QUICK REFERENCE GUIDE

Integrated circuits
Discrete semiconductors

FERRANTI
Semiconductors

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Quick Reference Guide

FERRANTI SEMICONDUCTORS

A short-form data book covering integrated circuits & discrete components

3rd Edition
1986

CONTENTS

This data book contains abbreviated information on the entire range of Ferranti Semiconductors.

Individual data sheets are available on request, as is technical advice on the usage of any of the devices listed.

PRODUCT INDEX – INTEGRATED CIRCUITS

PRODUCT INDEX – DISCRETE COMPONENTS

ALPHABETICAL LIST OF SYMBOLS

a	Turn-off base current factor (Tr)
A	Anode
A	Static current transfer ratio in common base circuit
AQL	Acceptable quality level
B	Base terminal
$B = h_{FE}$	Forward current transfer ratio, static, in common emitter circuit
β	Dynamic short-circuit forward current transfer ratio in common emitter circuit ($\beta = h_{21e}$)
$\beta_0 = h_{fe}$	Dynamic short-circuit forward current transfer ratio in common emitter circuit at f = 1 kHz
C, c	Collector terminal
C	Capacitance
$C_{b'c}$	Collector-junction capacitance
$C_{b'e}$	Emitter diffusion capacitance
Cc	Collector-junction capacitance (in general)
C_{case}	Case capacitance (in general)
C_{cb}	Collector-base-case capacitance
C_{CBO}	Collector-base capacitance (including case capacitance) with emitter open ($I_E = 0$)
$C_{c'b}$	Collector-junction capacitance
$C_{c'b'}$	Collector-junction capacitance
C_{ce}	Collector-emitter-case capacitance
C_D	Total diode capacitance
C_{eb}	Emitter-base-case capacitance
$C_{eb'}$	Emitter diffusion capacitance
C_{EBO}	Emitter-base capacitance (including case capacitance) with collector open ($I_C = 0$)
C_j	Junction capacitance of diodes
C_N	Neutralisation capacitance
C_n	Standardized capacitance
C_L	Load capacitance
C_p	Parallel capacitance
C_{th}	Thermal capacity (irrespective of heat dissipation to the environment)
C_{11}	Capacitance of the short-circuit input admittance (of parameter y_{11})
C_{12}	Capacitance of the short-circuit reverse transconductance (of parameter y_{12})
C_{21}	Capacitance of the short-circuit forward transconductance (of parameter y_{21})
C_{22}	Capacitance of the short-circuit output admittance (of parameter y_{22})
Di	Abbreviation for "diode"
E	Emitter terminal
E_{tr}	Transistor energy loss
f	Frequency
f_g	Cut-off frequency
f_α	Cut-off frequency of the short-circuit forward current transfer ratio in common base circuit
f_β	Cut-off frequency of the short-circuit forward current transfer ratio in common emitter circuit
$f_{\beta 1}$	Frequency at which $\beta = 1$
f_{max}	Maximum oscillation frequency
f_T	Current gain-bandwidth product (extrapolated cut-off frequency for $\beta = 1$: $f_T \approx f_{\beta 1}$)
g	Real component of the y-parameters
g_m	Internal transconductance
g_{th}	Coefficient thermal conductivity (total instantaneous value of thermal conduction)
$g_{th\ case}$	Coefficient of thermal conductivity (total instantaneous value of thermal conduction) between heat source and case, with infinitely good heat dissipation from the case ($T_{case} = T_{amb}$)

G	Admittance (DC or average value)
G_A	Anode gate
G_K	Cathode gate
G_p	Power gain
G_{pb}	Power gain in common base circuit
G_{pe}	Power gain in common emitter circuit
$G_{p\ opt}$	Optimum power gain
$G_{pb\ inv}$	Reverse power loss
$G_{pb\ opt}$	Optimum power gain in common base circuit
$G_{pe\ opt}$	Optimum power gain in common emitter circuit
G_{th}	Coefficient of thermal conductivity (thermal conduction constant)
G_{thJamb}	Coefficient of thermal conductivity (thermal conduction constant) between junction (heat source) and static ambient air
$G_{thJcase}$	Coefficient of thermal conductivity (thermal conduction constant) between heat source and case, with infinitely good heat dissipation from the case ($T_{case} = T_{amb}$)
G_{thL}	Coefficient of thermal conductivity (thermal conduction constant) between junction (heat source) and static ambient air when using a cooling plate of defined size.
γ	Dynamic short-circuit forward current transfer ratio in common collector circuit
h	Parameter of the hybrid matrix (h-matrix)
h_{11}	Short-circuit impedance
h_{12}	Open-circuit reverse voltage transfer ratio
h_{21}	Short-circuit forward current transfer ratio
h_{22}	Open-circuit output admittance
i_{AM}	Maximum recording current (peak value; Hd)
i_{BM}	Maximum base current (peak value)
i_{CM}	Maximum collector current (peak value)
i_{EM}	Maximum emitter current (peak value)
i_{FM}	Maximum forward current (peak value; Di)
i_{FS}	Surge current, maximum 1 sec
i_1	Input AC
i_{1M}	Maximum control current (peak value)
i_2	Output AC (in general)
I_A	Recording current (DC or average value)
I_A	Anode current
I_B	Base current (DC or average value)
I_{BAV}	Base current at stated integration time t_{av}
I_{B1}	Control current
I_{B2}	Turn-off base current
I_C	Collector current (DC or average value)
I_{CBO}	Collector-base cut-off current with emitter open ($I_E = 0$)
I_{CEO}	Collector-emitter cut-off current with base open ($I_B = 0$)
I_{CER}	Collector-emitter cut-off current with a resistance R_{BE} between base and emitter
I_{CES}	Collector-emitter cut-off current with a short-circuited emitter diode ($V_{BE} = 0$)
I_{CEV}	Collector-emitter cut-off current with blocked emitter diode
I_E	Emitter current (DC or average value)
I_{EAV}	Emitter current at stated integration time t_{av}
I_{EBO}	Emitter-base cut-off current with collector open ($I_C = 0$)
I_F	Forward current (DC or average value)
I_K	Short-circuit current
I_O	Rectified current
I_R	Reverse current
k	Distortion factor
L	Inductance
L_S	Series inductance

m	In a subscript: maximum (peak value)
max	In a subscript: maximum (e.g. upper limit of spread)
min	In a subscript: minimum (e.g. lower limit of spread)
M	In a subscript: maximum (peak value)
N	Number of turns
NF	Noise figure
NF_c	Mixing noise figure
P: p	Power dissipation
P_a	Amplifier output power
P_L	Amplifier dissipation power
P_I	Pulse dissipation
P_{tot}	Total power dissipation
Q	Quality factor
r	Resistance (instantaneous value)
$r_{bb'}$	Base series resistance
$r_{bb'}C_{b'c}$	Feedback time constant
$r_{cc'}$	Collector series resistance
$r_{eb'}$	Emitter series resistance
R	Resistance (DC or average value)
R_{BB}	Base dropping resistor
R_{BE}	Resistance between base and emitter
R_{CC}	Collector dropping resistor
R_d	Loss resistance (Di)
R_{EE}	Emitter dropping resistor
R_g	Internal resistance of generator
R_L	Load resistance
R_{LL}	Optimum load resistance
R_{min}	Minimum value of thermal resistance under continuous load
R_S	Series resistance
R_{th}	Thermal Resistance
$R_{thJcase}$	Thermal resistance between junction (heat source) and case with infinitely good heat dissipation from the case ($T_{case} = T_{amb}$)
R_{thc}	Thermal resistance of a chassis (cooling plate not heat sink)
R_{thL}	Thermal resistance between junction (heat source) and static ambient air when using a cooling plate of a defined size
R_{thJamb}	Thermal resistance between junction (heat source) and static ambient air
R_V	Dropping resistor
t	Time
t	Pulse length
t_{av}	Integration time
t_d	Delay time
t_f	Fall time
t_{fr}	Forward recovery time (Transistors): forward delay time (Diodes)
th	In subscript: thermal
t_{off}	Switch-off time
t_{on}	Turn-on time ($t_{on} = t_d + t_r$)
t_r	Rise time
t_{rr}	Reverse recovery time; reverse delay time
t_s	Storage time
t_{stg}	Storage time
t_{vu}	Approximate value of the voltage-dependent delay time
T	Temperature
T_{amb}	Ambient temperature
T_{case}	Case temperature
T_j	Junction temperature
T_r	Abbreviation for "transistor"
T_S	Storage temperature

T_{stg}	Storage temperature
ΔT	Temperature difference
τ	Cycle duration
τ	Time constant
τ_s	Storage time constant
τ_{th}	Thermal time constant (time in which a temperature difference ΔT changes by $\Delta T/e$)
v	Voltage (instantaneous value)
v_{FM}	Forward voltage, maximum (peak value)
V_{RF}	Input radio frequency voltage
v_{RM}	Maximum reverse voltage (peak value; Di)
v_{RS}	Surge voltage, maximum 1 sec (Di)
v_1	Input AC voltage
v_2	Output AC voltage
V	Voltage (DC or average value)
V_a (V_A)	Output voltage (measured peak-to-peak)
V_{batt}	Battery voltage
V_{BB}	Base operating voltage
V_{BE}	Base-emitter voltage
V_{BEfl}	Emitter open circuit DC voltage
V_{BEF}	Emitter forward voltage
$V_{(BR)CBO}$	Collector-base breakdown voltage
$V_{(BR)CEO}$	Collector-emitter breakdown voltage
$V_{(BR)EBO}$	Emitter-base breakdown voltage
V_{CB}	Collector-base voltage
V_{CBO}	Collector-base voltage with emitter open ($I_E=0$)
V_{CC}	Collector operating voltage
V_{CE}	Collector-emitter voltage
V_{CEO}	Collector-emitter reverse voltage base open ($I_B=0$)
V_{CER}	Collector-emitter reverse voltage with a resistor between base and emitter
V_{CES}	Collector-emitter voltage with short-circuited emitter diode ($V_{BE}=0$)
$V_{CE\,sat}$	Collector-emitter saturation voltage
V_{CEV}	Collector-emitter reverse voltage with blocked emitter diode
V_{DD}	Anode-cathode cut-off voltage
V_{EBO}	Emitter-base reverse voltage with collector open ($I_C=0$)
V_E	Input voltage
V_{EE}	Emitter operating voltage
V_F	Forward voltage
V_{FM}	Forward voltage (peak value)
V_L	Open-circuit voltage
V_O	Rectified voltage (Di)
V_{Oeff}	Output voltage, effective
V_{pt}	Function contact potential
V_R	Reverse voltage (Di)
V_{SWR}	Voltage standing wave ratio
V_{pp}	Peak-to-peak output voltage
V_i	Dynamically operating forward current transfer ratio
y	Parameter of the admittance matrix (Y-matrix)
y_{11}	Short-circuit input admittance
y_{12}	Short-circuit reverse transconductance
y_{21}	Short-circuit forward transconductance
y_{22}	Short-circuit output admittance
Z_{12}	Reverse impedance with input open
Z_1	Input impedance (in general)
Z_2	Output impedance (in general)
ηV	Reverse-to-forward voltage ratio
γ	Duty cycle (Tr)
ω	Angular frequency $\omega = 2 \cdot \pi \cdot f$

QUALITY AND RELIABILITY INFORMATION

QUALITY ASSURANCE

The Ferranti Quality Assurance Programme is, in general, linked to the British Standards scheme and the range of available standards is:

1. **Commercial** – with factory acceptance quality levels (AQL).

2. **BS Approved** – to BS 9300 series – categories P and Q (old system).
   also full, plus full and additional (new system).

3. **CECC harmonised European Standard** – 50000 series approval (categories F and L).

4. **CECC-50000 Series Approval** +20 year life requirement to meet British Telecom D3007 approval.

5. **High-Rel** – to RRE specification X6487 which includes 100% pre cap visual inspection, burn in etc. has been incorporated into the BS scheme as the basis for a high reliability screening procedure. Amendments to BS 9300 which include clauses 1.2.2.2 and 1.2.10 for pre cap and post cap screening are now published.

6. **Release to Defence Standard** (DEF STAN 05-21) conditions i.e. 6/49 release, Def Stan 0524 and 0529.

7. **Release to Civil Aviation Authority** (CAA) conditions.

8. **CV/DEF STAN** specifications where the appropriate device is approved – until such time as they are incorporated into the BS scheme.

9. **Non-Approved Types** – where certificates of conformance are required Ferranti is approved to release as follows: DQAB, NWPO, NSPO, COC, Form CP160.

GENERAL INFORMATION

GAIN GROUPINGS

Certain device families are available with selected gain (h_{FE}) groups denoted by a suffix such as A, B or C immediately following the device type number.
The gain group suffix is included in the device part-marking.

SCREENING PROCEDURES FOR DISCRETE COMPONENTS

When screening is specified in the detail specification it shall be applied to all devices in the production lot prior to the selection of samples for the Group A to D tests.

Where the number of devices rejected by the post burn-in tests exceeds 10% of the production lot, the lot shall be rejected.

	Inspection	BS9300 Clause reference and conditions of test		Screening procedure			
				A	B	C	D
1	Internal visual examination (see Note 1)	1.2.2.2		X	X		
2	High temperature storage	1.2.6.2.1	Temperature 150°C Duration 24h min.	X	X	X	
3	Rapid change of temperature	1.2.10.2	Duration 10 cycles	X	X	X	
4	Acceleration, steady state (see Note 2)	1.2.6.6	Direction of applied force = Y1 Duration = 60s minimum	X	X	X	
5	Container sealing			X	X	X	
	(a) Cavity devices						
	(i) Fine leak	1.2.6.14.1					
	(ii) Gross leak	1.2.6.14.2 or 1.2.6.14.3					
	(b) Glass encapsulated devices	1.2.6.14.4					
6.1	Pre-burn-in functional electrical measurements	Measure and record the values of the characteristics specified for the post-test end-points in the acceptance sampling tests		X			
6.2	Pre-burn-in functional electrical tests	Check that the characteristics specified for the post-test end-points are within the Group A limits			X	X	X
7	Burn-in		Under maximum rated conditions. Minimum duration in hours:	160	72	48	48
	(a) Diodes	1.2.7.2					
	(b) Transistors (ambient rated)	1.2.7.3 1.2.7.6.1					
	(c) Transistors (case rated)	1.2.7.6.2	High temperature reverse bias at V_{CB} = 75% to 85% of rated V_{VBO} $T = T_{case}$ max				
8.1	Post burn-in functional electrical measurements	1.2.10.3		X			
8.2	Post burn-in functional electrical tests		Reject devices outside Group A limits for characteristics measured for pre burn-in tests		X	X	X

NOTE 1 When a diode is so constructed that visual examination is possible, the test shall be performed after encapsulation, otherwise the test will not apply.

NOTE 2 Not applicable to double ended devices with axial leads.

SCREENING PROCEDURES FOR DISCRETE COMPONENTS *(Continued)*

1.2.10.3 Post burn-in rejection criteria. Reject devices with characteristics outside Group A limits.

Diodes (except reference and regulator diodes)

Reject devices having changes from the pre burn-in measurements of greater than the following:
V_F: +20%
I_R: +100% or 5nA whichever is greater

Reference diodes

Reject devices having changes from the pre burn-in measurments of greater than the following:
At specified I_Z: $|\Delta V_Z| \leqslant 1\%$ IVD for devices with tolerance of $\pm 1\%$ or tighter
$|\Delta V_Z| \leqslant 2\%$ IVD for devices with tolerance wider than $\pm 1\%$
(IVD = initial value of individual device)
I_{R1} = +100% or 5nA whichever is greater

Regulator diodes

Reject devices having changes from the pre burn-in measurements of greater than the following:
At specified I_Z:V_Z to be within the upper and lower specification limits I_{R1} = +100% or 5nA whichever is greater

Transistors (bipolar)

Reject devices having changes from the pre burn-in measurement of greater than the following:
h_{FE} or h_{fe} or $V_{CE(sat)}$: ±20%
Leakage or cut-off current: +100% or 5nA whichever is greater

SCREENING PROCEDURES FOR HI-REL INTEGRATED CIRCUITS

Production batches submitted for 100% screening shall be rejected if more than a total of 10% of the devices in the batch fail the electrical test requirements subsequent to the burn-in screen 1.2.9.2 in categories S1, S2 and S4.

Inspection	BS9400 Clause reference and conditions of test		Screening procedure			
			S1	S2	S3	S4
Pre-cap inspection	1.2.10	Level A	X			
	1.2.10	Level B		X	X	
High temperature storage	1.2.6.3	150°C duration 24 hours min	X	X	X	
Rapid change of temperature	1.2.6.13	−65 to +150°C 10 cycles	X	X	X	
Shock	1.2.6.6	14700 m/s²	X			
Acceleration steady state	1.2.6.9	294000 m/s² Directions Y1 and Y2	X			
		Direction Y1		X	X	
Fine and gross leak tests	1.2.6.14		X	X	X	
Electrical tests at 25°C		As per device specification functional and d.c.	X	X		X
Burn-in screen	1.2.9.2	125°C 240 hours min	X			
		160 hours min		X		X
Electrical tests at 25°C		As per device specification functional and d.c.	X			
Burn-in screen reverse bias		150°C 72 hours min	X			
Final electrical tests at 25°C		As per device specificaton functional and d.c.	X	X	X	X
Radiographic tests			X			

SECTION 1 : APPROVED PRODUCTS

CONTENTS

DISCRETE COMPONENTS

COMMERCIAL/APPROVED TYPE CROSS REFERENCE INDEX

BS NUMBER	Commercial Equivalent	Approval Status
9300		
C013	ZS104	R
C045	ZS102	R
C046	ZS106	R
C371	ZT83	R
C372	ZT84	R
C373	ZT86	R
C404	2N1893	R
C440	2N1613	R
C464	2N706A	R
C478	2N918	R
C479	2N2060	R
C492	2N929	O
C493	2N930	R
C495	2N696	R
C496	2N697	R
C554	2N2475	R
C555	2N2369A	R
C580	2N1131	R
C581	2N1132	R
C632	ZT91	R
C633	ZT92	R
C639	ZT90	R
C642	ZS150	R
C643	ZS151	R
C644	ZT89	R
C646	2N708	R
C648	BSY95A	R
C669	2N2904	R
C670	2N2905	R
C671	2N2904A	R
C672	2N2905A	R
C673	2N2906	R
C674	2N2907	R
C675	2N2906A	R
C676	2N2907A	R
C735	2N1711	R
C738	2N2484	R
C748	ZT80	R
C749	ZT180	R
C750	ZT81	R
C751	ZT181	R
C752	ZT82	R
C753	ZT182	R
C754	ZT87	R
C755	ZT187	R
C763	2N2218	R
C764	2N2219	R
9300		
C765	2N2218A	R
C766	2N2219A	R
C767	2N2221	R
C768	2N2222	R
C769	2N2221A	R
C770	2N2222A	R
9330		
F019	ZS100	R
F020	ZS101	R
F021	ZS102	R
F022	ZS103	R
F023	ZS104	R
F026	ZS100	R
F027	ZS101	R
F028	ZS102	R
F029	ZS103	R
F030	ZS104	R
9362		
F001	BUY80	C
F003	BUY81	C
F005	BUY82	C
9365		
F012	BFY50,1,2	C
F028	ZTX107	C
F029	ZTX108	C
F030	ZTX109	C
F031	ZTX500	C
F032	ZTX501	C
F033	ZTX502	C
F034	ZTX503	C
F035	ZTX504	C
F040	ZTX310	C
F041	ZTX311	C
F042	ZTX312	C
F043	ZTX313	C
F044	ZTX314	C
F050	2N3866	C
F054	ZTX341	C
F055	ZTX342	C
F058	ZT180	C
F059	ZT181	C
F060	ZT182	C
F061	ZT183	C
F062	ZT184	C
F063	ZT187	C
F064	ZT189	C
F072	ZTX300	C
F073	ZTX301	C

C = Current
O = Obsolete
P = Pending
R = Replaced (Now fully incorporated into BS-CECC system)
CAT F-§ indicates full plus additional assessment

BS NUMBER	Commercial Equivalent	Approval Status	BS NUMBER	Commercial Equivalent	Approval Status
9365			9365		
F074	ZTX302	C	F133	BFX34	C
F075	ZTX303	C	F137	ZTX450	C
F076	ZTX304	C	F138	ZTX451	C
F082	BFS96	C	F141§	ZTX360	C
F083	BFS97	C	F143§	ZTX550	C
F084	BFS98	C	F144§	ZTX551	C
F088	ZTX320	C	F153	BUX34	C
F089	ZTX321	C	F171	ZT210	C
F092	ZTX330	C	F172	ZT211	C
F093	ZTX331	C	F182§	2N4036	C
F096	BFS59	C	F183§	2N4037	C
F097	BFS60	C	F192§	ZTX541	C
F098	BFS61	C	F193§	ZTX542	C
F130	ZTX212	C	F194	2N3053	C
F131	ZTX213	C	F205ϕ	ZTX450	C
F132	ZTX214	C		ZTX451	C

C = Current P = Pending
CAT F-§indicates full plus additional assessment
CAT F-ϕindicates full plus additional assessment with long life requirements (D3007 equivalent)

CECC Number	Commercial Equivalent	Approval Status
50001		
015§	BAT22J	C
017§	BAT24H	C
018	FMC106J	C
027§	BAV70	C
028§	BAV74	C
029§	BAV99	C
033§	BAW56	C
040§	FMMD914	C
041§	HD2A	C
042§	HD3A	C
043§	HD4A	C
048ɸ	HD2A	C
049ɸ	HD3A	C
050ɸ	HD4A	C
052ɸ	BAV70	C
054ɸ	BAV99	C
055ɸ	BAW56	C
056ɸ	FMMD914	C
057	ZS100	C
057	ZS101	C
057	ZS102 (CV7045)	C
057	ZS103	C
057	ZS104 (CV7013)	C
057	ZS106 (CV7046)	C
058	ZS150 (CV7642)	C
058	ZS151 (CV7643)	C
50002		
003	BFX84/5/6	C
004	BC140	C
005	BC141	C
009	BC107P	C
010	BC108P	C
011	BC109P	C
012	BC177	C
013	BC178	C
014	BC179	C
015	BC160	C
016	BC161	C
017	BC415P	C
018	BC416P	C
019	BC177P	C
020	BC178P	C
021	BC179P	C
022	BC212P	C
023	BC213P	C
024	BC214P	C

CECC Number	Commercial Equivalent	Approval Status
50002		
025	BC307P	C
026	BC308P	C
027	BC309P	C
028§	BCY42	C
029§	BCY43	C
030§	BCY58	C
031§	BCY59	C
032§	BCY65E	C
033§	BCY77	C
034§	BCY78	C
035§	BCY79	C
039	2N2604	C
040	2N2605	C
041§	BC546P	C
042§	BC547P	C
043§	BC548P	C
044§	BC549P	C
045§	BC550P	C
046	BC556P	C
047	BC557P	C
048	BC558P	C
049	BC559P	C
050	BC560P	C
051§	BCY58P	C
052§	BCY59P	C
053§	BCY65EP	C
054	BCY77P	C
055	BCY78P	C
056	BCY79P	C
057	BC182P	C
058	BC183P	C
059	BC184P	C
060	BC237P	C
061	BC238P	C
062	BC239P	C
063§	BC327P	C
064§	BC328P	C
065	BC337P	C
066	BC338P	C
067	BC413P	C
068	BC414P	C
069	2N2102	C
070	2N2270	C
076§	BC107	C
077§	BC108	C
078§	BC109	C
079	BCY70	C
080	BCY71	C
081	BCY72	C
082	2N2405	C
097§	2N2060 (CV7479)	C

C = Current P = Pending
CAT F-§indicates full plus additional assessment
CAT F-ɸindicates full plus additional assessment with long life requirements (D3007 equivalent)

CECC Number	Commercial Equivalent	Approval Status
50002		
097§	2N2223	C
106§	ZT93	C
108§	BCW67/68	C
109§	BCX17/18	C
110§	BCW61	C
111§	BCX71	C
112	FMMTA55/56	C
114§	BCW69/70	C
	BCW29/30	C
115§	BCW31/32 /33/71/72	C
116§	BCW60	C
117§	BCW65/66	C
119§	BCX19/20	C
120§	BCX70	C
121§	FMMTA05/ A06	C
122§	FMMTA20	C
123§	BFQ31/31A	C
124§	FMMTA12/ A13/A14	C
137§	ZTX750 ZTX751 ZTX752 ZTX753	C
138§	ZTX650 ZTX651 ZTX652 ZTX653	C
139§	HT2	C
140§	HT3	C
142§	FST149	C
143ϕ	FST149	C
144§	FST150	C
145ϕ	FST150	C
148ϕ	BC107P	C
149ϕ	BC108P	C
150ϕ	BC109P	C
151ϕ	BCY58P	C
152ϕ	BCY59P	C
153ϕ	BCY65EP	C
154ϕ	HT2	C
155ϕ	BCW31	C
	BCW32	C
	BCW33	C
156ϕ	BCY77P	C
157ϕ	BCY78P	C
158ϕ	BCY79P	C
159ϕ	BC212P	C
160ϕ	BC213P	C
161ϕ	BC214P	C
162ϕ	HT3	C

CECC Number	Commercial Equivalent	Approval Status
50002		
190§	MPSA92/93	P
191ϕ	MPSA92/93	P
193§	ZT83 (CV7371) ZT84 (CV7372) ZT86 (CV7373)	C
194	2N918 (CV7478)	C
195	2N696 (CV7495) 2N697 (CV7496)	C
196	2N1131 (CV7580) 2N1132 (CV7581)	C
197§	ZT91 (CV7632)	C
	ZT92 (CV7633)	C
198§	ZT90 (CV7639)	C
199	2N1893 (CV7404)	C
200	2N1613 (CV7440) 2N1711 (CV7735)	C
201	2N930 (CV7493)	C
202	2N2475 (CV7554)	C
203§	ZT89 (CV7644)	C
204	2N2484 (CV7738)	C
205§	ZT80 (CV7748) ZT81 (CV7750) ZT82 (CV7752) ZT87 (CV7754)	C
206§	ZT180 (CV7749) ZT181 (CV7751) ZT182 (CV7753) ZT187 (CV7755)	C

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CAT F-§indicates full plus additional assessment
CAT F-ϕindicates full plus additional assessment with long life requirements (D3007 equivalent)

CECC Number	Commercial Equivalent	Approval Status
50002		
207§	BCY70P	C
	BCY71P	C
	BCY72P	C
208ϕ	BCY70P	P
	BCY71P	
	BCY72P	
209§	MPSA42	P
	MPSA43	
210ϕ	MPSA42	P
	MPSA43	
211§	FMMTA42	P
	FMMTA43	
212ϕ	FMMTA42	P
	FMMTA43	
213§	FMMTA92	P
	FMMTA93	
214ϕ	FMMTA92	P
	FMMTA93	
219	2N3418A	C
	2N3419A	C
	2N3420A	C
	2N3421A	C
50003		
002	BUY90	C
003	BUY92	C
005	BD320	C
006	BD322	C
007	BD321	C
008	BD323	C
010	BUY91	C
50004		
002	2N3261	C
008	BSV64	C
009	BSX59	C
010	BSX60	C
011	BSX61	C
013	2N709	C
014	2N2476	C
015	2N2938	C
022	2N2368	C
023	2N2369	C
029§	2N2218	C
	(CV7763)	
	2N2218A	
	(CV7765)	
	2N2219	
	(CV7764)	
	2N2219A	
	(CV7766)	
030§	2N2221	C
	(CV7767)	
	2N2221A	
	(CV7769)	

CECC Number	Commercial Equivalent	Approval Status
50004		
030§	2N2222	
	(CV7768)	
	2N2222A	
	(CV7770)	
053§	FMMT2369	C
	/2369A	C
054§	FMMT3903	C
	FMMT3904	C
055§	FMMT2222	C
	/2222A	C
056§	FMMT3905	
	FMMT3906	C
057§	FMMT2907	
	/2907A	P
069§	BSS66	C
069§	BSS67	C
070§	BSS69	C
070§	BSS70	C
071§	BSV52	C
075§	MPS2222/	
	2222A	C
076ϕ	MPS2222/	
	2222A	C
077§	MPS2907/	
	2907A	C
078ϕ	MPS2907/	
	2907A	C
081§	MPS2369/	
	2369A	C
082ϕ	MPS2369/	
	2369A	C
086§	BSS69	P
086ϕ	BSS70	P
123§	2N2894	C
139	2N706A	C
	(CV7464)	
140	2N2369A	C
	(CV7555)	
141	2N708	C
	(CV7646)	
142	BSY95A	C
	(CV7648)	
144§	2N2904	C
	(CV7769)	
	2N2904A	
	(CV7671)	
	2N2905	
	(CV7670)	
	2N2905A	
	(CV7672)	
145§	2N2906	C
	(CV7673)	
	2N2906A	
	(CV7675)	

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CECC Number	Commercial Equivalent	Approval Status	CECC Number	Commercial Equivalent	Approval Status
50004			50012		
145§	2N2907		021§	ZVN3206L	P
	(CV7674)			ZVN3210L	
	2N2907A		031§	ZVN0108B	C
	(CV7676)			ZVN2104B	
50005				ZVN2106B	
008	BZX84 Series	C		ZVN2110B	
009ϕ	BZX84 Series	C	032§	ZVN2204B	C
50007				ZVN2206B	
006	2N4427	C		ZVN2208B	
50012				ZVN2210B	
018§	ZVN0108A	C	033§	ZVP0108A	C
	ZVN2104A			ZVP2104A	
	ZVN2106A			ZVP2106A	
	ZVN2110A			ZVP2110A	
50012			034	ZVP0108B	C
019§	ZVN0530A	C		ZVP2104B	
	ZVN0535A			ZVP2106B	
	ZVN0540A			ZVP2110B	
	ZVN0545A		035§	ZVP2204B	P
020§	ZVN0120L	C		ZVP2206B	
	ZVN2115L			ZVP2208B	
				ZVP2210B	

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Type Number	Commercial Equivalent	Approval Status
CV7013	ZS104	C
CV7040	ZS122	C
CV7045	ZS102	C
CV7046	ZS106	C
CV7372	ZT84	C
CV7373	ZT86	C
CV7404	2N1893	C
CV7464	2N706A	C
CV7478	2N918	C
CV7479	2N2060	C
CV7492	2N929	O
CV7493	2N930	C
CV7495	2N696	C
CV7496	2N697	C
CV7554	2N2475	C
CV7555	2N2369A	C
CV7580	2N1131	C
CV7581	2N1132	C
CV7632	ZT91	C
CV7633	ZT92	C
CV7639	ZT90	C
CV7642	ZS150	C
CV7643	ZS151	C
CV7644	ZT89	C
CV7646	2N708	C
CV7648	BSY95A	C
CV7669	2N2904	C
CV7670	2N2905	C
CV7671	2N2904A	C
CV7672	2N2905A	C
CV7673	2N2906	C
CV7674	2N2907	C
CV7675	2N2906A	C
CV7676	2N2907A	C
CV7735	2N1711	C
CV7738	2N2484	C
CV7748	ZT80	C
CV7749	ZT180	C
CV7750	ZT81	C
CV7751	ZT181	C
CV7752	ZT82	C
CV7753	ZT182	C
CV7754	ZT87	C
CV7755	ZT187	C
CV7763	2N2218	C
CV7764	2N2219	C
CV7765	2N2218A	C
CV7766	2N2219A	C
CV7767	2N2221	C
CV7768	2N2222	C
CV7769	2N2221A	C
CV7770	2N2222A	C
CV8467	2N930	C
CV8615		C
CV8647	ZT92	C
CV8649	ZT86	C
CV8729	2N706A	C
CV8843	2N1613	C
CV8844	2N708	C
CV8848	2N2270	C
CV8890	2N3053	C
CV9047	2N2894	C
CV9211	2N706	C
CV9320	2N2368	C
CV9507	2N2905A	C
CV9516	ZT211	C
CV9543	2N2907	C
CV9604	2N2102	C
CV9888	ZT87	C
CV10150	ZT81	C
CV10741	ZT184	C
CV10750	ZT90	C
CV11091	ZT210	C
CV11096	ZT91	C

C = Current

TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
BAT22J	50001	015§	—	—	—	C
BAT24H	50001	017§	—	—	—	C
BAV70	50001	027§	—	—	—	C
BAV74	50001	028§	—	—	—	C
BAV99	50001	029§	—	—	—	C
	50001	054ϕ	—	—	—	C
BAW56	50001	033§	—	—	—	C
	50001	055ϕ	—	—	—	C
BC107	50002	076§	—	—	—	C
BC107P	50002	009	—	—	—	C
	50002	148ϕ	—	—	—	C
BC108	50002	077§	—	—	—	C
BC108P	50002	010	—	—	—	C
	50002	149ϕ	—	—	—	C
BC109	50002	078§	—	—	—	C
BC109P	50002	011	—	—	—	C
	50002	150ϕ	—	—	—	C
BC140	50002	004	—	—	—	C
BC141	50002	005	—	—	—	C
BC160	50002	015	—	—	—	C
BC161	50002	016	—	—	—	C
BC177	50002	012	—	—	—	C
BC177P	50002	019	—	—	—	C
BC178	50002	013	—	—	—	C
BC178P	50002	020	—	—	—	C
BC179	50002	014	—	—	—	C
BC179P	50002	021	—	—	—	C
BC182P	50002	057	—	—	—	C
BC183P	50002	058	—	—	—	C
BC184P	50002	059	—	—	—	C
BC212P	50002	022	—	—	—	C
	50002	159ϕ	—	—	—	C
BC213P	50002	023	—	—	—	C
	50002	160ϕ	—	—	—	C
BC214P	50002	024	—	—	—	C
	50002	161ϕ	—	—	—	C
BC237P	50002	060	—	—	—	C
BC238P	50002	061	—	—	—	C
BC239P	50002	062	—	—	—	C
BC307P	50002	025	—	—	—	C
BC308P	50002	026	—	—	—	C
BC309P	50002	027	—	—	—	C
BC327P	50002	063§	—	—	—	C
BC328P	50002	064§	—	—	—	C
BC337P	50002	065	—	—	—	C
BC338P	50002	066	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
BC413P	50002	067	—	—	—	C
BC414P	50002	068	—	—	—	C
BC415P	50002	017	—	—	—	C
BC416P	50002	018	—	—	—	C
BC546P	50002	041§	—	—	—	C
BC547P	50002	042§	—	—	—	C
BC548P	50002	043§	—	—	—	C
BC549P	50002	044§	—	—	—	C
BC550P	50002	045§	—	—	—	C
BC556P	50002	046	—	—	—	C
BC557P	50002	047	—	—	—	C
BC558P	50002	048	—	—	—	C
BC559P	50002	049	—	—	—	C
BC560P	50002	050	—	—	—	C
BCW29	50002	114§	—	—	—	C
	50002	163ϕ	—	—	—	P
BCW30	50002	114§	—	—	—	C
	50002	163§	—	—	—	P
BCW31	50002	115§	—	—	—	C
	50002	155ϕ	—	—	—	C
BCW32	50002	115§	—	—	—	C
	50002	155ϕ	—	—	—	C
BCW33	50002	115§	—	—	—	C
	50002	155ϕ	—	—	—	C
BCW60	50002	116§	—	—	—	C
BCW61	50002	110§	—	—	—	C
BCW65	50002	117§	—	—	—	C
BCW66	50002	117§	—	—	—	C
BCW67	50002	108§	—	—	—	C
BCW68	50002	108§	—	—	—	C
BCW69	50002	114§	—	—	—	C
	50002	163ϕ	—	—	—	P
BCW70	50002	114§	—	—	—	C
	50002	163ϕ	—	—	—	P
BCW71	50002	115§	—	—	—	C
BCW72	50002	115§	—	—	—	C
BCX17	50002	109§	—	—	—	C
BCX18	50002	109§	—	—	—	C
BCX19	50002	119§	—	—	—	C
BCX20	50002	119§	—	—	—	C
BCX70	50002	120§	—	—	—	C
BCX71	50002	111§	—	—	—	C
BCY42	50002	028§	—	—	—	C
BCY43	50002	029§	—	—	—	C
BCY58	50002	030§	—	—	—	C
BCY58P	50002	051§	—	—	—	C
	50002	151ϕ	—	—	—	C
BCY59	50002	031§	—	—	—	C
BCY59P	50002	052§	—	—	—	C
	50002	152ϕ	—	—	—	C
BCY65E	50002	032§	—	—	—	C
BCY65EP	50002	053§	—	—	—	C
	50002	153ϕ	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
BCY70	50002	079§	—	—	—	C
BCY70P	50002	207§	—	—	—	C
BCY70P	50002	208ϕ	—	—	—	P
BCY71	50002	080§	—	—	—	C
BCY71P	50002	207§	—	—	—	C
BCY71P	50002	208ϕ	—	—	—	P
BCY72	50002	081§	—	—	—	C
BCY72P	50002	207§	—	—	—	C
BCY72P	50002	208ϕ	—	—	—	P
BCY77	50002	033§	—	—	—	C
BCY77P	50002	054	—	—	—	C
	50002	156ϕ	—	—	—	C
BCY78	50002	034§	—	—	—	C
BCY78P	50002	055	—	—	—	C
	50002	157ϕ	—	—	—	C
BCY79	50002	035§	—	—	—	C
BCY79P	50002	056	—	—	—	C
	50002	158ϕ	—	—	—	C
BD320	50003	005	—	—	—	C
BD321	50003	007	—	—	—	C
BD322	50003	006	—	—	—	C
BD323	50003	008	—	—	—	C
BFQ31	50002	123§	—	—	—	C
BFQ31A	50002	123§	—	—	—	C
BFS59	BS9365	—	F096	—	—	C
BFS60	BS9365	—	F097	—	—	C
BFS61	BS9365	—	F098	—	—	C
BFS96	BS9365	—	F082	—	—	C
BFS97	BS9365	—	F083	—	—	C
BFS98	BS9365	—	F084	—	—	C
BFX34	BS9365	—	F133	—	—	C
BFX84	50002	003	—	—	—	C
BFX85	50002	003	—	—	—	C
BFX86	50002	003	—	—	—	C
BFY50	BS9365	—	—	F012	—	C
BFY51	BS9365	—	—	F012	—	C
BFY52	BS9365	—	—	F012	—	C
BSS66	50004	069	—	—	—	C
BSS67	50004	069	—	—	—	C
BSS69	50004	070	—	—	—	C
	50004	086§	—	—	—	P
BSS70	50004	070	—	—	—	C
	50004	086ϕ	—	—	—	P
BSV52	50004	071	—	—	—	C
BSV64	50004	008	—	—	—	C
BSX59	50004	009	—	—	—	C
BSX60	50004	010	—	—	—	C
BSX61	50004	011	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
BSY95A	50004	142§	—	—	CV7648	C
BUX34	BS9365	—	F153	—	—	C
BUY80	BS9362	—	F001	—	—	C
BUY81	BS9362	—	F003	—	—	C
BUY82	BS9362	—	F005	—	—	C
BUY90	50003	002	—	—	—	C
BUY91	50003	010	—	—	—	C
BUY92	50003	003	—	—	—	C
BZX84	50005	008	—	—	—	C
Series	50005	009φ	—	—	—	C
FMC106J	50001	018	—	—	—	C
FMMD914	50001	040§	—	—	—	C
	50001	056φ	—	—	—	C
FMMT2222	50004	055§	—	—	—	C
FMMT2222A	50004	055§	—	—	—	C
FMMT2369/	50004	053§	—	—	—	C
FMMT2369A			—	—	—	C
FMMT2907	50004	057§	—	—	—	P
FMMT2907A	50004	057§	—	—	—	P
FMMT3903	50004	054§	—	—	—	C
FMMT3904	50004	054§	—	—	—	C
FMMT3905	50004	056§	—	—	—	C
FMMT3906	50004	056§	—	—	—	C
FMMTA05	50002	121§	—	—	—	C
FMMTA06	50002	121§	—	—	—	C
FMMTA12	50004	124§	—	—	—	C
FMMTA13	50004	124§	—	—	—	C
FMMTA14	50004	124§	—	—	—	C
FMMTA20	50004	122§	—	—	—	C
FMMTA42	50002	211§	—	—	—	P
FMMTA43	50002	211§	—	—	—	P
FMMTA42	50002	212φ	—	—	—	P
FMMTA43	50002	212φ	—	—	—	P
FMMTA55	50002	112§	—	—	—	C
FMMTA56	50002	112§	—	—	—	C
FMMTA92	50002	213§	—	—	—	C
FMMTA93	50002	213§	—	—	—	C
FMMTA92	50002	214φ	—	—	—	C
FMMTA93	50002	214φ	—	—	—	C
FST149	50002	142§	—	—	—	C
		143φ	—	—	—	C
FST150	50002	144§	—	—	—	C
		145φ	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	CV Type Number	Approval Status
HD2A	50001	041	—	—	—	C
		048ϕ	—	—	—	C
HD3A	50001	042	—	—	—	C
		049ϕ	—	—	—	C
HD4A	50001	043	—	—	—	C
		050ϕ	—	—	—	C
HT2	50002	139	—	—	—	C
	50002	154ϕ	—	—	—	C
HT3	50002	140	—	—	—	C
	50002	162ϕ	—	—	—	C
MPS2222/22A	50004	075§	—	—	—	C
MPS2222/22A	50004	076ϕ	—	—	—	C
MPS2369/69A	50004	081§	—	—	—	C
MPS2369/69A	50004	082ϕ	—	—	—	C
MPS2907/07A	50004	077§	—	—	—	C
MPS2907/07A	50004	078ϕ	—	—	—	C
MPSA42	50002	209§	—	—	—	P
MPSA43	50002	209§	—	—	—	P
MPSA42	50002	210ϕ	—	—	—	P
MPSA43	50002	210ϕ	—	—	—	P
MPSA92/A93	50002	190§	—	—	—	P
MPSA92/A93	50002	191ϕ	—	—	—	P
ZS100	50001	057	—	—	—	C
ZS101	50001	057	—	—	—	C
ZS102	50001	057	—	—	CV7045	C
ZS103	50001	057	—	—	—	C
ZS104	50001	057	—	—	CV7013	C
ZS106	50001	057	—	—	CV7046	C
ZS150	50001	058	—	—	CV7642	C
ZS151	50001	058	—	—	CV7643	C
ZT80	50002	205§	—	—	CV7748	C
ZT81	50002	205§	—	—	CV7750	C
	—	—	—	—	CV10150	C
ZT82	50002	205§	—	—	CV7752	C
ZT83	50002	193§	—	—	CV7371	C
ZT84	50002	193§	—	—	CV7372	C
ZT86	50002	193§	—	—	CV7373	C
	—	—	—	—	CV8649	C
ZT87	50002	205§	—	—	CV7754	C
	—	—	—	—	CV9888	C
ZT89	50002	203§	—	—	CV7644	C
ZT90	50002	198§	—	—	CV7639	C
	—	—	—	—	CV10750	C
ZT91	50002	197§	—	—	CV7632	C
	—	—	—	—	CV11096	C
ZT92	50002	197§	—	—	CV7633	C
	—	—	—	—	CV8647	C
ZT93	50002	106§	—	—	—	C
ZT180	50002	206§	—	—	CV7749	C
	BS9365	—	F058	—	—	C
ZT181	50002	206§	—	—	CV7751	C
	BS9365	—	F059	—	—	C

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TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
ZT182	50002	206§	—	—	CV7753	C
	BS9365	—	F060	—	—	C
ZT183	BS9365	—	F061	—	—	C
ZT184	BS9365	—	F062	—	CV10741	C
ZT187	50002	206§	—	—	CV7755	C
	BS9365	—	F063	—	—	C
ZT189	BS9365	—	F064	—	—	C
ZT210	BS9365	—	F171	—	—	C
ZT211	BS9365	—	F172	—	CV9516	C
ZTX107	BS9365	—	F028	—	—	C
ZTX108	BS9365	—	F029	—	—	C
ZTX109	BS9365	—	F030	—	—	C
ZTX212	BS9365	—	F130	—	—	C
ZTX213	BS9365	—	F131	—	—	C
ZTX214	BS9365	—	F132	—	—	C
ZTX300	BS9365	—	F072	—	—	C
ZTX301	BS9365	—	F073	—	—	C
ZTX302	BS9365	—	F074	—	—	C
ZTX303	BS9365	—	F075	—	—	C
ZTX304	BS9365	—	F076	—	—	C
ZTX310	BS9365	—	F040	—	—	C
ZTX311	BS9365	—	F041	—	—	C
ZTX312	BS9365	—	F042	—	—	C
ZTX313	BS9365	—	F043	—	—	C
ZTX314	BS9365	—	F044	—	—	C
ZTX320	BS9365	—	F088	—	—	C
ZTX321	BS9365	—	F089	—	—	C
ZTX330	BS9365	—	F092	—	—	C
ZTX331	BS9365	—	F093	—	—	C
ZTX341	BS9365	—	F054	—	—	C
ZTX342	BS9365	—	F055	—	—	C
ZTX360	BS9365	F141§	—	—	—	C
ZTX450	BS9365	—	F137	—	—	C
		F205ϕ	—	—	—	C
ZTX451	BS9365	—	F138	—	—	C
		F205ϕ	—	—	—	C
ZTX500	BS9365	—	F031	—	—	C
ZTX501	BS9365	—	F032	—	—	C
ZTX502	BS9365	—	F033	—	—	C
ZTX503	BS9365	—	F034	—	—	C
ZTX504	BS9365	—	F035	—	—	C
ZTX541	BS9365	F192§	—	—	—	C
ZTX542	BS9365	F193§	—	—	—	C
ZTX550	BS9365	F143§	—	—	—	C
ZTX551	BS9365	F144§	—	—	—	C
ZTX650	50002	138§	—	—	—	C
ZTX651	50002	138§	—	—	—	C
ZTX652	50002	138§	—	—	—	C
ZTX653	50002	138§	—	—	—	C
ZTX750	50002	137§	—	—	—	C

C = Current P = Pending

CAT F-§indicates full plus additional assessment

CAT F-ϕindicates full plus additional assessment with long life requirements (D3007 equivalent)

TYPE NUMBER	BS/CECC TYPE				CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q		
ZTX751	50002	137§	—	—	—	C
ZTX752	50002	137§	—	—	—	C
ZTX753	50002	137§	—	—	—	C
ZVN0108A	50012	018§	—	—	—	C
ZVN0108B	50012	031§	—	—	—	C
ZVN0120L	50012	020§	—	—	—	C
ZVN0530A	50012	019§	—	—	—	C
ZVN0535A	50012	019§	—	—	—	C
ZVN0540A	50012	019§	—	—	—	C
ZVN0545A	50012	019§	—	—	—	C
ZVN2104A	50012	018§	—	—	—	C
ZVN2104B	50012	031§	—	—	—	C
ZVN2106A	50012	018§	—	—	—	C
ZVN2106B	50012	031§	—	—	—	C

C = Current P = Pending
CAT F-§indicates full plus additional assessment
CAT F-ϕindicates full plus additional assessment with long life requirements (D3007 equivalent)

TYPE NUMBER	BS/CECC TYPE					CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type		
ZVN2110A	50012	018§	—	—	—	—	C
ZVN2110B	50012	031§	—	—	—	—	C
ZVN2115L	50012	020§	—	—	—	—	C
ZVN2204B	50012	032§	—	—	—	—	C
ZVN2206B	50012	032§	—	—	—	—	C
ZVN2208B	50012	032§	—	—	—	—	C
ZVN2210B	50012	032§	—	—	—	—	C
ZVN3206L	50012	021§	—	—	—	—	P
ZVN3210L	50012	021§	—	—	—	—	P
ZVP0108A	50012	033§	—	—	—	—	C
ZVP0108B	50012	034§	—	—	—	—	C
ZVP2104A	50012	033§	—	—	—	—	C
ZVP2104B	50012	034§	—	—	—	—	C
ZVP2106A	50012	033§	—	—	—	—	C
ZVP2106B	50012	034§	—	—	—	—	C
ZVP2110A	50012	033§	—	—	—	—	C
ZVP2110B	50012	034§	—	—	—	—	C
ZVP2204B	50012	035§	—	—	—	—	P
ZVP2206B	50012	035§	—	—	—	—	P
ZVP2208B	50012	035§	—	—	—	—	P
ZVP2210B	50012	035§	—	—	—	—	P
2N696	50002	195§	—	—	—	CV7495	C
2N697	50002	195§	—	—	—	CV7496	C
2N706	—	—	—	—	—	CV9211	C
2N706A	—	—	—	—	—	CV8729	C
	50004	139§	—	—	—	CV7464	C
2N708	—	—	—	—	—	CV8844	C
	50004	141§	—	—	—	CV7646	C
2N709	50004	013§	—	—	—	—	C
2N918	50002	194§	—	—	—	CV7478	C
2N929	BS9300	—	—	—	C492	CV7492	O
2N930	—	—	—	—	—	CV8467	C
	50002	201§	—	—	—	CV7493	C
2N1131	50002	196§	—	—	—	CV7580	C
2N1132	50002	196§	—	—	—	CV7581	C
2N1613	—	—	—	—	—	CV8843	C
	50002	200§	—	—	—	CV7440	C
2N1711	50002	200§	—	—	—	CV7735	C
2N1893	50002	199§	—	—	—	CV7404	C

C = Current P = Pending
CAT F-§indicates full plus additional assessment
CAT F-ϕindicates full plus additional assessment with long life requirements (D3007 equivalent)

TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
2N2060	50002	097§	—	—	—	CV7479	C
2N2102	50002	069	—	—	—	—	C
	—	—	—	—	—	CV9604	C
2N2218	50004	029§	—	—	—	CV7763	C
2N2218A	50004	029§	—	—	—	CV7765	C
2N2219	50004	029§	—	—	—	CV7764	C
2N2219A	50004	029§	—	—	—	CV7766	C
2N2221	50004	030§	—	—	—	CV7767	C
2N2221A	50004	030§	—	—	—	CV7769	C
2N2222	50004	030§	—	—	—	CV7768	C
2N2222A	50004	030§	—	—	—	CV7770	C
2N2223	50002	097§	—	—	—	—	C
2N2270	50002	070§	—	—	—	—	C
	—	—	—	—	—	CV8848	C
2N2368	50004	022§	—	—	—	—	C
	—	—	—	—	—	CV9320	C
2N2369	50004	023§	—	—	—	—	C
2N2369A	50004	140§	—	—	—	CV7555	C
	—	—	—	—	—	CV8616	C
2N2405	50002	082§	—	—	—	—	C
2N2475	50002	202§	—	—	—	CV7554	C
2N2476	50004	014§	—	—	—	—	C
2N2484	50002	204§	—	—	—	CV7738	C
2N2604	50002	039§	—	—	—	—	C
2N2605	50002	040§	—	—	—	—	C
2N2894	50004	123§	—	—	—	—	C
	—	—	—	—	—	CV9047	C
2N2904	50004	144§	—	—	—	CV7669	C
2N2904A	50004	144§	—	—	—	CV7671	C
2N2905	50004	144§	—	—	—	CV7670	C
2N2905A	50004	144§	—	—	—	CV7672	C
2N2906	50004	145§	—	—	—	CV7673	C
2N2906A	50004	145§	—	—	—	CV7675	C
2N2907	50004	145§	—	—	—	CV7674	C
2N2907A	50004	145§	—	—	—	CV7676	C
2N3053	BS9365	F194	—	—	—	—	C
2N3261	50004	002	—	—	—	—	C
2N3418A	50002	219	—	—	—	—	C
2N3419A	50002	219	—	—	—	—	C
2N3420A	50002	219	—	—	—	—	C
2N3421A	50002	219	—	—	—	—	C
2N3866	BS9365	—	F050	—	—	—	C
2N4036	BS9365	F182§	—	—	—	—	C
2N4037	BS9365	F183§	—	—	—	—	C
2N4427	50007	006	—	—	—	—	C

C = Current P = Pending O = Obsolete

CAT F-§indicates full plus additional assessment

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INTEGRATED CIRCUITS
TELECOMMUNICATIONS TYPES

FERRANTI TYPE NUMBER	BS TYPE		
	Prefix	Category S11	Category S12
ZN7400	9401	F1757	F1758
ZN7401	9401	F1759	F1760
ZN7402	9401	F1761	F1762
ZN7403	9401	F1763	F1764
ZN7404	9403	F235	F236
ZN7405	9403	F237	F238
ZN7408	9401	F1804	F1805
ZN7410	9401	F1765	F1766
ZN7413	9401	F1767	F1768
ZN7420	9401	F1769	F1770
ZN7425	9401	F1806	F1807
ZN7430	9401	F1771	F1772
ZN7437	9401	F1773	F1774
ZN7438	9401	F1808	F1809
ZN7440	9401	F1775	F1776
ZN7442A	9440	F1129	F1130
ZN7450	9405	F1105	F1106
ZN7451	9405	F1107	F1108
ZN7454	9405	F1109	F1110
ZN7472	9420	F919	F920
ZN7473	9420	F921	F922
ZN7474	9420	F923	F924
ZN7475	9420	F925	F926
ZN7483	9405	F1111	F1112
ZN7485	9405	F1113	F1114
ZN7486	9401	F1777	F1778
ZN7490A	9442	F816	F817
ZN7491A	9440	F1131	F1132
ZN7493	9442	F818	F819
ZN7493A	9442	F820	F821
ZN7494	9440	F1133	F1134
ZN7495A	9440	F1135	F1136
ZN7496	9440	F1137	F1138
ZN74107	9420	F927	F928
ZN74121	9440	F1139	F1140
ZN74122	9440	F1141	F1142
ZN74123	9440	F1143	F1144
ZN74151A	9405	F1115	F1116
ZN74153	9405	F1117	F1118
ZN74154	9405	F1119	F1120
ZN74155	9405	F1121	F1122
ZN74157	9405	F1123	F1124
ZN74161	9442	F822	F823
ZN74163	9442	F824	F825
ZN74164	9440	F1145	F1146
ZN74165	9440	F1147	F1148
ZN74166	9440	F1149	F1150

FERRANTI TYPE NUMBER	BS TYPE		
	Prefix	Category S11	Category S12
ZN74174	9420	F929	F930
ZN74180	9405	F1177	F1178
ZN74193	9442	F826	F827
ZN74L00	9401	F1779	F1780
ZN74L02	9401	F1781	F1782
ZN74L03	9401	F1783	F1784
ZN74L04	9403	F239	F240
ZN74L10	9401	F1785	F1786
ZN74L20	9401	F1787	F1788
ZN74L30	9401	F1789	F1790
ZN74L74	9420	F906	F907
ZN74L90	9442	F828	F829
ZN74L93	9442	F830	F831
ZN74L95	9440	F1151	F1152

SECTION 2 : INTEGRATED CIRCUITS

CONTENTS

See rear section of book for package details

ARRAYS : THE ULA*

CONTENTS

*ULA is a registered trademark of Ferranti plc for semiconductors devices.

The ULA

Introduction

The purpose of this section is to provide an overview of the Ferranti family of ULAs and its CAD support. For more detailed information contact should be made with one of the design centres whose addresses and telephone numbers are given at the back of this publication.

The ULA*

The ULA family is one of the most comprehensive array product ranges available for the implementation of ULA custom LSI. The range has been developed to satisfy the widest possible combination of speed, complexity, linear and I/O capability at minimum system power levels.
All standard package styles are available including dual in-line, flat packs, ceramic and plastic chip carriers and pin grid.

ULAs for Digital Systems

The 'R' and 'DS' series are intended for digital systems with complexities up to 10,000 gates and gate delays down to 1ns. The 'R' series employs 2.5 micron, single layer interconnect technology with the 'DS' utilising 1.5 micron and double layer metal. The 'DS' series is designed for 100% autolayout with no manual intervention.
An outstanding feature of the series is the interface capability which allows the implementation of an extensive range of I/O functions together with high drive capability. The objective is to present the opportunity to intergrate as much of the system as possible, not just the logic hierarchy.

ULAs for Combined Linear and Digital Systems

The 'P' and 'G' series of Digilin* ULAs have been designed for those applications requiring mixed digital and linear performance and cover system complexities up to 1150 gates.
Components which have been specifically designed for analogue performance occupy over 50% of each ULA chip with special functions, such as high current drive transistors, bandgap references, regulators and shaping capacitors also included.
The range of circuits with both digital and analogue content which can be successfully integrated is very large covering the full range of logic functions together with interface circuits from TTL/CMOS input buffers, op-amps, comparators to data converter functions.

CAD Support

Ferranti Semiconductors has established a network of design centres around the world.
Each design centre has a ULA system engineering group with the experience and knowledge of the use of ULAs in most of the major market sectors plus the Ferranti Silicon Design System§ — a complete, totally integrated CAD system for the design, simulation and implementation of ULA custom LSI.
The Silicon Design System hardware is based on the VAX** range of computers and the software ULACAD is a complete suite of programs, including silicon compilers covering the engineering design cycle up to P.G. tapes.
The silicon compilers are a powerful feature of the ULACAD software system. They enable 100% automatic layout without manual intervention, and provide the facility for chip optimisation by creating the P.G. tape data base for a brand new generic array within a matter of minutes.
Chip optimisation is an important facility for large volume applications where the smallest chip size is necessary to give the best economics. Under these circumstances, the engineering check samples are produced using one of the standard autoroutable ULAs. Following customer approval the optimise faciltiy is implemented to define the P.G. tapes for a ULA to precisely match the performance and complexity requirements.
The Silicon Design System including an extensive range of ULACAD software is available for customers wishing to carry out their own designs. Alternatively this ULACAD software is available for customers with their own VAX based or workstation sytems.

* ULA and Digilin are trademarks of Ferranti plc for semiconductor devices.
§ The Silicon Design System is a trademark of Ferranti plc.
** VAX is a trademark of the Digital Equipment Corporation.

ULAs for Digital Systems

The 'R' and 'DS' series are intended for digital systems with complexities up to 10,000 gates and delays down to 1 ns. The 'R' series employs 2.5 micron, single layer interconnected technology with the 'DS' utilising 1.5 micron and double layer metal. The 'DS' series is designed for 100% autolayout with no manual intervention.

Features

- System Speeds to 100MHz
- Complexities 100 to 10,000 gates
- Average gate power 132µW at 100MHz
- 48mA bus drivers
- Digital and Linear Macros
- Complete CAD Support
- Silicon Compilers

System speeds to 100MHz

Array Family	Max System Speed	Gate Delay (ns)	Gate Count (max)	Average Gate Power (µW)
DSA	100	1.0	10,000	132
DSB	60	1.6	10,000	66
RA	40	2.5	2,000	580
DSC	25	4.0	10,000	22
RB	10	7.5	2,000	224
RC	5	15.0	2,000	56
RD	2.5	50.0	2,000	22

DS Series: System Complexity to 10,000 Gates

Array Type	Equivalent Gate Count	Peripheral I/O Cells	Bond Pads
ULA 6DS	630	32	40
ULA 12DS	1210	44	52
ULA 19DS	1870	64	72
ULA 25DS	2550	74	82
ULA 32DS	3230	82	92
ULA 38DS	3990	90	100
ULA 47DS	4860	104	114
ULA 60DS	6210	122	132
ULA 80DS	7920	138	150
ULA 100DS	10000	138	150

R Series: System Complexity to 2,000 Gates

Array Type	Gate Count	Peripheral I/O	Bond Pads
ULA 1R	130	20	20
ULA 3R	300	30	30
ULA 3R	500	38	40
ULA 9R	900	48	50
ULA 12R	1200	52	58
ULA 16R	1600	62	68
ULA 20R	2000	72	80

ULAs For Combined Digital & Linear Systems

The 'P' and 'G' series of Digilin ULAs have been designed for those applications requiring mixed digital and high performance linear functions.
All commonly used logic functions can be implemented using the matrix cells, whilst the peripheral cells contain components specially designed for analogue performance.
The range of circuits with linear content which can be successfully integrated is extensive and includes Schmitt triggers, regulators, comparators, op-amps, monostables, oscillators, ceramic resonators, white noise sources, peak reading circuits, data converter functions.

Features

- Digital and linear circuitry on a single chip.
- Operation from 1 to 15 volt supply.
- High current drive capability.
- Complete system integration capability.
- Reduced system space and power.
- Rapid development time.

P Series

Type No.	Matrix Cell Count	Gate Count	Peripheral Cell Count	Bond Pads
1P	64	128	16	26
3P	169	338	24	34
6P	289	578	32	42
9P	441	882	40	50
11P	576	1152	44	54

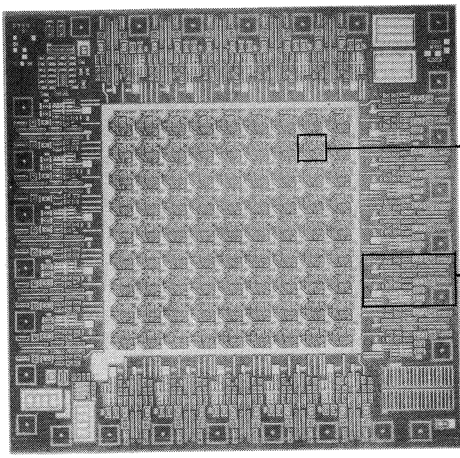
G Series

Type No.	Matrix Cell Count	Gate Count	Peripheral Cell Count	Bond Pads
03G	15	30	10	18
1G	49	98	16	24
2G	81	162	20	28
3G	121	242	24	32
4G	169	338	28	36
5G	225	450	32	40
6G	289	578	35	44

G Series Chip Organisation

Top Left Hand Corner
- Bandgap reference source

Top Right Hand Corner
- 2 × 35pF diffused capacitors



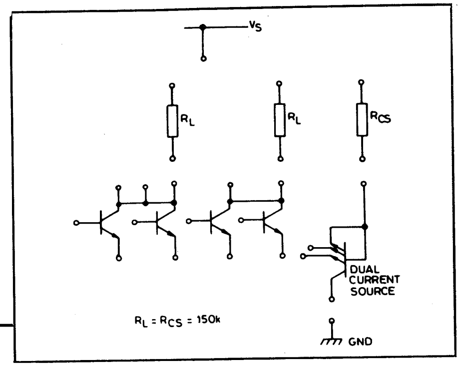
- 2 × 100mA transistors

Bottom Left Hand Corner

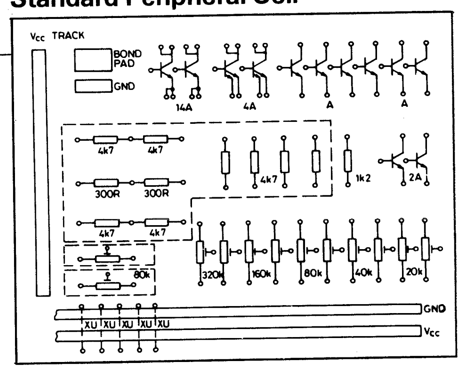
- 2 banks of 18 × 5k diffused resistors in separate "12V" islands

Bottom Right Hand Corner

Matrix Cell



Standard Peripheral Cell



Computer Aided Design

ULACAD Design Software

The ULACAD Software is a complete software system for the design simulation and implementation of ULA based custom integrated circuits and includes silicon compilers for 100% autolayout and chip optimisation of the 'DS' series. The software is contained in two environments, each of which has its own data base.

Design Environment

The design, simulation and verification of the system to be integrated are carried out in the design environment. Data entry is by schematic capture, high level design language or net listing. The design phase uses, where possible, macros contained within the software libraries. Alternatively, customer defined macros can be created .
ULASIM is a complete simulation program for both part and complete designs. It incorporates an advanced event driven simulator, supported by automatic calculation of logic delays and physical chip delays generated from the layout data base. For analogue functions, a library of ULA component characteristics is available for SPICE circuit analysis.
The ULACAD design data base is central to data capture, simulation and test schedule verification with complete design data stored in a fully structured hierarchical form.

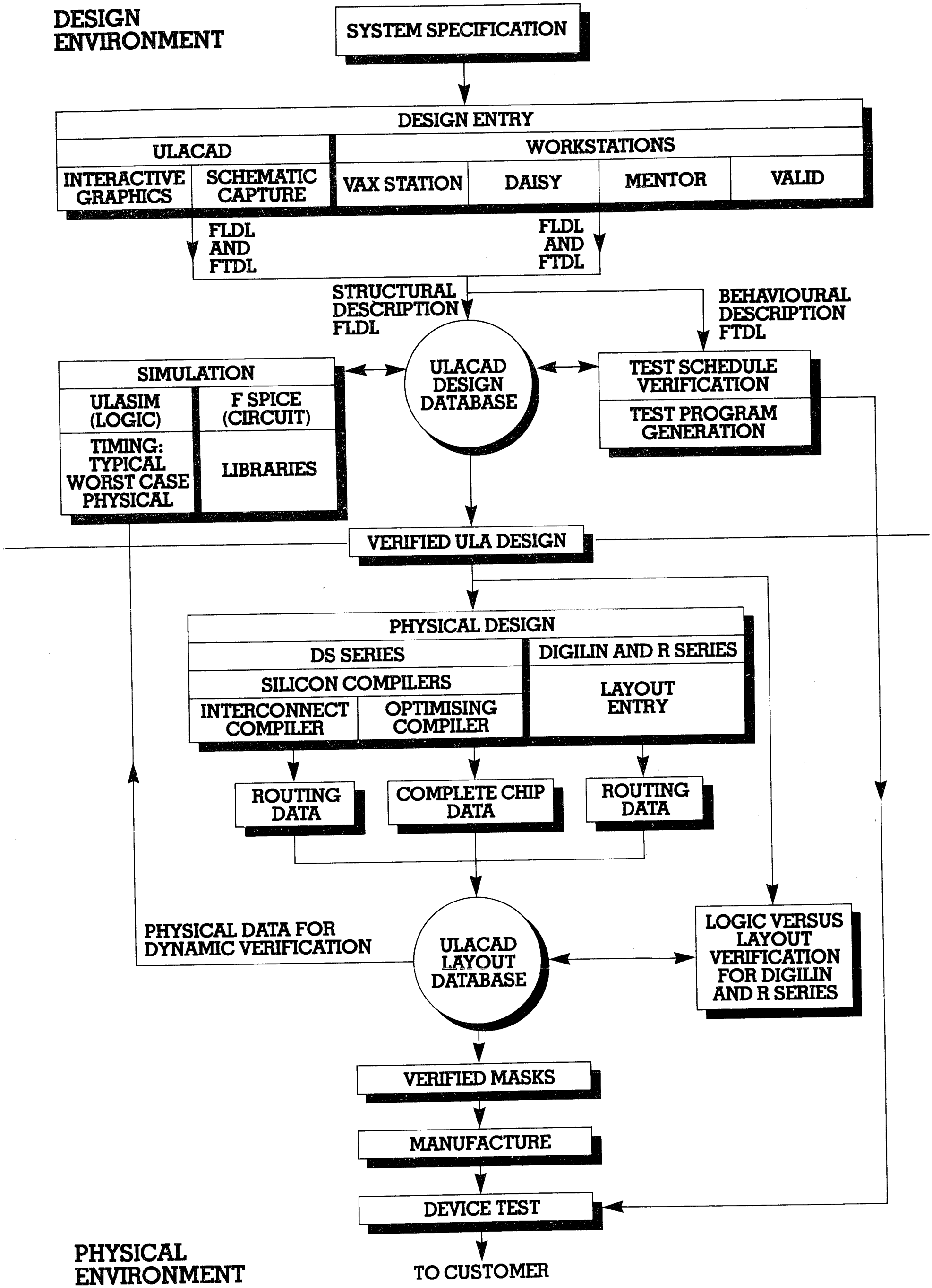
Physical Environment

The physical layout of the chip commences when the ULA system design has been completely verified. Silicon compilers enable 100% autolayout for the 'DS' series and provide the facility for chip optimisation giving the best economic solution. Layout macros are used for the 'G', 'P' and 'R' series.
The layout data base is the reference data base for the physical environment and is central to layout implementation and checking for the 'G', 'P' and 'R' series, and to autolayout by the silicon compiler system. It incorporates automatic calculation for physical delays.
P.G. tapes are generated from the verified layout data base and used to produce the interconnection mask to convert the uncommitted ULA to a custom LSI circuit.

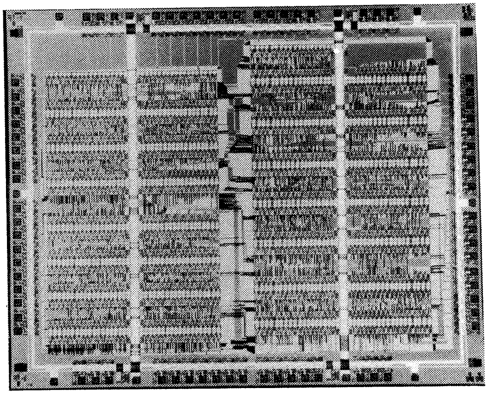
ULA Design Route

The ULA design route has the capability to accept customer design information at a number of different levels. In this way the service covers the range of interfaces from customer design to full design by Ferranti.

The table gives details of the various Customer Entry Levels, the choice of which to use depending on many factors such as the CAE tools available to the customer and the extent to which he wishes to become involved in the detailed design.
The UALCAD Software is portable over the whole VAX family of computers from MICROVAX to the VAX8600, including VAX 11/730, 11/750, 11/780, 11/782 and 11/785.
Daisy, Mentor and Valid workstations are supported by the necessary software for ULA design, and other workstations will be added progressively.


DESIGN ENVIRONMENT
SYSTEM SPECIFICATION
DESIGN ENTRY
ULACAD
WORKSTATIONS
INTERACTIVE GRAPHICS
SCHEMATIC CAPTURE
VAX STATION
DAISY
MENTOR
VALID
FLDL AND FTDL
FLDL AND FTDL
STRUCTURAL DESCRIPTION FLDL
BEHAVIOURAL DESCRIPTION FTDL
SIMULATION
ULASIM (LOGIC)
F SPICE (CIRCUIT)
TIMING: TYPICAL WORST CASE PHYSICAL
LIBRARIES
ULACAD DESIGN DATABASE
TEST SCHEDULE VERIFICATION
TEST PROGRAM GENERATION
VERIFIED ULA DESIGN
PHYSICAL DESIGN
DS SERIES
DIGILIN AND R SERIES
SILICON COMPILERS
INTERCONNECT COMPILER
OPTIMISING COMPILER
LAYOUT ENTRY
ROUTING DATA
COMPLETE CHIP DATA
ROUTING DATA
PHYSICAL DATA FOR DYNAMIC VERIFICATION
ULACAD LAYOUT DATABASE
LOGIC VERSUS LAYOUT VERIFICATION FOR DIGILIN AND R SERIES
VERIFIED MASKS
MANUFACTURE
DEVICE TEST
TO CUSTOMER
PHYSICAL ENVIRONMENT

DESIGN ROUTE	CUSTOMER INTEGRATION PACKAGE	ULA DESIGN CENTRE
Customer Entry Level 1		
The customer designs using Ferranti Design Elements or the Preferred TTL or CMOS and produces a verified breadboard and test schedule.	Logic and circuit diagrams DC & AC specifications Verified breadboard Test schedule	Conversion to FLDL Generate FTDL schedule Functional simulation Dynamic simulation Interconnect routing Pin out definition Dynamic verification Manufacture check samples
Customer Entry Level 2		
The customer designs on his workstation or mainframe using Preferred TTL or CMOS and functionally simulates.	Functional simulated logic on mag tape or floppy. Logic and circuit diagrams DC & AC specifications Test schedule	Conversion to FLDL Generate FTDL schedule Dynamic simulation Interconnect routing Pin out definition Dynamic verification Manufacture check samples.
Customer Entry Level 3		
The customer designs on his workstation using Ferranti Design Elements and carries out functional and timing simulation.	Functional and timing simulated logic in FLDL on mag tape or floppy Logic and circuit diagrams DC & AC specification FTDL test schedule	Dynamic simulation Interconnect routing Pin out definition Dynamic verfication Manufacture check samples
Customer Entry Level 4		
The customer designs using Ferranti Design Elements in the ULACAD Design Environment Software on VAX based system.	Fully simulated design database Logic and circuit diagrams DC & AC specification FTDL test schedule	Interconnect routing Pin out definition Dynamic verification Manufacture check samples



DESCRIPTION

The need to manipulate increasingly large amounts of data means that digital systems are developing an insatiable appetite for speed.
To meet these demands for higher speeds, plus the need for increased system complexity and performance, an ASIC approach is essential. Assessing the ability of a particular VLSI technology to meet a required system speed can however be difficult.
Gate delay is the basic speed parameter normally specified, and since this can be affected significantly by such system criteria as fan-out, supply voltage, clock frequency, capacitive loading, system complexity and temperature, it is often difficult to quantify the speed capability of the technology being considered.
The 'DS' series of ULAs* has been developed specifically to provide a low power ASIC solution for systems with speed requirements to over 100MHz and complexities from 500 to 10,000 gates.

'DS' Series of ULAs for 100 MHz Digital ASIC Systems

The series features gate delays, to below 1ns, which are virtually independent of fan-out, supply voltage and clock frequency, and flip-flops with clock to output delays of 1.5ns. The I/O cells are designed to allow the integration of special digital and linear functions which would normally require external components. Each cell contains a high current transistor to provide 48mA for direct bus drive.
Utilising 'Differential Logic' Macros, the 1.5 micron, double metal Ferranti Advanced Bipolar process — FAB 3, fully supported by the powerful ULACAD software system including silicon compilers for chip implementation, makes the 'DS' series fo ULAs one of the most advanced performance, high speed, ASIC product ranges available.

*Silicon Design System is a trademark of Ferranti plc
*ULA is a registered trademark of Ferranti plc for semiconductor devices.
*VAX is a trademark of the Digital Equipment Corporation.

Features

- System Speeds to 100MHz
- Complexities to 10,000 gates
- Average gate power 132µW at 100MHz
- 48mA bus drivers
- Digital and Linear Macros
- Complete CAD Support
- Silicon Compilers

Ferranti Advanced Bipolar Process – FAB 3

Key to the perforance is a new 1.5 micron advanced bipolar process with double layer metal featuring 6 micron grid pitch on both layers. It offers high and predictable speeds, low power levels and high current drive without chip area penalty.
It also provides the important bipolar performance advantages of excellent linear capability. This capability is particularly beneficial since it allows more of the system to be integrated. This offers the opportunity to further improve cost effectiveness and reduce overall system power requirements.

Features

- SYSTEM COMPLEXITY
  500 to 10,000 gates

- OUTSTANDING SPEED PERFORANCE
  True system performance: 100MHz
  'Differential Logic' flip-flop:
  clock to output delay 1.5ns
  clock frequency 250MHz
  Gate delay: 1ns
  virtually independent of fan-out, supply voltage and clock frequency

- COMPLETE CAD SUPPORT
  ULACAD Software covers Design, Simulation and Implementation
  Flexible Customer Interface
  Design Support for Commercial Workstations
  Silicon Compilers for 100% Autorouting and Optimisation
  Transportable Software for VAX* Based Systems
  Extensive Range of Fully Characterised Macros
  User Defined Macro Facility

- LOW POWER PERFORMANCE
  'Differential Logic' Flip-Flop

at 250MHz:	750μW (at 5V)
	300μW (at 2V)
at 140MHz:	380μW (at 5V)
	152μW (at 2V)
at 50MHz:	137μW (at 5V)
	55μW (at 2V)

  Average Gate Power

at 100MHz:	330μW (at 5V)
	132μW (at 2V)
at 60MHz:	165μW (at 5V)
	66μW (at 2V)
at 25MHz:	55μW (at 5V)
	22μW (at 2V)

- OUTSTANDING I/O CAPABILITY
  High Current Bus Drivers: 48mA at 0.5V
  Low Output Delays Driving High Capacitance Loads
  Wide range of Digital and Linear I/O Macros

- WIDE RANGE OF PACKAGE STYLES AND PIN COUNTS

'DIFFERENTIAL LOGIC'

'Differential Logic' is a radical approach to logic function design. It provides an order of magnitude improvement in speed-power product, ensuring that system power levels are kept to a minimum. It achieves a two to four times improvement in speed, with the added advantage that the flip-flop clock to output delay is less than two equivalent gate delays.

