	7V $\leq V_{IN} \leq$ 25V			3	10			50	mV
		7.5V $\leq V_{IN} \leq$ 25V	•		3	10			50	mV
	$I_O \leq I_{MAX}$	7.3V $\leq V_{IN} \leq$ 20V			3	10			50	mV
		8V $\leq V_{IN} \leq$ 12V			1	4			20	mV
			•		2	12			25	mV
Load Regulation, $\triangle V_O$	K, R, G Pkg.	5 mA $\leq I_O \leq$ 1.5A			10	25			50	mV
	V_{IN} = 10V	250mA $\leq I_O \leq$ 750mA			4	15			25	mV
	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 10V		•		7	25			50	mV
Quiescent Current, I_Q	$I_O \leq I_{MAX}$				4	6			6	mA
	V_{IN} = 10V		•		4	6.5			7	mA
Quiescent Current Change, $\triangle I_Q$	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 10V				0.2	0.5			0.5	mA
	$I_O \leq I_{MAX}$, 7.5V $\leq V_{IN} \leq$ 20V		•		0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 8V $\leq V_{IN} \leq$ 25V				0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 7V $\leq V_{IN} \leq$ 25V		•		0.2	1.0			1.0	mA
Output Noise Voltage, V_N	10 Hz $\leq$ f $\leq$ 100 kHz, V_{IN} = 10V				40	200		40		μV
Ripple Rejection, $\triangle V_{IN}/\triangle V_{OUT}$	f = 120 Hz	$I_O \leq I_{MAX}$		68	80		68			dB
	8 V $\leq V_{IN} \leq$ 18V	$I_O \leq$ 0.5 I_{MAX}	•	68	80		68			dB
Dropout Voltage	I_{OUT} = I_{MAX}				2.0	2.5		2.0		V
Output Resistance, R_O	f = 1 kHz				5			5		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = 35V	K, R, G Package			0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = 10V	K, R, G Package			2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA				0.2	2		0.6		mV/°C
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leq I_{MAX}$			7.3			7.3			V

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

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1 AMP, 3-TERMINAL POSITIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions			IP7812A IP140A-12 Min	IP7812A IP140A-12 Typ	IP7812A IP140A-12 Max	IP7812 LM140-12 Min	IP7812 LM140-12 Typ	IP7812 LM140-12 Max	Units
Output Voltage, V_O	K, R, G Pkg., I_O = 1A, V_{IN} = 19V			11.88	12	12.12	11.5	12	12.5	V
	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 14.8V $\leq V_{IN} \leq$ 27V		•	11.64		12.36	11.4		12.6	V
Low Supply, V_O	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 14.5V $\leq V_{IN} \leq$ 27V			11.40		12.36	11.4		12.6	V
Line Regulation, ΔV_O	I_O = 0.5 I_{MAX}	14.5V $\leq V_{IN} \leq$ 30V			4	18			120	mV
		14.8V $\leq V_{IN} \leq$ 30V	•		4	18			120	mV
	$I_O \leq I_{MAX}$	14.5V $\leq V_{IN} \leq$ 27V			4	18			120	mV
		16V $\leq V_{IN} \leq$ 22V			2	9			50	mV
			•		4	30			60	mV
Load Regulation, ΔV_O	K, R, G Pkg.	5 mA $\leq I_O \leq$ 1.5A			12	32			120	mV
	V_{IN} = 19V	250mA $\leq I_O \leq$ 750mA			4	19			60	mV
	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 19V		•		8	60			120	mV
Quiescent Current, I_Q	$I_O \leq I_{MAX}$				4	6			6	mA
	V_{IN} = 19V		•		4	6.5			7	mA
Quiescent Current Change, ΔI_Q	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 19V				0.2	0.5			0.5	mA
	$I_O \leq I_{MAX}$, 14.8V $\leq V_{IN} \leq$ 27V		•		0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 15V $\leq V_{IN} \leq$ 30V				0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 14.5V $\leq V_{IN} \leq$ 30V		•		0.2	1.0			1.0	mA
Output Noise Voltage, V_N	10 Hz $\leq$ f $\leq$ 100 kHz, V_{IN} = 19V				75	480		75		μV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	f = 120 Hz	$I_O \leq I_{MAX}$		61	72		61			dB
	15 V $\leq V_{IN} \leq$ 25V	$I_O \leq$ 0.5 I_{MAX}	•	61	72		61			dB
Dropout Voltage	I_{OUT} = I_{MAX}				2.0	2.5		2.0		V
Output Resistance, R_O	f = 1 kHz				8			8		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = 35V	K, R, G Package			0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = 19V	K, R, G Package			2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA				0.5	4.8		1.5		mV/°C
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leq I_{MAX}$			14.5			14.6			V

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

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1 AMP, 3-TERMINAL POSITIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions			IP7815A IP140A-15 Min	Typ	Max	IP7815 LM140-15 Min	Typ	Max	Units
Output Voltage, V_O	K, R, G Pkg., I_O = 1A, V_{IN} = 23V			14.85	15	15.15	14.4	15	15.6	V
	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 17.9V $\leq V_{IN} \leq$ 30V		●	14.55		15.45	14.25		15.75	V
Low Supply, V_O	$P_D \leq P_{MAX}$, 5mA $\leq I_O \leq I_{MAX}$ 17.5V $\leq V_{IN} \leq$ 30V			14.25		15.45	14.25		15.75	V
Line Regulation, $\triangle V_O$	I_O = 0.5 I_{MAX}	17.5V $\leq V_{IN} \leq$ 30V			4	22			150	mV
		17.9V $\leq V_{IN} \leq$ 30V	●		4	22			150	mV
	$I_O \leq I_{MAX}$	17.5V $\leq V_{IN} \leq$ 30V			4	22			150	mV
		20V $\leq V_{IN} \leq$ 26V			2	10			60	mV
			●		5	30			75	mV
Load Regulation, $\triangle V_O$	K, R, G Pkg.	5 mA $\leq I_O \leq$ 1.5A			12	35			150	mV
	V_{IN} = 23V	250mA $\leq I_O \leq$ 750mA			4	21			75	mV
	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 23V		●		9	75			150	mV
Quiescent Current, I_Q	$I_O \leq I_{MAX}$				4	6			6	mA
	V_{IN} = 23V		●		4	6.5			7	mA
Quiescent Current Change, $\triangle I_Q$	5 mA $\leq I_O \leq I_{MAX}$, V_{IN} = 23V				0.2	0.5			0.5	mA
	$I_O \leq I_{MAX}$, 17.9V $\leq V_{IN} \leq$ 30V		●		0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 18.5V $\leq V_{IN} \leq$ 30V				0.1	0.8			0.8	mA
	$I_O \leq$ 0.5 I_{MAX}, 17.5V $\leq V_{IN} \leq$ 30V		●		0.2	1.0			1.0	mA
Output Noise Voltage, V_N	10 Hz $\leq$ f $\leq$ 100 kHz, V_{IN} = 23V				90	600		90		μV
Ripple Rejection, $\triangle V_{IN}/\triangle V_{OUT}$	f = 120 Hz	$I_O \leq I_{MAX}$		60	70		60			dB
	18.5 V $\leq V_{IN} \leq$ 28.5V	$I_O \leq$ 0.5 I_{MAX}	●	60	70		60			dB
Dropout Voltage	$I_{OUT} = I_{MAX}$				2.0	2.5		2.0		V
Output Resistance, R_O	f = 1 kHz				9			9		mΩ
Short-Circuit Current, I_{sc}	V_{IN} = 35V	K, R, G Package			0.6	1.2		0.6	1.2	A
Peak Output Current, I_{pk}	V_{IN} = 23V	K, R, G Package			2.4	3.3		2.4	3.3	A
Average TC of V_{OUT}	I_O = 5 mA				0.6	6.0		1.8		mV/°C
Input Voltage Required to Maintain Line Regulation, V_{IN}	$I_O \leq I_{MAX}$			17.5			17.7			V

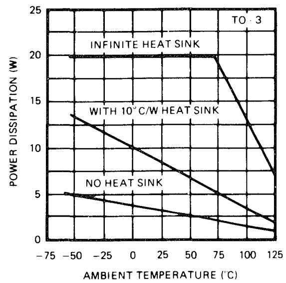
The ● denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 2. All characteristics are measured with a capacitor across the input of 0.22 μF and a capacity across the output of 0.1 μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_W \leq$ 10 ms, duty cycle $\leq$ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

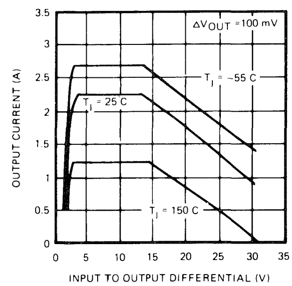
1 AMP, 3-TERMINAL POSITIVE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS

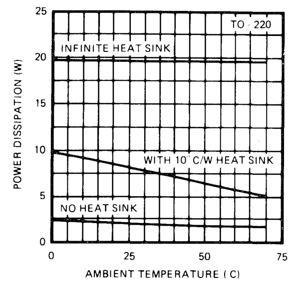
Maximum Average Power Dissipation



Peak Output Current

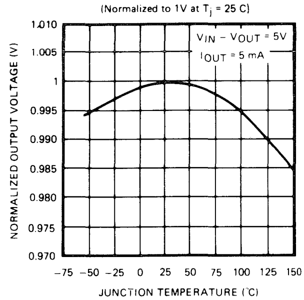


Maximum Average Power Dissipation

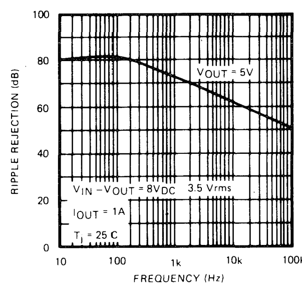


Output Voltage

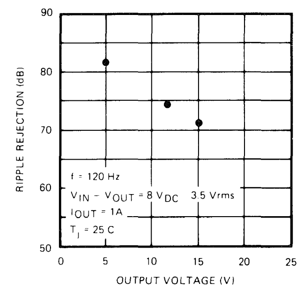
(Normalized to 1V at T_j = 25°C)



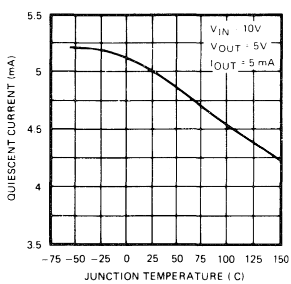
Ripple Rejection



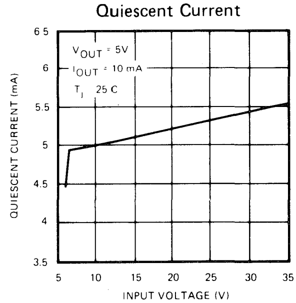
Ripple Rejection



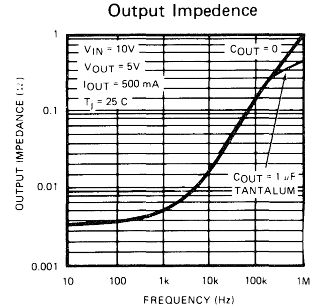
Quiescent Current



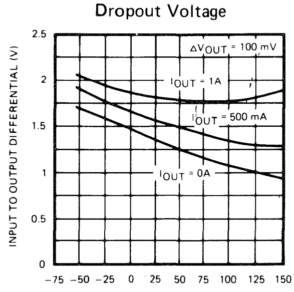
Quiescent Current



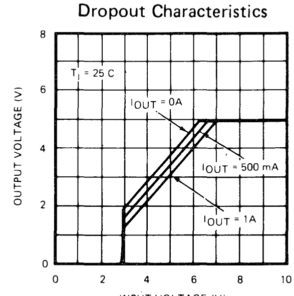
Output Impedence



Dropout Voltage



Dropout Characteristics



Seagate Microelectronics Limited

0.5 AMP, 3-TERMINAL POSITIVE REGULATORS

IP78M00 Series, IP78M00A Series, IP140M Series, IP140MA Series

DESCRIPTION

The IP78M00/A series of voltage regulators are fixed output regulators intended for local, on-card voltage regulation. These devices are available in 5, 12, and 15 volt options and are capable of delivering in excess of 500 mA over temperature. The A-suffix devices are fully specified at 0.5A, provide 0.01%/V line regulation, 0.3%/A load regulation, and ±1% output voltage tolerance at room temperature. Protection features include safe operating area, current limiting and thermal shutdown. The entire series of regulators is available in TO-39 and Ceramic DIP packages.

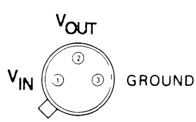
FEATURES

- 1% output voltage tolerance
- 5, 12 and 15V fixed output voltages available
- 0.01%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe operating area protection
- Start-up with negative voltage (± supplies) on output

4

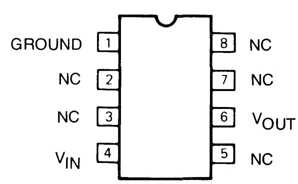
CONNECTIONS

(Bottom View)



TO-39

(Top View)



8 Pin J Package

0.5 AMP, 3-TERMINAL POSITIVE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_O = 5V, 12V, 15V) 35V

Internal Power Dissipation
(Note 1) Internally Limited

Operating Temperature Range (T_j)
IP78M00A, IP78M00 −55°C to +150°C
IP140MA, IP140M −55°C to +150°C

Maximum Junction Temperature
H Package TO-39 150°C
8 Pin Ceramic DIP Package J 150°C

Storage Temperature Range −65°C to 150°C

Lead Temperature (Soldering, 10 sec.) 300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS (NOTE 2)

Parameter	Test Conditions		IP78M05A IP140MA-5 Min	Typ	Max	IP78M05 IP140M-5 Min	Typ	Max	Units
Output Voltage, V_O	I_O = 100mA, V_{IN} = 10V		4.95	5	5.05	4.80	5	5.20	V
	$P_D \le P_{MAX}$, 5mA $\le I_O \le$ 350mA, 7.5V $\le V_{IN} \le$ 20V	•	4.85		5.15	4.75		5.25	V
Line Regulation, ΔV_O	I_O = 200mA, 7V $\le V_{IN} \le$ 25V			3	10			50	mV
	I_O = 200mA, 8V $\le V_{IN} \le$ 25V	•		3	10			25	mV
	I_O = 500mA, 8V $\le V_{IN} \le$ 12V			3	10			50	mV
Load Regulation, ΔV_O	5mA $\le I_O \le$ 500mA, V_{IN} = 10V	•		5	50			50	mV
Quiescent Current, I_Q	V_{IN} = 10V, I_O = 350mA	•		4	6		4	6	mA
Quiescent Current Change, ΔI_Q	5mA $\le I_O \le$ 500mA, V_{IN} = 10V	•		0.1	0.5			0.5	mA
	8V $\le V_{IN} \le$ 25V, I_O = 200mA	•		0.2	0.8			0.8	mA
Output Noise Voltage, V_n	10Hz $\le$ f $\le$ 100kHz			40	200		40	200	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	f = 120Hz, 8V $\le V_{IN} \le$ 18V, I_O = 300mA		65	80		62			dB
	f = 120Hz, 8V $\le V_{IN} \le$ 18V, I_O = 100mA	•	65	80		62			dB
Dropout Voltage	I_O = 350mA			2	2.5			2.5	V
Short Circuit Current, I_{SC}	V_{IN} = 35V			300	600		300	600	mA
Peak Output Current, I_{PK}	V_{IN} = 10V		0.7	1.0	1.4	0.7	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	I_O = 5mA			0.5	2.0		0.5		mV/°C

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 1: Thermal resistance of the TO-39 package (H) is typically 20°C/W junction to case and 120°C/W case to ambient. Although power dissipation is internally limited, these specifications apply for up to 2W for the TO-39 package, and 1.05W for the J package. Thermal resistance of the J package is typically 119°C/W junction to ambient. (Derate at 8.4mW/°C for ambient temperatures above 25°C).

Note 2: All characteristics are measured with a capacitor across the input of 0.22µF and a capacitor across the output of 0.1µF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_W \leqslant$ 10ms, duty cycle $\leqslant$ 5%. Output voltage changes due to changes in internal temperature must be taken into account separately.

0.5 AMP, 3-TERMINAL POSITIVE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

			IP78M12A IP140MA-12			IP78M12 IP140M-12			
Parameter	**Test Conditions**		**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Units**
Output Voltage, V_O	$I_O = 100mA$, $V_{IN} = 19V$		11.88	12	12.12	11.50	12	12.50	V
	$P_D \le P_{MAX}$, $5mA \le I_O \le 350mA$ $14.8V \le V_{IN} \le 27V$	•	11.64		12.36	11.40		12.60	V
Line Regulation, ΔV_O	$I_O = 200mA$, $14.5V \le V_{IN} \le 30V$			4	18			60	mV
	$I_O = 200mA$, $16V \le V_{IN} \le 30V$	•		4	18			30	mV
	$I_O = 500mA$, $16V \le V_{IN} \le 22V$			4	18			120	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 500mA$, $V_{IN} = 19V$	•		10	60			120	mV
Quiescent Current, I_Q	$V_{IN} = 19V$, $I_O = 350mA$	•		4	6		4	6	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 500mA$, $V_{IN} = 19V$	•		0.1	0.5			0.5	mA
	$14.8V \le V_{IN} \le 30V$, $I_O = 200mA$	•		0.2	0.8			0.8	mA
Output Noise Voltage, V_n	$10Hz \le f \le 100kHz$			75	480		75	480	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120Hz$, $I_O = 300mA$		58	72		55			dB
	$15V \le V_{IN} \le 25V$, $I_O = 100mA$	•	58	72		55			dB
Dropout Voltage	$I_O = 350mA$			2	2.5			2.5	V
Short Circuit Current, I_{SC}	$V_{IN} = 35V$			300	600		300	600	mA
Peak Output Current, I_{PK}	$V_{IN} = 19V$		0.7	1.0	1.4	0.7	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	$I_O = 5mA$			1.2	4.8		1.2		mV/°C

			IP78M15A IP140MA-15			IP78M15 IP140M-15			
Parameter	**Test Conditions**		**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Units**
Output Voltage, V_O	$I_O = 100mA$, $V_{IN} = 23V$		14.85	15	15.15	14.40	15	15.60	V
	$P_D \le P_{MAX}$, $5mA \le I_O \le 350mA$ $18V \le V_{IN} \le 30V$	•	14.55		15.45	14.25		15.75	V
Line Regulation, ΔV_O	$I_O = 200mA$, $17.5V \le V_{IN} \le 30V$			4	22			60	mV
	$I_O = 200mA$, $20V \le V_{IN} \le 30V$	•		4	22			30	mV
	$I_O = 500mA$, $20V \le V_{IN} \le 26V$			4	22			150	mV
Load Regulation, ΔV_O	$5mA \le I_O \le 500mA$, $V_{IN} = 23V$	•		12	75			150	mV
Quiescent Current, I_Q	$V_{IN} = 23V$, $I_O = 350mA$	•		4	6		4	6	mA
Quiescent Current Change, ΔI_Q	$5mA \le I_O \le 500mA$, $V_{IN} = 23V$	•		0.1	0.5			0.5	mA
	$18V \le V_{IN} \le 30V$, $I_O = 200mA$	•		0.2	0.8			0.8	mA
Output Noise Voltage, V_n	$10Hz \le f \le 100kHz$			90	600		90	600	µV
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120Hz$, $I_O = 300mA$		57	70		54			dB
	$18.5V \le V_{IN} \le 28.5V$, $I_O = 100mA$	•	57	70		54			dB
Dropout Voltage	$I_O = 350mA$			2	2.5			2.5	V
Short Circuit Current, I_{SC}	$V_{IN} = 35V$			300	600		300	600	mA
Peak Output Current, I_{PK}	$V_{IN} = 23V$		0.7	1.0	1.4	0.7	1.0	1.6	A
Average Temperature Coefficient of Output Voltage	$I_O = 5mA$			1.5	6.0		1.5		mV/°C

0.5 AMP, 3-TERMINAL POSITIVE REGULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP78M05AH	−55°C to +150°C	TO-39
IP78M05H	−55°C to +150°C	TO-39
IP78M12AH	−55°C to +150°C	TO-39
IP78M12H	−55°C to +150°C	TO-39
IP78M15AH	−55°C to +150°C	TO-39
IP78M15H	−55°C to +150°C	TO-39
IP78M05AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP78M05J	−55°C to +150°C	8 Pin Ceramic DIP
IP78M12AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP78M12J	−55°C to +150°C	8 Pin Ceramic DIP
IP78M15AJ	−55°C to +150°C	8 Pin Ceramic DIP
IP78M15J	−55°C to +150°C	8 Pin Ceramic DIP
IP140MAH-05	−55°C to +150°C	TO-39
IP140MH-05	−55°C to +150°C	TO-39
IP140MAH-12	−55°C to +150°C	TO-39
IP140MH-12	−55°C to +150°C	TO-39
IP140MAH-15	−55°C to +150°C	TO-39
IP140MH-15	−55°C to +150°C	TO-39

Seagate Microelectronics Limited

3 AMP POSITIVE ADJUSTABLE REGULATORS

IP150, IP150A, IP350A, IP350, LM150

DESCRIPTION

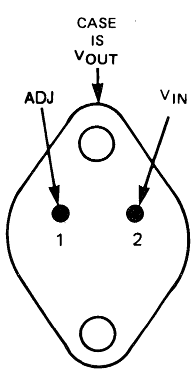
The IP150'A series are 3-terminal positive adjustable voltage regulators capable of spplying in excess of 3.0A over a 1.25V to 35V output range. These regulators are exceptionally easy to use and require only two external resistors to set the output voltage. In addition to improved line and load regulation, a major feature of the "A" series is the initial output voltage tolerance, which is guaranteed to be less than 1%. Over full operating conditions, including load, line, and power dissipation, the reference voltage is guaranteed not to vary more than 2%. These devices exhibit current limit, thermal overload protection, and improved power device safe operating area protection, making them essentially indestructible.