'Differential Logic' is based on steering current through a logic tree by means of differential pairs of transistors stacked across the supply rail (Fig. 1). Many complex and elegant logic functions can be implemented using this technique which is unique to bipolar technolgy. Unlike ECL, differential logic eliminates the need to generate and distribute accurate temperature compensated voltage references. Its inherent common mode rejection removes problems associated with noise, crosstalk, supply voltage distribution drops and variations in temperature.

A differential pair of transistors also has an extremely linear and sharp transfer characteristic. This enables differential gates to operate with logic swings as low as 100mV whilst retaining the same discrimination between logic levels as single ended circuits which have logic swings of 400mV or greater. Since power dissipation is directly proportional to logic swing, a power saving of 4:1 can be achieved with no compromise in speed.

In addition, differential logic has two further significant advantages illustrated by the 2 level D-type flip-flop (Fig.2) employed in the DS series.

1. Only two current sources are required to support the basic Master-Slave flip-flop function compared to six for a D-type flip-flop based on conventional gates.
2. The propagation delay from the active clock edge to both outputs is only marginally greater than for a single gate compared with two or three gates for conventional D-types.

"Differential Logic' automatically provides the true and inverse of every input and output removing the need for inverters. Hence an AND gate can become an OR, NOR or NAND simply by changing the order in which the connections are made. The significance of eliminating inverters is that the overall system speed can be increased for a given gate delay.

'Differential Logic' therefore provides a substantial increase in speed while greatly reducing the power. Moreover it is ideally suited to a hierarchical design approach, using the 'Differential Logic' macros available within the ULACAD software for VAX based sytems.

FIGURE 1. DIFFERENTIAL LOGIC STACKED ON TWO LEVELS

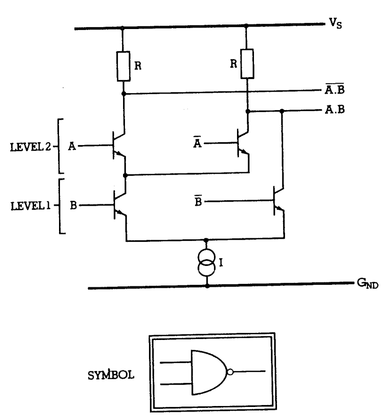
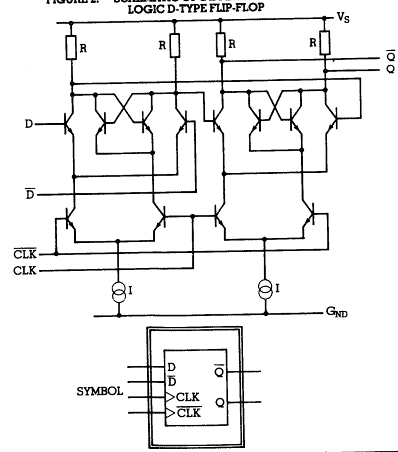


FIGURE 2. SCHEMATIC OF DIFFERENTIAL LOGIC D-TYPE FLIP-FLOP



SYSTEM SPEED

The fundamental factors determining system speeds are toggle rates of bistables and propagation delays through random logic, and the effect of loading on these parameters.

The outstanding performance of 'Differential Logic' functions is complemented by the high speed basic gate featured in the 'DS' Series of ULAs. The propagation delay of this gate, which can be less than 1ns, is virtually independent of fan-out, supply voltage and clock frequency. Fig. 3 shows the effect of fan-out on gate delay and compares a DSA Series gate with the degradation experienced by a typical CMOS gate. The inverter driver gate also features this virtual independence of fan-out loading, as seen in Fig 4.

This excellent performance under high load conditions is further enhanced by the clock driver gate. This gate has been designed to directly drive the very high fan-outs experienced on clock lines, avoiding partitioning into tree structures with its associated clock skew problems. The performance of this gate is shown in Fig. 5.

The effect of loading is equally important with the logic macro functions. Fig. 6 shows a similar improvement in performance using the Differential Logic D-Type Flip-Flop.

The ULACAD design software allows full advantage to be taken of these features during system design.

FIGURE 3.
INTERNAL LOGIC GATE
PROPAGATION DELAYS

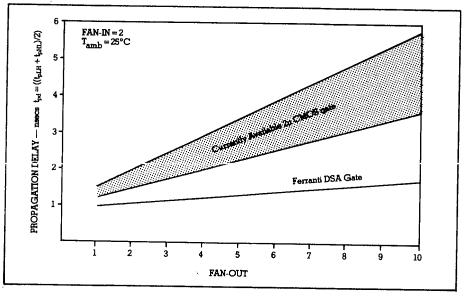


FIGURE 4.
INVERTER DRIVER GATE
PROPAGATION DELAYS

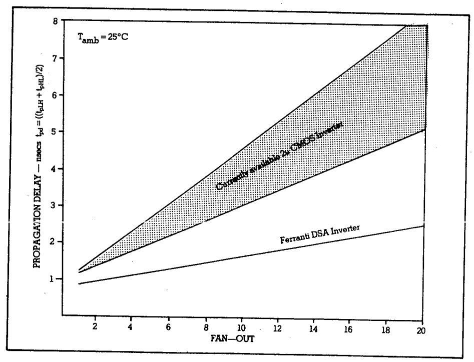
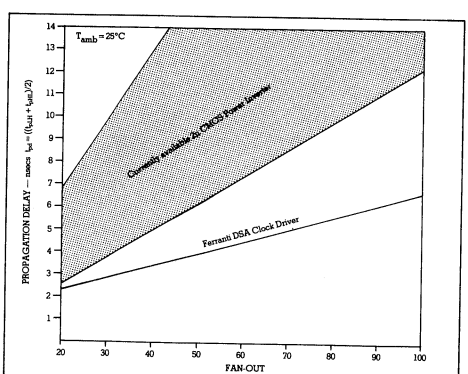
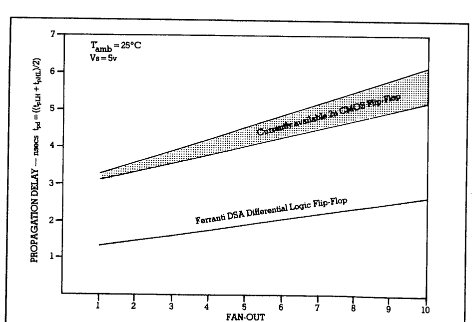


FIGURE 5.
PROPAGATION DELAYS FOR
HIGH FAN-OUT



NOTE: CMOS curve extrapolated from published data

FIGURE 6.
D-TYPE FLIP-FLOP
PROPAGATION DELAYS



THE 'DS' SERIES

ULA TYPE	ULA 6DS	ULA 12DS	ULA 19DS	ULA 25DS	ULA 32DS	ULA 38DS	ULA 47DS	ULA 60DS	ULA 80DS	ULA 100DS
Total Matrix Cells	252	484	748	1026	1292	1596	1900	2484	3168	4000
Equivalent Gates*	630	1210	1870	2550	3230	3990	4860	6210	7920	10000
Peripheral I/O Cells	32	44	64	74	82	90	104	122	138	138
Bond Pads	40	52	72	82	92	100	114	132	150	150

* A gate is defined as one 2 input - 2 output RNOR gate.

SPEED/POWER OPTIONS

A range of speed/power options are available for each of the 'DS' ULA types.

GATE PARAMETER	ARRAY TYPE			UNIT
	DSA	DSB	DSC	
For system speeds up to	100	60	25	MHz
RNOR gate delay—t_{pd}*	1.0	1.6	4.0	ns
RNOR gate delay—t_{pd}	1.4	2.4	6.1	ns
Average gate current—I_g	66	33	11	µA

Typical figures at $T_{amb} = 25°C$

*With selective use of additional matrix cell components

NOTES:
1. $t_{pd} = (t_{pLH} + t_{pHL})/2$
2. Figures are for 2 input gate, FAN-OUT = 2, with typical interconnect metal.
3. Gate current at 60% duty cycle.

'DIFFERENTIAL LOGIC'

The use of 'Differential Logic' Macros provides an order of magnitude improvement in speed/power product.

DIFFERENTIAL LOGIC D-TYPE FLIP-FLOP	ARRAY TYPE			UNIT
	DSA	DSB	DSC	
Toggle frequency	250	140	50	MHz
Clock to Output delay	1.5	2.7	7.5	ns
Current	150	76	27.4	µA

Typical figures at $T_{amb} = 25°C$

NOTE: 'Differential Logic' currently only available for VAX based system designs

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RANGE	UNIT
V_{CC}	Supply Voltage	−0.5 min +7.0 max	V
V_{IN}	Input Voltage	−0.5 min +5.5 max	V
T_{amb}	Operating Temperature	−55 min +125 max	°C
T_{stg}	Storage Temperature	−65 min +150 max	°C

NOTE: Operation at absolute maximum ratings is not implied. Exposure to stresses greater than those limited may affect reliability and could cause permanent damage to the device.

D.C. CHARACTERISTICS

At nominal $V_{CC} = 5V$ over temperature range $T_{amb} = 0$ to 70°C

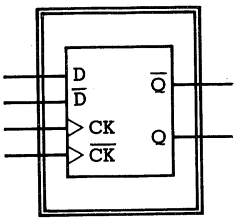
SYMBOL	PARAMETER	CONDITIONS	ARRAY TYPE	MIN	TYP	MAX	UNIT
V_{CC}	Supply Voltage		ALL	4.5	5.0	5.5	V
V_{IH}	High Level Input Voltage	TTL Input	ALL	2.0		5.5	V
V_{IL}	Low Level Input Voltage	TTL Input	ALL	0		0.8	V
I_{IH}	High Level Input Current	TTL Input $V_{IH} = V_{CC}$	ALL	0		10	μA
I_{IL}	Low Level Input Current	TTL Input $V_{IL} = 0.4V$	DSA DSB DSC	0 0 0		−0.6 −0.4 −100	mA mA μA
V_{OH}	High Level Output Voltage	Totem Pole Output, Tristate Output $I_O = I_{OH}$	ALL	2.4	3.4		V
V_{OL}	Low Level Output Voltage	Totem Pole Output, Tristate Output $I_O = I_{OL}$	ALL			0.5	V
I_{OH}	High Level Output Current	Totem Pole Output, Tristate Output	ALL			−400	μA
I_{OL}	Low Level Output Current	Totem Pole Output, Tristate Output, Open Collector Output $V_{OL} = 0.5V$	DSA DSB DSC			16 8 1.6	mA mA mA
		High Current Output Driver $V_{OL} = 0.5V$	All			48	mA

DIGITAL AND LINEAR MACROS

A wide range of fully characterised elements, from logic gates and functions to MSI, LSI and I/O Macros, are available for system specification and design. The elements also include 'Differential Logic' Macros.
The Macro Library, which is continually being expanded, contains well in excess of 100 different design elements which have been fully simulated and characterised. In addition, the designer can create user defined variants of these Macros.
Shown below are some typical examples of design elements.

DIFFERENTIAL LOGIC D-TYPE FLIP-FLOP

SYMBOL

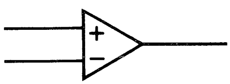


PARAMETER	ARRAY TYPE DSA	DSB	DSC	UNIT
Toggle Frequency	250	140	50	MHz
Clock to Output Delay	1.5	2.7	7.5	ns
Data Set Up Time	1	1.5	4.2	ns
Data Hold Time	0.5	0.9	2.5	ns
Cell Count	4	4	4	
Current	150	76	27.4	µA

Typical figures at $T_{amb} = 25°C$

VOLTAGE COMPARATOR

SYMBOL

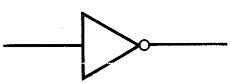


PARAMETER	ARRAY TYPE DSA	DSB	DSC	UNIT
Voltage Gain	45	45	45	dB
Offset Voltage	±10	±10	±10	mV
Bias Current	2	2	1.5	µA
CM Range	1-3	1-3	1-3	V
Bandwidth	6	6	4	MHz
I_{CC} Average	2.4	2.4	1.8	mA

Typical figures at $T_{amb} = 25°C$

48mA OUTPUT DRIVER

SYMBOL

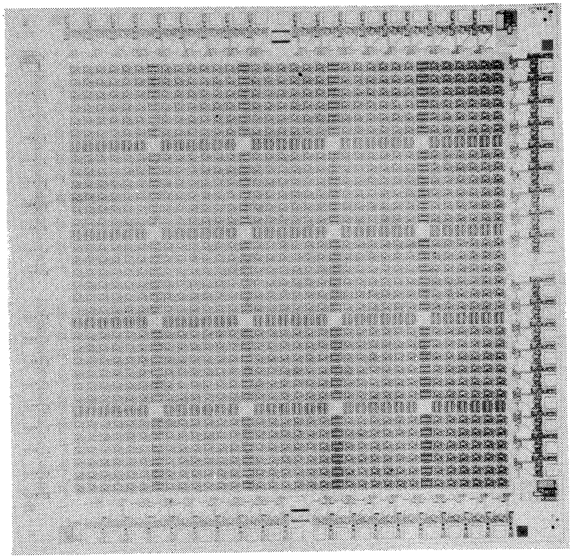


PARAMETER	ARRAY TYPE DSA	DSB	DSC	UNIT
V_{OL}(max)	0.5	0.5	0.5	V
I_{OL}(max)	48	48	48	mA
I_{OFF}(max)	20	20	20	µA
T_{ON}	15	15	25	ns
T_{OFF}	15	15	25	ns
I_{CC}(for input = 1)	1.8	1.8	1.8	µA
I_{CC}(for input = 0)	2.2	2.2	2.2	mA
I_{CC}Average	2	2	2	mA

NOTE: Load $C_L = 15pF$

Typical figures at $T_{amb} = 25°C$

ULA* 'R' Series



DESCRIPTION

The 'R' Series of ULAs are intended for the integration of digital systems up to 2000 gates. It is also designed to provide a wide variety of interface functions, and high drive capability. This combination of digital performance and powerful I/O function capability presents the opportunity to integrate much more of a system than would normally be possible with gate arrays.

The chip organisation for the 'R' Series of ULAs is shown below.

The central matrix of cells is designed to implement the system logic and the number of matrix cells of any given array determines the logic complexity. Each cell contains components which, when connected in the simplest form, provide two 2-input gates.

The peripheral cells contain high performance components for the implementation of a wide variety of I/O interface and linear functions. This important feature enables the 'R' Series to interface with all commonly used technologies and to provide totem pole and tristate outputs, oscillators, monostables, Schmitt trigger inputs, ECL to TTL level translators and to meet requirements for true bus and high output drive.

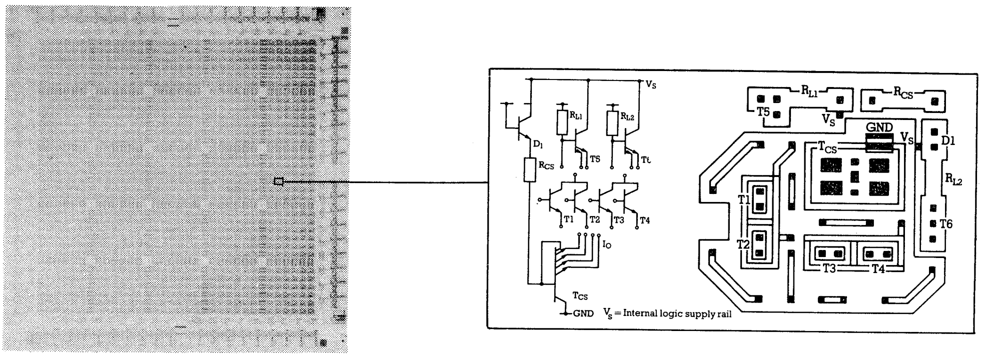
Features

- System clock rates up to 40MHz
- Extensive I/O interface and linear function capability.
- High output drive capability up to 32mA per peripheral cell.
- Wired-OR facilities reduce system gate count.
- 28 ULAs cover system complexities from 100 to 2000 gates.
- High yielding 5 mask process.
- Complete CAD to specify, design and verify ULA custom LSI.

Basic Chip Organisation

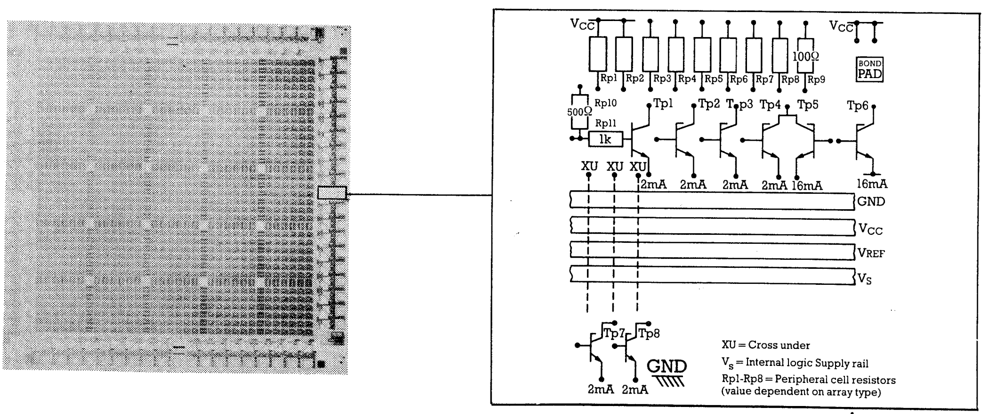
Matrix Cell

The matrix cell components provide two buffered current mode logic (CML) 2 I/P NOR gates which operate in the non-saturating mode. Each gate has two independent emitter follower buffered outputs. Minimum propagation delays of 1ns can be achieved and due to the emitter follower buffer, gate delays are independent of fan-out. The gate can operate at supply voltages down to 2V minimising gate power without sacrificing speed or performance. Two independent outputs provide a wired-OR facility which can reduce the number of gates by up to 30% with a corresponding decrease in multiple gate path delays and a smaller chip size for improved economics.



Peripheral Cell

A most important aspect of the 'R' series is the range of circuit function capability of the peripheral cell.
Each peripheral cell contains 11 resistors and 8 transistors which can be interconnected to produce a wide variety of I/O and linear functions to meet a customer's particular requirement. I/Os can be configured to interface with all commonly used technologies such as TTL, CMOS and ECL.
Schmitt trigger inputs, ECL to TTl translators, monostables, comparators, voltage controlled, crystal controlled and RC timed oscillators are all readily achieved.
The range of output functions that can be integrated include active pull-up and pull-down totem poles, tristates, open collectors and emitter followers and high current outputs up to 32mA.
The ready available of TTL compatible outputs with the associated source and sink currents and low $R_{CE\,sat}$ of 10 ohms means that high capacitive loads (such as MOS memory systems) can be switched at speed without the need for additional buffering. Many of these functions are available as fully characterised macros.



'R' Series Range

The 'R' Series is available in 4 ranges covering system speeds up to 2.5MHz, 5MHz, 10MHz and 40MHz. Each range contains 7 ULAs with complexities from 100 to 2000 gates.
The I/O and linear interface facilities are indicated by the number of I/O pads which also define the number of peripheral cells available for each ULA.

The 'R' Series

ULA TYPE	ULA IR	ULA 3R	ULA 5R	ULA 9R	ULA 12R	ULA 16R	ULA 20R
Gate Count*	130	300	500	900	1200	1600	2000
Peripheral I/O Cells	20	30	38	48	52	62	72
Bond Pads	20	30	40	50	58	68	80

*An equivalent gate is defined as one 2 input — 2 output RNOR gate.

NOTE: A number of the available I/O cell pads are required for V_{CC} and ground pins.
It may be necessary to configure additional pads for V_{CC} and ground, depending on the number and drive of the output buffers.

Speed/Power Options

GATE PARAMETER (Typical figures at T_{amb} = 25°C	ARRAY TYPE				Unit
	RA	RB	RC	RD	
For System Speeds Up To	40	10	5	2.5	MHz
Basic RNOR Gate Delay * tpd	2.5	7.5	15	50	ns
Average Gate Power	580	224	56	22	µW

*Gate delay can be reduced with selective use of additional matrix cell components.

NOTES: 1) $tpd = (t_{pLH} + t_{pHL})/2$

2) Figures are for 2 input gate, fan-out = 2 with typical interconnect metal.

Ratings

Operating Temperature Range

All ULAs are designed to operate over the full temperature range −55°C to +125°C and therefore embrace all various military, industrial and consumer temperature ranges.

Supply Voltage

By suitable interconnection of the on-chip components, regulation is readily achieved allowing the ULAs to operate from any supply rail using minimum external components.

Drive Capability

By suitable interconnection of the peripheral cell components high drive currents up to 64mA are available.

Absolute Maximum Ratings

Symbol	Parameter	Range
V_{CC}	Supply Voltage	+7.0V Max −0.5V Min
V_{IN}	Input Voltage	+5.5V Max −0.5V Min
T_{amb}	Operating temperature range	−55°C to +125°C
T_{stg}	Storage temperature	−65°C to +150°C

NOTE: Operation at absolute maximum ratings is not implied. Exposure to stresses greater than those listed may affect reliability and could cause permanent damage to the device.

Typical Array Characteristics

Values at $V_{CC}=5V$ $T_{amb}=25°C$ unless otherwise stated

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{CC}	Supply Voltage		4.5	5.0	5.5	V
$V_{IN(1)}$	High level input voltage	TTL/CMOS interface	2.0		5.5	V
$V_{IN(0)}$	Low level input voltage	TTL/CMOS interface	0		0.8	V
$I_{IN(1)}$	High level input current	TTL or 5V CMOS Emitter follower input $V_{IN}=2.4V$ $V_{IN}=5.5V$	 0 0		 20 20	 μA μA
$I_{IN(0)}$	Low level output current	Emitter follower input	0		−10	μA
$V_{OUT(1)}$	High level output voltage	$V_{CC}=4.5V$ $I_{OUT}=I_{OUT(1)}$	2.4	3.4		V
$V_{OUT(0)}$	Low level output voltage	$V_{CC}=4.5V$ $I_{OUT}=I_{OUT(0)}$			0.5	V
$I_{OUT(1)}$	High level output current	$V_{CC}=4.5V$ Totem Pole Output buffer			−400	μA
$I_{OUT(0)}$	Low level output current	Totem Pole or open collector output 0°C to 70°C −55°C to +125°C High current open collector output (per peripheral)			 16 8 32	 mA mA mA

Dynamic Performance

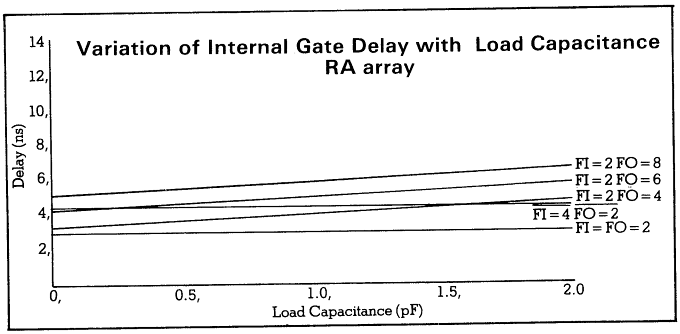
One of the features of the 'R' Series arrays is that its dynamic performance is virtually independent of nodal capacitance and fan-out. The graphs shown opposite illustrate the small effect output capacitance has on the gate delay which means that aluminium track length has little effect on the gate dynamic performance. This is due essentially to the emitter follower buffer.
By selectively speeding up the switching transistor of the CML gate, the dynamic performance can be enhanced significantly. Similarly, the emitter-follower output stage of the gate may be selectively speeded-up to, by selective use of additional matrix components, compensate for large capacitive loads, large fan-outs or long interconnection tracks e.g. clock lines.

Performance Example

Application:
"Steamer" Tape Drive Data Recovery

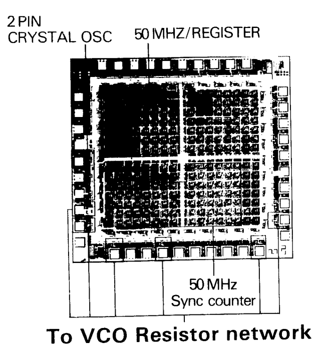
Chip Functions:
- Data capture (phase frequency detection, counters and registers
- VCO control
- Crystal oscillator

Chip Features:
- 50 MHz synchronous counter
- 50 MHz register
- Outputs drive VCO resistor network directly, from separate supply pin. (Symmetrical bipolar voltage levels.)
- 11 MHz crystal oscillator amplifier.



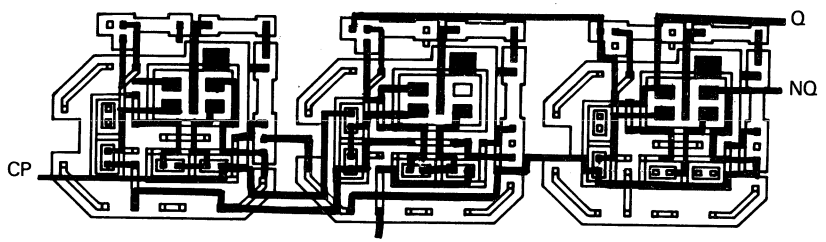
Typical Application

Tape drive data recovery



Functions Implementation

A library of fully characterised circuit and layout macros are available covering logic; linear and I/O functions. The illustration shows the illustration layout macro for a D-type flip-flop using 3 buffered CML matrix cells.



I/O & Linear Functions

Interface functions are produced using the peripheral cell components or by combining matrix and peripheral cells, when a wider variety of circuits can be implemented.

Linear Special Functions

Comparator	2P+M
Controlled mono or oscillator	2P+M
Precision/crystal oscillator	2P+M
Output Interfacing	
32mA open collector output	1P
64mA open collector output	2P
Totem pole with Tristate	1P+M
Tristate out/TTL in	1P+2M
LED/LCD driver	1P+1M
Input Interfacing	
TTL/CMOS buffer	1P+M
High Z_{IN} buffer	1P
Schmitt trigger	1P+M

*In the examples given P indicates peripheral cell and M matrix cell.

Logic Functions

Almost all the commonly used TTL and CMOS MSI functions can be implemented. The table gives examples of the gate count for some of the logic functions available in macro form.

Logic Functions	Library Reference Number	Cell Count
2 input NOR	RNOR2	½M
6 input NOR	RNOR6	1½M
Equivalence gate	REQV	2M
D latch with reset	DL1RQ	2½M
Pulse monostable	NMONO	4M
T type flip flop	TT1Q	3M
D type flip flop	DT1Q	3M
D type flip flop with set and reset	DT1SRQN	4½M
Synchronous decade counter	SDUC4	23M
D type synchronous up/down counter bit with ripple carry	SDUDC4R	7½M

ULA* 'P' Series

DESCRIPTION

The 'P' series of ULA's feature linear and digital circuitry on the same integrated circuit. This can be exploited to minimise the number of chips required for a system — often to a single chip solution.
Linear circuitry is designed using the wide range of resistors and transistors in each peripheral cell. Special linear components are featured on-chip to enhance the performance capabilities and minimise the requirements for external components.
The system logic is integrated in the central matrix area. Wafers are produced in two gate switching speed versions allowing the designer to optimise the power consumption to his system requirements.
The wide operating voltage range provide by the 'P' Series arrays simplifies interfacing problems.

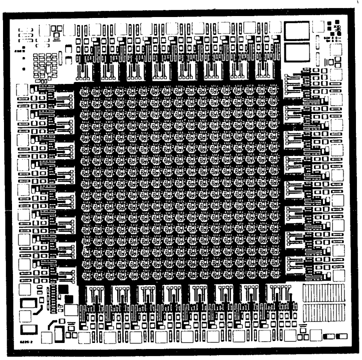
ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	+16.5V max −0.5V min
Input Voltage V_{IN} (using high voltage components)	+16.5V max −0.5V min
Input Voltage V_{IN} (using low voltage components)	+5.5V max −0.5V min
Operating Temperature Range	−55 to +125°C
Storage Temperature Range	−65 to +150°C

Note 1) All bond pads have a 15V operating rating.
Note 2) Operation at Absolute Maximum Ratings is not implied.

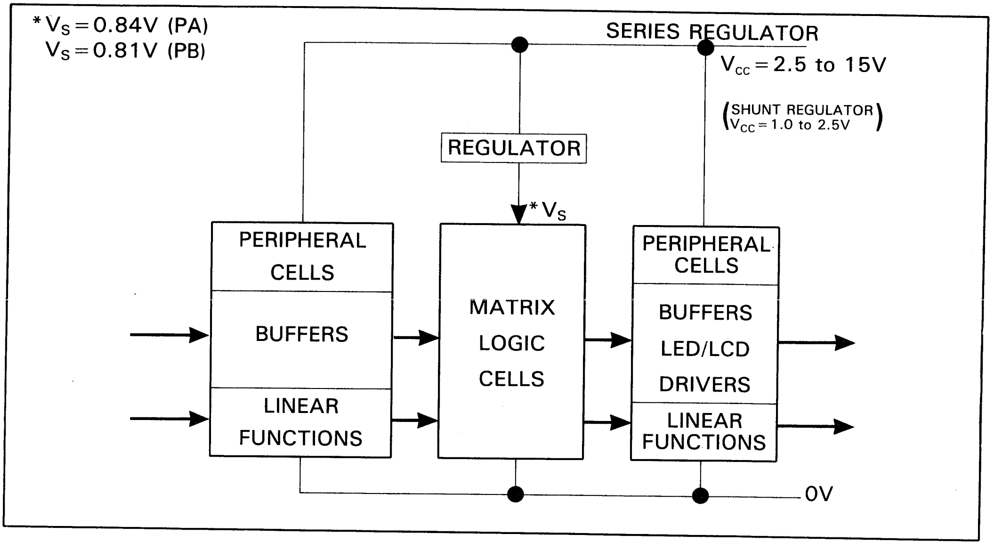
Features

- Digital and linear circuitry on a single chip
- Operation from 1.0 to 15.0V supply
- Complete system integration capability
- Rapid development time
- Reduced system space and power
- High current drive capability



*ULA is a registered trademark of Ferranti plc for semiconductor devices.

BASIC CHIP ORGANISATION



TYPICAL ARRAY CHARACTERISTICS (at T_{amb} = 25°C)

Parameter	Speed Option		Note
	P.A.	P.B.	
Gate delay (single-powered)	120ns	500ns	1
Gate delay (triple-powered)	40ns	170ns	1, 2
Gate power (single-powered)	3.3μW	0.8μW	1
Gate power (triple-powered)	9.9μW	2.4μW	1, 2
Clock rate (single-powered)	1.6MHz	400kHz	3
Clock rate (triple-powered)	4.8MHz	1.2MHz	2, 3
Gate power-delay product (single-powered)	0.5pJ	0.5pJ	1
Gate supply current* (single-powered)	4.0μA	1μA	1
Transistor pair base-emitter offset	<1mV	<1mV	
Bandgap reference	1.25V	1.25V	
Bandgap reference stability	100ppm/°C	100ppm/°C	
Voltage range: On-chip shunt regulator	1.0 to 2.5V	1.0 to 2.5V	
On-chip series regulator	2.5 to 5.5V	2.5 to 5.5V	
On-chip series regulator (using additional high voltage components)	2.5 to 15V	2.5 to 15V	

*The matrix supply current = number of gates × gate supply current.

Notes 1) Gate power, supply current and power delay product based on 60% duty cycle.

2) It is possible to reduce the propagation delay of the basic gate (single-powered) using a method termed "powering up". This results in a reduced gate delay and increased power consumption as shown for the "triple-powered" gates.

3) Clock rate is basd on critical (clock) path gate delay in an edge-triggered D-Type.

P-SERIES RANGE

Type No.	Matrix Cell Count	Number of Gates	Peripheral Cell Count	No. of Bond Pads
1P	64	128	16	26
3P	169	338	24	34
6P	289	578	32	42
9P	441	882	40	50
11P	576	1152	44	54

PERIPHERAL TRANSISTOR CHARACTERISTICS (at $T_{amb} = 25°C$)-typical values except where stated.

Symbol	Parameter	Conditions	Transistor Size*					Units
			1A	2A	4A	14A	75A	
$h_{FE\ forward}$	Current gain	$I_E = 100\mu A$	120	120	120	120	120	
$V_{CBO(min)}$			7.5	15.0	15.0	15.0	15.0	V(min)
$V_{EBO(min)}$			6.0	6.0	6.0	6.0	6.0	V(min)
$V_{CEO(min)}$			4.5	4.5	4.5	4.5	4.5	V(min)

*The term '1A' is used to define minimum area transistors. Therefore a 2A transistor has an emitter area twice that of a 1A.

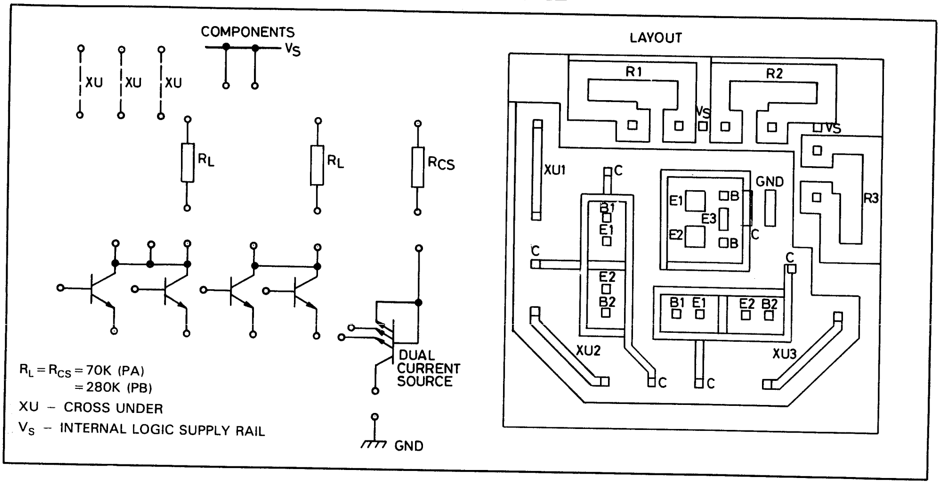
PERIPHERAL TRANSISTOR CHARACTERISTICS (at $T_{amb} = 0\text{-}70°C$) maximum values

Symbol	Parameter	Conditions	Transistor Size					Units
			1A	2A	4A	14A	75A	
$I_{C(max)}$	Collector current	Continuous saturated current	3	12	30	30	120	mA(max)

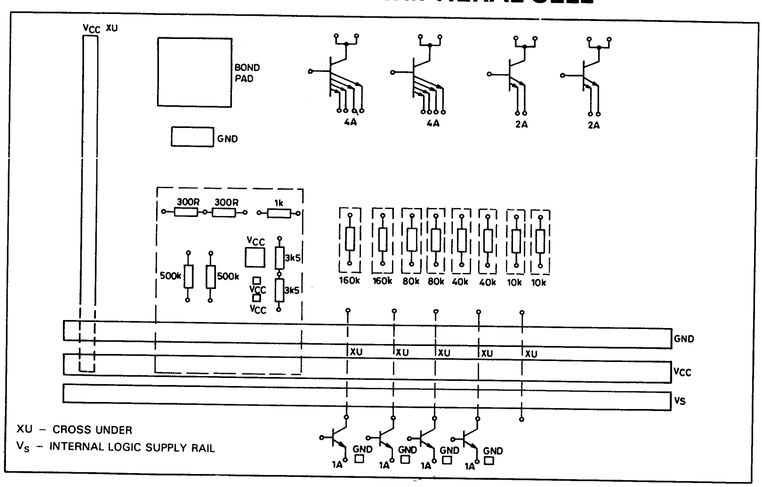
RESISTOR CHARACTERISTICS at $T_{amb} = 25°C$

	Resistor Type	
	Diffused	Epitaxial
Absolute tolerance	±30%	−50% +100%
Voltage coefficient (typ)	+1% per volt	+10% per volt
Temperature coefficient (typ)	+0.2% per °C	+0.7% per °C
Matching between resistors of equal value	±2%	±5%

MATRIX CELL



STANDARD PERIPHERAL CELL



TRANSISTORS

2 × 4A '15'V
2 × 2A '15'V
4 × 1A level-shift with integral collector matrix/peripheral XU.

Bond Pad

1 × matrix/peripheral XU

RESISTORS

1 × 7KΩ CT*
1 × 600R CT* diffused
1 × 1KΩ diffused
2 × 360KΩ epitaxial

} in common island

2 × 120KΩ 15V
2 × 60KΩ
2 × 30KΩ
2 × 6KΩ

} Epitaxial resistors in independent isolations

V_{CC} Rail

*CT = Centre Tap

SPECIAL PERIPHERAL CELLS

Top Left Hand Corner

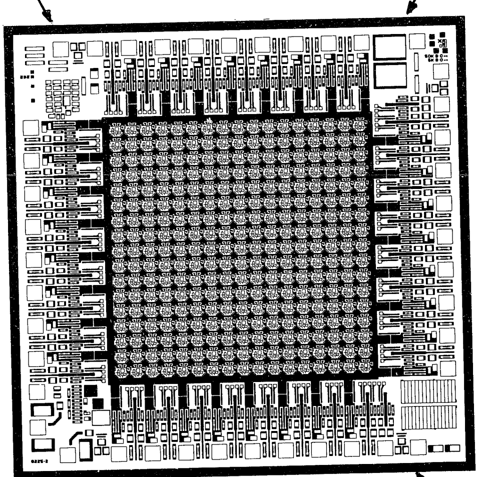
- Bandgap reference source
- 6 × 4.8KΩ 15V diffused resistors
- 2 × 30mA '15V' transistors
- 3 × low offset transistor
- 2 × bond pad

Top Right Hand Corner

- 2 × 35pF diffused capacitors
- 3 × bond bands
- 2 × 4.8KΩ 15V diffused resistors
- 3 × low offset transistors

½ Peripheral cell comprising

- 2 × 1A level-shift transistors
- 2 × 2A '15V' transistors
- 2 × 4A '15V' transistors
- 2 × 60KΩ epitaxial resistors
- 2 × 30KΩ epitaxial resistors



Bottom Left Hand Corner

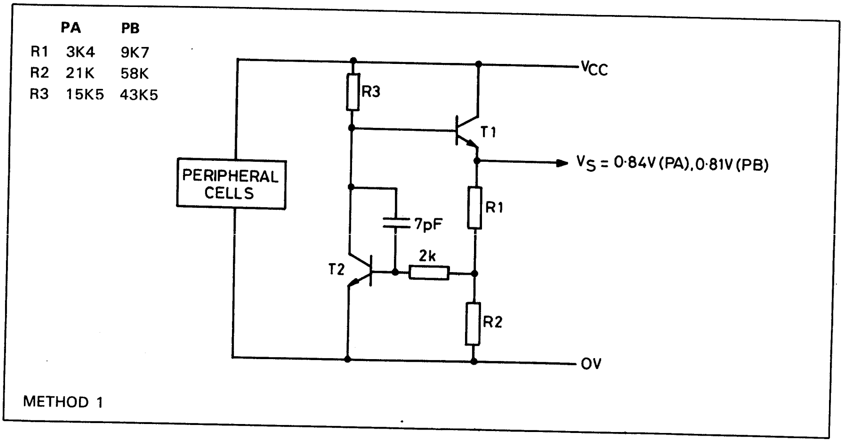
- 3 × 75A '15V' transistors
- 2 × 4A '15V' transistors
- 3 × low offset transistors
- 2 × 10KΩ epitaxial resistors
- Chip regulators
- 3 × bond pads

Bottom Right Hand Corner

- 3 × low offset transistors
- 2 banks of 15 × 5KΩ diffused resistors in 15V isolation islands
- 2 × bond pads
- ½ peripheral cell

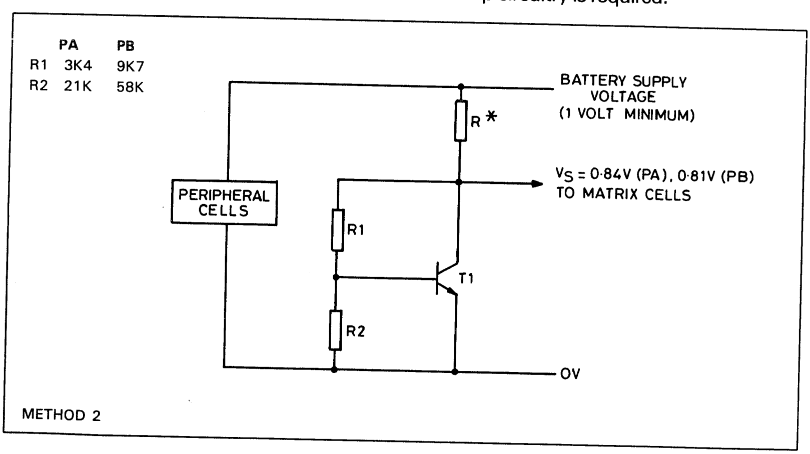
METHODS OF POWERING THE ULA

Several methods are available of powering the array. Choice of method is determined by the application and programmed on to the final interconnection pattern. Two are shown below.



Method 1

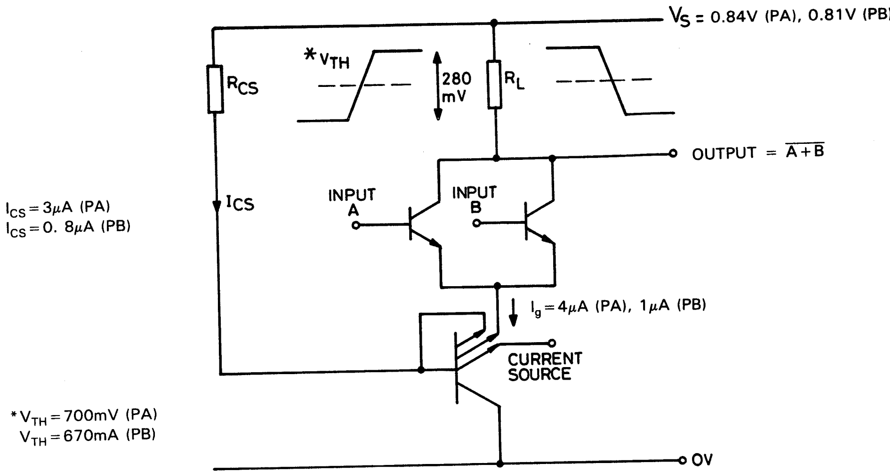
The non-saturating current mode logic (CML) cells are supplied from an "on-chip" regulator which provides a temperature compensated, noise free supply rail V_S. This is derived from the supply voltage V_{CC} which powers the peripheral cells. For supply voltages above 5.5V additional on-chip circuitry is required.



*Choice of resistor R depends on cell utilisation and battery voltage range.

Method 2

For single battery operation in the range 1.0 to 2.5V, the array is supplied via an external resistor which defines an appropriate current to the array and to an internal shunt regulator which defines the matrix supply voltage V_S.



Functions are all based on the CML NOR gate (½ cell).
They are simple to lay out and have well defined characteristics.
The dual current source consists of a multi-emitter transistor operated in the inverse mode. Two 2-input NOR gates can be constructed from each matrix cell A "D" flip flop can be constructed from only 3 cells and is the basic binary divider element.
Multi-input gates can be obtained by paralleling additional gate transistors.
The supply current per gate is nominally 4µA for the 'PA' options and 1µA for 'PB'.
The following list gives an indication of the numbers of cells which may be inter-connected to produce some commonly used circuit configurations.

CELL COUNTS FOR SOME TYPICAL LOGIC FUNCTIONS

Matrix Cell Functions	Number of Matrix Cells
2 input gate	½
4 input gate	1
Equivalence/Exclusive OR	2
Binary divider	3
Binary divider with preset	4
Data latch	2
D type flip flop with preset and clear	6
Monostable (narrow pulse)	3
Shift register bit	3

CELL COUNTS FOR SOME TYPICAL LINEAR FUNCTIONS

Peripheral Functions	Number of Peripheral Cells
Schmitt trigger	1
Totem pole/Tristate O/P	1
LED digit driver	1
LED segment driver	1
Comparator	2
RC oscillator	2
Analogue switch	1
Reference amplifier	1

DESCRIPTION

The G Series of ULA's provides a number of high performance linear functions together with very low power digital capability. Also featured is the ability for high current driving outputs. Each of the uncommitted matrix cells operates in the digital mode, being composed of five transistors, one of which is used as a dual current source, three resistors and three cross-unders. Around the periphery of the internal cell matrix is a series of cells which provide linear and interface functions. These cells consist of one bond pad, twelve transistors, five cross-unders and a total of eighteen resistors, twelve of which are in isolated islands. Also included in the periphery of the array are a bandgap reference, two 35pF shaping capacitors, two 100mA transistors, additional resistors and an on-chip voltage reference.
These arrays take advantage of the latest CAD technolgy. The circuit diagram, layout and test programme can be loaded directly into the Ferranti Silicon Design System*. Essential checks are carried out, and the analogue and digital parts of the circuit can be simulated, if required, using SPICE and FLDL respectively.

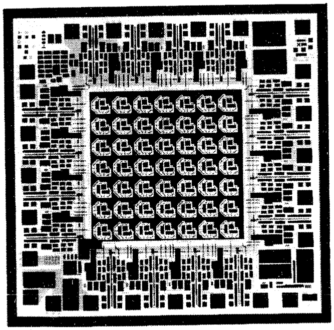
ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	+ 7.0V max − 0.5V min
Input Voltage V_{IN}	+ 5.5V max − 0.5V min
Operating Temperature Range	− 55 to + 125°C
Storage Temperature Range	− 65 to + 150°C

Note: All bond pads have a 12.6V(max) capability

Features

- Operation from 1.0 to 5.5V supply
- Single cell battery operation
- Rapid development time
- Reduced system space and power
- Complete system integration capability
- Linear and digital functions
- LED or LCD drive capability
- High current drive capability
- CAD-compatible



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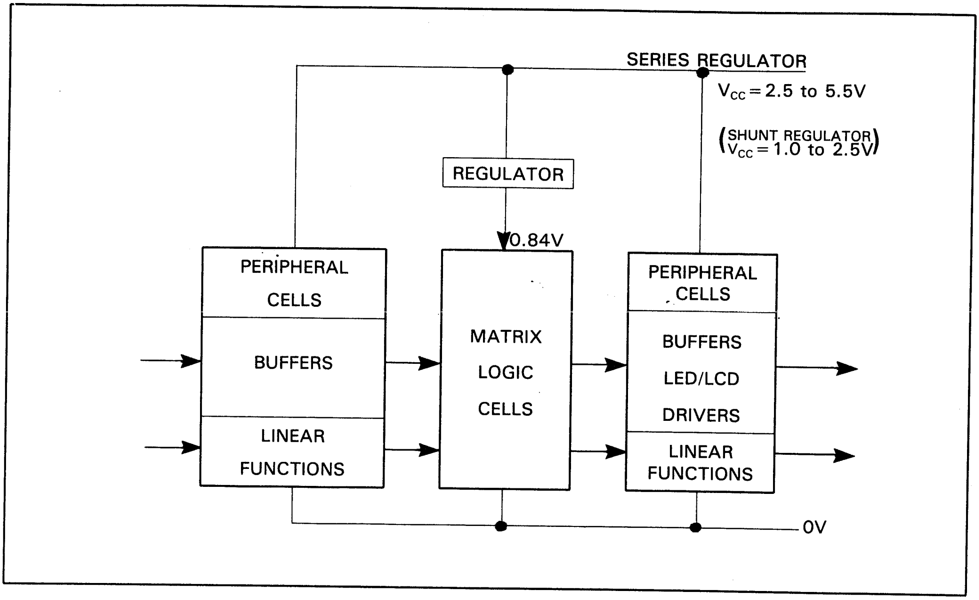
*Silicon Design System is a trademark of Ferranti plc.

BASIC CHIP ORGANISATION



TYPICAL ARRAY CHARACTERISTICS (at T_{amb} = 25°C)

Parameter	Value
Gate delay power product	0.8pJ
Gate delay with single power gate	690ns
Gate delay with triple power gate	230ns
Gate power	1.9μW
Clock rate with single power gate	220kHz
Clock rate with triple power gate	660kHz
Gate supply current*	2.4μA
Transistor pair base-emitter matching	<1mV
Analogue switch offset	<1mV
Bandgap reference	1.30V
Bandgap reference stability	100ppm/°C
Voltage range On-chip shunt regulator	1.0 to 2.5V
On-chip series regulator	2.0 to 5.5V

*The matrix supply current = number of gates × 2.4μA

Notes 1) Gate power, supply current and power delay product based on 60% duty cycle.

2) Clock rate is based on critical (clock) path gate delay in an edge-triggered D-Type.

Peripheral Transistor Characteristics (at $T_{amb} = 25°C$)-typical values except where stated.

Symbol	Parameter	Conditions	Transistor Size					Units
			A	2A	4A	14A	100A	
h_{FE}forward	Current gain	$I_E = 1\mu A$-$1mA$	140	140	150	150	-	
		$I_E = 1\mu A$-$100mA$	-	-	-	-	150	
h_{FE} inverse	Current gain	$I_E = 1\mu A$-$1mA$	8	10	20	40	-	
		$I_E = 1\mu A$-$100mA$	-	-	-	-	45	
I_{CBO}	Leakage current	$V_{CB} = 1V$	0.01	0.01	0.01	0.01	1	nA
I_{CEO}	Leakage current	$V_{CE} = 1V$	0.5	0.5	0.5	0.5	50	nA
V_{BE}	Voltage	$I_E = 10\mu A$	644	626	608	575	524	mV
V_{BE} matching between adjacent transistors		$I_E = 1\mu A$	±2	±1	±0.5	±0.3	±0.3	mV
V_{offset}	Collector offset voltage	$I_C = 10\mu A$, $I_B = 30\mu A$	3.0	3.0	1.5	0.8	1.0	mV
V_{offset} matching/adjacent pairs of transistors		$I_C = 10\mu A$, $I_B = 30\mu A$	50	50	10	10	50	uV
R_{sat}	Collector saturation resistance	$I_C = 1mA$, $I_B = 100\mu A$	55	55	30	25	-	ohm
		$I_C = 100mA$, $I_B = 10mA$	-	-	-	-	3	ohm
$V_{CBO(min)}$			7.5	12	7.5	7.5	12	V (min)
$V_{EBO(min)}$			6.0	6.0	6.0	6.0	6.0	V (min)
$V_{CEO(min)}$			4.5	4.5	4.5	4.5	4.5	V (min)
R_C	Collector slope		10	10	10	10	10	kΩ/mA

Peripheral Transistor Characteristics (at $T_{amb} = 0$-$70°C$) maximum values

Symbol	Parameter	Conditions	Transistor Size					Units
			A	2A	4A	14A	100A	
$I_{C(max)}$	Collector current		3	3	25	25	120	mA(max)

Figures are dependent on laod characteristics.

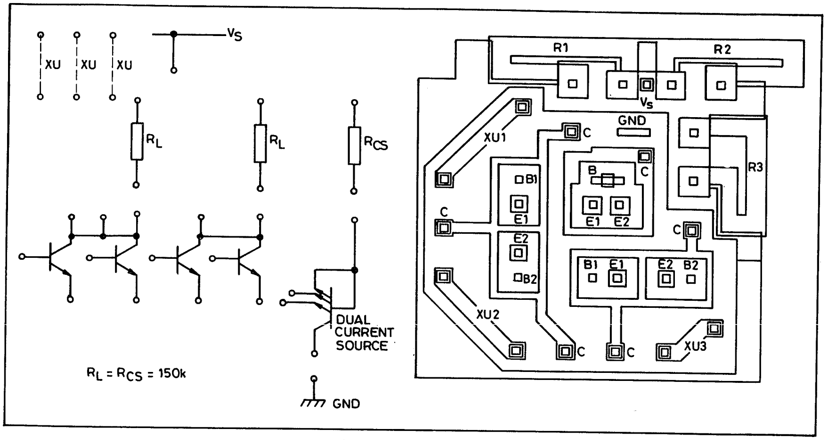
RESISTOR CHARACTERISTICS (at $T_{amb} = 25°C$)

	Resistor Type	
	Diffused	Pinch
Absolute tolerance	±30%	−50% +100%
Voltage coefficient (typ)	+1% per volt	+7% per volt
Temperature coefficient (typ)	+0.2% per °C	+0.7% per °C
Matching	±1%	±2%

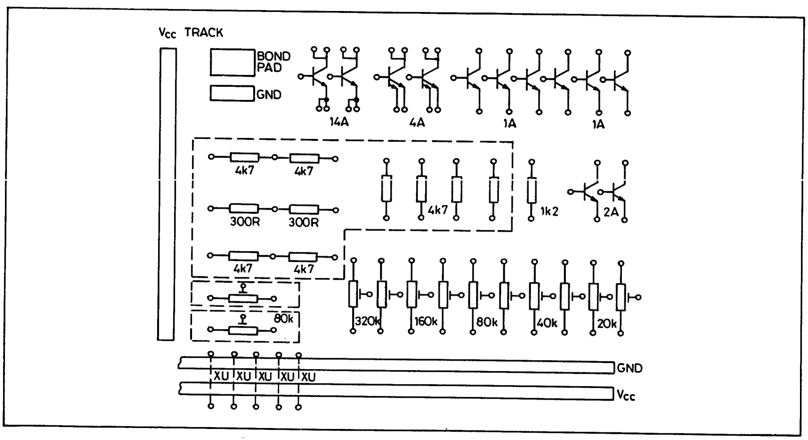
G-SERIES RANGE

Type No.	Matrix Cell Count	Number of Gates	Peripheral Cell Count	No. of Bond Pads
03G	15	30	10	18
1G	49	98	16	24
2G	81	162	20	28
3G	121	242	24	32
4G	169	338	28	36
5G	225	450	32	40
6G	289	578	36	44

MATRIX CELL



STANDARD PERIPHERAL CELL



TRANSISTORS

2 × 14A
2 × 4A
2 × 2A "12V"
6 × 1A

Bond Pad

V_{CC}track
5 Crosscunders to matrix

RESISTORS

2 × 320k
2 × 160k
2 × 80k
2 × 40k
2 × 20K
} Independently isolated pinch resistors

2 × 80k pinch resistors in "12V" islands

2 × 9K4 CT*
4 × 4K7
1 × 600 CT*
} Diffused resistors in common island

1 × 1K2 diffused resistor

*CT = Centre Tap

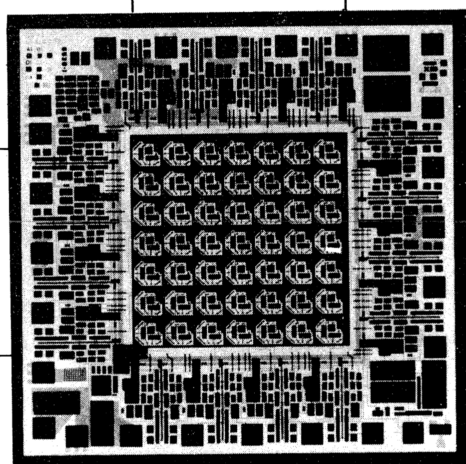
● SPECIAL PERIPHERAL CELLS

Top Left Hand Corner

- Bandgap reference source
- 2 × 10k p-type resistors
- 2 × 1k n-type resistors in "12V" island
- 1 × 20mA "12V" transistor
- 1 × bond pad

Top Right Hand Corner

- 2 × 35pF diffused capacitors
- 2 × bond pads



Bottom Left Hand Corner

- 2 × 100mA transistors
- 2 × 6k diffused resistors in separate "12V" islands
- 1 × 15mA "12V" transistor
- 3 × bond pads
- Chip regulator

Bottom Right Hand Corner

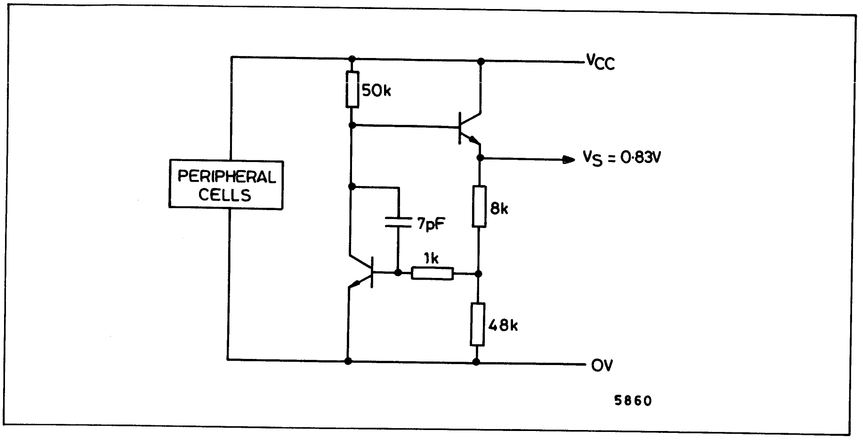
- 2 banks of 18 × 5k diffused resistors in separate "12V" islands
- 2 × bond pads

METHODS OF POWERING THE ULA

Several methods are available of powering the array. Choice of method is determined by the application and programmed on to the final interconnection pattern. Two are shown below.

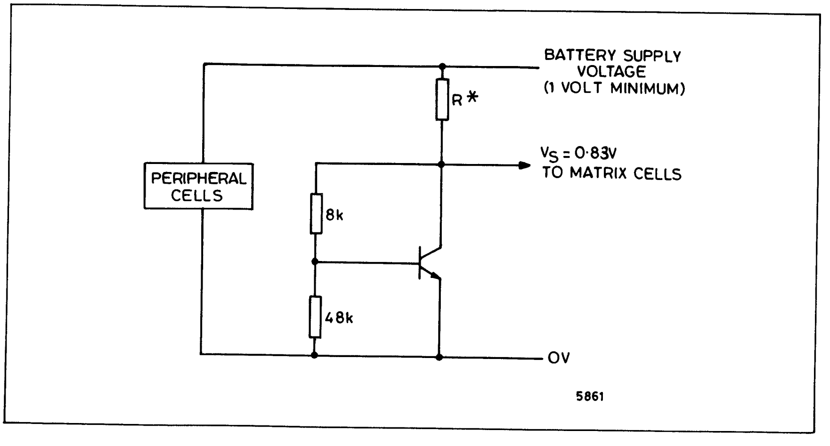
Method 1

The non-saturating current mode logic (CML) cells are supplied from an "on-chip" regulator which provides a temperature compensated, noise free supply rail V_S. This is derived from the supply voltage V_{CC} which powers the peripheral cells.



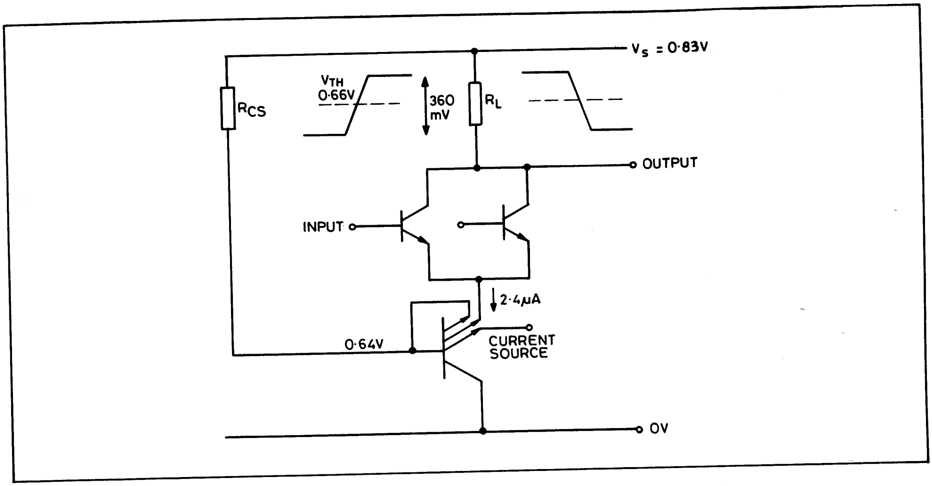
Method 2

For single battery operation, the array is supplied via an external resistor which defines an appropriate current to the array and to an internal shunt regulator which maintains the array supply voltage V_S at 0.84 volts.



*Choice of resistor R depends on cell utilisation and battery voltage range.

LOGIC CELL FUNCTIONS



Functions are all based on the CML NOR gate (½ cell).

They are simple to lay out and have well defined characteristics.

The dual current source consists of a multi-emitter transistor operated in the inverse mode. Two 2-input NOR gates can be constructed from each matrix cell. A "D" flip flop can be constructed from only 3 cells and is the basic binary divider element.

Multi-input gates can be obtained by common collectoring.

The supply current per gate is nominally 2.4 microamps.

The following list gives an indication of the numbers of cells which may be inter-connected to produce some commonly used circuit configurations.

CELL COUNTS FOR SOME TYPICAL LINEAR AND LOGIC FUNCTIONS

Matrix Cell Functions	Number of Matrix Cells
2 input gate	½
4 input gate	1
Equivalence/Exclusive OR	2
Binary divider	3
Binary divider with preset	4
Data latch	2
D type flip flop with preset and clear	6
Monostable (narrow pulse)	3
Shift register bit	3

Peripheral Functions	Typical Number of Peripheral Cells
Schmitt trigger	1
Totem pole/Tristate O/P	1
LED digit driver	1
LED segment driver	1
Comparator	1
Precision oscillator	2
Analogue switch	1
Reference amplifier	1

INTERFACE FUNCTIONS

These are formed from a mixture of peripheral and matrix cell components in general. The twin emitter transistors are capable of operating with a collector current of 1µA to 25mA. These transistors are therefore extremely versatile, and may be used as precision switches, matched transistors for the input stage of comparators, and as LED/LCD drivers in addition to their other roles as TTL/CMOS input or output buffers. Typical examples follow.

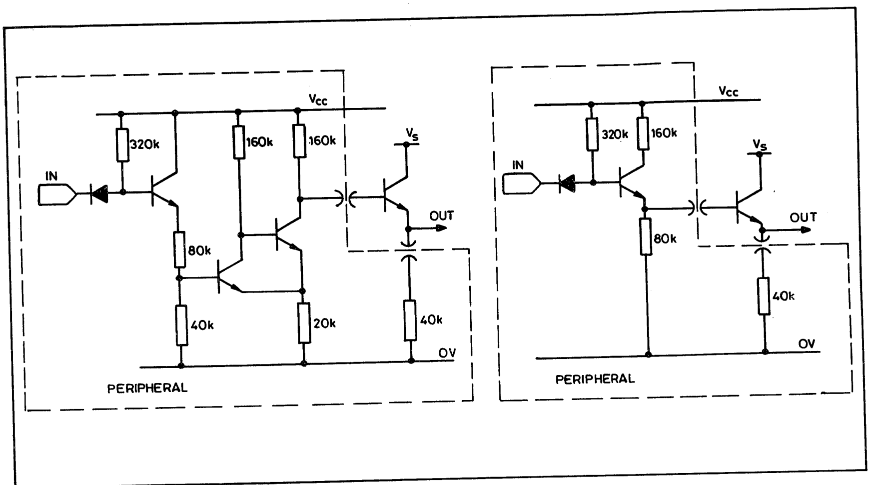
- TTL/CMOS input buffer
- Emitter follower input
- Schmitt trigger input
- LED digit driver
- LED segment driver
- Open collector output
- Totem pole output
- Analogue switch
- Comparator
- Voltage reference amplifier
- High performance op.amp.

Other linear functions include:

- Precision oscillator
- Bandgap reference
- Crystal oscillator
- RC oscillator
- Data conversion

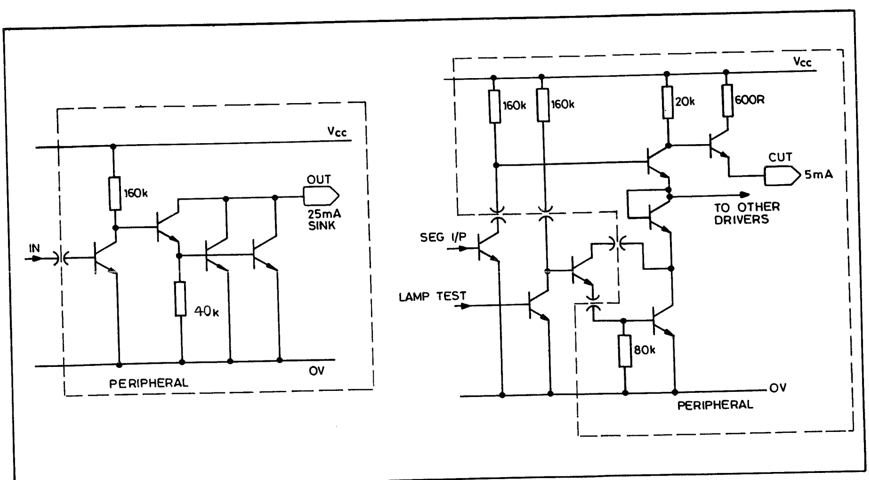
This section provides a few circuit ideas that have been implemented on the G-Series arrays. For further applications and ideas, refer to the G-Series Technical Handbook.

Interface Circuits



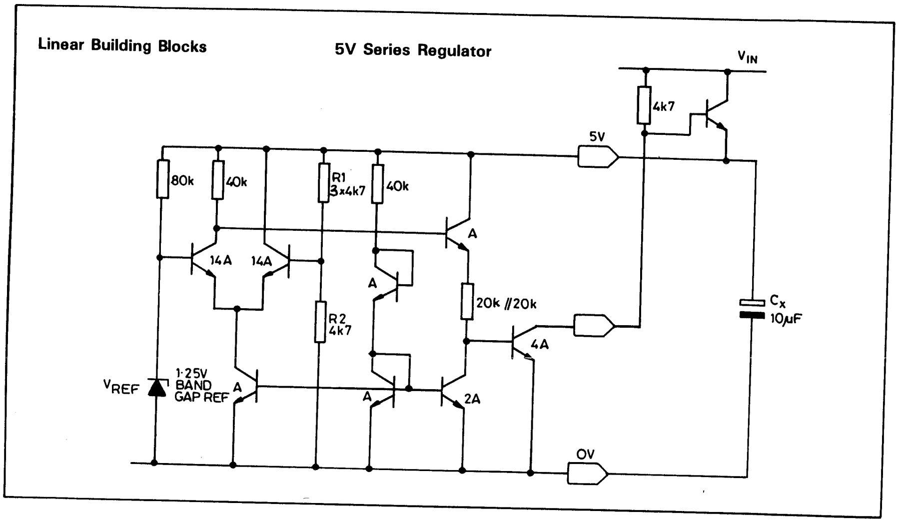
(a) Schmitt Trigger Input

(b) TTL/CMOS Input Buffer



(c) LED Digit Driver

(d) LED Segment Driver

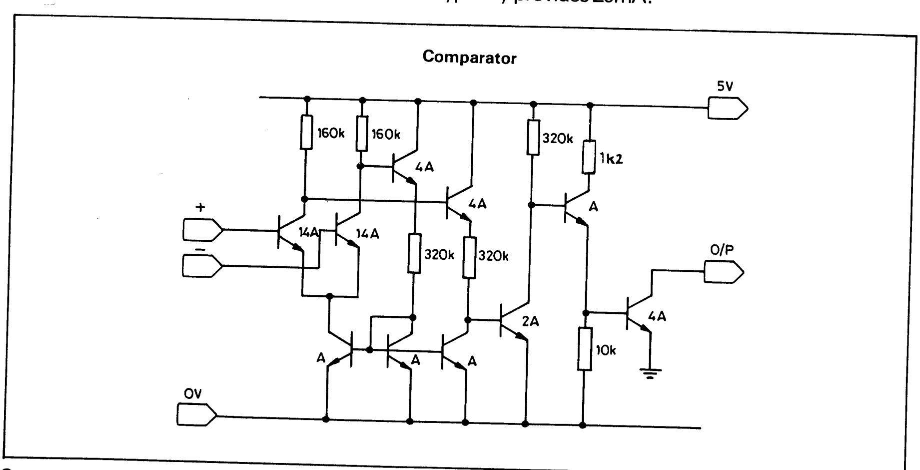


(a) 5V Series Regulator

This circuit uses one standard peripheral cell plus the bandgap reference to provide a regulated 5V supply. Other voltages can be obtained by changing the R_1/R_2 ratio in accordance with the following formula:

$$V_{out} = \frac{V_{REF}(R_1 + R_2)}{R_2}$$

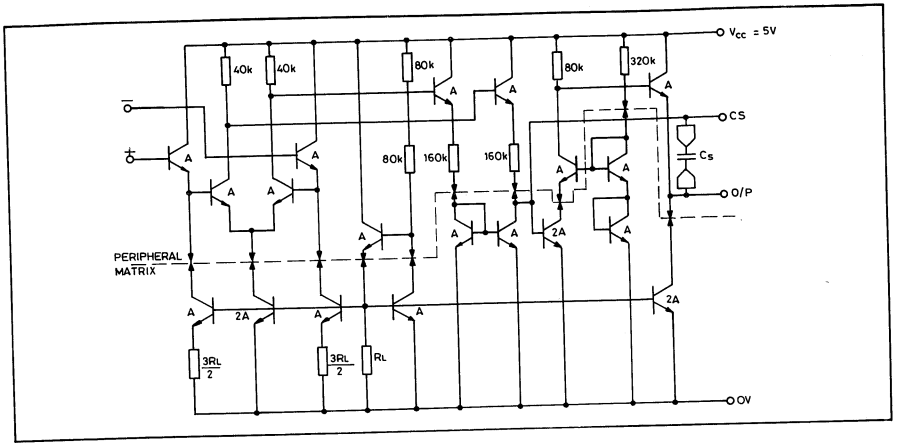
AC stability is achieved by use of an external capacitor C_X of approximately 10μF across the supply.
The circuit accepts input voltages from 8 to 15V and typically provides 20mA.



(b) Comparator

By using one single standard peripheral cell, excellent matching between components is achieved resulting in low offset voltages and currents (± 10mV and 30nA).

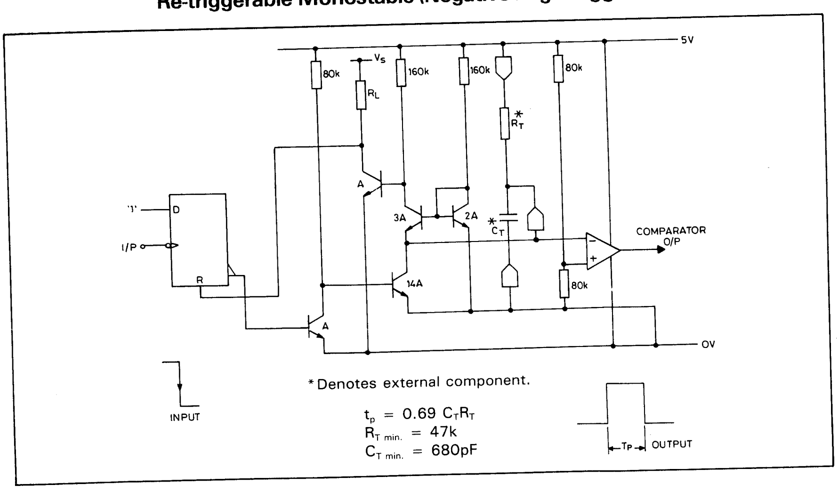
Amplifier



(c) Amplifier

This low offset (±5mV), low drift (25μV/°C) amplifier uses 2 standard peripheral cells and 2 matrix cells. It has a typical open loop gain of 800 (58dB). Several other amplifiers can also be designed and implemented. This is just one example.

Re-triggerable Monostable (Negative Edge Triggered)



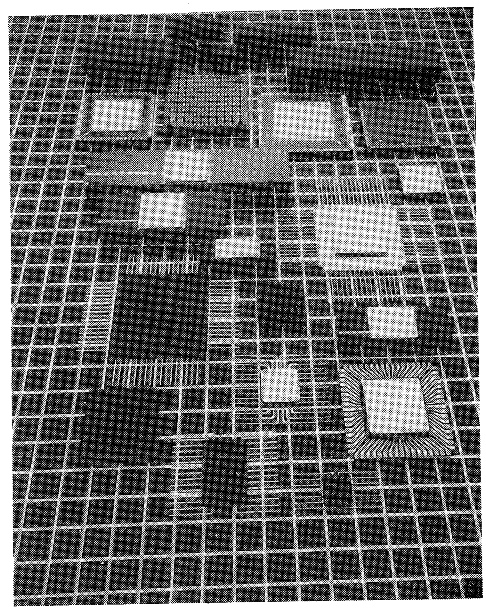
(d) Re-triggerable Monostable (Negative Edge Triggered)

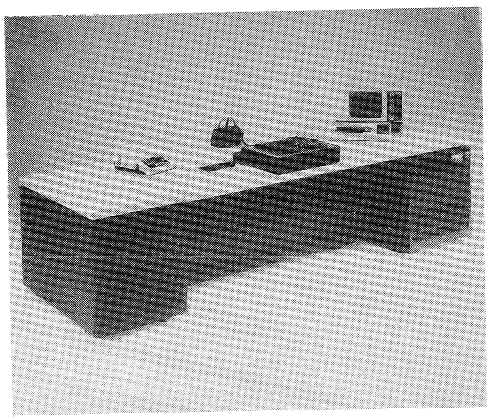
This monostable circuit is one of several that can be implemented in a G-Series array. This particular one uses 4 matrix and 2 peripheral cells.

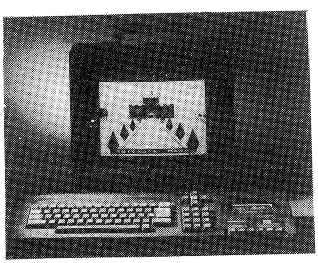
Packaging

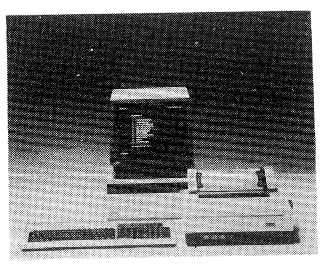
Various package styles are available including dual in-lines, flat packs, chip carriers and pin grid. The selection of a suitable package for a given application is determined by a number of factors:

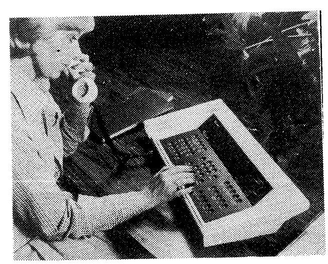
- number of input and output nodes
- number of V_{CC} and ground connections
- application environment and temperature range
- array die size relative to package island size
- power dissipation
- method of mounting package to pcb and pcb material











Applications

See what a little imagination and the ULA can do. The ULA is a fast and economic route to custom LSI and provides enormous economic and performance benefits. It has proved to be an outstanding success in applications as diverse as:-

Telecommunications from handsets to exchanges; mainframe, mini and personal computers; toys; power tools; photography; security systems and locks; industrial control; TV games; vending machines; domestic appliances; medical, automotive and aerospace electronics.

ARRAYS: THE MONOCHIP

The Monochip range of arrays is designed to facilitate the design and manufacture of linear custom LSI. The range consists of ten standard chip designs each containing a large number of integrated components (npn and pnp transistors, and resistors) or fixed locations. All that is required to complete a custom circuit is the aluminium interconnection layer.

The basic processing is identical for all Monochip circuits with ony the aluminium interconnection custom designed. Short development and production timescales result from this single mask customisation.

	MOC	MOD	MOE	MOG	MOH	MOJ	MOL	MOM	MON	MOP	MOQ
Transistors:											
NPN, small	22	50	48	58	70	36	76	137	170	71	55
NPN, 100mA					2	2	2	4	8	4	2
NPN, 200mA				2			2	4	4		
NPN, low noise								4			
PNP, single	8										
PNP, dual		16	15	18	22	12	22	44	64	54	21
PNP, quad							4	8			
PNP, vertical								4	6		
Schottky Diodes	6										
15Ω N+ Resistors					4		8	15	12	8	3
Base Resistors											
200Ω	8	15	8	19	29	8	23	60	68	21	18
450Ω	18	30	32	68	82	34	103	188	244	140	68
900Ω	20	28	28	65	75	30	77	140	226	142	57
1.8kΩ	13	29	25	44	54	24	53	104	161	96	40
3.6kΩ	12	24	26	27	36	20	36	84	111	64	26
Total Base Resistance	94kΩ	180kΩ	180kΩ	269kΩ	337kΩ	159kΩ	345kΩ	712kΩ	1014kΩ	597kΩ	250kΩ
Pinch Resistors											
30kΩ B/E	2		5								
100kΩ B/E											
2x60kΩ B/E				4	4	2	5	8	12	12	4
60kΩ Bulk		2									
Pads	14	16	18	18	18	18	24	28	40	24	18
Size (mls)	51x56	80x80	70x70	75x78	77x88	61x65	81x100	101x151	123x157	92x119	72x74

MOA, MOB, MOF are superceeded for new designs by MOG, MOH, MOR respectively.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	MOA to C, E to M 20V	MOD 36V
Storage Temperature	−66°C to +150°C	
Operating Temperature	Any range between −55°C and +125°C (depending on design requirements)	

MONOCHIP COMPONENTS

NPN TRANSISTORS

All linear Monochips contain large numbers of NPN transistors. With gains from 80 to 300, useful collector current from 10nA to 20mA and an f_T of 500MHz, these NPN's are the building blocks of linear design.

HIGH CURRENT NPN TRANSISTORS

Larger interdigitated NPN transistors are available on some arrays.

PNP TRANSISTORS

Lateral PNP transistors are on all Monochips. Some arrays have PNP transistors with split collectors. This effectively doubles their usefulness thereby creating a single structure to work as an active load or current mirror. Gains are between 5 and 80 and useful collector current from 10nA to 2mA. An f_T of 3MHz limits their use to low frequency operation.

DIODES

Diodes are formed by connecting the base and collector contacts together. For reverse voltages below 6V and NPN type is used. At higher reverse voltage a PNP transistor must be used.

ZENER DIODES

The reverse voltage breakdown of the base emitter junction can be used as a Zener diode with a breakdown voltage between 6 and 7.2 volts.

RESISTORS

Diffused resistors are in five basic values. The lowest value of 200Ω serves mainly as a crossunder or balancing resistor. The higher values are arranged in a 1.2.4.8 ration so that a large range of values can be generated by series and parallel connection. The absolute tolerance of diffused resistors is ±25% but the ratio matching is very good.

LARGE VALUE RESISTORS

Pinch resistors can be found on all arrays. They have a breakdown limitation of 6V.

THE MONOCHIP DESIGN KIT

The Monochip design kit is available to designers who wish to undertake a linear custom LSI design. The kit contains a handbook, breadboarding parts and some layout aids. The handbook describes the techniques of Monochip design with worked examples, circuit blocks and component parametric data. Circuit design can be checked by breadboarding using the kit parts. Colour printed layout sheets are provided, on request, to enable the interconnection to be designed.
The Monochip is presented as a kit to give the circuit designer a cost and time effective route to production custom linear LSI.

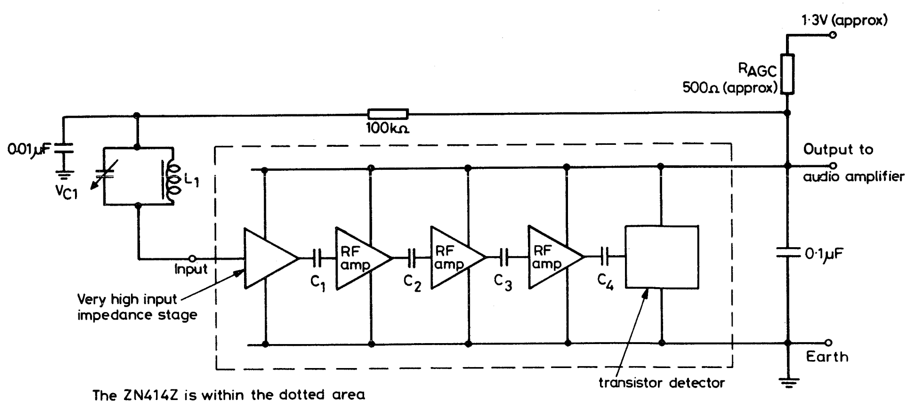
A.M. RADIO RECEIVER

ZN414Z

The ZN414Z provides a complete RF amplifier, detector and AGC circuit in a 3 pin TO-92 package, and needs only six external components to give a high quality A.M. tuner. Effective AGC action is available and is adjusted by altering one external resistor. The ZN414Z greatly simplifies the construction of A.M. receivers, both in design and assembly, without sacrificing audio quality.

FEATURES

- 1.2 to 1.6 volt operation
- 0.4mA current consumption
- Full medium and long wave operation
- No alignment
- Effective and variable AGC action
- Minimum of external components
- Excellent audio quality, low noise design
- 72dB power gain
- 3 pin TO-92 plastic package (Z)
- 0 to +70°C operation



Circuit Diagram

RADIO CIRCUITS

A.M. RADIO RECEIVER

ZN415E/ZN416E

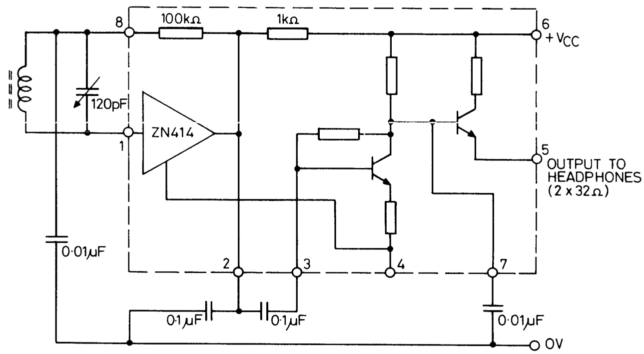
The ZN415E is a 12 transistor tuned radio frequency (TRF) circuit packaged in an 8 lead DIL package for simplicity and space economy giving a typical output of 120mV (pp).

The ZN416E is similar to the ZN415E but has a typical output voltage of 340mV (pp).

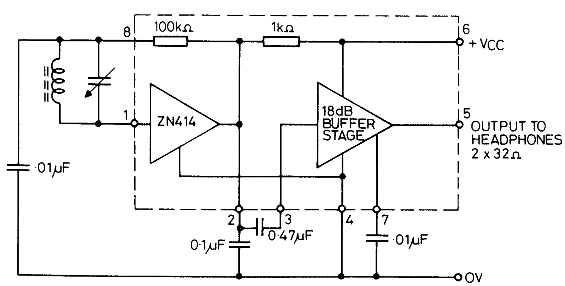
The Circuits provide a complete RF amplifier, detector, AGC circuit and output buffer stage. Requiring only six external components, a high quality AM tuner can be built which will give excellent audio quality directly into high sensitivity headphones. Current consumption is low and no setting up or alignment is required.

FEATURES

- Direct drive of headphones
- Low current consumption
- Only six external components required for complete radio
- No alignment necessary
- Single and effective AGC action
- Excellent audio quality
- Small economic 8-lead DIL (E8)



ZN415E System Diagram



ZN416E System Diagram

PRECISION SERVO INTEGRATED CIRCUIT

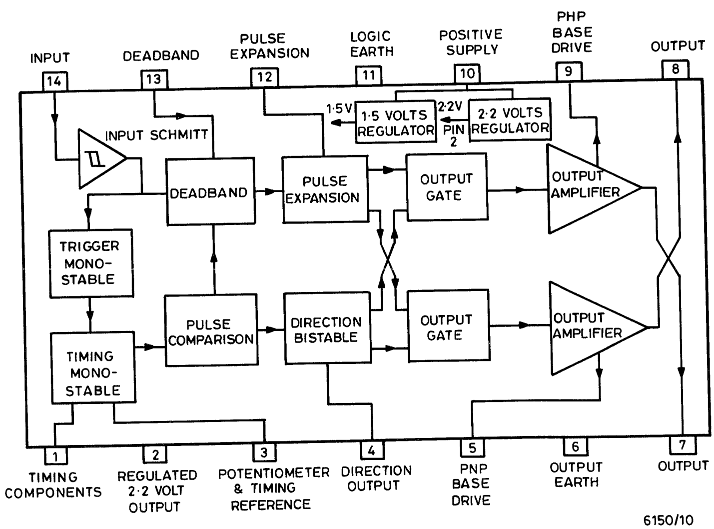
ZN409CE

The ZN409CE is a precision monolithic integrated circuit designed particularly for pulse-width position servo mechanisms used in all types of control applications. The low number of components required with the ZN409CE, together with its low power consumption, make this integrated circuit ideal for use in model aircraft, boats and cars where space, weight and battery life are at a premium. The amplifier will operate over a wide range of repetition rates and pulse widths and is therefore suitable for the majority of systems. The ZN409CE can also be used in motor speed control circuits.

The ZN409CE is available in a 14 lead moulded DIL package. (E14).

FEATURES

- Low External Component Count
- Low Quiescent Current
- Excellent Voltage and Temperature Stability
- High Output Drive Capability
- Consistent and Repeatable Performance
- Precision Internal Voltage Stabilisation
- Time Shared Error Pulse Expansion
- Balanced Deadband Control
- Schmitt Trigger Input Shaping
- Reversing Relay Output (D.C. Motor Speed Control)



System Diagram

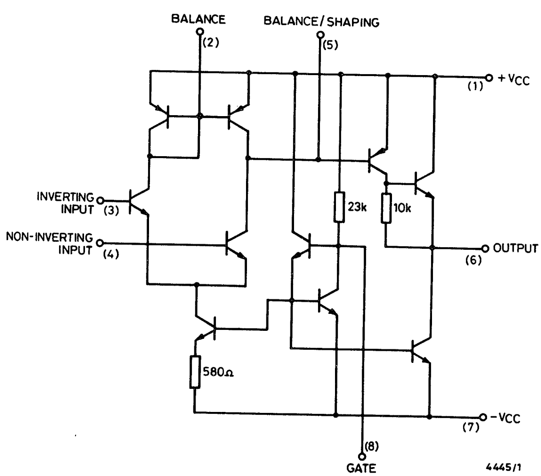
GATED LINEAR AMPLIFIER

ZN424P

The ZN424P is a versatile linear amplifier designed to satisfy the growing requirement for high quality signal processing. As a voltage amplifier the very low distortion and low noise performance makes the device ideally suited for audio applications. The gating facility, coupled with the ability to operate from a TTL supply, gives the device broad appeal in the instrumentation, computing and allied fields. The device is readily stabilised using an external capacitor, or capacitor/resistor combination.

FEATURES

- 86dB typical gain
- Very low open loop distortion
- Low noise ($e_n^2 = 4 \times 10^{-17}$ V^2/Hz; 100Hz to 20kHz)
- 200kΩ input resistance
- 20kHz open loop bandwidth (−3dB)
- 0.1 µs closed loop rise time
- Class A output — no crossover distortion
- 100V/µs slew rate (rising edge)
- Maximum output swing ±11V, ±17V at V_{CC} = ±18V
- Operation at 5V, TTL compatible
- Logic gate current drive capability
- Input-output isolation gating facility
- 8 lead moulded D.I.L. package (E8)



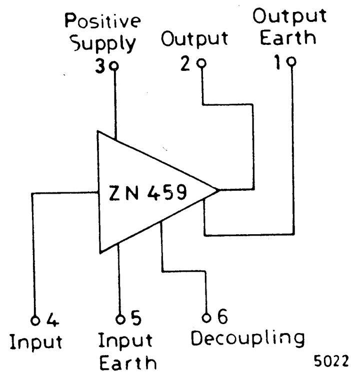
Circuit Diagram

ULTRA LOW NOISE WIDEBAND AMPLIFIER — ZN459/ZN459C/ZN459CP

The ZN459 is an ultra low noise amplifier with remarkable noise performance, very high gain bandwidth product (15GHz), and small package. This combination makes it exceptionally attractive for low noise applications such as thermal imaging where CMT detectors require multiple channel buffering and other imaging and sonar applications. Commercial applications include Industrial low noise applications, Multi-channel amplifiers, tachometers, general audio, etc.

FEATURES

- Low input noise resistance, 45Ω equivalent or 800pV per root cycle
- High bandwidth, 15MHz typical
- High, well controlled gain, 60db ±2dB
- Gain variable from 60db to 40dB
- Low supply current, <3mA from 5V
- Small package, 6 lead TO-71 (T6a) or 8 lead moulded D.I.L (E8)
- Commercial and Military specifications

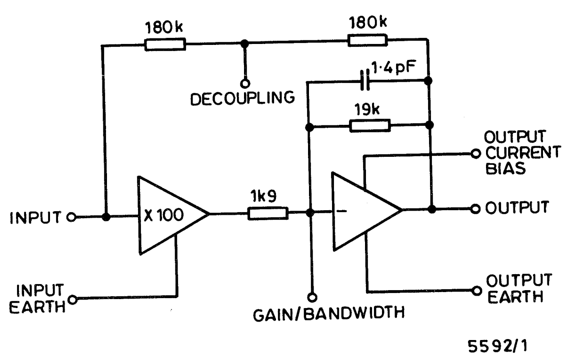


ULTRA LOW NOISE WIDEBAND PRE—AMPLIFIER — ZN460/ZN460C/ZN460CP

A versatile high grade a.c. pre-amplifier designed for applications requiring ultra low noise such as infra-red imaging and low noise wide band amplifiers, e.g. microphone, acoustic emission, transducer bridge amplifier. The matching of open loop gain coupled with small physical size make the ZN460 series ideal for multichannel amplification.

FEATURES

- High Controlled Gain : 60dB ±1dB typical
- Programmable Gain : 50-60dB typical
- Low Noise : 40Ω Equivalent Noise Resistance, or 800pV/√Hz
- Programmable Bandwidth : Up to 6MHz
- Low Supply Current : <3mA from 5V downwards
- Available in 8-lead moulded D.I.L. (E8) or 8-lead TO-78 (T8b)



Circuit Diagram

LOW POWER PRECISION REFERENCE SOURCES

ZNREF RANGE

The ZNREF family consists of a range of monolithic integrated circuits providing accurate reference voltages from 2.5 to 10 volts. The design of these references utilises an entirely new circuit concept, a novel feature of which is the ability to change the reference voltage by a single interconnection pattern modification.

The specification of these devices make them an ideal choice where a stable voltage reference source is required, particularly in data acquisition systems, portable instrumentation, codec systems and digital voltmeters.

FEATURES

- 150μA Knee current
- Trimmable output
- Excellent temperature stability
- Low output noise figure
- Low dynamic impedance
- Choice of temperature ranges
- 1% and 2%d tolerance versions available
- No external stabilising capacitor required (except for ZNREF025 in some cases)

ZNREF RANGE

Type Number	Nominal V_{REF} (V) at 500μA	I_{REF} (max.) (mA)	Dynamic Impedance (Ω)		Trim Range	Package
			Typ.	Max.		
ZNREF025	2.50	10	1.5	2	±5%	TO-18 (T3)
ZNREF040	4.01	75	2.0	3	±5%	TO-18 (T3)
ZNREF050	4.90	60	1.5	2	±5%	TO-18 (T3)
ZNREF062	6.17	50	2.0	3	±5%	TO-18 (T3)
ZNREF100	9.80	60	3.0	4	±2.5%	6-lead TO−39 (T6b)

REFERENCES

ZNREF ORDERING INFORMATION

e.g. ZNREF xxx A 1

- xxx: Nominal $V_{REF} \times 10$
- A: Temp. Range
- 1: Initial Tolerance

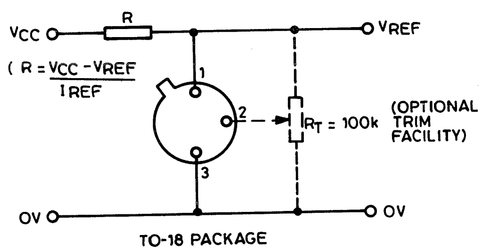
See below

ZNREF V_{REF} TEMPERATURE COEFFICIENTS AND RANGES

V_{REF} Initial tolerance	Grade A Military −55 to +125°C		Grade AB ZNREF 062 only −55 to +110°C		Grade C Commercial 0 to +70°C	
	Typ.	Max.	Typ.	Max.	Typ.	Max.
1%	35	50	25	40	15	50
2%	—	—	—	—	15	50

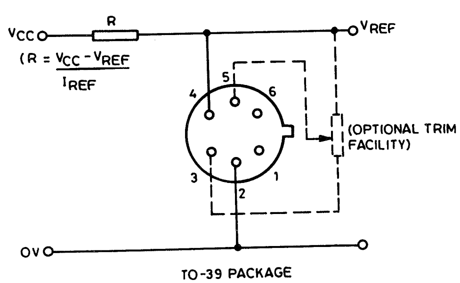
ZNREF TRIM CIRCUITS

Fig. 1 ZNREF025/040/050 and 062



N.B. Case is internally connected to OV

Fig. 2 ZNREF100



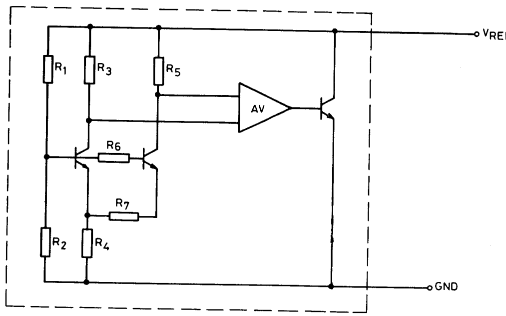
No connection should be made to pins 1 and 6

REFERENCES

ADVANCE INFORMATION
2.5V MICRO POWER PRECISION REFERENCE SOURCE — REF 25/REF25Z

The REF25 and REF25Z are monolithic integrated circuits using the band gap principle to provide a precise stable reference voltage of 2.5 volts without the need for an external shaping capacitor. There are two package options available, a 2 pin TO-18 metal can and a cost effective 3 pin plastic TO-92 package.

These references feature a recommended operation current range of 60 μA to 5mA which make them ideal for all low power and battery applications over an operating temperature range of 0 to 70°C, the temperature coefficients are typically 25ppm/°C REF25 and 35ppm/°C REF25Z.

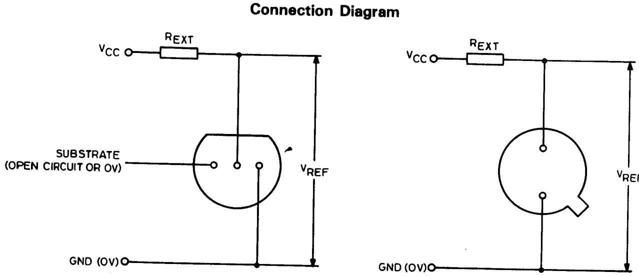


Internal Connections

FEATURES

- Low Knee current — typically 40 μA
- Ideal for battery operation — 150 μW
- Low cost
- Internally shaped
- Two package types
  1. REF25Z Very low cost plastic 3 pin TO-92
  2. REF25 Metal Can 2 pin TO-18
- Tight V_{out} tolerance
  - REF25Z ±2%
  - REF25 ±1%
- Low temperature coefficent
  - REF25Z 35ppm/°C typical
  - REF25 25ppm/°C typical
- Low slope resistance
  - REF25Z 1.2Ω typical, 2.0Ω max.
  - REF25 1.2Ω typical, 1.5Ω max.

Connection Diagram



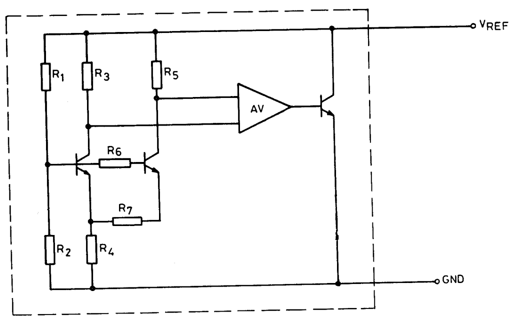
$R_{EXT} = (V_{CC} - V_{REF})/I_{REF}$

REF 25Z (Plastic TO-92) Bottom View — REF 25 (Metal Can TO-18) Bottom View

ADVANCE INFORMATION
5V MICROPOWER PRECISION REFERENCE SOURCE — REF 50/REF50Z

The REF50 and REF50Z are monolithic integrated circuits employing the band gap principle to provide a precise stable reference source of 5.0 volts without the need for an external shaping capacitor.

There are two package options for this device, either a 2 pin TO-18 metal can for the REF50 or a 3 pin plastic TO-92 for the REF50Z.

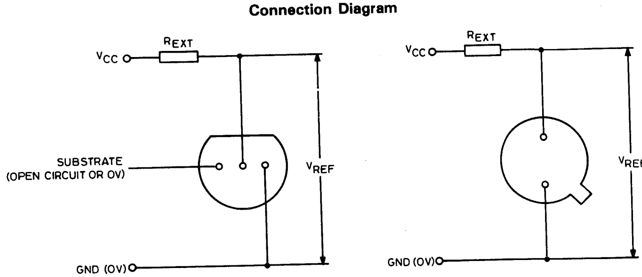


Internal Connections

FEATURES

- Low Knee current — typically 40—50 μA
- Ideal for battery operation — 150 μW
- Tight tolerance ±1% REF50
  ±2% REF50Z
- Internally shaped
- Low temperature coefficient
- Two package types
  - REF50 TO-18 2 pin metal can
  - REF50Z TO-92 3 pin plastic package

Connection Diagram



$R_{EXT} = (V_{CC} - V_{REF})/I_{REF}$

REF 50Z (Plastic TO-92) Bottom View

REF 50 (Metal Can TO-18) Bottom View

ADVANCE INFORMATION
2.5V PRECISION VOLTAGE REFERENCE SOURCE IN A SOT-23 SURFACE MOUNT PACKAGE

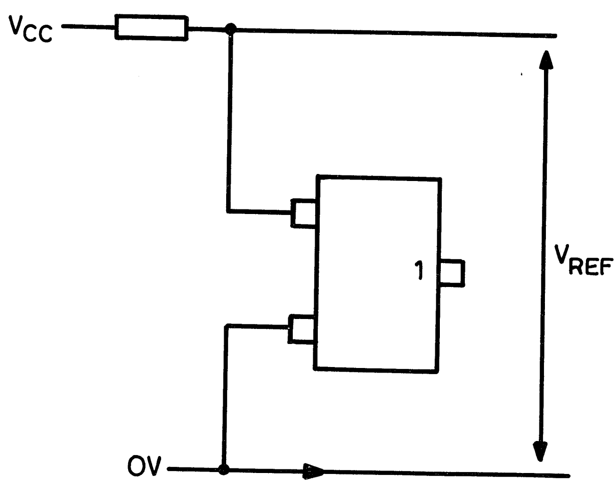
SR25D

The SR25D is a monolithic integrated circuit providing a precise stable reference source of 2.5 volts without the need for an external shaping capacitor.

This reference is packaged in an SOT-23 small outline package, making ideal for all surface mount applications.

FEATURES

- SOT-23 surface mount package
- Internally shaped — no need for an external shaping capacitor
- Low knee current — typically 80 μA
- Low temperature coefficient
- Low slope resistance



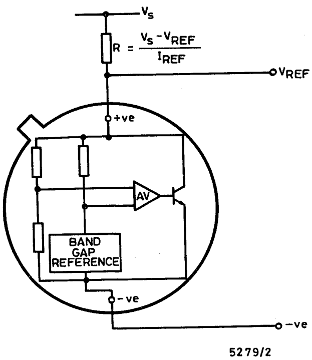
LOW COST PRECISION 2.45V REFERENCE REGULATOR

ZN404

The ZN404 is a monolithic integrated circuit providing a precise stable regulator source of 2.45V in a two lead package without the need for an external shaping capacitor.

FEATURES

- Low temperature coefficient
- Low slope resistance
- Very good long term stability
- Low Noise
- Internally shaped
- Tight tolerance
- Low cost
- Commercial (0° to +70°C) temperature range
- Two lead (TO-18) package (T2)



Circuit diagram

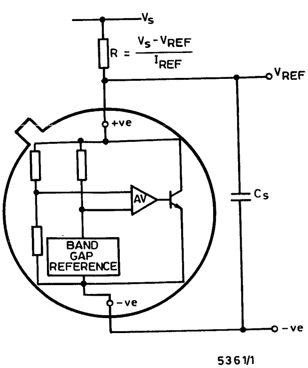
PRECISION 1.26 VOLT REFERENCE SOURCE

ZN423

The ZN423 is a monolithic integrated circuit utilising the energy bandgap voltage of a base-emitter junction to produce a precise, stable, reference source of 1.26 volts. This is derived via an external dropping resistor for supply voltages of 1.5 volts upwards. The temperature coefficient of the ZN423, unlike conventional Zener diodes, remains constant with reference current. The noise figure associated with breakdown mechanisms is also considerably reduced.

FEATURES

- Low voltage
- Low temperature coefficient
- Very good long term stability
- Low slope resistance
- Low RMS noise
- Tight tolerance
- High power supply rejection ratio
- Military temperature range
- Two lead (TO-18) package (T2)



Circuit Diagram

REFERENCE/pA DIODE

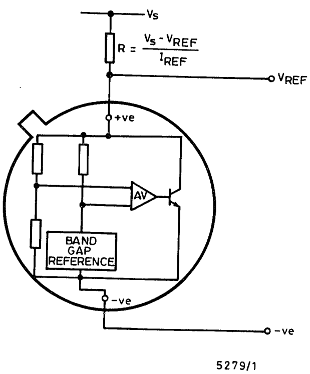
PRECISION 2.45V REFERENCE SOURCE

ZN458, A, B

The ZN458 is a monolithic integrated circuit providing a precise stable regulator source of 2.45 volts in a two lead package without the need for an external shaping capacitor.

FEATURES

- Guaranteed 5mV maximum deviation over full temperature range
- Low temperature coefficient 0.003%/°C
- Low slope resistance −0.1Ω
- Very good long term stability 10ppm
- Low noise − 10μV
- Internally shaped
- Tight tolerance − ±1.43%
- Two lead TO-18 package (T2)
- −20 to +70°C operating temperature range
- Wide operating current 2 − 120mA



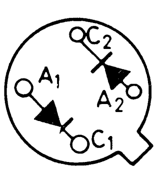
Circuit diagram

DUAL PICO-AMPERE DIODE

ZN490

FEATURES

- Ultra low leakage diode − 2pA
- Matched forward voltage drop − 5mV
- High reverse impedance
- Low capacitance − 2pF
- CDI technology
- 4 lead TO-72 package (T4)



Pin	Out
1	C_1
2	A_1
3	C_2
4	A_2

Substrate Connected to Pin 3
TO-72

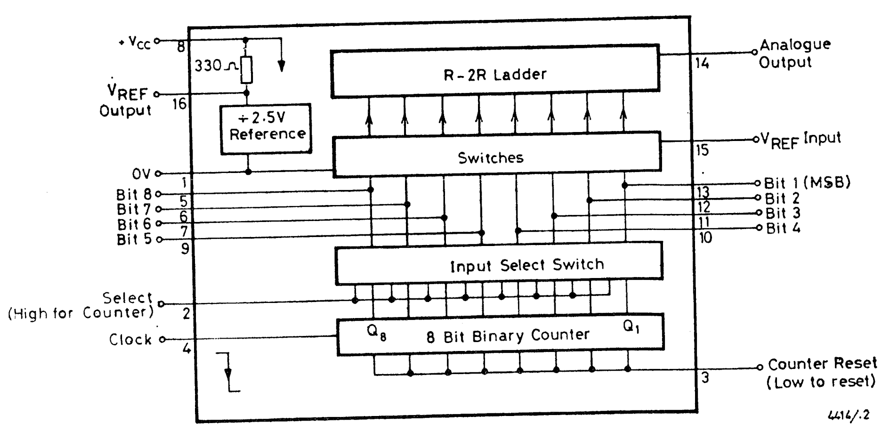
ZN425E-8
ZN425J-8
ZN425D

8-BIT D TO A/A TO D CONVERTER

The ZN425 is a low cost, dual-mode, 8-bit data converter fabricated on a single monolithic chip. It contains an 8-bit D to A converter utilising an advanced design R-2R ladder network and an array of precision bipolar switches. Also included are a precision 2.5V reference and a high-speed 8-bit binary counter.

FEATURES

- Monotonic over full temperature range
- 1 μs typical settling time in D to A mode
- 1 ms typical conversion time in A to D mode
- Voltage output DAC
- TTL and CMOS compatible
- Single +5V supply
- Temperature ranges 0 to +70°C, −55 to +125°C
- 16 lead moulded (E16), ceramic D.I.L. (H16) or SO-16 package



System Diagram

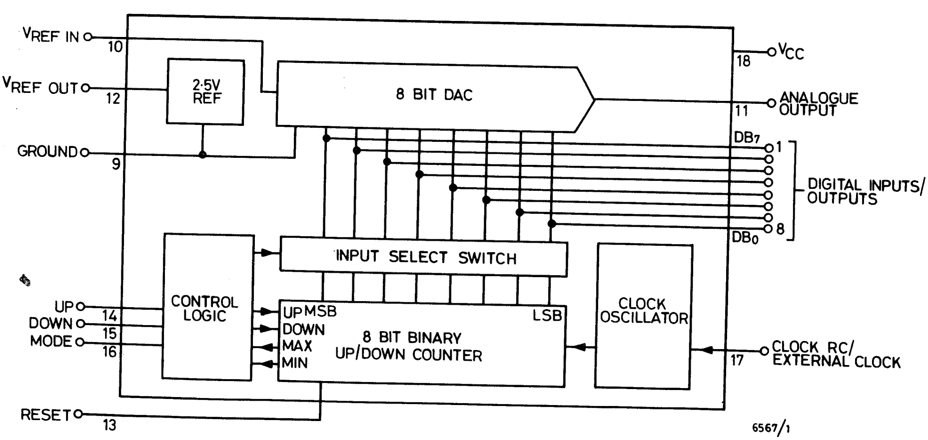
8-BIT MULTIFUNCTION DATA CONVERTER

ZN435E/ZN435EJ

The ZN435 is a versatile, multifunction 8-bit data conversion system. A voltage output DAC, 8-bit up/down counter, stable 2.5V bandgap reference and clock generator are contained on a single chip.

FEATURES

- Multimode device operates as:
  - —DAC
  - —ADC
  - —Tracking ADC
  - —Voltage to frequency converter
  - —Ramp and sawtooth generator
  - —Nonlinear waveform generator
  - —Voltage controlled oscillator
  - —Track-and-hold circuit
- 8-bit accuracy
- 800ns DAC setting time
- On-chip up/down counter
- On-chip clock
- On-chip voltage reference
- Single +5V supply
- Commercial or Military temperature range
- 18 lead moulded (E18) or ceramic DIL (H18) package



System Diagram

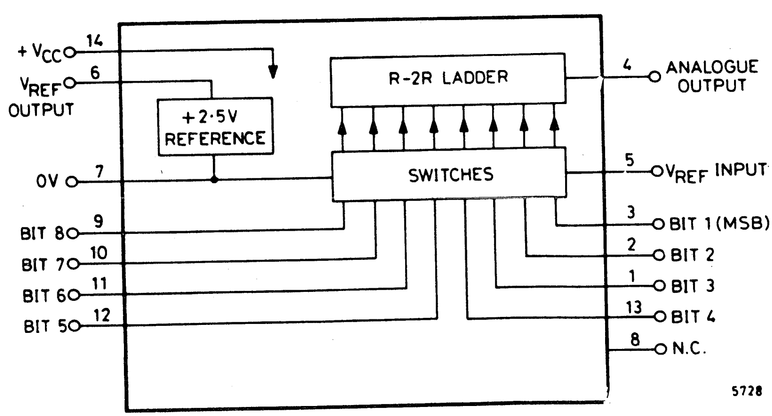
ZN426E-8
ZN426J-8

GENERAL PURPOSE 8-BIT D TO A CONVERTER

The ZN426 is an 8-bit monolithic D to A converter containing an R-2R ladder network, precision analogue switches and a 2.5V reference on a single chip. Use of the on-chip reference is optional thus affording greater flexibility and reduced power consumption when several converters are used in the same system. One on-chip reference can drive up to five ZN426's.

FEATURES

- Monotonic over full temperature range
- 1 μs typical settling time
- Voltage output
- TTL and CMOS compatible
- Single +5V supply
- Optional on-chip reference
- Temperature ranges 0 to +70°C, −55 to +125°C
- 14 lead moulded (E14) or ceramic DIL (H14) package



System Diagram

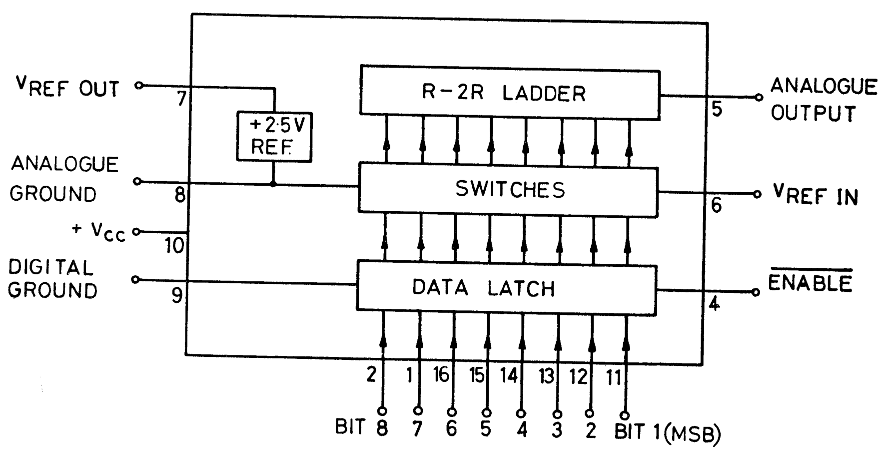
8-BIT MICROPROCESSOR COMPATIBLE D TO A CONVERTER

ZN428E-8
ZN428J-8
ZN428D

The ZN428 is a monolithic, 8-bit DAC designed for easy interfacing with microprocessors. It contains an R-2R ladder network and switches, a 2.5V precision reference and a data latch that allows the DAC to be updated from an 8-bit data bus. The ZN428 complements the ZN427 μP-compatible ADC.

FEATURES

- Monotonic over full temperature range
- 800ns typical settling time
- Voltage output
- Microprocessor, TTL and CMOS compatible
- Single +5V supply
- Optional on-chip reference
- Temperature ranges 0 to +70°C, −55 to +125°C
- 16 lead moulded (E16), ceramic DIL (H16) or SO-16 package



System Diagram

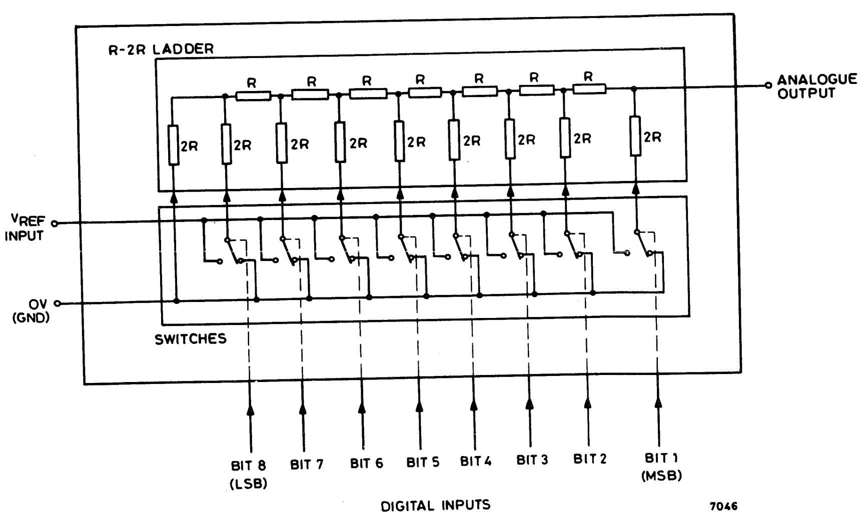
ZN429E
ZN429J
ZN429D

LOW COST 8-BIT D TO A CONVERTER

The ZN429 is a monolithic 8-bit D to A converter designed for cost-sensitive applications such as automotive and consumer products. It contains an R-2R ladder network and an array of precision bipolar switches. An external reference voltage is required for operation.

FEATURES

- Monotonic over full temperature range
- 1 μs typical settling time
- Voltage output
- TTL and CMOS compatible
- Single +5V supply
- Temperature ranges 0 to +70°C, −55 to +125°C
- 14 lead moulded (E14), ceramic DIL (H14) or SO-14 package
- 8-bit version also available in SO-14 package: Device type ZN429D



System Diagram

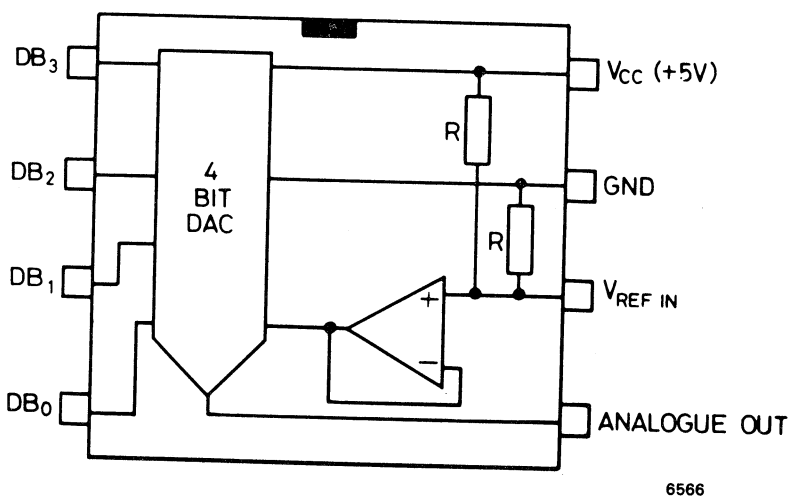
LOW COST 4-BIT D TO A CONVERTER

ZN434E/ZN434BE

The ZN434 is a 4-bit DAC containing a R-2R ladder network of diffused resistors and precision bipolar switches. An on-chip reference amplifier and attenuator provide a reference voltage of $\frac{V_{CC}}{2}$, allowing the I.C. to function with no external components.

FEATURES

- 4-bit resolution
- ¼ LSB linearity
- Voltage output
- 300ns settling time
- TTL and CMOS compatible
- Single +5V supply
- On-chip $\frac{V_{CC}}{2}$ reference
- Temperature ranges 0 to +70°C, −40 to +85°C
- 8 lead moulded DIL (E8) package



System Diagram

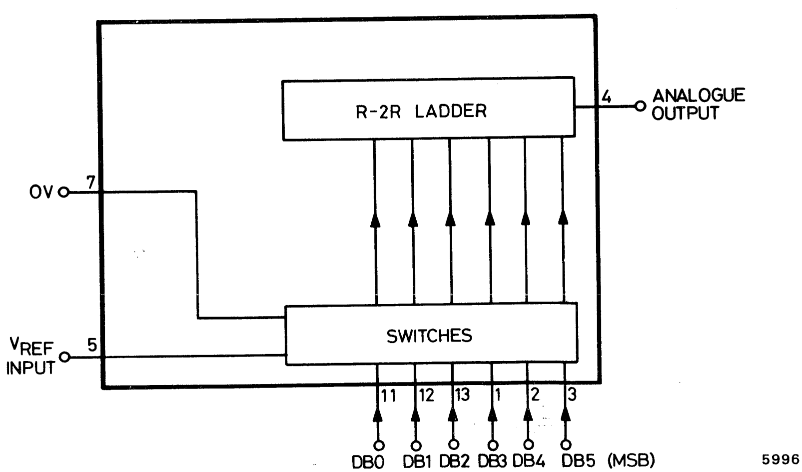
LOW COST 6-BIT MONOLITHIC D TO A CONVERTER

ZN436E/ZN436J

The ZN436 is a monolithic 6-bit digital to analogue converter containing an R-2R ladder network of diffused resistors with precision bipolar switches.

FEATURES

- 6-bit accuracy
- ZN436E — Commercial temperature range (0 to +70°C)
- ZN436J — Military temperature range (−55 to +125°C)
- TTL and 5V CMOS compatible
- Single +5V supply
- 1 μs settling time (typical)
- Designed for low cost applications
- 14 lead moulded (E14) or ceramic DIL (H14) package



System Diagram

ADVANCE INFORMATION
8-BIT MONOLITHIC VOLTAGE OUTPUT D TO A CONVERTER

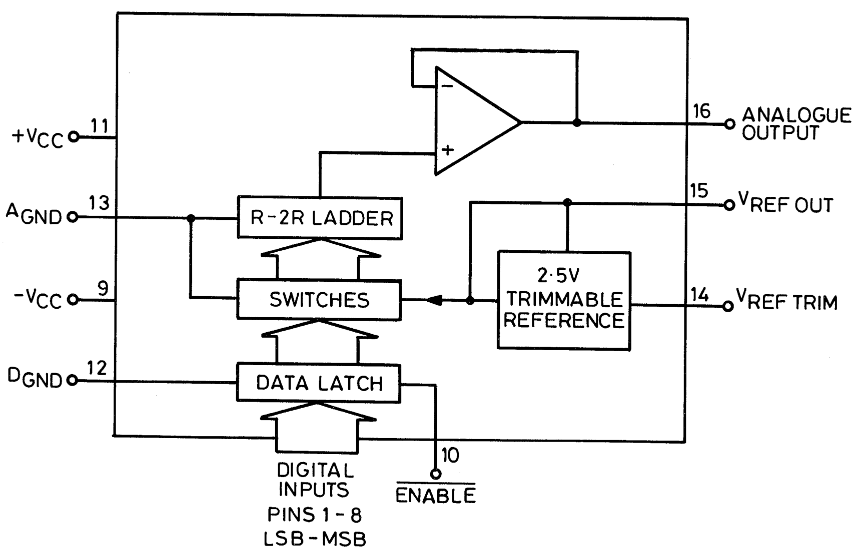
ZN438E/J

The ZN438 is a monolithic 8-bit D to A converter with input latches to facilitate updating from a data bus and a buffer amplifier to give a low analogue output impedance. The latch is transparent when $\overline{\text{ENABLE}}$ is low and the data is held when $\overline{\text{ENABLE}}$ is taken high.

The ZN438 also contains a trimmable 2.5 volt reference which is internally connected to the R-2R ladder switches and to V_{REF} out.

FEATURES

- On-chip high-speed output buffer amplifier capable of supplying ±4mA
- 1.25μs settling time to ± ½ LSB
- Trimmable bandgap reference
- μp, TTL and 5V CMOS compatible
- Commercial and military temperature ranges
- 16-lead moulded (E16) or ceramic DIL (H16) package



System Diagram

ADVANCE INFORMATION
TRIPLE 4-BIT VIDEO D TO A CONVERTER

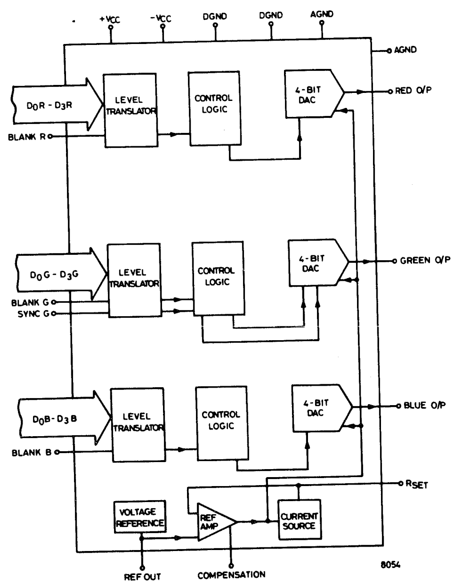
ZN454CJ

The ZN454CJ consists of three 4-bit D to A converters, providing a colour palette of 4096 possible display colours. The required level translators, control logic, a reference voltage source and reference amplifier are also integrated on-chip.

Each D to A converter accepts 4-bit digital video data word and SYNC/BLANK signals directly from a TTL source and produces a composite video output to directly drive a transmission line terminated by a 75Ω load at both ends.

FEATURES

- 3 Video DAC's — ideal for colour Graphics
- Fast, 8ns settling time
- Update rates to 100 MHz
- Low Giltch energy
- ¼ LSB linearity error
- On-chip reference source
- Composite SYNC and BLANK inputs
- TTL compatible inputs
- 28-lead ceramic DIL (H28) package



System Diagram

ADVANCE INFORMATION
TRIPLE 4-BIT VIDEO MEMDAC

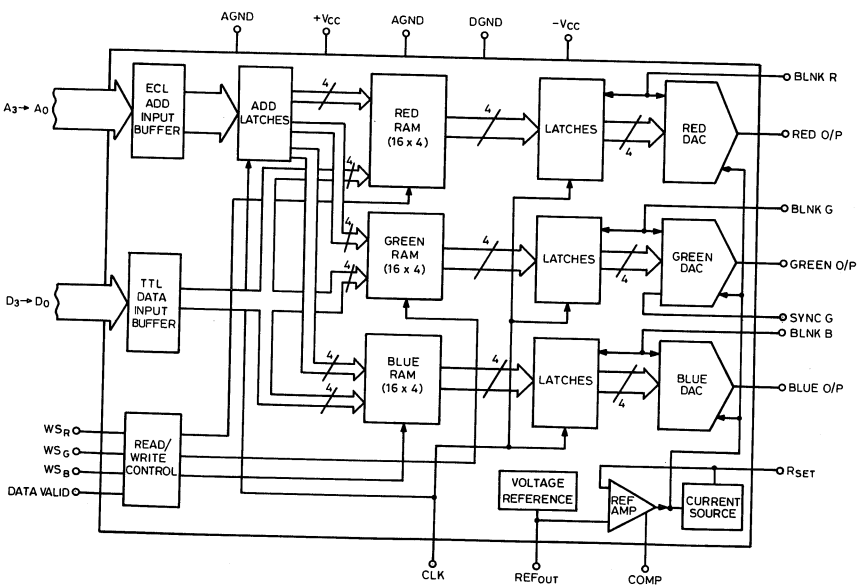
ZN455CJ

The ZN455 consists of three 4-Bit Video D to A converters each with a 16×4 colour map allowing the simultaneous display of 16 colours from a palette of 4096 colours. The ZN455 has two levels of pipeline to allow a high pixel rate and to ease system timing requirements. The first level is prior to each of the video RAM's on the ECL address bus and the output data from these RAM's is latched at the second level prior to being converted.

The ZN455 offers a versatile microprocessor and video controller interface and each output directly drives a doubly terminated 75Ω transmission line. The incorporation of a bandgap reference source, composite video controls, address latches and DAC input latches make this device the ideal choice for high performance bit-mapped colour graphics systems.

FEATURES

- 3 Video DAC's
- On-chip colour look-up tables
- Update rates to 100MHz
- Fast, 8ns DAC settling time
- Low glitch energy
- ¼ LSB linearity error
- On-chip data latches
- On-chip voltage reference source
- TTL/ECL compatable inputs
- Composite sync and blanking control inputs
- Generates standard (RS330, RS343) video signal output across a doubly terminated 75Ω load
- 28 pin DIL package



System Diagram

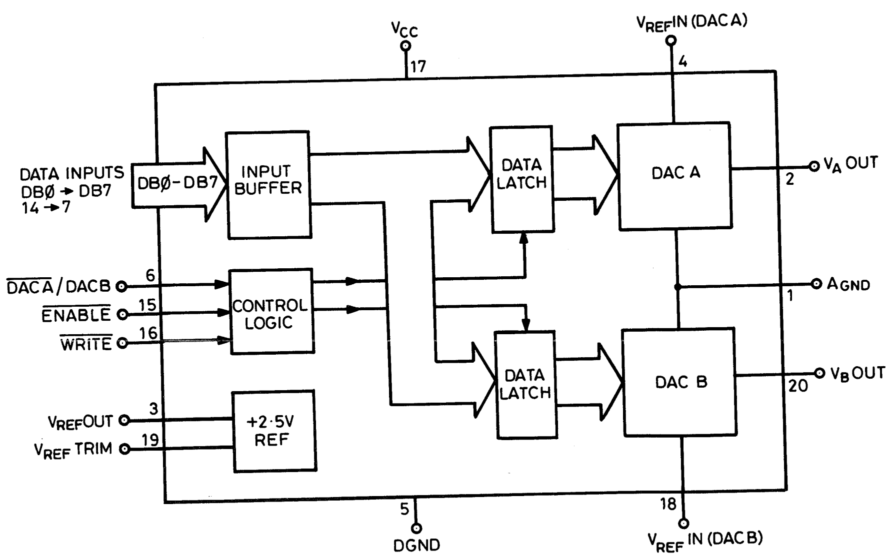
ADVANCE INFORMATION DUAL 8-BIT MICROPROCESSOR COMPATIBLE D TO A CONVERTER

ZN508E/J

The ZN508 is a monolithic dual 8-bit DAC designed to be easily interfaced to microprocessors. Integrated on-chip are two 8-bit DAC's, a 2.5V trimmable bandgap reference, separate V_{REF} inputs and data latches for each DAC. The on-chip reference can not only be used to drive the two DAC's but can also be used as a system reference. A consequence of the two DAC's being fabricated on the same chip is excellent, inherent, DAC to DAC matching.

FEATURES

- Monotontic over full temp. range
- 800 ns settling time
- Excellent DAC to DAC matching time
- Voltage output
- Separate V_{REF}IN for each DAC
- Microprocessor, TTL and CMOS compatible
- Optional on-chip reference
- Single 5V supply
- Temperature ranges 0 to +70°C, −55 to +125°C
- 20 lead moulded (E20) or ceramic DIL (H20) package



System Diagram

ADVANCE INFORMATION
8-BIT VIDEO D TO A CONVERTER

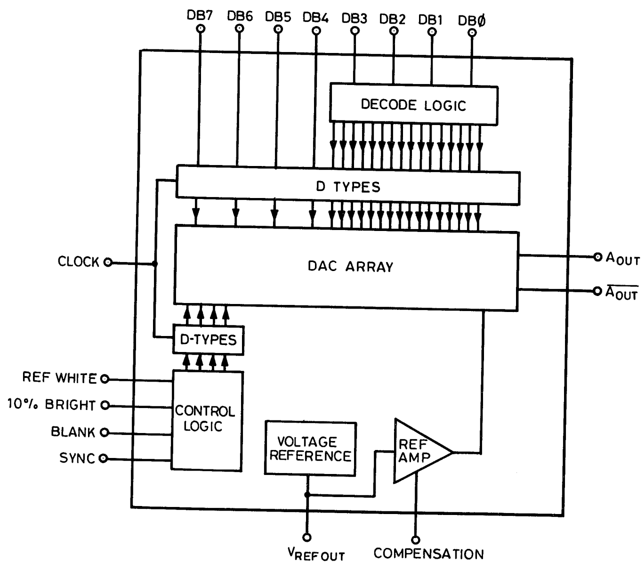
ZN515CJ

The ZN515 is a monolithic video digital-to-analog converter capable of accepting 8-bits of ECL compatible data at update rates as high as 100 MHz, and converting this information to give 1 of 256 levels of Gray Scale. Output "glitches" are minimised by careful design of the switch decoding circuits and the provision of on-chip data latches.

The ZN515 incorporates complete composite video controls including sync, blanking, 10% bright and reference white and produces a composite video output to directly drive a doubly terminated 75Ω transmission line. The on-chip bandgap reference can be used externally to drive other converters in the system reducing component count and enhancing temperature tracking. This is particularly useful in high performance colour graphics applications where the reference of one ZN515 could be used to drive the other two ZN515's.

FEATURES

- 100 MHz update rate
- Fast, 10 nS settling time (to ± ½ LSB)
- Low glitch energy
- ½ LSB linearity error
- Precision 1.25V bandgap reference
- Composite sync, blanking, reference white and 10% bright controls
- ECL compatible inputs
- Single 5.2V supply
- Generates standard (RS330, RS343) IV P-P output across 37.5Ω
- 24 pin DIL package



System Diagram

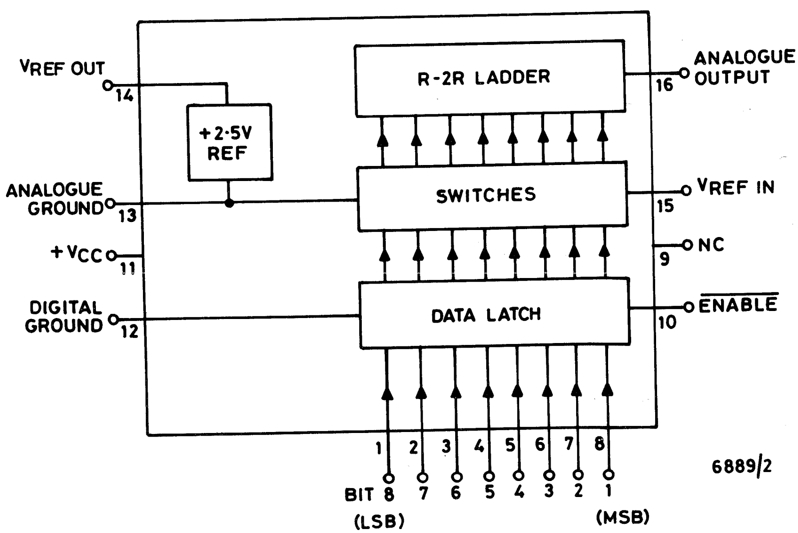
8-BIT LATCHED INPUT MONOLITHIC D TO A CONVERTER

ZN558E-8
ZN558J-8
ZN558D

The ZN558 is a Monolithic 8-bit D to A converter with input latches to facilitate updating from a data bus. The latch is transparent when Enable is LOW and the data is held when Enable is taken HIGH. The ZN558 also contains a 2.5 volt reference the use of which is pin optional to retain flexibility. An external fixed or varying reference may therefore be substituted.

FEATURES

- Monotonic over full temperature range
- 800ns typical settling time
- Contains DAC with data latch and on-chip reference
- Single +5V supply
- Microprocessor compatible
- TTL and 5V CMOS compatible
- Choice of commercial or military temperature range
- 16-lead ceramic (H16), moulded DIL (E16) or SO-16 package



System Diagram

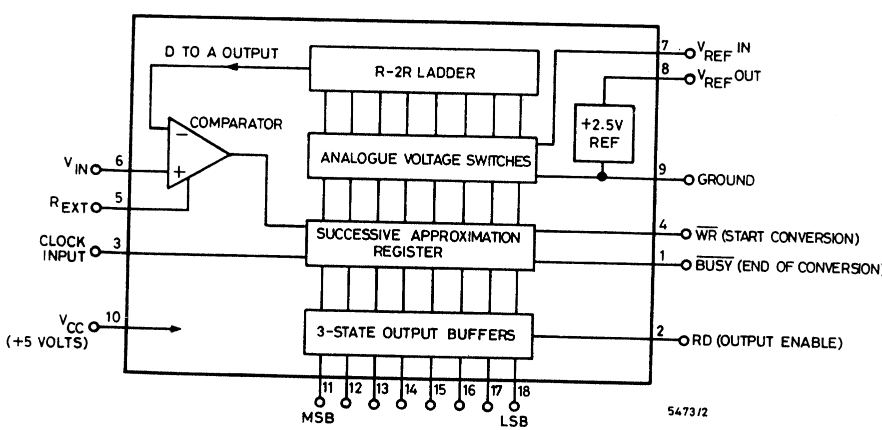
8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN427E-8
ZN427J-8
ZN427D

The ZN427 is a monolithic, 8-bit, successive approximation A to D converter designed for easy interfacing with microprocessors. It contains an 8-bit DAC, comparator, successive approximation register and a 2.5V precision reference. On-chip three state output buffers allow direct connection to an 8-bit data bus. The ZN427 complements the ZN428 μP-compatible DAC.

FEATURES

- No missing codes over full temperature range
- 10μs conversion time guaranteed
- Microprocessor, TTL and CMOS compatible
- Single +5V supply
- Optional on-chip reference
- Temperature ranges 0 to +70°C, −55 to +125°C
- 18 lead moulded (E18), ceramic DIL (H18) or SO-18 package



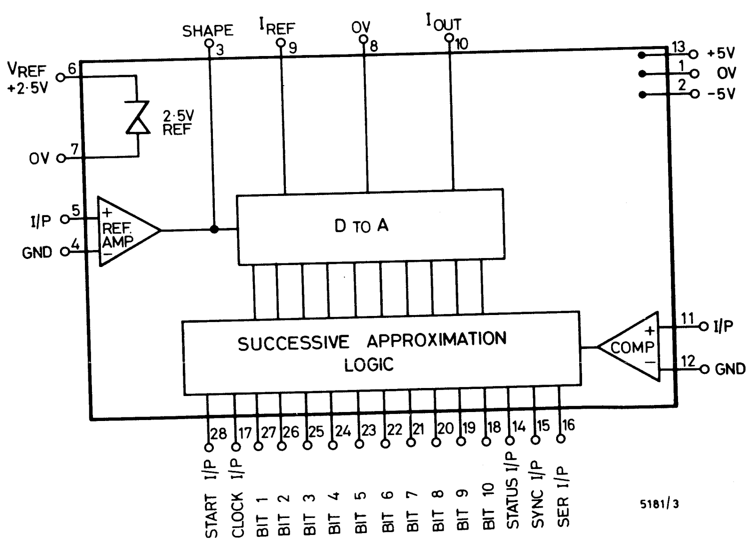
System Diagram

10-BIT SUCCESSIVE APPROXIMATION A TO D CONVERTER

The ZN432 is a monolithic, 10-bit, successive approximation A to D converter. It contains a 10-bit current-output DAC, successive approximation logic, comparator, 2.5V precision reference and reference amplifier, all on a single chip.

FEATURES

- No missing codes over full temperature range
- 20μs conversion time guaranteed
- Parallel and serial data outputs
- TTL and CMOS compatible
- ±5V supplies
- Optional on-chip reference
- Linearity error ± ½ LSB (max)
- Temperature ranges 0 to +70°C, −40 to +85°C, −55 to +125°C
- 28 lead ceramic (H28) or moulded DIL (E28) package



System Diagram

CONVERTERS

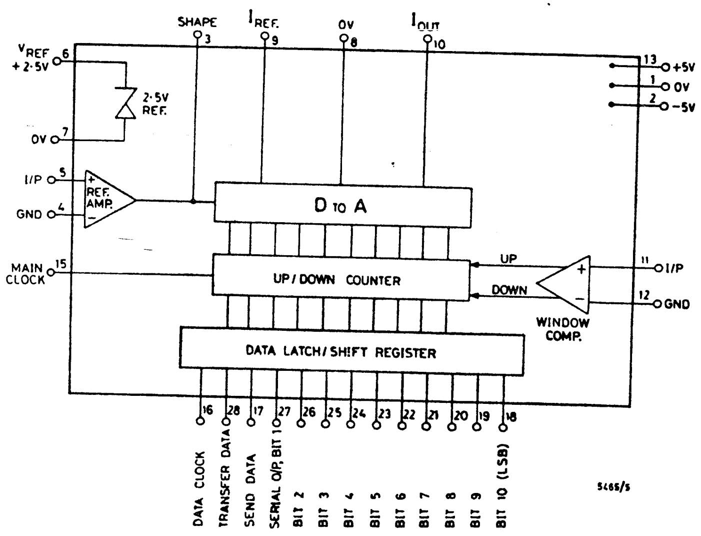
10-BIT TRACKING A TO D CONVERTER

ZN433 SERIES

The ZN433 is the world's first monolithic, 10-bit, tracking converter. It contains a 10-bit current-output DAC, up/down counter and data latch, window comparator, 2.5V precision reference and reference amplifier, all on a single chip. The tracking principle allows the conversion of a.c. signals up to 300 Hz full scale bandwidth and 600 Hz half full scale bandwidth, without the need for a sample and hold circuit.

FEATURES

- No missing codes over full temperature range
- 1μs update time
- Parallel and serial data outputs
- TTL and CMOS compatible
- ±5V supplies
- Optional on-chip reference
- Temperature ranges 0 to +70°C, −40 to +85°C, −55 to +125°C
- 28 lead ceramic DIL (H28) package



System Diagram

ADVANCE INFORMATION
8-BIT, 8 CHANNEL DATA ACQUISITION SYSTEM

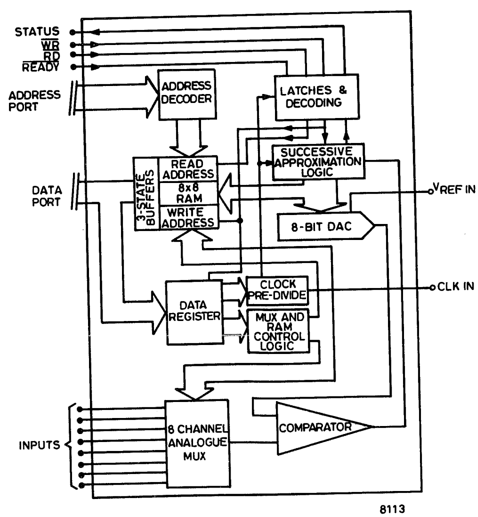
ZN437E
ZN437J

The ZN437 is a microprocessor compatible 8-bit successive approximation A to D converter with 8 multiplexed analogue input channels. The device has four modes of operation; single conversion on a named channel; continuous conversion on a named channel; single conversion of all channels; or continuous conversion on all channels. Each mode is selected by loading an initialisation word into the internal data register, which also serves to program the clock predivide.

The ZN437 also has an 8-bit, 8-byte RAM in which the latest conversion values of each analogue channel are saved and can be read by presenting a 3-bit word to the address part and taking $\overline{RD}$ low.

FEATURES

- No missing codes over full temperature range
- 20μs conversion time guaranteed
- 8 analogue inputs
- Better than ½LSB channel matching
- Accepts μP clock up to 4MHz
- On-chip 8×8 RAM
- Software programmable clock pre-divide ratio
- Commercial or military temperature ranges
- 28-lead moulded (E28) or ceramic DIL (H28) package



System Diagram

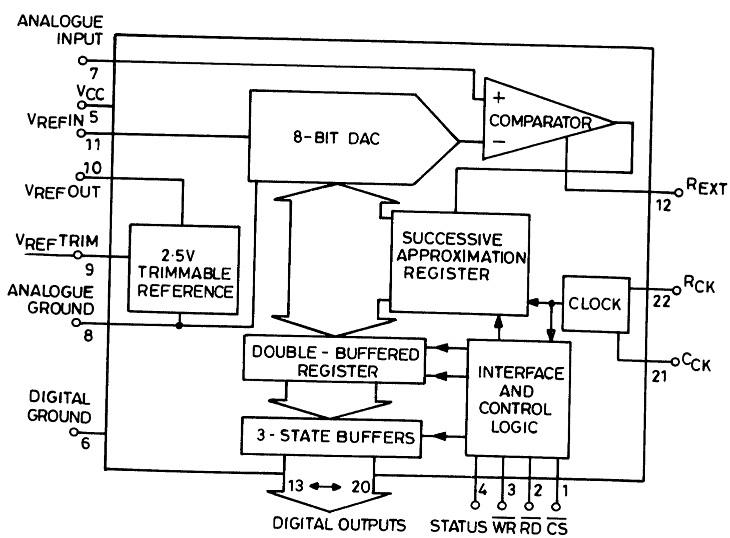
ADVANCE INFORMATION
8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN439

The ZN439 is an 8-bit successive approximation A to D converter designed to interface easily to a microprocessor. All active circuitry is contained on-chip including clock genarator, trimmable 2.5 volt bandgap reference and double buffered latches with three-state outputs. These features give extra flexibility with the double-buffered register allowing date to be read at any time irrespective of the conversion status.

FEATURES

- ¼, ½ or 1 LSB linearity error
- 5μs guaranteed conversion time
- Microprocessor, TTL, CMOS compatible
- On-chip clock
- Trimmable band-gap reference
- Versatile μ-processr interfacing with double buffered output latch
- Commercial or military temperature ranges
- ROM type operaton
- Equally suitable for 'stand alone' applications
- 22-lead ceramic (H22) or moulded DIL (E22) package



System Diagram

8060

6-BIT VIDEO A TO D CONVERTER

ZN440
ZN441

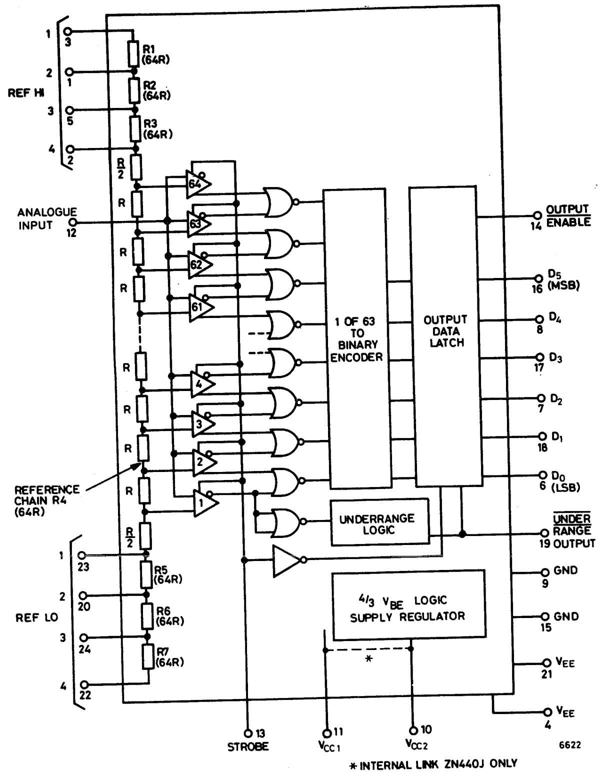
The ZN440 is a high speed, 6-bit, parallel A to D converter capable of digitising analogue signals at rates up to 16 megasamples per second. A.C. signals with frequency components up to several MHz can accurately be digitised without the need for a sample-and-hold circuit. Two or four ZN440/1's can be stacked to give a 7-or 8-bit converter with a minimum of external components.

The ZN441 is a lower speed selection from the ZN440 giving a minimum sample rate of 10MHz.

Applications include high-speed data acquisition, video and radar data conversion, digital signal storage and image processing.

FEATURES

- 16MHz sample rate — ZN440
- 6-bit resolution
- Expandable to 7 or 8-bits
- ± ½ LSB linearity
- No sample-and-hold required
- Unipolar or bipolar analogue input
- TTL compatible outputs
- ±5V supply
- 700mW power dissipation
- 24 lead ceramic DIL (H24) package



System Diagram

8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTERS

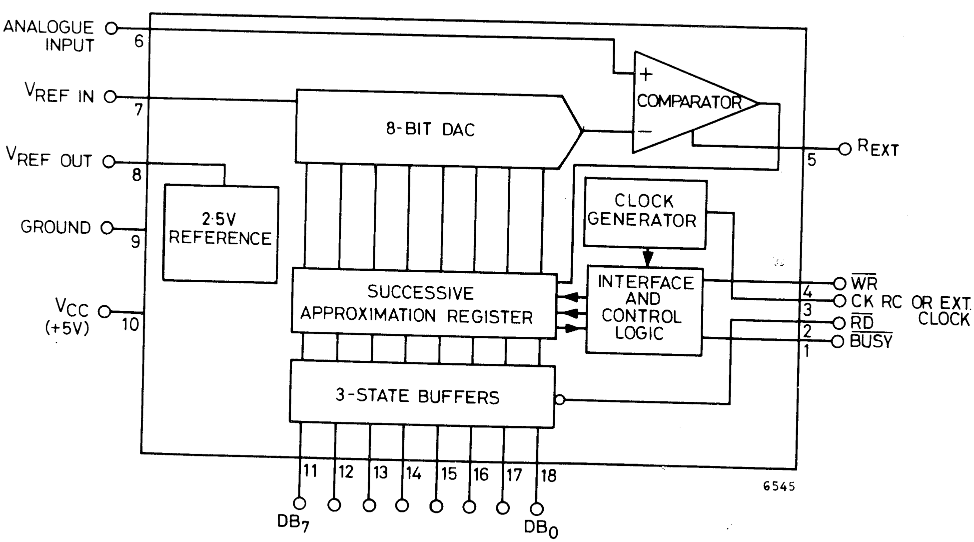
ZN447E/J
ZN448E/J
ZN449E/J

The ZN447, ZN448 and ZN449 are 8-bit, successive approximation A to D converters designed for easy interfacing to microprocessors. All active circuitry is contained on-chip including a clock generator and stable 2.5V bandgap reference.

Only a reference resistor and capacitor, clock resistor and capacitor and input resistors are required for operation with either unipolar or bipolar input voltages. The ZN447, ZN448 and ZN449 are the most complete 8-bit monolithic ADC's available.

FEATURES

- Easy interfacing to microprocessors or operates as a 'stand-alone' converter
- Fast 9μs conversion time guaranteed
- Choice of linearity: ¼ LSB – ZN447, ½ LSB – ZN448, 1 LSB – ZN449
- On-chip clock
- Choice of on-chip or external reference voltage
- Unipolar or bipolar input ranges
- Choice of commercial or military temperature range
- 18 lead moulded DIL (E18), ceramic DIL (H18) or SO-18 package



System Diagram

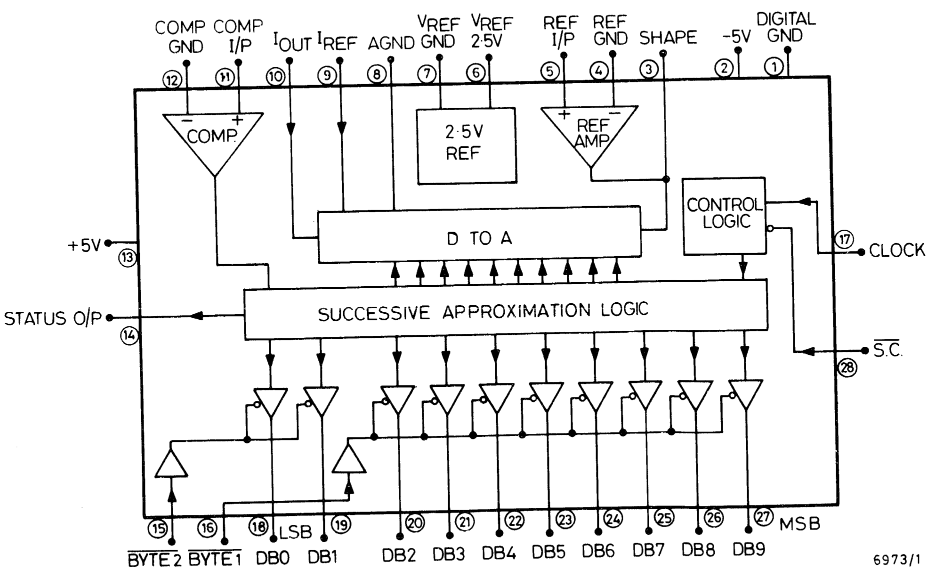
10-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN501AJ
ZN502E/CJ

The ZN501 and ZN502 are 10-bit monolithic data converters designed to provide microprocessor compatiblity. The device incorporates a current switching array (requiring no trim) successive approximation logic, 2.5V precision reference, reference amplifier, comparator and three state output buffers. With the aid of pins BYTE 1 and BYTE 2, the 10-bits of output data can be read as a 10-bit word consisting of 8- and 2-bit words.

FEATURES

- Choice of linearity: ½ LSB-ZN501, 1 LSB-ZN502
- No missing codes over full temperature range at appropriate accuracy
- 15μS typical, 20μS guaranteed conversion time
- Microprocessor and TTL/CMOS compatible
- Asynchronous $\overline{\text{START CONVERT}}$ pulse
- On-chip three-state output buffers
- Commercial and military temperature range
- Full 8- or 16-bit MICRO-Bus interface
- Unipolar or bipolar inputs
- Internal or external reference source
- 28-lead moulded (E28) or ceramic DIL (H28) package



System Diagram

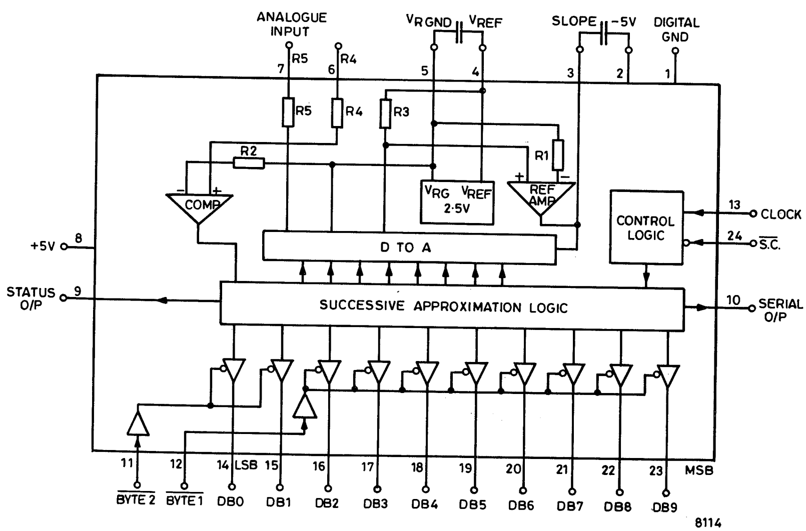
CONVERTERS

ADVANCE INFORMATION
10-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER — ZN503 ZN504

The ZN503 and ZN504 are 10-bit monolithic data converters designed to provide microprocessor compatiblity. The device incorporates a current switching array (requiring no trim) successive approximation logic, 2.5V precision reference, reference amplifier, comparator and three-state output buffers. The ZN503/4 has pin-programmable input ranges and only two external components are required to perform a full 10-bit A to D conversion. No user trims are required and the provision of a serial o/p makes the device ideal for high resolution remote sensing applications with a serial digital data link.

FEATURES

- No missing codes over full temperature range at appropriate accuracy
- 20μS guaranteed conversion time
- Microprocessor and TTL/CMOS compatible
- Parallel and serial outputs
- Asynchronous $\overline{\text{START CONVERT}}$ pulse
- On-chip three-state output buffers
- Commercial and military temperature range
- Only two external components required to perform a complete 10-bit conversion
- Unipolar or bipolar inputs
- Internal or external reference source
- 24-lead moulded (E24) or ceramic DIL (H24) package



System Diagram

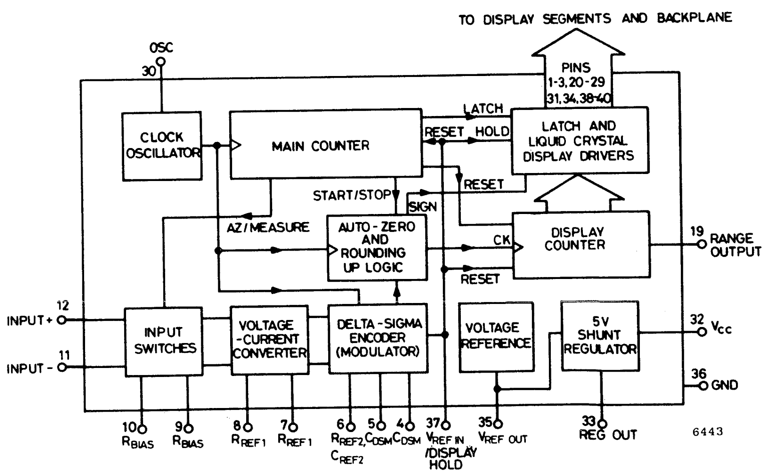
SINGLE CHIP 3½ DIGIT D.V.M. I.C.

ZN450E/ZN450CJ

The ZN450 is a complete digital voltmeter fabricated on a monolithic chip and requires only ten external, passive components for operation. A novel charge-balancing conversion technique ensures good linearity. The auto-zero function is completely digital in operation, thus obviating the need for a capacitor to store the error voltage. This versatile I.C. can be used as the basis not only for digital voltmeters and multimeters but also for other instruments such as digital thermometers.