FEATURES

- Available in military TO-257
- Guaranteed 1% output voltage tolerance
- Guaranteed 0.3% load regulation
- Guaranteed 0.01%/V line regulation
- Internal current limiting constant with temperature
- Internal thermal overload protection
- Improved output transistor safe operating area compensation
- Output adjustable between 1.25V and 35V

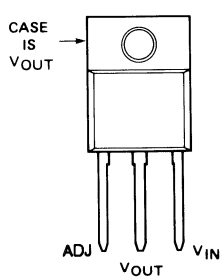
CONNECTIONS

(Bottom View)



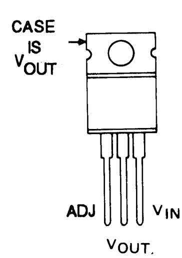
TO-3

(Top View)



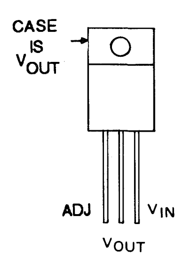
TO-218

(Top View)



TO-220

(Top View)



TO-257

3 AMP POSITIVE ADJUSTABLE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Power Dissipation Internally Limited

Input to Output Voltage Differential 35V

Operating Junction Temperature Range
IP150, IP150A, LM150 −55°C to +150°C
IP350A 0°C to +125°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec.) 300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS (NOTE 1)

Parameter	Test Conditions			IP150A Min	IP150A Typ	IP150A Max	LM150 IP150 Min	LM150 IP150 Typ	LM150 IP150 Max	Units
Reference Voltage, V_{REF}	I_{OUT} = 10 mA			1.238	1.250	1.262				V
	$3V \le (V_{IN} - V_{OUT}) \le 35V$, $10mA \le I_{OUT} \le 3A$, $P \le 30W$		•	1.225	1.250	1.270	1.20	1.25	1.30	V
Line Regulation, $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	$3V \le (V_{IN} - V_{OUT}) \le 35V$				0.005	0.01		0.005	0.01	%/V
	(See Note 2)		•		0.02	0.05		0.020	0.05	%/V
Load Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	$10 mA \le I_{OUT} \le 3A$	$V_O \le 5V$			5	15		5	15	mV
	(See Note 2)	$V_O \ge 5V$			0.1	0.3		0.1	0.3	%
		$V_O \le 5V$	•		15	50		20	50	mV
		$V_O \ge 5V$	•		0.3	1.0		0.3	1.0	%
Thermal Regulation	T_A = 25°C, 20 msec Pulse				0.002	0.01		0.002	0.01	%/W
Riipple Rejection	V_{OUT} = 10V,	$C_{ADJ} = 0$			65			65		dB
	f = 120 Hz	$C_{ADJ} = 10\mu F$	•	66	86		66	86		dB
Adjust Pin Current, I_{ADJ}			•		50	100		50	100	µA
Adjust Pin Current Change, ΔI_{ADJ}	$10 mA \le I_{OUT} \le 3A$, $3V \le (V_{IN} - V_{OUT}) \le 35V$		•		0.2	5		0.2	5	µA
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT}) = 35V$		•		3.5	5		3.5	5	mA
Current Limit, I_{CL}	$(V_{IN} - V_{OUT}) \le 10V$		•	3	4.5		3	4.5		A
	$(V_{IN} - V_{OUT}) = 30V$			0.3	1		0.3	1		A
Temperature Stability, $\frac{\Delta V_{OUT}}{\Delta TEMP}$			•		1	2		1		%
Long Term Stability, $\frac{\Delta V_{OUT}}{\Delta TIME}$	T_A = 125°C, 1000 Hrs				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	T_A = 25°C, $10Hz \le f \le 10kHz$				0.001			0.001		%
Thermal Resistance Junction to Case, Θ_{jc}	K Package				1.5			1.5		°C/W
	G Package				3	4		3	4	

3 AMP POSITIVE ADJUSTABLE REGULATORS

ELECTRICAL CHARACTERISTICS (SEE NOTE 1)

Parameter	Test Conditions			IP350A			IP350			Units
				Min	Typ	Max	Min	Typ	Max	
Reference Voltage, V_{REF}	$I_{OUT} = 10$ mA			1.238	1.250	1.262				V
	$3V \leq (V_{IN} - V_{OUT}) \leq 35V$, $10mA \leq I_{OUT} \leq 3A$, $P \leq 30V$		•	1.225	1.250	1.270	1.200	1.250	1.300	V
Line Regulation, $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	$3V \leq (V_{IN} - V_{OUT}) \leq 35V$				0.005	0.01		0.005	0.03	%/V
	(See Note 2)		•		0.02	0.05		0.02	0.07	%/V
Load Regulation, $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	$10 mA \leq I_{OUT} \leq 3A$ (See Note 2)	$V_O \leq 5V$			5	15		5	25	mV
		$V_O \geq 5V$			0.1	0.3		0.1	0.5	%
		$V_O \leq 5V$	•		15	50		20	70	mV
		$V_O \geq 5V$	•		0.3	1		0.3	1.5	%
Thermal Regulation	$T_A = 25°C$, 20 msec Pulse				0.002	0.01		0.002	0.03	%/W
Riipple Rejection	$V_{OUT} = 10V$, f = 120 Hz	$C_{ADJ} = 0$			65			65		dB
		$C_{ADJ} = 10\mu F$	•	66	86		66	86		dB
Adjust Pin Current, I_{ADJ}			•		50	100		50	100	µA
Adjust Pin Current Change, ΔI_{ADJ}	$10 mA \leq I_{OUT} \leq 3A$, $3V \leq (V_{IN} - V_{OUT}) \leq 35V$		•		0.2	5		0.2	5	µA
Minimum Load Current, I_{MIN}	$(V_{IN} - V_{OUT}) = 35V$		•		3.5	10		3.5	10	mA
Current Limit, I_{CL}	$(V_{IN} - V_{OUT}) \leq 10V$		•	3	4.5		3	4.5		A
	$(V_{IN} - V_{OUT}) = 30V$			0.25	1		0.25	1		A
Temperature Stability, $\frac{\Delta V_{OUT}}{\Delta TEMP}$			•		1	2		1		%
Long Term Stability, $\frac{\Delta V_{OUT}}{\Delta TIME}$	$T_A = 125°C$, 1000 hrs				0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT}), e_n	$T_A = 25°C$, $10Hz \leq f \leq 10kHz$				0.001			0.001		%
Thermal Resistance Junction to Case, θ_{jc}	K Package				1.5			1.5		°C/W
	T Package				3	4		3	4	°C/W
	V Package				1.5			1.5		°C/W

The • denotes specifications which apply over the full operating junction temperature range. All others apply at $T_j = 25°C$ unless otherwise specified.

Note 1: Unless otherwise specified, these specifications apply for $V_{IN} - V_{OUT} = 5V$, $I_{OUT} = 1.5A$. Although power dissipation is internally limited, these specifications apply for dissipations of 30W for the TO – 3, TO – 218 and TO-257, and 25W for the TO-220; $I_{MAX} = 3A$.

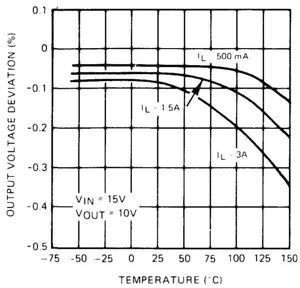
Note 2: Regulation is measured at constant junction temperature, using pulse testing techniques at a low duty cycle. Changes in output voltage due to heating effects are covered under thermal regulation specifications. Load regulation is measured from the bottom of the package for the TO-3 and on the back of the heat tab for the TO-218, TO-220 and TO-257.

3 AMP POSITIVE ADJUSTABLE REGULATORS

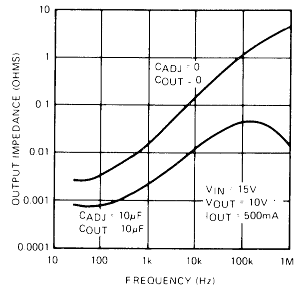
TYPICAL PERFORMANCE CHARACTERISTICS

4

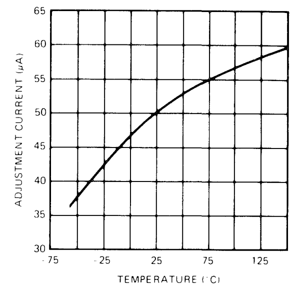
Load Regulation



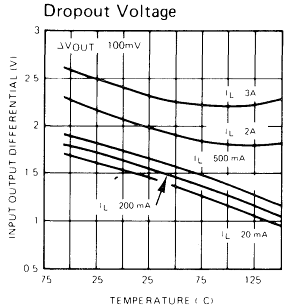
Output Impedance



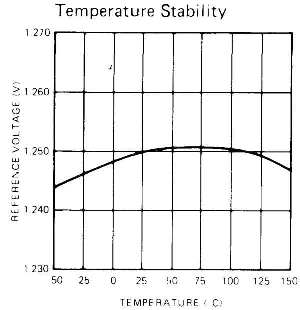
Adjustment Current



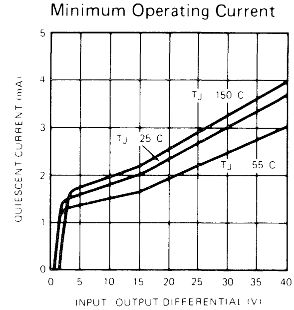
Dropout Voltage



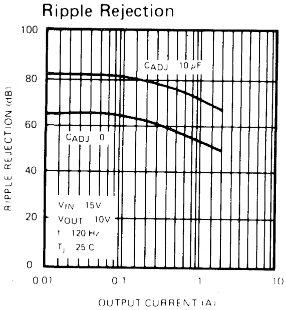
Temperature Stability



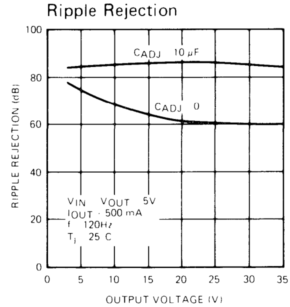
Minimum Operating Current



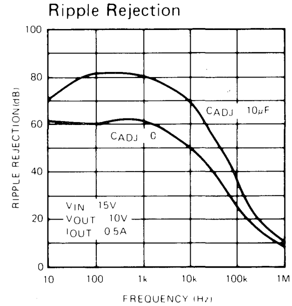
Ripple Rejection



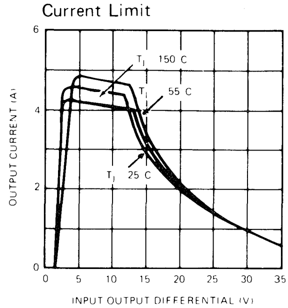
Ripple Rejection



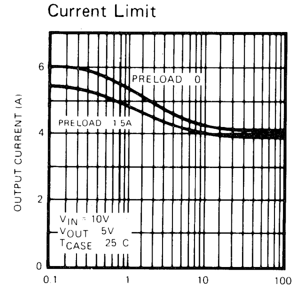
Ripple Rejection



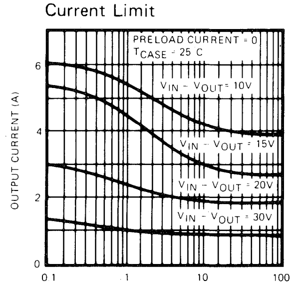
Current Limit



Current Limit

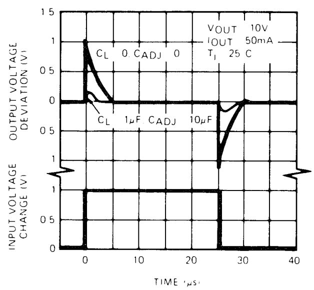


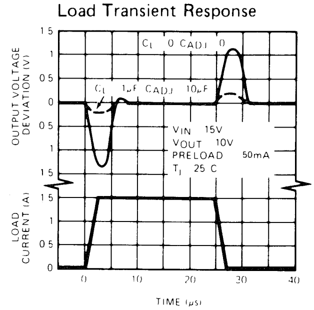
Current Limit



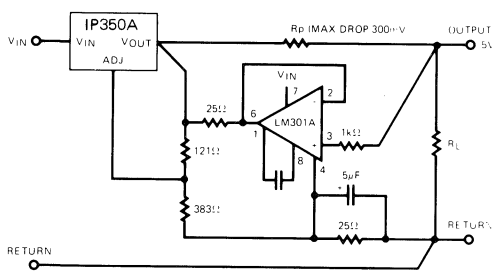
3 AMP POSITIVE ADJUSTABLE REGULATORS

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

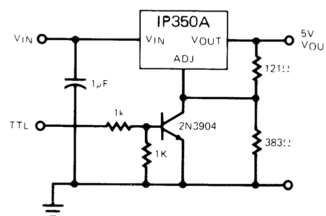




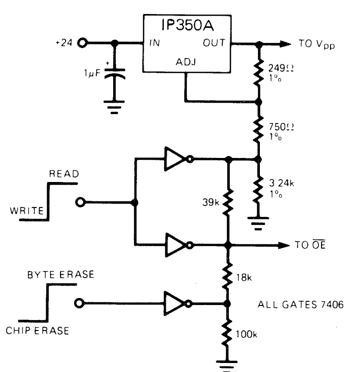
TYPICAL APPLICATIONS



Remote Sensing

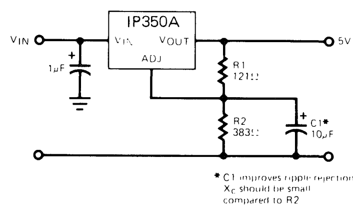


5V Regulator with Shut Down

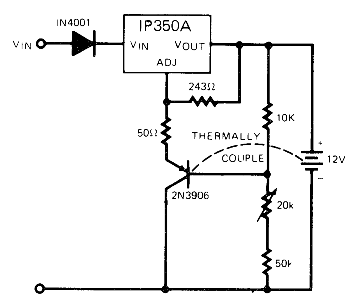


	$\overline{OE}$	Vpp
READ	0V	5V
WRITE		
BYTE	5V	21V
CHIP ERASE	12V	21V

2816 EEPROM Supply Programmer for Read/Write Control



Improving Ripple Rejection



Temperature Compensated Lead Acid Battery Charger

3 AMP POSITIVE ADJUSTABLE REGULATORS

ORDER INFORMATION

Part Number	Temperature Range	Package
IP150AK	−55°C to +150°C	TO-3
IP150K	−55°C to +150°C	TO-3
IP150G	−55°C to +150°C	TO-257
IP150AG	−55°C to +150°C	TO-257
LM150K	−55°C to +150°C	TO-3
IP350AK	0°C to +125°C	TO-3
IP350K	0°C to +125°C	TO-3
IP350AT	0°C to +125°C	TO-220
IP350T	0°C to +125°C	TO-220
IP350AV	0°C to +125°C	TO-218
IP350V	0°C to +125°C	TO-218

3 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

IP1R17, IP3R17, IP1R17A, IP3R17A

DESCRIPTION

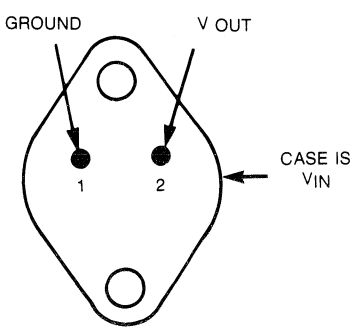
The IP1R17A/IP3R17A and IP1R17/IP3R17 series of fixed three terminal negative regulators are capable of delivering 3 amps of output current, and are available with several convenient output voltages. The A-suffix devices provide 0.01%/V line regulation, 0.5% load regulation, and a ±1% output voltage tolerance at room temperature. Over all specified operating conditions (load, line, power, and temperature), the output voltage is guaranteed not to vary by more than ±3%. Protection features include safe operating area current limiting for the output power transistor, and thermal shutdown. The entire series of regulators is available in a TO-3 package, and the commercial version is also available in a convenient, low cost plastic TO-220 package. For military applications the space saving Hermetic TO220 (TO257) is available.

FEATURES

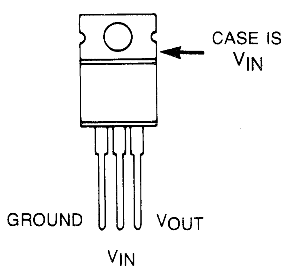
- 3 Amp output current capability
- ± 1% Output tolerance at room temperature (A suffix)
- 0.01%/V Line regulation
- 0.5% Load regulation
- −5, −5.2, −12, −15 Volt fixed output voltages available
- Short circuit current limit protection
- Safe operating area protection
- Thermal shutdown protection
- Improved version of LM145

PACKAGE INFORMATION

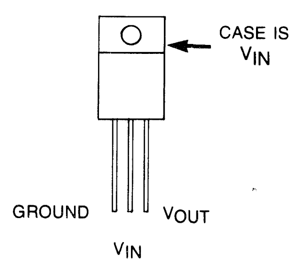
BOTTOM VIEW
TO-3 (K PACKAGE)



TOP VIEW
TO-220



TOP VIEW
TO-257



3 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_{OUT} = −5, −5.2, −12, or −15V) 35V

Power Dissipation Internally Limited

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec) 300°C

Operating Junction Temperature Range
IP1R17A/IP1R17 −55°C to + 150°C
IP3R17A/IP3R17 0°C to +125°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions (Note 1)		IP1R17A-5/IP3R17A-5			IP1R17-5/IP3R17-5			Units
				Min	Typ	Max	Min	Typ	Max	
V_{OUT}	Output Voltage			-5.05	-5.00	-4.95	-5.15	-5.00	-4.85	V
		-5mA ⩾ I_{OUT} ⩾ -3A -8V ⩾ V_{IN} ⩾ -20V, P ⩽ P_{MAX}	●	-5.15		-4.85	-5.25		-4.75	V
$\frac{\triangle V_{OUT}}{\triangle V_{IN}}$	Line Regulation	I_{OUT} = -5mA (Note 2)			3	15		6	30	mV
		-7.5V ⩾ V_{IN} ⩾ -35V	●		6	30		12	60	mV
$\frac{\triangle V_{OUT}}{\triangle I_{OUT}}$	Load Regulation	-5mA ⩾ I_{OUT} ⩾ -3A			5	25		10	50	mV
		(Note 2)	●		10	50		20	100	mV
I_Q	Quiescent Current	I_{OUT} = -5mA	●			5			5	mA
$\triangle I_Q$	Quiescent Current	-5mA ⩾ I_{OUT} ⩾ -3A	●			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, -7.5V ⩾ V_{IN} ⩾ -35V	●			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -3A, $\triangle V_{OUT}$ = 100mV	●		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	●	60	80		60	80		dB
	Thermal Regulation	t_{PULSE} = 20msec, $\triangle P = P_{MAX}$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -10V	●	-6.5	-4.5		-6.5	-4.5		A
I_{SC}	Short Circuit	V_{IN} = -10V			-4			-4		A
	Current	V_{IN} = -35V			-1			-1		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 100kHz			40			40		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.5	2.5		1.5	2.5	°C/W
	Junction to Case	G, T Package			3	4		3	4	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = −10V, and I_{OUT} = −1.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 30W for the TO−3 package, and for dissipations up to 20W for the TO−220 and TO-257.

Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

3 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R17A-5.2/IP3R17A-5.2 Min	Typ	Max	IP1R17-5.2/IP3R17-5.2 Min	Typ	Max	Units
V_{OUT}	Output Voltage			-5.25	-5.20	-5.15	-5.35	-5.20	-5.05	V
		$-5mA \geq I_{OUT} \geq -3A$ $-8.2V \geq V_{IN} \geq 20V$, $P \leq P_{MAX}$	•	-5.35		-5.05	-5.45		-4.95	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$I_{OUT} = -5mA$ (Note 2)			3	15		6	30	mV
		$-7.7V \geq V_{IN} \geq -35V$	•		6	30		12	60	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$-5mA \geq I_{OUT} \geq -3A$			5	25		10	50	mV
		(Note 2)	•		10	50		20	100	mV
I_Q	Quiescent Current	$I_{OUT} = -5mA$	•			5			5	mA
ΔI_Q	Quiescent Current	$-5mA \geq I_{OUT} \geq -3A$	•			10			10	mA
	Change (Load/Line)	$I_{OUT} = -5mA$, $-7.7V \geq V_{IN} \geq -35V$	•			5			5	mA
V_D	Dropout Voltage	$I_{OUT} = -3A$, $\Delta V_{OUT} = 100mV$	•		2.2	3.0		2.2	3.0	V
	Ripple Rejection	$I_{OUT} = -1A$, $f = 120Hz$	•	60	80		60	80		dB
	Thermal Regulation	$t_{PULSE} = 20msec$, $\Delta P = P_{MAX}$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	$V_{IN} = -10V$	•	-6.5	-4.5		-6.5	-4.5		A
I_{SC}	Short Circuit	$V_{IN} = -10V$			-4			-4		A
	Current	$V_{IN} = -35V$			-1			-1		A
e_n	Output Noise Voltage	$10Hz \leq f \leq 100kHz$			40			40		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.5	2.5		1.5	2.5	°C/W
	Junction to Case	G, T Package			3	4		3	4	°C/W
										°C/W

The • denotes specifications which apply over the full operating junction temperature range. All others apply at $T_{CASE} = 25°C$ unless otherwise specified.

Note 1: Unless otherwise specified, $V_{IN} = -10V$, and $I_{OUT} = -1.5A$. Although power dissipation is internally limited, these specifications apply for dissipations up to 30W for the TO-3 package, and for dissipations up to 20W for the TO-220 and TO-257.

Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

3 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R17A-12/IP3R17A-12 Min	IP1R17A-12/IP3R17A-12 Typ	IP1R17A-12/IP3R17A-12 Max	IP1R17-12/IP3R17-12 Min	IP1R17-12/IP3R17-12 Typ	IP1R17-12/IP3R17-12 Max	Units
V_{OUT}	Output Voltage			-12.12	-12.00	-11.88	-12.36	-12.00	-11.64	V
		$-5mA \geqslant I_{OUT} \geqslant -3A$ $-15V \geqslant V_{IN} \geqslant -27V$, $P \leqslant P_{MAX}$	•	-12.36		-11.64	-12.60		-11.40	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT} = -5mA (Note 2)			5	30		10	60	mV
		$-14.5V \geqslant V_{IN} \geqslant -35V$	•		10	60		20	120	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$-5mA \geqslant I_{OUT} \geqslant -3A$			10	60		20	120	mV
		(Note 2)	•		20	120		40	240	mV
I_Q	Quiescent Current	I_{OUT} = -5mA	•			5			5	mA
ΔI_Q	Quiescent Current	$-5mA \geqslant I_{OUT} \geqslant -3A$	•			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, $-14.5V \geqslant V_{IN} \geqslant -35V$	•			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -3A, ΔV_{OUT} = 250mV	•		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	•	52	72		52	72		dB
	Thermal Regulation	t_{PULSE} = 20msec, $\Delta P = P_{MAX}$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -17V	•	-6.5	-4.5		-6.5	-4.5		A
I_{SC}	Short Circuit	V_{IN} = -17V			-2.5			-2.5		A
	Current	V_{IN} = -35V			-1			-1		A
e_n	Output Noise Voltage	$10Hz \leqslant f \leqslant 100kHz$			75			75		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.5	2.5		1.5	2.5	°C/W
	Junction to Case	G, T Package			3	4		3	4	°C/W
										°C/W

The • denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = −17V, and I_{OUT} = −1.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 30W for the TO−3 package, and for dissipations up to 20W for the TO−220 and TO-257.

Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

3 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R17A-15/IP3R17A-15 Min	Typ	Max	IP1R17-15/IP3R17-15 Min	Typ	Max	Units
V_{OUT}	Output Voltage			-15.15	-15.00	-14.85	-15.45	-15.00	-14.55	V
		-5mA ⩾ I_{OUT} ⩾ -3A -18V ⩾ V_{IN} ⩾ -30V, P < P_{MAX}	•	-15.45		-14.55	-15.75		-14.25	V
ΔV_{OUT}	Line Regulation	I_{OUT} = -5mA (Note 2)			8	40		16	80	mV
ΔV_{IN}		-17.5V ⩾ V_{IN} ⩾ -35V	•		16	80		32	160	mV
ΔV_{OUT}	Load Regulation	-5mA ⩾ I_{OUT} ⩾ -3A			16	80		32	160	mV
ΔI_{OUT}		(Note 2)	•		32	160		64	320	mV
I_Q	Quiescent Current	I_{OUT} = -5mA	•			5			5	mA
ΔI_Q	Quiescent Current	-5mA ⩾ I_{OUT} ⩾ -3A	•			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, -17.5V ⩾ V_{IN} ⩾ -35V	•			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -3A, ΔV_{OUT} = 300mV	•		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	•	50	70		50	70		dB
	Thermal Regulation	t_{PULSE} = 20msec, $\Delta P = P_{MAX}$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -20V	•	-6.5	-4.5		-6.5	-4.5		A
I_{SC}	Short Circuit	V_{IN} = -20V			-2.3			-2.3		A
	Current	V_{IN} = -35V			-1			-1		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 100kHz			90			90		µV
	A_{VE} TC of V_{OUT}									mV
Θ_{JC}	Thermal Resistance,	K Package			1.5	2.5		1.5	2.5	°C/W
	Junction to Case	G, T Package			3	4		3	4	°C/W
										°C/W

The • denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = −20V, and I_{OUT} = −1.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 30W for the TO−3 package, and for dissipations up to 20W for the TO−220 and TO-257.

Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1R17AK-XX, IP1R17K-XX	−55°C to +150°C	TO-3
IP1R17AG-XX, IP1R17G-XX	−55°C to +150°C	TO-257
IP3R17AK-XX, IP3R17K-XX	0°C to +125°C	TO-3
IP3R17AT-XX, IP3R17T-XX	0°C to +125°C	TO-220

Seagate Microelectronics Limited

5 AMP, 3-TERMINAL, FIXED POSITIVE VOLTAGE REGULATORS

IP1R18A, IP3R18A, IP1R18, IP3R18

DESCRIPTION

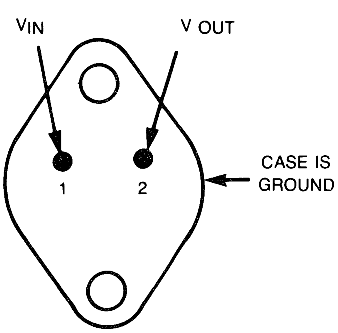
The IP1R18A/IP3R18A and IP1R18/IP3R18 series of fixed three terminal positive regulators are capable of delivering 5 amps of load current, and are available with several convenient output voltage options. The A-suffix devices provide 0.01%/V line regulation, 0.5% load regulation, and a ±1% output voltage tolerance at room temperature. Over all specified operating conditions (load, line, power, and temperature), the output voltage is guaranteed not to vary by more than ±3%. Protection features include safe operating area current limiting for the output power transistor, and thermal shutdown. The entire series of regulators is available in a TO-3 package, and the commercial version is also available in a convenient, low cost plastic TO-218 package.