FEATURES

- 199.9mV full-scale reading
- Digital auto-zero with guaranteed zero reading for 0V input
- True polarity at zero for null detection
- True differential inputs
- Direct drive of Liquid Crystal Display
- On-chip clock and precision reference
- Underrange/overrrange indication
- Low power consumption
- Wide supply voltage range, single supply rail
- No external active circuits required
- 40 lead moulded (E40) or ceramic (H40) DIL package



System Diagram

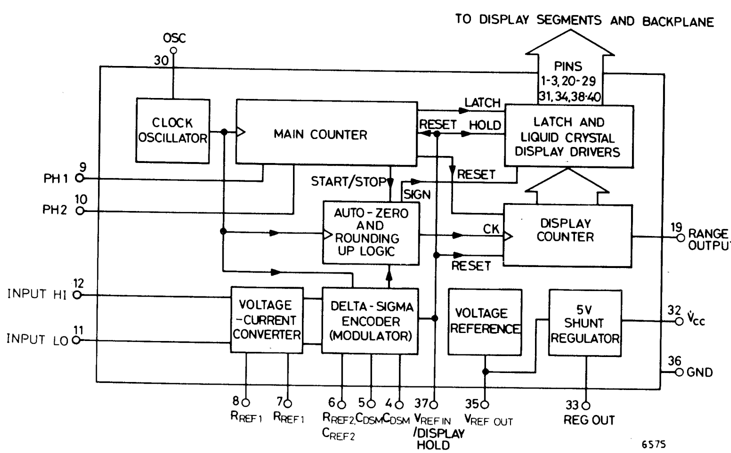
3½ DIGIT D.V.M. I.C. WITH EXTERNAL AUTO-ZERO — ZN451E/ZN451CJ

The ZN451 is a complete digital voltmeter fabricated on a monolithic chip. A novel charge-balancing conversion technique ensures good linearity. The auto-zero function is completely digital in operation, thus obviating the need for a capacitor to store the error voltage. Output signals are provided to control external auto-zero switches so that op-amps or other signal conditioning circuits can be included in the auto-zero loop to boost input impedance and/or improve sensitivity to as low as 1.999mV full-scale.

The versatile I.C. can be used as the basis not only for digital voltmeters and multimeters but also in other instruments such as thermometers and pressure gauges where its sensitivity allows interfacing to low output transducers such as thermocouples and strain gauges.

FEATURES

- External circuits may be included in the auto-zero loop
- Full-scale reading 1.999mV or lower
- Measures sum or difference of two inputs
- Digital auto-zero with guaranteed zero reading for 0V input
- True polarity at zero for null detection
- True differential inputs
- Direct drive of Liquid Crystal Display
- On-chip clock and precision reference
- Underrange/overrange indication
- Low power consumption
- Wide supply voltage range, single supply rail
- 40 lead moulded (E40) or ceramic (H40) DIL package



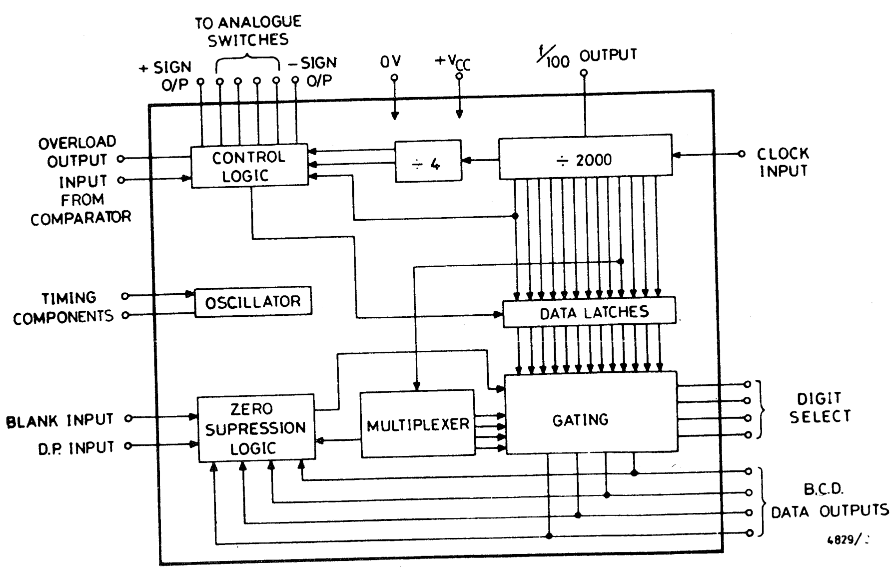
System Diagram

3½ DIGIT D.V.M LOGIC

The ZNA116E contains all the control logic necessary to construct a 3½ digit D.V.M., using the well-known dual slope integration technique, whilst leaving the designer free to configure the analogue input circuitry to his own requirements.

FEATURES

- 3½ digit display (±1999 max. reading)
- Automatic polarity detection and indication
- Overrange indication
- Leading zero blanking
- Blanking input
- Multiplexed, BCD outputs
- TTL, CMOS compatible
- Single +5V supply at 10mA typical
- On-chip oscillator
- 24 lead moulded DIL (E24) package



System Diagram

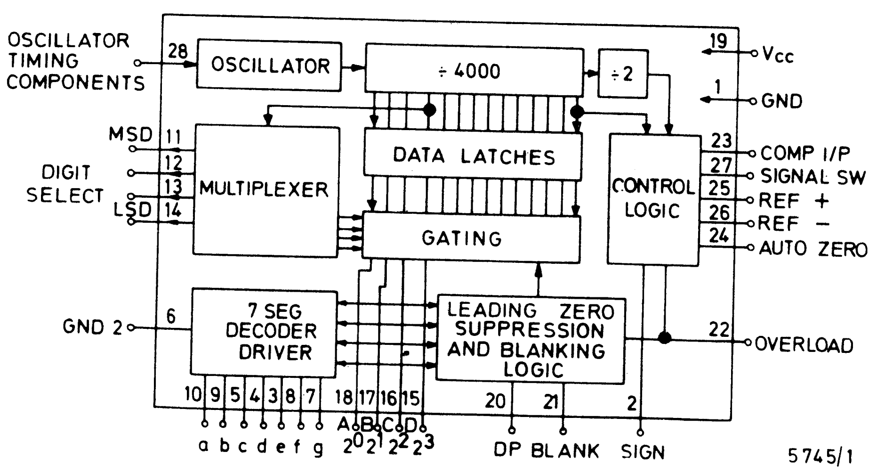
3¾ DIGIT D.V.M LOGIC

ZNA216E/ZNA216J

The ZNA216 contains all the control logic necessary to construct a dual-slope D.V.M., but leaves the analogue circuitry to be configured to the designer's own requirements. The I.C. incorporates many of the features of the ZNA116 and in addition includes seven-segment outputs for driving LED displays and an auto-zero facility to eliminate manual zero adjustment.

FEATURES

- 3¾ digit display (±3999 max. reading)
- Auto-zero facility
- Automatic polarity detection and indication
- Overrange indication
- Leading zero blanking
- Blanking input
- Multiplexed BCD and seven-segment outputs
- TTL, CMOS compatible
- Single +5V supply at 15mA typical
- On-chip oscillator
- 28 lead moulded (E28) or ceramic (H28) DIL package



System Diagram

MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS

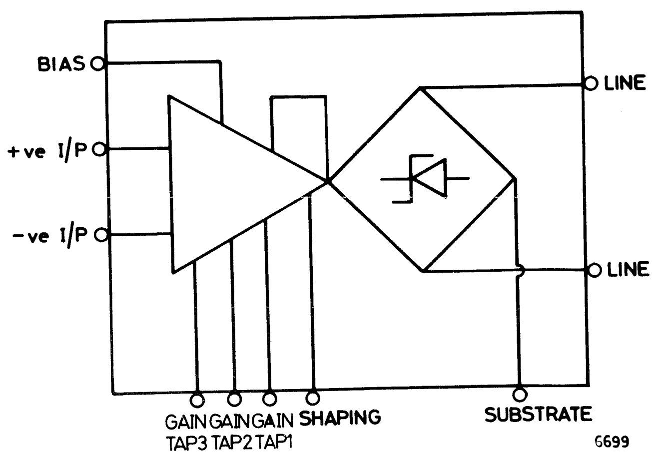
ZN470AE
ZN472E

This microphone amplifier was developed in conjunction with British Telecom for use with an electret transducer to replace the carbon transmitter. Dual polarity operation is accommodated by an on-chip bridge. Full lightning surge protection is given by on-chip components thus eliminating the need for an external surge suppression diode. The high input impedance makes it suitable for use with high or low impedance microphones that provide a high output voltage.

The ZN470 and ZN472 are available in a 14 lead, high dissipation moulded DIL (E14).

FEATURES

- Conforms to BT Specification S1377
- On chip bridge allows dual supply polarity operation
- Direct matching to electret transducers
- 4 gain settings by adjustable links
- Operates over 1 mA to 100 mA line current
- 220 mA continuous overload capacity
- Low noise
- Low distortion
- Operates on telephone supply lines
- Meets BT lightning surge requirements
- Minimum external components in telephone circuits



System Diagram

TELECOMMUNICATIONS CIRCUITS

ADVANCE INFORMATION
TONE CALLER INTEGRATED CIRCUIT

ZN473E

The ZN473E tone caller I.C. is intended to replace existing electromechanical bells in telephone handsets.

The A.C. ringing voltage, V_R, normally supplied to energise the bell is rectified by an on-chip bridge and used to power the complete circuit.

A standard 560kHz ceramic resonator is used to control the clock oscillator frequency which is then divided down to give two frequencies with a small separation. The output is switched between these two frequencies at 10Hz to give a warble tone.

Pin 5 is used to select output frequencies of either 1000Hz and 1250Hz or 1167Hz and 1333Hz.

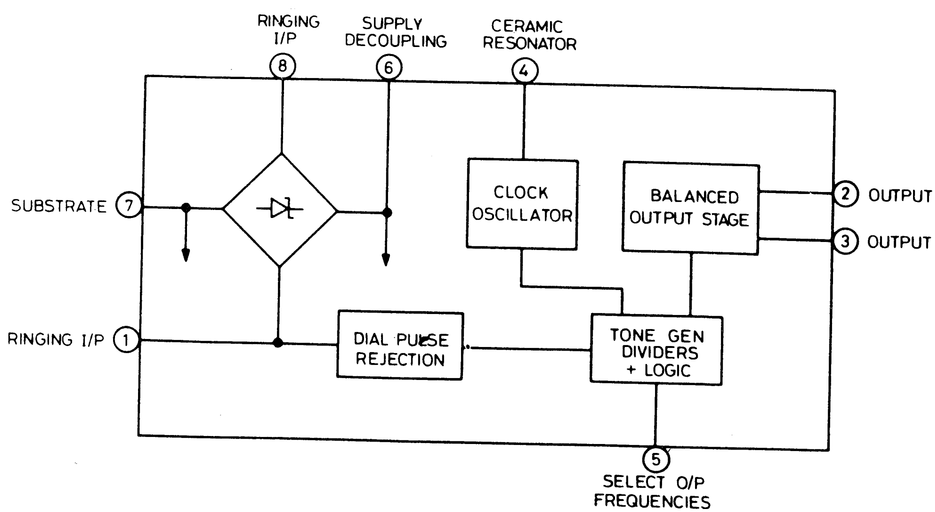
To prevent operation of the circuit on dial pulses a digital dial pulse rejection circuit inhibits the output except in the presence of the ringing supply.

The use of the ceramic resonator for clock control gives excellent tone frequency stability with temperature and life and eliminates complicated frequency setting procedures.

The device is packaged in an 8-lead moulded DIL package and is designed to operate over the temperature range −10 to +70°C.

FEATURES

- Full rectifier bridge for direct operation from ringing supply
- Balanced output for piezo electric or electromagnetic transducers
- Digital dial pulse rejection
- Frequency drift eliminated by ceramic resonator
- Choice of output tones
- Built-in lightning protection
- Low external component count
- Built-in supply voltage regulator
- Supply voltage threshold
- Low cost 8-lead DIL (E8) package



System Diagram

MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN475E

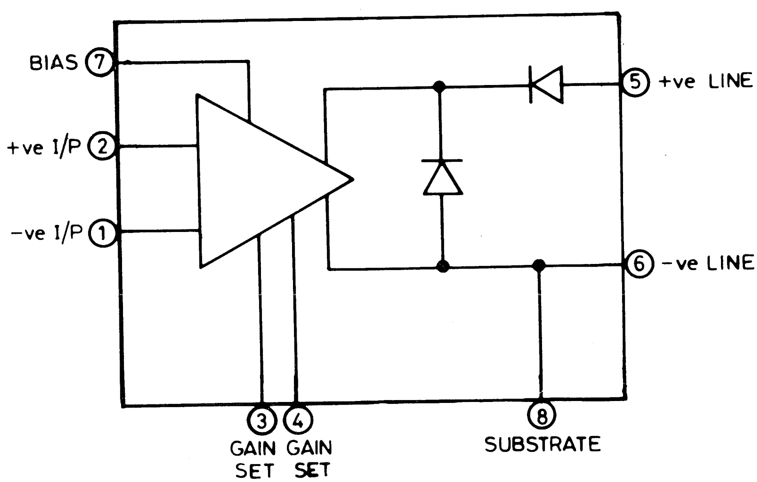
Some electret transducers are supplied with a built in impedance matching junction FET buffer to operate with a microphone amplifier of low input impedance. The ZN475E has been designed with a high input impedance to match directly with electret transducers without the need for an FET buffer.

The device operates from a single polarity supply, but includes protection from inadvertent supply reversal.

The amplifier gain can be adjusted over a wide range by an external resistor to suit a variety of different electret transducer sensitivities.

FEATURES

- Direct matching to electret transducers
- Gain adjustable by external resistor
- Operates from 1 mA to 100 mA line current
- Low noise
- Low distortion
- Operates on telephone supply lines
- Minimum external components in telephone circuits
- Low cost 8-lead moulded DIL package (E8)



System Diagram

TELECOMMUNICATIONS CIRCUITS

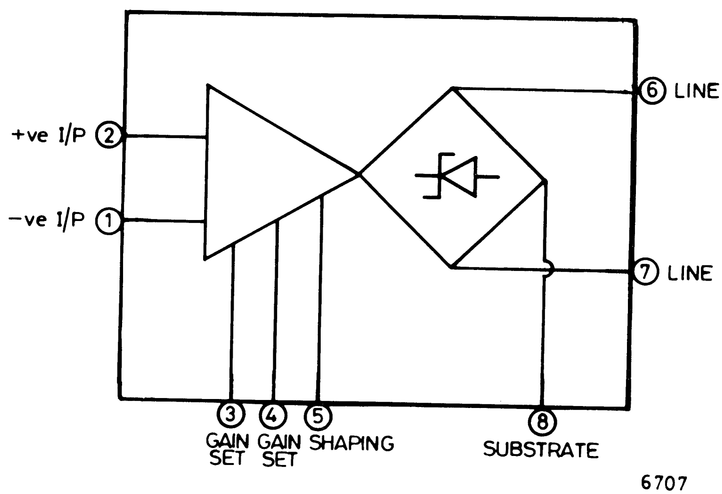
MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN476E

The ZN476E was developed specifically for use with low impedance transducers such as moving coil microphones to replace the carbon transmitter in telephone handsets. Dual polarity operation is accommodated by an on-chip bridge. Full lightning surge protection is given by on-chip components thus eliminating the need for an external surge suppression diode.

The amplifier gain can be adjusted over a wide range by an external resistor to suit a variety of different low impedance (moving coil) transducer sensitivities.

FEATURES

- On-chip bridge allows dual supply polarity operation
- Direct matching to low impedance (moving coil) transducers
- Gain adjustable by external resistor
- Operates from 1 mA to 100 mA line current
- Low noise
- Operates on telephone supply lines
- Minimum external components in telephone circuits
- Low cost 8-lead moulded DIL pacakage (E8)



System Diagram

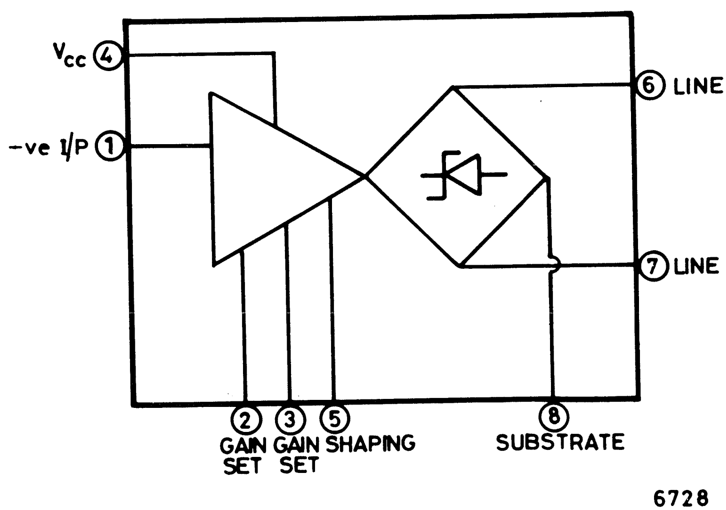
MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS ZN477E

The ZN477E was developed specifically for use with low impedance transducers such as electret microphones (with FET buffers) to replace the carbon transmitter in telephone handsets. Dual polarity operation is accommodated by an on-chip bridge. Full lightning surge protection is given by on-chip components thus eliminating the need for an external surge suppression diode.

The amplifier gain can be adjusted over a wide range by an external resistor to suit a variety of different low impedance transducer sensitivities.

FEATURES

- On-chip bridge allows dual supply polarity operation
- Designed to match electrets with FET buffers
- Gain adjustable by external resistor
- Operates from 1 mA to 100 mA line current
- Low noise
- Low distortion
- Operates on telephone supply lines
- Minimum external components in telephone circuits
- Low cost 8-lead moulded DIL pacakage (E8)



System Diagram

TELECOMMUNICATIONS CIRCUITS

MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN478E

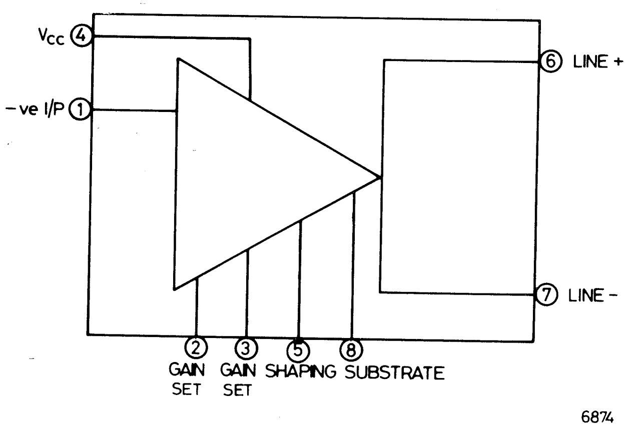
The ZN478E was developed specifically for use with low impedance transducers such as electrets (with FET buffers) microphones to replace the carbon transmitter in telephone handsets. The ZN478E is especially useful where a low operating voltage is required.

The amplifier gain can be adjusted over a wide range by an external resistor to suit a variety of different low impedance transducer sensitivities.

This is a single polarity device and care should be taken over line connection.

FEATURES

- Low working voltage
- Designed to match electrets with FET buffers
- Gain adjustable by external resistor
- Operates from 1 mA to 100 mA line current
- Low noise
- Low distortion
- Operates on telephone supply lines
- Minimum external components in telephone circuits
- Low cost
- 8-pin DIL package



System Diagram

ZN480E

RING DETECTOR

The ZN408E Ring Detector is intended for use when a special function is required in reponse to an incoming ringing signal.

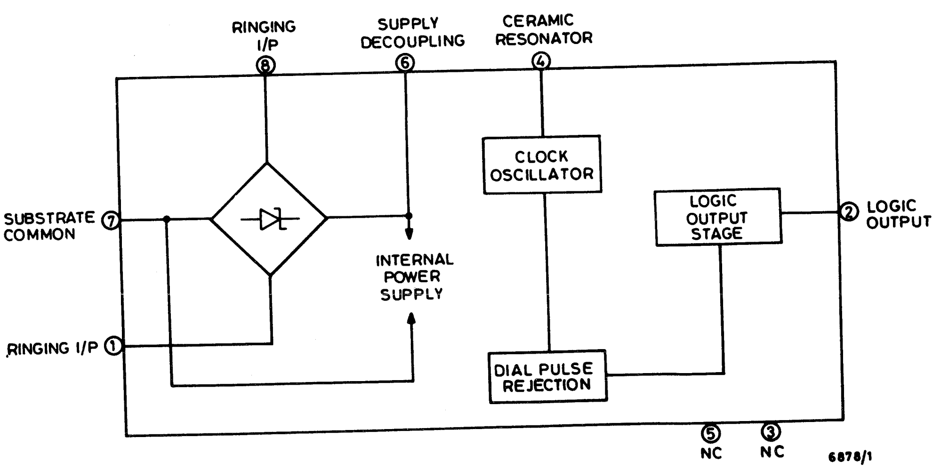
A logic output is provided which can be interfaced to a wide variety of equipment including microprocessors, answering machines, modems, lamp indicators and opto-isolators.

The A.C. ringing voltage V_R is rectified by an on-chip bridge and used to power-up the complete circuit.

A standard 560KHz ceramic resonator is used to control the clock oscillator which provides a reference for the dial pulse rejection circuitry giving an active high only in the presence of a ringing signal.

FEATURES

- Full rectifier bridge for direct operation from ringing supply
- Logic output
- Digital dial pulse rejection
- Frequency drift eliminated by ceramic resonator
- Built-in lightning protection
- Low external component count
- Built-in supply voltage regulator
- Supply voltage threshold
- Low cost 8-pin DIL package



System Diagram

TELECOMMUNICATIONS CIRCUITS

ADVANCE INFORMATION
BUFFER AMPLIFIER FOR ELECTRET MICROPHONES

ZN482Z

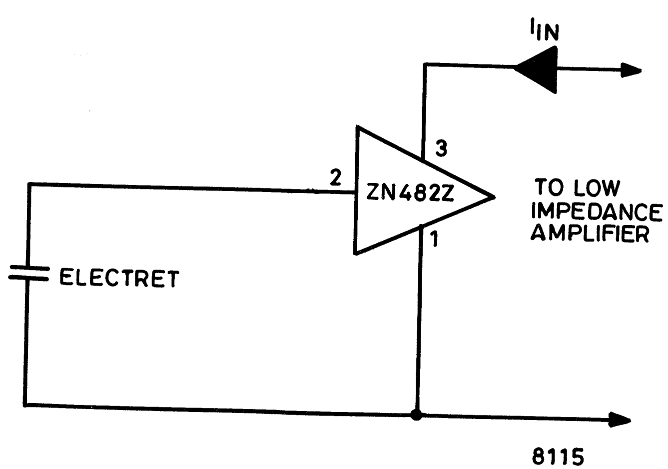
The buffer amplifier was developed for use with an electret transducer and the two are mounted in close proximity in the telephone handset.

It is designed to withstand leakage path currents which can appear across the terminals of the amplifier due to the harsh environmental conditions of temperature and humidity which are imposed on the electret.

The high input impedance gives the suitable low frequency response whilst the low output impedance is capable of driving the line linking handset to the main body of the telephone.

FEATURES

- Impedance matching between an electret microphone and an amplifier
- High input impedance
- Low output impedance
- Low noise
- Low distortion
- Low operating current
- High tolerance to input leakage resistance
- TO-92 package



System Diagram

ZN1003

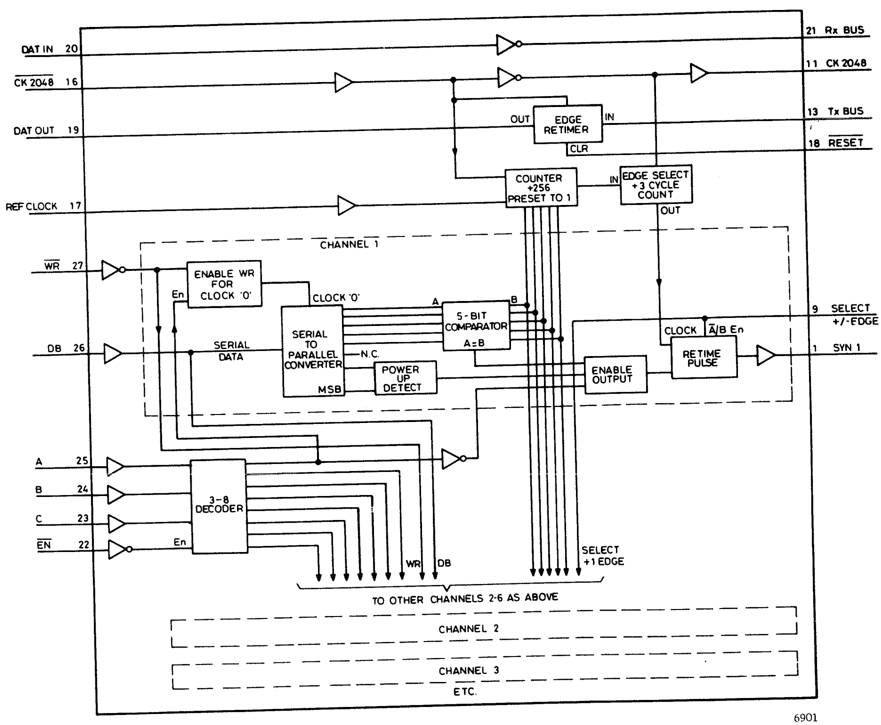
EIGHT CHANNEL TIME-SLOT ASSIGNER

The ZN1003 eight channel time-slot assigner has been designed in conjunction with British Telecom for use with those single chip codec/filters which do not have a time-slot assignment function built-in. The TSAC operates under the control of the board intelligence and provides synchronous pulses to each of up to eight devices. The synchronising pulses are of 8 clock cycles duration and can be selected to be derived from either the rising or the falling edge of the 2.048MHz clock.

The TSAC will be able to drive the majority of codec/filter devices. Also provided on the chip are waveform buffers and a re-timing circuit for the PCM signals.

FEATURES

- Dynamic time-slot assignment
- Clock buffering
- DATOUT buffering and retiming
- Direct microprocessor control
- Syn pulse derived form either edge of the 2.048MHz clock
- 28-lead moulded DIL package



System Diagram

TELECOMMUNICATIONS CIRCUITS

ADVANCE INFORMATION
2MBIT PCM SIGNALLING CIRCUIT: HDB3 ENCODER/DECODER

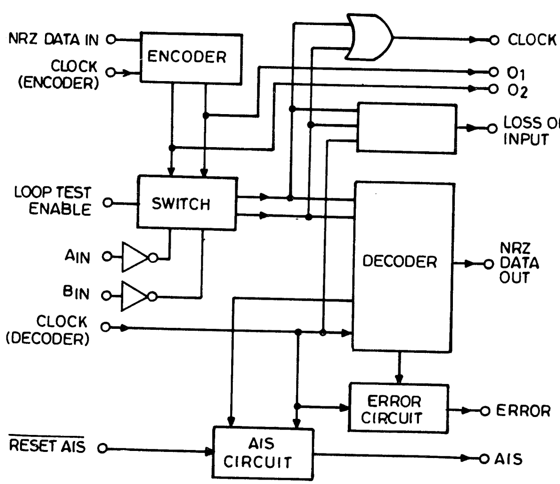
ZN1440E

The 2MBit PCM signalling circuits are a group of I.C's. performing the common signalling and error detection functions required of a 2.048MBit 30 channel PCM transmission link operating to the appropriate CCITT recommendations. The circuits are fabricated using the Ferranti FAB-2 CDI process, operate from a single 5 volt supply and have TTL compatible inputs and outputs.

The ZN1440E is an encoder/decoder for the pseudo-ternary transmission code HDB3 as defined in the annex to CCITT recommendation G703. The device encodes and decodes simultaneously and asynchronously. Error monitoring functions are provided to detect violations of HDB3 coding, all ones detection and loss of input (all zeroes detection). In addition a loop back function is provided for terminal testing.

FEATURES

- HDB3 encoding and decoding to CCITT recommendation G703
- Asynchronous operation
- Decode data in NRZ
- Loop back control
- Simultaneous encoding and decoding
- Clock recovery signal generated from incoming HDB3 data
- HDB3 error monitor
- 5 volt operation
- Loss of input alarm (all zeroes detector)
- Low cost 16-lead plastic DIL package



System Diagram

ADVANCE INFORMATION
2MBIT PCM SIGNALLING CIRCUIT:
PCM SYNCHRONISING WORD GENERATOR

ZN1444E

The 2MBit PCM signalling circuits comprise a group of circuits which will perform the common signalling and error detection functions for a 2.048MBit 30 channel PCM transmission link operating to the appropriate CCITT recommendations. The circuits are fabricated using the Ferranti FAB-2 CDI process and operate from a single 5 volt supply. Relevant inputs and outputs are TTL compatible.

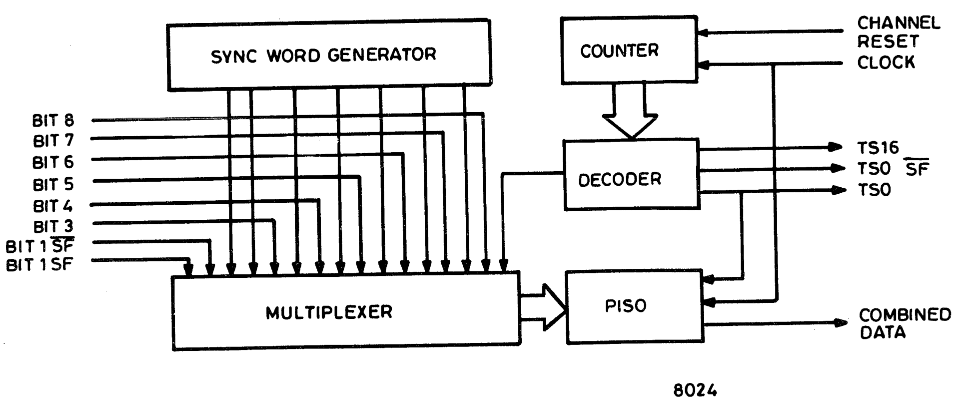
The ZN1444E generates the synchronising word in accordance with CCITT recommendation G732 The synchronising word is injected onto the PCM data highway during time slot 0 in alternate frames. The spare time slot 0 data bits, bit 1 in every frame, and bits 3 to 8 inclusive in alternate frames (i.e. those not containing the synchronising word) are available as parallel inputs and are output onto the PCM data highway.

The data output of the ZN1444E is "open collector" and can be "wire-AND-ed" directly onto the data highway.

The device also provides a time slot 0 channel pulse TS0, a time slot 0 non-sync frame TS0 $\overline{SF}$, and a time slot 16, TS16, output.

FEATURES

- Conforms to CCITT recommendation G732
- All relevant inputs and outputs are TTL compatible
- 5 volt operation
- Direct output onto PCM data highway
- Channel pulses provided for both time slot 0 and time slot 16
- Combined data output is "open collector" permitting "wired" type operation
- Provides time slot 0 non-sync frame
- Low cost 16-lead plastic DIL package



System Diagram

TELECOMMUNICATIONS CIRCUITS

ADVANCE INFORMATION
2MBIT PCM SIGNALLING CIRCUIT:
PCM SYNCHRONISING WORD GENERATOR

ZN1445E

The 2MBit PCM signalling circuits are a group of I.C's. performing the common signalling and error detection functions required of a 2.048MBit 30 channel PCM transmission link operating to the appropriate CCITT recommendations. The circuits are fabricated using the Ferranti FAB-2 CDI process, operate from a single 5 volt supply and have TTL compatible inputs and outputs.

The ZN1445E provides synchronisation by search and detection of the frame alignment word when it is received at the remote end of the transmission system; this word is generated at the sending end of the system by the ZN1444E in accordance with CCITT recommendation G732.

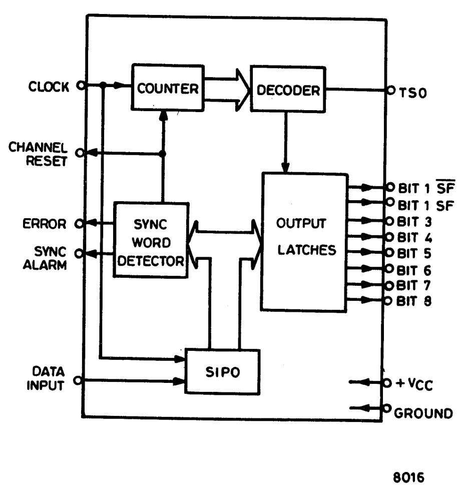
Corruption of indivdual synchronisation words is signified by an 'Error' output and loss of synchronisation is indicated by a 'Sync Alarm' output; loss of synchronism is assumed when three consecutive synchronisation words have been received with errors.

The 'Channel Reset' output goes low for the first period of the clock after time slot 0 in sync frames whenever the ZN1445E has established that the receiver terminal is in synchronisation in order that the rest of the receiver terminal may be reset.

The 'TSO' output is high for a period of 8 bits starting from the end of the first bit of the sychronising word. The spare data bits from the synchronising word are provided as parallel outputs.

FEATURES

- Conforms to CCITT recommendation G732
- Synchronising word error monitor
- Out of sychronisation alarm
- All inputs and outputs are TTL compatible
- 5 volt operation
- Low cost 16-lead plastic DIL package



System Diagram

ADVANCE INFORMATION
2MBIT PCM SIGNALLING CIRCUIT: TIME SLOT 16 RECEIVER AND TRANSMITTER

ZN1446E

The 2MBit PCM signalling circuits comprise a group of circuits which will perform the common signalling and error detection functions for a 2.048MBit 30 channel PCM transmission link operating to the appropriate CCITT recommendations. The circuits are fabricated using the Ferranti FAB-2 CDI process and operate from a single 5 volt supply. Relevant inputs and outputs are TTL compatible.

Two modes of operation are possible with the ZN1446E. The mode of operation is selected via the "mode control" input (pin 13).

When the mode control input is held high the device is in the transmit mode. In this mode the device accepts binary or AMI format data at 64 KBit/sec and outputs this signalling information onto the digital highway during time slot 16 at 2Mbit/sec.

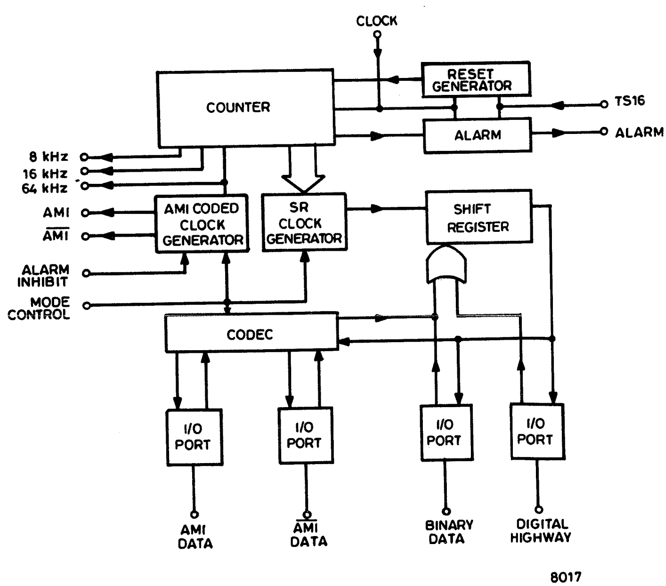
When the mode control input is held low the device is in the receive mode. In this mode the device accepts signalling information during time slot 16 from the digital highway at 2Mbit/sec and outputs this data in both binary and AMI forms at 64 Kbit/sec.

In either mode an AMI coded clock output and also both an AMI and $\overline{\text{AMI}}$ ouput is provided conforming to CCITT recommendation G372.

An alarm inhibit facility is provided enabling the 8KHz timing signal to be removed from the AMI codec clock output. The alarm output gives indication of incorrect operation of the internal counter.

FEATURES

- Conforms to CCITT recommendation G732
- All inputs and outputs are TTL compatible
- 5 volt operation
- Binary and AMI format data input/output
- Receive/transmit on one chip
- "Open collector" output permitting "wired" operation
- 8, 16 and 64KHz clock outputs provided
- Low cost 16-lead plastic DIL package



System Diagram

TELECOMMUNICATIONS CIRCUITS

CODEC I.C. SET

ZNPCM1/ZNPCM2

The ZNPCM1 and ZNPCM2 combine with a modicum of capacitors to make an integrated codec system for converting analogue (voice frequency) signals to digital (pulse code modulation) signals and vice-versa. The ZNPCM2 converts the analogue input to a delta-sigma modulated pulse stream which is then transformed into a pcm lulse stream by the ZNPCM1. Both devices also provide the reverse function.

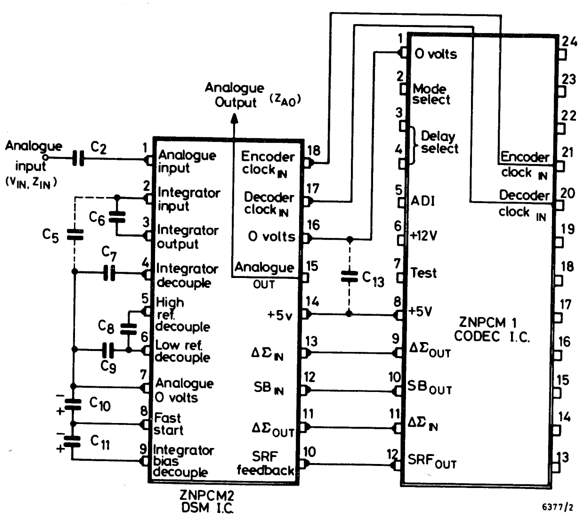
Both devices are manufactured using the Ferranti bipolar process. The ZNPCM1 and ZNPCM2 are supplied in 24 and 18 lead DIL packages respectively and moulded or cerdip versions are available.

FEATURES

- Converts a delta-sigma modulated digital pulse stream inot compressed 'A' law pcm and vice-versa
- Enables realisation of a single-channel codec circuit with minimum component useage
- Pin selectable input-output interface providing either single channel operation at 64K bit/s (2.048KHz external clock) or up to 2,048K bit/s (2,084KHz external clock) for multi-channel burst format
- Encoder and decoder can be clocked asynchronously (useful for pcm multiplex applications)
- Optional alternate digit inversion
- Electrically and pin compatible with AY-3-9900
- Fully TTL compatible
- Requires only a single 5V supply
- Moulded (E24) or cerdip (J24) package

ZNPCM2E/ZMPCM2J

- Converts analogue (300-3,400Hz) signals into a delta-sigma modulated pulse stream and vice-versa
- Complimentary to the ZNPCM1 and AY-3-9900
- Requires only a single 5V supply
- Moulded (E18) or cerdip (J18) package



ZNPCM1/ZNPCM2 Interface

ADVANCE INFORMATION
SINGLE CHIP SYNCHRONOUS CODEC

ZNPCM3

The ZNPCM3 monolithic codec I.C. is the result of a joint development programme between British Telecom and Ferranti Electronics Limited. Developed for use in single channel codec systems, the device converts unfiltered audio signals into 8K samples/second compressed 'A' law pcm; the reverse function being performed in the decode direction.

The ZNPCM3 combines the essential features of the popular ZNPCM1 coded I.C. and the ZNPCM2 delta-sigma modulator I.C. in addition to providing the transmit/receive filter functions and a time slot assignment facility.

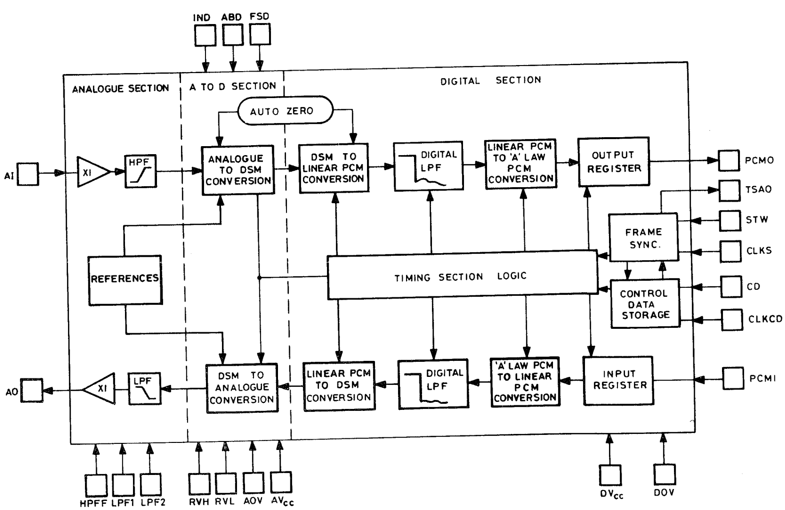
The ZNPCM3 operates from a 2048KHz system clock in the sychronous mode. Operating from a single +5V supply the ZNPCM3 dissipates 250mW when active and 20mW when powered down. It is available in a 28 lead DIL package (E28) or (H28) or a moulded chip carrier (Q28) and is designed to operate over the temperature range 0 to +70°C.

The device is manufactured using the Ferranti advanced bipolar process (FAB II) which is a simple six mask process. The chip is 95% digital on construction, minimising analogue circuit content and precision requirements, thereby achieving a design which has predictable and easily testable transmission characteristics.

The ZNPCM3 performance complies with CCITT system recommendations G711/G712 (1972).

FEATURES

- Converts analogue voice signals onto compressed pcm and vice-versa, using an on-chip delta-sigma modulated (DSM) code converter
- 'A' law companding characteristic
- Incorporates fixed ADI
- Single +5V power supply option
- Low power option by use of +2V digital supply pin
- On-chip digital transmit/receive low pass-filters (LPF)
- On-chip 3rd order analogue input high-pass filter (HPF). (Optional)
- Power down facility
- Moulded chip carrier encapsulation (Q28) plus moulded (E28) and ceramic (H28) DIL



System Diagram

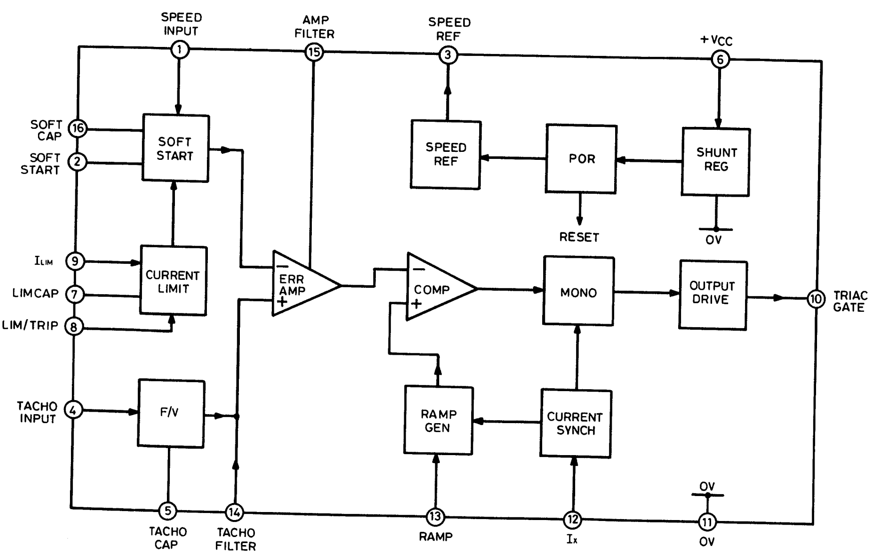
ADVANCE INFORMATION
UNIVERSAL MOTOR SPEED CONTROLLER

ZN410

The ZN410 is a monolithic silicon integrated circuit which has been designed for the purpose of speed control of Universal (AC series) Motors in cost sensitive applications. The circuit contains all the functions required for the phase control of universal motors in closed loop systems. It incorporates a tacho input suitable for magnetic coil pickup and requires a minimum of extrnal components. Possible application areas are in power tools, food processors, washing machines, vaccum cleaners and many other consumer and industrial products.

FEATURES

- Low external component count
- Magnetic pickup tacho input
- Optional current limit or trip
- Soft start ramp circuit
- Negative triac gate firing pulses
- Full cycle conduction with inductive load
- On-chip shunt regulator
- Circuit reset on power down
- Direct drive from AC line



System Diagram

UNVIVERSAL MOTOR SPEED CONTROLLER

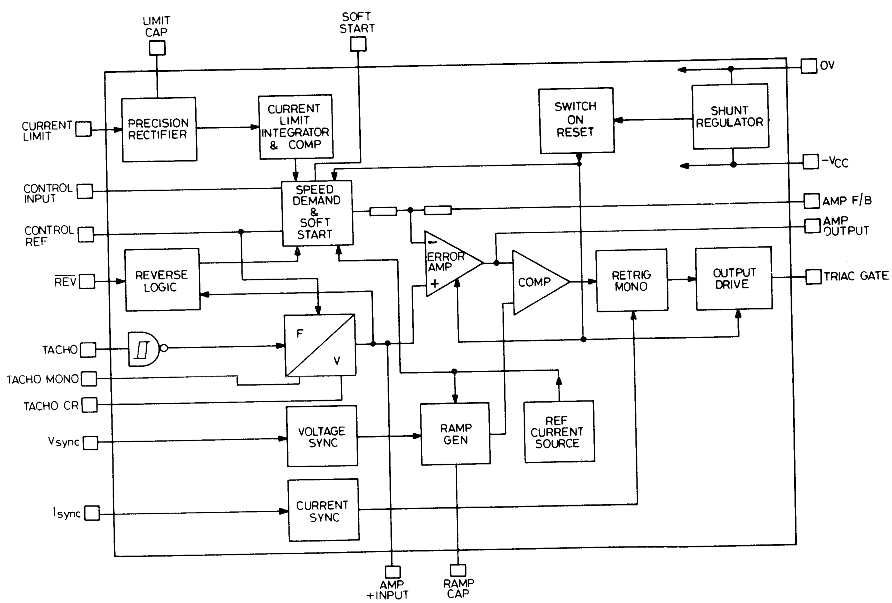
ZN411

DESCRIPTION

The ZN411 is a monlithic silicon integrated circuit designed for the purpose of closed loop speed control of Universal Motors for use in power tools, food mixers, vaccum cleaners etc. The I.C. will also function in open loop and with both resistive or inductive loads in a multiplicity of phase control applications, e.g. heating and lighting controllers. The device is available as the ZN411E in an 18-pin plastic package (E18).

FEATURES

- Direct supply from a.c. mains or d.c. power source
- On-chip shunt regulator
- Low external component count
- Soft start ramp circuit
- Circuit reset on power down
- Negative triac firing pulses
- Triac retrigger facility
- Current limit
- Guaranteed full cycle conduction with inductive load
- Tacho input compatible with hall effect switch devices
- Open or closed loop operation



System Diagram

DIGITAL CLINICAL THERMOMETER INTEGRATED CIRCUIT ZN412

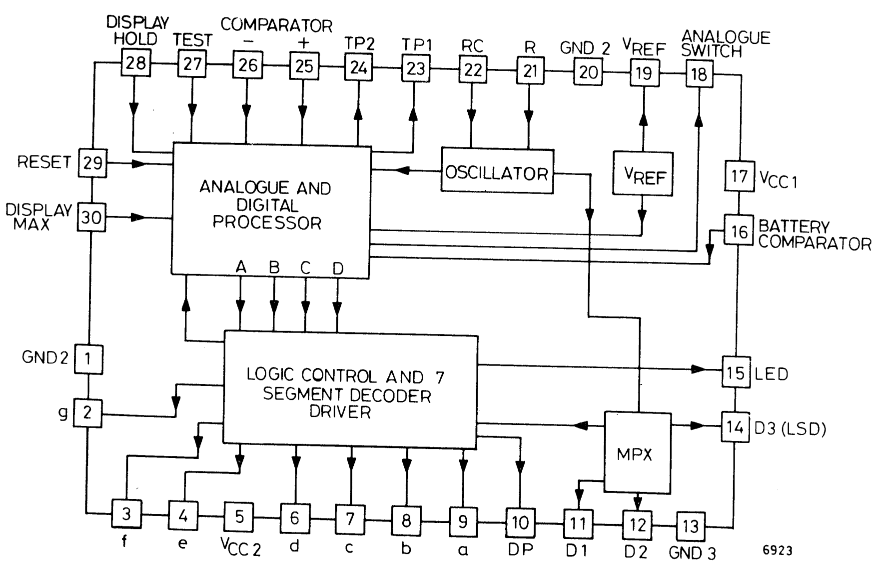
By combining complex linear and digital functions on the same chip the ZN412 enables a digital clinical thermometer to be constructed with few external components.

The ZN412 has multiplexed data outputs capable of directly driving a 3 digit seven segment LED display. These outputs are controlled by an on-chip A/D processor which converts the output from an external probe element into a digital number. Temperature can be displayed from 35.0°C to 47.6°C with a resolution of 0.1°C at a sample rate of 3 per second. Above 42.9°C, however, all the decimal points will be on whereas below 35°C, 3.4.9. will be displayed. A number of useful features are incorporated into the ZN412, including a self-check facility, battery status indication, reset and display hold.

The device is available in a 30-lead flat pack package (G30)

FEATURES

- Low external component count
- Low supply current
- Accuracy ±1 LSB (0.1°C)
- Direct drive of LED display
- Self Testing facility
- Battery status indication
- Consistent and repeatable performance
- 5 second response time



System Diagram

ADVANCE INFORMATION
SCSI LOGIC INTERFACE CIRCUIT

ZN1011Q

The ZN1011Q is designed to be used with a microprocessor and (usually) a DMA controller to provide an SCSI interface capability. Components such as the microprocessor, DMA controller, RAM, EPROM, are usually already present on designs where an SCSI interface is to be provided. It only remains to add the ZN1011Q, terminating resistors (if at one end of SCSI cable), and to write the device driver firmware for the SCSI interface.

In designs using a microprocessor which has many tasks to perform, it may be desirable to provide a dedicated microprocessor to control SCSI operations with the ZN1011Q.

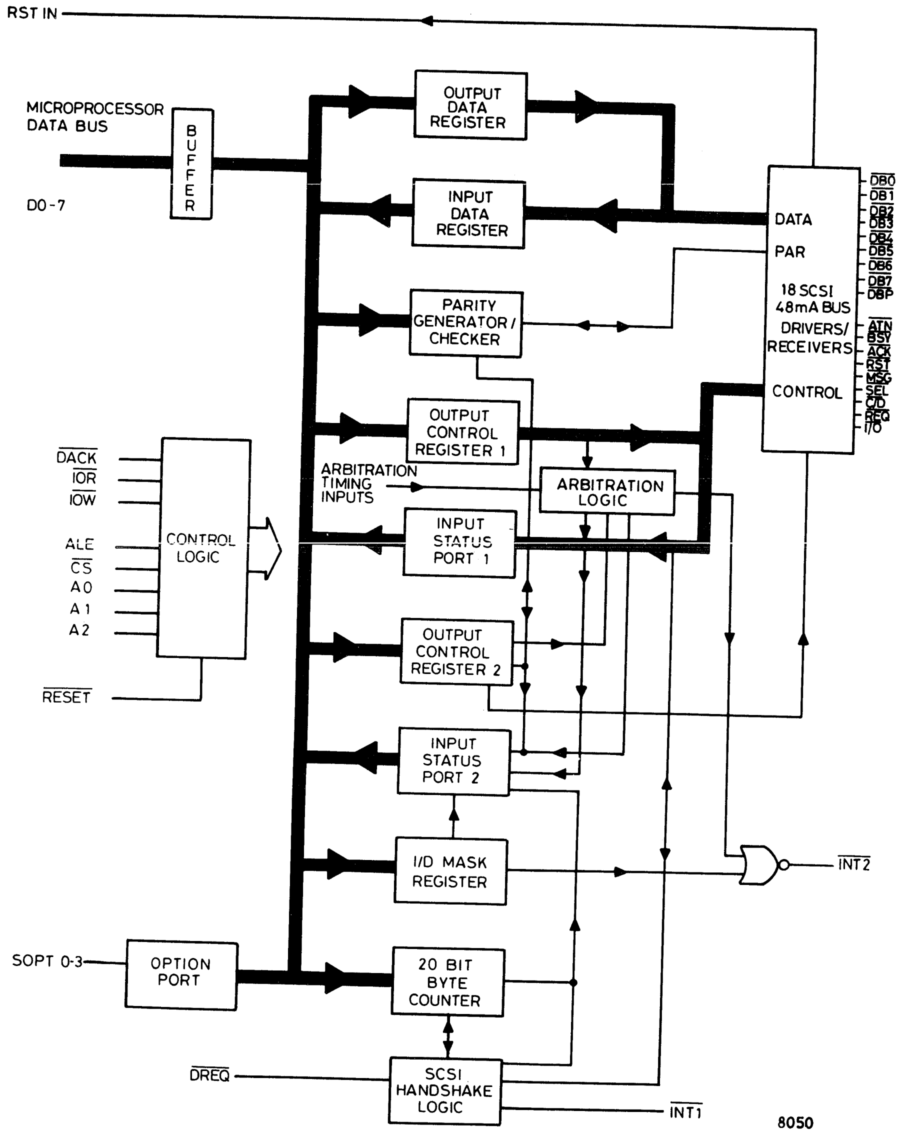
The necessary high current drivers and receivers are contained within the ZN1011Q and therefore it can be connected directly to the SCSI interface.

The ZN1011Q itself performs the Arbitration Phase (if required), informing the microprocessor when the Arbitration delay is over and a priority decision is required. The Selection, Command, Status and Message phases are usually carried out by the microprocessor working via the control and status registers on the ZN1011Q. The Data Phase is usually carried out by the DMA controller working in conjunction with the ZN1011Q. The design of the data path allows overlapping of the DMA cycle and SCSI handshake making high speed transfers possible. Alternatively, in low-cost systems, where there may be no DMA controller, the Data Phase may be performed by the microprocessor itself.

The ZN1011Q is ideally suited to implement the SCSI interface in all levels of equipment from disc drivers and printers to intelligent terminals.

FEATURES

- On-chip SCSI receivers and 48mA open collector buffer drivers allow direct connection to SCSI bus
- Can be programmed to be Initiator, Target or both
- Can be used in either SCSI or SASI environments
- Supports Arbitration and Disconnection/Reconnection
- SCSI data parity generation and (optional) checking
- Internal address latch facilities for use with multiplexed address/data buses
- Usable with popular microprocessors including Z80, Z800, 8086, 8088, 80186,68000, Z8000, 8051, 8085
- Usable with popular DMA controllers
  fly-by types e.g. 9517A, 8237, 9516, flow-through types e.g. Z80DMA, 80186, 68450, 9516
- On-chip 20-bit byte counter to control automatic SCSI handshaking
- Microprocessor has full flexible control over SCSI operations
- Arbitration delays defined by external clock (4 to 6MHz or 8 to 12MHz)
- (Optional) interrupts
- Conforms to ANSI draft proposal ANSC X3T9.2/(82-2). Proposed ANSI standard SCSI X3.131M-198X
- Pinout is compatible with standard SCSI connector
- Fabricated using an advanced bipolar process giving rugged latch-up free operation
- Sufficient Ground pins to ensure adequate noise margins under worst-case interface conditions
- The ZN1011Q is available in a type C plastic quad-package suitable for surface or socket mounting



System Diagram

ADVANCE INFORMATION COLOUR PALETTE RAM

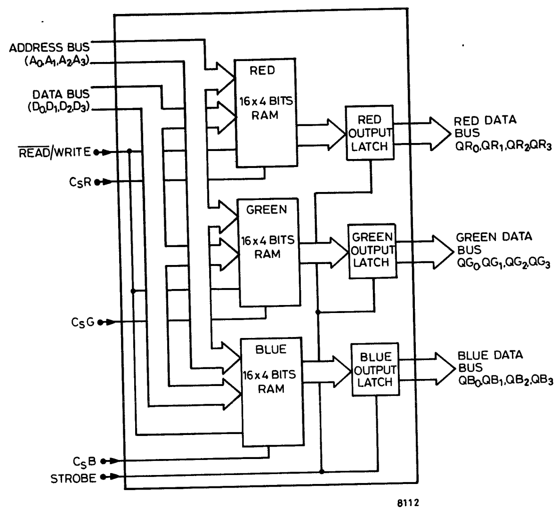
ZN1014

DESCRIPTION

The ZN1014 has been specifically designed for colour graphic display applications. It consists of three 16×4-bit RAM's and three quad latches. The operation of the ZN1014 with the ZN454 triple 4-bit DAC allows a useable palette of 16, from the 4096 possible colours, to be displayed simultaneously. This two chip colour palette approach provides additional flexibility in that the separation of the decoding and DAC circuits from the colour lock up table provides the user with the option of extending the colour palette.

FEATURES

- Read cycle of 25ns
- Write access time of 50ns
- TTL and 5V CMOS compatible
- 28-lead moulded (E28) or ceramic DIL (H28) package



System Diagram

CONTROL CIRCUITS

PRECISION TIMER

ZN1034E

By combining complex linear and digital functions on the same chip, the ZN1034E enables the construction of simple precision timers using low cost components.

The frequency of an on-chip oscillator is determined by an externally connected capacitor and resistor. Fine adjustment of the frequency can be achieved by varying the value of an external trimming resistor. Pulses from the oscillator are fed into a 12 stage binary divider and the divider output changes state after 4095 pulses.

In this way precise time periods can be defined by timing capacitors and resistors of much smaller values than would be required by a single RC time constant timer.

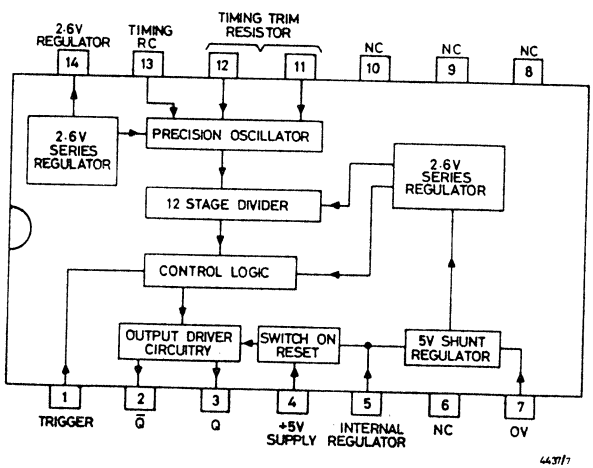
A control circuit enables the division, or count, to begin when either (a) with trigger input LO the supply goes HI (supply initiation), or (b) with supply HI the trigger input goes LO (trigger initiation).

The I.C. can operate from normal +5V logic supplies or from any higher voltage by using a suitable voltage dropping resistor and by connecting the internal shunt regulator to the supply pin.

The ZN1034E is contained in a 14 lead moulded DIL (E14).

FEATURES

- Extremely simple, requiring only one external resistor and capacitor
- 12 stage counter provides time intervals up to 7,500 CR
- Low internal current consumption of 5mA allows battery operation. Output current capability of 25mA
- Excellent temperature stability <0.01%/°C
- Accurate repetitive timing 0.01% typical
- On-chip regulator or TTL supply option
- Complementary TTL compatible outputs



System Diagram for ZN1034E

ADVANCE INFORMATION
MULTIFUNCTION TIMER CIRCUIT

ZN1036

This single chip combination of linear and digital circuitry enables the designer to produce low cost long time period high performance timers for a wide variety of applications without the need for high value high accuracy timing components.

The oscillator frequency is set with a resistor/capacitor combination with a fine adjustment facility controlled by an external potentiometer. A buffered oscillator output is available from the chip.

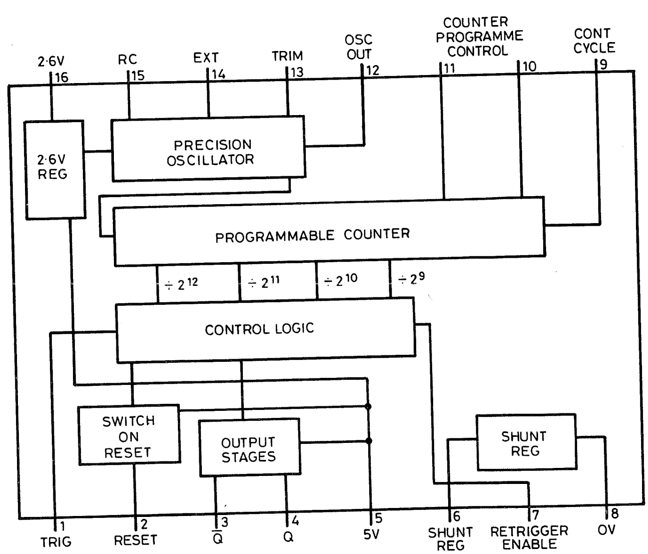
An internal counter then divides this basic frequency by 2^9, 2^{10}, 2^{11}, 2^{12} depending on the status of the counter program inputs. After the required number of pulses the complementary outputs change state.

Timing can be supply or trigger initiated and a retrigger option is also available. In addition to the internal switch on reset an external reset can also be applied to clear the counter.

Power supply can be from normal 5 volt or any higher voltage using a suitable resistor with the internal shunt regulator.

FEATURES

- Time periods from milliseconds to days
- External control of operational mode
- Accurate and repeatable performance
- Complementary high current output drivers
- Time period trimming facility
- Minimum of external components required



System Diagram

CONTROL CIRCUITS

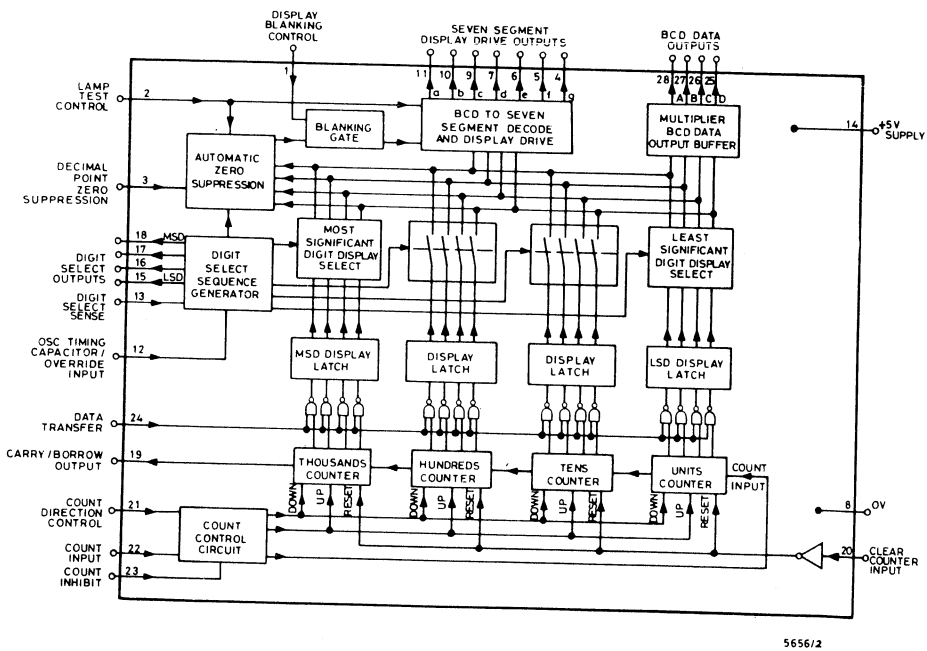
UNIVERSAL 4 DIGIT DISPLAY COUNTER

ZN1040E-RD

The counter offers such functions as up/down synchronous counting, Schmitt trigger input, direct cascading and inhibit and clear facilities. Separate memory latches are available and the display control circuitry offers variable mark-space *(intensity)* control, blanking, lamp test, separate B.C.D. outputs as well as segment outputs, automatic zero suppression and catering for the decimal point. The internal oscillator drives a self-scanning system, but provision is made for external override for synchronisation purposes.

FEATURES

- 4 digits of synchronous reversible count, up to 5MHz
- Multiplexed B.C.D. outputs
- Large output drive capability, 80mA with 0.4V drop on segment outputs and 16mA at 0.4V on others
- Direct cascading for extra digits
- Fully TTL compatible, single 5V supply
- 28 lead moulded DIL (E28) package



System Diagram

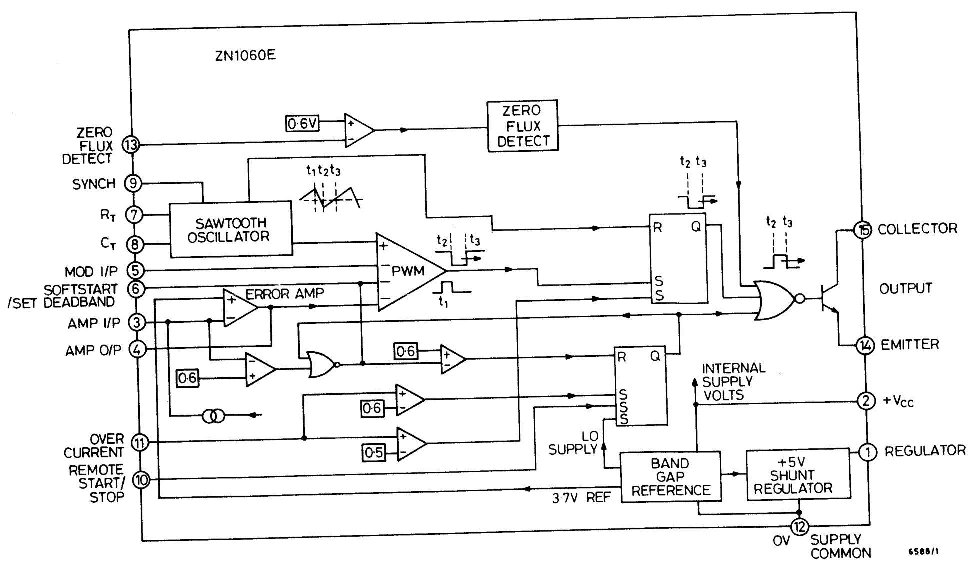
MONOLITHIC SWITCHING REGULATOR CONTROL CIRCUIT ZN1060E

The ZN1060E is a high performance monolithic integrated circuit switching regulator control chip designed for use in a variety of power control applications such as switching power supplies, DC/DC converters or motor speed control.

The device incorporates all the control and protection functions required in a switched mode power supply, including a linear trailing edge pulse width modulator with double pulse suppression logic, error amplifier, temperature compensated voltage reference, high speed current limit, sawtooth oscillator, undervoltage/overvoltage protection, de-magnetising antisaturation protection, an output stage, remote shut down facilities and much more. The ZN1060 has been characterised for operation over the −20 to +85°C temperature range.

FEATURES

- Stabilised power supply
- Low supply voltage protection
- Temperature compensated voltage reference
- Linear pulse width modulator
- Programmable duty cycle
- Programmable soft start
- Double pulse suppression
- High speed current limiting
- 16 lead moulded DIL (E16)
- Loop fault protection
- Uncommitted error amplifier
- Overvoltage protection
- Remote on/off switching
- Secondary current monitoring
- Multiple device synchronisation
- Case saturation protection



System Diagram

CONTROL CIRCUITS

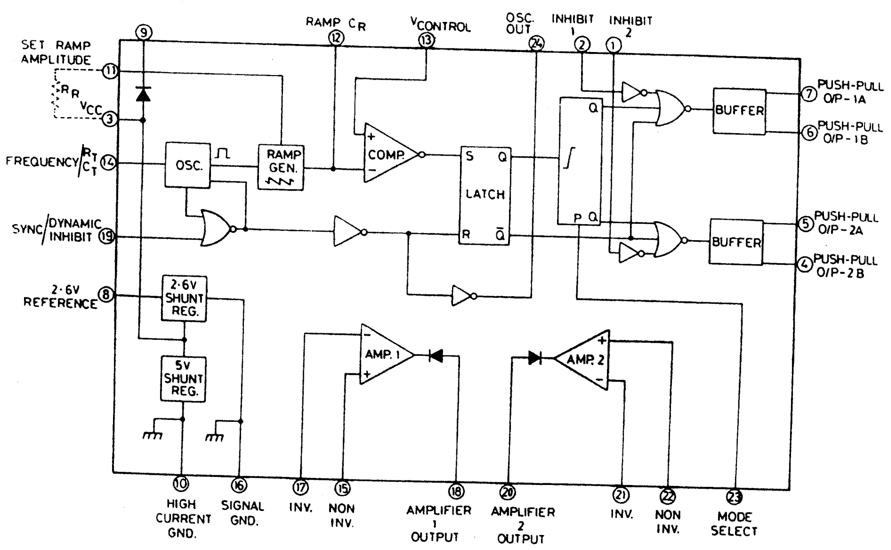
SWITCHED MODE POWER CONTROL CIRCUIT — ZN1066E/ZN1066J

The ZN1066E/ZN1066J is a switching regulator control and drive unit which provides all the control and safety features for pulse width modulated push-pull, bridge, series and single ended switching mode power supplies, motor speed control, inverters and general power control applications including thyristor and triac circuits.

The device is designed to supply the pulse width modulated drive to the base of two external power transistors.

FEATURES

- Voltage reference
- 2 operational amplifiers
- Precision oscillator
- Pulse width modulator
- Pulse steering flip-flop
- Dual alternative output switches
- Dynamic current limiting and shut down circuitry
- Inherently hardened to Nuclear Radiation
- Full military performance: ZN1066J (24 lead ceramic H24)
- 24 lead moulded DIL (E24)



System Diagram

TV SYNCHRONISING PULSE GENERATOR

ZNA134H

The ZNA134H integrated circuit utilises a 2.5625MHz* crystal to generate all the horizontal, vertical, mixed blanking and synchronising pulses necessary for raster generation in 625 or 525 line commercial, industrial or military television systems. The synchronous dividers and decoding logic employed within the unit ensure perfect interlace, together with spike-free output waveforms having precisely defined relative positions and pulse widths. The device is contained within a 16 lead ceramic DIL (H16).

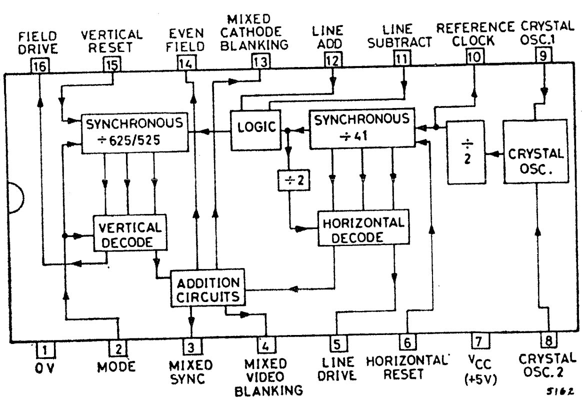
A selected version, the ZNA134H-RED is available for operation over the military temperature range.

The device is also available with BSS2 screening on special request.

*Dependent on line system used, series resonant.

FEATURES

- 625 and 525 line standards
- CCIR and EIA standard outputs
- Single 5 volt supply, fully TTL compatible
- Easy synchronising between generators
- Direct reset to vertical and horizontal counters
- Facility for adding and subtracting lines
- Automatic interlacing
- On-chip oscillator (requiring external crystal)
- Can be driven with an external oscillator
- Field reference output



System Diagram

TV CROSSHATCH GENERATOR

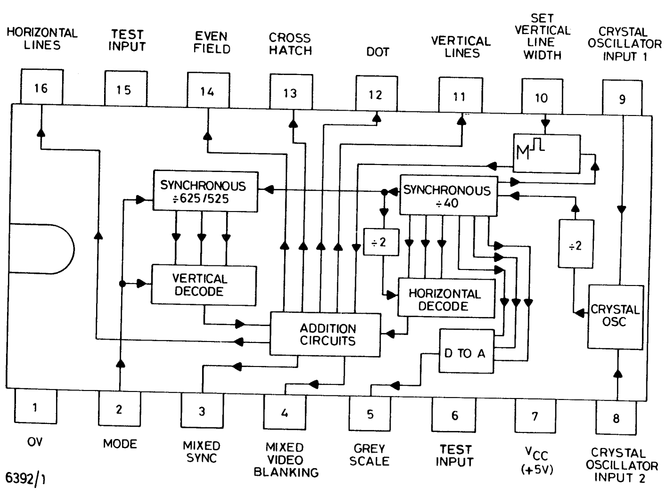
ZNA234E

The ZNA234 integrated circuit makes available all the waveforms necessary to produce crosshatch, dot and greyscale test patterns on a television screen. All that is required is a 2.5MHz crystal (or external oscillator) and a minimum of external components for mixing the video, sync and blanking pulses to give a composite video signal. This can either be injected directly into the video stages of a receiver, or used to drive a UHF modulator/oscillator for connection to the aerial socket. The device is contained within a 16 lead DIL moulded package (E16).

The device is also available in a ceramic package for military temperature range applications.

FEATURES

- Single 5 volts supply
- 625 or 525 line operation
- Sync and blanking outputs to CCIR or EIA standard
- On-chip oscillator can be driven by external oscillator
- Field reference output
- Direct reset to vertical and horizontal counters
- Adjustable line width
- Separate outputs for:
  - Crosshatch
  - Dot
  - Vertical lines
  - Horizontal lines
  - Greyscale
  - Mixed sync
  - Mixed video blanking



System Diagram

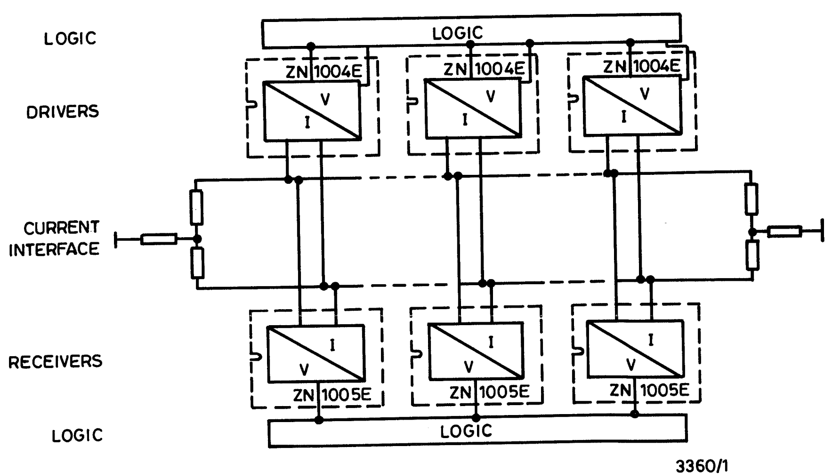
LINE DRIVER AND RECEIVER

ZN1004E
ZN1005E

The ZN1004E and ZN1005E have been designed for high speed data transmission between computers and remote peripheral equipment using twisted pair cable. The driver has two inputs, data and gate, and four outputs which sink current according to the input state. The receiver detects the low level signals from the line and restores them to TTL logic levels. Operating temperature range for both circuits is 0 to +70°C and the devices are contained in 14 lead moulded DIL packages (E14).

FEATURES

- Balanced data switching
- Balanced switching from driver to driver
- Bidirectional working
- Propagation delay, input of driver to output of receiver (zero line length), is 22ns typical
- High impedance to the line
- Fully TTL/DTL compatible



System Diagram

MONOSTABLE

HIGH PERFORMANCE MONOSTABLE

ZN1010
ZN2010

The ZN1010/ZN2010 are monolithic monostables which have complementary outputs capable of driving full fan-outs of 10 and which may be triggered from either positive or negative going input signals with inhibit and lock-out facilities. The input stage incorporates a Schmitt trigger — enabling the use of slow input edges.

The integrating mode timing operation and active capacitor discharge within the device ensures that a very high duty cycle may be achieved and no large transient currents are drawn from the supply rail. The recovery time is typically 1% of the timing period for a timing resistor of 10kΩ.

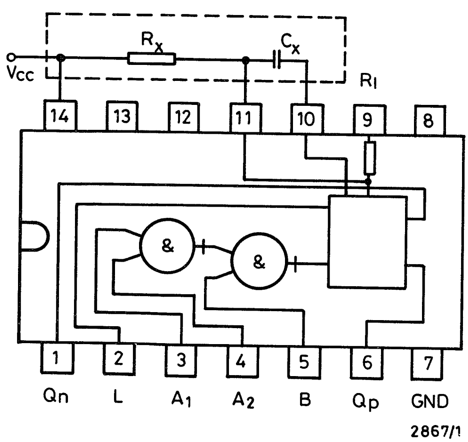
Internal compensation results in excellent pulse width stability with respect to temperature and supply voltage. Typical figures are: ±0.2% of the pulse width at 25°C over the temperature range 0 to +70°C, and a 0.25% variation over the supply voltage range +4.75V to +5.25V.