FEATURES

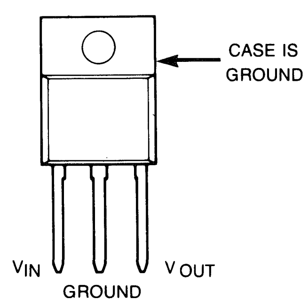
- 5 Amp output current capability
- ±1% Output tolerance at room temperature (A suffix)
- 0.01%/V Line regulation
- 0.5% Load regulation
- 5, 12, 15 Volt fixed output voltages available
- Short circuit current limit protection
- Safe operating area protection
- Thermal shutdown protection
- Available in convenient, low cost plastic TO-218 package

PACKAGE INFORMATION

BOTTOM VIEW
TO-3 (K PACKAGE)



TOP VIEW
TO-218 (V PACKAGE)



5 AMP, 3-TERMINAL, FIXED POSITIVE VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_{OUT} = 5, 12, or 15V) 35V

Power Dissipation Internally Limited

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 sec) 300°C

Operating Junction Temperature Range
IP1R18A/IP1R18 −55°C to + 150°C
IP3R18A/IP3R18 0°C to +125°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions (Note 1)		IP1R18A-5 IP3R18A-5			IP1R18-5 IP3R18-5			Units
				Min	Typ	Max	Min	Typ	Max	
				4.95	5.00	5.05	4.85		5.15	V
V_{OUT}	Output Voltage	5mA ⩽ I_{OUT} ⩽ 5A 8V ⩽ V_{IN} ⩽ 20V, P ⩽ 50W	●	4.85		5.15	4.75		5.25	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	I_{OUT} = 5mA (Note 2)			3	15		6	30	mV
		7.5V ⩽ V_{IN} ⩽ 35V	●		6	30		12	60	mV
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	5mA ⩽ I_{OUT} ⩽ 5A			5	25		10	50	mV
		(Note 2)	●		10	50		20	100	mV
I_Q	Quiescent Current	I_{OUT} = 5mA	●			7			7	mA
ΔI_Q	Quiescent Current	5mA ⩽ I_{OUT} ⩽ 5A	●			10			10	mA
	Change (Load/Line)	I_{OUT} = 5mA, 7.5V ⩽ V_{IN} ⩽ 35V	●			3			3	mA
V_D	Dropout Voltage	I_{OUT} = 5A, ΔV_{OUT} = 100mV	●		2.5	3.0		2.5	3.0	V
	Ripple Rejection	I_{OUT} = 1A, f = 120Hz	●	60	80		60	80		dB
	Thermal Regulation	t_{PULSE} = 20msec, ΔP = 50W			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = 10V	●		8	12		8	12	A
I_{SC}	Short Circuit	V_{IN} = 10V			7			7		A
	Current	V_{IN} = 35V			2			2		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 100kHz			40			40		μV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = 10V, and I_{OUT} = 2.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to thermal regulation specification.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R18A-12 IP3R18A-12 Min	Typ	Max	IP1R18-12 IP3R18-12 Min	Typ	Max	Units
V_{OUT}	Output Voltage			11.88	12.00	12.12	11.64	12.00	12.36	V
		$5mA \leq I_{OUT} \leq 5A$ $15V \leq V_{IN} \leq 27V$, $P \leq 50W$	●	11.64		12.36	11.40		12.60	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$I_{OUT} = 5mA$ (Note 2)			5	30		10	60	mV
		$14.5V \leq V_{IN} \leq 35V$	●		10	60		20	120	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$5mA \leq I_{OUT} \leq 5A$			10	60		20	120	mV
		(Note 2)	●		20	120		40	240	mV
I_Q	Quiescent Current	$I_{OUT} = 5mA$	●			7			7	mA
ΔI_Q	Quiescent Current	$5mA \leq I_{OUT} \leq 5A$	●			10			10	mA
	Change (Load/Line)	$I_{OUT} = 5mA$, $14.5V \leq V_{IN} \leq 35V$	●			3			3	mA
V_D	Dropout Voltage	$I_{OUT} = 5A$, $\Delta V_{OUT} = 250mV$	●		2.5	3.0		2.5	3.0	V
	Ripple Rejection	$I_{OUT} = 1A$, $f = 120Hz$	●	52	72		52	72		dB
	Thermal Regulation	$t_{PULSE} = 20msec$, $\Delta P = 50W$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	$V_{IN} = 17V$	●		8	12		8	12	A
I_{SC}	Short Circuit	$V_{IN} = 17V$			4			4		A
	Current	$V_{IN} = 35V$			2			2		A
e_n	Output Noise Voltage				75			75		uV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at $T_{CASE} = 25°C$ unless otherwise specified.

Note 1: Unless otherwise specified, $V_{IN} = 17V$, and $I_{OUT} = 2.5A$. Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.

Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to thermal regulation specification.

5 AMP, 3-TERMINAL, FIXED POSITIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R18A-15 IP3R18A-15 Min	Typ	Max	IP1R18-15 IP3R18-15 Min	Typ	Max	Units
V_{OUT}	Output Voltage			14.85	15.00	15.15	14.55	15.00	15.45	V
		5mA ⩽ I_{OUT} ⩽ 5A 18V ⩽ V_{IN} ⩽ 30V, P⩽ 50W	●	14.55		15.45	14.25		15.75	V
ΔV_{OUT} / ΔV_{IN}	Line Regulation	I_{OUT} = 5mA (Note 2)			8	40		16	80	mV
		17.5V ⩽ V_{IN} ⩽ 35V	●		16	80		32	160	mV
ΔV_{OUT} / ΔI_{OUT}	Load Regulation	5mA ⩽ I_{OUT} ⩽ 5A			16	80		32	160	mV
		(Note 2)	●		32	160		64	320	mV
I_Q	Quiescent Current	I_{OUT} = 5mA	●			7			7	mA
ΔI_Q	Quiescent Current Change (Load/Line)	5mA ⩽ I_{OUT} ⩽ 5A	●			10			10	mA
		I_{OUT}= 5mA, 17.5V ⩽ V_{IN} ⩽ 35V	●			3			3	mA
V_D	Dropout Voltage	I_{OUT} = 5A, ΔV_{OUT} = 300mV	●		2.5	3.0		2.5	3.0	V
	Ripple Rejection	I_{OUT} = 1A, f = 120Hz	●	50	70		50	70		dB
	Thermal Regulation	t_{PULSE} = 20msec, ΔP = 50W			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = 20V	●		8	12		8	12	A
I_{SC}	Short Circuit Current	V_{IN} = 20V			3.5			3.5		A
		V_{IN} = 35V			2			2		A
e_n	Output Noise Voltage				90			90		uV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance, Junction to Case	K Package			1.0	1.5		1.0	1.5	°C/W
		V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = 20V , and I_{OUT} = 2.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to thermal regulation specification.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1R18AK-XX, IP1R18K-XX	−55°C to 150°C	TO-3
IP3R18AK-XX, IP3R18K-XX	0°C to 125°C	TO-3
IP3R18AV-XX, IP3R18V-XX	0°C to 125°C	TO-218

Seagate Microelectronics Limited

5 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

IP1R19A, IP3R19A, IP1R19, IP3R19

DESCRIPTION

The IP1R19A/IP3R19A and IP1R19/IP3R19 series of fixed three terminal negative regulators are capable of delivering 5 amps of load current, and are available with several convenient output voltages. The A-suffix devices provide 0.01%/V line regulation, 0.5% load regulation, and a ±1% output voltage tolerance at room temperature. Over all specified operating conditions (load, line, power, and temperature), the output voltage is guaranteed not to vary by more than ±3%. Protection features include safe operating area current limiting for the output power transistor, and thermal shutdown. The entire series of regulators is available in a TO-3 package, and the commercial version is also available in a convenient, low cost plastic TO-218 package.

FEATURES

- 5 Amp output current capability
- ±1% Output tolerance at room temperature (A suffix)
- 0.01%/V Line regulation
- 0.5% Load regulation
- −5, −5.2, −12, −15 Volt fixed output voltages available
- Short circuit current limit protection
- Safe operating area protection
- Thermal shutdown protection
- Available in convenient, low cost plastic TO-218 package

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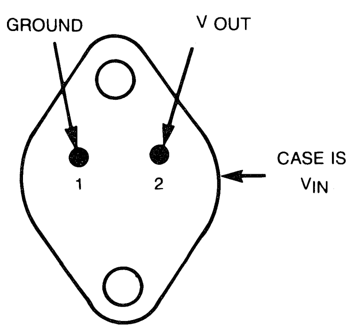
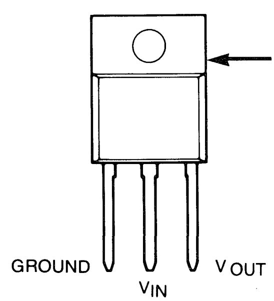
PACKAGE INFORMATION

BOTTOM VIEW
TO-3 (K PACKAGE)



TOP VIEW
TO-218 (V PACKAGE)



IP1R19A, IP3R19A, IP1R19, IP3R19

5 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_{OUT} = -5, -5.2, -12, or -15V) 35V

Power Dissipation Internally Limited

Storage Temperature Range -65°C to +150°C

Lead Temperature (Soldering, 10 sec) 300°C

Operating Junction Temperature Range
IP1R19A/IP1R19 -55°C to + 150°C
IP3R19A/IP3R19 0°C to +125°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

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ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions (Note 1)		P1R19A-5 IP3R19A-5 Min	Typ	Max	IP1R19-5 IP3R19-5 Min	Typ	Max	Units
V_{OUT}	Output Voltage			-5.05	-5.00	-4.95	-5.15	-5.00	-4.85	V
		-5mA ⩾ I_{OUT} ⩾ -5A -8V ⩾ V_{IN} ⩾ -20V, P⩽ 50W	●	-5.15		-4.85	-5.25		-4.75	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT} = -5mA (Note 2)			3	15		6	30	mV
		-7.5V ⩾ V_{IN} ⩾ -35V	●		6	30		12	60	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	-5mA ⩾ I_{OUT} ⩾ -5A			5	25		10	50	mV
		(Note 2)	●		10	50		20	100	mV
I_Q	Quiescent Current	I_{OUT} = 5mA	●			5			5	mA
ΔI_Q	Quiescent Current	-5mA ⩾ I_{OUT} ⩾ -5A	●			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, -7.5V ⩾ V_{IN} ⩾ -35V	●			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -5A, ΔV_{OUT} = 100mV	●		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	●	60	80		60	80		dB
	Thermal Regulation	t_{PULSE} = 20msec, ΔP = 50W			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -10V	●	-12	-8		-12	-8		A
I_{SC}	Short Circuit	V_{IN} = -10V			-7			-7		A
	Current	V_{IN} = -35V			-2			-2		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 100kHz			40			40		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = -10V, I_{OUT} = -2.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

5 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R19A-5.2 IP3R19A-5.2			IP1R19-5.2 IP3R19-5.2			Units
				Min	Typ	Max	Min	Typ	Max	
V_{OUT}	Output Voltage			-5.25	-5.20	-5.15	-5.35	-5.20	-5.05	V
		$-5mA \geq I_{OUT} \geq -5A$ $-8.2V \geq V_{IN} \geq -20V$, $P \leq 50W$	●	-5.35		-5.05	-5.45		-4.95	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$I_{OUT} = -5mA$ (Note 2)			3	15		6	30	mV
		$-7.7V \geq V_{IN} \geq -35V$	●		6	30		12	60	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$-5mA \geq I_{OUT} \geq -5A$			5	25		10	50	mV
		(Note 2)	●		10	50		20	100	mV
I_Q	Quiescent Current	$I_{OUT} = -5mA$	●			5			5	mA
ΔI_Q	Quiescent Current	$-5mA \geq I_{OUT} \geq -5A$	●			10			10	mA
	Change (Load/Line)	$I_{OUT} = -5mA$, $-7.7V \geq V_{IN} \geq -35V$	●			5			5	mA
V_D	Dropout Voltage	$I_{OUT} = -5A$, $\Delta V_{OUT} = 100mV$	●		2.2	3.0		2.2	3.0	V
	Ripple Rejection	$I_{OUT} = -1A$, $f = 120Hz$	●	60	80		60	80		dB
	Thermal Regulation	$t_{PULSE} = 20msec$, $\Delta P = 50W$			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	$V_{IN} = -10V$	●	-12	-8		-12	-8		A
I_{SC}	Short Circuit	$V_{IN} = -10V$			-7			-7		A
	Current	$V_{IN} = -35V$			-2			-2		A
e_n	Output Noise Voltage	$10Hz \leq f \leq 100kHz$			40			40		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at $T_{CASE} = 25°C$ unless otherwise specified.

Note 1: Unless otherwise specified, $V_{IN} = -10V$, $I_{OUT} = -2.5A$ Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

5 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions (Note 1)		IP1R19A-12 IP3R19A-12 Min	Typ	Max	IP1R19-12 IP3R19-12 Min	Typ	Max	Units
V_{OUT}	Output Voltage			-12.12	-12.00	-11.88	-12.36	-12.00	-11.64	V
		-5mA ⩾ I_{OUT} ⩾ -5A -15V ⩾ V_{IN} ⩾ -27V, P ⩽ 50W	●	-12.36		-11.64	-12.60		-11.40	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT} = -5mA (Note 2)			5	30		10	60	mV
		-14.5V ⩾ V_{IN} ⩾ -35V	●		10	60		20	120	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	-5mA ⩾ I_{OUT} ⩾ -5A			10	60		20	120	mV
		(Note 2)	●		20	120		40	240	mV
I_Q	Quiescent Current	I_{OUT} = -5mA	●			5			5	mA
ΔI_Q	Quiescent Current	-5mA ⩾ I_{OUT} ⩾ -5A	●			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, -14.5V ⩾ V_{IN} ⩾ -35V	●			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -5A, ΔV_{OUT} = 250mV	●		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	●	52	72		52	72		dB
	Thermal Regulation	t_{PULSE} = 20msec, ΔP = 50W			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -17V	●	-12	-8		-12	-8		A
I_{SC}	Short Circuit	V_{IN} = -17V			-4			-4		A
	Current	V_{IN} = -35V			-2			-2		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 100kHz			75			75		μV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = -17V, I_{OUT} = -2.5A Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

5 AMP, 3-TERMINAL, FIXED NEGATIVE VOLTAGE REGULATORS

ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions		IP1R19A-15 IP3R19A-15 Min	Typ	Max	IP1R19-15 IP3R19-15 Min	Typ	Max	Units
V_{OUT}	Output Voltage			-15.15	-15.00	-14.85	-15.45	-15.00	-14.55	V
		-5mA ⩾ I_{OUT} ⩾ -5A -18V ⩾ V_{IN} ⩾ -30V, P ⩽ 50W	●	-15.45		-14.55	-15.75		-14.25	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT} = -5mA (Note 2)			8	40		16	80	mV
		-17.5V ⩾ V_{IN} ⩾ -35V	●		16	80		32	160	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	-5mA ⩾ I_{OUT} ⩾ -5A			16	80		32	160	mV
		(Note 2)	●		32	160		64	320	mV
I_Q	Quiescent Current	I_{OUT} = -5mA	●			5			5	mA
ΔI_Q	Quiescent Current	-5mA ⩾ I_{OUT} ⩾ -5A	●			10			10	mA
	Change (Load/Line)	I_{OUT} = -5mA, -17.5V ⩾ V_{IN} ⩾ -35V	●			5			5	mA
V_D	Dropout Voltage	I_{OUT} = -5A, ΔV_{OUT} = 300mV	●		2.2	3.0		2.2	3.0	V
	Ripple Rejection	I_{OUT} = -1A, f = 120Hz	●	50	70		50	70		dB
	Thermal Regulation	t_{PULSE} = 20msec, ΔP = 50W			0.002	0.01		0.002	0.02	%/W
I_{PEAK}	Peak Output Current (dc)	V_{IN} = -20V	●	-12	-8		-12	-8		A
I_{SC}	Short Circuit	V_{IN} = -20V			-3.5			3.5		A
	Current	V_{IN} = -35V			-2			-2		A
e_n	Output Noise Voltage	10Hz ⩽ f ⩽ 10kHz			90			90		µV
	AVE TC of V_{OUT}									mV
θ_{JC}	Thermal Resistance,	K Package			1.0	1.5		1.0	1.5	°C/W
	Junction to Case	V Package			1.0	1.5		1.0	1.5	°C/W
										°C/W

The ● denotes specifications which apply over the full operating junction temperature range. All others apply at T_{CASE} = 25°C unless otherwise specified.

Note 1: Unless otherwise specified, V_{IN} = -20V, I_{OUT} = 2.5A. Although power dissipation is internally limited, these specifications apply for dissipations up to 50W.
Note 2: Load and line regulation are electrically independent and are measured using pulse testing techniques at low duty cycle in order to maintain constant junction temperature. To determine the effects on the output voltage due to device heating refer to the thermal regulation specification.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1R19AK-XX	−55°C to 150°C	TO-3
IP1R19K-XX	−55°C to 150°C	TO-3
IP3R19AK-XX	0°C to 125°C	TO-3
IP3R19K-XX	0°C to 125°C	TO-3
IP3R19AV-XX	0°C to 125°C	TO-218
IP3R19V-XX	0°C to 125°C	TO-218

MILITARY PRODUCTS

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MILITARY PRODUCTS

Seagate Microelectronics offers a wide variety of product screened to MIL-STD-883, Method 5004, BS9400 and CECC 90200. All products are 100% tested to Seagate Microelectronics data sheet electrical limits.

Quality conformance inspection is performed in accordance with MIL-STD-883, Method 5005.

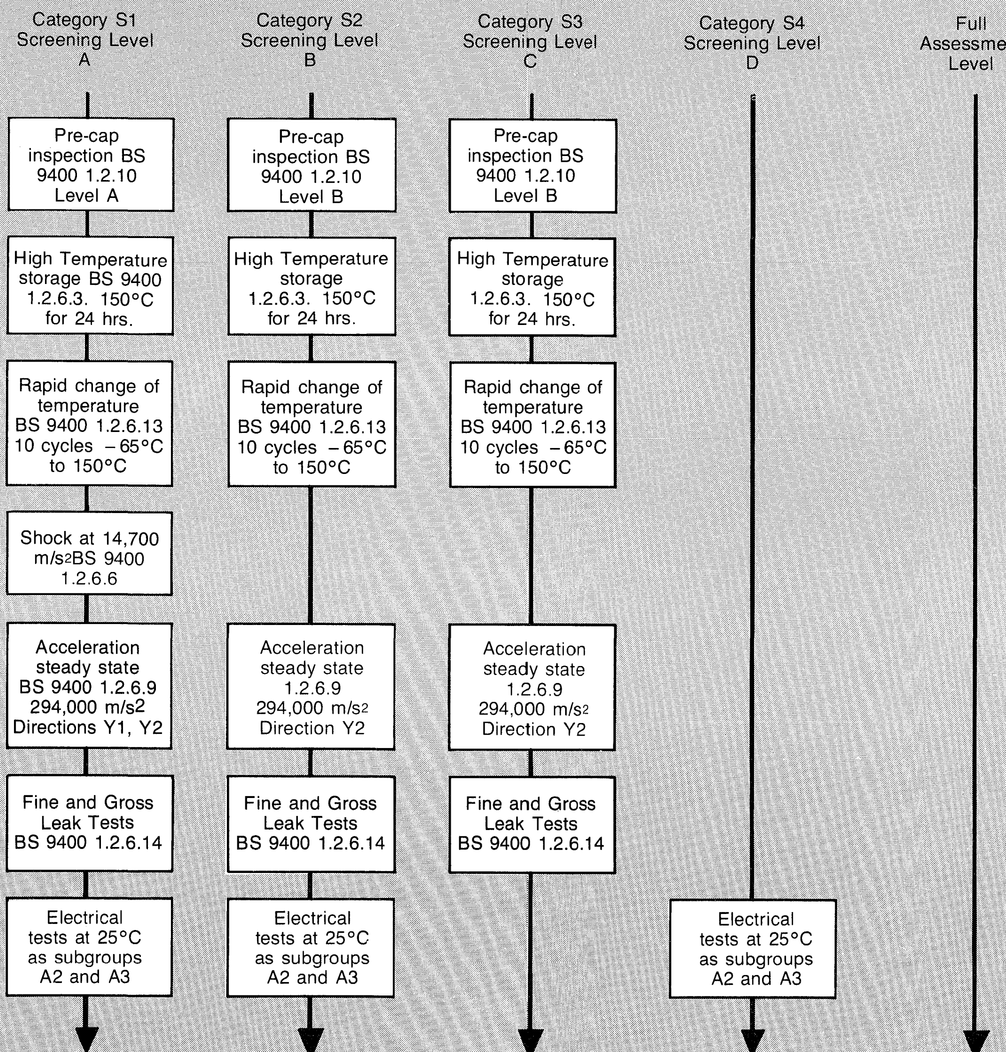
BS9400 and CECC 90200 generic quality conformance data is generally available for common device and package combination tests.

Seagate Microelectronics provides a large selection of hermetic packages for military use:

Package Type	**Suffix Designator**
CERDIP	J
TO-3	K
TO-39	H
TO-66	R
TO-257 (Hermetic TO-220 style)	G

MILITARY PRODUCTS

If during electrical tests performed after burn-in, more than 10% defective are found, the production lot will be rejected



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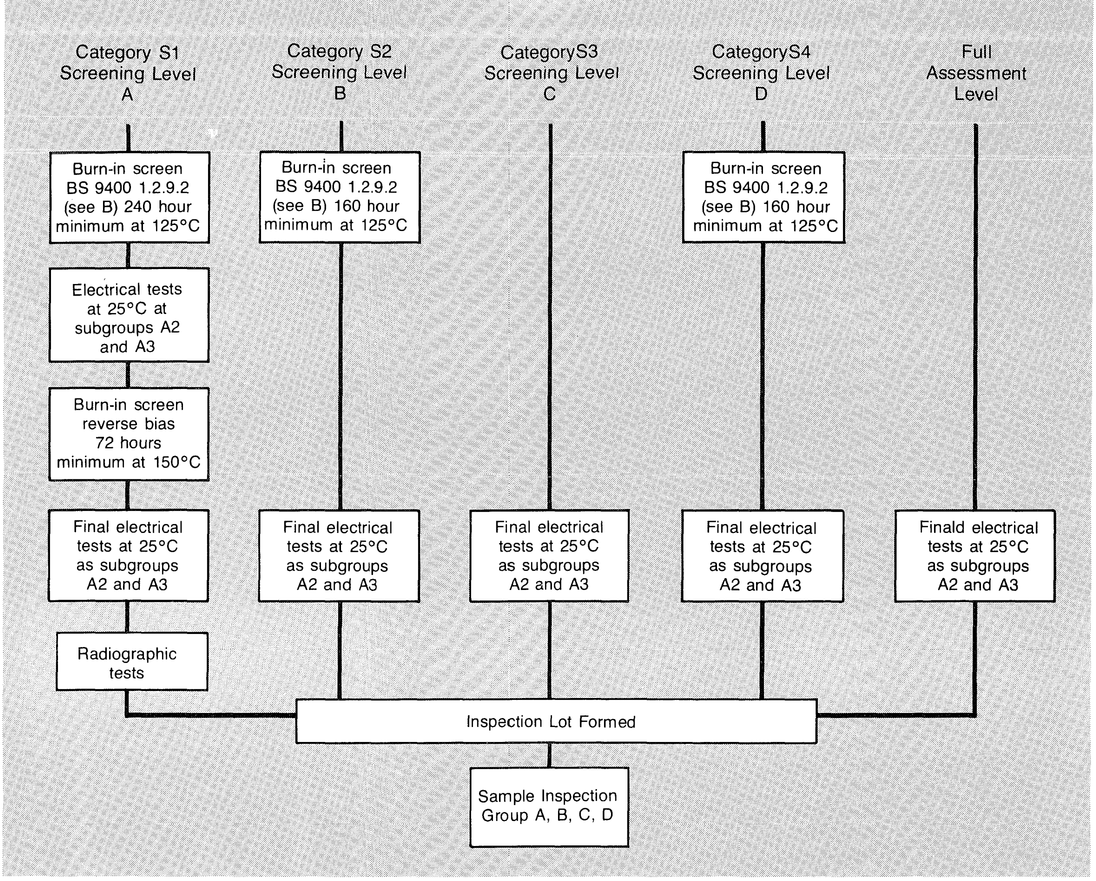

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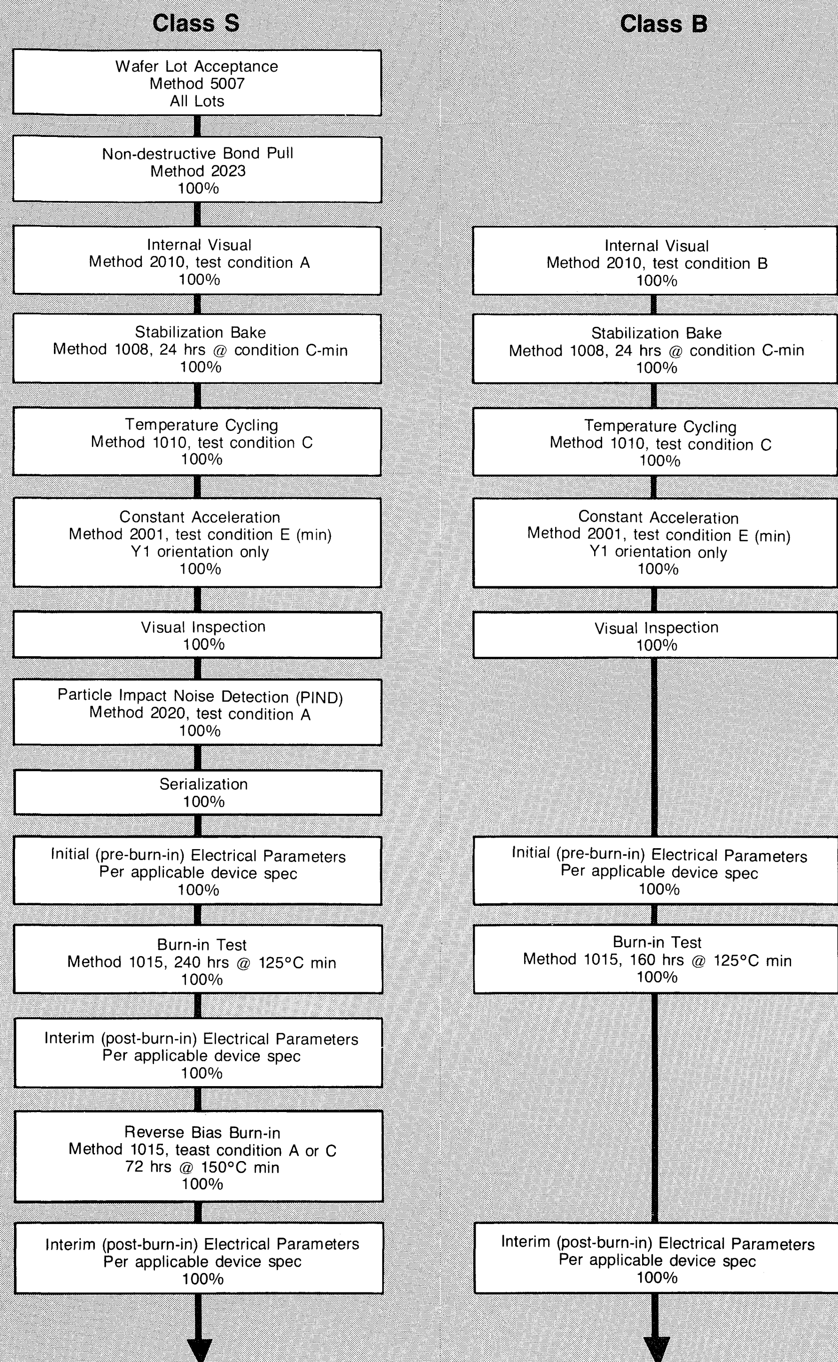
SAMPLING PLAN COMPARATIVE ANALYSIS

Parameter	SME Sampling Plan	883 Method 5005	BS9400	CECC 90200
DC +25°C	0.1% AQL 1.8% LTPD	0.3% AQL 2% LTPD	1.5% AQL	0.65% AQL
DC +125°C	0.1% AQL 1.8% LTPD	0.4% AQL 3% LTPD	4% AQL	1% AQL
DC -55°C	0.1% AQL 1.8% LTPD	0.8% AQL 5% LTPD	4% AQL	1% AQL
AC +25°C (Dynamic)	0.1% AQL 1.8% LTPD	0.3% AQL 2% LTPD	4% AQL	1.5% AQL
AC +125°C (Dynamic)	0.1% AQL 1.8% LTPD	0.4% AQL 3% LTPD	4% AQL (3 Monthly)	4% AQL (3 Monthly)
AC -55°C (Dynamic)	0.1% AQL 1.8% LTPD	0.8% AQL 5% LTPD	4% AQL (3 Monthly)	4% AQL (3 Monthly)


Class S
Class B
Wafer Lot Acceptance
Method 5007
All Lots
Non-destructive Bond Pull
Method 2023
100%
Internal Visual
Method 2010, test condition A
100%
Internal Visual
Method 2010, test condition B
100%
Stabilization Bake
Method 1008, 24 hrs @ condition C-min
100%
Stabilization Bake
Method 1008, 24 hrs @ condition C-min
100%
Temperature Cycling
Method 1010, test condition C
100%
Temperature Cycling
Method 1010, test condition C
100%
Constant Acceleration
Method 2001, test condition E (min)
Y1 orientation only
100%
Constant Acceleration
Method 2001, test condition E (min)
Y1 orientation only
100%
Visual Inspection
100%
Visual Inspection
100%
Particle Impact Noise Detection (PIND)
Method 2020, test condition A
100%
Serialization
100%
Initial (pre-burn-in) Electrical Parameters
Per applicable device spec
100%
Initial (pre-burn-in) Electrical Parameters
Per applicable device spec
100%
Burn-in Test
Method 1015, 240 hrs @ 125°C min
100%
Burn-in Test
Method 1015, 160 hrs @ 125°C min
100%
Interim (post-burn-in) Electrical Parameters
Per applicable device spec
100%
Reverse Bias Burn-in
Method 1015, teast condition A or C
72 hrs @ 150°C min
100%
Interim (post-burn-in) Electrical Parameters
Per applicable device spec
100%
Interim (post-burn-in) Electrical Parameters
Per applicable device spec
100%

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MILITARY PROCESSING FLOW CHART — MIL STD 883 (Cont.)

MILITARY PRODUCTS

Class S

Percent Defective Allowable (PDA) Calculation
5%, 3%, functional parameters @25°C
All lots

Final Electrical Tests
(a) Static tests:
(1) 25°C (Subgroup 1, table I, 5005)
(2) Max & min rated operating temp.
(Subgroups 2, 3, table I, 5005)

(B) Dynamic or functional tests
(1) 25°C (Subgroup 4 or 7, table I method 5005)
(2) Minimum and maximum rated operating temperature
(Subgroups 5 and 6, or 8 table I method 5005)
(c) Switching tests at 25°C
(Subgroup 9, table I method 5005)

Seal: (a) Fine (b) Gross
Method 1014
100%

Radiographic
Method 2012, two views
100%

Qualification or Quality Conformance
Inspection Test Sample Selection
Method 5005, per applicable device spec
All Lots

External Visual
Method 2009
100%

Class B

Percent Defective Allowable (PDA) Calculation
5%. All lots

Final Electrical Tests
(a) Static tests:
(1) 25°C (Subgroup 1, table I, 5005)
(2) Max & min rated operating temp.
(Subgroups 2, 3, table I, 5005)

(B) Dynamic or functional tests
(1) 25°C (Subgroup 4 or 7, table I method 5005)
(2) Minimum and maximum rated operating temperature
(Subgroups 5 and 6, or 8 table I method 5005)
(c) Switching tests at 25°C
(Subgroup 9, table I method 5005)

Seal: (a) Fine (b) Gross
Method 1014
100%

Qualification or Quality Conformance
Inspection Test Sample Selection
Method 5005, per applicable device spec
All Lots

External Visual
Method 2009
100%

MILITARY PRODUCTS

1) BS 9430 - Voltage Regulators		Voltage Regulators Contd		Voltage Regulators Contd	
IP117K	F0394 (0119)	IP150AK	F0597	IP1R18K	F0876
IP117R	F0401	IP120K/7900K	F0604	IP1R17K	F0904
iP117G	F0772	IP120R	F0611	IP1R17G	T.B.A.
IP117HVK	F0408	IP120AK	F0618	IP145K	F0149
IP117HVR	F0415	IP120AR	F0625	IP109K	F0039
IP117HVG	F0779	IP120MH	F0632	IP109H	F0031
IP117AK	F0422	IP120MR	F0639	**2) BS 9493 - PWMs & Supervisory Circuits**	
IP117AR	F0429	IP120MAH	F0646	IP1P125J	F0094
IP117AG	F0786	IP120MAR	F0653	IP1060BJ	F0113
IP117AHVK	F0436	IP137K	F0660 (0389)	IP1524J	F0120
IP117AHVR	F0443	IP137R	F0667	IP1524BJ	F0087
IP117AHVG	F0793	IP137G	F0800	IP1525AJ	F0127
IP117MHVR	F0471	IP137HVK	F0674	IP1526J	F0134
IP117MAH	F0478	IP137HVR	F0681	IP1526AJ	F0141
IP117MAR	F0485	IP137HVG	F0814	IP1527AJ	F0148
IP117MAHVH	F0492	IP137AK	F0688	IP1543J	F0196
IP117MAHVR	F0499	IP137AR	F0695	IP1842J	F0155
IP123K	F0506	IP137AG	F0807	IP1843J	F0162
IP123AK	F0513	IP137AHVK	F0702	IP1844J	F0245
IP138K	F0520	IP137AHVR	F0709	IP1845J	F0252
IP138AK	F0527	IP137AHVG	F0821	IP5560J	F0169
IP140K/7800K	F0534 (0102)	IP137MH	F0716 (0386)	IP5561J	F0175
IP140R	F0541	IP137MR	F0723	IP35063J	F0187
IP140AK	F0548 (0107)	IP137MHVH	F0730		
IP140AR	F0555	IP137MHVR	F0737		
IP140MH	F0562	IP137MAH	F0744		
IP140MR	F0569	IP137MAR	F0751		
IP140MAH	F0576	IP137MAHVH	F0758		
IP140MAR	F0583	IP137MAHVR	F0765		
IP150K	F0590 (0360)	IP1R19K	F0828		

(Note figures in brackets are existing specification numbers and are available from Seagate Microelectronics.)

VOLTAGE REGULATORS

DEVICE	MIL. DRWG.	STATUS
IP117H/883B IP117K/883B IP117R/883B	7703401XX 7703401YX 7703401ZX	APPROVED APPROVED APPROVED
IP117HVH IP117HVK/883B IP117HVR/883B	773402XX 773402YX 773402ZX	APPROVED APPROVED CAN BE ADDED
IP137H/883B IP137K/883B IP137R/883B	773403XX 7703403YX 7703403ZX	APPROVED APPROVED APPROVED
IP137HVH/883B IP137HVK/883B IP137HVR/883B	7703404XX 7703404YX 7703404ZX	APPROVED APPROVED CAN BE ADDED
IP117AH/883B IP117AK/883B IP117AR/883B	773405XX 773405YX 773405ZX	APPROVED APPROVED APPROVED
IP137AH/883B IP137AK/883B IP137AR/883B	773406XX 7703406YX 7703406ZX	APPROVED APPROVED APPROVED
IP117AHVH/883B IP117AHVK/883B IP117AHVR/883B	7703407XX 7703407YX 7703407ZX	APPROVED APPROVED CAN BE ADDED
IP137AHVH/883B IP137AHVK/883B IP137AHVR/883B	7703408XX 7703408YX 7703408XX	APPROVED APPROVED CAN BE ADDED
IP117G/883B IP117HVG/883B IP137G/883B IP137HVG/883B IP117AG/883B IP137AG/883B IP117AHVG/883B IP137AHVG/883B	7703401TX 7703402TX 7703403TX 7703404TX 7703405TX 7703406TX 7703407TX 7703408TX	APPROVED APPROVED APPROVED APPROVED APPROVED APPROVED APPROVED APPROVED
IP123K-5/883B IP123K-12/883B IP123R-15/883B IP123AK-5/883B IP123AK-12/883B IP123AK-15/883B	5962-8777501YX 5962-8777502YX 5962-8777503YX 5962-8777504YX 5962-8777505YX 5962-8777506YX	APPROVED CAN BE ADDED CAN BE ADDED CAN BE ADDED CAN BE ADDED CAN BE ADDED

NOTE: Please contact factory for current status.

MILITARY PRODUCTS

VOLTAGE REGULATORS

DEVICE	MIL DRWG.	STATUS
IP150K/883B IP150AK/883B	5962-8767501XX 5962-8767502XX	APPROVED APPROVED
IP78M05AH/883B IP7805AK/883B IP7805AR/883B IP7805AG/883B	5962-8778201XX 5962-8778201YX 5962-8778201ZX 5962-8778201TX	APPROVED APPROVED APPROVED APPROVED
IP78M12AH/883B IP7812AK/883B IP7812AR/883B	5962-8777601XX 5962-8777601YX 5962-8777601ZX	APPROVED APPROVED APPROVED
IP78M15AH/883B IP7815AK/883B IP7815AR/883B IP7815AG/883B	5962-8855301XX 5962-8855301YX 5962-8855301ZX 5962-8855301TX	APPROVED APPROVED APPROVED APPROVED
IP79M05AH/883B IP7905AK/883B IP7905AR/883B IP7905AG/883B	5962-8874601XX 5962-8874601YX 5962-8874601ZX 5962-8874601TX	IN DESC IN PROGRESS IN DESC IN PROGRESS IN DESC IN PROGRESS IN DESC IN PROGRESS
IP79M12AH/883B IP7912AK/883B IP7912AR/883B IP7912AG/883B IP79AIG/883B	5962-8874701XX 5962-8874701YX 5962-8874701ZX 5962-8874701TX 5962-8874701UX	APPROVED APPROVED APPROVED APPROVED APPROVED
IP79M15AH/883B IP7915AK/883B IP7915AR/883B IP7915AG/883B IP7915AIG/883B	5962-8874801XX 5962-8874801YX 5962-8874801ZX 5962-8874801TX 5962-8874801UX	APPROVED APPROVED APPROVED APPROVED APPROVED
LM109K/883B	5962-8777401YX	IN DESC IN PROGRESS

PULSE WIDTH MODULATORS

DEVICE	MIL. DRWG.	STATUS
IP1524J/883B	7802801EX	APPROVED
IP1524BJ/883B	5962-87645	APPROVED
IP1526J/883B IP1526AJ/883B	5962-8551501VX 5962-8551502VX	APPROVED APPROVED
IP1842J/883B IP1843J/883B IP1844J/883B IP1845J/883B	5962-8670401PX 5962-8670402PX 5962-8670403PX 5962-867040PX	APPROVED APPROVED APPROVED APPROVED
IP5560J/883B	5962-8672201EX	APPROVED
IP1543J/883B	5962-8774001EX	APPROVED

NOTE: Please contact factory for current status.

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APPLICATIONS INFORMATION

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APPLICATIONS INFORMATION

HIGH PERFORMANCE PULSE WIDTH MODULATORS

INTRODUCTION

The IP1525A/27A pulse width modulators are an improved family of switch mode power supply control integrated circuits. They are pin for pin compatible with the UC/SG1525A, UC/SG1527A families.

The optimized chip design exhibits significant benefits in the following areas:

- Crossover current reduction
- Lower power consumption
- Oscillator frequencies up to 500 kHz
- Increased reliability and improved performance over the entire operating temperature range.

BLOCK DIAGRAM

These PWM integrated circuits contain all four basic control elements: voltage reference, oscillator, error amplifier, and pulse width modulator. Additional functions provided are: low impedance drive, undervoltage lockout, soft start, logic compatible shut down, multiple pulse suppression and external oscillator synchronization.

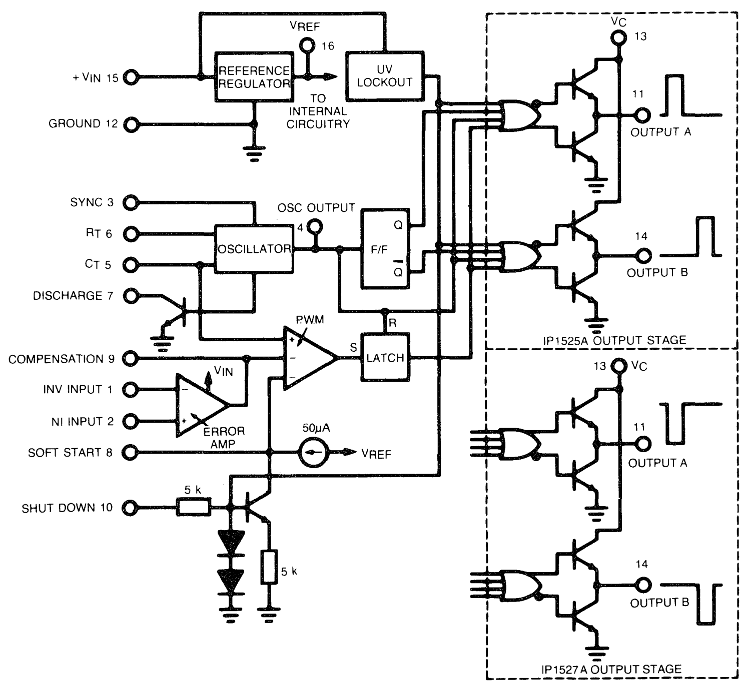

Figure 1: Block Diagram of the IP1525A/27A

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APPLICATIONS INFORMATION

VOLTAGE REFERENCE

The on-chip +5.1V bandgap reference is trimmed to ± 1% accuracy. It is essentially a temperature compensated, short circuit protected linear regulator.

V_{REF} supplies power to most of the internal circuitry and is also available for external use at pin 16. If currents above 20 mA are needed, figure 2 shows a configuration that uses an external PNP transistor. In applications with high system noise or non optimal layout V_{REF} should be decoupled with a 100nF ceramic capacitor.

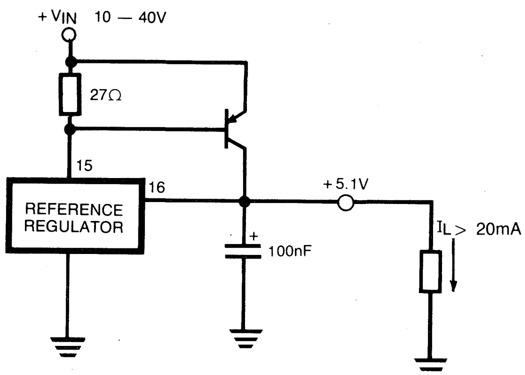


Figure 2: High Current Reference Regulator

OSCILLATOR

The oscillator circuit consists of a current source, programmable via R_T, a timing capacitor (C_T), a comparator, and a discharge transistor.

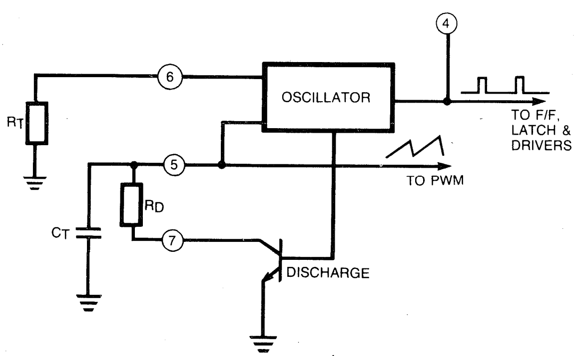
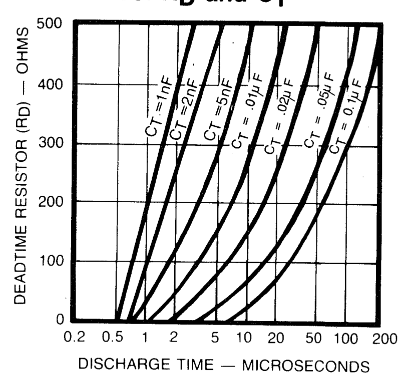


Figure 3: Oscillator

The oscillator circuit consists of a current source, programmable via R_T, a timing capacitor (C_T), a comparator, and a discharge transistor.

The voltage present at pin 6 (R_T) is approximately + 3.6V. The current that flows through the timing resistor R_T is mirrored internally and made available to charge the timing capacitor C_T. This constant current charging of C_T produces a linear ramp voltage. When the ramp reaches 3.5 V. The comparator changes state: the discharge transistor is turned ON, C_T is discharged toward ground through R_D, and the output on pin 4 becomes high. When the voltage across C_T reaches 0.9 V, the comparator again changes state: pin 4 becomes low and the cycle is repeated. An external resistor R_D, modifies the discharge time. In doing so, it increases the clock pulse width and the dead time. R_D can be as high as RT/15 (see Figure 4). For minimum dead time, pins 5 and 7 are connected together.

Figure 4: Oscillator Discharge Times vs. R_D and C_T



The saw tooth waveform generated at pin 5 is used at the pulse width modulator. The narrow clock pulses available at pin 4 are used for the following functions:

1. Blanking pulses for both outputs.
2. Reset to the latch that follows the pulse width modulator.
3. Sync pulses for external circuits.

The SYNC input can be used to synchronize multiple controllers to a single clock source. A positive TTL level at pin 3 will override the internal comparator and initiate a discharge cycle in the oscillator. The free running oscillator frequency should be set to 10% to 20% **lower** than that of the master clock, so that the external SYNC pulse will initiate the discharge cycle before the internal comparator changes it's state.

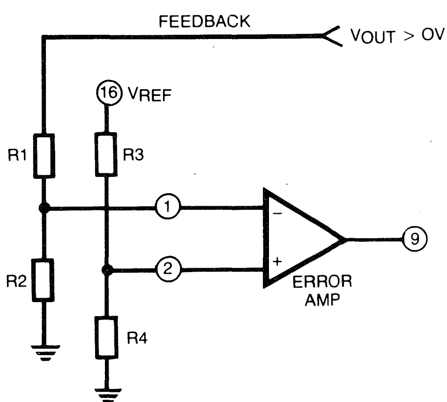
APPLICATIONS INFORMATION

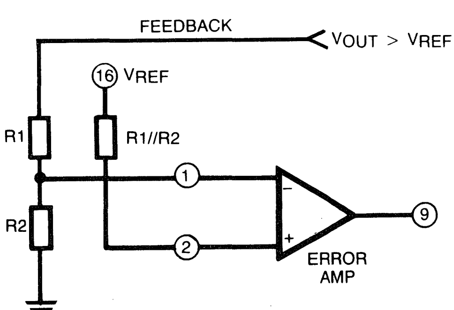
SWITCHING FREQUENCY

Switching frequency, the rate at which every power switch in the circuit goes through a complete cycle, determines size, weight, efficiency, and cost of the finished power supply.

Within the usual design range, the power density or power to volume ratio increases with the frequency. The size and weight of the magnetic and filtering elements are reduced when the frequency increases. Projected densities of 2.5 W/in^3 at 20 kHz approach 10 W/in^3 at 200 kHz and 51 W/in^3 at 1 MHz. For these reasons and thanks to the advent of power MOSFETs, new designs at higher frequencies are now more practical. The IP1525A/27A have useful oscillator frequencies up to 500 kHz.

Three possible connections to the error amplifier are shown in Figure 5. For output voltages above + 5.1 V, the amplifier can operate at a common mode voltage up to V_{IN}—2V. For negative output voltages, the feedback network is returned to V_{REF} and the common mode voltage V_I should be no lower than 1.5V.