Operating temperature ranges: ZN1010 (0 to +70°C), ZN2010 (−55 to +125°C)

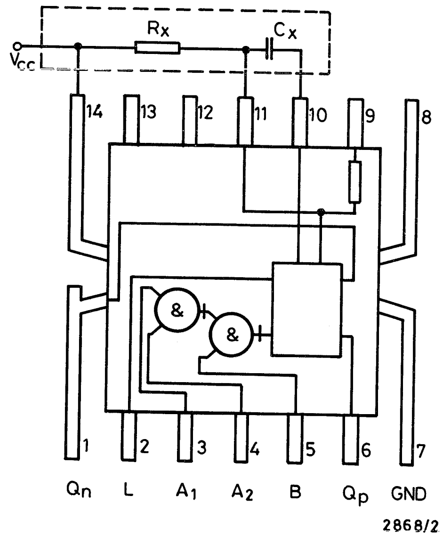
Device packages: ZN1010E/2010E — 14 lead moulded DIL (E14), ZN1010F/2010F — 14 lead ceramic flat-pack (F14)

FEATURES

- Optional lock-out facility
- Excellent pulse width, stability with temperature and supply voltage
- High duty cycle, typically 99.7%
- Fully TTL compatible
- Available in 2 package styles



ZN1010E/2010E



ZN1010F/2010F

Logic Diagram

A_1, A_2 } Negative edge triggered inputs
B Positive edge triggered inputs
L Lock-out facility

Q_n Negative-going output
Q_p Positive-going output
R_I Internal Timing Resistor

STORE INTERFACE

ZN1025E/F

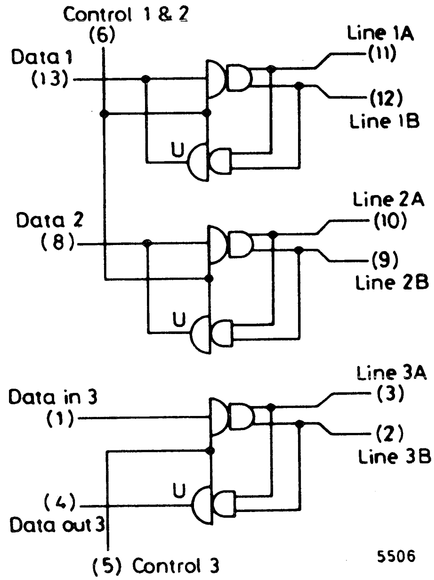
The ZN1025 is basically a triple line-driver/receiver designed for interfacing between control processor units on a common biased highway. The device operates at very fast speeds giving a typical delay, between the input of the transmitter and the output of the receiver, of 22ns. This, combined with low power dissipation, TTL compatibility and small package size makes the circuit ideal for fast, compact computer systems.

The transmitter will transmit a balanced signal, suitable for twisted pair or ribbon cable, over a maximum distance of 50 metres. the receiver is capable of withstanding common mode voltages of up to 1 volt.

The circuit is available in either 14 lead moulded DIL (E14) or ceramic flat-pack (F14).

FEATURES

- Extremely fast: 22ns typical
- Low power dissipation; 250mW typical
- Single 5V supply
- Fully TTL compatible
- Military operating temperature range −40 to +85°C



Logic Diagram

INTERFACE CIRCUITS

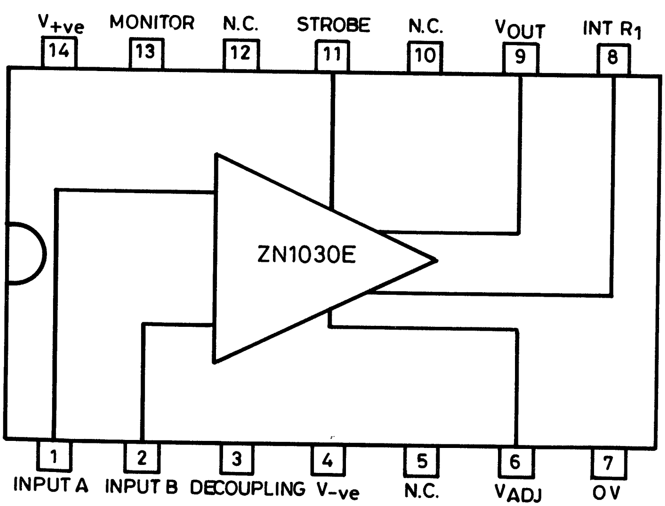
SENSE AMPLIFIER

ZN1030E

The ZN1030E is a monolithic integrated circuit designed specifically for use in core stores. The device features an external threshold adjustment facility and a built-in reference voltage. The output current capability of the device is 26mA into a 150Ω load and the circuit exhibits a typical input/output delay of 10ns. The device is contained in a 14 lead moulded DIL package (E14).

FEATURES

- Input/output delay of 10ns
- External threshold adjustment facility
- No external components to supply reference



3224/2

ARGUS 16-BIT MILITARY MICROPROCESSOR

ADVANCE INFORMATION

- High performance — operating speed over 1.4MPS
- Low power consumption
- Reduced space and weight demand
- High resistance to radiation damage

Argus M700/40 will be the firs processor in the Argus M700 range to be implemented entirely in LSI form and will significantly enhance the power and versatility of Argus M700 based systems.

Developed as part of the Argus M700 Military Computer System, the Argus M700/40 Military Microprocessor will be fully compatible with all other Ferranti Argus M700 series products. Argus M700/40 can therefore replace other M700 processors in existing systems as well as forming the basis of new configurations.

Argus M700/40 is a high performance microprocessor that executes the full M700 instruction set, providing bit, byte, field and word operation along with hardware double length and floating point arithmetic. High operating speed is achieved for all instructions including multiply/divide operations in both single and double length format, to give an overall operating speed in excess of 1.4MIPS.

Argus M700/40 combines sophisticated VLSI array based circuit design with advanced hybrid techniques to give high performance with low power consumption and compact dimensions. M700/40 dissipates 4 Watts typical, 6 Watts maximum, from the 2.5V and 5V power supplies. The microprocessor is to be supplied as a single hybrid package measuring only 61mm × 89mm.

Argus M700/40 can be used in all naval, land mobile and avionic applications and will be available to full military temperature range (−55°C to +125°C) specification. The M700/40 package contains 4 LSI circuits mounted in 84 pin leadless ceramic chip carriers, and is conformally coated to BS9450 and can be cooled either by convection (air blown) or conduction.

The 4 LSI circuits used in Argus M700/40 are manufactured using the advanced Ferranti FAB-2 bipolar process. This process not only gives high performance and low power consumption but also ensures intrinsically high levels of immunity to radiation damage. Argus M700/40 meets all relevant nuclear hardness specifications.

For detailed information on Argus M700/40 systems please cotact:

Ferranti Computer Systems Limited, Computer Sales Department, Ty Coch Way, Cwmbran, Gwent, NP44 7XX   TEL: CWMBRAN (06333) 71111   TELEX: 497636

F100-L 16-BIT MICROPROCESSOR SYSTEM

The F100-L family of LSI bipolar parts operate from a single 5V supply and are fully TTL compatible. All devices are available in commercial (C suffix) and military (A suffix) temperature range versions and also in most cases to BS and BSS2 specifications.

In the majority of cases all devices are available in ceramic dual in-line packages (J suffix) and leadless ceramic chip carriers (K or M suffix). The interface set (F111-L and F112-L) is also available in plastic package (E suffix) for operation over the commercial temperature range only.

As an example an F100-L-AJ-BSS2 is a military temperature range device in a ceramic dual in-line package to BS9000 category S2.

F100-L 16-BIT MICROPROCESSOR

The Ferranti Computer Systems F100-L is the first Microprocessor to be wholly designed and manufactured in Europe, and has been designed as one part of an overall system concept. The F100-L features a comprehensive instruction set of 153 instructions and its structure has been chosen to provide the facilities necessary to enable fast, real-time systems, as well as less complex applications to be developed in the most simple, straightforward manner possible.

The Ferranti Electronics bipolar process used for this device ensures fast instruction times and has the added advantage of possesing a high degree of radiation tolerance which is of paramount importance in modern military and space oriented projects.

The microprocessor is encapsulated in a 40 lead DIL package (J40) or a 40 pad ceramic chip carrier (K40).

MICROPROCESSOR SUPPORT CHIPS

Complete system implementation can be performed using combinations of the following devices:

CLOCK GENERATOR ZN1001

A general purpose oscillator requiring only a crystal to define the clock rate, and a resistor-capacitor to set the width of the clock pulse. The device can be used to drive the F100-L, F101-L and F200-L.

The clock generator is encapsulated in a 16 lead DIL package (J16) or a 20 pad ceramic chip carrier (M20).

MULTIPLY AND DIVIDE UNIT F101-L

A single chip device that interfaces directly to the F100-L, providing full signed 2's-complement multiply and divide functions in a 40 lead ceramic DIL package (J40) or a 40 pad ceramic chip carrier (K40).

INTERFACE SET F111-L AND F112-L

An interface set of one F111-L (Control Interface) and two F112-L's (Data Interface) used to connect any system device to the Input/Output Bus. The Interface Set has five modes of operation covering all aspects of system interfacing including DMA channel control. F112-L devices incorporate high current bus drivers enabling a terminated bus to be used. Both devices are encapsulated in 40 lead DIL packages (E40), (H40) or a ceramic carrier (K40).

F100-L 16-BIT MICROPROCESSOR SYSTEM

MEMORY INTERFACES F113-L and F114-L

For the small system using only memory and memory-mapped input/output the Memory Interfaces provide direct control of RAM and ROM and include two sets of timing circuits and generate the necessary control signals (e.g. $\overline{\text{Write}}$, $\overline{\text{Memory Enable}}$) for connection to two speeds of memory.

The choice of device depends on the memory system being used:

F113-L High Speed Interface
F114-L Medium Speed Low Power version
Both types are encapsulated in 24 lead DIL packages (H24 or ceramic chip carriers (M24)

REAL TIME INTERRUPT CHIPS F115-L and F117-L

The F115-L has an on-chip oscillator and when used with an external crystal can generate real time interrupts at any of fifteen rates selectable by hardwiring or software control. An external device can also generate interrupts using the F115-L logic.

Full vectoring capability is provided, enabling the F100-L to differentiate between real time interrupts, external device interrupts, and interrupts generated by other external devices not connected to the F115-L. The F115-L is encapsulated in a 24 lead package (H24).

The F117-L Two Channel interrupt controller provides full vectored interrupt capability for two external devices connected to an F100-L system. On receiving an interrupt accept signal the device will pass vector data, via the bus, to the F100-L program counter and remove vector data from the bus once the counter is loaded.

The F117-L has an on-chip oscillator for use with an external crystal and provides a buffered clock output plus a half clock frequency output.

The device is supplied in a 24 lead package (H24).

F100 PROCESSOR HYBRID FBH5092

This thick film module contains an F100-L Microprocessor, F101-L Multiply and Divide Unit, Clock Generation, and two F112-L Data Interfaces acting as buffers to drive the F100-L bus. The active LSI components are packaged in leadless ceramic chip carriers which are soldered to the ceramic (alumina) substrate of the 64 lead hybrid assembly.

Using the Processor Hybrid saves approximately half of the board area normally occupied by DIL's and therefore offers significant savings in applications where space is at a premium. The unit also reduces the number of soldered joints required and, of course, has the advantage in that it can be pretested to the required specification.

F200-L 16-BIT MICROPROCESSOR SYSTEM

- High performance — operating speed over 300 KIPS
- On-chip multiply/divide
- Address range from 64K to 1 Megaword
- Compatibility with F100 Microprocessor System
- Severe environmental specification includes radiation hardness

F200-L, the advanced successor to the F100-L microprocessor has been developed in response to the increasingly stringent requirements of real-time environment operation. The next generation of industrial, scientific, defence and aerospace systems will demand even higher processing power coupled with the highest levels of reliability under adverse conditions. F200-L will meet these requirements, offering an excellent combination of performance, versatility, ruggedness and total system compatibility.

The 16-bit F200-L will execute a comprehensive real-time instruction set that is orientated to programming in a high level language. The set incorporates arithmetic and logical operations along with jump, shift, bit manipulation and multi-length instructions giving an operating speed of over 300 KIPS. The instruction set also includes multiply/divide instructions which support F200-L's high speed on-chip multiply/divide facility, a major feature of the design.

F200-L can independently access a total of 64k words of RAM/ROM, an ideal total for small scale embedded system applications. For larger systems or in situations where a large memory is desirable the F200-L can address up to a Megaword, organised on a memory paged basis, via the F220-L Memory Paging Controller.

The high performance and extensive addressing facilities of F200-L are matched by an outstanding tolerance to environmental factors and a high quality of manufacture. F200-L features a true hard environment specification that not only includes a wide operating temperature range and excellent resistance to shock and vibration but also a high degree of immunity to radiation damage. F200-L is a bipolar microprocessor, fabricated with the advanced FAB-2 process which gives an intrinsically high level of radiation hardness, a feature of particular importance in many space and defence applications.

F200-L will be available in both commercial 0°C to 70°C and Full Military −55°C to +125°C temperature range versions and will also be released to BS9000 quality approval including full assessment and BS level S2.

Encapsulated in a 40-pin Ceramic package (J40) the F200-L shares the same pin-outs as its predecessor the F100-L, and is in all other respects fully compatible with the hardware and software items of the F100 product range. F200-L uses the same input/output bus, can interface to the same F100 series support chips and can run identical software. Despite the great increase in performance compared to F100-L, power consumption has been kept to 1W from a single +5V power supply allowing F200-L to be substituted for F100-L in existing systems.

For Hybrid use the F200-L is also available in a 48 pad ceramic chip carrier. For details contact Ferranti Computer Systems.

F200-L 16-BIT MICROPROCESSOR SYSTEM

F220-L

- Supports F200-L microprocessor
- One megaword addressing capability
- Severe environmental specification includes radiation hardness

The F220-L Memory Paging Controller has been designed for operation under adverse conditions in a wide range of industrial, scientific, defence and aerospace applications. F220-L will be available in a choice of temperature ranges including commercial 0°C to 70°C and Full Military −55°C to +125°C and will also be supplied to BS9000 Full Assessment and Level S2 quality standards.

The F220-L is fabricated using the advanced FAB-2 bipolar process and therefore combines high operating speed with an outstanding level of radiation hardness, a feature of particular significance in defence and aerospace systems.

F220-L has been designed for a high degree of commonality with the existing F100 product range, and uses the same F100 input/output bus, the same control signals and can interface to standard F100 card modules.

The F220-L Memory Paging Controller is a special purpose unit that increases the addressing capability of F200-L. F200-L, the latest microprocessor from Ferranti Computer Systems is a high performance design with a basic addressing range of 64K. F220-L dramatically increases this range, enabling F200-L to access a total of up to one megaword.

F200 memory can be organised as a page system with one base page and up to 31 other pages, each consisting of a 32K memory block. F220-L is connected to each of these memory pages via page enable lines. In a simple configuration F220-L will access the base page and five other pages. F220-L can access all 32 pages, to give a total one megaword, when external decode logic is added to the system.

F220-L can also provide paged addressing for up to 6 input/output modules in the system, which interface to the Memory Paging Controller via the DMA daisy chain. The ability of F220-L to handle memory requests from both the F200-L and input/output peripherals is a significant advantage to the designer, greatly simplifying the configuration of sophisticated real-time systems.

F100 SOFTWARE

There is a comprehensive set of program development and testing aids for use with F100 Systems:

Cross Product Development Software
Resident Development Software
Coral 66 Compiler
Subroutine Library
Hardware Test Programs

For detailed information on the F100-L and F200-L Microprocessor system please contact:

Ferranti Computer Systems Limited,
Computer Sales Department,
Ty Coch Way,
Cwmbran,
Gwent, NP44 7XX
TEL: CWMBRAN (06333) 71111
TELEX: 497636

THE EUROBUS SYSTEM

The Eurobus is an advanced, real-time computer bus, processor independent by virtue of a central arbitration facility. It is supported by special LSI interface circuits, enabling special purpose computer modules to be developed for specific applications.

The technical implementation of Eurobus has been carried out by Ferranti Computer Systems on behalf of the Ministry of Defence and has resulted in the design of an Interface Set (consisting of two device types), an Interrupt Vector Chip and an Arbiter Chip. These devices are usually used in a rack backplane system in order to interface processor cards, memory cards and peripheral interface cards which are plugged into the rack.

Although suitable for all systems the Eurobus approach is particularly relevant to a modular building block approach to system construction. In this way the designer can exploit the range of computer modules to build systems of all levels of complexity from simple stand alone computers to subsystems of complex distributed processing networks. The Ferranti Argus M700 is a computing system based on Eurobus.

The Argus M700 is a high performance Military Computer System developed from the Ferranti Argus 700 series of civil computers to meet the needs of the UK Ministry of Defence. It is now a preferred system for UK defence projects and, being suitable for use in military environments, has been selected by the Royal Air Force, the Royal Navy and the British Army in new defence systems.

See page IC71 for futher details Argus M700.

EUROBUS INTERFACE SET

In a 16-bit system an interface set will consist of one Control Chip and two Data Chips.

The Control Chip (type ZN1008) provides the relevant signals for the data Chips, Eurobus and device interfaces. The Control Chip handles DMA and program interrupts, interfaces to the Bus Arbiter for bus allocation and has the bus de-allocation facility required for multi-bus Argus M700 systems.

The Data Chip (type ZN1009) handles 8-bits of parallel Eurobus data/address for each device, and has tristate device highway drivers, address recognition logic and master and slave address registers. The chip also has an output data latch for master write cycles and a by-pass data path for slave read cycles.

The interface set is available to the commercial temperature range (ZN1008CJ, ZN1009CJ), military temperature range (ZN1008AJ, ZN1009AJ). Both devices are encapsulated in 40 lead ceramic packages (J40). Chip carrier versions are also available (K40). The intention is to offer BSS2 versions in ceramic dual in line in the near future.

INTERRUPT VECTOR CHIP (ULA5C038)

This circuit enables peripherals on the Eurobus to interrupt a processor directly with a vector cycle instead of an indirect interrupt via the Bus Arbiter. It contains a status register, logic to control the vector cycles of the interrupt process and counters to assist DMA transfers.

The chip greatly simplifies the design of peripheral interface units which require interrupt or DMA facilities. The device is encapsulated in a 40 lead ceramic pack (J40) to commercial or military temperature range specification (ULA5C038CJ and ULA5C038AJ) respectively.

EUROBUS ARBITER CHIP (ULA5C054)

This device implements the full range of Eurobus arbitration facilities and controls the ordered use of the Eurobus by up to 8 masters, one or more of which may be bus linkers controlling interbus transfers. The Arbiter detects interrupts from each master and also multiplexes power fail, Eurobus fail and external interrupt signals. In the case of a clash of requests the Arbiter Chip allocates the bus in accordance with a pre-defined priority structure.

The device is available in a 40 lead pack (J40) for commercial (ULA5C054CJ) or military (ULA5C054AJ) temperature range use.

For detailed information on Eurobus and Argus M700 systems please contact:
Ferranti Computer Systems Limited, Computer Sales Department, Ty Coch Way, Cwmbran, Gwent, NP44 7XX TEL: CWMBRAN (06333) 71111 TELEX: 497636

SECTION 3 : DISCRETE COMPONENTS

1 E-LINE TRANSISTORS (TO-92 STYLE – UP TO 1.5W)

2 METAL CAN TRANSISTORS (SMALL SIGNAL – UP TO 2.5W)

3 MOSFETS

4 POWER TRANSISTORS

5 SURFACE MOUNTED AND HYBRID DEVICES SOT-23, MULTICHIP, DICE

6 FSD1001

7 R.F. TRANSISTORS AND DIODES

8 OPTO ELECTRONICS

9 DIODES (ALL TYPES)

E-LINE (TO-92 STYLE) TRANSISTORS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

TAPED PRODUCT (Page E11)

E-line transistors can be supplied on tape for automatic insertion. Two types of packaging are available.

(a) Devices mounted on tape and then put on a reel which is then overpacked in a cardboard box.

(b) Devices mounted on tape and then folded in a concertina (or Z) form directly into a cardboard box (Ammo Pack).

LEAD CONFIGURATIONS

The alternative lead configurations are denoted by a suffix such as K, L, M or S at the end of the part number.

The available lead formations may be listed as:

IN-LINE	no suffix
TO-5/39 pin circle	suffix K
TO-18 pin circle	suffix L
Flat mounting	suffix M + V
In-line wide-spacing	suffix S

TABLE 1 : NPN GENERAL PURPOSE

The devices shown in this table are general purpose transistors designed for small and medium signal amplification from d.c. to radio frequencies. Typical application areas include: AUDIO FREQUENCY AMPLIFIERS, DRIVERS and OUTPUT STAGES, OSCILLATORS, AND GENERAL PURPOSE SWITCHES.

Type	V_{CBO}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	P_{tot} at $T_{amb}=25°C$	Complement
	V	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	MHz	I_C mA	mW	
ZTX453	120	100	1000	0.7	150	15	40	200	150	150	50	1000	—
ZTX452	100	80	1000	0.7	150	15	40	150	150	150	50	1000	ZTX552
MPSA06	80	80	500	0.25	100	10	50	—	100	100	10	750	MPSA56
BC546P	80	65	200	0.25	10	0.5	75	200	2	300*	10	500	BC556P
ZTX451	80	60	1000	0.35	150	15	50	150	150	150	50	1000	ZTX551
BFS61	80	60	1000	0.35	150	15	40	160	150	150	50	500	BFS98
MPS2222A	75	45	800	1.0	500	50	100	300	150	300	20	500	MPS2907A
ZTX304	70	70	500	0.35	50	5	50	300	10	150	10	300	ZTX504
MPSA05	60	60	500	0.25	100	10	50	—	100	100	10	750	—
BCY65EP	60	60	100	0.35	10	0.25	120	460	2	125	10	1000†	BCY77P
BC182P	60	50	200	0.25	10	0.5	100	480	2	150	10	300	BC212P
ZTX107	60	50	100	0.1*	10	1	125	500	2	350*	10	300	ZTX212
ZTX450	60	45	1000	0.25	150	15	100	300	150	150	50	1000	ZTX550
BFS60	60	40	1000	0.25	150	15	100	300	150	150	50	500	BFS97
2N4401	60	40	600	0.4	150	15	100	300	150	250	20	500	2N4403
2N4400	60	40	600	0.4	150	15	50	150	150	200	20	500	2N4402
2N3904	60	40	200	0.2	10	1	100	300	10	300	10	500	2N3906
2N3903	60	40	200	0.2	10	1	50	150	10	250	10	500	2N3905
BFS59	60	30	1000	0.35	150	15	40	300	150	150	50	500	BFS96
MPS2222	60	30	800	1.6	500	50	100	300	150	250	20	500	MPS2907
BC547P	50	45	200	0.25	10	0.5	75	450	2	300*	10	500	BC557P
ZTX382	50	45	200	0.25	10	0.5	100	850	2	150	10	350	—
BC107P	50	45	200	0.2	10	0.5	120	460	2	150	10	300	BC177P
BC237P	50	45	200	0.2	10	0.5	120	460	2	150	10	300	BC307P
ZTX237	50	45	200	0.25	10	0.5	120	460	2	150	10	300	ZTX212
ZTX223	50	30	800	0.3	100	10	100	450	50	100	50	500	—
ZTX303	45	45	500	0.35	50	5	50	300	10	150	10	300	ZTX503
BCY59P	45	45	200	0.35	10	0.25	120	630	2	125	10	1000†	BCY79P
ZTX238	45	30	200	0.25	10	0.5	120	800	2	150	10	350	ZTX213
ZTX383	45	30	200	0.25	10	0.5	100	850	2	150	10	350	—
ZTX384	45	30	200	0.25	10	0.5	250	—	2	150	10	350	—
BC183P	45	30	200	0.25	10	0.5	100	850	2	150	10	300	BC213P
ZTX108	45	30	100	0.1*	10	1	125	900	2	350*	10	300	ZTX213
2N4123	40	30	200	0.3	50	5	50	150	2	250	10	500	2N4125
ZTX302	35	35	500	0.25	50	5	100	300	10	150	10	300	ZTX502
ZTX301	35	35	500	0.25	50	5	50	300	10	150	10	300	ZTX501
BCY58P	32	32	200	0.35	10	0.25	120	630	2	125	10	1000†	BCY78P
BC548P	30	30	200	0.25	10	0.5	75	800	2	300*	10	500	BC558P
2N4124	30	25	200	0.3	50	5	120	360	2	300	10	500	2N4126
BC108P	30	20	200	0.2	10	0.5	120	800	2	150	10	300	BC178P
BC238P	30	20	200	0.2	10	0.5	120	800	2	150	10	300	BC308P
ZTX300	25	25	500	0.35	10	1	50	300	10	150	10	300	ZTX500
MPSA20	—	40	100	0.25	10	1	40	400	5	125	5	500	—

*Typical †$T_{case} = 45°C$

TABLE 2 : PNP GENERAL PURPOSE

The devices shown in this table are general purpose transistors designed for small and medium signal amplification from d.c. to radio frequencies. Typical application areas include: AUDIO FREQUENCY AMPLIFIERS, DRIVERS and OUTPUT STAGES, OSCILLATORS, AND GENERAL PURPOSE SWITCHES.

Type	V_{CBO}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	P_{tot} at T_{amb} = 25°C	Complement
	V	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	MHz	I_C mA	mW	
ZTX553	120	100	1000	0.7	150	15	40	200	150	150	50	1000	ZTX453
ZTX552	100	100	1000	0.7	150	15	40	150	150	150	50	1000	ZTX452
MPSA56	80	80	500	0.25	100	10	50	—	100	100	10	750	MPSA06
BC556P	80	65	200	0.25	10	0.5	75	450	2	150*	10	500	BC546P
ZTX551	80	60	1000	0.35	150	15	50	150	150	150	50	1000	ZTX451
BFS98	80	60	1000	0.35	150	15	40	160	150	150	50	500	BFS61
ZTX504	70	70	500	0.6	50	5	50	300	10	150	10	300	ZTX304
MPS2907A	60	60	600	1.6	500	50	100	300	150	200	50	500	MPS2222A
MPSA55	60	60	500	0.25	100	10	50	—	100	100	10	750	MPSA05
BCY77P	60	60	100	0.25	10	0.25	120	460	2	180*	10	1000†	BCY65EP
ZTX212	60	50	200	0.25	10	0.5	60	400	2	200	10	500	ZTX107
BC212P	60	50	200	0.6	100	5	60	400	2	200	10	300	BC182P
ZTX550	60	45	1000	0.25	150	15	100	300	150	150	50	1000	ZTX450
BFS97	60	40	1000	0.25	150	15	100	300	150	50	150	500	BFS60
MPS2907	60	40	600	1.6	500	50	100	300	150	200	50	500	MPS2222
BFS96	60	30	1000	0.35	150	15	40	300	150	150	50	500	BFS59
BC557P	50	45	200	0.25	10	0.5	75	450	2	150*	10	500	BC547P
BC177P	50	45	200	0.2	10	0.5	120	460	2	130	10	300	BC107P
BC307P	50	45	200	0.2	10	0.5	120	460	2	130*	10	300	BC237P
BCY70P	50	40	200	0.5	50	5	100	—	10	250	10	350	—
BCY71P	45	45	200	0.5	50	5	100	400	10	15	0.1	350	—
ZTX503	45	45	500	0.35	50	5	50	300	10	150	10	300	ZTX303
ZTX531	45	45	500	0.7	10	0.5	40	120	0.01	30	0.5	250	ZTX331
BCY79P	45	45	200	0.25	10	0.25	120	460	2	180*	10	1000†	BCY59P
ZTX213	45	30	200	0.25	10	0.5	80	550	2	200	10	500	ZTX108
BC213P	45	30	200	0.6	100	5	80	600	2	200	10	300	BC183P
2N4403	40	40	600	0.4	150	15	100	300	150	200	20	500	2N4401
2N4402	40	40	600	0.4	150	15	50	150	150	150	20	500	2N4400
2N3906	40	40	200	0.25	10	1	100	300	10	250	10	500	2N3904
2N3905	40	40	200	0.25	10	1	50	150	10	200	10	500	2N3903
ZTX502	35	35	500	0.25	50	5	100	300	10	150	10	300	ZTX302
ZTX501	35	35	500	0.25	50	5	50	300	10	150	10	300	ZTX301
BCY78P	32	32	200	0.25	10	0.25	120	630	2	180*	10	1000†	BCY58P
ZTX530	30	30	500	0.7	10	0.5	100	400	0.1	30	0.5	250	ZTX330
BC558P	30	30	200	0.25	10	0.5	75	800	2	150*	10	500	BC548P
2N4125	30	30	200	0.4	50	5	50	150	2	200	10	500	2N4123
BC178P	30	25	200	0.2	10	0.5	120	800	2	130	10	300	BC108P
BC308P	30	25	200	0.2	10	0.5	120	800	2	130*	10	300	BC238P
BCY72P	30	25	200	0.5	50	3	100	—	10	250	10	350	—
ZTX500	25	25	500	0.35	50	5	50	300	10	150	10	300	ZTX300
2N4126	25	25	200	0.4	50	5	120	360	2	250	10	500	2N4124

*Typical   †T_{case} = 45°C.

TABLE 3 : NPN SWITCHING

The transistors in this table are characterised for general medium/high speed switching applications and other application areas, e.g. high speed core driving.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	Max. Switching Times		at	Complement
	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	MHz	I_C mA	t_{on} ns	t_{off} ns	I_C mA	
BCY65EP	60	100	0.35	10	0.25	120	460	2	125	10	150	800	10	BCY77P
MPS3642	45	500	0.22	150	15	40	120	150	—	—	14	80	300	—
BCY59P	45	200	0.35	10	0.25	120	630	2	125	10	150	800	10	BCY79P
ZTX360	40	1000	0.6	500	50	25	150	560	200	50	40	75	500	—
MPS2222A	40	800	1.0	500	50	100	300	150	300	20	35	285	150	MPS2907A
2N4401	40	600	0.4	150	15	100	300	150	250	20	35	255	150	2N4403
2N4400	40	600	0.4	150	15	50	150	150	200	20	35	255	150	2N4402
2N3904	40	200	0.2	10	1	100	300	10	300	10	70	250	10	2N3906
2N3903	40	200	0.2	10	1	50	150	10	250	10	70	225	10	2N3905
BCY58P	32	200	0.35	10	0.25	120	630	2	125	10	150	800	10	BCY78P
MPS2222	30	800	1.6	500	50	100	300	150	250	20	35	285	150	MPS2907
2N4123	30	200	0.3	50	5	50	150	2	250	10	37*	136*	10	2N4125
2N4124	25	200	0.3	50	5	120	360	2	300	10	37*	136*	10	2N4126
MPS706A	20	200	0.6	10	1	20	60	10	200	10	40	75	10	—
MPS706	20	200	0.6	10	1	20	50*	10	200	10	40	75	10	—
ZTX314	15	500	0.2	10	1	40	120	10	500	10	12	18	10	—
ZTX313	15	500	0.24	10	1	40	120	10	500	10	12	18	10	—
ZTX311	15	500	—	—	—	50	200	10	200	10	(note 1)			—
MPS2369A	15	200	0.25	10	1	40	120	10	—	—	12	18	10	—
MPS2369	15	200	0.25	10	1	40	120	10	—	—	12	18	10	—
ZTX312	12	500	0.24	10	1	40	—	10	400	10	15	20	10	—
ZTX310	12	500	0.6	10	1	20	—	10	200	10	(note 2)			—

*Typical   Note 1: $t_{stg} = 60$ns.   Note 2: $t_{stg} = 25$ns.

TABLE 4 : PNP SWITCHING

The transistors in this table are characterised for general medium/high speed switching applications and other application areas, e.g. high speed core driving.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE} at			Min f_T at		Max. Switching Times at			Complement
				I_C	I_B	Min	Max	I_C		I_C	t_{on}	t_{off}	I_C	
	V	mA	V	mA	mA			mA	MHz	mA	ns	ns	mA	
MPS2907A	60	600	1.6	500	50	100	300	150	200	50	50	110	150	MPS2222A
BCY77P	60	100	0.25	10	0.25	120	460	2	180*	10	85	150	10	BCY65EP
BCY79P	45	200	0.25	10	0.25	120	460	2	180*	10	85	150	10	BCY59P
2N4403	40	600	0.4	150	15	100	300	150	200	20	35	255	150	2N4401
2N4402	40	600	0.4	150	15	50	150	150	150	20	35	255	150	2N4400
MPS2907	40	600	1.6	500	50	100	300	150	200	15	50	110	150	MPS2222
2N3906	40	200	0.25	10	1	100	300	10	250	10	70	300	10	2N3904
2N3905	40	200	0.25	10	1	50	150	10	200	10	70	260	10	2N3903
BCY78P	32	200	0.25	10	0.25	120	630	2	180*	10	85	150	10	BCY58P
2N4125	30	200	0.4	50	5	50	150	2	200	10	43*	155*	10	2N4123
2N4126	25	200	0.4	50	5	120	360	2	250	10	43*	155*	10	2N4124
ZTX510	12	200	0.2	30	3	40	150	30	400	30	60	90	30	—

*Typical

TABLE 5 : NPN LOW NOISE

The transistors in this table are characterised for low noise, low level amplification and are ideally suited for audio pre-amplifiers as well as universal applications.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	Max. Noise Figure	at		Complement
	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	MHz	I_C mA	N dB	I_C μA	f Hz	
BCY65EP	60	100	0.35	10	0.25	120	460	2	125	10	6	200	1k	BCY77P
2N5209	50	50	0.7	10	1	100	300	0.1	30	0.5	3	200	30 – 15k	2N5086
2N5210	50	50	0.7	10	1	200	600	0.1	30	0.5	2	200	30 – 15k	2N5087
ZTX331	45	500	0.7	10	0.5	40	120	0.01	30	0.5	3*	10	1k	ZTX531
BC550P	45	200	0.25	10	0.5	200	800	2	300*	10	3	200	30 – 15k	BC560P
ZTX382	45	200	0.25	10	0.5	100	850	2	150	10	6	200	30 – 15k	–
BCY59P	45	200	0.35	10	0.25	120	630	2	125	10	6	200	1k	BCY79P
BC414P	45	100	0.25	10	0.5	200	800	2	250*	10	3	200	30 – 15k	BC416P
2N3904	40	200	0.2	10	1	100	300	10	300	10	5	200	30 – 15k	2N3906
2N3903	40	200	0.2	10	1	50	150	10	250	10	6	200	30 – 15k	2N3905
BCY58P	32	200	0.35	10	0.25	120	630	2	125	10	6	200	1k	BCY78P
ZTX330	30	500	0.7	10	0.5	100	400	0.1	30	0.5	3*	10	1k	ZTX530
BC549P	30	200	0.25	10	0.5	200	800	2	300*	10	4	200	30 – 15k	BC559P
ZTX239	30	200	0.25	10	0.5	180	800	2	150	10	4	200	30 – 15k	ZTX214
ZTX383	30	200	0.25	10	0.5	100	850	2	150	10	6	200	30 – 15k	–
BC184P	30	200	0.25	10	0.5	250	–	2	150	10	4	200	30 – 15k	BC214P
ZTX384	30	200	0.25	10	0.5	250	–	2	150	10	4	200	30 – 15k	–
2N4123	30	200	0.3	50	5	50	150	2	250	10	6	200	30 – 15k	2N4125
BC413P	30	100	0.25	10	0.5	200	800	2	250*	10	3	200	30 – 15k	BC415P
ZTX109	30	100	0.1*	10	1	240	900	2	350*	10	4	10	1k	ZTX214
2N4124	25	200	0.3	50	5	120	360	2	300	10	5	20	30 – 15k	2N4126
ZTX114	25	200	0.35	10	0.1	200	–	2	350*	10	3	30	1k	–
BC109P	20	50	0.2	10	0.5	180	800	2	300	10	4	200	30 – 15k	BC179P
BC239P	20	50	0.2	10	0.5	180	800	2	150	10	4	200	30 – 15k	BC309P

*Typical

TABLE 6 : PNP LOW NOISE

The transistors in this table are characterised for low noise, low level amplification and are ideally suited for audio pre-amplifiers as well as universal applications.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	Max. Noise Figure	at		Complement
	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	MHz	I_C mA	N dB	I_C µA	f Hz	
BCY77P	60	100	0.25	10	0.25	120	460	2	180*	10	6	200	1k	BCY65EP
2N5086	50	50	0.3	10	1	150	500	0.1	40	0.5	3	200	30 – 15k	2N5209
2N5087	50	50	0.3	10	1	250	800	0.1	40	0.5	2	200	30 – 15k	2N5210
ZTX531	45	500	0.7	10	0.5	40	120	0.1	30	0.5	3*	100	1k	ZTX331
BCY71P	45	200	0.5	50	5	100	400	10	15	0.1	2	100	30 – 15k	–
BC560P	45	200	0.25	10	0.5	110	800	2	300*	10	2	200	30 – 15k	BC550P
BCY79P	45	200	0.25	10	0.25	120	460	2	180*	10	6	200	1k	BCY59P
BC416P	45	100	0.3	10	0.5	110	800	2	200*	10	2	200	30 – 15k	BC414P
BCY70P	40	200	0.5	50	5	100	–	10	250	10	6	100	30 – 15k	–
2N3906	40	200	0.25	10	1	100	300	10	250	10	4	200	30 – 15k	2N3904
2N3905	40	200	0.25	10	1	50	150	10	200	10	5	200	30 – 15k	2N3903
BCY78P	32	200	0.25	10	0.25	120	630	2	180*	10	6	200	1k	BCY58P
ZTX530	30	500	0.7	10	0.5	100	400	0.1	30	0.5	3*	100	1k	ZTX330
ZTX214	30	200	0.25	10	0.5	140	550	2	200	10	2	200	30 – 15k	ZTX109
BC559P	30	200	0.25	10	0.5	110	800	2	300*	10	4	200	30 – 15k	BC549P
2N4125	30	200	0.4	50	5	50	150	2	200	10	5	200	30 – 15k	2N4123
BC214P	30	200	0.6	100	5	140	600	2	200	10	2	200	30 – 15k	BC184P
BC415P	30	100	0.3	10	0.5	110	800	2	200*	10	2	200	30 – 15k	BC413P
BCY72P	25	200	500	50	5	100	–	10	250	10	6	100	30 – 15k	–
2N4126	25	200	0.4	50	5	120	360	2	250	10	4	200	30 – 15k	2N4124
BC179P	20	50	0.2	10	0.5	180	800	2	130*	10	4	200	30 – 15k	BC109P
BC309P	20	50	0.2	10	0.5	180	800	2	130*	10	4	200	30 – 15k	BC239P

*Typical

TABLE 7 : NPN/PNP MEDIUM POWER

The transistors shown in this table have been designed to operate and provide useful gain at current levels up to 2 amps with power dissipation capabilities in excess of 1000 mW at 25°C ambient temperature.

Typical application areas include: Audio Frequency Drivers and Output Stages, Relay Switching, etc.

Type	V_{CBO} V	V_{CEO} V	Max Cont. I_C mA	Max $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min	h_{FE} Max	at I_C mA	Min f_T MHz	at I_C mA	P_{tot} at T_{amb} = 25°C mW	Complement
NPN													
ZTX455	160	140	1000	0.7	150	15	100	300	150	100	50	1000	—
ZTX454	140	120	1000	0.7	150	15	100	300	150	100	50	1000	—
ZTX653	120	100	2000	0.3	1000	100	100	300	500	100	100	1000	ZTX753
ZTX453	120	100	1000	0.7	150	15	40	200	150	150	50	1000	—
ZTX652	100	80	2000	0.3	1000	100	100	300	500	100	100	1000	ZTX752
ZTX452	100	80	1000	0.7	150	15	40	150	150	150	50	1000	—
MPSA06	80	80	500	0.25	100	10	50	—	100	100	10	750	MPSA56
ZTX651	80	60	2000	0.3	1000	100	100	300	500	100	100	1000	ZTX751
ZTX451	80	60	1000	0.35	150	15	50	150	150	150	50	1000	ZTX551
MPSA05	60	60	500	0.25	100	10	50	—	100	100	10	750	MPSA55
ZTX650	60	45	2000	0.3	1000	100	100	300	500	100	100	1000	ZTX750
ZTX450	60	45	1000	0.25	150	15	100	300	150	50	50	1000	ZTX550
ZTX337	50	45	800	0.7	500	50	100	630	100	200*	10	750	ZTX537
BC337P	50	45	800	0.7	500	50	100	630	100	100	10	625	BC327P
ZTX449	50	30	1000	0.5	1000	100	100	300	500	150	50	1000	ZTX549
ZTX338	30	25	800	0.7	500	50	100	630	100	200*	10	750	ZTX538
BC338P	30	25	800	0.7	500	50	100	630	100	100	10	625	BC328P
PNP													
ZTX753	120	100	2000	0.3	1000	100	100	100	500	75	100	1000	ZTX653
ZTX553	120	100	1000	0.7	150	15	40	200	150	150	50	1000	ZTX453
ZTX752	100	80	2000	0.3	1000	100	100	300	500	75	100	1000	ZTX652
ZTX552	100	80	1000	0.7	150	15	40	150	150	150	50	1000	ZTX452
MPSA56	80	80	500	0.25	100	10	50	—	100	100	10	750	MPSA06
ZTX751	80	60	2000	0.3	1000	100	100	300	500	75	100	1000	ZTX651
ZTX551	80	60	1000	0.35	150	15	50	150	150	150	50	1000	ZTX451
MPSA55	60	60	500	0.25	100	10	50	—	100	100	10	750	MPSA05
ZTX750	60	45	2000	0.3	1000	100	100	300	500	75	100	1000	ZTX650
ZTX550	60	45	1000	0.25	150	15	100	300	150	150	50	1000	ZTX450
ZTX537	50	45	800	0.7	500	50	100	630	100	200*	10	750	ZTX337
BC327P	50	45	800	0.7	500	50	100	630	100	100	10	625	BC337P
ZTX549	35	25	1000	0.5	1000	100	100	300	1000	100	100	1000	ZTX449
ZTX538	30	25	800	0.7	500	50	100	630	100	200*	10	750	ZTX338
BC328P	30	25	800	0.7	500	50	100	630	100	100	10	625	BC338P

*Typical

TABLE 8 : NPN/PNP HIGH PERFORMANCE TYPES

These transistors offer the ultimate performance for a TO-92 style package, and are suited to audio output stages, lamp driving, general switching applications etc.

Type	V_{CBO} V	V_{CEO} V	Max Cont I_C mA	Max I_{CM} A	Max $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min	h_{FE} Max	at I_C mA	Min f_T MHz	at I_C mA	P_{tot} at $T_{amb}=25°C$ mW	Complement
NPN														
ZTX657	300	300	500	1	0.5	100	10	50	—	100	30	10	1000	ZTX757
ZTX656	200	200	500	1	0.5	100	10	50	—	100	30	10	1000	ZTX756
ZTX655	150	150	1000	2	0.5	1000	200	50	—	500	30	10	1000	ZTX755
ZTX654	125	125	1000	2	0.5	1000	200	50	—	500	30	10	1000	ZTX754
ZTX653	120	100	2000	6	0.3	1000	100	100	300	500	100	100	1000	ZTX753
ZTX652	100	80	2000	6	0.3	1000	100	100	300	500	100	100	1000	ZTX752
ZTX651	80	60	2000	6	0.3	1000	100	100	300	500	100	100	1000	ZTX751
ZTX650	60	45	2000	6	0.3	1000	100	100	300	500	100	100	1000	ZTX750
ZTX649	35	25	2000	6	0.3	1000	100	100	300	1000	150	100	1000	ZTX749
PNP														
ZTX757	300	300	500	1	0.5	100	10	50	—	100	30	10	1000	ZTX657
ZTX756	200	200	500	1	0.5	100	10	50	—	100	30	10	1000	ZTX656
ZTX755	150	150	1000	2	0.5	1000	200	50	—	500	30	10	1000	ZTX655
ZTX754	125	125	1000	2	0.5	1000	200	50	—	500	30	10	1000	ZTX654
ZTX753	120	100	2000	6	0.3	1000	100	100	300	500	75	50	1000	ZTX653
ZTX752	100	80	2000	6	0.3	1000	100	100	300	500	75	50	1000	ZTX652
ZTX751	80	60	2000	6	0.3	1000	100	100	300	500	75	50	1000	ZTX651
ZTX750	60	45	2000	6	0.3	1000	100	100	300	500	75	50	1000	ZTX650
ZTX749	35	25	2000	6	0.3	1000	100	100	300	1000	100	100	1000	ZTX649

TABLE 9 : NPN DARLINGTON TYPES

The devices shown in this table are designed for applications requiring very high current gain. The monolithic construction has the inherent advantages of fast switching times, low saturation voltages and low leakage current.

Type	V_{CBO} V	V_{CEO} V	Max Cont I_C mA	Max $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min	h_{FE} Max	at I_C mA	Max. I_{CBO} nA	at V_{CB} V	P_{tot} at $T_{amb}=25°C$ mW
ZTX601	180	160	1000	1.2	1000	10	2K	100K	500	100	160	1000
ZTX600	160	140	1000	1.2	1000	10	2K	100K	500	100	140	1000
BCX38C	80	60	800	1.25	800	8	10K	—	500	100	60	1000
BCX38B	80	60	800	1.25	800	8	4K	—	500	100	60	1000
BCX38A	80	60	800	1.25	800	8	1K	—	500	100	60	1000
MPSA14	30	30	300	1.5	100	0.1	20K	—	100	100	30	750
MPSA13	30	30	300	1.5	100	0.1	10K	—	100	100	30	750
MPSA12	—	20	300	1	10	0.01	20K	—	10	100	15	750

TABLE 10 : NPN/PNP HIGH FREQUENCY

The devices shown in this table are designed for high frequency operation is such application areas as amplification, switching and oscillation.

The transistors marked with † are particularly suitable for use in RF and Video IF stages of television receivers where important characteristics include high frequency response, low feedback capacitance and low noise.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			Min f_T at		Max. Noise Figure at			Max. C_{obo} at 1 MHz		RF P_O or RF P_G at	
	V	mA	V	I_C mA	I_B mA	MHz	I_C mA	N dB	I_C µA	f MHz	pF	V_{CB} V	mW or dB	f MHz
NPN														
ZTX327	30	400	1.0	100	20	800*	25	—	—	—	3.0	30	350mW	400
BF196P†⊙	30	25	—	—	—	400*	4	3	4	35	1.3⊖	10	500mW	—
BF197P†§	25	25	—	—	—	550*	5	—	—	—	1.8⊖	10	500mW	—
ZTX320	15	500	0.4	10	1.0	600	4	<6	1	60	1.7	10	15dB	200
ZTX321	15	500	0.4	3.0	0.3	600	4	<6	1	60	1.7	10	15dB	200
ZTX322	15	500	0.4	10	1.0	600	4	<6	1	60	1.7	10	15dB	200
ZTX323	15	500	0.4	10	1.0	600	4	<6	1	60	1.7	10	15dB	200

*Typical

⊙C_{re} = 0.2pF (typical)

⊖Refers to C_{oe}

†Pin connections for these devices are: c – e – b

§C_{re} = 0.3pF (typical)

TABLE 11 : NPN/PNP HIGH VOLTAGE

The transistors shown in this table are designed for driving Numerical Indicator Tubes, Neon Lamps and other applications requiring high voltage capability at relatively low collector current or a high voltage complementary pair.

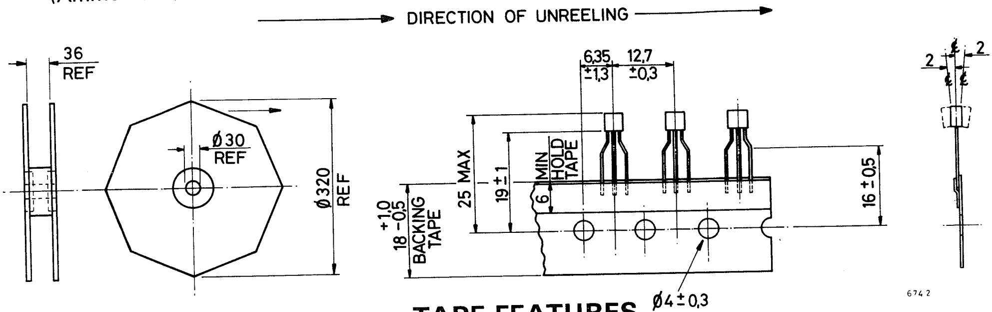
Type	V_{CBO}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Max I_{CBO} at		P_{tot} at T_{amb} = 25°C	Complement
	V	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	µA	V_{CB} V	mW	
NPN													
ZTX657	300	300	500	0.5	100	10	50	—	100	0.10	200	1000	ZTX757
MPSA42	300	300	500	0.5	20	2.0	40	—	10	0.10	200	680	MPSA92
BF393	300	300	500	2.0	20	2.0	40	—	10	0.10	200	625	BF493
BF392	250	250	500	2.0	20	2.0	40	—	10	0.10	200	625	BF492
ZTX656	200	200	500	0.5	100	10	50	—	100	0.10	160	1000	ZTX756
MPSA43	200	200	500	0.4	20	2.0	40	—	10	0.10	160	680	MPSA93
BF391	200	200	500	2.0	20	2.0	40	—	10	0.10	160	625	BF491
ZTX655	150	150	1000	0.5	1000	200	50	—	500	0.10	125	1000	ZTX755
ZTX654	125	125	1000	0.5	1000	200	50	—	500	0.10	100	1000	ZTX754
ZTX342	120	120	100	0.5	2	0.1	30	—	2	0.5	100	300	ZTX542
ZTX341	100	100	100	0.5	2	0.1	30	—	2	0.5	80	300	ZTX541
PNP													
ZTX757	300	300	500	0.5	100	10	50	—	100	0.10	200	1000	ZTX657
ZTX557	300	300	500	0.3	50	5.0	50	300	50	0.10	200	1000	—
MPSA92	300	300	500	0.5	20	2.0	40	—	10	0.25	200	680	MPSA42
BF493	300	300	500	2.0	20	2.0	40	—	10	0.10	200	625	BF393
BF492	250	250	500	2.0	20	2.0	40	—	10	0.10	200	625	BF392
ZTX756	200	200	500	0.5	100	10	50	—	100	0.10	160	1000	ZTX656
ZTX556	200	200	500	0.3	50	5.0	50	300	50	0.10	160	1000	—
MPSA93	200	200	500	0.4	20	2.0	40	—	10	0.25	160	680	MPSA43
BF491	200	200	500	2.0	20	2.0	40	—	10	0.10	160	625	BF391
ZTX755	150	150	1000	0.5	1000	200	50	—	500	0.10	125	1000	ZTX655
ZTX555	160	150	1000	0.3	100	10	50	300	300	0.10	140	1000	—
ZTX754	125	125	1000	0.5	1000	200	50	—	500	0.10	100	1000	ZTX654
ZTX554	140	125	1000	0.3	100	10	50	300	300	0.10	120	1000	—
ZTX542	120	120	100	0.5	2	0.1	30	—	2	0.5	100	300	ZTX342
ZTX541	100	100	100	0.5	2	0.1	30	—	2	0.5	80	300	ZTX341

TAPED PRODUCT

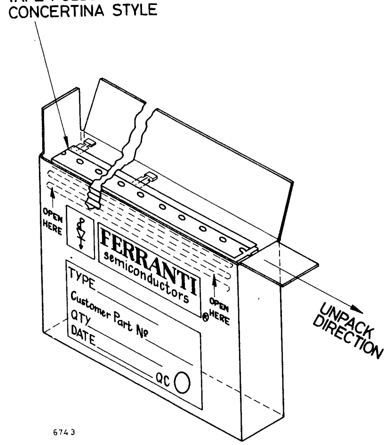
E-line transistors can be supplied on tape for automatic insertion. Two types of packaging are available:

(a) The tape, bearing the devices, is wound on a reel and supplied in a cardboard box.

(b) The tape, bearing the devices, is folded in a concertina (or Z) form and supplied in a cardboard box (Ammo Pack).



TAPE FOLDED IN CARTON CONCERTINA STYLE



TAPE FEATURES

- Each Reel or Box contains 2000 devices.
- No more than 2 consecutive vacant spaces on the tape.
- Minimum of 5 vacant spaces at beginning and end of tape.
- Available with choice of orientation

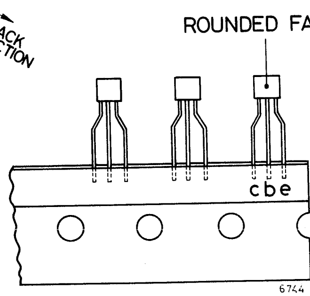
To order E-line transistors on tape, the following format should be used.

(a) Suffix 'STO' for product taped and put on reels.

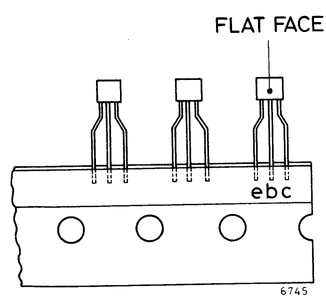
(b) Suffix 'STZ' for product taped and folded (Ammo Pack).

(c) Orientation (option A or B).

e.g. ZTX 650 STOA.



OPTION A



OPTION B

METAL CAN TRANSISTORS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

PLEASE NOTE:

LEAD LENGTH FOR TO-18 and TO-39 PRODUCTS

The standard lead length for our range of Metal Can Transistors is 12.7 mm (0.5 in),long lead version 38.1 mm (1.5 in.) can be supplied if specifically requested.

LEAD/CAN FINISH

The standard lead/can finish is tin plate.

The Ferranti range of Metal Can transistors is available to a wide range of Quality Assurance levels linked, in the main, to the British Standards scheme (BS 9000) for the qualification of electronic components of assessed quality and as such, devices are suitable for use in military, industrial and professional equipments.

Metal Can MOSFETs are curently available in a TO-39 package. Specific requirements for MOSFETs in a TO-18 package will be considered and evaluated.

The Metal Can MOSFET range is in general supplied to Def Stan 0521 Release with specific types being offered to BS/CECC approval. Full details are contained within the MOSFET Section of this publication.

NPN LOW LEVEL

TABLE 1 – NPN SILICON PLANAR LOW LEVEL TRANSISTORS

The devices shown in this table are low level transistors designed for small and medium signal, low and medium power amplification from DC to radio frequencies in Commercial, Industrial and Military equipments.

These transistors are particularly suitable for use as Audio Frequency Amplifiers, Driver and Output Stages, Oscillators and General Purpose Switches.

The devices are listed in order of decreasing Breakdown Voltages (V_{CB} and V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}) etc.

Type	V_{CB}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Min f_T at		P_{tot} at T_{amb} = 25°C	Package	Complement
	V	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	mW		
ZT92	120	100	1000	1.2	200	20	65	200	200	60	50	1000	TO-39	–
ZT91	120	100	1000	1.2	200	20	40	120	200	60	50	1000	TO-39	–
2N2405	120	90	1000	0.2	50	5	60	200	150	–	–	1000	TO-39	–
ZT93	120	80	1000	0.5	150	15	40	120	150	60	50	1000	TO-39	–
2N1893	120	80	500	1.2	50	5	40	120	150	–	–	800	TO-39	–
2N2102	120	65	1000	0.5	150	15	40	120	150	60	50	1000	TO-39	2N4036
ZT88	100	80	500	0.2	50	5	75	170	10	200	10	300	TO-18	–
ZT86	100	80	500	0.2	50	5	38	85	10	200	10	300	TO-18	–
BFX85	100	60	1000	0.35	150	15	70	–	150	50	50	800	TO-39	–
BFX84	100	60	1000	0.35	150	15	30	–	150	50	50	800	TO-39	–
BC141	100	60	1000	1.0	1000	100	40	250	100	50	50	3700*	TO-39	BC161
BC140	80	40	1000	1.0	1000	100	40	250	100	50	50	3700*	TO-39	BC160
BFY50	80	35	1000	0.2	150	15	30	–	150	60	50	800	TO-39	–
2N1613	75	50	1000	1.5	150	15	40	120	150	60	50	800	TO-39	–
2N1711	75	50	1000	1.5	150	15	100	300	150	70	50	800	TO-39	–
ZT89	70	70	500	0.2	50	5	75	250	10	200	10	300	TO-18	ZT189
ZT90	60	60	1000	0.7	200	20	60	200	200	60	50	1000	TO-39	ZT211
ZT95	60	60	1000	1.2	200	20	30	200	350	60	50	1000	TO-39	ZT211
BCY65E	60	60	100	0.35	10	0.25	120	460	2	125	10	1000*	TO-18	BCY77
2N2270	60	45	1000	0.9	150	15	50	200	150	60	50	1000	TO-39	–
ZT94	60	45	1000	0.7	200	20	20	–	10	60	50	1000	TO-39	ZT210
ZT83	60	45	500	0.2	50	5	38	85	10	200	10	300	TO-18	ZT183
ZT84	60	45	500	0.2	50	5	75	170	10	200	10	300	TO-18	ZT184

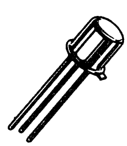
*At T_{case} = 45°C

continued—

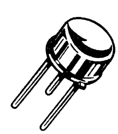
NPN LOW LEVEL *Continued*

Type	V_{CB} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min.	h_{FE} Max.	at I_C mA	Min f_T MHz	at I_C mA	P_{tot} at $T_{amb}=25°C$ mW	Package	Complement
2N3053	60	40	700	1.4	150	15	50	250	150	100	50	1000	TO-39	2N4037
2N696	60	40	500	1.5	150	15	20	60	150	80	50	600	TO-39	2N1131
2N697	60	40	500	1.5	150	15	40	120	150	100	50	600	TO-39	2N1132
BFY51	60	30	1000	0.35	150	15	40	—	150	50	50	800	TO-39	—
BC107	50	45	200	0.2	10	0.5	120	460	2	150	10	300	TO-18	BC177
BCY59	45	45	200	0.35	10	0.25	120	630	2	125	10	1000*	TO-18	BCY79
2N929	45	45	30	1	10	0.5	40	120	0.01	—	—	300	TO-18	—
2N930	45	45	30	1	10	0.5	100	300	0.01	—	—	300	TO-18	—
ZT81	45	35	500	0.2	10	2	38	162	10	200	10	300	TO-18	ZT181
ZT82	45	35	500	0.2	10	2	75	250	10	200	10	300	TO-18	ZT182
BFX86	40	35	1000	0.35	150	15	70	—	150	50	50	800	TO-39	—
BCY42	40	25	200	0.25	10	1	40	90	1	100	1	300	TO-18	—
BCY43	40	20	200	0.25	10	1	75	150	1	100	1	300	TO-18	—
BFY52	40	20	1000	0.35	150	15	60	—	150	50	50	800	TO-39	—
BCY58	32	32	200	0.35	10	0.25	120	630	2	125	10	1000*	TO-18	BCY78
BC108	30	20	200	0.2	10	0.5	120	800	2	150	10	300	TO-18	BC178
ZT80	25	25	500	0.2	10	2	38	162	10	200	10	300	TO-18	ZT180
ZT87	25	25	500	0.2	10	2	75	250	10	200	10	300	TO-18	ZT187
2N706A	25	20	—	0.6	10	1	20	60	10	200	10	300	TO-18	—
2N706	25	20	—	0.6	10	1	20	—	10	200	10	300	TO-18	—
BSY95A	20	15	200	0.35	10	0.2	50	200	10	200	10	300	TO-18	—

*At $t_{case} = 45°C$



TO-18



TO-39

PNP LOW LEVEL

TABLE 2 – PNP SILICON PLANAR LOW LEVEL TRANSISTORS

The devices shown in this table are low level transistors designed for small and medium signal, low and medium power amplification from DC to radio frequencies in Commercial, Industrial and Military equipments.

These transistors are particularly suitable for use as Audio Frequency Amplifiers, Driver and Output Stages, Oscillators and General Purpose Switches.

The devices are listed in order of decreasing Breakdown Voltages (V_{CB} and V_{CEO}), decreasing Collector Currents (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CB}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Min f_T	at	P_{tot} at T_{amb} = 25°C	Package	Complement
	V	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	mW		
ZT211	90	65	1000	0.65	150	15	40	120	150	60	50	1000	TO-39	ZT90/95
2N4036	90	65	1000	0.65	150	15	40	140	150	—	—	1000	TO-39	2N2102
ZT189	70	70	500	0.2	50	5	75	250	10	150	10	300	TO-18	ZT89
BC161	60	60	1000	1.0	1000	100	40	250	100	50	50	3700*	TO-39	BC141
BCY77	60	60	100	0.25	10	0.25	120	460	2	180†	10	1000*	TO-18	BCY65E
2N2605	60	45	30	0.5	10	0.5	150	—	0.5	30	0.5	400	TO-46	—
2N2604	60	45	30	0.5	10	0.5	60	—	0.5	30	0.5	400	TO-46	—
ZT210	60	40	1000	1.4	150	15	20	100	150	60	50	1000	TO-39	ZT94
2N4037	60	40	1000	1.4	150	15	50	250	150	—	—	1000	TO-39	2N3053
BC177	50	45	200	0.2	10	0.5	120	460	2	130	10	300	TO-18	BC107
BCY70	50	40	200	0.25	10	1	100	—	10	250	10	350	TO-18	—
2N1131	50	35	600	1.5	150	15	20	45	150	—	—	600	TO-39	2N696
2N1132	50	35	600	1.5	150	15	30	90	150	—	—	600	TO-39	2N697
ZT183	45	45	500	0.4	50	5	38	85	10	150	10	300	TO-18	ZT83
ZT184	45	45	500	0.4	50	5	75	170	10	150	10	300	TO-18	ZT84
BCY79	45	45	200	0.25	10	0.25	120	460	2	180†	10	1000*	TO-18	BCY59
BCY71	45	45	200	0.25	10	1	100	400	10	250	10	350	TO-18	—
ZT181	45	35	500	0.2	10	1	38	162	10	150	10	300	TO-18	ZT81
ZT182	45	35	500	0.2	10	1	75	260	10	150	10	300	TO-18	ZT82
BC160	40	40	1000	1.0	1000	100	40	250	100	50	50	3700*	TO-39	BC140
BCY78	32	32	200	0.25	10	0.25	120	630	2	180†	10	1000*	TO-18	BCY58
BCY72	30	25	200	0.25	10	1	100	—	10	250	10	350	TO-18	—
BC178	30	25	200	0.2	10	0.5	120	800	2	130	10	300	TO-18	BC108
ZT180	25	25	500	0.2	10	1	38	162	10	150	10	300	TO-18	ZT80
ZT187	25	25	500	0.2	10	1	75	250	10	150	10	300	TO-18	ZT87

*At T_{case} = 45°C   †Typical

TABLE 3 – NPN SILICON PLANAR MEDIUM AND HIGH SPEED SWITCHING TRANSISTORS

The devices shown in this table are characterised for medium and high speed switching applications in Commercial, Industrial and Military equipments.

The devices are listed in order of decreasing Breakdown Voltage (V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	f_T Min at		Switching Times (Max) at			Package	Comple-ment
	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	t_{on} ns	t_{off} ns	I_C mA		
2N3262	100	1500	0.6	1000	100	40	—	500	—	—	40	750	1000	TO-39	—
ZT86	80	500	0.2	50	5	38	85	10	200	10	50*	170*	20	TO-18	—
ZT88	80	500	0.2	50	5	75	170	10	200	10	50*	170*	20	TO-18	—
ZT89	70	500	0.2	50	5	75	250	10	200	10	50*	170*	20	TO-18	ZT189
2N2102	65	1000	0.5	150	15	40	120	150	60	50	(note 1)			TO-39	2N4036
BFX85	60	1000	0.35	150	15	70	—	150	50	50	55*	360*	150	TO-39	—
BFX84	60	1000	0.35	150	15	30	—	150	50	50	55*	360*	150	TO-39	—
BCY65E	60	100	0.35	10	0.25	120	460	2	125	10	150	800	10	TO-18	BCY77
2N1613	50	1000	1.5	150	15	40	120	150	60	50	(note 1)			TO-39	—
2N2270	45	1000	0.9	150	15	50	200	150	60	50	(note 1)			TO-39	—
ZT83	45	500	0.2	50	5	38	85	10	200	10	50*	170*	20	TO-18	ZT183
ZT84	45	500	0.2	50	5	75	170	10	200	10	50*	170*	20	TO-18	ZT184
BCY59	45	200	0.35	10	0.25	120	630	2	125	10	150	800	10	TO-18	BCY79
2N2218A	40	800	0.3	150	15	40	120	150	250	20	35	285	150	TO-39	2N2904A
2N2219A	40	800	0.3	150	15	100	300	150	300	20	35	285	150	TO-39	2N2905A
2N2221A	40	800	0.3	150	15	40	120	150	250	20	35	285	150	TO-18	2N2906A
2N2222A	40	800	0.3	150	15	100	300	150	300	20	35	285	150	TO-18	2N2907A
BFY50	35	1000	0.2	150	15	30	—	150	60	50	55*	360*	150	TO-39	—
BFX86	35	1000	0.35	150	15	70	—	150	50	50	55*	360*	150	TO-39	—
ZT81	35	500	0.2	10	2	38	162	10	200	10	50*	170*	20	TO-18	ZT181
ZT82	35	500	0.2	10	2	75	250	10	200	10	50*	170*	20	TO-18	ZT182
2N3512	35	—	0.4	150	7.5	10	—	500	—	—	30	45	150	TO-39	—
BCY58	32	200	0.35	10	0.25	120	630	2	125	10	150	800	10	TO-18	BCY78

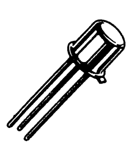
*Typical. Note 1 $t_{tot} = 30$ ns

Continued—

NPN SWITCHING *Continued*

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	f_T Min	at	Switching Times (Max) at			Package	Complement
	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	t_{on} ns	t_{off} ns	I_C mA		
BFY51	30	1000	0.35	150	15	40	—	150	50	50	55*	360*	150	TO-39	—
2N2218	30	800	0.4	150	15	40	120	150	250	20	25*	175*	150	TO-39	2N2904
2N2219	30	800	0.4	150	15	100	300	150	250	20	25*	200*	150	TO-39	2N2905
2N2221	30	800	0.4	150	15	40	120	150	250	20	25*	175*	150	TO-18	2N2906
2N2222	30	800	0.4	150	15	100	300	150	250	20	25*	200*	150	TO-18	2N2907
ZT80	25	500	0.2	10	2	38	162	10	200	10	50*	170*	20	TO-18	ZT180
ZT87	25	500	0.2	10	2	75	250	10	200	10	50*	170*	20	TO-18	ZT187
BFY52	20	1000	0.35	150	15	60	—	150	50	50	55*	360*	150	TO-39	—
2N706A	20	—	0.6	10	1	20	—	10	200	10	40	75	10	TO-18	—
2N2477	20	—	0.4	150	3.75	40	—	150	250	50	25	45	150	TO-39	—
2N2476	20	—	0.4	150	7.5	20	—	150	250	50	25	45	150	TO-39	—
2N2369A	15	500	0.2	10	1	—	120	10	—	—	9	13	10	TO-18	—
2N2368	15	500	0.24	10	1	20	60	10	—	—	12	15	10	TO-18	—
2N2369	15	500	0.24	10	1	40	120	10	—	—	12	18	10	TO-18	—
BSY95A	15	200	0.35	10	0.2	50	200	10	200	10	(note 3)			TO-18	—
2N708	15	—	0.4	10	1	30	120	10	300	10	(note 2)			TO-18	—
2N2938	13	500	0.4	50	1.6	30	105*	50	500	10	30	30	50	TO-18	—
2N2475	6	300	0.4	20	0.66	30	150	20	600	20	20	15	20	TO-18	—
2N709	6	—	0.3	3	0.15	20	120	10	600	5	15	15	10	TO-18	—

*Typical   Note 2 $t_{stg} = 25$ns   Note 3 $t_{stg} = 50$ns



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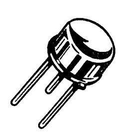

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TABLE 4 – SILICON PLANAR MEDIUM AND HIGH SPEED SWITCHING TRANSISTORS

The devices shown in this table are characterised for medium and high speed switching applications in Commercial, Industrial and Military equipments.

The devices are listed in order of decreasing Breakdown Voltage (V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	f_T Min at		Switching Times (Max) at			Package	Complement
	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	t_{on} ns	t_{off} ns	I_C mA		
ZT189	70	500	0.2	50	5	75	250	10	150	10	120*	250*	20	TO-18	ZT89
2N4036	65	1000	0.65	150	15	40	140	150	—	—	110	700	150	TO-39	2N2102
2N2904A	60	600	0.4	150	15	40	120	150	200	50	45	100	150	TO-39	2N2218A
2N2905A	60	600	0.4	150	15	100	300	150	200	50	45	100	150	TO-39	2N2219A
2N2906A	60	600	0.4	150	15	40	120	150	200	50	45	100	150	TO-18	2N2221A
2N2907A	60	600	0.4	150	15	100	300	150	200	50	45	100	150	TO-18	2N2222A
BCY77	60	100	0.25	10	0.25	120	460	2	180*	10	150	800	10	TO-18	BCY65E
ZT183	45	500	0.4	50	5	38	85	10	150	10	120*	250*	20	TO-18	ZT83
ZT184	45	500	0.4	50	5	75	170	10	150	10	120*	250*	20	TO-18	ZT84
BCY79	45	200	0.25	10	0.25	120	460	2	180*	10	150	800	10	TO-18	BCY59
2N2904	40	600	0.4	150	15	40	120	150	200	50	45	100	150	TO-39	2N2218
2N2905	40	600	0.4	150	15	100	300	150	200	50	45	100	150	TO-39	2N2219
2N2906	40	600	0.4	150	15	40	120	150	200	50	45	100	150	TO-18	2N2221
2N2907	40	600	0.4	150	15	100	300	150	200	50	45	100	150	TO-18	2N2222
ZT181	35	500	0.2	10	1	38	162	10	150	10	120*	250*	20	TO-18	ZT81
ZT182	35	500	0.2	10	1	75	260	10	150	10	120*	250*	20	TO-18	ZT82
BCY78	32	200	0.25	10	0.25	120	630	2	180*	10	150	800	10	TO-18	BCY58
ZT180	25	500	0.2	10	1	38	162	10	150	10	120*	250*	20	TO-18	ZT80
ZT187	25	500	0.2	10	1	75	250	10	150	70	120*	250*	20	TO-18	ZT87
2N2894	12	200	0.15	10	1	40	150	30	400	30	60	90	30	TO-18	—

*Typical

NPN LOW NOISE

TABLE 5 – NPN SILICON PLANAR LOW NOISE TRANSISTORS

The transistors shown in this table are characterised for low noise, low level amplification and are particularly suitable for audio pre-amplifiers as well as universal applications.

The devices are listed in order of decreasing Breakdown Voltage (V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	f_TMin at		Noise Figure at			Package	Complement
	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	N dB	I_C μA	f Hz		
ZT91	100	1000	1.2	200	20	40	120	200	60	50	6	300	1K	TO-39	–
ZT92	100	1000	1.2	200	20	65	200	200	60	50	6	300	1K	TO-39	–
ZT93	80	1000	0.5	150	15	40	120	150	60	50	6	300	1K	TO-39	–
ZT86	80	500	0.2	50	5	38	85	10	200	10	<6	100	1K	TO-18	–
ZT88	80	500	0.2	50	5	75	170	10	200	10	<6	100	1K	TO-18	–
ZT89	70	500	0.2	50	5	75	250	10	200	10	<6	100	1K	TO-18	ZT189
ZT90	60	1000	0.7	200	20	60	200	200	60	50	6	300	1K	TO-39	ZT211
ZT95	60	1000	1.2	200	20	30	200	350	60	50	6	300	1K	TO-39	ZT211
BCY65E	60	100	0.35	10	0.25	120	460	2	125	10	<6	200	1K	TO-18	BCY77
2N2484	60	50	0.35	1	0.1	100	500	0.01	–	–	<3	200	1K	TO-18	–
ZT94	45	1000	0.7	200	20	20	–	10	60	50	6	300	1K	TO-39	ZT210
ZT83	45	500	0.2	50	5	38	85	10	200	10	<6	100	1K	TO-18	ZT183
ZT84	45	500	0.2	50	5	75	170	10	200	10	<6	100	1K	TO-18	ZT184
BCY59	45	200	0.35	10	0.25	120	630	2	125	10	<6	200	1K	TO-18	BCY79
2N929	45	30	1	10	0.5	40	120	0.01	–	–	<4	10	1K	TO-18	–
2N930	45	30	1	10	0.5	100	300	0.01	–	–	<4	10	1K	TO-18	–
2N2219A	40	800	0.3	150	15	100	300	150	300	20	<4	100	1K	TO-39	2N2905A
2N2222A	40	800	0.3	150	15	100	300	150	300	20	<4	100	1K	TO-18	2N2907A
ZT81	35	500	0.2	10	2	38	162	10	200	10	<6	100	1K	TO-18	ZT181
ZT82	35	500	0.2	10	2	75	250	10	200	10	<6	100	1K	TO-18	ZT182
BCY58	32	200	0.35	10	0.25	120	630	2	125	10	<6	200	1K	TO-18	BCY78
ZT80	25	500	0.2	10	2	38	162	10	200	10	<6	100	1K	TO-18	ZT180
ZT87	25	500	0.2	10	2	75	250	10	200	10	<6	100	1K	TO-18	ZT187
BC109	20	50	0.2	10	0.5	180	800	2	150	10	<4	200	30-15K	TO-18	BC179

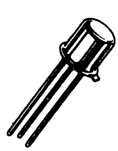
TABLE 6 – PNP SILICON PLANAR LOW NOISE TRANSISTORS

The transistors shown in this table are characterised for low noise, low level amplification and are particularly suitable for audio pre-amplifiers as well as universal applications.

The devices are listed in order of decreasing Breakdown Voltage (V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min.	h_{FE} Max.	at I_C mA	f_TMin MHz	at I_C mA	Noise Figure N dB	at I_C μA	at f Hz	Package	Complement
ZT189	70	500	0.2	50	5	75	250	10	150	10	6	100	1K	TO-18	ZT89
BCY77	60	100	0.25	10	0.25	120	460	2	180*	10	<6	200	1K	TO-18	BCY65E
ZT183	45	500	0.4	50	5	38	85	10	150	10	6	100	1K	TO-18	ZT83
ZT184	45	500	0.4	50	5	75	170	10	150	10	6	100	1K	TO-18	ZT84
BCY79	45	200	0.25	10	0.25	120	460	2	180*	10	<6	200	1K	TO-18	BCY59
BCY71	45	200	0.25	10	1	100	400	10	250	10	<6	100	10-10K	TO-18	–
BCY70	40	200	0.25	10	1	100	–	10	150	10	<6	100	10-10K	TO-18	–
2N2605	45	30	0.5	10	0.5	150	–	0.5	30	0.5	<3	10	10-15.7K	TO-46	–
2N2604	45	30	0.5	10	0.5	60	–	0.5	30	0.5	<4	10	10-15.7K	TO-46	–
ZT181	35	500	0.2	10	1	38	162	10	150	10	6	100	1K	TO-18	ZT81
ZT182	35	500	0.2	10	1	75	260	10	150	10	6	100	1K	TO-18	ZT82
BCY78	32	200	0.25	10	0.25	120	630	2	180*	10	<6	200	1K	TO-18	BCY58
BCY72	25	200	0.25	10	1	100	–	10	250	10	<2	100	10-10K	TO-18	–
ZT180	25	500	0.2	10	1	38	162	10	150	10	6	100	1K	TO-18	ZT80
ZT187	25	500	0.2	10	1	75	250	10	150	10	6	100	1K	TO-18	ZT87
BC179	20	50	0.2	10	0.5	180	800	2	130*	10	<4	200	30-15K	TO-18	BC109

*Typical



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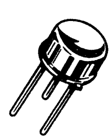

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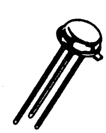

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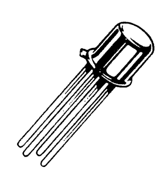

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HIGH FREQUENCY

TABLE 7 – NPN SILICON PLANAR HIGH FREQUENCY TRANSISTORS

The transistors shown in these tables are designed for high frequency operation Amplifier and Oscillator applications. The tables should be referred to in conjunction with the RF Section which contains details of the available range of Ferranti high frequency transistors.