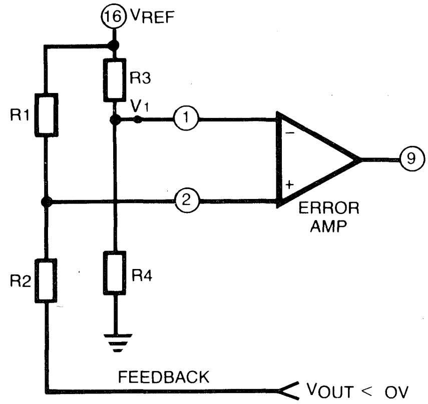
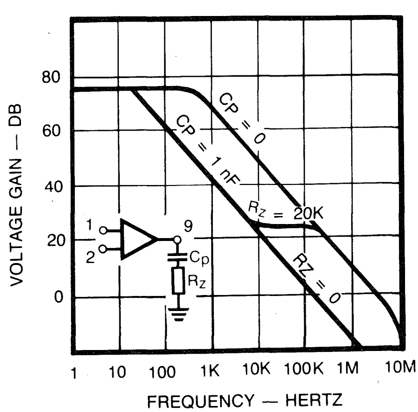


Figure 5: Error Amplifier Connections

Positive or negative power supply voltages can be regulated by varying the reference node of the feedback network.

The transconductance amplifier has a typical output impedance of 6MΩ, with a single pole at 200 Hz. The open loop voltage gain is about 10,000 (80dB) and can be reduced by a shunt impedance from pin 9 to ground. Figure 6 shows how the open loop pole may be shifted by adding a compensation capacitor C_p. In those cases where a two pole LC output filter is used, it may be necessary to compensate for the two pole roll-off. This can be done by inserting a zero through the addition of R_Z.

Figure 6: Error Amplifier Open-loop Frequency Response



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APPLICATIONS INFORMATION

Several forms of compensation networks are shown on Figure 7 (a), (b) and (c). If the feedback network is a low impedance, the output buffer circuit of Figure 7 (d) may be used.

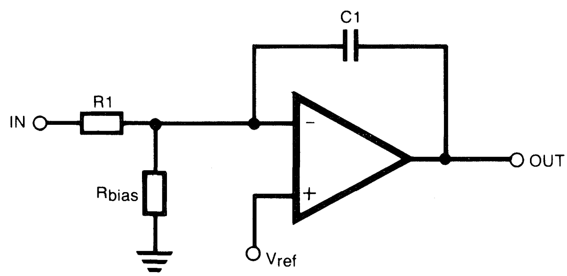
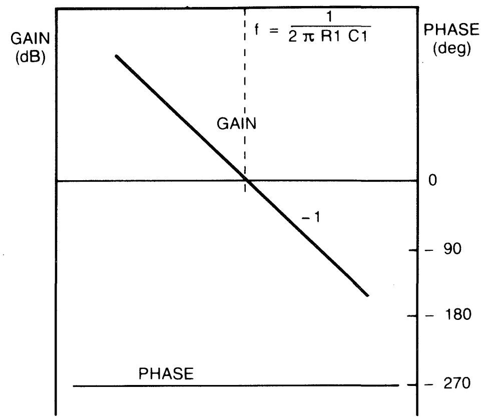


Figure 7(a): Type 1 Amplifier Schematic



Type 1: Amplifier Transfer Function

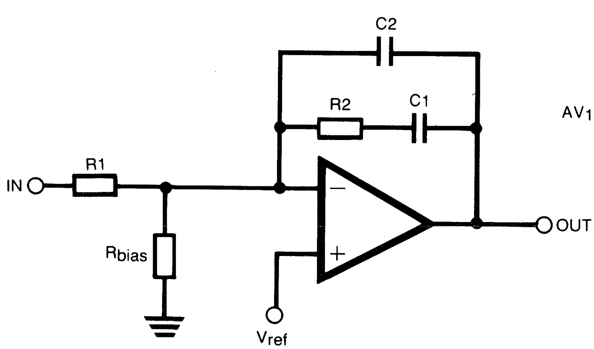
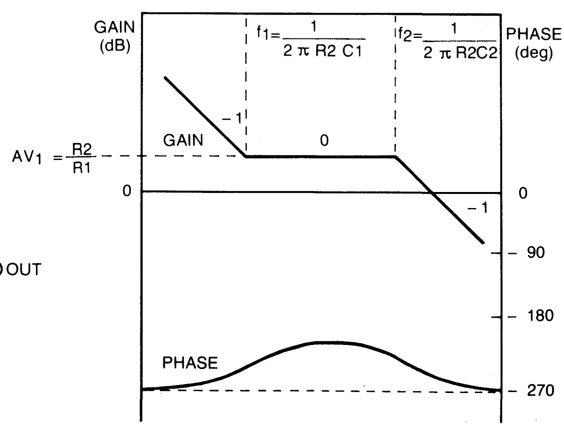


Figure 7(b): Type 2 Amplifier Schematic



Type 2: Amplifier Transfer Function

APPLICATIONS INFORMATION

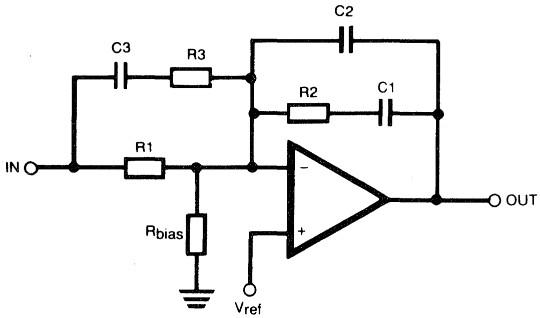
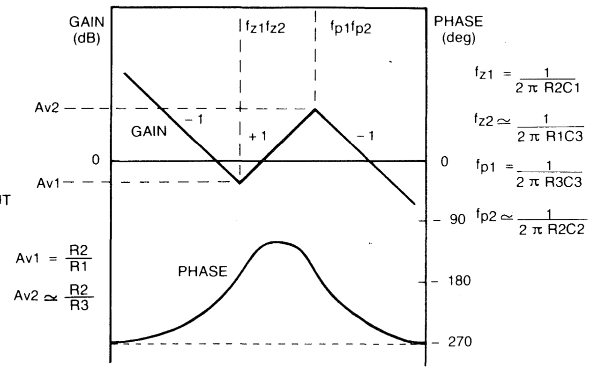


Figure 7(c): Type 3 Amplifier Schematic



Type 3: Amplifier Transfer Function

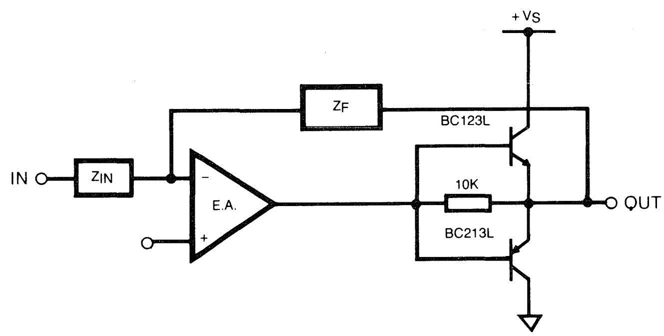


Figure 7(d): Driving a Low Impedance Feedback Network with an External Buffer

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The error amplifier is powered by + V_{IN}. Its output, however, is limited to 5.7 V by an internal PNP clamp connected from pin 9 to V_{REF}.

Figure 8 illustrates the relationship between the PWM duty cycle and the error amplifier output voltage.

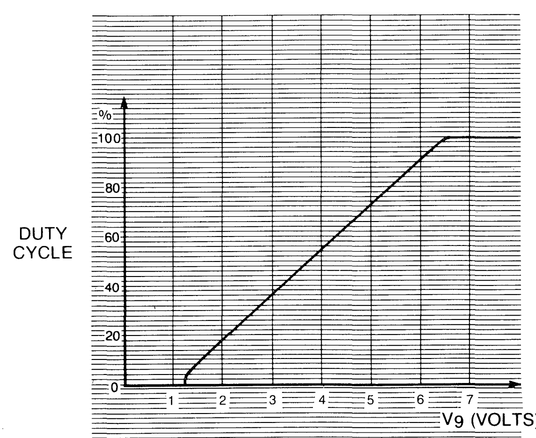

Figure 8: PWM Duty Cycle vs. Error Amplifier Output Voltage

APPLICATIONS INFORMATION

PWM COMPARATOR

This circuit generates the width modulated pulses by comparing the ramp and error voltage signals, Fig. 9.

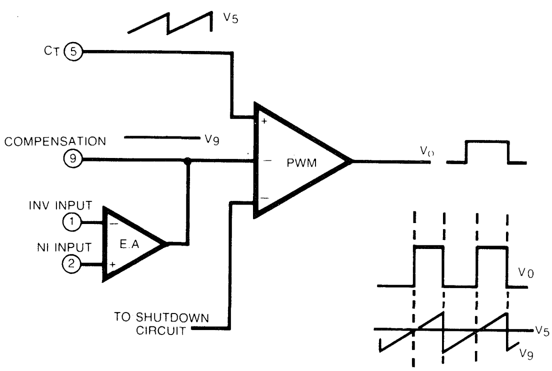

Figure 9: PWM Comparator

Pulse width is controlled by the crossing points of the error voltage with respect to the ramp. When V_9 is less than V_5, the comparator output is low. When V_9 is greater than V_5, the comparator output is high.

OUTPUT DRIVE STAGE

Low impedance, fast transition drive with minimal dissipation is prerequisite for high frequency power switching. Simultaneous conduction of the source and sink transistors in a totem-pole configuration contributes to system losses and necessitates additional decoupling and current limiting.

The output stage of the IP1525A/27A exhibits a 500 mA peak drive capability without conduction overlap providing effective drive up to 500 kHz. The saturation characteristic of the output driver is shown in Fig. 10.

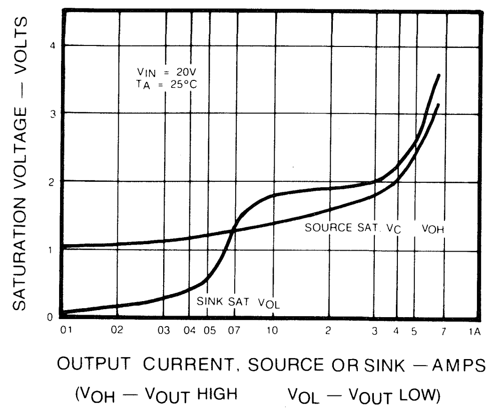

Figure 10: IP1525A Output Saturation Characteristics

Two output polarities are available. In the 1525A the output is high during the ON state, suitable for direct drive of grounded source power FET's. Alternatively the 1527A output is high during OFF state, meeting the requirements of proportional base drive circuits.

Figures 10(a), (b), (c) and (d), illustrate a number of output drive configurations. The power FET options include series current limiting and schottky clamp diodes, protection against output ringing.

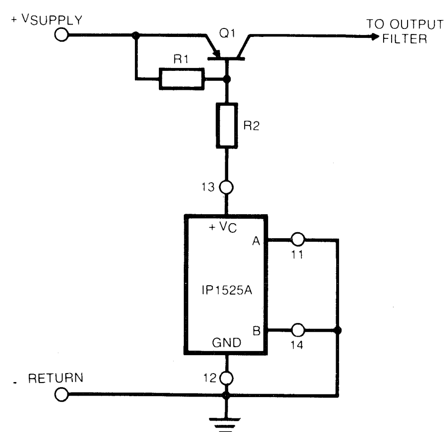

Figure 10(a): Single Ended Supply

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APPLICATIONS INFORMATION

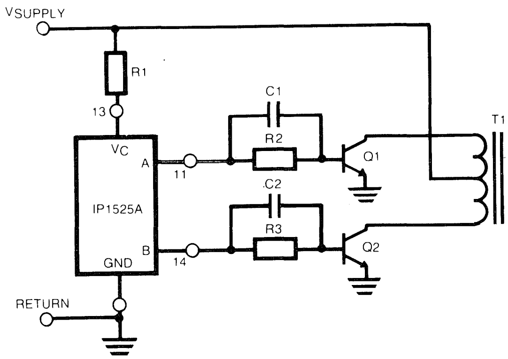


Figure 10(b): Bipolar Push Pull Supply

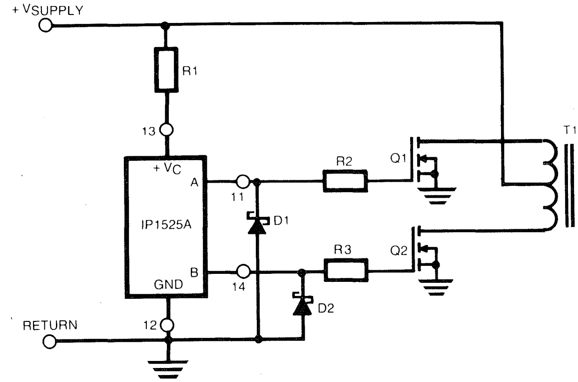


Figure 10(c): Power Fet Push-Pull Supply

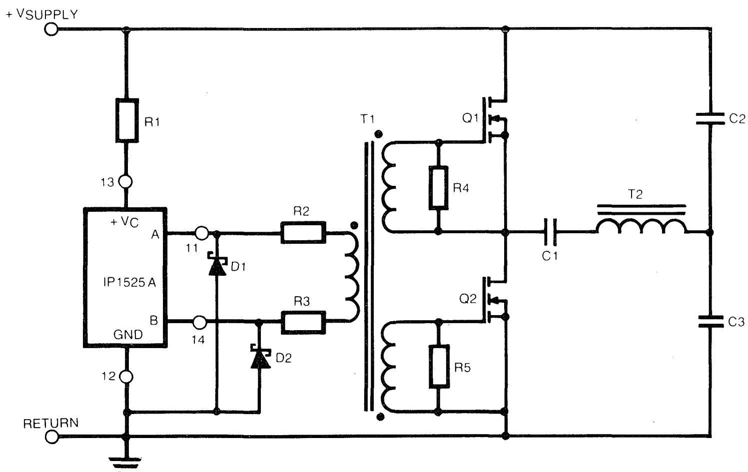


Figure 10(d): Driving Gate Drive Transformers Directly

MULTIPLE PULSE SUPPRESSION LOGIC

The PWM logic ensures that single pulses reach alternate outputs within each switching period. This occurs regardless of the action of the shutdown circuit or compensation node pull-down utilized in pulse by pulse current limiting techniques. This feature is critical in push-pull converters where two output pulses in succession on one driver would cause power transformer saturation and consequent failure of the power devices.

DEAD TIME

The dead time is that portion of each clock period when, at maximum duty cycle, both outputs are maintained OFF. This is necessary to prevent destructive crossover currents, which could occur if two totem pole power switches were ON simultaneously.

The IP1525A/27A have a minimum built in dead time of 500 ns which allows usable duty cycles up to 90% at 200 kHz. A resistor (up to RT/15), connected between pins 5 and 7, provides dead time adjustment. Figure 11 shows the effect of dead time on maximum output pulse width.

APPLICATIONS INFORMATION

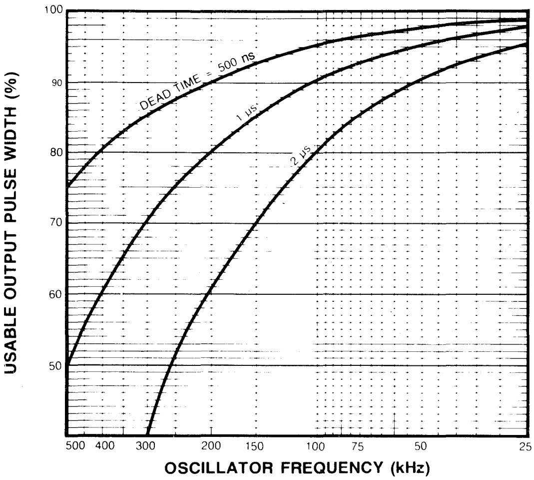


Figure 11: Effect of Dead Time on Output Pulse Dynamic Range

SOFT START

Controlled power supply turn ON is provided by the SOFT-START circuit. This feature sets a duty cycle that gradually increases from zero to the value called for by the error amplifier. The output voltage, therefore, ramps to its nominal value minimising overshoot without creating a sudden current in-rush that could cause overstressing of the rectifiers and saturation of the magnetic components.

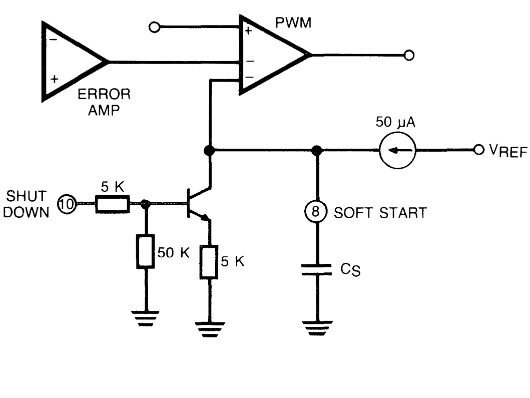


Figure 12: Soft-Start and Shut Down Circuits

An external capacitor C_S provides the timing element for the soft start cycle. This capacitor is charged via an internal 50 µA current source to approximately 4.4V.

The turn ON time can be calculated from the time required to charge C_S to 3.5V (full duty cycle) with 50 µA.

$$\text{Turn ON Time} = \frac{C_S \times 3.5\text{ V}}{50\mu\text{A}} = \frac{C_S\ (\mu\text{F})}{14.3}\ \text{(s)}$$

The softstart capacitor is discharged automatically during power down or when a shutdown signal is received.

UNDERVOLTAGE LOCKOUT

The under voltage (UV) lockout circuit monitors the reference voltage (V_{REF}) with an accurate and stable comparator which holds the output stages low in the IP1525A (High in the IP1527A). In addition the soft start capacitor is maintained in a discharged condition.

Once the reference voltage reaches 4.9V, corresponding to a supply voltage of 6.7V, the soft start is initiated. The UV lockout exhibits 300 mV of hysteresis to eliminate jitter at threashold of turn on. Monitoring V_{REF} (as opposed to V_{IN}) is especially significant when the voltage reference has to source current into a discharged decoupling capacitor.

SHUTDOWN FUNCTION

The shutdown pin provides a convenient port for protective functions and converter sequencing. During steady state operation if the voltage on Pin 10 exceeds logic 1 three things happen. The output drivers are disabled within 100 ns, the PWM latch is set for the remainder of the switching period and the soft start capacitor is discharged by a 150 µA current source.

CURRENT LIMITING

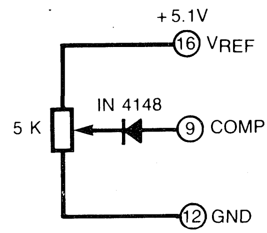
In case of an overload condition, it is desirable to protect the power supply by limiting its output current. This can be done in two ways: linearly and digitally.

Linear current limiting will reduce the output voltage if the current demand becomes excessive. The high output impedance of the error amplifier allows a voltage clamp, Figure 13 (a), to limit the duty cycle. This, in turn, will limit the current delivered to the load.

The circuit of Figure 13 (b) uses a voltage comparator to sense current in the ground return loop. When an overload occurs, it clamps pin 9 to a predetermined level and limits the duty cycle and the output current.

If desired the circuits of Figure 13 can also be used to clamp pin 8 for an equivalent width limiting effect.

(a)



(b)

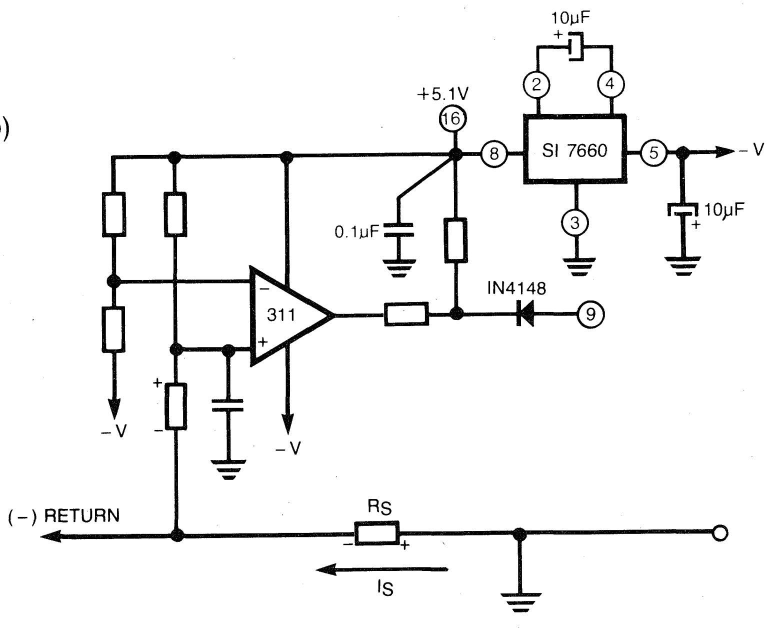


Figure 13: Linear Current Limiting

APPLICATIONS INFORMATION

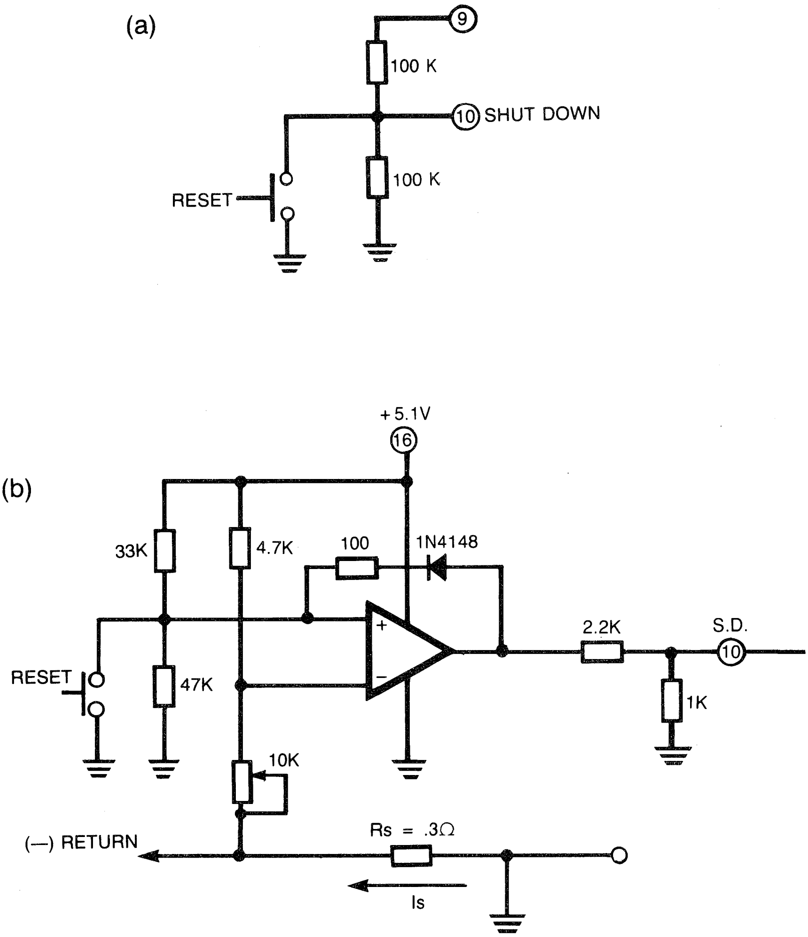


Figure 14: Digital Current Limiting

Digital or pulse by pulse current limiting will shut the output voltage OFF when a fault is sensed. The circuit of Figure 14 (a) uses the error amplifier output level as a duty cycle indicator. When the duty cycle exceeds a predetermined maximum, the shut down circuit is activated. In Figure 14 (b) the comparator output goes high when an overload is sensed and generates a shutdown signal for pin 10. Alternatively an open collector comparator or transistor can be used to pull down the compensation node, Pin 9, this sets the PWM latch, turning off both outputs. The outputs remain inactive, once the fault condition has ceased, until the clock pulse resets the PWM latch, thus achieving pulse by pulse protection.

CONCLUSION

The switch-mode environment demands control devices that include comprehensive protection and realistic drive capability in addition to the basic pulse width modulation function. The IP1525A/27A family of regulating pulse width modulators meets this demand without compromising system reliability or performance.

Seagate Microelectronics Limited

APPLICATIONS INFORMATION

THE IP1R07A LINEAR POST REGULATOR

INTRODUCTION

As switch mode technology matures, driven by tighter specification and escalating power density requirements, the proportion of overall system losses contributed by post regulation has become significant. Whilst advances in switching regulator and magnetic amplifier techniques have minimised this inefficiency at high power, losses incurred in linear post regulation remain unacceptable.