Type	V_{CB} V	V_{CEO} V	Max. I_C mA	h_{FE} at Min.	h_{FE} at Max.	h_{FE} at I_C mA	f_T Min. at MHz	f_T Min. at I_C mA	Noise Figure at N dB	Noise Figure at I_C mA	Noise Figure at f MHz	C_{obo} Max. at 1 MHz pF	C_{obo} Max. at 1 MHz V_{CB} V	RF, P_O or RF, P_G at mW or dB	RF, P_O or RF, P_G at f MHz	Package
2N918	30	15	–	20	–	3	–	–	<6	1	60	1.7	10	15dB	200	TO-72
2N2708	35	20	–	30	200	2	700	2	<8.5	2	200	1.5	15	15dB	200	TO-18

TABLE 7a – MEDIUM POWER R.F. TRANSISTORS TO 1 WATT

Suitable for drivers and general purpose RF amplifiers.

Type	Maximum Rating		R.F. Performance (Minimum)				Package
	V_{CBO} Volts	V_{CEO} Volts	V_{CC} Volts	P_{OUT} Watts	P_G dB	F_O MHz	
2N3866	55	30	28.0	0.7	8.5	400	TO-39
2N4427	40	20	12.0	1.0	10.0	175	TO-39

HIGH VOLTAGE

TABLE 8 – NPN SILICON PLANAR HIGH VOLTAGE (LOW CURRENT) TRANSISTORS

The transistors shown in this table are designed for general applications where device voltages in excess of 100 volts are required.

Type	V_{CB} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	Max $V_{CE(sat)}$ at I_C mA	Max $V_{CE(sat)}$ at I_B mA	h_{FE} at Min.	h_{FE} at Max.	h_{FE} at I_C mA	I_{CBO} at μA	I_{CBO} at V_{CB} V	P_{tot} at T_{amb} = 25°C mW	Package	Complement
ZT91	120	100	1000	1.2	200	20	40	120	200	1	100	1000	TO-39	–
ZT92	120	100	1000	1.2	200	20	65	200	200	1	100	1000	TO-39	–
ZT93	120	80	1000	0.5	150	15	40	120	150	0.1	80	1000	TO-39	–
2N2102	120	65	1000	0.5	150	15	40	120	150	0.1	120	1000	TO-39	2N4036

CORE DRIVERS

TABLE 9 – NPN SILICON PLANAR HIGH SPEED CORE DRIVER TRANSISTORS

The devices shown in this table are designed for use in fast, medium and high voltage, high current core driving applications where the high speed at high current capability is of prime importance.

Type	V_{CB} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	I_B mA	h_{FE} Min.	Max.	at I_C mA	Switching Times (Max) at t_{on} ns	t_{off} ns	I_C mA	P_{tot} at T_{amb} = 25°C mW	Package
BSX59	70	45	1000	0.3	150	15	25	—	500	35	60	500	800	TO-39
BSX60	70	30	1000	0.3	150	15	30	90	500	40	70	500	800	TO-39
BSX61	70	45	1000	0.5	150	15	25	—	500	50	100	500	800	TO-39
2N3261	40	15	500	0.35	100	10	40	150	10	13	16	100	300	TO-18
2N3512	60	35	—	0.4	150	7.5	10	—	500	30	45	150	800	TO-39
2N3724	50	30	500	0.2	100	10	60	150	100	35	60	500	800	TO-39
2N3725	80	40	500	0.26	100	10	60	150	100	35	60	500	800	TO-39

DARLINGTONS

TABLE 10 – NPN SILICON HIGH CURRENT DARLINGTON TRANSISTORS

The devices shown in this table are designed for applications requiring very high current gain. The monolithic construction has the inherent advantages of fast switching times, low saturation voltages and low leakage currents.

This table should be referred to in conjunction with the LF Power Transistor Section which contains full details of the available range of Darlington Transistors.

Type	V_{CB} V	V_{CEO} V	Max. I_C A	Max $V_{CE(sat)}$ at V	I_C A	I_B mA	h_{FE} Min.	Max.	at I_C A	Max C_{obo} at 1 MHz pF	V_{CB} V	Max. I_{CBO} at µA	V_{CB} V	P_{tot} at T_{amb} = 25°C W	Package
BD320A	80	60	1	1.6	1	1	1K	—	0.5	6	10	1	60	5	TO-39
BD320B	80	60	1	1.6	1	1	5K	—	0.5	6	10	1	60	5	TO-39
BD320C	80	60	1	1.6	1	1	10K	—	0.5	6	10	1	60	5	TO-39
BD321A	80	60	2	1.7	2	2	1K	—	1	8.5	10	1	60	5	TO-39
BD321B	80	60	2	1.7	2	2	5K	—	1	8.5	10	1	60	5	TO-39
BD321C	80	60	2	1.7	2	2	10K	—	1	8.5	10	1	60	5	TO-39
BD322A	80	60	1	1.6	1	1	1K	—	0.5	6	10	1	60	7.5	TO-39
BD322B	80	60	1	1.6	1	1	5K	—	0.5	6	10	1	60	7.5	TO-39
BD322C	80	60	1	1.6	1	1	10K	—	0.5	6	10	1	60	7.5	TO-39
BD323A	80	60	2	1.7	2	2	1K	—	1	8.5	10	1	60	10	TO-39
BD323B	80	60	2	1.7	2	2	5K	—	1	8.5	10	1	60	10	TO-39
BD323C	80	60	2	1.7	2	2	10K	—	1	8.5	10	1	60	10	TO-39
2N6383	40	40	10	3	10	100	1K	20K	5	200	10	1*	40	100	TO-3
2N6384	60	60	10	3	10	100	1K	20K	5	200	10	1*	60	100	TO-3
2N6385	80	80	10	3	10	100	1K	20K	5	200	10	1*	80	100	TO-3

*Refers to I_{CEO} (in mA)

NPN HIGH CURRENT SWITCHING

TABLE 11 – NPN SILICON PLANAR HIGH CURRENT SWITCHING TRANSISTORS

The transistors shown in this table are designed for high current, high dissipation switching applications in Industrial and Military equipments.

This table should be referred to in conjunction with the LF Power Transistor Section which contains full details of the available range of High Power Transistors.

The devices are listed in order of decreasing Breakdown Voltages (V_{CB} and V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CB}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$†	at		h_{FE}		at	Switching Times (Typ) at			P_{tot} at T_{case} = 25°C	Package	Complement
	V	V	A	V	I_C A	I_B A	Min.	Max.	I_C A	t_{on} ns	t_{off} ns	I_C A	W		
BUY82	150	60	10	1	10	1	40	—	1.5	320	245	10	30	TO-39	BUY92
							15	—	10						
BUY81	150	60	7.5	1	7.5	0.75	40	—	1	160	430	5	24	TO-39	BUY91
							10	—	7.5						
BUY80	150	60	5	1	5	0.5	40	—	0.5	170	200	5	20	TO-39	BUY90
							15	—	5						
2N3419A	125	80	5*	1	5	0.5	20	60	1	300	1200	1	30	TO-39	—
2N3421A	125	80	5*	1	5	0.5	40	120	1	300	1200	1	30	TO-39	—
BUX34	120	60	5	1	5	0.5	40	150	2	140	180	5	20	TO-39	—
BFX34	120	60	5*	1	5	0.5	40	150	2	140	180	5	5	TO-39	—
BSV64	100	60	5*	1	5	0.5	40	—	2	140	180	5	5	TO-39	—
2N3418A	85	60	5*	1	5	0.5	20	60	1	300	3000	1	30	TO-39	—
2N3420A	85	60	5*	1	5	0.5	40	120	1	300	3000	1	30	TO-39	—

*I_{CM} †Pulsed 300 μs

PNP HIGH CURRENT SWITCHING

TABLE 12 – PNP SILICON PLANAR HIGH CURRENT SWITCHING TRANSISTORS

The transistors shown in this table are designed for high current, high dissipation switching applications in Industrial and Military equipments.

This table should be referred to in conjunction with the LF Power Transistor Section which contains full details of the available range of High Power Transistors.

The devices are listed in order of decreasing Breakdown Voltages (V_{CB} and V_{CEO}), decreasing Collector Current (I_C), Power Dissipation (P_{tot}), etc.

Type	V_{CB}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$†	at		h_{FE}		at	Switching Times (Typ) at			P_{tot} at T_{case} = 25°C	Package	Complement
	V	V	A	V	I_C A	I_B A	Min.	Max.	I_C A	t_{on} ns	t_{off} ns	I_C A	W		
BUY92	100	60	7.5	1	7.5	0.75	40	—	1	—	—	—	30	TO-39	BUY82
BUY91	100	60	5	1	5	0.5	40	—	1	—	—	—	24	TO-39	BUY81
BUY90	100	60	3	1	3	0.3	40	—	1	—	—	—	20	TO-39	BUY80

†Pulsed 300 μs

MOSFETS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

Ferranti MOSFET Technology is amongst the worlds most advanced...

Ferranti MOSFETs utilise a vertical DMOS structure. These devices are produced using a well proven silicon gate manufacturing process which provides excellent device stability under high voltage conditions. Low input capacitance and fast switching speeds are achieved by virtue of the chips having compact overlay (cell) or interdigitated geometries. In common with all MOSFET devices they do not exhibit thermal runaway and thermally induced secondary breakdown.

Ferranti DMOS structure has no grooves of any kind and is truly planar. This design approach completely avoids the problems associated with V and U grooves, where high electric fields at the bottom of the grooves severely limit breakdown voltage performance.

Ferranti MOSFETs are enhancement mode FET's (normally -OFF) especially suited to a wide range of switching and amplifying applications where High Input Impedance, High Gain, High Frequency and Fast Switching Speed is desired. They combine the power handling capabilities of Bipolar Transistors with the high input impedance and negative temperature coefficient of FET's.

FEATURES

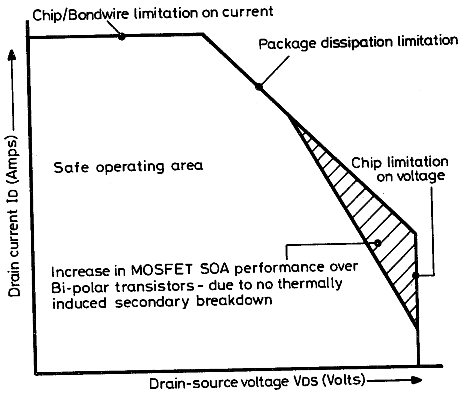
- N-channel, P-channel devices
- Drain currents up to 18A continuous, 72A pulsed
- Breakdown voltages up to 450V
- Drain-Source ON-resistances as low as 0.12Ω max.
- Switching times as low as 4ns
- Power dissipations up to 75W

PROCESS HIGHLIGHTS

1. **Poly-Silicon Gate Process**
   The poly-silicon gate greatly reduces the possibility of sodium-ion contamination in the gate oxide thus giving high stability of threshold voltage.
2. **Ion Implantation**
   The use of ion implantation gives stability in the control of threshold voltages in manufacture.
3. **Self Aligned Gates**
   The self aligned DMOS process allows extremely short channel lengths to be achieved, giving these devices excellent linear transfer characteristics.
4. **Planar Construction**
   The vertical DMOS structure eliminates the need for anisotropically etched V or U grooves in the surface of the device, giving improved performance and higher voltages.
5. **Compact Geometries**
   Compact transistor chip designs utilizing overlay (cell) or interdigitated structures optimised for low ON-resistances, low capacitances and fast switching speeds.

THERMAL RUNAWAY

The devices do not exhibit thermal runaway or thermally induced secondary breakdown.



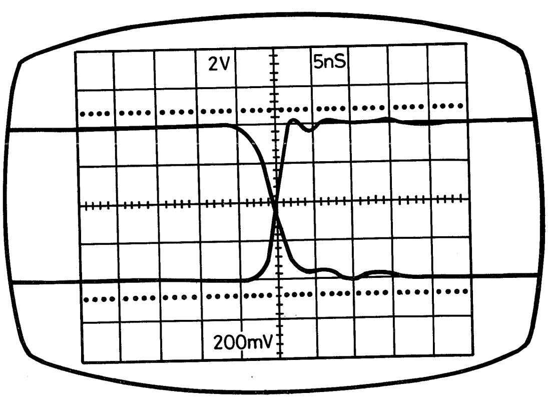
Carrier mobility in a MOSFET channel region decreases with temperature. If localized heating occurs in a MOSFET the carrier mobility decreases in the region affected, and as a consequence, the localized current reduces. This negative feedback mechanism forces overload currents to be uniformly distributed within the transistor.

TEMPERATURE STABILITY

The transconductance and switching times of these MOSFETs change very little with temperature compared to bipolar transistors.

FAST SWITCHING SPEEDS

MOSFETs are majority-carrier devices, and consequently do not exhibit minority carrier storage delays. Switching times are ultra-fast, primarily being determined by the device capacitances and the drive circuitry.



TYPICAL MOSFET SWITCHING CHARACTERISTIC

MOSFETS

HIGH INPUT IMPEDANCE

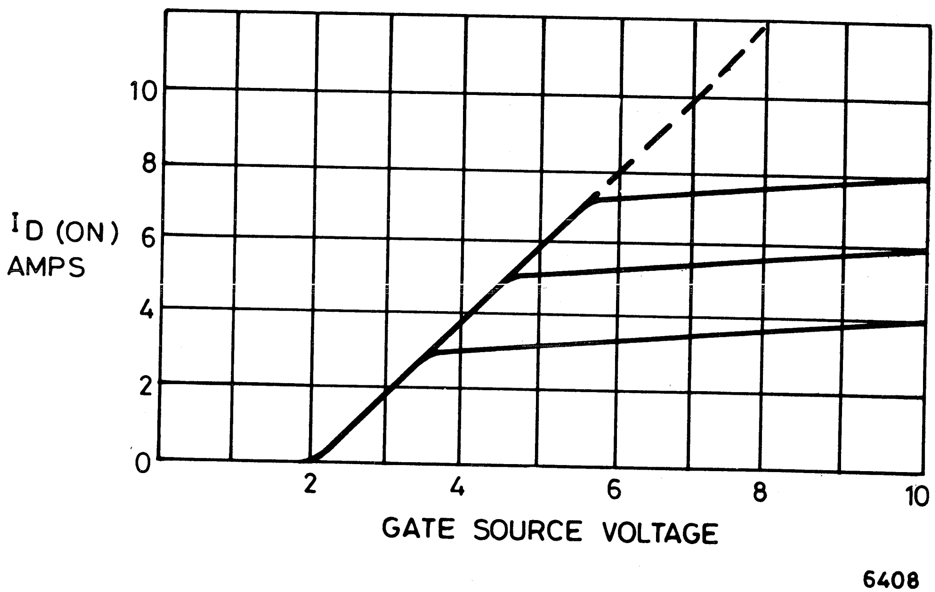
By virtue of the insulated gate structure, input currents are very low, typically a few pico amps at 25°C.

HIGH GAIN

Current gains are generally in the range 10^5 to 10^6.

LINEARITY OF TRANSFER CHARACTERISTICS

Above the threshold voltage, the relationship between drain current and gate voltage in these short channel devices is approximately linear. In other words, the device transconductance, which is the rate of change of drain current with gate voltage, becomes constant at high drain currents.



TYPICAL MOSFET TRANSFER CHARACTERISTICS

PRODUCT ADVANTAGES FOR CIRCUIT DESIGN

1. Less peripheral components are required than in the case of bipolar types leading to reduced design time, less complexity and lower cost.

2. Can be easily connected in parallel to obtain very high current handling performance without the problem related to bipolar transistors, that of base current sharing resistors.

3. Improved reliability due to temperature stability and freedom from thermally induced secondary breakdown.

APPLICATIONS OF MOSFETS

I.C. Logic Interface Driver

The high input impedance and high power gain make these devices ideally suited as direct interfaces for microprocessor and standard logic e.g. CMOS, TTL, PMOS and NMOS.

Analogue Switching

The output resistance can be switched from very high to very low values with minimal input power bringing design advantages for controlled variable resistance, analogue switching and controlled current sources.

Audio Amplification

The linearity of the transfer characteristics coupled with the fast switching speed gives improved designs in Class A operation, Class D operation and Push-pull audio outputs using complementary types.

Control Circuits

Pulse modulation systems utilise the characteristics of high power gain, speed and thermal stability in d.c. motor speed control, a.c. motor speed control and Stepping motor control.

Sensor Applications

The high input resistance and high power gain enable the devices to be used in sample and hold circuits, touch sensitive circuits, and battery operation – standby power minimal.

Power Supply Circuits

The fast switching speeds, temperature stability, and freedom from thermally induced secondary breakdown of these devices are outstanding characteristics desirable in the areas of switch mode power supplies, d.c./d.c. conversion, and regulation.

Timing Circuits

The input, consisting of capacitance shunted by high input resistance, is ideal for circuits using RC timing components such as pulse and industrial timers, delay circuits, flashing indicators and other types of periodic pulsing applications.

Switching

The fast switching speeds, temperature stability, and freedom from thermally induced secondary breakdown are desirable for very fast pulse generators, filament lamp drivers and laser diode drivers.

Frequency Amplification

The high frequency bandwidth gives amplification from d.c. to hundreds of megahertz allowing useage in radio frequency power stages up to and including communication bands, ultra sonic power stages and high frequency drivers of L.E.D's and laser diodes in fibre optic systems.

Telecommunications

Mechanical contact replacements for fast and efficient switching.

MOSFETS

PRODUCT TYPE CODE

All Ferranti MOSFETs are designated by an 8 digit alpha-numeric code. The code is read as follows:

[Z]	[V]	[ ]	[ ] [ ]	[ ] [ ]	[ ]
Ferranti	VMOS	Channel	Chip Type	Voltage (÷ 10)	Package Code

CHANNEL: N/P

CHIP TYPE: 01/05/13/21/22/32/33

VOLTAGE (÷ 10)

06 = 60V
10 = 100V
20 = 200V
35 = 350V

PACKAGE CODE:

E-Line	A
TO-39	B
TO-220	L
SOT-23	F
Dice	D

EXAMPLE

[Z]	[V]	[N]	[2] [2]	[0] [8]	[L]
Ferranti	VMOS	Channel	Chip Type	Voltage (÷ 10)	Package Code

Also industry standards: BS 107P, BS 170P, BS 250P, VN10LP

N-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ Ω Max. @	I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
450	50	0.1	ZVN0545A	0.09	0.7	E-Line
			ZVN0545B	0.15	5	TO-39
			ZVN0545L	0.15	20	TO-220
400			ZVN0540A	0.09	0.7	E-Line
			ZVN0540B	0.15	5	TO-39
			ZVN0540L	0.15	20	TO-220
350			ZVN0535A	0.09	0.7	E-Line
			ZVN0535B	0.15	5	TO-39
			ZVN0535L	0.15	20	TO-220
	35		ZVN2535A	0.09	0.7	E-Line
			ZVN2535B	0.24	5	TO-39
			ZVN2535L	0.25	20	TO-220
300	50		ZVN0530A	0.09	0.7	E-Line
			ZVN0530B	0.15	5	TO-39
			ZVN0530L	0.15	20	TO-220
	35		ZVN2530A	0.09	0.7	E-Line
			ZVN2530B	0.24	5	TO-39
			ZVN2530L	0.25	20	TO-220
260	40		ZVN0526A	0.10	0.7	E-Line
240	16	0.25	ZVN0124A	0.16	0.7	E-Line
			ZVN0124B	0.4	5	TO-39
			ZVN0124L	0.5	20	TO-220
	6	1.0	ZVN2224B	1.20	20	TO-39
			ZVN2224L	1.20	20	TO-220
200	40	0.1	ZVN1320A	0.10	0.625	E-Line
			ZVN1320B	0.25	5	TO-39
			ZVN1320F	0.05	0.25	SOT-23
	28	0.02	BS 107PT	0.12	0.5	E-Line
	25	0.1	ZVN3320A	0.1	0.625	E-Line
			ZVN3320B	0.25	5	TO-39
			ZVN3320F	0.06	0.25	SOT-23
	23	0.025	BS 107P	0.12	0.5	E-Line
	16	0.25	ZVN0120A	0.16	0.7	E-Line
			ZVN0120B	0.42	5	TO-39
			ZVN0120L	0.50	20	TO-220

N-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ @ Ω Max.	I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
200	10	0.25	ZVN2120A	0.18	0.7	E-Line
			ZVN2120B	0.46	5	TO-39
			ZVN2120L	0.50	20	TO-220
	2.5	1.0	ZVN2220B	1.85	20	TO-39
			ZVN2220L	1.85	20	TO-220
	0.5	5.0	ZVN3220L	8.0	75	TO-220
170	23	0.1	ZVN0117TA	0.1	0.7	E-Line
150	40	0.1	ZVN3315A	0.1	0.625	E-Line
			ZVN3315B	0.25	5	TO-39
			ZVN3315F	0.05	0.25	SOT-23
	16	0.25	ZVN2115A	0.16	0.7	E-Line
			ZVN2115B	0.42	5	TO-39
			ZVN2115L	0.50	20	TO-220
	2.5	1.0	ZVN2215B	1.85	20	TO-39
			ZVN2215L	1.85	20	TO-220
100	10	0.50	ZVN3310A	0.2	0.625	E-Line
			ZVN3310B	0.5	5	TO-39
			ZVN3310F	0.1	0.25	SOT-23
	4	1.0	ZVN2110A	0.32	0.7	E-Line
			ZVN2110B	0.85	5	TO-39
			ZVN2110L	1.5	20	TO-220
	0.8	2.0	ZVN2210B	3.45	20	TO-39
			ZVN2210L	3.45	20	TO-220
	0.18	8.0	ZVN3210L	14.0	75	TO-220
90	250	0.005	ZVN1409A	0.01	0.625	E-Line
80			ZVN1408A	0.01	0.625	E-Line
	10	0.5	ZVN1308A	0.2	0.625	E-Line
			ZVN1308B	0.5	5	TO-39
			ZVN1308F	0.1	0.25	SOT-23
	4	1.0	ZVN0108A	0.32	0.7	E-Line
			ZVN0108B	0.85	5	TO-39
			ZVN0108L	1.5	20	TO-220

N-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ @ Ω Max.	I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
80	0.8	2.0	ZVN2208B	3.45	20	TO-39
			ZVN2208L	3.45	20	TO-220
60	250	0.005	ZVN1406A	0.01	0.625	E-Line
	10	0.50	ZVN1306A	0.2	0.625	E-Line
			ZVN1306B	0.5	5	TO-39
			ZVN1306F	0.10	0.25	SOT-23
	5	0.50	VN10LP	0.3	0.625	E-Line
			VN10LF	0.15	0.25	SOT-23
			ZVN3306A	0.27	0.625	E-Line
			ZVN3306B	0.75	5	TO-39
			ZVN3306F	0.15	0.25	SOT-23
		0.2	BS 170P	0.5	0.625	E-Line
			BS 170F	0.15	0.25	SOT-23
	4	1.0	ZVN0106A	0.32	0.7	E-Line
			ZVN0106B	0.85	5	TO-39
			ZVN0106L	1.5	20	TO-220
	2		ZVN2106A	0.45	0.7	E-Line
			ZVN2106B	1.2	5	TO-39
			ZVN2106L	2.0	20	TO-220
	0.5	2.0	ZVN2206B	4.8	20	TO-39
			ZVN2206L	4.8	20	TO-220
	0.12	8.0	ZVN3206L	18.0	75	TO-220
40	250	0.005	ZVN1404A	0.01	0.625	E-Line
	5	0.5	ZVN3304A	0.27	0.625	E-Line
			ZVN3304B	0.75	5	TO-39
			ZVN3304F	0.15	0.25	SOT-23
	2	1.0	ZVN2104A	0.45	0.7	E-Line
			ZVN2104B	1.2	5	TO-39
			ZVN2104L	2.0	20	TO-220
	0.5	2.0	ZVN2204B	4.8	20	TO-39
			ZVN2204L	4.8	20	TO-220

MOSFETS

N-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ @ Ω Max.	I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
20	5	0.5	ZVN3302A	0.27	0.625	E-Line
			ZVN3302B	0.75	5	TO-39
			ZVN3302F	0.15	0.25	SOT-23
	2	1.0	ZVN0102A	0.45	0.7	E-Line
			ZVN0102B	1.2	5	TO-39
			ZVN0102L	2.0	20	TO-220
	0.5	2.0	ZVN2202B	4.8	20	TO-39
			ZVN2202L	4.8	20	TO-220

P-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ Ω Max.	@ I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
450	150	0.05	ZVP0545A	0.045	0.7	E-Line
			ZVP0545B	0.10	5	TO-39
			ZVP0545L	0.10	20	TO-220
400			ZVP0540A	0.045	0.7	E-Line
			ZVP0540B	0.10	5	TO-39
			ZVP0540L	0.10	20	TO-220
350	100	0.05	ZVP0535A	0.05	0.7	E-Line
			ZVP0535B	0.12	5	TO-39
			ZVP0535L	0.12	20	TO-220
300			ZVP0530A	0.05	0.7	E-Line
			ZVP0530B	0.12	5	TO-39
			ZVP0530L	0.12	20	TO-220
200	80	0.05	ZVP1320A	0.07	0.625	E-Line
			ZVP1320B	0.10	5	TO-39
			ZVP1320F	0.035	0.25	SOT-23
	32	0.125	ZVP0120A	0.11	0.7	E-Line
			ZVP0120B	0.25	5	TO-39
			ZVP0120L	0.25	20	TO-220
	12	0.5	ZVP2220B	0.9	20	TO-39
			ZVP2220L	0.9	20	TO-220
150	80	0.05	ZVP3315A	0.07	0.625	E-Line
			ZVP3315B	0.10	5	TO-39
			ZVP3315F	0.035	0.25	SOT-23
	32	0.125	ZVP2115A	0.11	0.7	E-Line
			ZVP2115B	0.25	5	TO-39
			ZVP2115L	0.25	20	TO-220
	12	0.5	ZVP2215B	0.9	20	TO-39
			ZVP2215L	0.9	20	TO-220
100	20	0.150	ZVP3310A	0.14	0.625	E-Line
			ZVP3310B	0.30	5	TO-39
			ZVP3310F	0.075	0.25	SOT-23
	8	0.375	ZVP2110A	0.23	0.7	SOT-23
			ZVP2110B	0.6	5	TO-39
			ZVP2110L	0.75	20	TO-220
	3	0.75	ZVP2210B	1.5	20	TO-39
			ZVP2210L	1.5	20	TO-220

MOSFETS

P-CHANNEL MOSFET SELECTION GUIDE

BV_{DSS} V Min.	$R_{DS(ON)}$ Ω Max. @	I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
80	20	0.15	ZVP1308A	0.14	0.625	E-Line
			ZVP1308B	0.30	5	TO-39
			ZVP1308F	0.075	0.25	SOT-23
	8	0.375	ZVP0108A	0.23	0.7	E-Line
			ZVP0108B	0.6	5	TO-39
			ZVP0108L	0.75	20	TO-220
	3	0.75	ZVP2208B	1.5	20	TO-39
			ZVP2208L	1.5	20	TO-220
60	20	0.15	ZVP1306A	0.14	0.625	E-Line
			ZVP1306B	0.30	5	TO-39
			ZVP1306F	0.075	0.25	SOT-23
	14	0.2	ZVP3306A	0.16	0.625	E-Line
			ZVP3306B	0.4	5	TO-39
			ZVP3306F	0.09	0.25	SOT-23
		0.2	BS250P	0.23	0.7	E-Line
			BS250F	0.09	0.25	SOT-23
	8	0.375	ZVP0106A	0.23	0.7	E-Line
			ZVP0106B	0.6	5	TO-39
			ZVP0106L	0.75	20	TO-220
	5	0.5	ZVP2106A	0.28	0.7	E-Line
			ZVP2106B	0.76	5	TO-39
			ZVP2106L	1.0	20	TO-220
	1.6	1.0	ZVP2206B	2.0	20	TO-39
			ZVP2206L	2.0	20	TO-220
40	14	0.2	ZVP3304A	0.16	0.625	E-Line
			ZVP3304B	0.4	5	TO-39
			ZVP3304F	0.09	0.25	SOT-23
	5	0.5	ZVP2104A	0.28	0.7	E-Line
			ZVP2104B	0.76	5	TO-39
			ZVP2104L	1.0	20	TO-220
	1.6	1.0	ZVP2204B	2.0	20	TO-39
			ZVP2204L	2.0	20	TO-220
20	14	0.2	ZVP3302A	0.16	0.625	E-Line
			ZVP3302B	0.4	5	TO-39

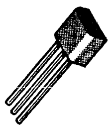
P-CHANNEL MOSFET SELECTION GUIDE

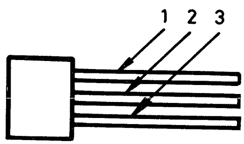
BV_{DSS} V Min.	$R_{DS(ON)}$ Ω Max.	@ I_D A	Device	$I_{D(cont)}$ A Max.	P_D W	Package
20	14	0.2	ZVP3302F	0.09	0.25	SOT-23
	5	0.5	ZVP0102A	0.28	0.7	E-Line
			ZVP0102B	0.76	5	TO-39
			ZVP0102L	1.0	20	TO-220
	1.6	1.0	ZVP2202B	2.0	20	TO-39
			ZVP2202L	2.0	20	TO-220

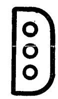
MOSFETS

PIN OUTS (For dimensions refer to section headed 'Package Outlines')

E-Line
Package Code Suffix A



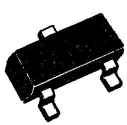


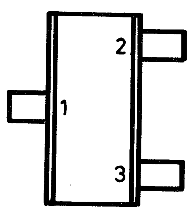


PIN OUT	
1	Drain
2	Gate
3	Source

Also available with various lead bends
and on Tape and Reel.

SOT-23
Package Code Suffix F



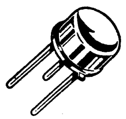


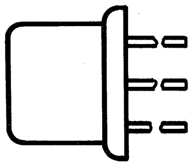
PIN OUT	
1	Drain
2	Source
3	Gate

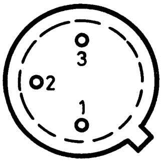
Available on Tape and Reel.

PIN OUTS (For dimensions refer to section headed 'Package Outlines')

TO-39
Package Code Suffix B

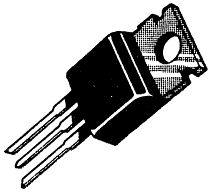


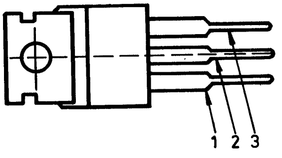




PIN OUT	
1	Source
2	Gate
3	Drain & Case

TO-220
Package Code Suffix L





PIN OUT	
1	Gate
2	Drain & Tab
3	Source

POWER TRANSISTORS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

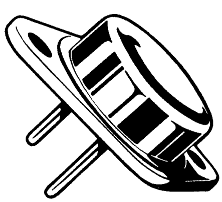
NPN DIFFUSED JUNCTION

TABLE 1 – NPN SILICON DIFFUSED JUNCTION TRANSISTORS

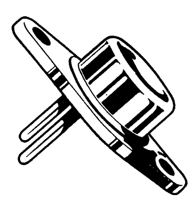
The transistors shown in this table are designed for high current, high dissipation applications where a large safe operating area is required. Typical application areas include a wide variety of power switching and linear applications such as regulators, inverters, audio-output stages and solenoid drivers.

The devices are listed in order of decreasing Collector Current ($I_C(max)$), Breakdown Voltages, Power Dissipation (P_{tot}) etc.

Type	$I_{C(max)}$ A	V_{CBO} V	V_{CEO} V	h_{FE} min.	h_{FE} max.	at I_C A	P_{tot} at T_{case} = 25°C W	Package
2N6103	16	45	40	15	60	8	75	TO-220
2N3055	15	100	60	20	70	4	115	TO-3
FGT3055	15	100	60	20	70	4	75	TO-220
2N3442	10	160	140	20	70	3	117	TO-3
2N6101	10	80	70	20	80	5	75	TO-220
2N6099	10	70	60	20	80	4	75	TO-220
2N3054	4	90	55	25	150	0.5	25	TO-66
2N3441	3	160	140	25	100	0.5	25	TO-66



TO-3

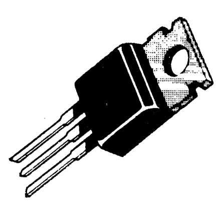


TO-66

PLASTIC POWER TRANSISTOR SELECTOR CHART (TO-220 PACKAGE)

V_{CEO} Volts	I_C 3 Amps (TIP) I_C 4 Amps (BD) NPN	PNP	5 Amps NPN	PNP	7 Amps NPN	PNP	7 Amps NPN	PNP	⩾ 10 Amps NPN
30					2N6288	2N6111			
40	TIP29	TIP30	TIP31	TIP32			TIP41	TIP42	2N6103
45	BD239	BD240	BD241	BD242			BD243	BD244	
50					2N6290	2N6109			
60	BD239A TIP29A	BD240A TIP30A	BD241A TIP31A	BD242A TIP32A			BD243A TIP41A	BD244A TIP42A	2N6099 FGT3055
70					2N6292	2N6107			
80	BD239B TIP29B	BD240B TIP30B	BD241B TIP31B	BD242B TIP32B			BD243B TIP41B	BD244B TIP42B	2N6101
100	BD239C TIP29C	BD240C TIP30C	BD241C TIP31C	BD242C TIP32C			BD243C TIP41C	BD244C TIP42C	
P_{tot}	30W	30W	40W	40W	40W	40W	65W	65W	75W note 1

Note 1: Refer to the Diffused Junction transistor section for more details of the devices in these columns.



TO-220

NPN PLASTIC POWER

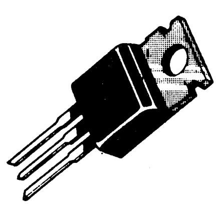
TABLE 2 – NPN EPITAXIAL BASE TRANSISTORS

The transistors shown in this table are designed for general purpose power applications and offer good switching and saturation performance with an excellent safe operating area in the popular TO-220 plastic package.

The devices are listed in order of decreasing Collector Current (I_C(max)), Breakdown Voltages, Power Dissipation (P_{tot}) etc.

Type	I_C(max) A	V_{CER} V	V_{CEO} V	h_{FE} Min.	h_{FE} Max.	at I_C A	P_{tot} at T_{case} =25°C W	PNP Complement
BD243C	6.5	115	100	15	—	3	65	BD244C
TIP41C	7	100	100	15	150	3	65	TIP42C
BD243B	6.5	90	80	15	—	3	65	BD244B
TIP41B	7	80	80	15	150	3	65	TIP42B
2N6292	7	80*	70	30	150	2	40	2N6107
BD243A	6.5	70	60	15	—	3	65	BD244A
TIP41A	7	60	60	15	150	3	65	TIP42A
2N6290	7	60*	50	30	150	2.5	40	2N6109
BD243	6.5	55	45	15	—	3	65	BD244
TIP41	7	40	40	15	150	3	65	TIP42
2N6288	7	40*	30	30	150	3	40	2N6111
BD241C	5	115	100	10	—	3	40	BD242C
TIP31C	5	100	100	10	50	3	40	TIP32C
BD241B	5	90	80	10	—	3	40	BD242B
TIP31B	5	80	80	10	50	3	40	TIP32B
BD241A	5	70	60	10	—	3	40	BD242A
TIP31A	5	60	60	10	50	3	40	TIP32A
BD241	5	55	45	10	—	3	40	BD242
TIP31	5	40	40	10	50	3	40	TIP32
BD239C	4	115	100	15	—	1	30	BD240C
TIP29C	3	100	100	15	150	1	30	TIP30C
BD239B	4	90	80	15	—	1	30	BD240B
TIP29B	3	80	80	15	150	1	30	TIP30B
BD239A	4	70	60	15	—	1	30	BD240A
TIP29A	3	60	60	15	150	1	30	TIP30A
BD239	4	55	45	15	—	1	30	BD240
TIP29	3	40	40	15	150	1	30	TIP30

*V_{CEX}



TO-220

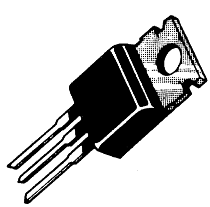
TABLE 3 – PNP EPITAXIAL BASE TRANSISTORS

The transistors shown in this table are designed for general purpose power applications and offer good switching and saturation performance with an excellent safe operating area in the popular TO-220 plastic package.

The devices are listed in order of decreasing Collector Current (I_C(max)), . Breakdown Voltages, Power Dissipation (P_{tot}) etc.

Type	I_C(max) A	V_{CER} V	V_{CEO} V	h_{FE} Min.	h_{FE} Max.	at I_C A	P_{tot} at T_{case} = 25°C W	PNP Complement
BD244C	6.5	115	100	15	—	3	65	BD243C
TIP42C	7	100	100	15	150	3	65	TIP41C
BD244B	6.5	90	80	15	—	3	65	BD243B
TIP42B	7	80	80	15	150	3	65	TIP41B
2N6107	7	80*	70	30	150	2	40	2N6292
BD244A	6.5	70	60	15	—	3	65	BD243A
TIP42A	7	60	60	15	150	3	65	TIP41A
2N6109	7	60*	50	30	150	2.5	40	2N6290
BD244	6.5	55	45	15	—	3	65	BD243
TIP42	7	40	40	15	150	3	65	TIP41
2N6111	7	40*	30	30	150	3	40	2N6288
BD242C	5	115	100	10	—	3	40	BD241C
TIP32C	5	100	100	10	50	3	40	TIP31C
BD242B	5	90	80	10	—	3	40	BD241B
TIP32B	5	80	80	10	50	3	40	TIP31B
BD242A	5	70	60	10	—	3	40	BD241A
TIP32A	5	60	60	10	50	3	40	TIP31A
BD242	5	55	45	10	—	3	40	BD241
TIP32	5	40	40	10	50	3	40	TIP31
BD240C	4	115	100	15	—	1	30	BD239C
TIP30C	3	100	100	15	150	1	30	TIP29C
BD240B	4	90	80	15	—	1	30	BD239B
TIP30B	3	80	80	15	150	1	30	TIP29B
BD240A	4	70	60	15	—	1	30	BD239A
TIP30A	3	60	60	15	150	1	30	TIP29A
BD240	4	55	45	15	—	1	30	BD239
TIP30	3	40	40	15	150	1	30	TIP29

*V_{CEX}



TO-220

DARLINGTONS

POWER DARLINGTON SELECTOR CHART

Package I_C / V_{CEO} Volts	TO-39 A	TO-39 2A	TO-220 10A (BDX) 8A (TIP) NPN	TO-220 10A (BDX) 8A (TIP) PNP	TO-3 10A
40	—	—	—	—	2N6383
45	BCX21	—	BDX33	BDX34	—
60	BD320 BD322	BD321 BD323	BDX33A TIP120	BDX34A TIP125	2N6384
80	— —	— —	BDX33B TIP121	BDX34B TIP126	2N6385
100	—	—	BDX33C TIP122	BDX34C TIP127	—
120	—	—	BDX33D	—	—

TABLE 4 – PNP SILICON HIGH CURRENT DARLINGTON TRANSISTORS

The devices shown in this table are designed for applications requiring very high current gain. The monolithic construction has the inherent advantages of fast switching times, low saturation voltages and low leakage currents.

The devices are listed in order of decreasing Collector Current (I_C(max)), Breakdown Voltages and Power Dissipation (P_{tot}) etc.

Type	I_C (Max) A	V_{CBO} V	V_{CEO} V	Max $V_{CE(sat)}$ V	at I_C A	at I_B mA	h_{FE} Min	h_{FE} Max	at I_C A	P_{tot} at $T_{case} = 25°C$ W	Package	Complement
BDX34C	10	100	100	2.5	3	6	750	—	3	70	TO-220	BDX33C
BDX34B	10	80	80	2.5	3	6	750	—	3	70	TO-220	BDX33B
BDX34A	10	60	60	2.5	4	8	750	—	4	70	TO-220	BDX33A
BDX34	10	45	45	2.5	4	8	750	—	4	70	TO-220	BDX33
TIP127	8	100	100	2	3	12	IK	—	3	65	TO-220	TIP122
TIP126	8	80	80	2	3	12	IK	—	3	65	TO-220	TIP121
TIP125	8	60	60	2	3	12	IK	—	3	65	TO-220	TIP120

TABLE 4a – NPN SILICON HIGH CURRENT DARLINGTON TRANSISTORS

The devices shown in this table are designed for applications requiring very high current gain. The monolithic construction has the inherent advantages of fast switching times, low saturation voltages and low leakage currents.

The devices are listed in order of decreasing Collector Current (I_C(max)), Breakdown Voltages and Power Dissipation (P_{tot}) etc.

Type	I_C (Max)	V_{CBO}	V_{CEO}	Max $V_{CE(sat)}$ at			h_{FE} at			P_{tot} at T_{case} = 25°C	Package	Complement
					I_C	I_B			I_C			
	A	V	V	V	A	mA	Min	Max	A	W		
BDX33D	10	120	120	2.5	3	6	750	—	3	70	TO-220	—
BDX33C	10	100	100	2.5	3	6	750	—	3	70	TO-220	BDX34C
2N6385	10	80	80	2.0	5	10	1K	20K	5	100	TO-3	—
BDX33B	10	80	80	2.5	3	6	750	—	3	70	TO-220	BDX34B
2N6384	10	60	60	2.0	5	10	1K	20K	5	100	TO-3	—
BDX33A	10	60	60	2.5	4	8	750	—	4	70	TO-220	BDX34A
BDX33	10	45	45	2.5	4	8	750	—	4	70	TO-220	BDX34
2N6383	10	40	40	2.0	5	10	1K	20K	5	100	TO-3	—
TIP122	8	100	100	2	3	12	1K	—	3	65	TO-220	TIP127
TIP121	8	80	80	2	3	12	1K	—	3	65	TO-220	TIP126
TIP120	8	60	60	2	3	12	1K	—	3	65	TO-220	TIP125
BD323C	2	80	60	1.7	2	2	10K	—	1	10	TO-39	—
BD323B	2	80	60	1.7	2	2	5K	—	1	10	TO-39	—
BD323A	2	80	60	1.7	2	2	1K	—	1	10	TO-39	—
BD321C	2	80	60	1.7	2	2	10K	—	1	5	TO-39	—
BD321B	2	80	60	1.7	2	2	5K	—	1	5	TO-39	—
BD321A	2	80	60	1.7	2	2	1K	—	1	5	TO-39	—
BD322C	1	80	60	1.6	1	1	10K	—	0.5	7.5	TO-39	—
BD322B	1	80	60	1.6	1	1	5K	—	0.5	7.5	TO-39	—
BD322A	1	80	60	1.6	1	1	1K	—	0.5	7.5	TO-39	—
BD320C	1	80	60	1.6	1	1	10K	—	0.5	5	TO-39	—
BD320B	1	80	60	1.6	1	1	5K	—	0.5	5	TO-39	—
BD320A	1	80	60	1.6	1	1	1K	—	0.5	5	TO-39	—
BCX21	1	60	45	1.6	1	1	1.5K	—	0.5	3.5	TO-39	—

HIGH VOLTAGE

NPN HIGH VOLTAGE SELECTOR CHART

Package I_C / V_{CEO} Volts	TO-39 <2A	TO-66 2-5A	TO-3 10A
140		2N3441	2N3442
175		2N3583	
250	2N3440	2N3584	
300		2N3585	
350	2N3439		

TABLE 5 – NPN HIGH VOLTAGE TRANSISTORS

The transistors shown in this table are characterised for high voltage operation in industrial, commercial and military equipments.

Typical application areas include differential and operational amplifiers, inverters, inductive switching and series regulators.

The devices are listed in order of decreasing Collector Current ($I_{C(max)}$), Breakdown Voltages, Power Dissipation (P_{tot}) etc.

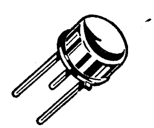
Type	I_C (Max) cont.	V_{CBO}	V_{CEO}	$V_{CE(sat)}$	at		h_{FE}		at	P_{tot} at T_{case} =25°C	Package
	A	V	V	V	I_C A	I_B mA	Min	Max	I_C A	W	
2N3442	10	160	160*	1	3	300	20	70	3	117	TO-3
2N3441	3	160	160*	1	0.5	50	25	100	0.5	25	TO-66
2N3585	2	500	300	0.75	1	125	25	100	1	35	TO-66
2N3584	2	375	250	0.75	1	125	25	100	1	35	TO-66
2N3583	2	250	175	0.75	1	125	10	—	1	35	TO-66
2N3439	1	450	350	0.5	0.05	4	40	160	0.02	10	TO-39
2N3440	1	300	250	0.5	0.05	4	40	160	0.02	10	TO-39

*V_{CEX} †Typical h_{FE}

PLANAR SWITCHING TRANSISTOR SELECTOR CHART

Devices listed are NPN except where marked with * which signifies PNP.

Package / I_C / V_{CEO} Volts	TO-39 1A	TO-39 2A	TO-39 3A	TO-39 5A	TO-39 7.5A	TO-39 10A
40	2N4037*			BSV60		
60	2N4036*	BSV64 BFX34	2N3418A 2N3420A BUY90*	BUX34 BUY80 BUY91*	BUY81 BUY92*	BUY82
80	2N4000		2N3419A 2N3421A			
100	2N4001					



TO-39

SWITCHING

TABLE 6 – NPN SILICON PLANAR HIGH CURRENT SWITCHING TRANSISTORS

The transistors shown in this table are designed for high current, high dissipation switching applications in Industrial and Military equipments.

The devices are listed in order of decreasing Collector Current, Breakdown Voltage, Power Dissipation, etc.

Type	I_C (Max)	V_{CEO}	Max $V_{CE(sat)}$	at		h_{FE}		at	Switching Times		at	P_{tot} at T_{case} = 25°C	Package
	A	V	V	I_C A	I_B A	min.	max.	I_C A	t_{on} ns	t_{off} ns	I_C A	W	
BUY82	10	60	1	10	0.75	15	—	10	320	245	10	30	TO-39
BUY81	7.5	60	1	7.5	0.5	10	—	7.5	160	430	5	24	TO-39
BUY80	5	60	1	5	0.5	15	—	5	170	200	5	20	TO-39
BUX34	5	60	1	5	0.5	40	150	2	140	180	5	20	TO-39
BSV60	5	40	0.9	2	0.2	40	120	2	500	1000	1	6.2	TO-39
2N3419A	3	80	0.5	2	0.2	20	60	1	300	3000	1	30	TO-39
2N3420A	3	80	0.5	2	0.2	40	120	1	300	3000	1	30	TO-39
2N3418A	3	60	0.5	2	0.2	20	60	1	300	3000	1	30	TO-39
2N3421A	3	60	0.5	2	0.2	40	120	1	300	3000	1	30	TO-39
BFX34	2	60	1	5	0.5	40	150	2	140	180	5	5	TO-39
BSV64	2	60	1	5	0.5	40	—	2	140	180	5	5	TO-39
2N4001	1	100	0.5	1	0.1	40	120	0.5	300	2000	0.5	20	TO-39
2N4000	1	80	0.5	1	0.1	30	120	0.5	300	2000	0.5	20	TO-39

TABLE 7 – PNP SILICON PLANAR HIGH CURRENT SWITCHING TRANSISTORS

The transistors shown in this table are designed for high current, high dissipation switching applications in Industrial and Military equipments.

The devices are listed in order of decreasing Collector Current, Breakdown Voltage, Power Dissipation, etc.

Type	I_C (Max)	V_{CEO}	Max $V_{CE(sat)}$	at		h_{FE}		at	Switching Times		at	P_{tot} at T_{case} = 25°C	Package
	A	V	V	I_C A	I_B A	min.	max.	I_C A	t_{on} ns	t_{off} ns	I_C A	W	
BUY92	7.5	60	1	7.5	0.75	40	—	1	—	—	—	30	TO-39
BUY91	5	60	1	5	0.5	40	—	1	—	—	—	25	TO-39
BUY90	3	60	1	3	0.3	40	—	1	—	—	—	20	TO-39
2N4036	1	65	0.65	0.15	0.015	40	140	0.15	110	700	0.15	1*	TO-39
2N4037	1	40	1.4	0.15	0.015	50	250	0.15	—	—	—	1*	TP-39

*at T_{amb} = 25°C

HIGH VOLTAGE/HIGH CURRENT SWITCHING TRANSISTORS

MAXIVOLT – A series of power transistors fully designed for high voltage switching application.

MAXIVOLT SELECTOR CHART

$I_{C(sat)}$		1A	5A	5A	10A	15A	20A	25A
V_{CEV}	260V	—	—	—	—	—	—	2N6686
	280V	—	—	—	—	—	—	2N6687
	300V	—	—	—	—	—	2N6688	—
	450V	2N6771* BUW40* —	2N6671 2N6738* BUW41*	— — —	2N6674 — —	2N6676 — —	— — —	— — —
	550V	2N6772* BUW40A* —	2N6672 2N6739* BUW41A*	— — —	2N6675 — —	2N6677 — —	— — —	— — —
	650V	2N6773* BUW40B* —	2N6673 2N6740* BUW41B*	— — —	2N6675 — —	2N6678 — —	— — —	— —
	800V	— — —	— — —	2N6751 BUX31 BUX32	— — —	— — —	— — —	— — —
	850V	—	—	2N6752	—	—	—	—
	900V	— — —	— — —	2N6753 BUX31A BUX32A	— — —	— — —	— — —	— — —
	1000V	— — —	— — —	2N6754 BUX31B BUX32B	— — —	— — —	— — —	— — —
Characteristics	Temp. to	LIMITS						
$I_{CEV(max)}$ at $V_{CE} = V_{CEV}$	25°C 100°C 125°C	0.1mA — 1mA	0.1mA — 1mA	0.1mA 1mA —	0.1mA 2mA —	0.1mA 1mA —	0.05mA — 0.5mA	0.05mA — 0.5mA
$V_{CE(sat)}$ (max.) at $I_{C(sat)}$	25°C 100°C 125°C	1V — 2V	1V — 2V	1V 1.5V —	1V 2V —	1V 2V —	1.5V — 1.5V	1.5V — 1.5V
$t_{r(max)}$ at $I_{C(sat)}$	25°C 100°C 125°C	0.2μs — 0.5μs	0.5μs — 0.8μs	0.45μs 0.6μs —	0.6μs 1μs —	0.6μs 1μs —	0.35μs — 0.6μs	0.35μs — 0.6μs
$t_{s(max)}$ at $I_{C(sat)}$	25°C 100°C 125°C	2.5μs — 4.5μs	2.5μs — 4μs	3μs 4μs —	2.5μs 4μs —	2.5μs 4μs —	0.8μs — 2.5μs	0.8μs — 2.5μs
$t_{r(max)}$ at $I_{C(sat)}$	25°C 100°C 125°C	0.4μs — 1.3μs	0.4μs — 0.8μs	0.4μs 0.7μs —	0.5μs 1μs —	0.5μs 1μs —	0.5μs — 0.8μs	0.5μs — 0.8μs
$t_{c(max)}$ at $I_{C(sat)}$	25°C 100°C 125°C	0.4μs — 1.3μs	0.4μs — 0.8μs	0.4μs 0.8μs —	0.5μs 0.8μs —	0.5μs 0.8μs —	0.5μs — 0.8μs	0.5μs — 0.8

All Maxivolt transistors are supplied in JEDEC TO-3 packages, except as noted below:
*Supplied in JEDEC TO-220 plastic package.

MAXIVOLT SERIES

TABLE 8 – NPN MULTI – EPITAXIAL DOUBLE DIFFUSED POWER SWITCHING TRANSISTORS

The devices shown in this table are specially designed for off-line switching power supplies, converters and p.w.m regulators. These Maxivolt transistors feature high voltage capability, fast switching speeds and high SOA ratings. They are 100% tested for parameters essential to the design of such circuits – including 100% testing under high temperature conditions for maximum switching efficiency.

The devices are listed in order of decreasing Collector Current ($I_{C(max)}$), Breakdown Voltages, Power Dissipation (P_{tot}) etc.

Type	$I_{C(sat)}$ A	V_{CBV} V	V_{CEO} V	h_{FE} at Min.	h_{FE} at I_C	h_{FE} at V_{CE}	Max. $V_{CE(sat)}$ at V	Max. $V_{CE(sat)}$ at I_C	Max. $V_{CE(sat)}$ at I_B	P_{tot} at T_{case} = 25°C W	Package
2N6687	25	280	180	15	25	2	1.5	25	2.5	200	TO-3
2N6686	25	260	160	15	25	2	1.5	25	2.5	200	TO-3
2N6688	20	300	200	15	20	2	1.5	20	2	200	TO-3
2N6678	15	650	400	8	15	3	1	15	3	175	TO-3
2N6677	15	550	350	8	15	3	1	15	3	175	TO-3
2N6676	15	450	300	8	15	3	1	15	3	175	TO-3
2N6675	10	650	400	8	10	2	1	10	2	175	TO-3
2N6674	10	450	300	8	10	2	1	10	2	175	TO-3
BUX32B	6	1000	500	8	6	3	1	6	1.2	150	TO-3
BUX32A	6	900	450	8	6	3	1	6	1.2	150	TO-3
BUX32	6	800	400	8	6	3	1	6	1.2	150	TO-3
2N6754	5	1000	500	8	5	3	1	5	1	150	TO-3
2N6753	5	900	500	8	5	3	1	5	1	150	TO-3
2N6752	5	850	450	8	5	3	1	5	1	150	TO-3
2N6751	5	800	400	8	5	3	1	5	1	150	TO-3
2N6673	5	650	400	10	5	3	1	5	1	150	TO-3
2N6672	5	550	350	10	5	3	1	5	1	150	TO-3
2N6671	5	450	300	10	5	3	1	5	1	150	TO-3
BUW41B	5	650	400	10	5	3	1	5	1	150	TO-3
2N6740	5	650	400	10	5	3	1	5	1	100	TO-220
BUW41A	5	550	350	10	5	3	1	5	1	100	TO-220
2N6739	5	550	350	10	5	3	1	5	1	100	TO-220
BUW41	5	450	300	10	5	3	1	5	1	100	TO-220
2N6738	5	450	300	10	5	3	1	5	1	100	TO-220
BUX31B	4	1000	500	8	4	3	1	4	0.8	150	TO-3
BUX31A	4	900	450	8	4	3	1	4	0.8	150	TO-3
BUX31	4	800	400	8	4	3	1	4	0.8	150	TO-3
BUW40B	1	650	400	10	1	3	1	1	0.2	40	TO-220
2N6773	1	650	400	10	1	3	1	1	0.2	40	TO-220
BUW40A	1	550	350	10	1	3	1	1	0.2	40	TO-220
2N6772	1	550	350	10	1	3	1	1	0.2	40	TO-220
BUW40	1	450	300	10	1	3	1	1	0.2	40	TO-220
2N6771	5	450	300	10	1	3	1	1	0.2	40	TO-220

SURFACE MOUNTED AND HYBRID DEVICES

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

SOT-23 PLASTIC ENCAPSULATED SEMICONDUCTORS

GENERAL INFORMATION

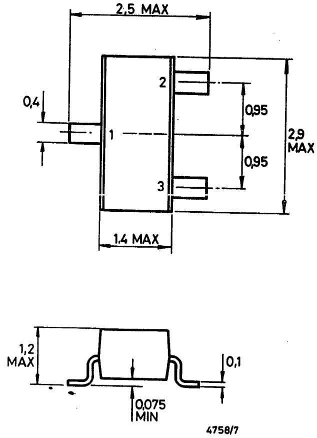
SOT-23 is the internationally standardised semiconductor package for hybrid and surface mountable assemblies of transistors and diodes. Designed specifically for use in thick film hybrid circuits the devices offer considerable advantages over other packages and "chip and wire" assembly techniques.

A wide range of bipolar transistors, MOSFETs and a variety of Schottky, Zener and Tuner diodes are available to help the designer maximise circuit performance.

This micro-miniature package provides the optimum cost/real estate solution to high volume hybrid and surface mount assemblies, whether in commercial, telecommunications, industrial or military applications.

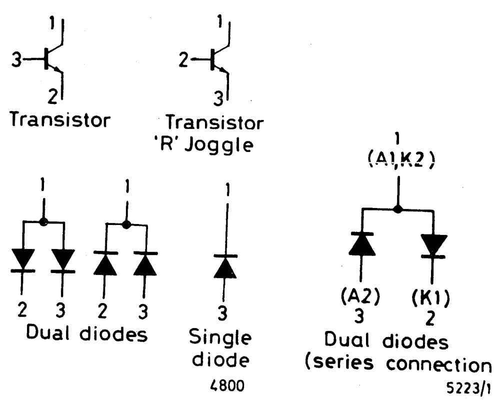
Ferranti Electronics Limited are engaged in an on-going approval exercise to enable the release of SOT-23 devices to BS/CECC specifications.

SOT-23 PACKAGE OUTLINE



Dimesions in millimetres

PIN CONNECTIONS



R joggle transistors are identified by a suffix R after the type number. Devices are identified by a code stamped on the body of the device according to the tables on pages H3 and H4.

For further information on the Ferranti range of MOSFET SOT-23 devices please refer to section headed MOSFETs.

MAXIMUM THERMAL RATINGS

Junction Temperature	175°C
Operating and Storage Temperature	−65°C to +175°C

SOT-23 TRANSISTORS & DIODES

PRODUCT LIST AND DEVICE IDENTIFICATION

TRANSISTORS		
Device Type	Standard marking	Reverse Joggle marking
BC846A	1A	—
BC846B	1B	—
BC847A	1E	—
BC847B	1F	—
BC848A	1J	—
BC848B	1K	—
BC848C	1L	—
BC849B	2B	—
BC849C	2C	—
BC850B	2F	—
BC850C	2G	—
BC856A	3A	—
BC856B	3B	—
BC857A	3E	—
BC857B	3F	—
BC858A	3J	—
BC858B	3K	—
BC858C	3L	—
BC859A	4A	—
BC859B	4D	—
BC859C	4C	—
BC860A	4E	—
BC860B	4F	—
BC860C	4G	—
BCV71	K7	K6
BCV72	K8	K9
BCW29	C1	C4
BCW30	C2	C5
BCW31	D1	D4
BCW32	D2	D5
BCW33	D3	D6
BCW60A	AA	—
BCW60B	AB	—
BCW60C	AC	AR
BCW60D	AD	—
BCW61A	BA	CA
BCW61B	BB	CB
BCW61C	BC	CC
BCW61D	BD	CD
BCW65A	EA	—
BCW65B	EB	—
BCW65C	EC	—
BCW66F	EF	7P
BCW66G	EG	5T
BCW66H	EH	—
BCW67A	DA	—
BCW67B	DB	—
BCW67C	DC	—
BCW68F	DF	—
BCW68G	DG	6T
BCW68H	DH	—

TRANSISTORS		
Device Type	Standard marking	Reverse Joggle marking
BCW69	H1	H4
BCW70	H2	H5
BCW71	K1	K4
BCW72	K2	K5
BCW89	H3	H6
BCX17	T1	T4
BCX18	T2	T5
BCX19	U1	U4
BCX20	U2	U5
BCX70G	AG	—
BCX70H	AH	—
BCX70J	AJ	AX
BCX70K	AK	P9
BCX71G	BG	CG
BCX71H	BH	6P
BCX71J	BJ	J8
BCX71K	BK	CK
BFQ31	S2	S3
BFQ31A	S4	S5
BFS20	G1	G4
BSS63	T3	T6
BSS64	U3	U6
BSS65	L1	L5
BSS66	M6	M8
BSS67	M7	M9
BSS69	L2	L6
BSS70	L3	L7
BSS79B	CE	—
BSS79C	CF	—
BSS80B	CH	—
BSS80C	CJ	—
BSS82B	CL	—
BSS82C	CM	—
BSV52	B2	B4
FMMT-A05	1H	—
FMMT-A06	1G	—
FMMT-A12	3W	—
FMMT-A13	1M	—
FMMT-A14	1N	—
FMMT-A20	1C	—
FMMT-A42	3E	7E
FMMT-A43	1E	5E
FMMT-A55	2H	—
FMMT-A56	2G	—
FMMT-A70	2C	—
FMMT-A92	4E	8E
FMMT-A93	2E	6E
FMMT38A	4J	—
FMMT38B	5J	—
FMMT38C	7J	—

SOT-23 TRANSISTORS & DIODES

PRODUCT LIST AND DEVICE IDENTIFICATION

TRANSISTORS

Device Type	Standard marking	Reverse Joggle marking
FMMT918	3B	—
FMMT2222	1B	2P
FMMT2222A	1P	3P
FMMT2369	1J	—
FMMT2369A	P5	—
FMMT2907	2B	—
FMMT2907A	2F	5P
FMMT3903	1W	—
FMMT3904	1A	—
FMMT3905	2W	—
FMMT3906	2A	—
FMMT4123	ZB	—
FMMT4124	ZC	—
FMMT4125	ZD	—
FMMT4126	ZE	—
FMMT4400	1K	—
FMMT4401	1L	—
FMMT4402	2K	—
FMMT4403	2L	—
FMMT5087	2M	3M
HT2	2T	—
HT3	3T	—

DIODES

Device Type	Device marking
BAL99	E2
BAR99	E3
BAS16	A3
BAV70	A4
BAV74	JA
BAV99	A7
BAW56	A1
BZX84-C2V7	W4
BZX84-C3V0	W5
BZX84-C3V3	W6
BZX84-C3V6	W7
BZX84-C3V9	W8
BZX84-C4V3	W9
BZX84-C4V7	Z1
BZX84-C5V1	Z2
BZX84-C5V6	Z3
BZX84-C6V2	Z4
BZX84-C6V8	Z5
BZX84-C7V5	Z6
BZX84-C8V2	Z7
BZX84-C9V1	Z8
BZX84-C10	Z9
BZX84-C11	Y1
BZX84-C12	Y2
BZX84-C13	Y3
BZX84-C15	Y4
BZX84-C16	Y5
BZX84-C18	Y6
BZX84-C20	Y7
BZX84-C22	Y8
BZX84-C24	Y9
BZX84-C27	X1
BZX84-C30	X2
BZX84-C33	X3
BZX84-C36	X4
BZX84-C39	X5
BZX84-C43	X6
BZX84-C47	X7
FMMD914	5D
FMMD6050	5A
FMMD6100	5B
FMMD7000	5C
HD2A	5D
HD3A	4D
HD4A	7D
ZC830	J1
ZC830A	J1
ZC830B	J1
ZC831	J3
ZC831A	J3
ZC831B	J4
ZC832	J4
ZC831A	J4
ZC832B	J4
ZC833	J2
ZC833A	J2
ZC833B	J2
ZC834	J5
ZC834A	J5
ZC834B	J5
ZC835	J6
ZC835A	J6
ZC835B	J6
ZC836	J7
ZC836A	J7
ZC836B	J7
ZC2800E	E6
ZC2811E	E8
ZC5800E	E9

APPROVED PRODUCTS

Device Type	BS/CECC number	Approval status	Device Type	BS/CECC number	Approval status
Diodes					
BAV70	50001 – 027	A	BCX17 – 18	50002 – 109	A
BAV70*	50001 – 052	A	BCX19 – 20	50002 – 119	A
BAV74	50001 – 028	A	BCX70	50002 – 120	A
BAV99	50001 – 029	A	BCX71	50002 – 111	A
BAV99*	50001 – 054	A	BFQ31 – 31A	50002 – 123	A
BAW56	50001 – 033	A	BSS66 – 67	50004 – 069	A
BAW56*	50001 – 055	A	BSS69 – 70*	50004 – 070	A
BZX84 Series	50005 – 008	A	BSV52	50004 – 071	A
BZX84 Series*	50005 – 009	A	FMMT2222/A	50004 – 055	A
FMMD914	50001 – 040	A	FMMT2369/A	50004 – 053	A
FMMD914*	50001 – 056	A	FMMT2907/A	50004 – 057	P
HD2A	50001 – 041	A	FMMT3903/4	50004 – 054	A
HD2A*	50001 – 048	A	FMMT3905/6	50004 – 056	A
HD3A	50001 – 042	P	FMMT-A05/6	50002 – 121	A
HD3A*	50001 – 049	A	FMMT-A12/13/14	50004 – 124	A
HD4A	50001 – 043	A	FMMT-A20	50002 – 122	A
HD4A*	50001 – 050	A	FMMT-A42/43	50002 – 211	P
			FMMT-A42/43*	50002 – 212	P
Transistors			FMMT-A55/56	50002 – 112	A
BCW29 – 30	50002 – 114	A	FMMT-A92/93	50002 – 213	A
BCW29 – 30*	50002 – 163	A	FMMT-A92/93*	50002 – 214	A
BCW31 – 33	50002 – 115	A	FST149	50002 – 142	A
BCW31 – 33*	50002 – 115	A	FST149*	50002 – 143	A
BCW60	50002 – 116	A	FST150	50002 – 144	A
BCW61	50002 – 110	A	FST150*	50002 – 145	A
BCW65 – 66	50002 – 117	A	HT2	50002 – 139	A
BCW67 – 68	50002 – 108	A	HT2*	50002 – 154	A
BCW69 – 70	50002 – 113	A	HT3	50002 – 140	A
BCW69 – 70*	50002 – 163	A	HT3*	50002 – 162	A
BCW71 – 72	50002 – 118	A			

*Indicates full plus additional assessment with long life requirements.

SOT-23 TRANSISTORS

NPN GENERAL PURPOSE

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min./max.	h_{FE} at I_C/V_{CE} mA/volts	$V_{CE(sat)}$ max Volts	$V_{CE(sat)}$ at I_C/I_B mA	f_T typical MHz
BC846A	80	65	100	300	110/220	2/5	0.25	10/0.5	300
BC846B	80	65	100	300	200/450	2/5	0.25	10/0.5	300
BCV71	80	60	100	300	100/220	2/5	0.25	10/0.5	300
BCV72	80	60	100	300	200/450	2/5	0.25	10/0.5	300
FMMT2484	60	60	50	300	100/500	0.01/5	0.35	1/0.1	200
FMMT3903	60	40	200	300	50/150	10/1	0.2	10/1	250§
FMMT3904	60	40	200	300	100/300	10/1	0.2	10/1	300§
BC847A	50	45	100	300	110/220	2/5	0.25	10/0.5	300
BC847B	50	45	100	300	200/450	2/5	0.25	10/0.5	300
BC850B	50	45	100	300	200/450	2/5	0.25	10/0.5	300
BC850C	50	45	100	300	420/800	2/5	0.25	10/0.5	300
BCW71	50	45	100	300	110/220	2/5	0.25	10/0.5	300
BCW72	50	45	100	300	200/450	2/5	0.25	10/0.5	300
BCX70G	45	45	200	300	120/220	2/5	0.35	10/0.25	250
BCX70H	45	45	200	300	180/310	2/5	0.35	10/0.25	250
BCX70J	45	45	200	300	250/460	2/5	0.35	10/0.25	250
BCX70K	45	45	200	300	380/630	2/5	0.35	10/0.25	250
BCW60A	32	32	200	300	120/220	2/5	0.35	10/0.25	250
BCW60B	32	32	200	300	180/310	2/5	0.35	10/0.25	250
BCW60C	32	32	200	300	250/460	2/5	0.35	10/0.25	250
BCW60D	32	32	200	300	380/630	2/5	0.35	10/0.25	250
FMMT4123	40	30	200	300	50/150	2/1	0.3	50/5	250
FMMT4214	30	25	200	300	120/360	2/1	0.3	50/5	300
BC848A	30	30	100	300	110/220	2/5	0.25	10/0.5	300
BC848B	30	30	100	300	200/450	2/5	0.25	10/0.5	300
BC848C	30	30	100	300	420/800	2/5	0.25	10/0.5	300
BC849B	30	30	100	300	200/450	2/5	0.25	10/0.5	300
BC849C	30	30	100	300	420/800	2/5	0.25	10/0.5	300
BCW31	30	20	100	300	110/220	2/5	0.25	10/0.5	300
BCW32	30	20	100	300	200/450	2/5	0.25	10/0.5	300
BCW33	30	20	100	300	420/800	2/5	0.25	10/0.5	300
FMMT-A20	40	40	100	300	40/400	5/10	0.25	10/1	125†

*Maximum power dissipation is calculated assuming that the device is mounted on a ceramic substrate measuring 10 × 8 × 0.6mm.

†Min at I_C = 5mA, V_{CE} = 10V, f = 100 MHz

§Min at I_C = 10mA, V_{CE} = 20V, f = 100 MHz

PNP GENERAL PURPOSE

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min./max.	at I_C/V_{CE} mA/volts	$V_{CE(sat)}$ max Volts	at I_C/I_B mA	f_T typical MHz
BC856A	80	65	100	300	110/220	2/5	0.3	10/0.5	150
BC856B	80	65	100	300	200/450	2/5	0.3	10/0.5	150
BCW89	80	60	100	300	120/260	2/5	0.3	10/0.5	150
FMMT3905	60	40	200	300	50/150	10/1	0.2	10/1.0	250§
FMMT3906	60	40	200	300	100/300	2/1	0.2	10/1.0	300§
FMMT-A70	50	50	100	300	40/400	5/10	0.3	10/1.0	150
FMMT5087	50	50	100	300	250/800	0.1/5	0.3	10/1.0	100
BC857A	50	45	100	300	110/220	2/5	0.3	10/0.5	150
BC857B	50	45	100	300	200/450	2/5	0.3	10/0.5	150
BC860A	50	45	100	300	110/220	2/5	0.25	10/0.5	300
BC860B	50	45	100	300	200/450	2/5	0.25	10/0.5	300
BC860C	50	45	100	300	420/800	2/5	0.25	10/0.5	300
BCW69	50	45	100	300	120/260	2/5	0.3	10/0.5	150
BCW70	50	45	100	300	215/500	2/5	0.3	10/0.5	150
BCX71G	45	45	200	300	120/220	2/5	0.25	10/0.25	180
BCX71H	45	45	200	300	180/310	2/5	0.25	10/0.25	180
BCX71J	45	45	200	300	250/460	2/5	0.25	10/0.25	180
BCX71K	45	45	200	300	380/630	2/5	0.25	10/0.25	180
BCW61A	32	32	200	300	120/220	2/5	0.25	10/0.25	180
BCW61B	32	32	200	300	180/310	2/5	0.25	10/0.25	180
BCW61C	32	63	200	300	250/460	2/5	0.25	10/0.25	180
BCW61D	32	32	200	300	380/630	2/5	0.25	10/0.25	180
FMMT4125	30	30	200	300	50/150	2/1	0.4	50/5	200
FMMT4126	25	25	200	300	120/360	2/1	0.4	50/5	250
BC858A	30	30	100	300	110/220	2/5	0.3	10/0.5	150
BC858B	30	30	100	300	200/450	2/5	0.3	10/0.5	150
BC858C	30	30	100	300	420/800	2/5	0.5	10/0.5	150
BC859A	30	30	100	300	110/220	2/5	0.25	10/0.5	300
BC859B	30	30	100	300	200/450	2/5	0.25	10/0.5	300
BC859C	30	30	100	300	420/800	2/5	0.25	10/0.5	300
BCW29	30	20	100	300	120/260	2/5	0.3	10/0.5	150
BCW30	30	20	100	300	215/500	2/5	0.3	10/0.5	150

*Device mounted on 10×8×0.6mm ceramic substrate.
§Min.at $I_C = 10mA$, $V_{CE} = 20V$, f = 100MHz

SOT-23 TRANSISTORS

NPN SWITCHING

Type	Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min./max.	at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max. Volts	at I_C/I_B mA	f_T Typ. MHz
BSS79B	75	40	800	300	40/120	150/10	0.3	150/15	250
BSS79C	75	40	800	300	100/300	150/10	0.3	150/15	250
FMMT2222A	75	40	600	300	100/300	150/10	0.3	150/15	300
FMMT4400	60	40	600	300	50/150	150/1	0.4	150/15	200
FMMT4401	60	40	600	300	100/300	150/1	0.4	150/15	200
BSS66	60	40	100	300	50/150	10/1	0.2	10/1	250
BSS67	60	40	100	300	100/300	10/1	0.2	10/1	300
FMMT2222	60	30	600	300	100/300	150/10	0.4	150/15	250
FMMT2369A	40	15	200	200	40/120	10/1	0.2	10/1	500
FMMT2369	40	15	200	200	40/120	10/1	0.25	10/1	500
BSV52	20	12	100	200	40/120	10/1	0.25	10/1	500

*Device mounted on 10×8×0.6mm ceramic substrate.

PNP SWITCHING

Type	Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min./max.	at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max. Volts	at I_C/I_B mA	f_T Typ. MHz
BSS82B	60	60	800	300	40/120	150/10	0.4	150/15	200
BSS82C	60	60	800	300	100/300	150/10	0.4	150/15	200
FMMT2907A	60	60	600	300	100/300	150/10	0.4	150/15	200
FMMT2907	60	40	600	300	100/300	150/10	0.4	150/15	200
BSS80B	60	40	800	300	40/120	150/10	0.4	150/15	200
BSS80C	60	40	800	300	100/300	150/10	0.4	150/15	200
FMMT4402	40	40	600	300	50/150	150/1	0.4	150/15	200
FMMT4403	40	40	600	300	100/300	150/1	0.4	150/15	200
BSS69	40	40	100	300	50/150	10/1	0.25	10/1	200
BSS70	40	40	100	300	100/300	10/1	0.25	10/1	250
BSS65	12	12	100	200	40/150	30/0.5	0.15	10/1	400

*Device mounted on 10×8×0.6mm ceramic substrate.

NPN MEDIUM POWER

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	V_{CES} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min/max	at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max Volts	at I_C/I_B mA	f_T at $I_C=20$mA MHz(min)	Noise Figure at $I_C=0.2$mA dB(max)	Complement
FMMTA06	80	80	500	350	50/—	10/1	0.25	100/10	100§	—	FMMTA56
BCW66F	75	45	1000	350	100/250	100/1	0.3	100/10	100	10	BCW68F
BCW66G	75	45	1000	350	160/400	100/1	0.3	100/10	100	10	BCW68G
BCW66H	75	45	1000	350	250/630	100/1	0.3	100/10	100	10	BCW68H
FMMTA05	60	80	500	350	50/—	10/1	0.25	100/10	100§	—	FMMTA55
BCW65A	60	32	1000	350	100/250	100/1	0.3	100/10	100	10	BCW67A
BCW65B	60	32	1000	350	160/400	100/1	0.3	100/10	100	10	BCW67B
BCW65C	60	32	1000	350	250/630	100/1	0.3	100/10	100	10	BCW67C
BCX19	50	45	1000	350	100/600	100/1	0.62	500/50	200†	—	BCX17/17R
BCX20	30	25	1000	350	100/600	100/1	0.62	500/50	200†	—	BCX18/18R

*Device mounted on 10 × 8 × 0.6mm ceramic substrate.
†Typical.
§Min. at $I_C = 10$mA, $V_{CE} = 2$V, f = 100MHz

PNP MEDIUM POWER

Type	V_{CES} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min/max	at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max Volts	at I_C/I_B mA	f_T at $I_C=20$mA MHz(min)	Noise Figure at $I_C=0.2$mA dB(max)	Complement
FMMTA56	80	80	500	350	50/—	10/1	0.25	100/10	100§	—	FMMTA06
BCW68F	60	45	1000	350	100/250	100/1	0.3	100/10	100	10	BCW66F
BCW68G	60	45	1000	350	160/400	100/1	0.3	100/10	100	10	BCW66G
BCW68H	60	45	1000	350	250/630	100/1	0.3	100/10	100	10	BCW66H
FMMTA55	60	60	500	350	50/—	10/1	0.25	100/10	100§	—	FMMTA05
BCW67A	45	32	1000	350	100/250	100/1	0.3	100/10	100	10	BCW65A
BCW67B	45	32	1000	350	160/400	100/1	0.3	100/10	100	10	BCW65B
BCW67C	45	32	1000	350	250/630	100/1	0.3	100/10	100	10	BCW65C
BCX17	50	45	1000	350	100/600	100/1	0.62	500/50	100†	—	BCX19/19R
BCX18	30	25	1000	350	100/600	100/1	0.62	500/50	100†	—	BCX20/20R

*Device mounted on 10 × 8 × 0.6mm ceramic substrate.
†Typical.
§Min. at $I_C = 10$mA, $V_{CE} = 2$V, f = 100MHz.