The IP1R07A represents a timely advance in linear regulator design, specifically meeting switch mode power supply secondary regulation requirements.

DESIGNING FOR EFFICIENCY

Conventional three terminal regulators are inefficient power processors. Power dissipation in a linear regulator is given by the expression.

$$P_D = I_O (V_{IN} - V_{OUT})$$

The majority of monolithic voltage regulators require an input to output voltage differential (dropout) of 2-3V (6-9W dissipation at 3A and minimum line). Analysis of the existing techniques for low power secondary regulation highlights the requirement for efficient linear regulation in the 1A to 3A range. The IP1R07A linear post regulator fulfils this demand.

A block diagram of the IP1R07A is shown in figure 1.

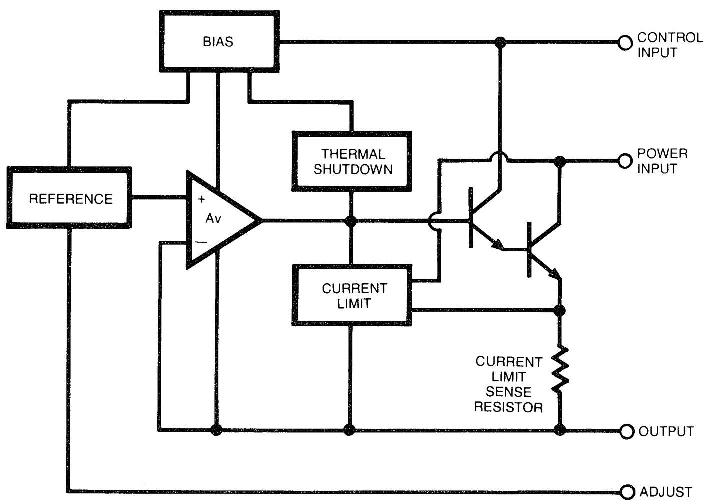


Figure 1: Block Diagram of the IP1R07A

High efficiency is achieved by separating the collectors of the internal Darlington transistor pair into control and power inputs, respectively, exploiting the low saturation voltage of the power device. The typical drop out voltage at 3A realised with this technique is 0.8V (2.4W dissipation at minimum line).

In addition to reduced power dissipation the IP1R07A exhibits excellent line and load regulation, comprehensive internal protection and an initial ± 1% output voltage tolerance.

The IP1R07A is compared with contemporary solutions to linear post regulation in table 1.

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APPLICATIONS INFORMATION

LINEAR REGULATOR TYPE	ADVANTAGES	DISADVANTAGES
DISCRETE COMPONENTS	HIGH PERFORMANCE	*HIGH COMPONENT COUNT *NO INHERENT THERMAL LIMITING *LARGE BOARD AREA
AUTOMOTIVE REGULATORS	*LOW DROP OUT *THREE TERMINAL DEVICE	*LOW EFFICIENCY (PNP PASS DEVICE) *AVERAGE PERFORMANCE *LOAD DEPENDANT STABILITY
HYBRID	*LOW DROP OUT *THREE TERMINAL DEVICE	*AVERAGE PERFORMANCE *LOAD DEPENDANT STABILITY *NO INHERENT THERMAL LIMITING *BULKY PACKAGE
IP1R07A	*LOW DROP OUT *HIGH EFFICIENCY *INTERNALLY STABILISED *HIGH PERFORMANCE *THERMAL LIMITING	*EXTRA BIAS RAIL REQUIRED

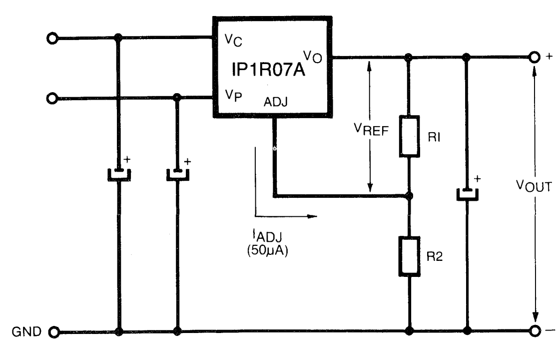
Table 1

OPERATION & O/P VOLTAGE SETTING

In common with most adjustable regulators the IP1R07A develops and maintains a nominal 1.25v reference voltage (V_{ref}) between its output and adjustment terminals, as illustrated below in Figure 2. If this reference voltage is applied across R1, a constant current is caused to flow through R2, thereby adjusting the output voltage to:

$V_{out} = V_{ref} (1 + R2/R1) + I_{adj} R2$

Because the adjustment current represents an error term in the output voltage expression, the IP1R07A was designed to minimize both the value of I_{ADJ} and its variation with line and load changes. As a result, all but 50μa of the circuit's quiescent operating current appears at the output terminal, thereby establishing a minimum load current requirement. If the value of R1 is such that the minimum load current is not exceeded, the output voltage will rise. The tightened initial V_{REF} tolerance of the IP1R07A allows inexpensive 1% or 2% metal film resistors to be used to get the output voltage well within acceptable limits.



$$V_{OUT} = V_{REF} (1 + \frac{R1}{R2}) + I_{ADJ} R2$$

Figure 2: Operation and output voltage setting

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BYPASS CAPACITORS

It is good practice to use a 1μF solid aluminium or 25μF electrolytic input bypass capacitor, particularly if the regulator is located any appreciable distance from the output filter. Improved ripple rejection can be achieved by adding a capacitor from the adjust pin to return. The reactance of the capacitor at the frequency of interest should be small compared to that of the voltage setting resistor.

Regulator output impedance is in the order of 10 mΩ or less and increases as a function of frequency above 10KHz due to the gain roll-off of the error amplifier. A solid aluminium bypass capacitor connected to the regulator output will maintain low impedance up to 1MHz. This capacitor should be shunted with a ceramic capacitor when driving switching loads.

REMOTE SENSING

As the IP1R07A internal feedback loop is regulating the voltage between the adjust pin and the heat tab of the package, the device is unable to provide true remote load sensing. The load regulation is limited by the resistance of the output tab and the wire connecting the regulator to the load. Negative side sensing is a conventional Kelvin connection, with the bottom of the divider returned to the negative side of the load. best load regulation is obtained when the top of the divider is connected, with the load, directly to the tab of the package. The correct divider connection is illustrated in figure 3. (**Note:** In practical converters R2 would be connected to the output terminal and the output voltage adjusted to accommodate line drop).

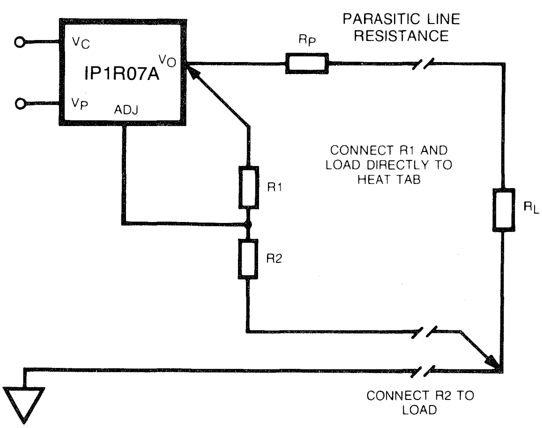


Figure 3: Connections for best load regulation

LAYOUT

In general all lines should be kept short and direct to reduce voltage drops and minimize thermal effects and inductance. A single point "star" return prevents circulating return currents.

PACKAGING

Versatile TO-218 and hermetic TO-257 packages supplement the increased efficiency of the IP1R07A with electrical and thermal characteristics equivalent to those of a TO3 can. The TO-218 exhibits excellent thermal performance under the pulse conditions and high ambient temperature encountered in the S.M.P.S. environment.

In order to realise the full capabilities of the IP1R07 linear post regulator sufficient attention must be paid to all aspects of thermal management.

DEVELOPING THE BIAS RAIL

As the bias circuitry consumes less than 100mA, developing the control input voltage is not a problem.

In a flyback converter an overwind on the secondary, together with a rectifier and electrolytic capacitor supplies the bias current.

In a forward converter the control input voltage can be supplied by either an overwind on the output filter choke or by peak detecting the voltage from the same winding that supplies the power input. Figs 4 and 5.

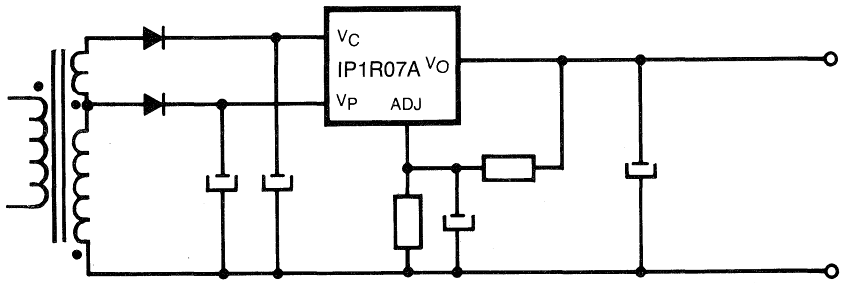
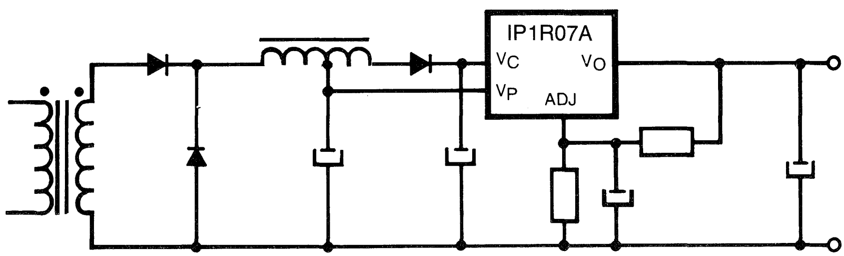
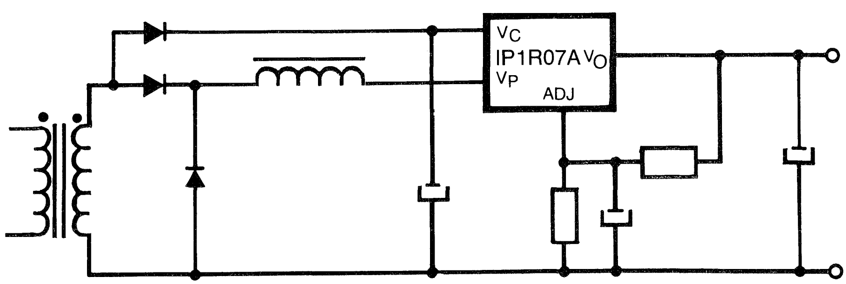


Figure 4: Flyback converter secondary linear regulation

(a) Secondary overwind



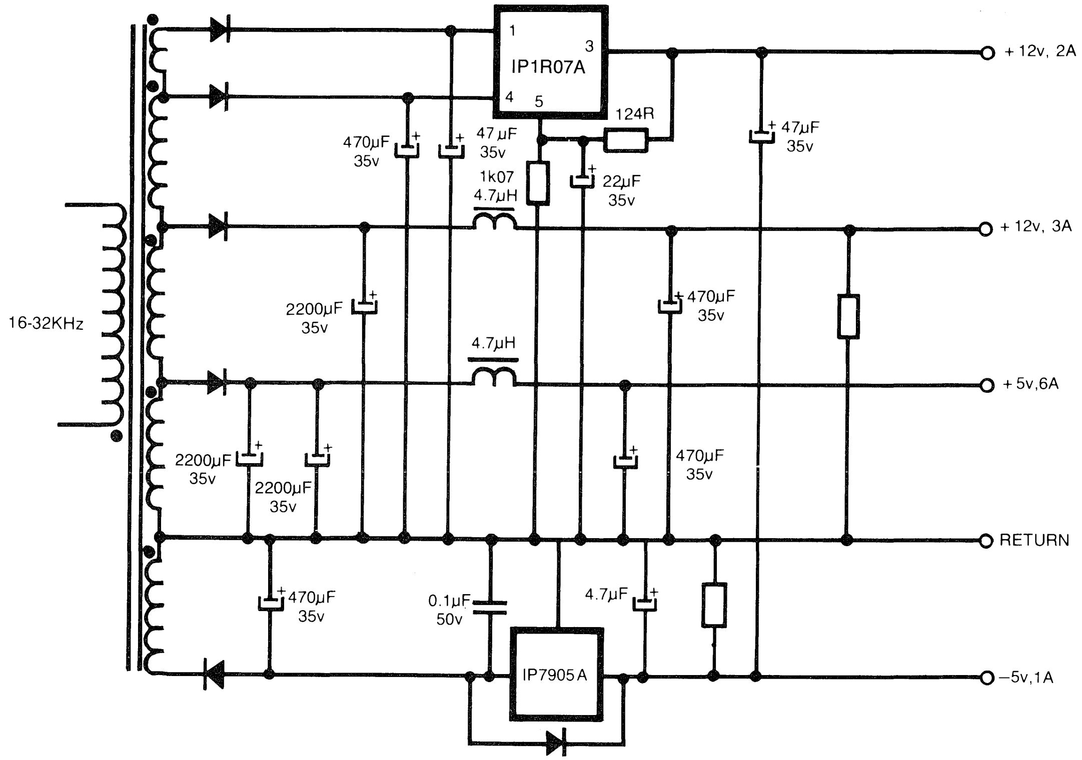
(a) Filter choke overwind



(b) Secondary peak rectification

Figure 5: Forward converter secondary linear regulation

DEVELOPING THE BIAS RAIL



The IP1R07A linear post regulator in a self oscillating flyback converter.

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A TYPICAL APPLICATION

Secondary post regulated 12V rail for visual display unit;

In desk top computers the power supply often powers a visual display unit in addition to the processor circuitry and disc drive. In the absence of post regulation the power supply may interact with the V.D.U. as follows:-

(a) Line time base/switching frequency interaction: This phenomenon occurs in variable frequency converters and manifests itself as a band travelling down the screen or image jitter.

(b) Dynamic cross regulation effects;
Generally observed as partial image collapse synchronous to pulse loading on other supply rails, this may occur during head movements in a disc drive or step current demands from a printing operation.

Each of these effects can be eliminated by using linear post regulation for the VDU power rail.

Typically the VDU current demand is a 1-1.2A resistive current plus a 3.0A band consisting of 50Hz half sinusoid field current pulses. A typical circuit arrangement for an SMPS post regulator application using the IP1R07A is shown in figure 6.

SUMMARY

The IP1R07A linear post regulator introduces a new concept in switch-mode power supply secondary regulation. The provision of a low current bias rail is a small price to pay for the increase in system efficiency contributed by this adaptable device.

Seagate Microelectronics Limited

APPLICATIONS INFORMATION

THE IP34063 SWITCHING REGULATOR CONTROL CIRCUIT

INTRODUCTION

The Seagate Microelectronics IP34063 series (Figure 1) are monolithic control circuits which contain all the active functions necessary for single-ended DC-DC converter designs. A simplified version of the 78S40, Figure 2, the IP34063 design has included the operational amplifier and on-chip flywheel diode, which are not required for the majority of DC-DC converter systems; the flywheel diode in the 78S40 being an inefficient component and in most applications replaced by an off-chip device.

The IP34063 contains internal voltage reference, comparator, controlled duty cycle oscillator with current limit circuit and a high current output switch (1.5 Apk), as shown in Figure 1.

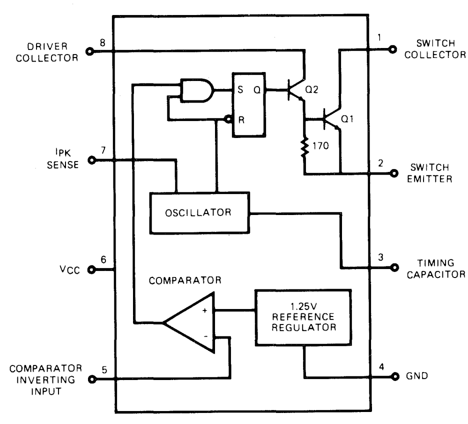

Fig. 1 IP34063/33063/35063 Block Diagram

These functions make the IP34063 ideally suited for Buck, Boost and inverting converter applications, and results in a significant reduction of system parts count. The devices are available in 8 pin dual inline or surface mount packages.

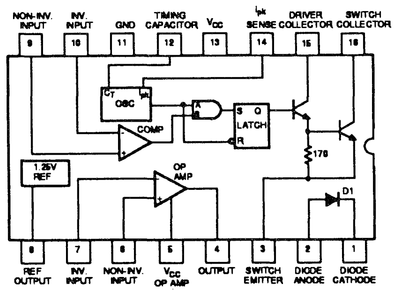

Fig. 2 78S40

PRINCIPAL OF OPERATION

The IP34063 has an unusual mode of operation which needs to be explained to gain a complete understanding of the device.

First let us consider the operation of what is termed a standard PWM power supply control IC.

STANDARD PWM CONTROL IC OPERATION

A simplified block diagram of a standard PWM power supply control IC is shown in Figure 3. The main power switch is controlled by the output of a pulse width modulator.

The PWM signal which directly controls and regulates the power supply is derived from a comparison between a DC voltage proportional to output error and a ramp signal derived from an oscillator. Figure 4 highlights the operation. Each time the oscillator ramp is reset to its low state, the PWM signal turns the switch on. Subsequently, when the oscillator signal ramps up to the DC error voltage, the switch turns off.

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In a system such as this the switching frequency is set by the oscillator, and the switch duty cycle is set by the DC error voltage.

The output signal is therefore always synchronized with the oscillator reset.

This control method can therefore be termed proportional control and has the advantage of excellent regulation and transient response.

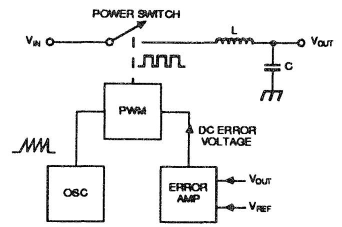


Fig. 3 Simplified PWM Power Supply

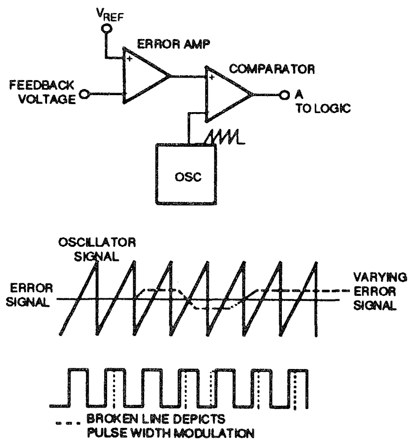


Fig. 4 Standard PWM Control IC Operation

IP34063 — FUNCTIONAL DESCRIPTION

In the case of the IP34063, the operation described for the standard PWM control IC is modified. Referring to Figure 1, it can be seen that the power switch is controlled by an on-off signal derived from a digital comparison (based on high or low states) between the oscillator and the comparator output signal.

That is, a direct comparison between the oscillator and an error signal does not take place. This unusual mode of operation means that there is no actual pulse width modulation at all.

THE OSCILLATOR

An external timing capacitor C_T is charged and discharged by a current source and sink circuit which contains upper and lower preset thresholds, subsequently deriving the ramp waveform shown in Figure 5.

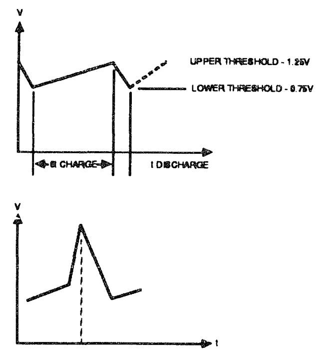


Fig. 5 Oscillator Waveforms During Normal and Overdrive (Overcurrent Sense Conditions)

The required ramp up and down times are yielded by designing the IP34063 so that the discharge current is six times greater than the charge current yield.

The oscillator therefore produces a signal with a fixed 6/7 or 85.7% duty cycle.

During the ramp-up portion of the cycle, a logic 1 is present at the A input of the AND gate.

If the output voltage of the switching regulator is below normal (refer to Figure 6), the output of the comparator will present a logic 1 at the B input

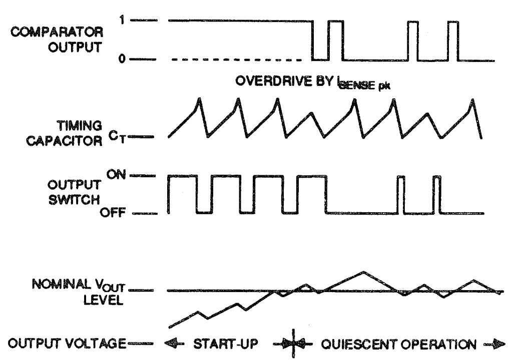


Fig. 6 IP34063 Operating Waveforms

of the AND gate. These conditions set the latch and cause the Q output to go to a logic 1, enabling the driver and the output switch to conduct.

When the oscillator ramp reaches its upper threshold, C_T will begin discharging, and a logic 0 will be present at the A input of the AND gate. The latch is then reset and the driver and switch turned off.

The output is off regardless of comparator state during the ramp down period of the oscillator signal, and is synchronous with the oscillator ramping down, while the turn on transition is totally non synchronous. There is actually no pulse width modulation at all. The effective output pulse can and does vary in frequency and phase with respect to the on-chip oscillator waveform, due to the fact that a turn on is not completely assured during the oscillator ramp up period, if the comparator output is not in a correct logic state. Table 1 presents the necessary conditions for output switch turn on and turn off.

Output variation is from a full 85.7% duty cycle where the comparator input is lower than the 1.25V reference, as start up to zero duty cycle when the comparator input is higher than V_{Ref}. In between these end points the turn on and turn off points are a combination of the output filter controlled ripple, oscillator frequency ripple, and system noise.

CURRENT LIMIT

The current limit or I_{pk} sense input to the oscillator also affects system duty cycle by altering the oscillator ramp waveform.

Monitoring the voltage drop across an external sense resistor placed in series with V_{CC} and the output switch gives a voltage on the I_{pk} sense pin which, if greater than 330mV, increases the charging current to the timing capacitor C_T, as shown in Figure 5(b).

This enables a faster transition to the upper oscillator threshold, thereby shortening the on time of the output switch, and thus reducing the amount of energy stored in the inductor.

Operating the IP34063 in an overload or shorted condition will cause a very short but finite time of output conduction, which can then be followed by either a normal or extended off-time interval provided by the oscillator ramp-down time of C_T.

Table 1 IP34063 Truth Table

Active Condition of	AND Gate Inputs		Latch Inputs		Output	
Timing Capacitor C_T	A	B	S	R	Switch	Comments on State of Output Switch
Begins Ramp-up	/	0	0	\	0	Switching Regulator's Output is ≥ nominal ("B" = 0).
Begins Ramp-Down	\	0	0	/	0	No change since "B" was 0 before C_T Ramp-Down.
Ramping Down	0	/	0	1	0	No change even though switching regulator output < nominal. Output switch cannot initiated durintg C_T Ramp-Down.
Ramping Down	0	\	0	1	0	No change since output switch conduction was terminated when "A" went to 0.
Ramping Up	1	/	/	0	/	Switching regulator's output went < nominal during C_T Ramping Up ("B" ⇒ 1). Partial on cycle for output switch.
Ramping Up	1	\	\	0	1	Switching regulators output went ≥ nominal ("B" ⇒ 0) during C_T Ramp-Up. No change since "B" cannot reset latch.
Begins Ramp-Up	/	1	/	\	/	Complete on-cycle since "B" was 1 before C_T started Ramp-Up.
Begins Ramp-Down	\	1	\	/	\	Output switch conduction is always terminated whenever C_T is Ramping Down.

Note 1. Output switch can only be activated during ramp up portion of oscillator signal.
Note 2. Activation is a function of comparator output state.
Note 3. Output switch is only activated during ramp down of oscillator signal.

APPLICATIONS INFORMATION

SOFT START

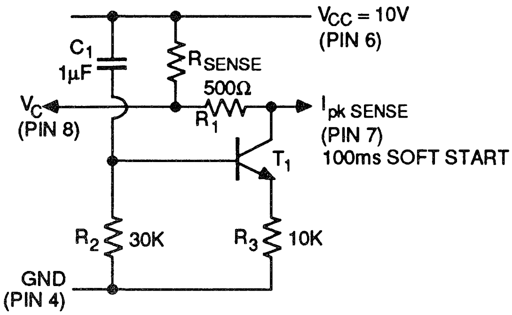


Fig. 7 IP34063 Soft Start Circuit

The IP34063, does not have the feature of on chip soft start circuitry. However, a simple circuit which can be added to achieve soft start is shown in Figure 7.