SOT-23 TRANSISTORS

DARLINGTON – NPN

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min	h_{FE} at I_C/V_{CE} mA/Volts	I_{CBO} nA	at V_{CB} Volts
FMMTA14	30	30	300	300	10K	10/5	100	30
FMMTA13	30	30	300	300	5K	10/5	100	30
FMMTA12	20	20	300	300	20K	10/5	100	15
FMMT38A	80	60	300	350	1K	500/5	100	60
FMMT38B	80	60	300	350	4K	500/5	100	60
FMMT38C	80	60	300	350	10K	500/5	100	60

*Device mounted on 10×8×0.6mm ceramic substrate.

HIGH VOLTAGE

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min/max	h_{FE} at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max. Volts	at I_C/I_B mA	Max. I_{CBO} μA	at V_{CB} Volts	Complement
NPN											
FMMTA42	300	300	200	300	40/–	10/10	0.5	20/2.0	0.1	200	FMMTA92
FMMTA43	200	200	200	300	40/–	10/10	0.4	20/2.0	0.1	160	FMMTA93
BSS64	120	80	100	300	20/–	4/1	0.7	4/0.4	50	90	BSS63
HT2	90	80	100	300	50/–	10/1	0.75	50/5	0.1	80	HT3
PNP											
FMMTA92	300	300	200	300	40/–	10/10	0.5	20/2.0	0.25	200	FMMTA42
FMMTA93	200	200	200	300	40/–	10/10	0.4	20/2.0	0.25	160	FMMTA43
BSS63	110	100	100	300	30/–	10/5	0.25	25/2.5	10	100	BSS64
HT3	90	80	100	300	50/–	10/1	0.75	50/5	0.1	80	HT2

*Device mounted on 10×8×0.6mm ceramic substrate.

NPN HIGH FREQUENCY

Type	V_{CBO} V	V_{CEO} V	I_C mA	P_{tot}* mW	h_{FE} min/max	h_{FE} at I_C/V_{CE} mA/V	f_T MHz (Typ.)	at I_C mA	C_{ib} at 1MHz pF (max.)	at V_{CE} V	C_{obo} at 1MHz pF (max.)	at V_{CE} V
FMMT918	30	15	100	200	20/–	3/1	600§	4	2.0	0.5	1.7	10
BFQ31/31A	30	15	100	200	20/100	3/1	600§	4	2.0	0.5	1.7	10
BFS20	30	20	25	200	40/–	7/10	450	5	0.4	10.0	0.8†	10

*Device mounted on 10×8×0.6mm ceramic substrate.
†Typical.
§Minimum.
N.B. Values quoted under C_{ib} and C_{ob} for BFS20 refer to C_{re} and C_{TC} respectively.

SILICON PLANAR HIGH SPEED SWITCHING DIODES

Ratings and Characteristics at 25°C ambient temperature

Type	Description	Ratings V_R Volts	Ratings I_F mA	t_{rr} max. ns	Max. V_F at I_F = mA 10/50/100
BAS16	Single diode	75	100	6	0.855/1.0/-
FMMD914	Single diode	75	75	4/8	1.0 / - /-
HD3A	Single diode	75	100	6	1.0 / - /-
BAL99	Single diode	70	100	6	0.855/1.1/1.3
BAR99	Single diode	70	100	6	0.855/1.1/1.3
FMMD6050	Single diode	70	100	6	- / - /1.1
FMMD7000	Dual diode with series connection	70	200	5	-/ - /1.1
BAV70	Dual diode with common cathode	70	100	6	0.855/1.1/1.3
BAV74	Dual diode with common cathode	50	150	4	- / - /1.0
HD2A	Dual diode with common cathode	75	100	6	1.0 / - /-
FMMD6100	Dual diode with common cathode	70	200	5	- / - 1.1
BAW56	Dual diode with common anode	70	100	6	0.855/1.1/1.3
HD4A	Dual diode with common anode	75	100	6	1.0 / - /-

SILICON PLANAR REFERENCE DIODES

Ratings and Characteristics at 25°C ambient temperature

Type	Reference Voltage V_Z at I_Z=5mA Volts Nom.	Min.	Max.	Differential Resistance r_Z at I_Z=5mA Ohms Max.	Temperature Coefficient S_Z at I_Z=5mA %/°C Typical	Reverse Current I_R µA Max.	at V_R Volts
BZX84-C2V7	2.7	2.5	2.9	120	−0.07	20.0	1
BZX84-C3V0	3.0	2.8	3.2	120	−0.07	10.0	1
BZX84-C3V3	3.3	3.1	3.5	110	−0.06	5.0	1
BZX84-C3V6	3.6	3.4	3.8	105	−0.07	5.0	1
BZX84-C3V9	3.9	3.7	4.1	100	−0.055	3.0	1
BZX84-C4V3	4.3	4.0	4.6	90	−0.045	3.0	1
BZX84-C4V7	4.7	4.4	5.0	80	−0.025	3.0	2
BZX84-C5V1	5.1	4.8	5.4	60	+0.02	2.0	2
BZX84-C5V6	5.6	5.2	6.0	40	+0.03	1.0	2
BZX84-C6V2	6.2	5.8	6.6	10	+0.04	3.0	4
BZX84-C6V8	6.8	6.4	7.2	15	+0.045	2.0	4
BZX84-C7V5	7.5	7.0	7.9	15	+0.05	1.0	5
BZX84-C8V2	8.2	7.7	8.7	15	+0.055	0.7	5
BZX84-C9V1	9.1	8.5	9.6	15	+0.06	0.5	6
BZX84-C10	10	9.4	10.6	20	+0.065	0.2	7
BZX84-C11	11	10.4	11.6	20	+0.07	0.1	8
BZX84-C12	12	11.4	12.7	25	+0.075	0.1	8
BZX84-C13	13	12.4	14.1	30	+0.075	0.1	9
BZX84-C15	15	13.8	15.6	30	+0.075	0.05	10
BZX84-C16	16	15.3	17.1	40	+0.08	0.05	11
BZX84-C18	18	16.8	19.1	45	+0.08	0.05	13
BZX84-C20	20	18.8	21.2	55	+0.08	0.05	14
BZX84-C22	22	20.8	23.3	55	+0.08	0.05	15
BZX84-C24	24	22.8	25.6	70	+0.08	0.05	17
	I_Z=2mA			I_Z=2mA	I_Z=2mA	I_Z=2mA	
BZX84-C27	27	25.1	28.9	80	+0.08	0.05	19
BZX84-C30	30	28	32	80	+0.08	0.05	21
BZX84-C33	33	31	35	80	+0.08	0.05	23
BZX84-C36	36	34	38	90	+0.08	0.05	25
BZX84-C39	39	37	41	130	+0.08	0.05	27
BZX84-C43	43	40	46	150	+0.08	0.05	30
BZX84-C47	47	44	50	170	+0.08	0.05	33

SILICON ION IMPLANTED HYPERABRUPT TUNER DIODES

Designed for use in VHF electronic tuning applications where large capacitance variations and high Q are required.

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	Reverse Breakdown Voltage V_R Volts max.	Nominal Capacitance at $V_R = 2V$, $f = 1MHz$ C_{tot} pF min.	typ.	max.	Capacitance Ratio $f = 1MHz$ C_2/C_{20} min.	max.	Q at $V_R = 3V$ $f = 50MHz$ min.
ZC830A	25	9.0	10	11.0	4.5	6.0	300
ZC831A	25	13.5	15	16.5	4.5	6.0	300
ZC832A	25	19.8	22	24.2	5.0	6.5	200
ZC833A	25	29.7	33	36.3	5.0	6.5	200
ZC834A	25	42.3	47	51.7	5.0	6.5	200
ZC835A	25	61.2	68	74.8	5.0	6.5	100
ZC836A	25	90.0	100	110.0	5.0	6.5	100

N.B. Tighter tolerances on diode capacitance, tracking, capacitance ratio can be supplied on request in matched sets of any numbers or in matched groups.

To order devices with nominal diode capacitance ±20% no suffix is used e.g. ZC833.

To order devices with nominal diode capacitance ±5% the suffix B is used e.g. ZC833B.

SCHOTTKY BARRIER DIODES

Applications under pulsed conditions include ultra high speed switching damping sampling gates and pulse shaping. RF applications include low noise mixers, large and small signal detectors, limiters and discriminators.

Type	V_F at $I_F = 1mA$ max. (mV)	V_{BR} at $I_R = 10\mu A$ min. (volts)	I_R max. nA at V_R (volts)		I_F at $V_F = 1V$ min. (mA)	C_T at $V_R = 0V$ $f = 1MHz$ max. (pF)
ZC2800E	410	70	200	50	15	2.0
ZC2811E	410	15	100	10	20	1.2
ZC5800E	410	50	200	35	15	2.0

STANDARD MATCHING SPECIFICATIONS

ZC2800 – ZC5800

Max. $\Delta V = 20mV$, $I_F = 0.5$ to $5.0mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

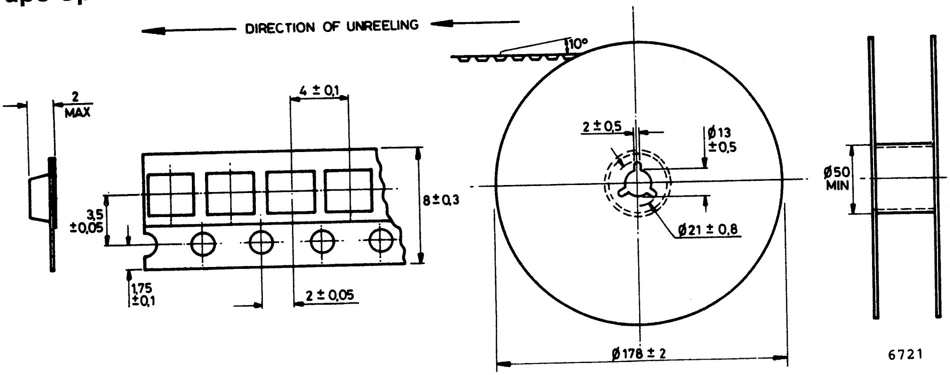
ZC2811

Max. $\Delta V = 20mV$, $I_F = 1$ to $10mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

TAPE AND REEL INFORMATION

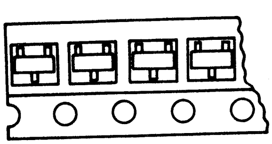
The complete range of SOT-23 devices is now availabe on Super-8 tape for use with automatic placement equipment. Tape packaging also has special attractions for customers using manual placement since it makes it easier to assemble and orientate these tiny components; stock accounting is also simplified.

Tape Specification

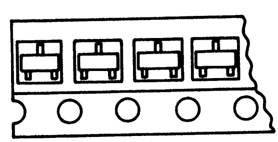


TAPE FEATURES

- Robust Plastic Tape.
- Each reel contains 3000 devices.
- 0.25% allowable missing devices/tape.
- No more than 2 consecutive vacant spaces on the tape.
- 100 min. allowable vacant spaces at the start of the reel and 50 min. at the end of the reel.
- Tape peel-off strength of 30 to 80 grm. at 10° angle, at 120mm per minute pull rate.
- Components available in two forms on tape.
- Ordering Format:
  Suffix "T" followed by A or B to indicate option required, (i.e. FMMT3904TA)



OPTION A



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OPTION B

SEMICONDUCTOR NETWORKS

Ferranti semiconductor networks are arrays of interconnected or isolated semiconductor dice encapsulated in a single multilead package.

In addition to a useful range of standard arrays, Ferranti offer a **custom-build engineering service** to design network package layouts to meet customers' own specifications. Networks can be designed to replace directly discrete semiconductor assemblies.

STANDARD PRODUCTS – SILICON PLANAR DUAL TRANSISTORS

A range of dual transistors for differential amplifiers and other applications requiring matched transistors with a high degree of parameter uniformity, encapsulated in multilead TO-5.

- The 2N2060 is also available to BS CECC specification 50002-097

Ratings and Characteristics
at 25°C ambient temperature (each transistor)

Type	Maximum Ratings					h_{FE} at I_C = 10mA V_{CE} = 6V*		f_T(Min.) MHZ at I_C	
	V_{CBO} Volts	V_{CEO} Volts	V_{EBO} Volts	I_C mA	P_{tot} mW	Min.	Max.		mA
ZDT40	45	35	4	500	300	75	200	200	10
ZDT41	60	45	7	500	300	75	170	200	10
ZDT42	60	60	7	500	300	60	200	200	10
ZDT44	60	60	7	500	300	60	200	200	10
ZDT45	100	70	7	500	300	60	200	200	10
2N2060	100	60	7	500	500	50	150	60	50
2N2223	100	60	7	500	500	50	200	50	50
2N2223A	100	60	7	500	500	50	200	50	50

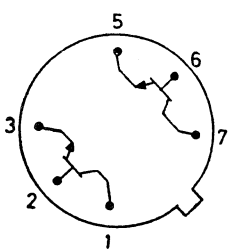
*Measured under pulsed conditions

Transistor Matching Characteristics

Type	Max Static Forward current Transfer Gain Ratio h_{FE1}/h_{FE2} Min.	Max.	Max. Base-Emitter Voltage Differential $\lvert V_{BE1} - V_{BE2} \rvert$ mV	Max. Voltage Differential Temperature Coefficient µV/°C
ZDT40	–	–	–	–
ZDT41	–	–	–	–
ZDT42	0.9	1.0	5	10
ZDT44	0.8	1.0	10	20
ZDT45	0.8	1.0	10	20
2N2060	0.9	1.0	5	10
2N2223	0.8	1.0	15	25
2N2223A	0.9	1.0	5	25

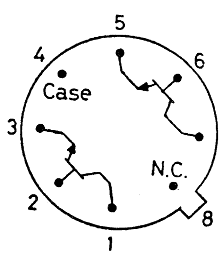
Pin Configuration

2N2060, 2N2223, 2N2223A

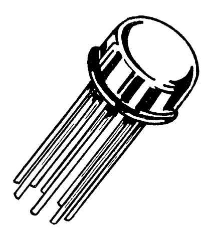


6 Lead TO-5 Pins 4 and 8 omitted
All leads electrically isolated from case.

ZDT40 through 45



8 Lead TO-5



8 Lead TO-5

SEMICONDUCTOR NETWORKS

STANDARD PRODUCTS – SILICON PLANAR QUAD TRANSISTORS

Devices in this range consist of four electrically isolated transistors encapsulated in a single moulded or ceramic dual in-line package. Their applications range from small signal amplification through to medium power switching and coredriving.

- FF3725JA Approved to BS/CECC 50004 019

General Description

Device type	Package	Description	Applications
FF2221E FF2221J	Moulded DIL Ceramic DIL	4 isolated n-p-n transistors similar to 2N2221	Designed for general purpose switching applications and d.c. to VHF amplifier circuits
FF2222E FF2222J	Moulded DIL Ceramic DIL	4 isolated n-p-n transistors similar to 2N2222	
FF2483E FF2483J	Moulded DIL Ceramic DIL	4 isolated n-p-n transistors similar to 2N2483	Designed for low level, low noise, high gain amplifier circuits
FF2484E FF2484J	Moulded DIL Ceramic DIL	4 isolated n-p-n transistors similar to 2N2484	
FF2906E FF2906J	Moulded DIL Ceramic DIL	4 isolated p-n-p transistors similar to 2N2906	Designed for general purpose switching applications and d.c. to VHF amplifier circuits
FF2907E FF2907J	Moulded DIL Ceramic DIL	4 isolated p-n-p transistors similar to 2N2907	
FF3467J	Ceramic DIL	4 isolated p-n-p transistors similar to 2N3467	Designed for high current, high speed switching applications such as core or wire memory driving
FF3725EA FF3725JA	Moulded DIL Ceramic DIL	4 isolated n-p-n transistors similar to 2N3725	

Ratings and Characteristics

at 25°C ambient temperature (each transistor)

Type		Maximum Ratings			h_{FE}		max		min f_T	
	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_D* mW	min/max at	I_C mA	$V_{CE(sat)}$ Volts at	I_C mA	MHz at	I_C mA
FF2221E	60	40	500	400	40/–	150	0.4	150	200	20.0
FF2221J	60	40	600	750	40/–	150	0.4	150	200	20.0
FF2222E	60	40	500	400	100/–	150	0.4	150	200	20.0
FF2222J	60	40	600	750	100/–	150	0.4	150	200	20.0
FF2483E	60	40	100	400	150/–	1	0.35	1	175†	0.5
FF2483J	60	40	100	600	150/–	1	0.35	1	175†	0.5
FF2484E	60	40	100	400	300/–	1	0.35	1	175†	0.5
FF2484J	60	40	100	600	300/–	1	0.35	1	175†	0.5
FF2906E	–60	–40	–600	600	40/–	–150	–0.4	–150	200	–50.0
FF2906J	–60	–40	–600	750	40/–	–150	–0.4	–150	200	–50.0
FF2907E	–60	–40	–600	600	100/–	–150	–0.4	–150	200	–50.0
FF2907J	–60	–40	–600	750	100/–	–150	–0.4	–150	200	–50.0
FF3467J	–40	–40	–1000	900	20/–	–500	–0.5	–500	190†	–50.0
FF3725EA	60	40	500	600	35/200	100	0.3	100	250	50.0
FF3725JA	60	40	1500	750	35/250	100	0.26	100	325†	50.0

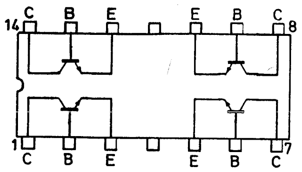
*Power dissipation per transistor. †Typical

Pin configurations overleaf.

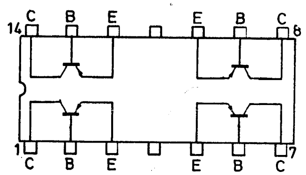
SEMICONDUCTOR NETWORKS

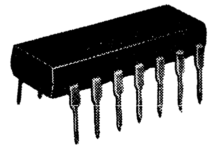
STANDARD PRODUCTS — SILICON PLANAR QUAD TRANSISTORS
Pin Configuration

n-p-n



p-n-p





14 Lead DIL

STANDARD PRODUCTS – SILICON PLANAR COREDRIVER DIODE ARRAYS

These arrays of 16 coredriver diodes are for use in high current, fast switching applications. Available in moulded D.I.L. and flat-pack encapsulation, these arrays have the advantages of high density packing and improved reliability.

- BAT22J Approved to British standards/CECC Specification 50001 015(F)
- BAT24H Approved to British standards/CECC Specification 50001 017(F)

Absolute Maximum Ratings
at 25°C ambient temperature

Type	Package	Single diode Max. V_{RWM} Volts	Max. mean forward current $I_F(Av)$ mA	Operating temperature range °C
BAT22	Moulded DIL	40	400	−55 to +150
BAT22J	Ceramic DIL	40	400	−65 to +200
BAT24H	Ceramic flat pack	40	300	−65 to +200
BAT26	Moulded DIL	40	400	−55 to +150
BAT28H	Ceramic flat pack	40	300	−65 to +200

Electrical Characteristics
at 25°C ambient temperature (single diode)

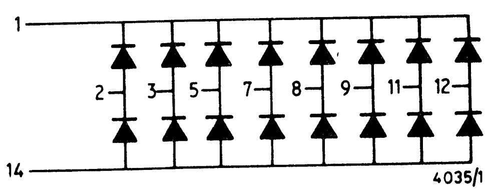
Type	Max. I_R at V_R µA	Volts	Max. V_F at $I_F = 100mA$ Volts	Max. Reverse Recovery Time T_{rr}* at $I_F = I_{RM} = 200mA$ $R_L = 100\Omega$ ns
BAT22	0.1	25	1.1	20
BAT22J	0.1	25	1.1	20
BAT24H	0.1	25	1.1	20
BAT26	0.1	25	1.1	20
BAT28H	0.1	25	1.1	20

*Time to recover to 10% of I_R Peak.

Circuit configurations

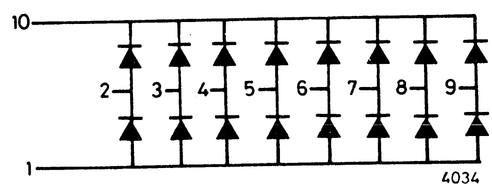
BAT22, BAT22J

14 lead DIL
leads 4, 6, 10 and 13 not connected



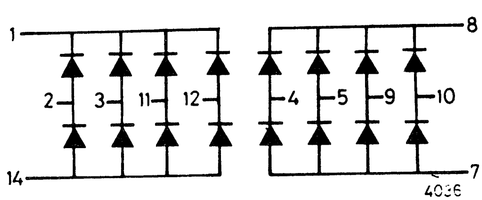
BAT24H

10 lead ceramic flat-pack



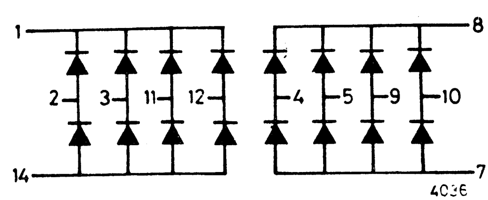
BAT26

14 lead DIL
leads 6 and 13 not connected



BAT28H

14 lead ceramic flat-pack
leads 6 and 13 not connected



SEMICONDUCTOR NETWORKS

CUSTOM DESIGNED NETWORKS

Ferranti Semiconductor Networks are arrays of interconnected or isolated semiconductor dice encapsulated in a multilead package. Within these networks it is practical to incorporate complementary transistors, Darlington pairs, matched sets of diodes or transistors, etc., selected from a wide variety of semiconductor types with well defined parameters. In addition, within the limitations of the package power dissipation and available lead-outs, many components can be encapsulated, thus achieving high packaging densities.

In the main, semiconductor networks are manufactured to meet customers' own requirements. The Ferranti custom-design engineering service will design network package layouts to replace discrete semiconductor assemblies.

The following pages are designed to assist those who may wish to use the above Ferranti service.

ADVANTAGES OF SEMICONDUCTOR NETWORKS

There are many instances where changing to a custom-built network can be advantageous

- **Where space is limited:** The high packing densities achievable within a network offer considerable space-saving to the equipment designer. This is often the main reason for changing from a discrete component assembly.
- **Improved Reliability:** A high order of reliability is achieved from network manufacturing techniques. The reliability of a system may be enhanced by employing a network where this reduces the number of soldered joints.
- **When assembly costs are high compared to component cost:** Networks are supplied fully tested and ready for installation and offer the ability to mount many semiconductor types in one operation, thus affording obvious cost-saving on assembly. In addition, networks can be manufactured to standard integrated circuit package outlines, assisting with standardisation of packages, an advantage when using automatic handling methods.
- **When requirements lie between a few hundred to many thousands:** This is where networks are most economical. For quantities in the hundreds of thousands it is often better to consider a monolithic circuit approach, assuming a standard commercial integrated circuit or known custom-built process meets with the requirements of performance and cost.
- **Limited tooling charges:** In many cases networks can be designed and manufactured without incurring any such charge. Where new lead frame design or extensive engineering effort is required, a contribution to development may be requested.

CHOICE OF PACKAGE

A variety of package styles can be specified for the encapsulation of networks, the choice depending on the particular application restraints.

- **Dual in-line (D.I.L.):** A plastic package particularly useful in printed circuit board assemblies where the area beneath the DIL encapsulation can be utilised for connections and cross-overs. Available in standard form with 14 or 16 leads, this package allows total maximum power dissipations up to 800mW at 15°C ambient temperature.
- **Ceramic Dual in-line:** A hermetic package offering the advantages of DIL encapsulation particularly suited for use in military environments. Available in standard form with 14 or 16 leads this package allows total maximum power dissipations up to 2W at 25°C ambient temperature.

SEMICONDUCTOR NETWORKS

- **Ceramic flat-pack**: A hermetic package offering advantages of flat-pack encapsulation particularly suited for use in military environments. Available in standard form with 10 or 14 leads. This package allows total maximum power dissipations up to 1.5W at 25°C ambient temperature.
- **Multilead TO-5**: A hermetic metal can package suitable for use in military environments. Available with 6, 8, 10 or 12 leads, this package allows total maximum power dissipations up to 1W at 25°C ambient temperature.

Ferranti will consider any suggestion to modify the lead configurations of the above packages to suit particular requirements.

CHOICE OF SEMICONDUCTORS

All dice used in Ferranti Networks are manufactured using planar technology. In general it is possible to replace discrete semiconductor assemblies directly in a network since Ferranti will undertake to select dice from standard ranges to meet special requirements, including dice matching.

CHOICE OF LEAD FRAME

In order to achieve optimum reliability from a semiconductor network certain rules with regard to packaging, bonding and to the choice of lead frame design must be obeyed. Ferranti's long experience in network manufacture has established an expertise in the design of networks within these constraints and an accumulation of a comprehensive set of readily available lead frame variants. Ferranti will undertake the design in conjunction with the customers circuit diagram and pinning preference. Typical layouts and lead frame designs are illustrated.

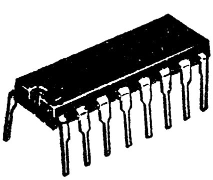
RELIABILITY AND TESTING

Ferranti ensure reliable operation of semiconductor networks by stringent quality control procedures at each phase of manufacture. Finally, networks are subject to environmental test prior to 100% electrical testing to an agreed specification.

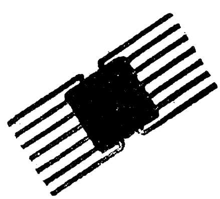
SPECIFICATION

A customer wishing to use the Ferranti Networks should provide a circuit diagram and specification incorporating the following information:

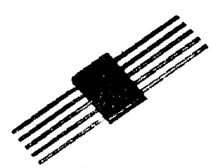
- **Package outline**
- **Pinning preference**
- **Temperature and dissipation requirements**
- **Ferranti device type numbers, if known**
- **Additional environmental requirements or tests**



16 Lead DIL



14 Lead 6.35mm × 6.35mm Ceramic Flat Pack



10 Lead 6.35mm × 4.44mm Ceramic Flat Pack

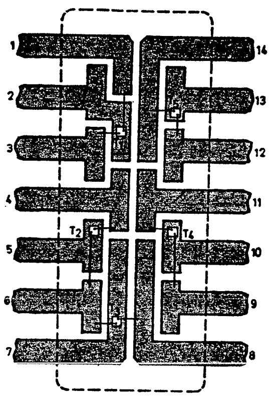
SEMICONDUCTOR NETWORKS

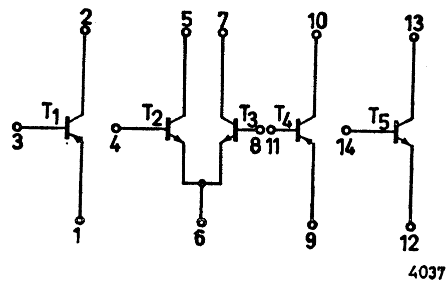
TYPICAL CUSTOM DESIGNED NETWORKS

The following diagrams depict typical network layouts and associated circuitry. In each case the lead frame is designed to key with the encapsulant and to give maximum rigidity to the pins. Unused pins are designed out unless otherwise specified.

It is important to note that dice-to-dice bonds and bonds to the lead frame in close proximity to a mounted dice are not used as these are considered reliability hazards. Also bond wires are kept as short as possible and crossed bonds are avoided to enhance reliability.

Circuit 1 – **A transistor array encapsulated in 14 lead D.I.L.**

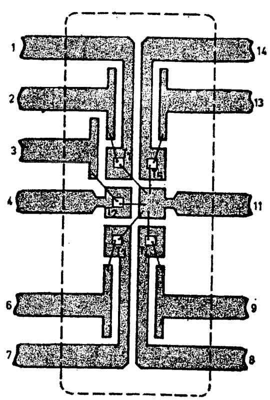


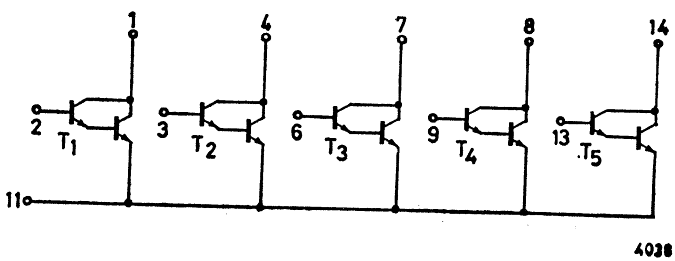


T_2 T_3 and T_5 are n-p-n transistors
T_1 and T_4 are p-n-p transistors

Circuit diagram.

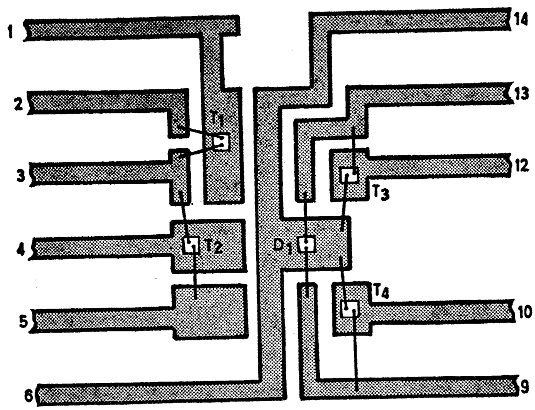
Circuit 2 – **An array of 5 monolithic darlington pairs encapsulated in modified 14 lead D.I.L.**

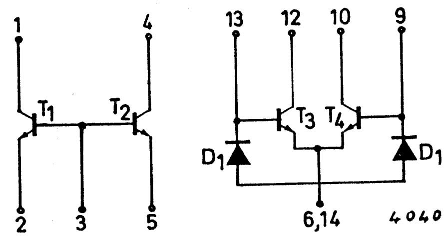




T_1 to T_5 are monolithic darlington pairs.

Circuit 3 – **A transistor and diode array encapsulated in modified 14 lead ceramic flat-pack (6.35 mm × 6.35 mm)**

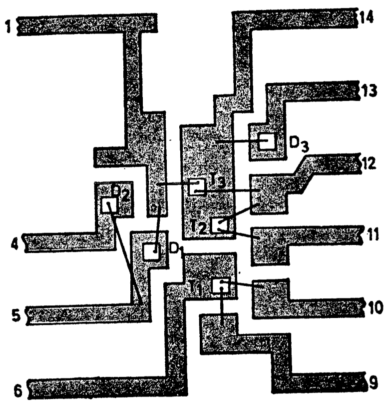


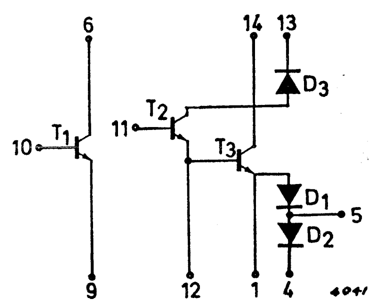


Circuit diagram.

T_1 to T_4 are n-p-n transistors
D_1 is a dual diode common anode.

Circuit 4 – **A transistor and diode array encapsulated in modified 14 lead ceramic flat-pack (6.35 mm × 4.44 mm)**





Circuit diagram.

T_1 to T_3 are n-p-n transistors
D_1 to D_3 are diodes.

R.F. TRANSISTORS AND DIODES

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

RF TRANSISTORS

SMALL SIGNAL

Many types are offered in a range of packages to enable the designer to select cost effective devices compatible with the equipment and market.

Small signal types are available in hermetic metal can packages for ultimate reliability and performance, in E-line silicone plastic for economy and reliability and SOT-23 and Micro-E micro-miniature packages for hybrid circuit construction.

TABLE 1 : RADIO, T.V. & I.F. TRANSISTORS

Ferranti R.F. transistors cover applications from consumer electronics to high performance modern communication equipment.

Type	V_{CBO} Volts Max.	V_{CEO} Volts Max.	V_{EBO} Volts Max.	I_C mA Max.	Typical Feedback Capacity	Typical f_T	Package
BFS20	30	20	4.0	25	0.35pF $I_C = 1mA$ $V_{CE} = 10V$ f = 1 MHz	550 MHz $I_C = 5mA$ $V_{CE} = 10V$ f = 100 MHZ	SOT-23
BFS20R*	30	20	4.0	25			SOT-23
BF196P†§	40	30	4.0	25	0.3pF $I_C = 1mA$ $V_{CE} = 10V$ f = 10.7 MHz	400 MHz $I_C = 4mA$ $V_{CE} = 10V$ f = 100 MHz	E-line (TO-92 style)
BF197P§	40	25	4.0	25	0.3pF $I_C = 1mA$ $V_{CE} = 10V$ f = 10.7 MHz	550 MHz $I_C = 5mA$ $V_{CE} = 10V$ f = 100 MHz	E-line (TO-92 style)

*Suffix R denotes reversed base and emitter lead connections.
§Pin connections for these devices are: c-e-b.
†BF196P Device has AGC characteristics.

TABLE 2 : R.F. TRANSISTORS UP TO 1 WATT

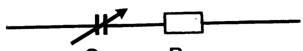
Suitable for drivers and general purpose RF amplifiers.

Type	Maximum Rating		R.F. Performance (Minimum)				Package
	V_{CBO} Volts	V_{CEO} Volts	V_{CC} Volts	P_{OUT} Watts	P_G dB	F_O MHz	
ZTX327	55	30	12.0	0.35	6.4	400	E-line
2N3866	55	30	28.0	0.7	8.5	400	TO-39
2N4427	40	20	12.0	1.0	10.0	175	TO-39

VARIABLE CAPACITANCE TUNER DIODES

FERRANTI TUNER DIODES are silicon epitaxial diffused p-n junction diodes which exhibit a voltage dependant junction capacitance when biased between the forward conduction region (0.7V) and reverse breakdown (up to −30V). By using epitaxial techniques, the quality factor (Q) of tuning diodes is such that they may be used in many applications where mechanical tuning was formerly used. Moreover, electronic tuning using these diodes has advantages over mechanical tuning using ganged capacitors because they are small, fast acting and can be tuned remotely.

Tuner diodes can be represented as a variable capacitance with a resistance in series (Fig. 1).



C_j = junction capacitance
R_s = series resistance

Fig. 1.

The capacitance of the junction is determined by the voltage, the area of the junction and the doping density of the semiconductor material. The relationship between capacitance and voltage is given by:

$$C_T = C_P + C_{jv}$$

$$C_{jv} = \frac{C_{jO}}{\left(1 + \frac{V_R}{\varnothing}\right)^N}$$

where C_T = total capacitance
C_P = stray capacitance due to package
C_{jO} = junction capacitance at 0V
C_{jv} = junction capacitance at applied bias voltage V_R
V_R = applied bias voltage
$\varnothing$ = contact potential
N = power law of the junction or slope factor

The power law N is determined by the impurity gradient of the diode; and is 0.33 for a graded junction and 0.5 for a step junction.

Referring to Fig. 1, the series resistance (R_S) is the sum of the resistance of the semiconductor element and of the package components.

The quality factor (Q) is quoted for a given frequency and is given by the equation:

$$Q = \frac{1}{2\pi f C j R_S}$$

To maximise Q, R_S must be minimised. This is achieved by the use of an epitaxial structure so minimising the amount of high resistivity material in series with the junction.

VARIABLE CAPACITANCE TUNER DIODES

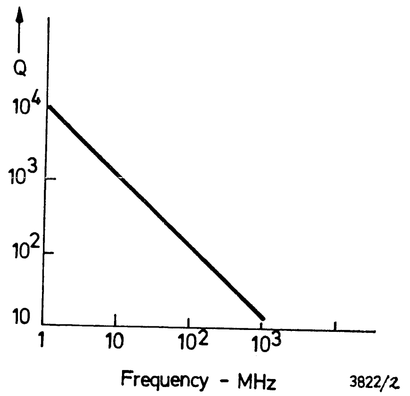


Fig. 2 – Variation of Q with frequency

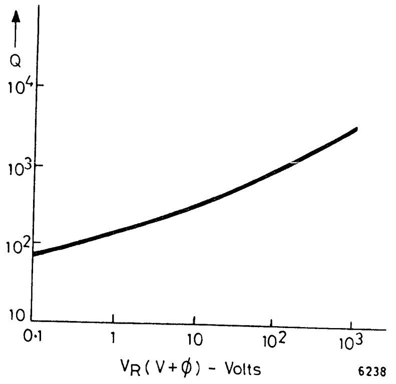


Fig. 3 – Variation of Q with bias voltage

Figures 2 and 3 show the variation of the quality factor with the frequency and bias voltage.

The design engineer must ensure that the epitaxial layer has a high enough resistivity to sustain the required voltage and enough width to allow a continuous change in capacitance until breakdown occurs.

As previously stated the power law N can be between 0.33 and 0.5 according to the type of junction. By utilising special diffusion techniques devices with power law approaching 0.5 (typically 0.47) can be obtained. By using planar techniques the capacitance can be closely controlled to within /10% and low leakage currents achieved.

The variation of capacitance with voltage is used in such applications as remote tuning and automatic frequency control in VHF, UHF and microwave systems. To minimise the production of harmonics the peak-to-peak variation of the signal waveform must be sufficiently small so as not to vary the capacitance significantly during the cycle.

Tuner diodes are particularly useful in FM modulators because of good linearity for small voltage variations.

HYPERABRUPT VARIABLE CAPACITANCE TUNER DIODES

SILICON ION IMPLANTED HYPERABRUPT TUNER DIODES

Designed for use in HF, VHF, UHF electronic tuning applications where large capacitance variations and high Q are required.

Ion implantation is a semiconductor doping technique enabling close control of doping and profile. Its use enables devices to be produced with consistant characteristics to closely controlled tolerances.

Applications of the technique to the manufacture of Hyperabrupt tuner diodes guarantees long term stability in the uniformity of the capacitance/voltage characteristics of these devices.

To appreciate the advantages of the Hyperabrupt tuner diodes ZC800 series, over conventional types when used in electronic tuning applications it is advantageous to consider the theory of the tuner diode.

As detailed in the conventional variable capacitance tuner diode section, the relationship between capacitance and bias voltage is given by:

$$C_{jv} = \frac{C_{jO}}{\left(1 + \frac{V_R}{\varnothing}\right)^N}$$

where C_{jO} = junction capacitance at 0V
C_{jv} = junction capacitance at applied bias voltage V_R
V_R = applied bias voltage
$\varnothing$ = contact potential
N = power law of the junction or slope factor

This may be simplified to the form $C \propto \frac{1}{V^N}$

For a conventional tuner diode, the value of N is typically 0.47. Fig. 4 shows the typical straight line graph for a ZC712 conventional ½ law tuner diode. It can be seen that by changing the applied bias voltage from 2 to 30 volts, the capacitance is reduced from 100pF to 33pF, representing a capacitance ratio of 3 to 1.

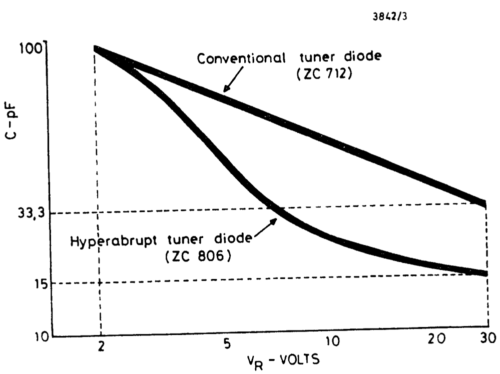


Fig. 4

Comparison of the C/V relationships of the Hyperabrupt and a conventional tuner diode.

By modifying the design of the diode it is possible to make N greater than 0.5, so providing a greater capacitance ratio for a given voltage change. As can be seen from Fig. 4, the 2 to 20V capacitance ratio for a ZC700 series diode is 2.8, whereas for the ZC806 hyperabrupt diode it is 6.5. In an LC tuned circuit in which the resonant frequency is proportional to $C^{-\frac{1}{2}}$, the use of the ZC800 series of hyperabrupt diodes allows a frequency tuning ratio in excess of 2:1 for an 18V change in bias voltage. For a similar 2:1 change in frequency a ZC700 (an abrupt) diode would demand a voltage change of greater than 40V.

TABLE 3 : VARIABLE CAPACITANCE TUNER DIODES
(ABRUPT TYPE)

ZC700, ZC740 Series

Designed for VHF and UHF electronic tuning applications, and other applications such as automatic frequency control.

Parameter ($T_{amb}=25°C$)	Symbol	Min.	Typ.	Max.	Unit
Reverse Breakdown Voltage	V_R	–	–	30.0	V
Reverse Voltage Leakage ($V_R=25V$)	I_R	–	–	0.02	μA
Case Capacitance	C_C	–	0.15	–	pF
Temperature coefficient of capacitance ($V_R=3V$)	η	–	0.02	–	%/°C

CHARACTERISTICS (at 25°C ambient temperature).

Type		C_T at $V_R=4V$, $f=1MHz$ pF			Min. C_2/C_{30} at $f=1MHz$	Min. Q at $V_R=4V$ $f=50MHz$	Package	
		Min.	Typ.	Max.			ZC700 to ZC714	ZC740 to ZC754
							Glass	Plastic
ZC700	ZC740	6.12	6.8	7.48	2.7	450	DO-7	E-line
ZC701	ZC741	7.4	8.2	9.1	2.7	450	DO-7	E-line
ZC702	ZC742	9.0	10.0	11.0	2.7	400	DO-7	E-line
ZC703	ZC743	10.8	12.0	13.2	2.8	400	DO-7	E-line
ZC704	ZC744	13.5	15.0	16.5	2.8	400	DO-7	E-line
ZC705	ZC745	16.2	18.0	19.8	2.8	350	DO-7	E-line
ZC706	ZC746	19.8	22.0	24.2	2.8	350	DO-7	E-line
ZC707	ZC747	24.3	27.0	29.7	2.8	300	DO-7	E-line
ZC708	ZC748	29.7	33.0	36.3	2.8	200	DO-7	E-line
ZC709	ZC749	35.1	39.0	42.9	2.8	150	DO-7	E-line
ZC710	ZC750	42.3	47.0	51.7	2.8	150	DO-7	E-line
ZC711	ZC751	50.4	56.0	61.6	2.8	150	DO-7	E-line
ZC712	ZC752	61.2	68.0	74.8	2.8	150	DO-7	E-line
ZC713	ZC753	73.8	82.0	90.2	2.8	100	DO-7	E-line
ZC714	ZC754	90.0	100.0	110.0	2.8	100	DO-7	E-line

TABLE 4 : VARIABLE CAPACITANCE TUNER DIODES (HYPERABRUPT TYPE)

Hyperabrupt tuning diodes may be used in any electronic tuning system to replace conventional tuning diodes.

Remote tuning control, automatic frequency control and octave tuning in mobile, airborne and other systems in which limited voltages are available or desirable are typical applications.

ZC800, ZC820 and ZC830A Series

Parameter ($T_{amb} = 25°C$)	Symbol	Value	Unit
Reverse Breakdown Voltage	V_R	25	Volts
Forward Current	I_F	200	mA
Power Dissipation – ZC800 Series ZC820 Series ZC830A Series	P_D* P_D* P_D*	400 300 200	mW mW mW
Junction Temperature – ZC800 Series ZC820 Series ZC830A Series	T_j T_j T_j	175 125 125	°C °C °C
Storage Temperature Range	T_{stg}	–65 to +200	°C

*Power dissipation is calculated assuming that the device is mounted on a ceramic substrate measuring 10 × 8 × 0.6mm.

CHARACTERISTICS (at 25°C ambient temperature).

Type		Nominal Capacitance in pF $V_R = 2V$, f = 1 MHz			Minimum Q at $V_R = 3V$ f = 50 MHz	Capacitance Ratio C_2/C_{20}, f = 1 MHz	
Glass DO-7	Plastic E-line	Min.	Nom.	Max.		Min.	Max.
ZC800	ZC820	8	10	12	300	4.5	6.0
ZC801	ZC821	12	15	18	300	4.5	6.0
ZC802	ZC822	17.6	22	26.4	200	5.0	6.5
ZC803	ZC823	26.4	33	39.6	200	5.0	6.5
ZC804	ZC824	37.6	47	56.4	200	5.0	6.5
ZC805	ZC825	54.4	68	81.6	100	5.0	6.5
ZC806	ZC826	80.0	100	120.0	100	5.0	6.5
SOT-23							
ZC830A		9.0	10	11.0	300	4.5	6.0
ZC831A		13.5	15	16.5	300	4.5	6.0
ZC832A		19.8	22	24.2	200	5.0	6.5
ZC833A		29.7	33	36.3	200	5.0	6.5
ZC834A		42.3	47	51.7	200	5.0	6.5
ZC835A		61.2	68	74.8	100	5.0	6.5
ZC836A		90.0	100	110.0	100	5.0	6.5

In all cases Maximum Reverse Voltage Leakage Current, $I_R = 0.02\mu A$ at $V_R = 20V$

To order devices with 2V nominal capacity ±10% add suffix A, ±5% add suffix B

N.B. Tighter tolerance on diode capacitance ratio can be supplied on request. Such devices can be supplied in matched sets with or without a specified tracking tolerance as required.

SCHOTTKY BARRIER DIODES

Under forward bias, conduction is by electrons injected into the n-type region from the metal layer. This results in the base region (N-type) of the Schottky Barrier Diode (S.B.D.), under forward bias, remaining a relatively high resistance which affects the forward slope resistance of the device (see fig. 1). For the ZC2800 device this forward slope resistance is typically 20 to 30 ohms compared with about 1 ohm for a p-n junction of similar dimensions.

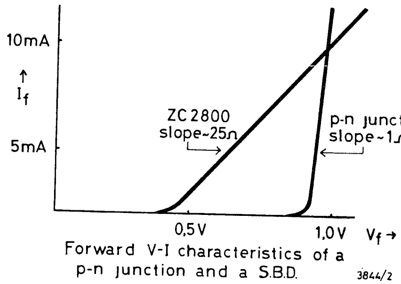


Fig. 5

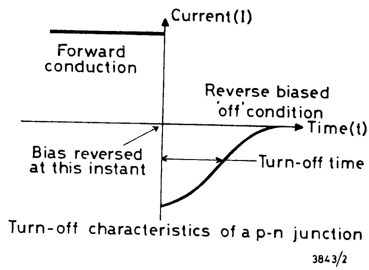


Fig. 6

The absence of injected minority carriers leads to the S.B.D's most important characteristic – its very fast turn-off time. When a p-n junction is switched from forward to reverse bias a large current comprising the injected minority carriers, continues to flow until all these carriers have been swept out of the base region. The device then blocks further current flow apart from a small leakage but the time involved between switching to reverse bias and the device turning 'off' is usually in the range of 1 to 100ns (see Fig. 6).

The S.B.D., with no minority carriers to be removed, turns off much more quickly; the ZC2800 requires a time of less than 100ps.

The S.B.D. turns on at a lower value of forward bias than do p-n junctions. The ZC2800 requires approximately 0.4V compared with approximately 0.8V for a similar sized p-n junction (see Fig 5).

Summarising, the characteristics of these devices are fast switching speed, low forward turn-on voltage, low stored charge, low reverse leakage current and high rectification efficiency. Applications include high and low level detection, mixing and modulation in the U.H.F. region, also pulse-shaping, voltage clamping, and any uses requiring pico-second switching times. For use as mixers and modulators, devices can be supplied in matched pairs or quads in any of the listed packages.

TABLE 5 : SCHOTTKY BARRIER DIODES

These devices have a high breakdown voltage and ultra fast switching capabilities. R.F. applications include low noise mixers, large and small signal detectors, limiters and discriminators. Applications under pulsed conditions include ultra high speed switching, clamping, sampling gates and pulse shaping.

AVAILABLE IN: E-LINE (TO-92 Style)
SOT-23 MICROMINIATURE

ABSOLUTE MAXIMUM RATINGS (SOT-23 and E-line).

Parameter	Symbol	ZC2800, ZC2811 ZC5800	Unit
Power Dissipation*	P_{tot}	250	mW
Operating Temperature	T_{amb}	−65 to +200	°C
Storage Temperature	T_{stg}	−65 to +200	°C

*Derate to zero at 200°C and measured using an infinite heat sink.
Note: Matched pairs or Quads of diodes can be supplied on request.

STANDARD MATCHING SPECIFICATIONS (all packages):

ZC2800 – ZC5800
Max. $\Delta V = 20mV$, $I_F = 0.5$ to $5.0mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

ZC2811
Max. $\Delta V = 20mV$, $I_F = 1$ to $10mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

SCHOTTKY BARRIER DIODES

CHARACTERISTICS (at 25°C ambient temperature) SOT-23 and E-line.

Parameter	Type	Symbol	Min.	Max.	Unit	Test Conditions
Breakdown Voltage	ZC2800 ZC2811 ZC5800	V_{BR}	70 15 50	— — —	V V V	$I_R = 10\mu A$
Reverse leakage current	ZC2800 ZC2811 ZC5800	I_R	— — —	200 100 200	nA nA nA	$V_R = 50V$ $V_R = 10V$ $V_R = 35V$
Forward voltage	ZC2800 ZC2811 ZC5800	V_F	— — —	410 410 410	mV mV mV	$I_F = 1mA$
Forward current	ZC2800 ZC2811 ZC5800	I_F	15 20 15	— — —	mA mA mA	$V_F = 1V$
Capacitance	ZC2800 ZC2811 ZC5800	C_T	— — —	2.0 1.2 2.0	pF pF pF	$V_R = 0V$ $f = 1MHz$
Effective minority lifetime	ZC2800 ZC2811 ZC5800	τ	— — —	100 100 100	ps ps ps	Krakauer method

SEMICONDUCTOR DICE

The increasing demand within the electronics industry for miniaturisation coupled with improved subsystem reliability and reduced costs has resulted in a rapid expansion of hybrid micro-circuit activity. This in turn has increased the pressure on semiconductor manufacturers to supply components compatible with hybrid circuit assembly techniques.

In response Ferranti Electronics Limited have made their wide range of planar passivated semiconductor dice available against the FSD 1001 specification contained herein.

As a result of the many testing and shipping alternatives available for semiconductor dice, their purchase is not as clear cut as that of their encapsulated counterparts. This specification is designed to alleviate some of the problems involved in the procurement of dice by explaining the shipping options, specification, and guarantees offered by Ferranti Electronics Limited for their supply.

CONTENTS

GENERAL INFORMATION

The basic silicon dice is the smallest form of semiconductor available and provides an optimum solution where hybrid real estate is at a premium. However, against this one must off-set the additional care and more sophisticated handling precautions that are essential if the hybrid manufacturer is to take full advantage of the economies associated with the purchase of bare silicon dice.

Ferranti offers a wide range of planar passivated discrete and integrated circuit semiconductors in unencapsulated dice and wafer form covering many active component requirements. The range includes transistors having high gain at collector currents of a few micro-amps to transistors operating at several amps and with high collector voltages, switching and low leakage diodes available in common anode and common cathode multiple arrays, reference diodes up to 47 volts.

The available range of dice is continually being extended as new device types are introduced. If your specific requirement is not covered in the published literature, please refer to our Sales Department who will be pleased to discuss the matter with you.

(a) PHYSICAL CHARACTERISTICS

Actual dice geometries and dimensions are contained in pages SD18 onwards. The following table gives a general guide to dice thickness which is a function of the normal dice area, i.e. larger area devices must be thicker than the small area devices to maintain mechanical strength.

	Nominal Dice Size (millimetres)	Dice Thickness (millimetres)	Maximum Taper (millimetres)
Discrete Components	0.380 × 0.380 to 0.480 × 0.480	0.089 to 0.140	0.0254
	0.510 × 0.510 to 0.640 × 0.640	0.120 to 0.170	0.0254
	0.660 × 0.660 and above	0.135 to 0.185	0.0254
Integrated Circuits	See section 4 for Dice Sizes	0.330 to 0.410 (See Note 1)	0.0254

Note 1: The thickness indicated refers to standard dice supplied individually or in slice form. Reduced thickness slices suitable for scribing and cracking are available on request.

All discrete dice are backed with gold layer, minimum 1500A thick, which is evaporated onto the slice and then sintered in at temperature to ensure its integrity. Integrated circuit dice do not require back contact but are provided with suitably finished back surface.

Both backing processes are designed such that Ferranti dice are compatible with both eutectic and epoxy mounting techniques.

Top contacts are aluminium for discrete dice and silicon aluminium for TTL dice, both suitable for conventional thermo-compression and ultrasonic bonding with gold or aluminium wire.

(b) RELIABILITY

All dice supplied by Ferranti Electronics Limited are selected from those used in the manufacture of the Ferranti product range, which includes devices which have attained the level of performance necessary for acceptance as BS/CECC approved products. They are produced on the same well proven production lines and subjected to the same rigid process control procedures at each stage of manufacture to ensure the reliability and performance of the final product.

(c) HANDLING PRECAUTIONS

All dice are planar passivated, but it is necessary to ensure they are not subjected to abnormally high humidities and temperatures. Production equipment should ideally conform at least to the minimum standard of equipment normally employed by semiconductor manufacturers.

(d) PACKAGING AND SUPPLY ALTERNATIVES

Semiconductor dice are supplied in a variety of shipping options as follows:

1 Wafer or Slice form – Unscribed wafers or slices in unprobed or probed form. In the case of unprobed wafers or slices it is obviously impossible to guarantee the number of good dice on a wafer. All that can be offered is an indication of the normal yields found on our own probe tests.

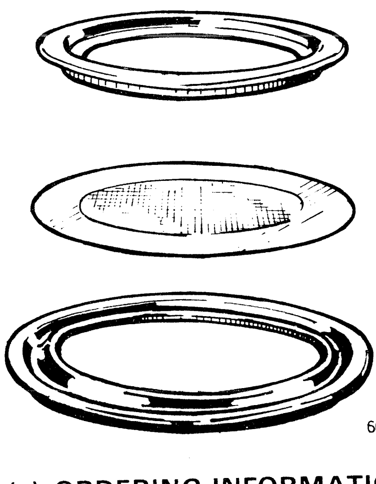
Probed slices or wafers are tested to the major d.c. parameters for discrete devices and functional for integrated circuits, rejects being automatically inked. In both cases unscribed slices or wafers are shipped in specially designed plastic boxes offering the highest degree of protection and preventing movement and breakages.

2 Dice Carrying Diaphragm – For the supply of individual dice Ferranti have developed a dice carrying diaphragm. After slices have been probed (rejects inked) and scribed, sections of the slice (1/4 or 1/6 dependent upon size of dice) are laid on low adhesive film and cracked. The film with the 1/4 or 1/6 wafer is then stretched over a metal ring and held in position by a second ring pressed over the first.

In this way dice are separated whilst retaining the relative position they held in slice form, with each die orientated in the same way, i.e. geometries aligned.

In the case of large discrete devices a similar method is used employing a vacuum process to hold the dice in place.

DICE DIAPHRAGM



6605

In each case this method of dice shipment enables the user to employ both automatic and hand assembly techniques for liberating the die.

(e) ORDERING INFORMATION

Dice should be ordered by quoting the encapsulated component reference followed by the word 'dice'.

This specification, FSD1001, should be quoted along with the shipping required.

e.g.: 2N2369 DICE to FSD1001 – OPTION 'B'

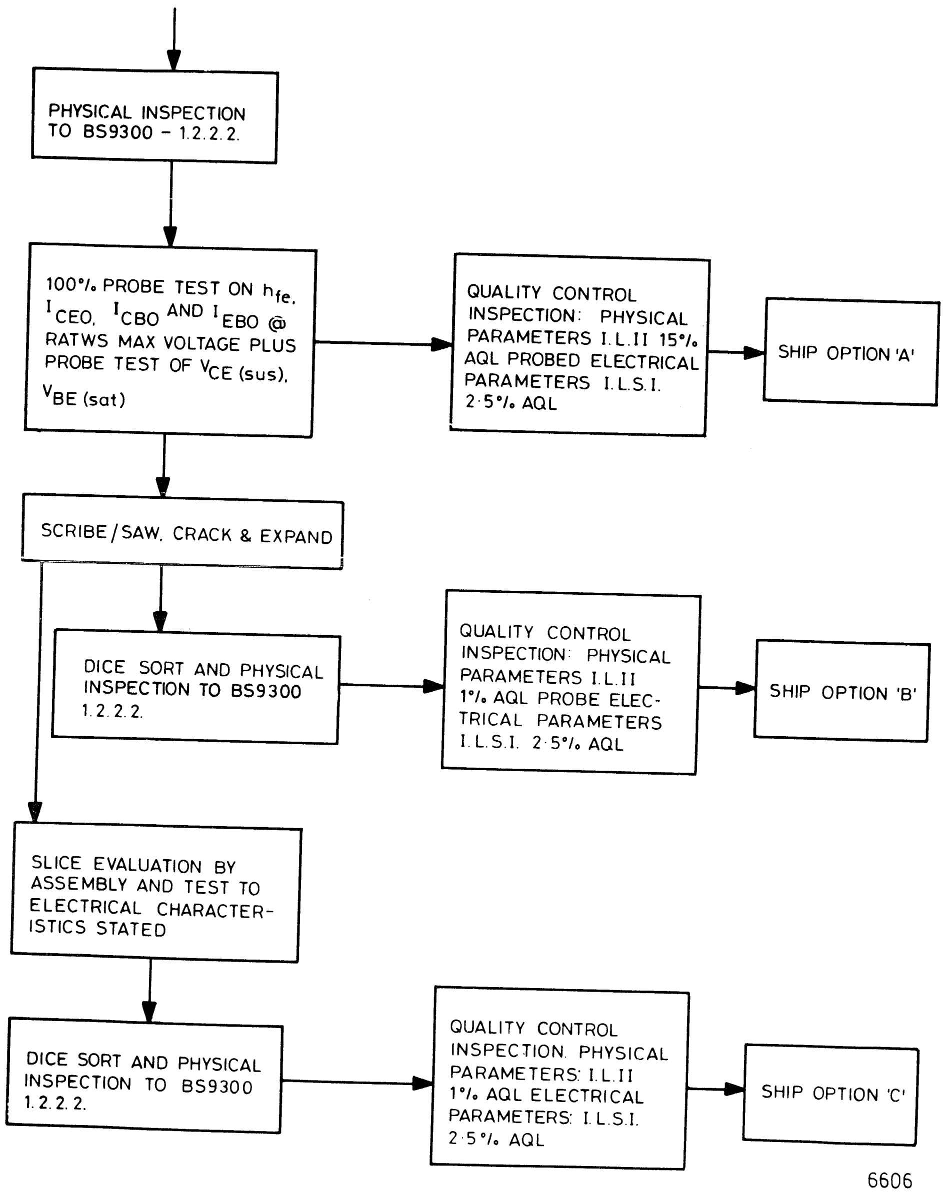
Any Release Note requirement should be quoted.

The various shipping options offer the facility for the user to purchase dice from various stages of manufacture.

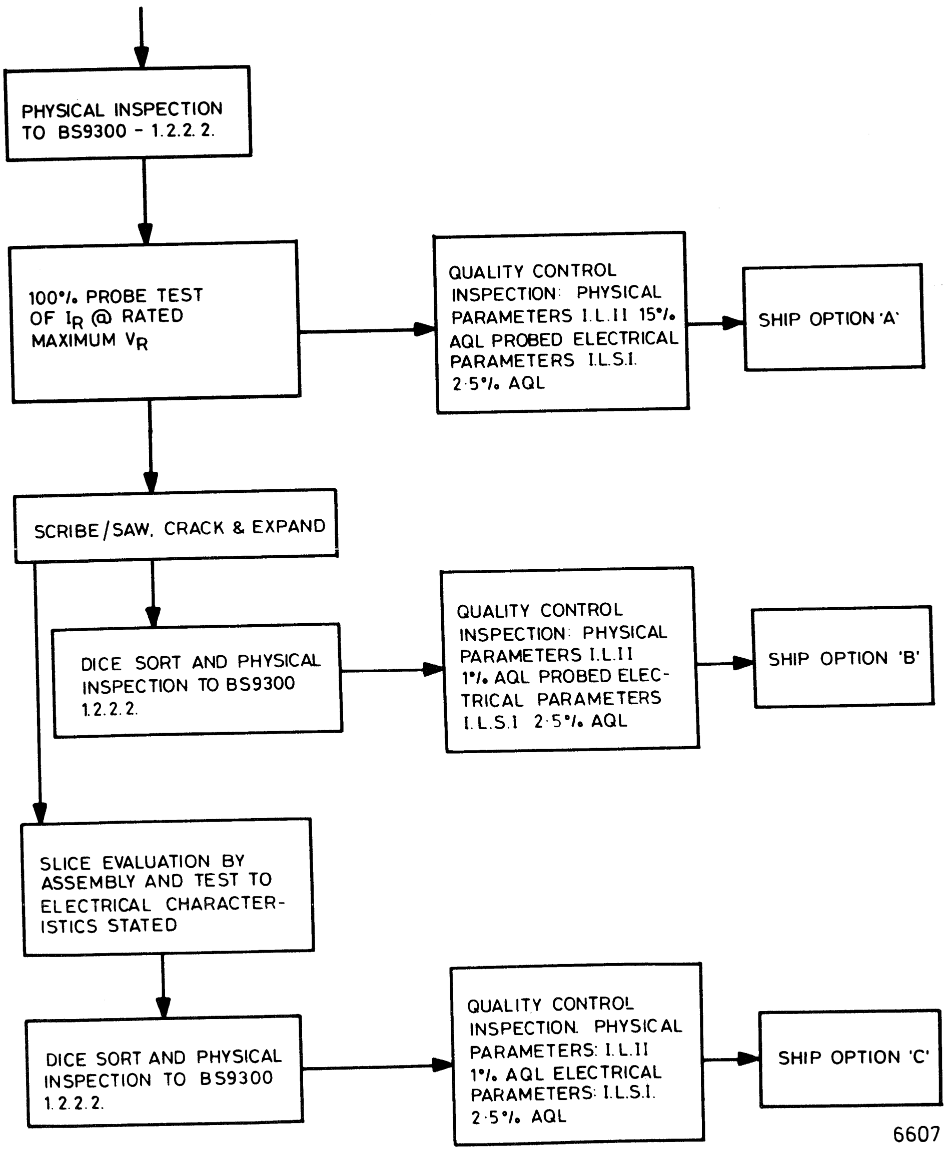
Dice ordered at the more advanced processing stages are progressively more expensive but less work will be required from the user and a higher level of yield is guaranteed.

PROCESS CHARTS

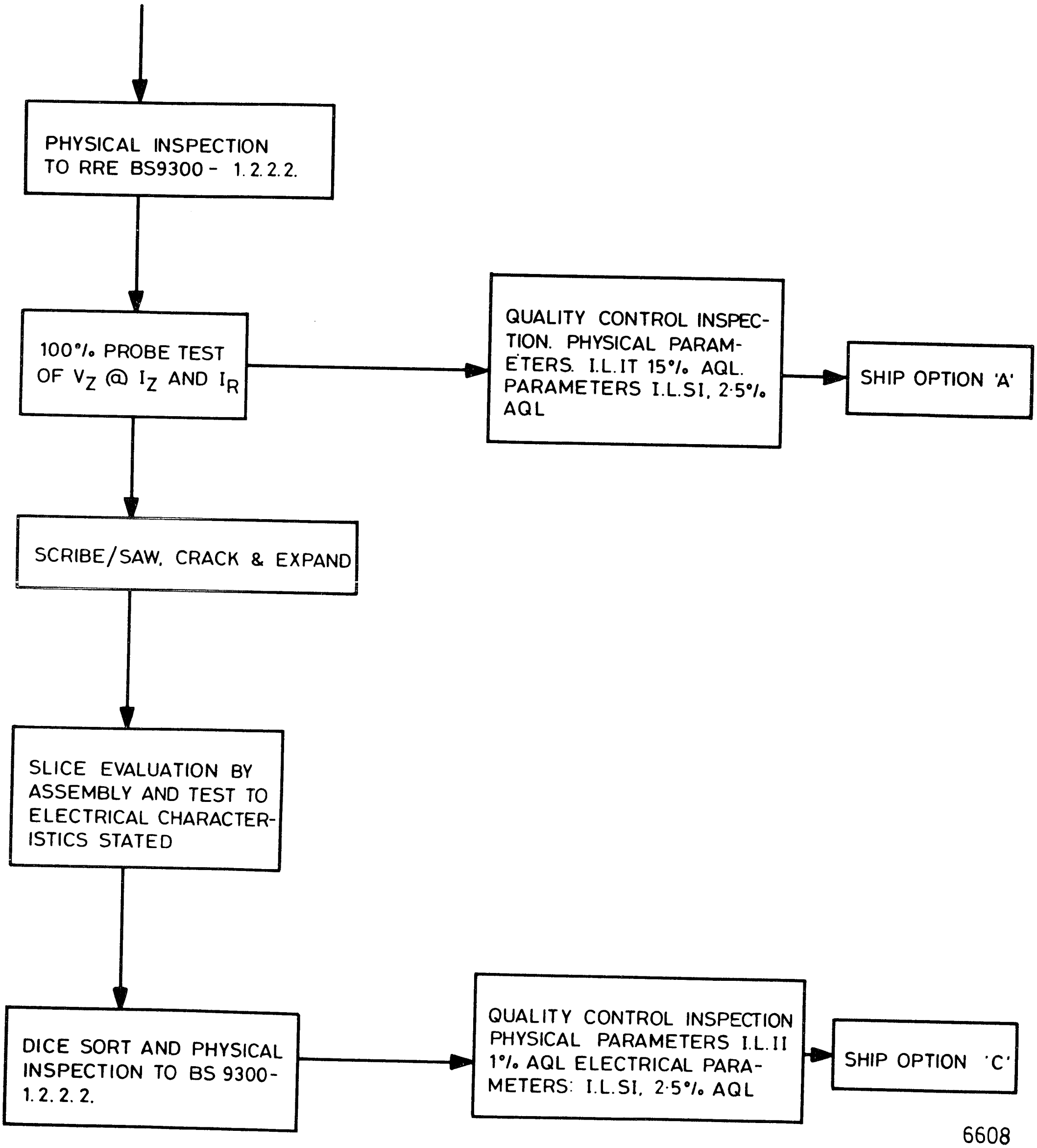
(a) TRANSISTOR DICE PROCESS CHART



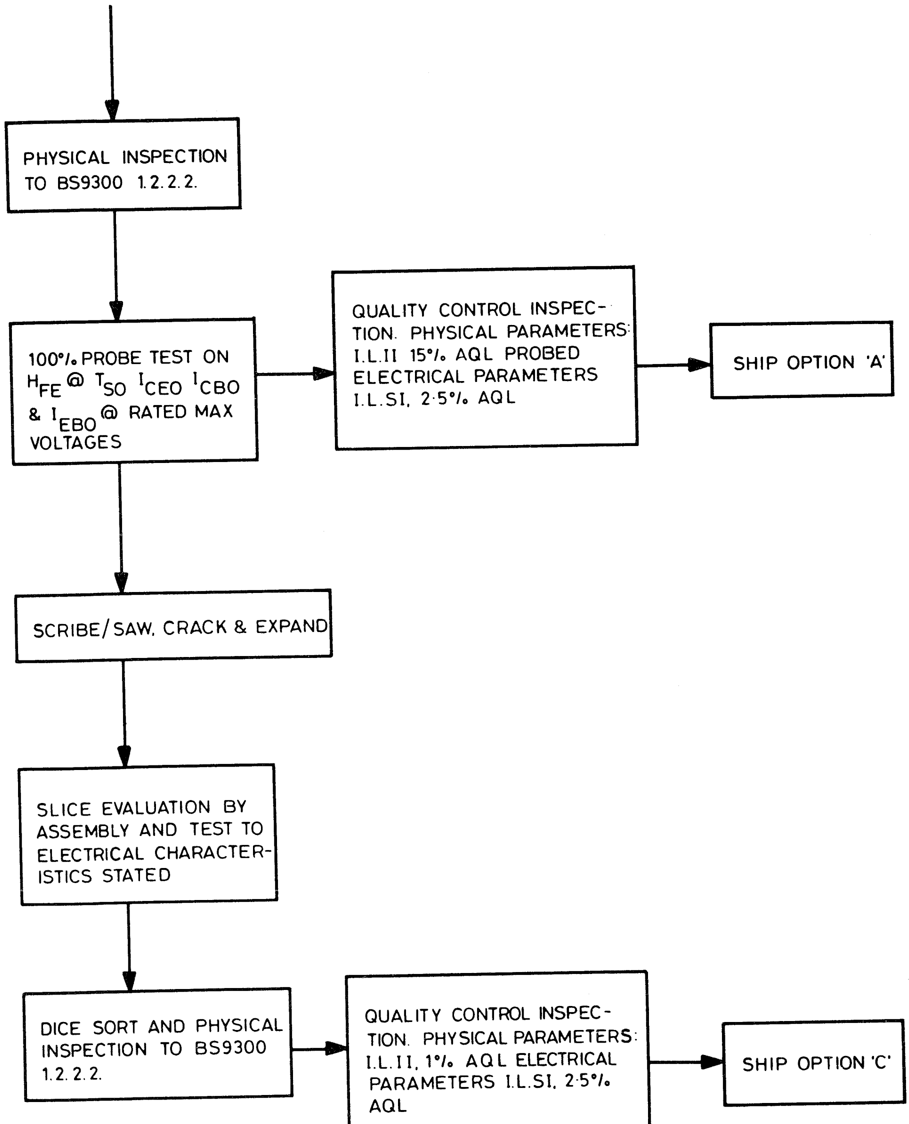
(b) GENERAL PURPOSE DIODE PROCESS CHART



(c) REFERENCE DIODE PROCESS CHART



(d) PHOTO TRANSISTOR DICE PROCESS CHART



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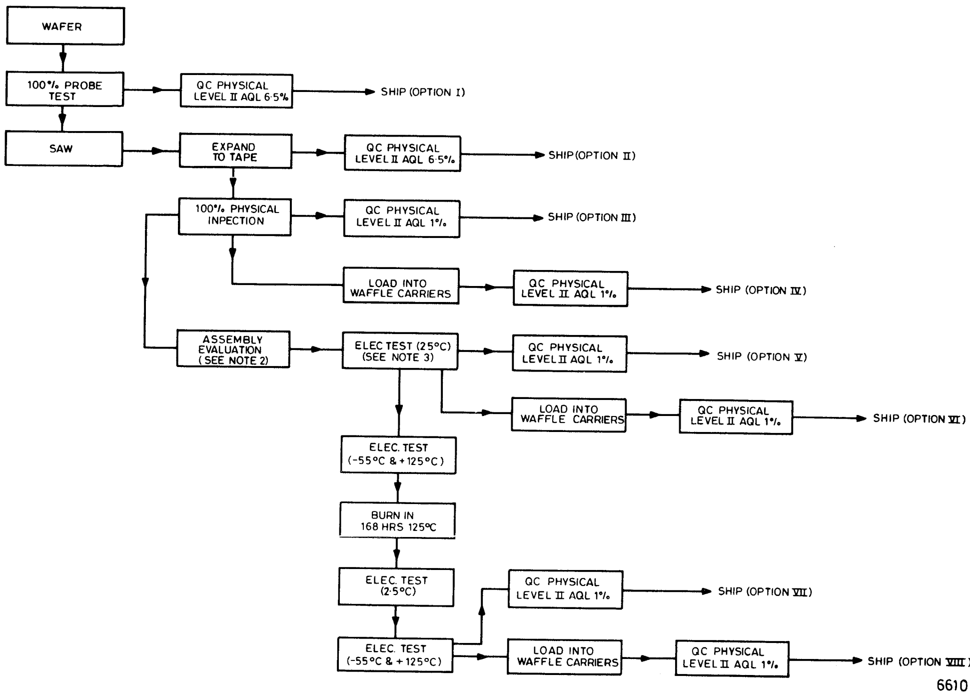
(e) INTEGRATED CIRCUIT DICE PROCESS CHART



NOTE 1 All physical inspection in accordance with BS 9400 condition 'B' paras. 1.2.10.2.1, 1.2.10.2.2 and 1.2.10.2.6.

NOTE 2 **ASSEMBLY EVALUATION**

1. Select 32 dice per wafer (where not practical per different batch).
2. Die epoxy attach to suitable package.
3. Thermosonic bond at 150°C with 0.0013" (33μ) Au. wire.
4. QC bond strength test (level II AQL 0.25%) to be carried out on a minimum of 5 devices, minimum bond strength 4.0gm.

NOTE 3 **ELECTRICAL TEST**

1. Select 20 mechanically good devices.
2. Elec. test (Acc 2 Raj3).

ELECTRICAL CHARACTERISTICS

(a) TRANSISTOR ELECTRICAL CHARACTERISTICS

P.N.P. SMALL SIGNAL TRANSISTORS

Dice Type	V_{CBO} Min.	V_{CEO} Min.	I_{CBO} Max. at V_{CB}		h_{FE}		@ I_C	V_{CE}	$V_{CE(sat)}$	I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	nA	V	Min.	Max.	mA	V	Max.	mA	mA	MHz	pF	
BC556A	80	65	15	30	110	220	2	5	0.3	10	0.5	150	4.5§	G2
BC556B	80	65	15	30	200	450	2	5	0.3	10	0.5	150	4.5§	G2
BCY77A	60	60	20*	50*	120	220	2	5	0.25	10	0.25	180§	7	G2
BCY77B	60	60	20*	50*	180	310	2	5	0.25	10	0.25	180§	7	G2
BCY77C	60	60	20*	50*	250	460	2	5	0.25	10	0.25	180§	7	G2
BC212A	60	50	15	30	100	300	2	5	0.07	10	0.5	200	5§	G2
BC212B	60	50	15	30	200	400	2	5	0.07	10	0.5	200	5	G2
BC307A	50	45	100*	50*	120	220	2	5	0.2	10	0.5	130§	6	G2
BC307B	50	45	100*	50*	180	460	2	5	0.2	10	0.5	130§	6	G2
BC557A	50	45	15	30	110	220	2	5	0.3	10	0.5	150	4.5§	G2
BC557B	50	45	15	30	200	450	2	5	0.3	10	0.5	150	4.5§	G2
BCY70	50	40	500	50	100	—	1	1	0.25	10	1.0	250	6	G3
BCY79A	45	45	20*	35*	120	220	2	5	0.25	10	0.25	180§	7	G2
BCY79B	45	45	20*	35*	180	310	2	5	0.25	10	0.25	180§	7	G2
BCY79C	45	45	20*	35*	250	460	2	5	0.25	10	0.25	180§	7	G2
BCY71	45	45	500	45	100	—	1	1	0.25	10	1.0	250	6	G3
2N3905	40	40	50†	30†	40	—	1	1	0.25	10	1.0	200	4.5	G3
2N3906	40	40	50†	30†	80	—	1	1	0.25	10	1.0	250	4.5	G3
BC213A	45	30	15	30	100	300	2	5	0.07	10	0.5	200	5§	G2
BC213B	45	30	15	30	200	400	2	5	0.07	10	0.5	200	5§	G2
BC213C	45	30	15	30	350	600	2	5	0.07	10	0.5	200	5§	G2
BC214B	45	30	15	30	200	600	2	5	0.07	10	0.5	200	5§	G2
BC214C	45	30	15	30	350	400	2	5	0.07	10	0.5	200	5§	G2
BCY78A	32	32	20*	25*	120	220	2	5	0.25	10	0.25	180§	7	G2
BCY78B	32	32	20*	25*	180	310	2	5	0.25	10	0.25	180§	7	G2
BCY78C	32	32	20*	25*	250	460	2	5	0.25	10	0.25	180§	7	G2
BCY78D	32	32	20*	25*	380	630	2	5	0.25	10	0.25	180§	7	G2
BC558A	30	30	15	30	110	220	2	5	0.3	10	0.5	150§	4.5§	G2
BC558B	30	30	15	30	200	450	2	5	0.3	10	0.5	150§	4.5§	G2
BC558C	30	30	15	30	420	800	2	5	0.3	10	0.5	150§	4.5§	G2
BC559B	30	30	15	30	200	450	2	5	0.3	10	0.5	300§	4.5§	G2
BC559C	30	30	15	30	420	800	2	5	0.3	10	0.5	300§	4.5	G2
BCY72	30	25	500	30	100	—	1	1	0.25	10	1.0	250	6	G3
BC308A	30	25	100	20	120	220	2	5	0.2	10	0.5	130§	6	G2
BC308B	30	25	100	20	180	460	2	5	0.2	10	0.5	130§	6	G2
BC308C	30	25	100	20	380	800	2	5	0.2	10	0.5	130§	6	G2
BC309B	25	20	100	20	180	460	2	5	0.2	10	0.5	130	6	G2
BC309C	25	20	100	20	380	800	2	5	0.2	20	0.5	130	6	G2

$V_{CE(sat)}$, f_T and C_{obo} are parameters which are assembly dependent and figures quoted are those typically achieved on Ferranti assembly lines.