The circuit uses the I_{pk} sense pin to overdrive the oscillator, thereby speeding up the ramp-up time and shortening the on time of the output switch.

When V_{CC} is applied to the circuit, T1 is on and I_{pk} overdrives the oscillator. As capacitor C1 charges up, T1 turns off reducing the overdrive voltage on the I_{pk} sense pin and finally returning the device to normal operation. The circuit shown provides a soft start time of approximately 100ms.

Under extreme conditions, the voltage across C_T can approach V_{CC} when the current limit sense input is overdriven; this provides a relatively long off time.

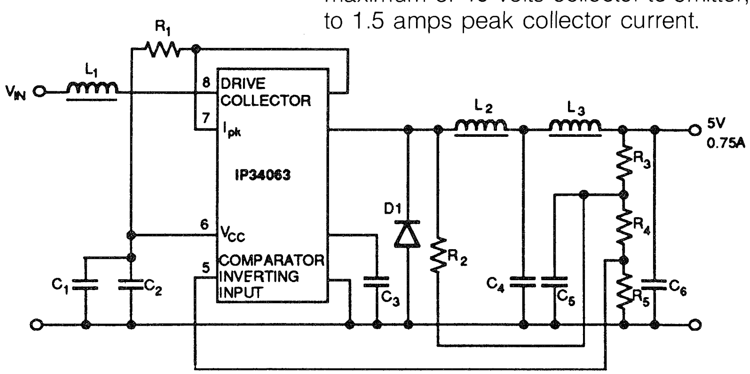
This mode of operation is an excellent device protection feature due to the reduced power dissipation of the output switch that results from the long off time.

DRIVER AND OUTPUT SWITCH

To improve flexibility in designing with the IP34063 the driver collector, output switch collector, and emitter are pinned out separately.

This allows the option of driving the output transistor into saturation with selected forced gain or driving it near saturation when connected as a darlington.

The output switch has a typical current gain of 70 at 1 amp, and is designed to switch a maximum of 40 volts collector-to-emitter, with up to 1.5 amps peak collector current.



Parts List
C1 — 10µf 50V
C2 — 0.1 µf 50V
C3 — 680pf
C4 — 470µf 6.3V
C5 — 0.1µf
C6 — 47µf
R1 — 0.2Ω
R2 — 20KΩ
R3 — 2KΩ
R4 — 13KΩ
R5 — 13KΩ
L1 — 100µh 501/2T 0.3mm DR6 x 8mm BOBBIN SD CORE H7c1
L2 — 150µh 0.3mm RM8/H7c1 CORE, AIR GAP 0.3mm
D1 — PHILLIPS BYV27 — 50

Fig. 8 Practical Power Supply Design

6

APPLICATIONS INFORMATION

PRACTICAL POWER SUPPLY DESIGN

The unusual operating mode of the IP34063 does not detract from its usefulness. In fact, excellent performance and design benefits can be achieved from its use. A DC-DC converter design is shown in Figure 8. The circuit operates off a 10 to 40 volt input and is capable of supplying 1.0 amps at 5.0 volts.

The circuit is designed so that the output pulse is synchronous with the oscillator signal. As previously explained the output pulse normally varies asynchronously with the oscillator waveform, due to the method of regulation the device employs.

The key to the circuit is that the output is well filtered and a portion of the output switch voltage is fed to the string of output reference resistors; with a single-pole response for 90° phase shift.

This produces a sawtooth waveform superimposed on the DC signal fed back to the comparator; and by double filtering the output the predominant signal at the comparator pin is the sawtooth on a DC bias. With this composite signal a fairly stable power pulse starting point relative to the oscillator signal is produced, as well as a known pulse turn off point, which is directly controlled by the oscillator.

This circuit yields a practical converter that produces a current of 0.6 to 1 amp at an input range of 10 to 40 volts. The output noise is 5mV, line regulation at 0.75A of 20mV, and load regulation of 50mV at 0.6A to 0.95A output current.

The efficiency varies from 70 to 80 percent.

APPLICATIONS INFORMATION

1% POSITIVE ADJUSTABLE REGULATORS

Seagate Microelectronics families of three terminal positive adjustable voltage regulators are exceptionally easy to use and require only two external resistors to set the output voltage. Over 1.25V to 35V output range the IP117A series is capable of supplying in excess of 1.5A, the IP150A series can supply in excess of 3A, and the IP138A series supplies in excess of 5A.

In addition to improved line and load regulation, a major feature of the "A" series is the initial output voltage tolerance, which is guaranteed to be less than 1%. Over full operating conditions including load, line, and power dissipation, the reference voltage is guaranteed not to vary more than 2%. These devices exhibit current limit, thermal overload protection, and improved power device safe operating are protection, making them essentially indestructable.

Applications for these devices include adjustable power supplies, constant current regulation, improved linear regulators and battery chargers.

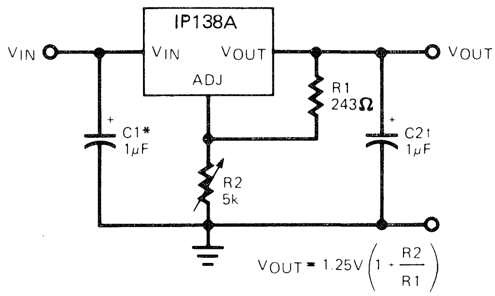


Fig. 1 Basic Adjustable Regulator

GENERAL

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Functioning as a three terminal floating regulator these 1% devices develop and maintain a nominal 1.25V reference voltage (V_{REF}) between its output and adjustment terminals, as illustrated in Figure 1. If this reference voltage is applied across R_1, a constant current I1 is caused to flow through R2, thereby adjusting the output voltage to

$$V_{OUT} = V_{REF} (1 = R2/r-) + I_{ADJ}R2$$

Because the 50μA of adjustment current represents an error term in the output voltage expression, the IP117A, IP150A, and IP138A series were designed to minimize both the value of I_{ADJ} and its variation with line and load changes. As a result, all but 50uA of the circuit's quiescent operating current appears at the output terminal, thereby establishing a minimum load current requirement. If the value of R1 is such that the minimum load current is not exceeded, the output voltage will rise.

ACCURACY OF THE OUTPUT VOLTAGE

From the expression above it is evident that even if the resistors R1 and R2 are of exact value, the accuracy of the output voltage is limited by errors in V_{REF}. Earlier adjustable regulators have had a reference tolerance of ±4%, which is dangerously close to the ±5% supply tolerance required in many logic and analog systems. In addition, 1% resistors can drift up to ±0.01%/°C, increasing the output voltage tolerance even further. For example, using 2% resistors and a ±4% tolerance for V_{REF}, calculations indicate that a 5V regulator design will vary between 4.66V and 5.36V, which is a tolerance of ±7%. If the same procedure were used in the design of a 15V regulator instead the expected tolerance would increase to ±8%. as a result of these errors most applications require some method of trimming, which is both expensive and not conducive to volume production.

APPLICATIONS INFORMATION

One of the design enhancements featured in Seagate Microelectronics adjustable regulators is the tightened initial tolerance in the value of V_{REF}. Production wafer-level trimming techniques now enable the reference voltage to be specified within 1%. This allows relatively inexpensive 1% or 2% film resistors to be used for R1 and R2 to set the output voltage, and acceptable system output voltage tolerances to be achieved.

With a guaranteed 1% reference, a 5V power supply design, using 2% resistors, would have a worst case manufacturing tolerance of ±4%. If 1% resistors were used, the tolerance would drop to ±2%.

For convenience, a table of standard 1% resistor values shown below.

Table of 1/2% and 1% Standard Resistance Values

1.00	1.47	2.15	3.16	4.64	6.81
1.02	1.50	2.21	3.24	4.75	6.98
1.05	1.54	2.26	3.32	4.87	7.15
1.07	1.58	2.32	3.40	4.99	7.32
1.10	1.62	2.37	3.48	5.11	7.50
1.13	1.65	2.43	3.57	5.23	7.68
1.15	1.69	2.49	3.65	5.36	7.87
1.18	1.74	2.55	3.74	5.49	8.06
1.21	1.78	2.61	3.83	5.62	8.25
1.24	1.82	2.67	3.92	8.76	8.45
1.27	1.87	2.74	4.02	5.90	8.66
1.30	1.91	2.80	4.12	6.04	8.87
1.33	1.96	2.87	4.22	6.19	9.09
1.37	2.00	2.94	4.32	6.34	9.31
1.40	2.05	3.01	4.42	6.49	9.53
1.43	2.10	3.09	4.53	6.65	9.76

Standard Resistance Values are obtained from the Decade Table by multiplying by multiples of 10. As an example, 1.21 can represent 1.21Ω, 12.1Ω, 121Ω, 1.21KΩ etc.

BYPASS CAPACITORS

Input bypassing using a 1μF tantalum or 25μF electrolytic capacitor is recommended when the input filter capacitors are more than 5 inches from the device. Improved ripple rejection (80 dB) can be achieved by adding a 10μF capacitor from the adjust pin to ground. Increasing the size of the capacitor to 20μF will help ripple rejection at low output voltage since the reactance of this capacitor should be small compared to the voltage setting resistor, R2. For improved AC transient response and to prevent the possibility of oscillation due to unknown reactive load, a 1μF capacitor is also recommended at the output. because of their low impedance at high frequencies, the best type of capacitor to use is solid tantalum.

PROTECTION DIODES

The IP117A, IP150A and IP138A series of adjustable regulators do not require a protection diode from the adjustment terminal to the output (see Figure 2). Improved internal circuitry eliminates the need for this diode when the adjustment pin is bypassed with a capacitor to improve ripple rejection.

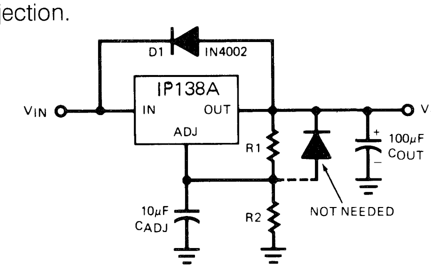

Fig. 2

If a very large output capacitor is used, such as 100μF shown in Figure 2, the regulator could be damaged or destroyed if the input is accidentally shorted to ground or crowbarred. This is due to the output capacitor discharging into the output terminal of the regulator. To prevent damage a diode D1 is recommended to safely discharge the capacitor.

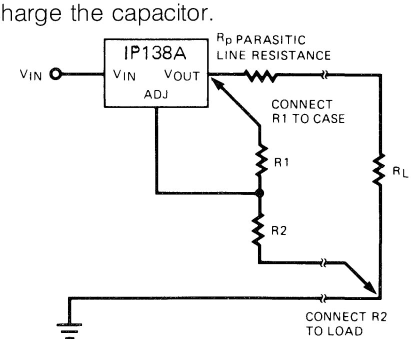

Fig. 3 Connections for Best Load Regulation

APPLICATIONS INFORMATION

LOAD REGULATION

Because these regulators are three terminal devices, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistence of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider (R1) is connected directly to the case not to the load. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be

$$Rp \times \left(\frac{R + R1}{R1}\right),\ Rp = \text{Parasitic Line Resistance}$$

Connected as shown, Rp is not multiplied by the divider ration. Rp is about 0.004Ω per foot using 16 gauge wire. This translates to 4mV/ft at 1A load current, so it is important to keep the positive lead between regulator and load as short as possible, and use large wire or PC board traces.

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APPLICATIONS INFORMATION

FIXED OUTPUT VOLTAGE REGULATORS

Seagate Microelectronics provides three terminal voltage regulators with several fixed output voltages which are useful in a wide range of applications. Devices specified at 1 amp include the IP140A, LM140, IP7800A and IP7800 series of positive regulators. These devices are available with 5, 12 and 15V outputs. Negative regulators specified at 1.5 amps include the IP120A, LM120, IP7900A and IP7900 series. These devices have −5, −12 and −15V fixed output voltages available.

The A-suffix devices provide 0.01% per volt line regulation. Load regulation is 0.3% per amp and output voltage tolerance at room temperature is ±1%. Protection features include safe operating area current limiting and thermal shutdown.

These regulators are all available in the metal TO-3 and TO-66 power packages as well as the 0.5A version TM1 78M479M in metal TO-39 can. The TO-257 (hermetic TO-220 style) power package is available for the IP120A/LM120/IP140A/LM140/IP7800A/IP7800 series.

The fixed output regulator series is designed with thermal protection, output short-circuit protection and output transistor safe area protection. However, as with any IC regulator, it becomes necessary to take precautions to assure that the regulator is not inadvertently damaged. The following describes possible misapplications and methods to prevent damage to the regulator.

Shorting the Regulator Input: When using large capacitors at the output of these regulators, a protection diode connected input to output (Figure 1) may be required if the input is shorted to ground. Without the protection diode, an input short will cause the input to rapidly approach ground potential, while the output remains near the initial V_{OUT} because of the stored charge in the large output capacitor. The capacitor will then discharge through a large internal input to output diode and parasitic transistors. If the energy

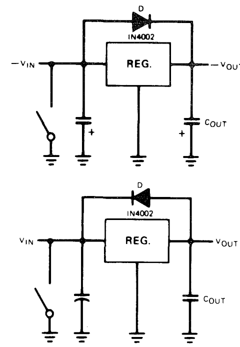

Fig. 1 Input Short

released by the capacitor is large enough, this diode, low current metal and the regulator will be destroyed. The fast diode in Figure 1 will shunt most of the capacitor's discharge current around the regulator. Generally no protection diode is required for values of output capacitance ⩽10 μF.

Raising the Output Voltage above the Input Voltage with a Positive Regulator: Since the output of the regulator does not sink current, forcing the output high can cause damage to internal low current paths in a manner similar to that just described in the "Shorting the Regulator Input" section.

Pulling the Output Voltage Below the Input Voltage with a Negative Regulator: Since the output of the regulator does not source current, forcing the output low can cause damage to internal low current paths in a manner similar to that described in the "Shorting the Regulator Input" section.

APPLICATIONS INFORMATION

Regulator Floating Ground (Figure 2): When the ground pin alone becomes disconnected, the output approaches the unregulated input, causing possible damage to other circuits connected to V_{OUT}. If ground is reconnected with power "ON", damage may also occur to the regulator. This fault is most likely to occur when plugging in regulators or modules with on card regulators into powered up sockets. Power should be turned off first, or ground should be connected first if power must be left on.

Transient Voltages: If transients exceed the maximum rated input voltage of the regulator, or reach more than 0.8V below ground (0.8V above ground for negative regulators) and have sufficient energy, they will damage the regulator. The solution is to use a large input capacitor, a series input breakdown diode, a choke, a transient suppressor or a combination of these.

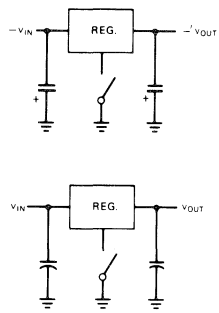

Fig. 2 Regulator Floating Ground

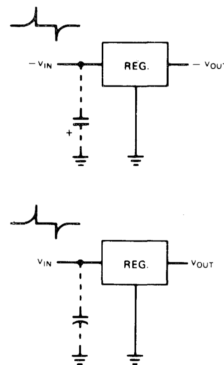

Fig. 3 Transients

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APPLICATIONS INFORMATION

1.5 AMP NEGATIVE ADJUSTABLE REGULATORS

The IP137A, LM137, IP137AHV, and LM137HV series of negative adjustable regulators will deliver up to 1.5 amps output current over an output voltage range of −1.2V to −47V. Seagate Microelectronics has made significant improvements in these regulators compared to previous devices, such as better line and load regulation. The A-suffix devices provide 0.1% per volt line regulation, 0.5% load regulation and a maximum output voltage error of 1%.

Internal current limiting coupled with true thermal limiting prevents device damage due to overloads or shorts, even if the regulator is not fastened to a heat sink. Thermal regulation is 0.02% per watt.

Applications include adjustable power supplies, system power supplies, precision voltage regulators and on-card regulators.

Maximum reliability is attained with Seagate Microelectronic's advanced processing techniques.

OUTPUT VOLTAGE

The output voltage is determined by two external resistors, R1 and R2 (see Figure 1). The exact formula for the output voltage is:

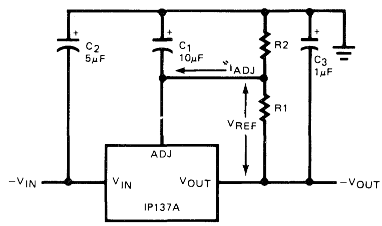
$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R2)$$

Where: V_{REF} = Reference Voltage, I_{ADJ} = Adjustment Pin Current.

In most applications, the second term is small enough to be ignored, typically about 0.5% of V_{OUT}. In more critical applications, the exact formula should be used, with I_{ADJ} equal to 65 uA. Solving for R2 yields:

$$R2 = \frac{V_{OUT} - V_{REF}}{\frac{V_{REF}}{R1} - I_{ADJ}}$$

Smaller values of R1 and R2 will reduce the influence of I_{ADJ} on the output voltage, but the no-load current drain on the regulator will be increased. Typical values for R1 are between 100Ω and 300Ω giving 12.5mA and 4.2mA no-load current respectively. There is an additional consideration in selecting R1, the minimum load current specification of the regulator.



EXAMPLES:

1. A precision 10V regulator to supply up to 1Amp load current.
   a. Select R_1 = 100Ω to minimize effect of I_{ADJ}
   b. Calculate $R_2 = \frac{V_{OUT} - V_{REF}}{\frac{V_{REF}}{R_1} - I_{ADJ}} = \frac{10V - 1.25V}{\frac{1.25V}{100\Omega} - 65\mu A} = 704\Omega$
2. A 15V regulator to run off batteries and supply 50mA V_{IN} MAX = 25V
   a. To minimize battery drain, select R_1 as high as possible
      $R_1 = \frac{1.25V}{3mA} = 417\Omega$, use 404Ω, 1%
   b. The high value for R_1 will exaggerate the error due to I_{ADJ}, so the exact formula to calculate R_2 should be used.
      $R_2 = \frac{V_{OUT} - V_{REF}}{\frac{V_{REF}}{R_1} - I_{ADJ}} = \frac{15V - 1.25V}{\frac{1.25V}{404\Omega} - 65 \times 10^{-6}} = 4539\Omega$

      Use R_2 = 4530Ω

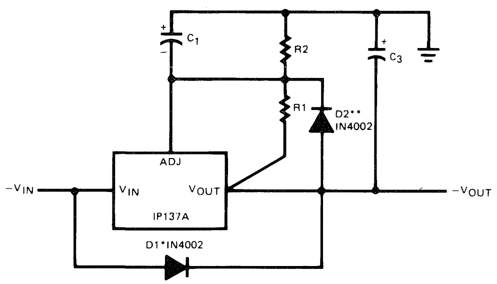
Figure 1

The operating current of the IP137A flows from input to output. If this current is not absorbed by the load, the output of the regulator will rise above the regulated value. The current drawn by R1 and R2 is normally high enough to absorb the current, but care must be taken in no-load situations where R1 and R2 have high values. The maximum value for the operating current, which must be absorbed, is 5mA for the IP137A. If input-output voltage differential is less than 10V, the operating current that must be absorbed drops to 3mA.

APPLICATIONS INFORMATION

CAPACITORS AND PROTECTION DIODES

An output capacitor, C3, is required to provide proper frequency compensation of the regulator feedback loop. A 1μF or larger solid tantalum capacitor is generally sufficient for this purpose if the 1MHz impedance of the capacitor is 2Ω or less. High Q capacitors, such as Mylar, are not recommended because they tend to reduce the phase margin at light load currents. Aluminium electrolytic capacitors may also be used, but the minimum value should be 10μF to ensure a low impedance at 1MHz. The output capacitor should



D1 protects the regulator from input shorts to ground. It is required only when C3 is larger than 20μF and V_{OUT} is larger than 6V.

** D2 protects the adjust pin of the regulator from output shorts if C2 is larger than 10μF *and* V_{OUT} is larger than −25V.

Figure 2

be located within a few inches of the regulator to keep lead impedance to a minimum. The following caution should be noted: if the output voltage is greater than 6V and a output capacitor greater than 20μF has been used, it is possible to damage the regulator if the input voltage becomes shorted, due to the output capacitor discharging into the regulator. This can be prevented by using diode DI (see Figure 2) between the input and the output.

The input capacitor, C2, is only required if the regulator is more than 4 inches from the raw supply filter capacitor.

BYPASSING THE ADJUSTMENT PIN

The adjustment pin of the IP137A may be bypassed with a capacitor to ground, C1, to reduce output ripple, noise, and impedance. These parameters scale directly with output voltage if the adjustment pin is not bypassed. A bypass capacitor reduces ripple, noise, and impedance to that of a 1.25V regulator. In a 15V regulator for example, these parameters are improved by 15V/1.25V = 12 to 1. This improvement holds only for those frequencies where the impedance of the bypass capacitor is less than R1. 10μF is generally sufficient for 60Hz power line applications where the ripple frequency is 120Hz, since X_C = 130Ω. The capacitor should have a voltage rating at least as high as the output voltage of the regulator. Values larger than 10μF may be used, but if the output is larger than 25V, a diode, d2 should be added between the output and adjustment pins (see Figure 2).

PROPER CONNECTION OF DIVIDER RESISTORS

The IP137A has an excellent load regulation specification of 0.5% and is measured at a point 1/8″ from the bottom of the package. To prevent degradation of load regulation, the resistors which set output voltage, R1 and R2, must be connected as shown in Figure 3. Note that the positive side of the load has a true force and sense (Kelvin) connection, but the negative side of the load does not.

R1 should be connected directly to the output lead of the regulator, as close as possible to the specified point 1/8″ from the case. R2 should be connected to the positive side of the load separately from the positive (ground) connection to the raw supply. With this arrangement, load regulation is degraded only by the resistance between the regulator output pin and the load. If R1 is connected to the load, regulation will be degraded.

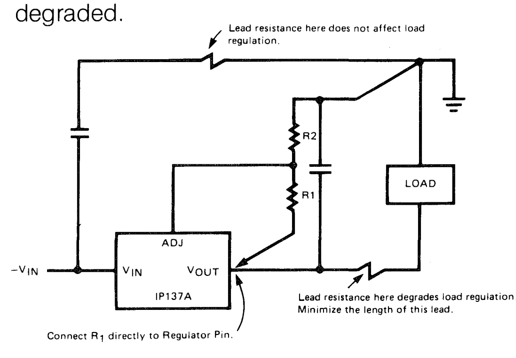


Figure 3

PACKAGE INFORMATION

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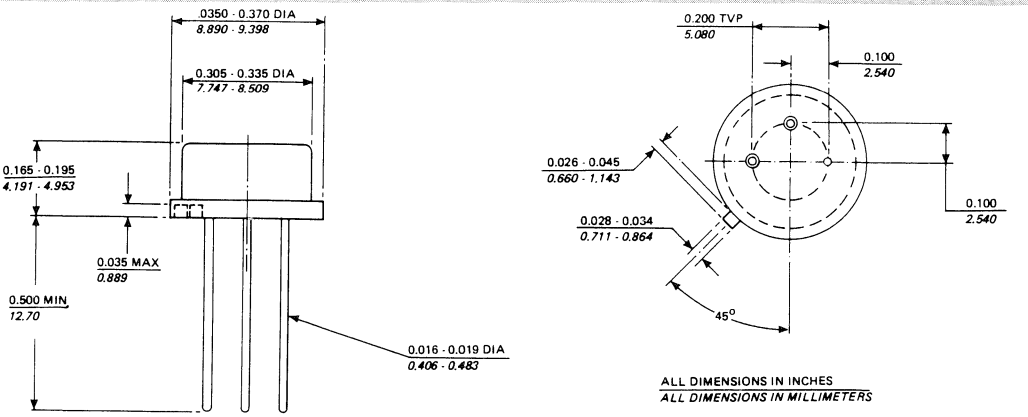
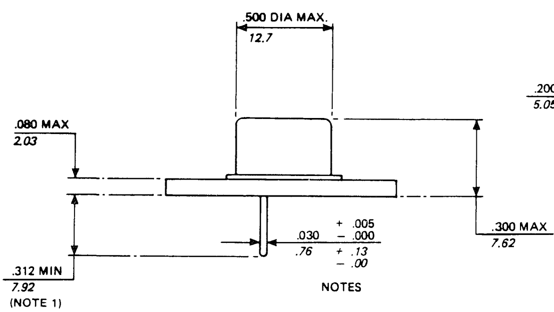
PACKAGE INFORMATION

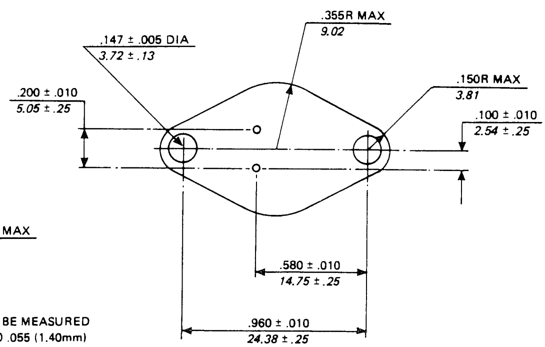
3-lead TO-39 Metal Package (H)



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

2-lead TO-66 (R)

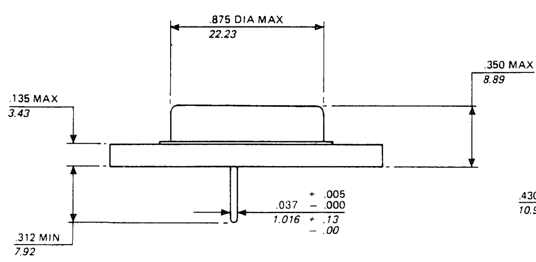


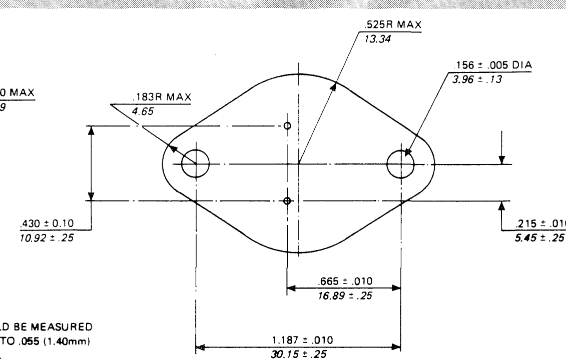


NOTES

1. THIS DIMENSION SHOULD BE MEASURED AT POINT .050 (1.27mm) TO .055 (1.40mm) BELOW SEATING PLANE.
2. ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

2-lead TO-3 (K)





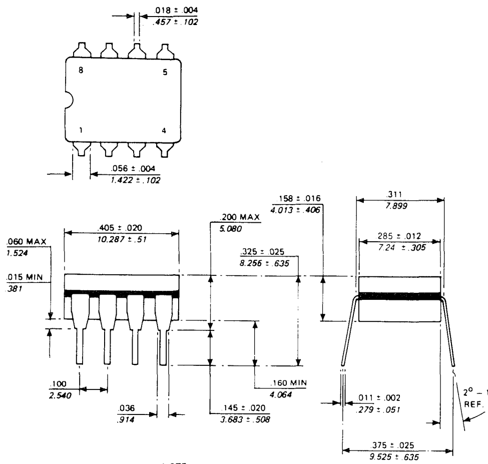
NOTES

1. THIS DIMENSION SHOULD BE MEASURED AT POINT .005 (1.27mm) TO .055 (1.40mm) BELOW SEATING PLANE.
2. ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

7

PACKAGE INFORMATION

8-lead Ceramic DIP (J)



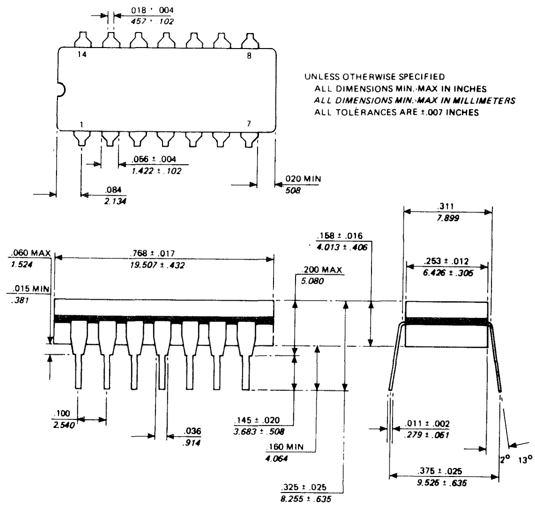
NOTE

ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

Notes:

1. Specified body dimensions allow for differences between SSI, MSI and LSI packages.
2. Lead material tolerances are for tin plate finish only. Solder dip finish adds 2-10 mils thickness to all lead tip dimensions.

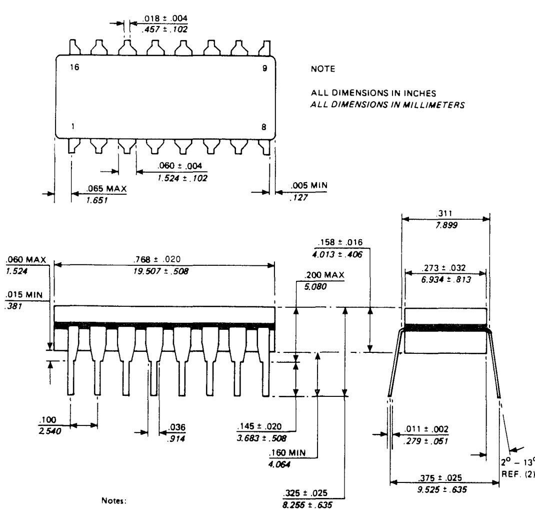
14-lead Ceramic DIP (J)



Note

Lead material tolerances are for tin plate finish only. Solder dip finish adds 2-10 mils thickness to all lead tip dimensions.

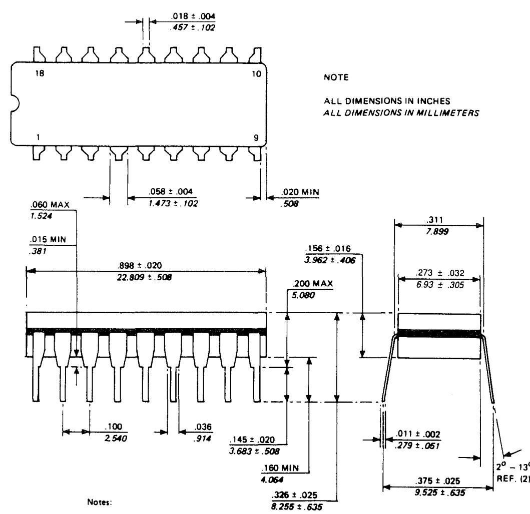
16-lead Ceramic DIP (J)



Notes:

1. Specified body dimensions allow for differences between SSI, MSI and LSI packages.
2. Lead material tolerances are for tin plate finish only. Solder dip finish adds 2-10 mils thickness to all lead tip dimensions.

18-lead Ceramic DIP (J)



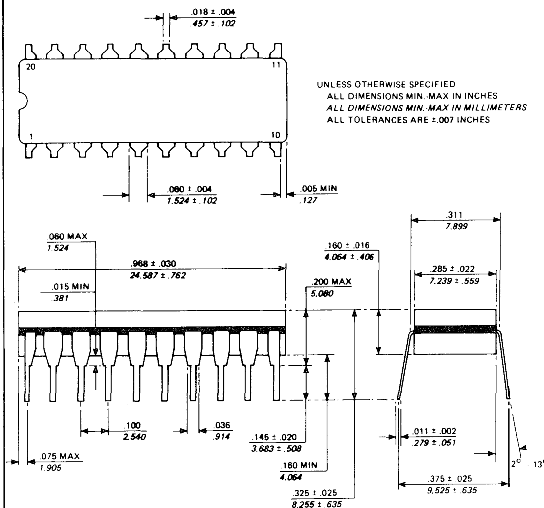
Notes:

1. Specified body dimensions allow for differences between SSI, MSI and LSI packages.
2. Lead material tolerances are for tin plate finish only. Solder dip finish adds 2-10 mils thickness to all lead tip dimensions.

7

PACKAGE INFORMATION

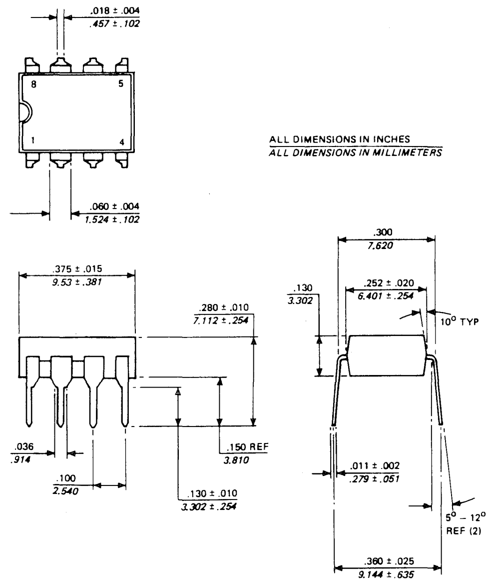
20-lead Ceramic DIP (J)



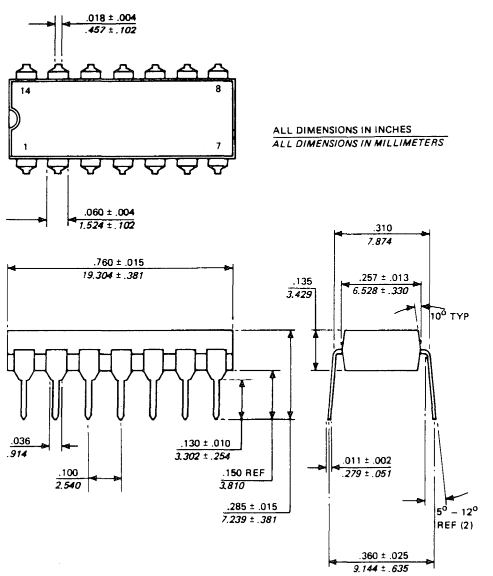
Notes

1. Specified body dimensions allow for differences betweenSSI, MSI and LSI packages.
2. Lead material tolerances are for tin plate finish only. Solder dip finish adds 2-10 mils thickness to all lead tip dimensions.

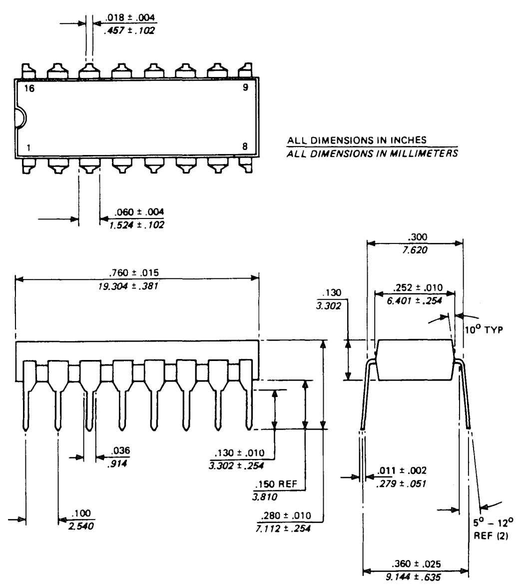
8-lead Molded DIP (N)



14-lead Molded DIP (N)



16-lead Molded DIP (N)



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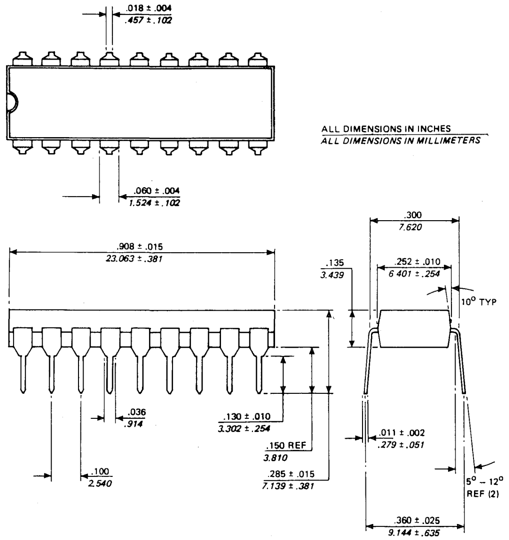
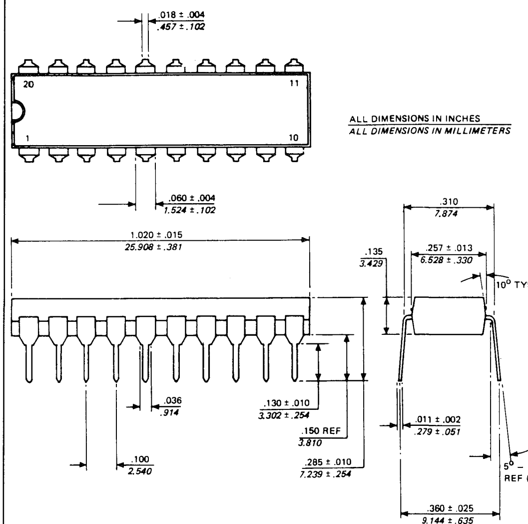
PACKAGE INFORMATION

18-lead Molded DIP (N)



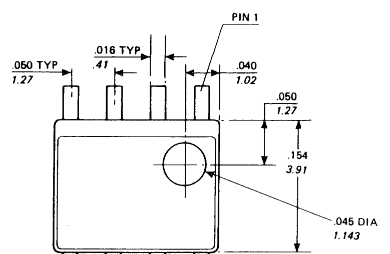
ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

20-lead Molded DIP (N)

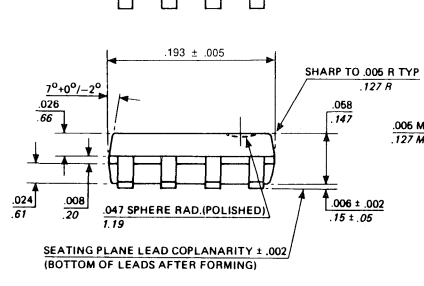


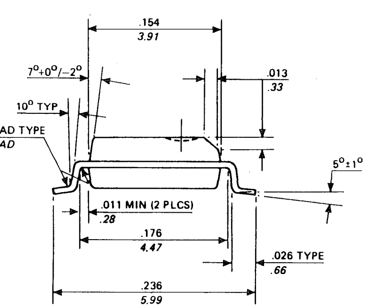
ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

8-lead S.O. (D)



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS





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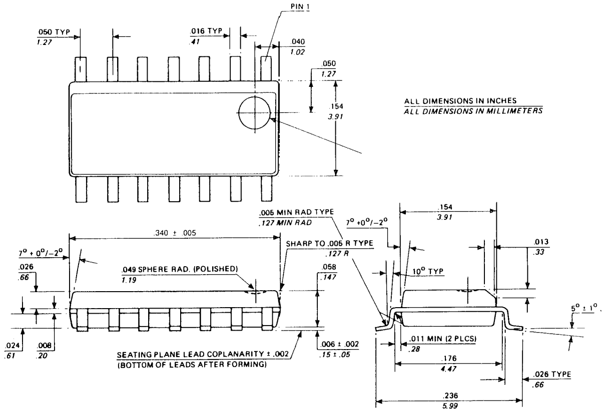
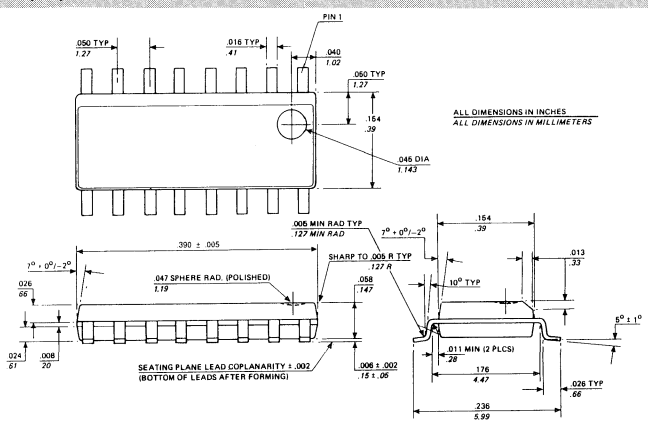
PACKAGE INFORMATION

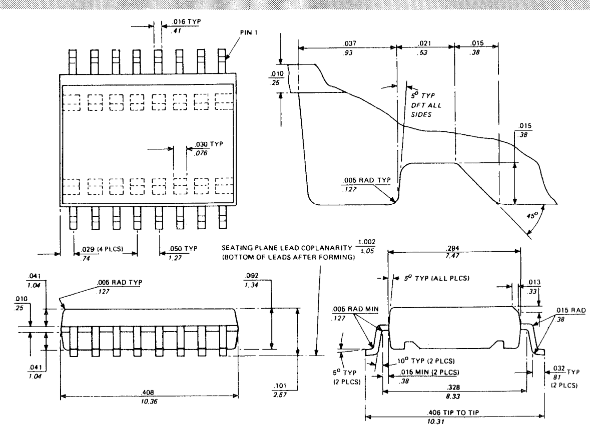
14-lead S.O. (D)



16-lead S.O. (D)



16-lead Wide Body S.O. (D)



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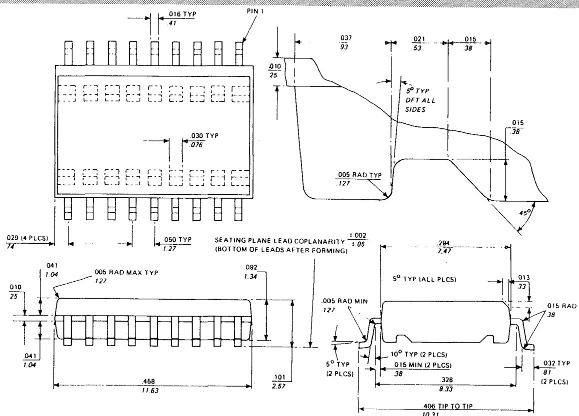
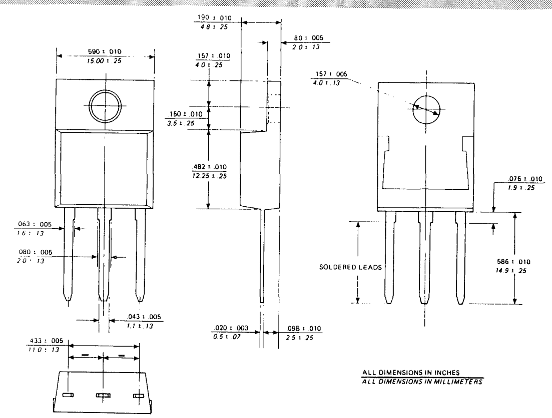
PACKAGE INFORMATION

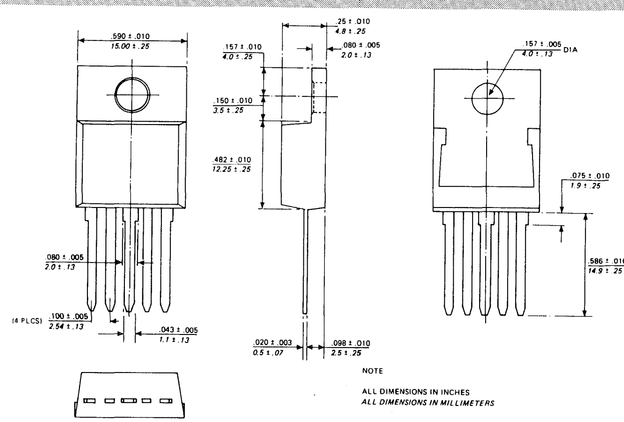
18-lead Wide Body S.O. (D)



3-lead TO-218 (V)



5-lead TO-218 (V)



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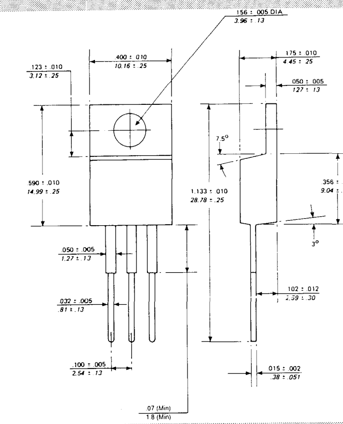
PACKAGE INFORMATION

3-lead TO-220 (T)

NOTE

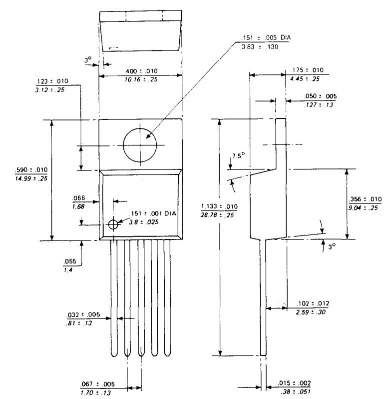
ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS



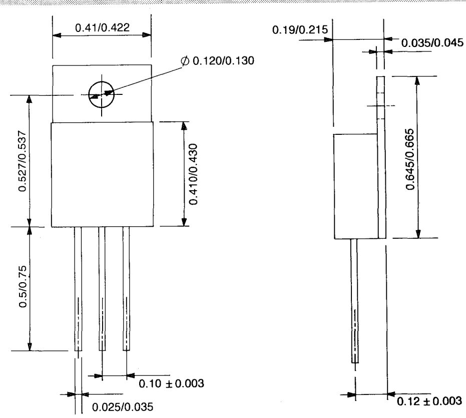
5-lead TO-220 (T)

NOTE

ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS



3-lead TO-257 (G)



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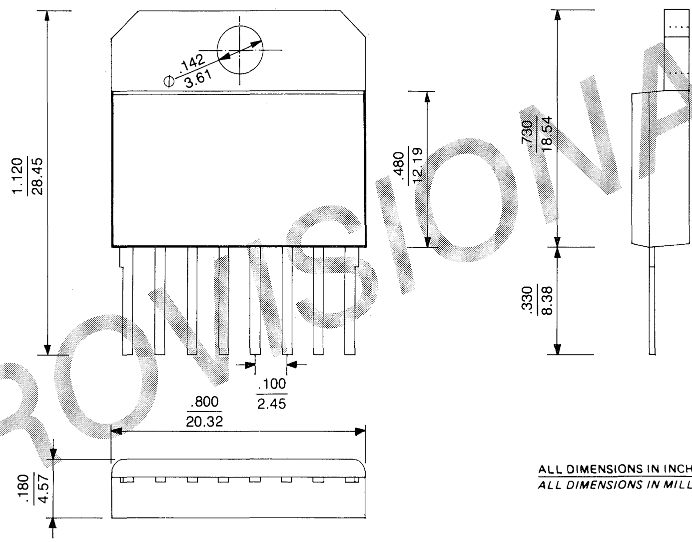
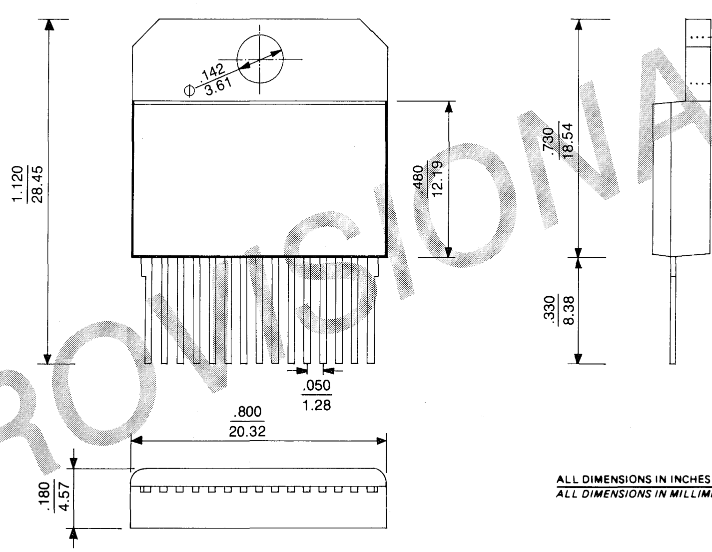
PACKAGE INFORMATION

8-lead 0.600 Power SIP (W)



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

15-lead 0.800 Power SIP (W)



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS IN MILLIMETERS

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MacIntosh Road, Kirkton Campus, Livingston EH54 7BW, Scotland.
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