*I_{CES} at V_{CES} †I_{CEX} at V_{CE} §Typical

ELECTRICAL CHARACTERISTICS

N.P.N. SMALL SIGNAL TRANSISTORS

Dice Type	V_{CBO} Min.	V_{CEO} Min.	I_{CBO} Max.	at V_{CB}	← h_{FE} →		@ I_C	V_{CE}	$V_{CE(sat)}$	I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	nA	V	Min.	Max.	mA	V	Max.	mA	mA	MHz	pF	
BC546A	80	65	15	30	110	220	2	5	0.25	10	0.5	300§	4.5	G1
BC546B	80	65	15	30	200	450	2	5	0.25	10	0.5	300§	4.5	G1
BCY65EA	60	60	10*	32*	120	220	2	5	0.35	10	0.25	125	6	G1
BC182	60	50	15	50	100	480	2	5	0.25	10	0.5	150	5	G1
2N3903	60	40	50†	30†	50	150	10	1	0.2	10	1.0	250	4	G3
2N3904	60	40	50†	30†	100	300	10	1	0.2	10	1.0	300	4	G3
BC107A	50	45	15*	50*	120	220	2	5	0.2	10	0.5	150	6	G1
BC107B	50	45	15*	50*	180	460	2	5	0.2	10	0.5	150	6	G1
BC237A	50	45	15*	50*	120	220	2	5	0.2	10	0.5	150	4.5	G1
BC237B	50	45	15*	50*	180	460	2	5	0.2	10	0.5	150	4.5	G1
BC547A	50	45	15	30	110	220	2	5	0.25	10	0.5	300§	4.5	G1
BC547B	50	45	15	30	200	450	2	5	0.25	10	0.5	300§	4.5	G1
BC550B	50	45	15	30	200	450	2	5	0.25	10	0.5	300§	4.5	G1
BC550C	50	45	15	30	420	800	2	5	0.25	10	0.5	300§	4.5	G1
BCY59A	45	45	10*	45*	120	220	2	5	0.35	10	0.25	125	6	G1
BCY59B	45	45	10*	45*	180	310	2	5	0.35	10	0.25	125	6	G1
BCY59C	45	45	10*	45*	250	460	2	5	0.35	10	0.25	125	6	G1
BCY59D	45	45	10*	45*	380	630	2	5	0.35	10	0.25	125	6	G1
2N930	45	45	10*	45*	100	300	0.1	5	1.0	10	0.5	300	8	G1
BC183	45	30	15	30	100	850	2	5	0.25	10	0.5	150	5	G1
BC184	45	30	15	30	250	—	2	5	0.25	10	0.5	150	5	G1
BCY58A	32	32	10*	32*	120	220	2	5	0.35	10	0.25	125	6	G1
BCY58B	32	32	10*	32*	180	310	2	5	0.35	10	0.25	125	6	G1
BCY58C	32	32	10*	32*	250	460	2	5	0.35	10	0.25	125	6	G1
BCY58D	32	32	10*	32*	380	630	2	5	0.35	10	0.25	125	6	G1
BC548A	30	30	15	30	110	220	2	5	0.25	10	0.5	300§	4.5	G1
BC548B	30	30	15	30	200	450	2	5	0.25	10	0.5	300§	4.5	G1
BC548C	30	30	15	30	420	800	2	5	0.25	10	0.5	300§	4.5	G1
BC549B	30	30	15	30	200	450	2	5	0.25	10	0.5	300§	4.5	G1
BC549C	30	30	15	30	420	880	2	5	0.25	10	0.5	300§	4.5	G1
BC108A	30	20	15*	30*	120	220	2	5	0.2	10	0.5	150	6	G1
BC108B	30	20	15*	30*	180	460	2	5	0.2	10	0.5	150	6	G1
BC108C	30	20	15*	30*	380	800	2	5	0.2	10	0.5	150	6	G1
BC109B	30	20	15*	30*	180	460	2	5	0.2	10	0.5	150	6	G1
BC109C	30	20	15*	30*	380	800	2	5	0.2	10	0.5	150	6	G1
BC238A	30	20	15*	30*	120	220	2	5	0.2	10	0.5	150	4.5	G1
BC238B	30	20	15*	30*	180	460	2	5	0.2	10	0.5	150	4.5	G1
BC238C	30	20	15*	30*	380	800	2	5	0.2	10	0.5	150	4.5	G1
BC239B	30	20	15*	30*	180	460	2	5	0.2	10	0.5	150	4.5	G1
BC239C	30	20	15*	30*	380	800	2	5	0.2	10	0.5	150	4.5	G1

$V_{CE(sat)}$, f_T and C_{obo} are parameters which are assembly dependent and figures quoted are those typically achieved on Ferranti assembly lines.

*I_{CES} at V_{CES} †I_{CEX} at V_{CE} §Typical

ELECTRICAL CHARACTERISTICS

N.P.N. MEDIUM POWER

Dice Type	V_{CBO} Min.	V_{CEO} Min.	I_{CBO} Max.	at V_{CB}	h_{FE} Min.	h_{FE} Max.	@ I_C	V_{CE}	$V_{CE(sat)}$ Max.	I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	nA	V	Min.	Max.	mA	V	Max.	mA	mA	MHz	pF	
ZTX653	120	100	100	100	100	300	500	2	0.5	2000	200	140	—	G17
ZTX453	120	100	100	100	40	200	150	10	0.7	150	15	150	15	G4
ZTX652	100	80	100	80	100	300	500	2	0.5	2000	200	140	—	G17
ZTX452	100	80	100	80	40	150	150	10	0.7	150	15	150	15	G4
MPSA06	80	80	100	80	50	—	100	1	0.25	100	10	100	—	G4
ZTX651	80	60	100	60	100	300	500	2	0.5	2000	200	140	—	G17
ZTX451	80	60	100	60	50	150	150	10	0.35	150	15	150	15	G4
BFY50	80	35	500	80	30	—	150	10	0.1	10	1	60	12	G4
MPSA05	60	60	100	60	50	—	100	1	0.25	100	10	100	—	G4
ZTX650	60	45	100	45	100	300	500	2	0.5	2000	200	140	—	G17
ZTX450	60	45	100	45	100	300	150	10	0.25	150	15	150	15	G4
BFY51	60	30	500	60	40	—	150	10	0.15	10	1	50	12	G4
BC337A	50	45	100*	45	100	250	100	1	0.7	500	50	100	12	G4
BC337B	50	45	100*	45	160	400	100	1	0.7	500	50	100	12	G4
BC337C	50	45	100*	45	250	630	100	1	0.7	500	50	100	12	G4
BFY52	40	20	500	40	60	—	150	10	0.15	10	1	50	12	G4
BC338A	30	25	100*	25	100	250	100	1	0.7	500	50	100§	12§	G4
BC338B	30	25	100*	25	160	400	100	1	0.7	500	50	100§	12§	G4
BC338C	30	25	100*	25	250	630	100	1	0.7	500	50	100§	12§	G4

P.N.P. MEDIUM POWER

Dice Type	V_{CBO} Min.	V_{CEO} Min.	I_{CBO} Max.	at V_{CB}	h_{FE} Min.	h_{FE} Max.	@ I_C	V_{CE}	$V_{CE(sat)}$ Max.	I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	nA	V	Min.	Max.	mA	V	Max.	mA	mA	MHz	pF	
ZTX753	120	100	100	100	100	300	500	2	0.5	2000	200	100	—	G16
ZTX752	100	80	100	80	100	300	500	2	0.5	2000	200	100	—	G16
ZTX552	100	80	100	80	40	150	150	10	0.7	150	15	150	25	G6
MPSA56	80	80	100	80	50	—	100	1	0.25	100	10	100	—	G6
ZTX751	80	60	100	60	100	300	500	2	0.5	2000	200	100	—	G16
ZTX551	80	60	100	60	50	150	150	10	0.35	150	15	150	25	G6
MPSA55	60	60	100	60	50	—	100	1	0.25	100	10	100	—	G6
ZTX750	60	45	100	45	100	300	500	2	0.5	2000	200	100	—	G16
ZTX550	60	45	100	45	100	300	150	10	0.25	150	15	150	25	G6
BC327A	50	45	100*	45	100	250	100	1	0.7	500	50	100§	12§	G6
BC327B	50	45	100*	45	160	400	100	1	0.7	500	50	100§	12§	G6
BC327C	50	45	100*	45	250	630	100	1	0.7	500	50	100§	12§	G6
BC328A	30	25	100*	25	100	250	100	1	0.7	500	50	100§	12§	G6
BC328B	30	25	100*	25	160	400	100	1	0.7	500	50	100§	12§	G6
BC328C	30	25	100*	25	250	630	100	1	0.7	500	50	100§	12§	G6

$V_{CE(sat)}$, f_T and C_{obo} are parameters which are assembly dependent and figures quoted are those typically achieved on Ferranti assembly lines.

*I_{CES} at V_{CES} §Typical

ELECTRICAL CHARACTERISTICS

N.P.N. SWITCHING TRANSISTORS

Dice Type	V_{CB} Min.	V_{CE} Min.	t_{on} Max.	t_{off} Max.	h_{FE}		at I_C	V_{CE}	$V_{CE(sat)}$ Max.	at I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	ns	ns	Min.	Max.	mA	V	V	mA	mA	MHz	pF	
2N2218A	75	40	35	285	40	120	150	10	0.3	150	15	250	8	G5
2N2219A	75	40	35	285	100	300	150	10	0.3	150	15	300	8	G5
2N2221A	75	40	35	285	40	120	150	10	0.3	150	15	250	8	G5
2N2222A	75	40	35	285	100	300	150	10	0.3	150	15	300	8	G5
2N2218	60	30	35	285	40	120	150	10	0.4	150	15	250	8	G5
2N2219	60	30	35	285	100	300	150	10	0.4	150	15	250	8	G5
2N2221	60	30	35	285	40	120	150	10	0.4	150	15	250	8	G5
2N2222	60	30	35	285	100	300	150	10	0.4	150	15	250	8	G5
2N2369	40	15	12	18	40	120	10	1	0.24	10	1	500	4	G18
2N2369A	40	15	12	18	40	120	10	1	0.2	10	1	500	4	G18

P.N.P. SWITCHING TRANSISTORS

Dice Type	V_{CB} Min.	V_{CE} Min.	t_{on} Max.	t_{off} Max.	h_{FE}		at I_C	V_{CE}	$V_{CE(sat)}$ Max.	at I_C	I_B	f_T Min.	C_{obo} Max.	Geometry
	V	V	ns	ns	Min.	Max.	mA	V	V	mA	mA	MHz	pF	
2N2907A	60	60	45	100	100	300	150	10	0.4	150	15	200	8	G7
2N2907	60	40	45	100	100	300	150	10	0.4	150	15	200	8	G7
2N2894	12	12	60	90	40	150	30	0.5	0.5	100	10	400	6	G8

N.P.N. HIGH FREQUENCY TRANSISTORS

Dice Type	V_{CBO} Min.	V_{CEO} Min.	h_{FE}	at I_C	at V_{CE}	P_{out} Min. at	F	at V_{CE}	f_T Min.	N Max.	Geometry
	V	V	Min.	mA	V	mW	MHz	V	GHz	dB	
2N918	30	15	20	3	1	30	500	10.0	0.6	6	G14

$V_{CE(sat)}$, f_T and C_{obo} are parameters which are assembly dependent and figures quoted are those typically achieved on Ferranti assembly lines.

ELECTRICAL CHARACTERISTICS

N.P.N. POWER TRANSISTORS

Dice Type	V_{CB} Min.	V_{CE} Min.	h_{FE}	@ I_C	V_{CE}	h_{FE}	@ I_C	V_{CE}	$V_{CE(sat)}$ Max.	@ I_C	I_B	f_T Min.	Geometry
	V	V	Min.	A	V	Min.	A	V	V	A	A	MHz	
BUY80	150	60	40	0.5	5	15	5.0	5	1.0	5.0	0.5	60§	G11
BUY81	150	60	40	1.0	5	10	7.5	5	1.0	7.5	0.75	60§	G12
BUY82	150	60	40	1.5	5	15	10.0	5	1.0	10.0	1.0	60§	G13

P.N.P. POWER TRANSISTORS

Dice Type	V_{CB} Min.	V_{CE} Min.	h_{FE}	@ I_C	V_{CE}	h_{FE}	@ I_C	V_{CE}	$V_{CE(sat)}$ Max.	@ I_C	I_B	f_T Min.	Geometry
	V	V	Min.	A	V	Min.	A	V	V	A	A	MHz	
BUY90	100	60	40	1.0	5	20	3.0	5	1.0	3.0	0.3	60§	G9
BUY91	100	60	40	1.0	5	15	5.0	5	1.0	5.0	0.5	60§	G10
BUY92	100	60	40	1.0	5	15	7.5	5	1.0	7.5	0.75	60§	G13

$V_{CE(sat)}$ and f_T are parameters which are assembly dependent and figures quoted are those typically achieved on Ferranti assembly lines.
§Typical.

ELECTRICAL CHARACTERISTICS

(b) DIODE ELECTRICAL CHARACTERISTICS

ZENER DIODES

Dice Type	Reference Voltage (V_Z) Nom.	Min.	Max.	@ I_Z	Differential Resistance R_Z	@ I_Z	Temperature Coefficient S_Z	@ I_Z	Reverse Current I_R	@ V_R	Geometry
	V	V	V	mA	Ω	mA	%°C	mA	mA	V	
ND2V7	2.7	2.4	3.0	5	120	5	−0.07	5	20	1	G26
ND3V0	3.0	3.0	3.6	5	120	5	−0.07	5	10	1	G26
ND3V3	3.3	2.9	3.6	5	110	5	−0.06	5	5	1	G26
ND3V6	3.6	3.2	4.0	5	105	5	−0.07	5	5	1	G26
ND3V9	3.9	3.5	4.3	5	100	5	−0.055	5	3	1	G26
ND4V3	4.3	3.9	4.7	5	90	5	−0.045	5	3	1	G26
NC4V7	4.7	4.4	5.0	5	80	5	−0.025	5	3	2	G26
NC5V1	5.1	4.8	5.4	5	60	5	+0.02	5	2	2	G26
NC5V6	5.6	5.2	6.0	5	40	5	+0.03	5	1	2	G26
NC6V2	6.2	5.8	6.6	5	10	5	+0.04	5	3	4	G26
NC6V8	6.8	6.4	7.2	5	15	5	+0.045	5	2	4	G26
NC7V5	7.5	7.0	7.9	5	15	5	+0.05	5	1	5	G26
NC8V2	8.2	7.7	8.7	5	15	5	+0.055	5	0.7	5	G25
NC9V1	9.1	8.5	9.6	5	115	5	+0.06	5	0.5	6	G25
NC10	10	9.4	10.6	5	20	5	+0.065	5	0.2	7	G25
NC11	11	10.4	11.6	5	20	5	+0.07	5	0.1	8	G25
NC12	12	11.4	12.7	5	25	5	+0.075	5	0.1	8	G25
NC13	13	12.4	14.1	5	30	5	+0.075	5	0.1	9	G25
NC15	15	13.8	15.6	5	30	5	+0.075	5	0.05	10	G25
NC16	16	15.3	17.1	5	40	5	+0.08	5	0.05	11	G25
NC18	18	16.8	19.1	5	45	5	+0.08	5	0.05	13	G25
NC20	20	18.8	21.2	5	55	5	+0.08	5	0.05	14	G25
NC22	22	20.8	23.3	5	55	5	+0.08	5	0.05	15	G25
NC24	24	22.8	25.6	5	70	5	+0.08	5	0.05	17	G25
NC27	27	25.1	28.9	2	80	2	+0.08	2	0.05	19	G25
NC30	30	28.0	32.0	2	80	2	+0.08	2	0.05	21	G25
NC33	33	31.0	35.0	2	80	2	+0.08	2	0.05	23	G25
NC36	36	34.0	38.0	2	90	2	+0.08	2	0.05	25	G25
NC39	39	37.0	41.0	2	130	2	+0.08	2	0.05	27	G25
NC43	43	40.0	46.0	2	150	2	+0.08	2	0.05	30	G25
NC47	47	44.0	50.0	2	170	2	+0.08	2	0.05	33	G25

NOTE: Zener diodes below 4.7 volts are only available to ±10% of any nominal voltage of 4.7 volts and over are to ±5% of nominal. In both cases tolerances are based on those laid out in BS 3494.

ELECTRICAL CHARACTERISTICS

SINGLE HIGH VOLTAGE SWITCHING DIODE

Dice Type	V_{RWM}	Forward Voltage V_F Max. @	I_F	Reverse Current I_R Max. @	V_R	T_{RR}* Max.	Geometry
	V	V	mA	μA	V	ns	
HD3A	75	1.2	110	1	75	6	G19

DUAL HIGH VOLTAGE SWITCHING DIODE

Dice Type	V_{RWM}	Forward Voltage V_F Max. @	I_F	Reverse Current I_R Max. @	V_R	T_{RR}* Max.	Geometry
	V	V	mA	μA	V	ns	
HD2A	75	1.2	110	1	75	6	G22

DUAL HIGH SPEED SWITCHING DIODE

Dice Type	V_{RWM}	Forward Voltage V_F Max. @	I_F	Reverse Current I_R Max. @	V_R	T_{RR}* Max.	Geometry
	V	V	mA	μA	V	ns	
FD2A	60	1.2	110	1	60	4	G21
FD2B	30	1.2	110	1	30	4	G21
FD2RA	60	1.2	110	1	60	7	G22
FD2RB	30	1.2	110	1	30	7	G22

QUAD HIGH SPEED SWITCHING DIODE

Dice Type	V_{RWM}	Forward Voltage V_F Max. @	I_F	Reverse Current I_R Max. @	V_R	T_{RR}* Max.	Geometry
	V	V	mA	μA	V	ns	
FD4A	50	1	110	1	50	4	G24
FD4B	35	1	110	1	35	4	G24
FD4RA	50	1	110	1	50	6	G24
FD4RB	35	1	110	1	35	6	G24

*Measured under the following conditions:
$I_F = 10mA$, $V_R = 6V$, $R_L = 100$, Recover to 10% I_R peak.

LOW LEAKAGE DIODES

Dice Type	V_{RWM}	Forward Voltage V_F Max. @	I_F	Reverse Current I_R Max. @	V_R	Geometry
	V	V	mA	nA	V	
LD2A	100	1.2	200	1	100	G21
LD2RA	100	1.2	200	5	100	G21
LD4A	100	1.2	200	1	100	G23
LD4RA	100	1.2	200	5	100	G23

ELECTRICAL CHARACTERISTICS

(c) PHOTO TRANSISTOR ELECTRICAL CHARACTERISTICS

Dice Type	V_{CEO} Min.	V_{CBO} Min.	Dark Leakage Current Max.	← h_{FE} →		@ V_{CE}	@ I_C	Illumination Sensitivity (Note 1)	Geometry
	V	V	μA	Min.	Max.	V	mA	μA/lumen/ft	
ZM100	35	35	1.0	4000*	16000*	5	2	35	G29
ZM110	35	35	0.025	400*	1200*	5	2	5	G27
ZM210	35	35	0.10	400*	1200*	5	2	14	G28

NOTE 1. Illumination sensitivity relates to h_{FE} shown, but should be used for guidance only. Measurement conditions: Standard Illuminant 'A' Tungsten Filament at 2856°K colour temperature.

*Devices are available in selected gain groups within these min and max figures. Any requests with regards to the selections available should be directed to: Opto Electronic Marketing, Ferranti Electronics Limited.

(d) INTEGRATED CIRCUITS ELECTRICAL CHARACTERISTICS

TYPICAL CHARACTERISTICS FOR STANDARD AND LOW POWER TTL.

Parameter	Standard Power TTL		Low Power TTL		Absolute Max. Ratings	All Devices
	Basic Gate	Bistable	Basic Gate	Bistable		
Propagation Delay	10ns	20ns	33ns	65ns	V_{CC}(continuous)	7V*
Power Dissipation	10mW	50mW	1mW	4mW	Input Voltage	−0.5V to 5.5V
Input Current High Level	1nA	1nA	1nA	1nA	Storage Temp. Range	−65°C to +150°C
Input Current Low Level	−110mA	−1.0mA	−100μA	−100μA	Output Voltage	−0.5V to 5.5V
Fan Out	10	10	10	10	Voltage between Inputs	5.5V
D.C. Noise Margin	1V	1V	1V	1V		
V_{CC} 74 Series	5.0V ±5%	5.0V ±5%	5.0V ±5%	5.0V ±5%		

*This rating is effectively reduced to 5.5V if the unused inputs are connected to V_{CC}.

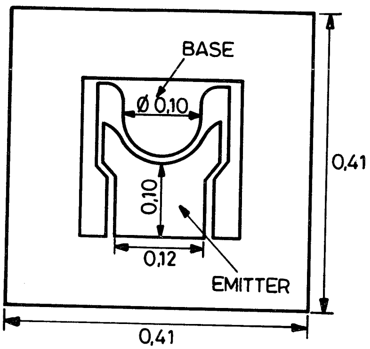
GUARANTEED ELECTRICAL CHARACTERISTICS (BASIC GATE).

Parameters	Test Conditions		Min.		Typ.§		Max.		Unit		V_{CC}	
	Standard	Low	St.	Low	St.	Low	St.	Low	St.	Low	St.	Low
V_{OL} Low Level Output Voltage	$V_{IH}=2.0V$ $I_{OL}=16.0mA$	$V_{IH}=2.0V$ $I_{OL}=3.6mA$			0.2	0.2	0.4	0.4	V	V	Min.	Min.
V_{OH} High Level Output Voltage	$V_{IL}=0.8V$ $I_{OH}=-400\mu A$	$V_{IL}=0.7V$ $I_{OH}=-200\mu A$	2.4	2.4	3.4	3:3			V	V	Min.	Min.
I_{IL} Low Level Input Current	$V_{IL}=0.4V$	$V_{IL}=0.3V$			−1.0	−0.11	−1.6	−0.18	mA	mA	Max.	Max.
I_{IH} High Level Input Current	$V_1=2.4V$ $V_1=5.5V$	$V_1=2.4V$ $V_1=5.5V$			1nA 1nA	1nA 1nA	40μA 1.0μA	10μA 25μA			Max. Max.	Max. Max.
I_{OS} Short Cct. Output Current	$V_1=0V$ $V_0=0V$	$V_1=0V$ $V_0=0V$	−18	−3			−55	−15	mA	mA	Max.	Max.
t_{PLH} Prop. Delay Time, Low−High Level O/P	$C_L=15pF$ $R_L=400\Omega$	$C_L=50pF$ $R_L=4k\Omega$			11	35	22	60	ns	ns	Nom	Nom
t_{PHL} Prop. Delay Time, High−Low Level O/P	$C_L=15pF$ $R_L=400\Omega$	$C_L=50pF$ $R_L=4k\Omega$			7	31	15	60	ns	ns	Nom	Nom

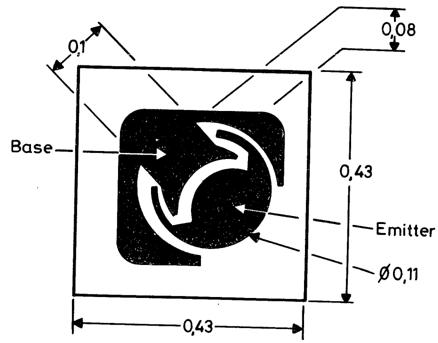
†Typical characteristics are at $V_{CC}=5.0V$, $T_{amb}=25°C$.

DICE GEOMETRIES

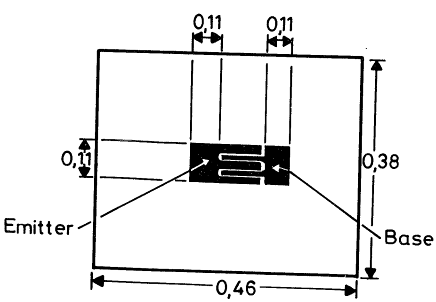
(a) TRANSISTOR GEOMETRIES



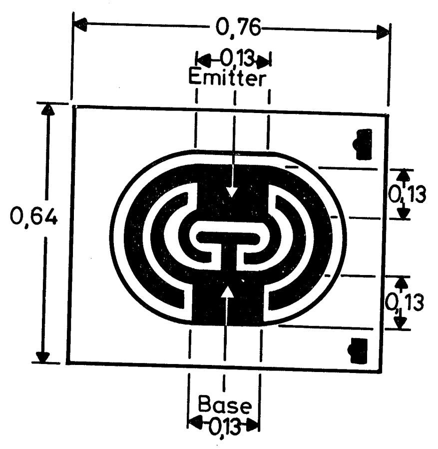
GEOMETRY 1



GEOMETRY 2



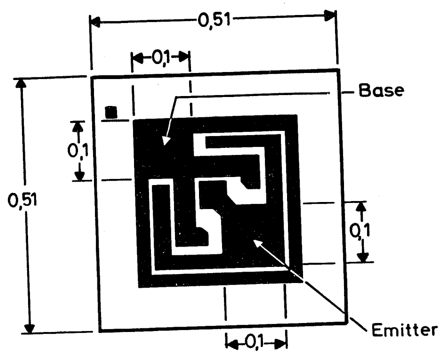
GEOMETRY 3



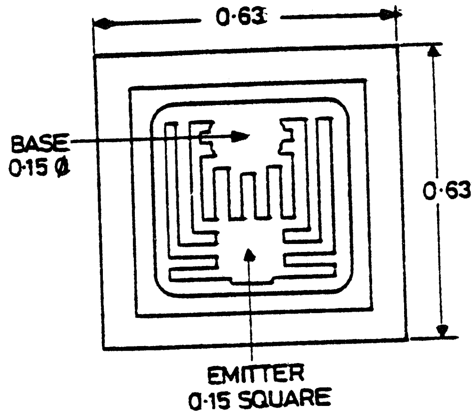
GEOMETRY 4

Dimensions in millimetres

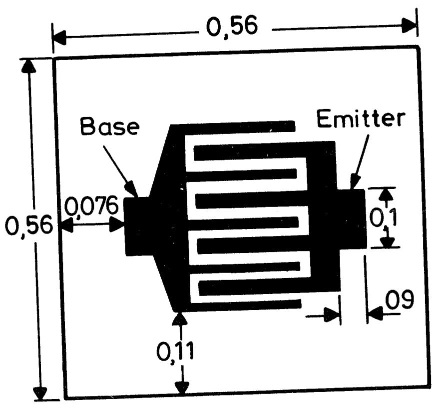
DICE GEOMETRIES



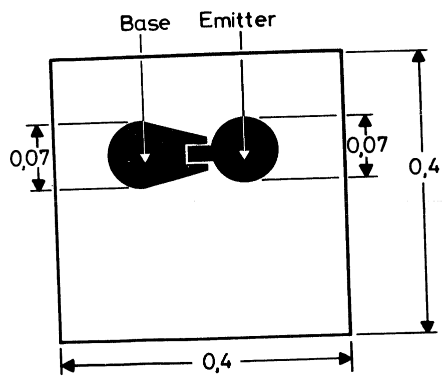
GEOMETRY 5



GEOMETRY 6



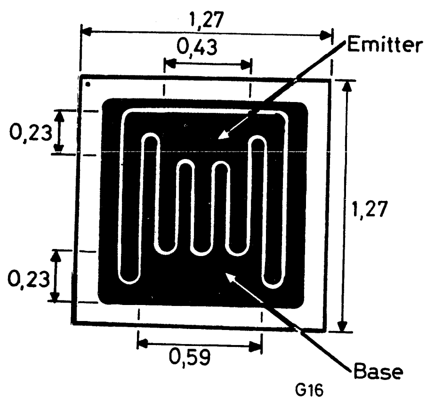
GEOMETRY 7



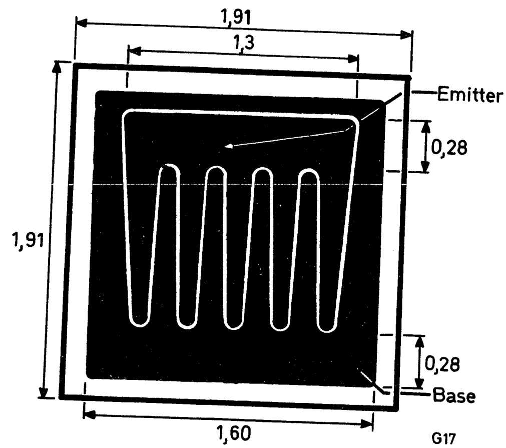
GEOMETRY 8

Dimensions in millimetres

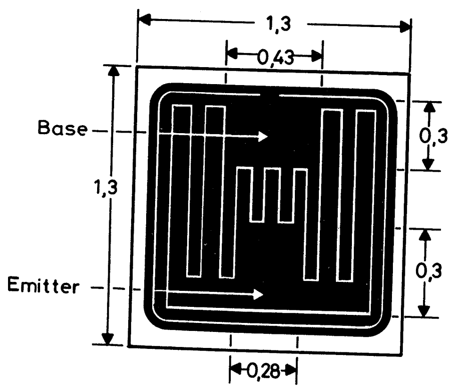
DICE GEOMETRIES



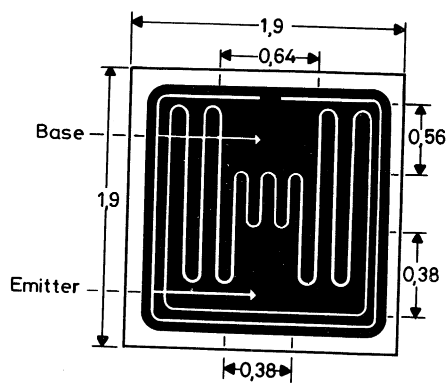
GEOMETRY 9



GEOMETRY 10



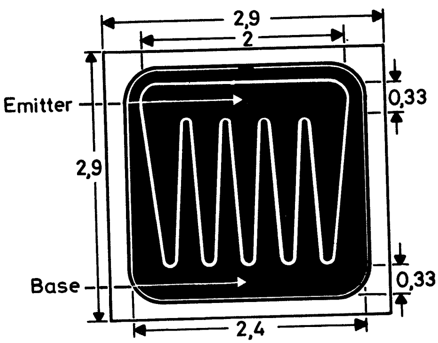
GEOMETRY 11



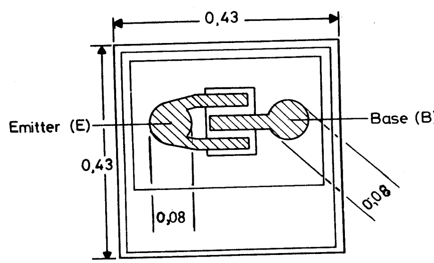
GEOMETRY 12

Dimensions in millimetres

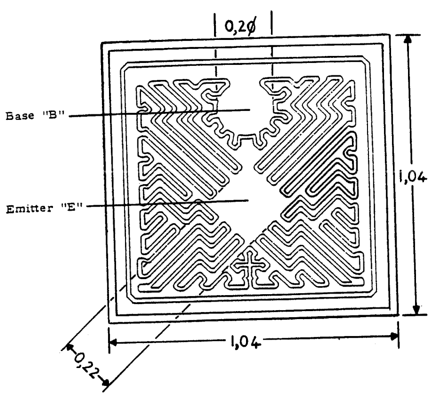
DICE GEOMETRIES



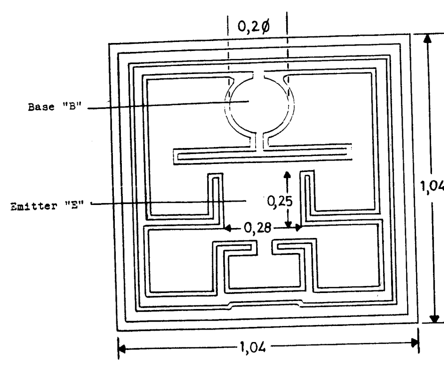
GEOMETRY 13



GEOMETRY 14



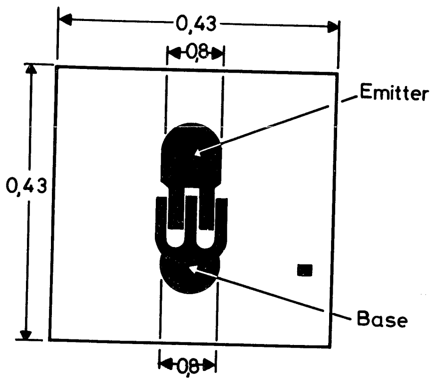
GEOMETRY 16



GEOMETRY 17

Dimensions in millimetres

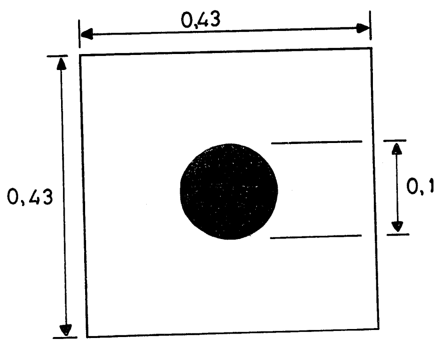
DICE GEOMETRIES



GEOMETRY 18

Dimensions in millimetres

(b) DIODE GEOMETRIES



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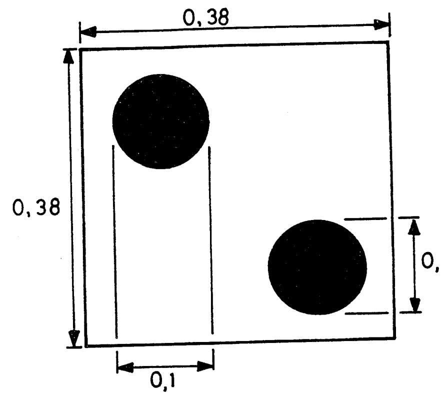

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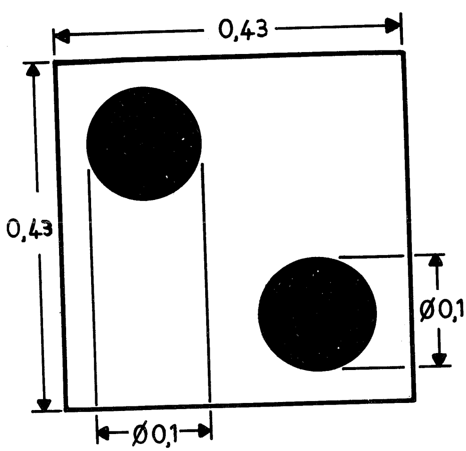

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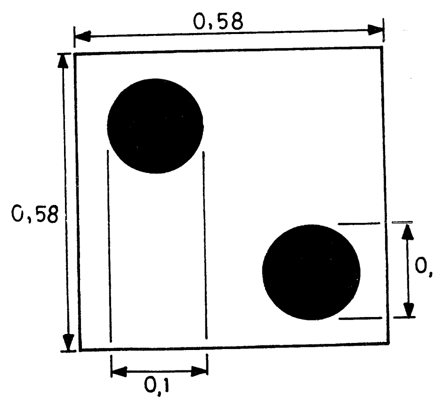
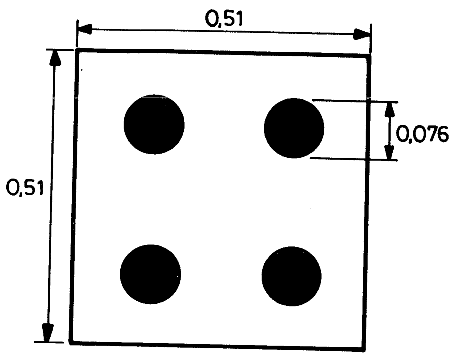


GEOMETRY 22

Dimensions in millimetres

DICE GEOMETRIES



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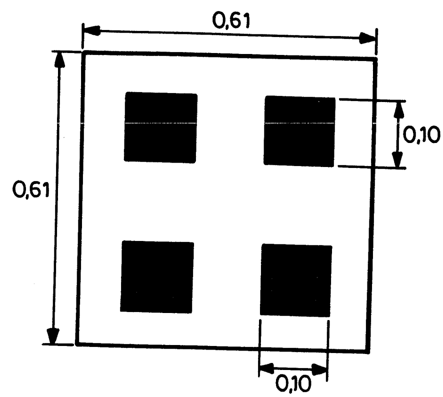

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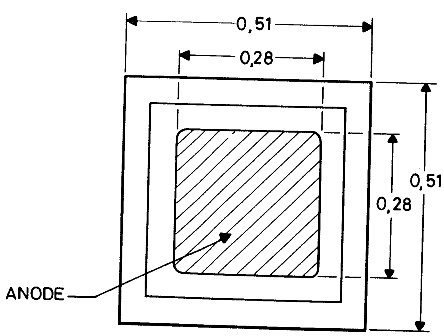

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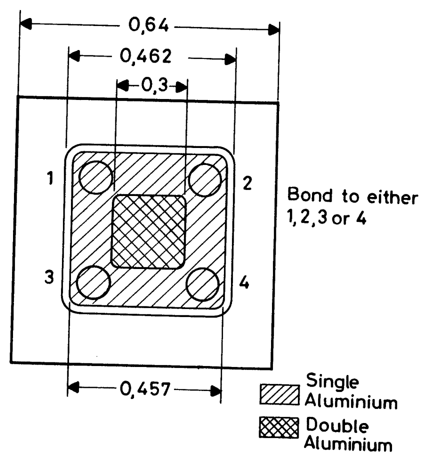
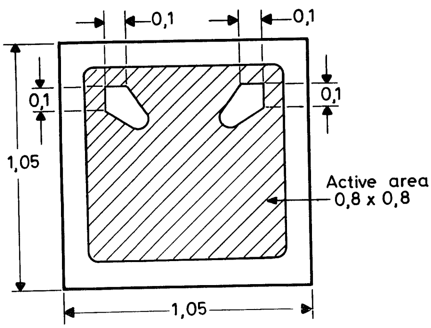


GEOMETRY 26

Dimensions in millimetres

(c) PHOTO-TRANSISTOR GEOMETRIES



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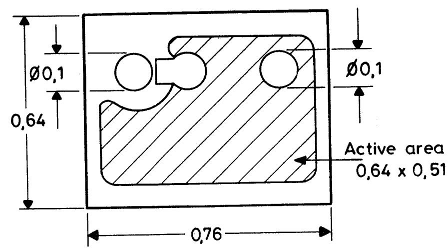
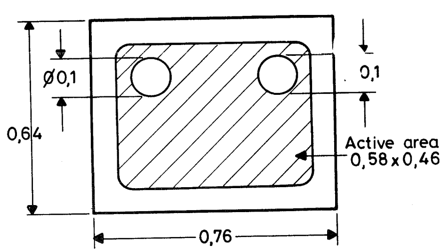


GEOMETRY 28



GEOMETRY 29

Dimensions in millimetres

OPTO-ELECTRONIC DEVICES

CONTENTS

MS SERIES

SILICON MESA PHOTOCELLS

A range of silicon photovoltaic cells of mesa construction available in sizes from micro-miniature to large active area for general purpose use.

Unencapsulated cells are coated with a special varnish to protect against contamination and moisture ingress.

Encapsulated cells are set into tough bakelite or epoxy housings with stud or pin mountings (suffix E).

Devices are graded for standard use under both high (suffix A) and low (suffix B) light levels.

TYPICAL CHARACTERISTICS (at 25°C).

Type	Active Area mm	3000 lumens/sq. ft		200 lumens/sq. ft		Comments
		V_{OC} mV	I_{SC} mA	V_{OC} mV	I_{SC} mA	
MS1A	3.48 × 1.83	500	1.0	–	–	Miniature for punched tape or punched card reading systems
MS1AE	3.48 × 1.83	500	1.0	–	–	
MS1B	3.48 × 1.83	500	1.0	350	0.065	
MS1BE	3.48 × 1.83	500	1.0	350	0.065	
MS2A	18.85 × 11.63	500	27	–	–	Photovoltaic for high and low light level applications
MS2AE	18.85 × 11.63	500	31	–	–	
MS2B	18.85 × 11.63	500	31	400	2.0	
MS2BE	18.85 × 11.63	500	34	400	2.3	
MS4A	6.15 × 5.26	500	5	–	–	
MS4B	6.15 × 5.26	500	5	350	0.33	
MS5A	12.5 × 5.26	500	10	–	–	
MS5B	12.5 × 5.26	500	10	350	0.66	
MS6A	18.85 × 5.26	500	15	–	–	
MS6B	18.85 × 5.26	500	15	350	0.99	
MS7A	25.2 × 5.26	500	20	–	–	
MS7B	25.2 × 5.26	500	20	350	1.32	
MS9A	2.13 × 0.99	500	0.3	–	–	Micro-miniature for punched tape or punched card reading systems for high light level applications
MS9AE	2.13 × 0.99	500	0.3	–	–	
MS9B	2.13 × 0.99	500	0.3	350	0.02	
MS9BE	2.13 × 0.99	500	0.3	350	0.02	
MS11A	477 sq. mm.	500	48	–	–	Large area photovoltaic
MS11AE	477 sq. mm.	500	54	–	–	
MS11B	477 sq. mm.	550	54	330*	3.6	
MS11BE	477 sq. mm.	550	60	330*	4.0	

*Minimum.

MS-15 INFRA-RED PHOTOCELL

This silicon photocell has been specifically developed for the detection of Infra-red radiation in the wavelength range of 0.75 to 1.1 microns. Originally used in conjunction with a Helium Neon laser for the simulation of gun-fire in a training target system, the MS15 can be used in a wide range of more general applications where the detection of Infra-red radiation is necessary. The MS15 is ideally suited for the sensing of Gallium Arsenide l.e.d.s or filtered tungsten light sources in most detection and alarm systems. A low value of junction capacitance means that the MS15 has a high speed of response.

TYPICAL CHARACTERISTICS (at 25°C)

Type	Active Area mm	Min. Reverse Resistance $V_R = 4.5V$ ohms	Max. c_j $V = 0$ $f = 1 kHz$ pF	Minimum Open Circuit Voltage Source Intensity (foot candles)* 0.5	1.0	1.5	Peak Spectral Response
MS15	12.7 × 12.7	75000	8000	28 mV	35 mV	40 mV	0.9μ

*This is the illumination intensity of a tungsten source at 2870°K; cells covered with 2mm thickness of Chance Bros. infra-red filter type OX5; radiation limited to wavelengths beyond 0.75μm.

SILICON PLANAR PHOTOTRANSISTORS

GENERAL APPLICATIONS OF FERRANTI PHOTOTRANSISTORS

Alarm Systems, Process Control, Edge and Position Sensing, Optical Character Recognition, Tape Readers, Card Readers, Electronic Flash Control, etc.

ZM100 SERIES TO-18 HERMETIC (ZM100/110, BPX25/29)

A range of phototransistors/photodarlingtons housed in a hermetic TO-18 type package with either a glass lens or plain window.

The lensed device provides high sensitivity with a narrow acceptance angle for improved discrimination.

CHARACTERISTICS (at 25°C).

Type	Maximum Ratings			Maximum Collector Dark Current at 25°C (μA)	Typical Sensitivity* μA/lumen/sq. ft.
	V_{CEO} (V)	V_{EBO} (V)	P_{tot} (mW)		
ZM100	35	10	300	1.0	2000
ZM110	35	5	300	0.025	200
BPX25	32	5	300	0.1	200
BPX29	32	5	300	0.1	8

*Illumination source is a tungsten filament lamp at 2856°K colour temperature.

ZMP SERIES — CLEAR EPOXY PACKAGE (ZMP31/51)

A phototransistor encapsulated in an economical clear plastic package for general purpose applications.

CHARACTERISTICS (at 25°C).

Type	Maximum Ratings			Maximum Collector Dark Current at 25°C (nA)	Typical Sensitivity* μA/lumen/sq. ft.
	V_{CEO} (V)	V_{ECO} (V)	P_{tot} (mW)		
ZMP31	35	6	100	25	20
ZMP51	35	6	200	25	20

*Illumination source is a tungsten filament lamp at 2856°K colour temperature.
Standard illuminant A.

PROGRAMMABLE LIGHT ACTIVATED PHOTOSWITCHES

A range of monolithic integrated circuit photoswitches capable of providing a logic output when illuminated at a pre-determined light level, the level being set by adjustment of an external RC network.

Operating from a single 5 volt supply each light activated switch provides a TTL compatible output, an output drive of 4.8mA and a variable sensitivity capability. The option exists for operation with either fixed or variable hysteresis.

The ZNP100 is packaged in a hermetic , 8-pin TO-5 can with glass window, and allows complete programming on all options, whilst the ZNP102 and 103 are available with 15% fixed hysteresis in 4 lead TO-72 cans with glass window.

CHARACTERISTICS (at 25°C).

Parameter	Min.	Typ.	Max.	Units	Test conditions
Supply voltage (V_{CC})	4.75	—	5.25	Volts	
Supply current (I_C)	—	16	22	mA	$V_{CC} = 5.0V$
Logical 1 output voltage	2.4	—	—	Volts	$V_{CC} = 4.75V$ $I_L = 120\mu A$
Logical 0 output voltage	—	—	0.4	Volts	$V_{CC} = 4.75V$ $I_{sink} = 4.8mA$
Light level range of operation	10*	—	10,000†	$\mu W/cm^2$	See Note 1
Capacitive component in time constant	2,200	—	—	pF	$V_{CC} = 5.0V$
Resistive component in time constant	3	—	100	kΩ	$V_{CC} = 5.0V$
Maximum switching frequency	—	50	—	kHz	At 10,000$\mu A/cm^2$ Illumination level
Variation in sensitivity threshold ($\mu W/cm^2$) with V_{CC}	— — —	+5 0 −5	— — —	% % %	$V_{CC} = 5.25V$ $V_{CC} = 5.0V$ $V_{CC} = 4.75V$
Variation in sensitivity threshold with temperature	—	−0.6	—	%/°C	$V_{CC} = 5.0V$
Operating temperature	—	—	70	°C	

*Typical RC = 40k × 100,000pF. †Typical RC = 3k × 2,200pF.

Note 1. The illumination source is an unfiltered tungsten filament at a colour temperature of 2856°K.

BPW41D

INFRA-RED PHOTODETECTOR

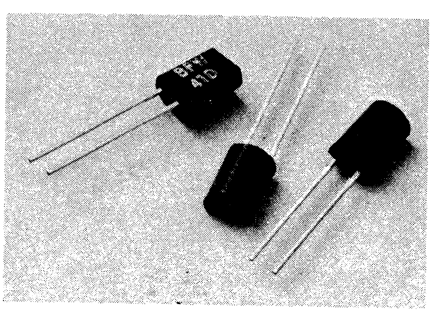
The BPW41D is a large area, silicon p.i.n. photodiode having a low junction capacitance and consequently capable of fast response times. The active chip is packaged in a plastic moulding which contains a near infra-red transmissive filter such that the device is sensitive to infra-red radiation only, and has a high rejection of wavelengths below 700 nm. The BPW41D is therefore eminently suitable for use in I.R. remote control links.

ELECTRICAL CHARACTERISTICS IN PHOTOCONDUCTIVE MODE (at 25°C).

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Reverse dark current	I_R	—	2	30	nA	$V_R = 10V$, $E = 0$
Light current	I_L	—	75	—	μA	$V_R = 5V$, $E_V = 1000 lux$ (See note 1)
		25	45	—	μA	$V_R = 5V$ $E_e = 1 mW/cm^2$ $\lambda p = 950 nm$ (See note 2)
Reverse breakdown voltage	V_{BR}	32	—	—	V	$I_R = 100 \mu A$, $E = 0$
Junction capacitance	C_j	—	25	40	pF	$V_R = 3V$, $f = 1 MHz$ $E = 0$
Noise equivalent power	N.E.P.	—	10^{-14}	—	$WHz^{-0.5}$	
Turn-on time	t_{on}	—	50	—	ns	$V_R = 10V$, $R_L = 1 k\Omega$
Turn-off time	t_{off}	—	50	—	ns	

Note 1. The Illumination source is Standard Illuminant 'A' (an unfiltered tungsten filament lamp at 2856°K colour temperature).

Note 2. The illumination source is a GaAs l.e.d. emitting at 950 nm.



I.R. REMOTE CONTROL APPLICATIONS ADVICE

Advice is available on complete I.R. remote control systems for applications such as those listed below. The combination of I.R. emitting diode, photodetector and detector electronics is critical in defining the performance of a remote control system, and advice is freely available as the best system combination for a given application.

SUITABLE APPLICATIONS FOR I.R. REMOTE CONTROL

Television, Hi-Fi Systems, Slide Projectors, Model Cars, Trains, etc., Garage Doors, Domestic Appliances.

OPTO-ELECTRONIC SEMICONDUCTOR DICE

The majority of Ferranti Opto-electronic semiconductors are available as unencapsulated dice or in wafer form, details of which can be obtained on request from Discrete Component Marketing.

Information concerning phototransistor dice, their specifications and inspection routes together with the various testing and shipping options can be found in the Semiconductor Dice section of this book.

COMPETITOR CROSS REFERENCE LIST

The following cross-reference list has been compiled as a guide for design engineers and purchasing agents and indicates the nearest Ferranti equivalent to a variety of competitive manufacturer's devices. In some cases there will be minor differences in electrical characteristics and/or package details and acceptability may be first determined by reviewing the data presented in this catalogue.

Additional information, if requested, may be obtained by contacting Ferranti Electronics Limited, Discrete Component Marketing.

The data contained in this guide is believed to be accurate. However, no responsibility is assumed by Ferranti Electronics Limited for the use of this data in actual circuit design.

Competitive Part Number	Device Type	Ferranti Equivalent
BPW30	Photodarlington	ZM100
BPW41	Infra-red Response Photodiode	BPW41D
BPX25	Phototransistor	BPX25
BPX29	Phototransistor	BPX29
BPX31	Phototransistor	ZM110
BPX43	Phototransistor	ZM110
BPX99	Phototransistor	ZM110
BPY62	Phototransistor	ZM110
FPT120A	Phototransistor	ZM110
FPT120B	Phototransistor	ZM110
FPT120C	Phototransistor	ZM110
FPT130A	Phototransistor	ZM110
FPT130B	Phototransistor	ZM110
FPT220	Phototransistor	ZM110
FPT230	Phototransistor	ZM110
FPT320	Phototransistor	ZM110
FPT330	Phototransistor	ZM110
FPT400	Phototransistor	ZM110
FPT410	Phototransistor	ZM110
FPT500	Phototransistor	ZM110
FPT530	Phototransistor	ZM110
FPT560	Photodarlington	ZM100
MRD300	Phototransistor	ZM110
MRD310	Phototransistor	ZM110
MRD370	Photodarlington	ZM100
MRD810	Phototransistor	ZM110
MRD3050	Phototransistor	BPX29
MRD3051	Phototransistor	BPX29
MRD3052	Phototransistor	BPX29
MRD3053	Phototransistor	BPX29
MRD3054	Phototransistor	ZM110
MRD3055	Phototransistor	ZM110
MRD3056	Phototransistor	ZM110
MT1	Phototransistor	ZM110
MT2	Phototransistor	ZM110
SFH205	Infra-red Response Photodiode	BPW41D
TIL81	Phototransistor	ZM110
TIL100	Infra-red Response Photodiode	BPW41D

GLOSSARY OF TERMS

Å Angstrom.

Absolute Spectral response Output or response at absolute power levels against wavelength.

Angstrom Unit of length used in the measurement of electromagnetic radiation. One angstrom = 10^{-10} metres.

Blackbody A standard for all irradiance measurements being a 100% efficient radiator and absorber of radiant energy.

Boltzman's constant (k) 1.38×10^{-16} ergs per degree Kelvin.

Candela Unit of luminous intensity evaluated in terms of the luminous intensity of a black body at the temperature of the solidification of platinum (2,046°K).

Candela/cm² Unit of luminance known as a "stilb."

C.I.E. International Commission on Illumination.

Colour Temperature The equivalent absolute measurement in °K of a black body whose wavelength distribution is closest to that of the non-black body (light source) being measured, thus defining its spectral density.

Dark Current Leakage of current across the junction or across the surface of a photodetector when there is no incident radiation.

Detector quantum efficiency Ratio of $\frac{\text{number of carriers generated}}{\text{number of photons absorbed}}$

E Photometric unit of illuminance in lumens/square foot (lm/ft^2)

Foot Candle 1 foot candle is equal to 1 lumen per square foot.

Foot Lambert A measure of brightness corresponding to an emission of 1 lumen per square foot for a perfectly diffused source.

H Radiometric unit of irradiance or radiation flux density in watts/cm^2 (W/cm^2).

Illumination The density of luminous flux incident on a surface and expressed in lux (lumens/m^2), phot (lumens/cm^2) or lumens/ft^2.

Incident Falling, striking or landing on.

Irradiance Radiant energy striking a given surface being the radiometric equivalent to illumination and expressed as Watts/cm^2.

Lumen The luminous flux from a point source of one candela within a solid angle of one steradian.

Lux A unit of illuminance in the metric system equivalent to lumens/m^2.

Micron (μ) A unit of length used in the measurement of electromagnetic wavelength. One micron = 10^{-6} metres.

Monochromatic Radiation of a single or very narrow band of wavelengths.

Noise Equivalent Power (N.E.P.) That quantity of light incident upon a photodiode that produces a signal equal to the noise level internally generated by the photodiode.

Peak spectral Emission/Output Generally used to define that wavelength at which a source/sensor produces its highest output.

Photoconductive Devices Components which undergo a change in resistivity by a change in incident light intensity.

Photovoltaic Devices Components which, when absorbing incident light, generate a voltage across their junction.

Point Source A radiation (or light) source having a maximum dimension being less than one-tenth the distance from source to detector.

Steradian The solid angle subtended at the centre of a sphere of radius r by an area of r^2 on its surface. A complete sphere comprises 4 steradians.

DIODES

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

PLEASE NOTE:

UNENCAPSULATED DIODES

The majority of diode products are available in unencapsulated slice or dice form.

The purchase of dice is not so clear-cut as the purchase of encapsulated counterparts. In view of the many testing and shipping options, Ferranti have issued their DICE SPECIFICATION FSD1001 (refer to FSD1001 section of this book).

HIGH FREQUENCY DIODES

Because of the specialised nature of high frequency diodes, the Ferranti range of tuner and Schottky barrier diodes is covered more fully in the R.F.section.

BZX84 SERIES SOT-23 ZENERS

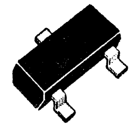
TABLE 1

The BZX84 series of silicon voltage regulator diodes is designed for voltage reference and stabilizer applications.

The series consists of 31 types with nominal zener voltages ranging from 2.7V to 47V with a ±5% tolerance.

Encapsulated in the popular SOT-23 package, these devices are designed specifically for use in thin and thick film hybrid circuits in both industrial and commercial applications.

Micro-miniature equivalent to the popular type BZY88



SOT-23

ELECTRICAL CHARACTERISTICS (at 25°C ambient temperature).

BZX84 Type Number	Zener Voltage V_Z at $I_Z = 5mA$ Volts			Differential Resistance r_Z at $I_Z = 5mA$ Ohms	Temperature Coefficient S_Z at $I_Z = 5mA$ %/°C	Reverse Current I_R µA	at V_R Volts	Device Marking
	Nom.	Min.	Max.	Max.	Typical	Max.		
C2V7	2.7	2.5	2.9	120	−0.07	20	1	W4
C3V0	3.0	2.8	3.2	120	−0.07	10	1	W5
C3V3	3.3	3.1	3.5	110	−0.06	5	1	W6
C3V6	3.6	3.4	3.8	105	−0.07	5	1	W7
C3V9	3.9	3.7	4.1	100	−0.055	3	1	W8
C4V3	4.3	4.0	4.6	90	−0.045	3	1	W9
C4V7	4.7	4.4	5.0	80	−0.025	3	2	Z1
C5V1	5.1	4.8	5.4	60	+0.02	2	2	Z2
C5V6	5.6	5.2	6.0	40	+0.03	1	2	Z3
C6V2	6.2	5.8	6.6	10	+0.04	3	4	Z4
C6V8	6.8	6.4	7.2	15	+0.045	2	4	Z5
C7V5	7.5	7.0	7.9	15	+0.05	1	5	Z6
C8V2	8.2	7.7	8.7	15	+0.055	0.7	5	Z7
C9V1	9.1	8.5	9.6	15	+0.06	0.5	6	Z8
C10	10	9.4	10.6	20	+0.065	0.2	7	Z9
C11	11	10.4	11.6	20	+0.07	0.1	8	Y1
C12	12	11.4	12.7	25	+0.075	0.1	8	Y2
C13	13	12.4	14.1	30	+0.075	0.1	9	Y3
C15	15	13.8	15.6	30	+0.075	0.05	10	Y4
C16	16	15.3	17.1	40	+0.08	0.05	11	Y5
C18	18	16.8	19.1	45	+0.08	0.05	13	Y6
C20	20	18.8	21.2	55	+0.08	0.05	14	Y7
C22	22	20.8	23.3	55	+0.08	0.05	15	Y8
C24	24	22.8	25.6	70	+0.08	0.05	17	Y9
	V_Z at $I_Z = 2mA$			r_Z at $I_Z = 2mA$	S_Z at $I_Z = 2mA$			
C27	27	25.1	28.9	80	+0.08	0.05	19	X1
C30	30	28.0	32.0	80	+0.08	0.05	21	X2
C33	33	31.0	35.0	80	+0.08	0.05	23	X3
C36	36	34.0	38.0	90	+0.08	0.05	25	X4
C39	39	37.0	41.0	130	+0.08	0.05	27	X5
C43	43	40.0	46.0	150	+0.08	0.05	30	X6
C47	47	44.0	50.0	170	+0.08	0.05	33	X7

For additional specification details at $I_Z = 1mA$ and 20mA etc. please refer to individual data sheets. Further details of SOT-23 devices are contained in the Hybrid section.

TABLE 2 – SILICON PLANAR EPITAXIAL HIGH SPEED SWITCHING DIODES

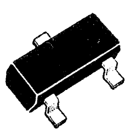
The **BAV** and **BAW** series of micro-miniature plastic encapsulated single diode and double diode pairs are primarily intended for use in thick and thin film hybrid circuits. Application areas include fast switching and general logic use.

The **ZDX** series of E-line (TO-92) plastic encapsulated double diode pairs is designed for use in high speed switching, biasing, phase detecting and discriminating applications.

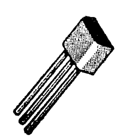
Type	Description	Max. V_{RWM} V	Max. $I_{F(AV)}$ mA	Max. I_R (at V_{RWM}) μA	Max V_F at V	I_F mA	Max. t_{rr}† ns	Package	Device Marking
ZDX6	Series diode pair	70	250	1.0	0.855	10	6	E-line	ZDX6
BAV70	Common cathode diode pair	70	100	5.0	0.855	10	6	SOT-23	A4
BAV99	Series diode pair	70	100	2.5	0.855	10	6	SOT-23	A7
BAW56	Common anode diode pair	70	100	2.5	0.855	10	6	SOT-23	A1
BAV74	Common cathode diode pair	50	100	0.1	1.0	100	4	SOT-23	JA
ZDX2F	Common cathode diode pair	50	250	1.0	1.2	100	3	E-line	ZDX2F
ZDX2R	Common anode diode pair	50	250	1.0	1.2	100	4	E-line	ZDX2R
ZDX5	Series diode pair	30	250	1.0	0.855	10	6	E-line	ZDX5
ZDX1F	Common cathode diode pair	20	250	1.0	1.2	100	3	E-line	ZDX1F
ZDX1R	Common anode diode pair	20	250	1.0	1.2	100	4	E-line	ZDX1R
FMMD914	Single diode	75	75	0.1	1.0	10	4	SOT-23	5D

*Continuous Forward Current (I_F).
†Refer to individual data sheets for details of Max. Recovery Time, test conditions etc.

N.B. Refer to Package Outlines section for pinning details.



SOT-23



E-LINE (TO-92)

GENERAL PURPOSE DIODES

TABLE 3 – SILICON DIFFUSED JUNCTION DIODES

The ZS100 and ZS120 series of diffused junction glass encapsulated diodes have been designed for general purpose applications of up to 800 volts requiring forward currents of up to 400mA and 250mA respectively. They are mounted in glass DO-7 packages.

The ZS100 series is BS APPROVED.

Selector Table

V_{RWM} / I_R (at V_{RWM})	50 Volts	100 Volts	200 Volts	300 Volts	400 Volts	600 Volts	800 Volts
0.2μA	ZS100	ZS101	ZS102	ZS103	ZS104	ZS106	ZS108
0.5μA	ZS120	ZS121	ZS122	ZS123	ZS124	–	–

ZS100 Series

Max. $I_{F(AV)} = 400mA$

Max. $I_{FRM} = 4A$

Max. V_F (at $I_F = 400mA$) $= 1V$

ZS120 Series

Max. $I_{F(AV)} = 250mA$

Max. $I_{FRM} = 1.25A$

Max. V_F (at $I_F = 250mA$) $= 1.1V$

TABLE 4 – SILICON PLANAR EPITAXIAL LOW LEAKAGE DIODES

The ZS150 series of glass encapsulated diodes have been designed for applications which demand a very low leakage current, a high degree of reliability and fast recovery characteristics. The ZS150 and ZS151 are APPROVED to BS9300 C642 and BS9300 C643 respectively.

The ZDX3/4 series are plastic encapsulated diode pairs designed for use in applications requiring low leakage characteristics.

ZDX3F, ZDX4F – COMMON CATHODE DIODE PAIR
ZDX3R, ZDX4R – COMMON ANODE DIODE PAIR

Selector Table

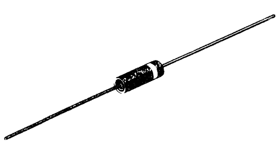
I_R (at V_{RWM}) / V_{RWM}	1nA	5nA	100nA
50V	ZS150	ZDX3F/3R ZS152	ZS154
100V	ZS151	ZDX4F/4R ZS153	ZS155

ZS150 Series

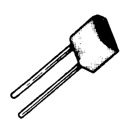
Max. $I_{F(AV)} = 250mA$
Max. $I_{FSM} = 3A$
Max. V_F (at $I_F = 200mA$) = 1.2V
Typ. $t_{rr} = 250ns$
(at $I_F = 600mA$, $I_R = 100mA$)
Max. $t_{fr} = 10ns$
(at $I_F = 10mA$)

ZDX3/4 Series

Max. $I_{F(AV)} = 250mA$
Max. $I_{FSM} = 3A$
Max. V_F (at $I_F = 200mA$) = 1.4V
Max. $t_{rr} = 400ns$
(at $I_F = I_R = 50 - 400mA$)
Max. $t_{fr} = 10ns$
(at $I_F = 10mA$)



GLASS DO-7



E-LINE (TO-92)

VARIABLE CAPACITANCE TUNER DIODES

TABLE 5 – SILICON EPITAXIAL PLANAR DIFFUSED DIODES

Designed for VHF and UHF electronic tuning applications

$T_{amb} = 25°C$

Parameter	Symbol	Min.	Typ.	Max.	Unit
Reverse Breakdown Voltage	V_R	–	–	30.0	V
Reverse Voltage Leakage ($V_R = 25V$)	I_R	–	–	0.02	μA
Case Capacitance	C_C	–	0.15	–	pF
Temperature coefficient of capacitance ($V_R = 3V$)	η	–	0.02	–	%/°C

CHARACTERISTICS (at 25°C ambient temperature).

Type		C_T at $V_R = 4V$, f = 1 MHz pF			Min. C_2/C_{30} at f = 1 MHz	Min. Q at $V_R = 4V$ f = 50 MHz	Package	
		Min.	Typ.	Max.			ZC700 to ZC714	ZC740 to ZC754
							Glass	Plastic
ZC700	ZC740	6.12	6.8	7.48	2.7	450	DO-7	E-line
ZC701	ZC741	7.4	8.2	9.1	2.7	450	DO-7	E-line
ZC702	ZC742	9.0	10.0	11.0	2.7	400	DO-7	E-line
ZC703	ZC743	10.8	12.0	13.2	2.8	400	DO-7	E-line
ZC704	ZC744	13.5	15.0	16.5	2.8	400	DO-7	E-line
ZC705	ZC745	16.2	18.0	19.8	2.8	350	DO-7	E-line
ZC706	ZC746	19.8	22.0	24.2	2.8	350	DO-7	E-line
ZC707	ZC747	24.3	27.0	29.7	2.8	300	DO-7	E-line
ZC708	ZC748	29.7	33.0	36.3	2.8	200	DO-7	E-line
ZC709	ZC749	35.1	39.0	42.9	2.8	150	DO-7	E-line
ZC710	ZC750	42.3	47.0	51.7	2.8	150	DO-7	E-line
ZC711	ZC751	50.4	56.0	61.6	2.8	150	DO-7	E-line
ZC712	ZC752	61.2	68.0	74.8	2.8	150	DO-7	E-line
ZC713	ZC753	73.8	82.0	90.2	2.8	100	DO-7	E-line
ZC714	ZC754	90.0	100.0	110.0	2.8	100	DO-7	E-line

HYPERABRUPT VARIABLE CAPACITANCE TUNER DIODES

TABLE 6 – SILICON ION IMPLANTED HYPERABRUPT TUNER DIODES

Designed for use in HF, VHF and UHF electronic tuning applications where large capacitance variations and high Q are required.

Ion implantation is a semiconductor doping technique enabling close control of doping and profile. Its use enables devices to be produced with consistant characteristics to closely controlled tolerances. Applications of the technique to the manufacture of Hyperabrupt tuner diodes guarantees long term stability in the uniformity of the capacitance/voltage characteristics of these devices.

THE ZC800, ZC820 and ZC830A SERIES

A series of professional range devices for very high frequency range operation.

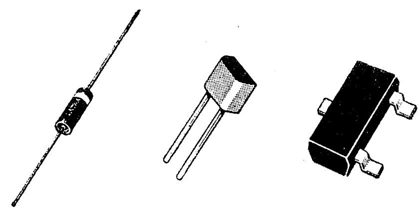
- Available in three package options:

  Economical plastic E-line package

  Microminiature SOT-23

  High reliability glass DO-7

NOT TO SCALE



DO-7 ZC800 Series | E-LINE ZC820 Series | SOT-23 ZC830A Series

ABSOLUTE MAXIMUM RATINGS (at $T_{amb} = 25°C$).

Parameter	Symbol	Value	Unit
Reverse Breakdown Voltage	V_R	25	Volts
Forward Current	I_F	200	mA
Power Dissipation – ZC800 Series	P_D*	400	mW
ZC820 Series	P_D*	300	mW
ZC830A Series	P_D*	200	mW
Junction Temperature – ZC800 Series	T_j	175	°C
ZC820 Series	T_j	125	°C
ZC830A Series	T_j	125	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

*Power dissipation is calculated assuming that the device is mounted on a ceramic substrate measuring 10×8×0.6mm.

N.B. HIGH FREQUENCY DIODES

Because of the specialised nature of high frequency diodes, the Ferranti range of tuner and Schottky barrier diodes is covered more fully in the R.F.section.

HYPERABRUPT VARIABLE CAPACITANCE TUNER DIODES

TABLE 6a – ZC800, ZC820 SERIES FOR PCB MOUNTING.

CHARACTERISTICS (at 25°C ambient temperature).

Type		Nominal Capacitance in pF $V_R = 2V$, f = 1 MHz			Minimum Q at $V_R = 3V$ f = 50 MHz	Capacitance Ratio C_2/C_{20}, f = 1 MHz	
Glass DO-7	Plastic E-line	Min.	Nom.	Max.		Min.	Max.
ZC800	ZC820	8	10	12	300	4.5	6.0
ZC801	ZC821	12	15	18	300	4.5	6.0
ZC802	ZC822	17.6	22	26.4	200	5.0	6.5
ZC803	ZC823	26.4	33	39.6	200	5.0	6.5
ZC804	ZC824	37.6	47	56.4	200	5.0	6.5
ZC805	ZC825	54.4	68	81.6	100	5.0	6.5
ZC806	ZC826	80.0	100	120.0	100	5.0	6.5

In all cases Maximum Reverse Voltage Leakage Current, $I_R = 0.02\mu A$ at $V_R = 20V$
To order devices with 2V nominal capacity ±10% add suffix A
±5% add suffix B

TABLE 6b – ZC830A SERIES FOR THICK FILM HYBRID CIRCUITS.

CHARACTERISTICS (at 25°C ambient temperature).

Type	Nominal Capacitance in pF $V_R = 2V$, f = 1 MHz			Minimum Q at $V_R = 3V$ f = 50 MHz	Capacitance Ratio C_2/C_{20}, f = 1 MHz		Device Marking
SOT-23	Min.	Nom.	Max.		Min.	Max.	
ZC830A	9.0	10	11.0	300	4.5	6.0	J1
ZC831A	13.5	15	16.5	300	4.5	6.0	J3
ZC832A	19.8	22	24.2	200	5.0	6.5	J4
ZC833A	29.7	33	36.3	200	5.0	6.5	A2
ZC834A	42.3	47	51.7	200	5.0	6.5	J5
ZC835A	61.2	68	74.8	100	5.0	6.5	J6
ZC836A	90.0	100	110.0	100	5.0	6.5	J7

In all cases Maximum Reverse Voltage Leakage Current, $I_R = 0.02\mu A$ at $V_R = 20V$
To order devices with 2V nominal capacity ±5% add suffix B

N.B. Tighter tolerance on diode capacitance or capacitance ratio can be supplied on request. Such devices can be supplied in matched sets with or without a specified tracking tolerance as required.

TABLE 7 – SILICON PLANAR EPITAXIAL SCHOTTKY BARRIER DIODES

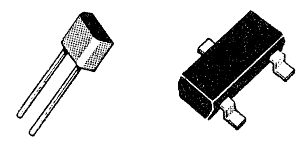
The construction of these epitaxial, planar, passivated diodes utilises a Schottky barrier resulting in devices which have a high breakdown voltage and ultra fast switching capabilities.

Applications under pulsed conditions include ultra high speed switching, clamping, sampling gates and pulse shaping. R.F. operation applications include low noise mixers, large and small signal detectors, limiters and discriminators.

FEATURES

- Available in three packages:
  Economical Plastic E-line
  Microminiature SOT-23
- Low Leakage Current
- Low Forward Voltage
- Ultra High Speed Switching

NOT TO SCALE



E-LINE TO-92
NO SUFFIX

SOT-23
SUFFIX E

ABSOLUTE MAXIMUM RATINGS (SOT-23 and E-line).

Parameter	Symbol	ZC2800, ZC2810 ZC2811, ZC5800	Unit
Power Dissipation*	P_{tot}	250	mW
Operating Temperature	T_{amb}	−65 to +200	°C
Storage Temperature	T_{stg}	−65 to +200	°C

*Derate to zero at 200°C and measured using an infinite heat sink.

SOT-23 PACKAGE DEVICE MARKING:

Type	Code
ZC2800E	E6
ZC2810E	E7
ZC2811E	E8
ZC5800E	E9

N.B. HIGH FREQUENCY DIODES

Because of the specialised nature of high frequency diodes, the Ferranti range of tuner and Schottky barrier diodes is covered more fully in the R.F.section.

SCHOTTKY BARRIER DIODES

TABLE 7a – CHARACTERISTICS (at 25°C ambient temperature) SOT-23 and E-line.

Parameter	Type	Symbol	Min.	Max.	Unit	Test Conditions
Breakdown Voltage	ZC2800 ZC2810 ZC2811 ZC5800	V_{BR}	70 20 15 50	– – – –	V V V V	$I_R = 10\mu A$
Reverse leakage current	ZC2800 ZC2810 ZC2811 ZC5800	I_R	– – – –	200 100 100 200	nA nA nA nA	$V_R = 50V$ $V_R = 15V$ $V_R = 10V$ $V_R = 35V$
Forward voltage	ZC2800 ZC2810 ZC2811 ZC5800	V_F	– – – –	410 410 410 410	mV mV mV mV	$I_F = 1\,mA$
Forward current	ZC2800 ZC2810 ZC2811 ZC5800	I_F	15 35 20 15	– – – –	mA mA mA mA	$V_F = 1V$
Capacitance	ZC2800 ZC2810 ZC2811 ZC5800	C_T	– – – –	2.0 1.2 1.2 2.0	pF pF pF pF	$V_R = 0V$ $f = 1\,MHz$
Effective minority lifetime	ZC2800 ZC2810 ZC2811 ZC5800	τ	– – – –	100 100 100 100	ps ps ps ps	$I_F = 5\,mA$ Krakauer method

Note: Matched pairs or quads of diodes can be supplied on request.

STANDARD MATCHING SPECIFICATIONS (all packages):

ZC2800 – ZC5800

Max. $\Delta V = 20\,mV$, $I_F = 0.5$ to $5.0\,mA$
Max. $\Delta C = 0.2\,pF$, $V_R = 0V$

ZC2810 – ZC2811

Max. $\Delta V = 20\,mV$, $I_F = 1$ to $10\,mA$
Max. $\Delta C = 0.2\,pF$, $V_R = 0V$

TABLE 7a — CHARACTERISTICS (at 25°C ambient temperature) SOT-23 and E-line.

Parameter	Type	Symbol	Min.	Max.	Unit	Test Conditions
Breakdown Voltage	ZC2800 ZC2810 ZC2811 ZC5800	V_{BR}	70 20 15 50	— — — —	V V V V	$I_R = 10\mu A$
Reverse leakage current	ZC2800 ZC2810 ZC2811 ZC5800	I_R	— — — —	200 100 100 200	nA nA nA nA	$V_R = 50V$ $V_R = 15V$ $V_R = 10V$ $V_R = 35V$
Forward voltage	ZC2800 ZC2810 ZC2811 ZC5800	V_F	— — — —	410 410 410 410	mV mV mV mV	$I_F = 1mA$
Forward current	ZC2800 ZC2810 ZC2811 ZC5800	I_F	15 35 20 15	— — — —	mA mA mA mA	$V_F = 1V$
Capacitance	ZC2800 ZC2810 ZC2811 ZC5800	C_T	— — — —	2.0 1.2 1.2 2.0	pF pF pF pF	$V_R = 0V$ $f = 1MHz$
Effective minority lifetime	ZC2800 ZC2810 ZC2811 ZC5800	τ	— — — —	100 100 100 100	ps ps ps ps	$I_F = 5mA$ Krakauer method

Note: Matched pairs or quads of diodes can be supplied on request.

STANDARD MATCHING SPECIFICATIONS (all packages):

ZC2800 – ZC5800
Max. $\Delta V = 20mV$, $I_F = 0.5$ to $5.0mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

ZC2810 – ZC2811
Max. $\Delta V = 20mV$, $I_F = 1$ to $10mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

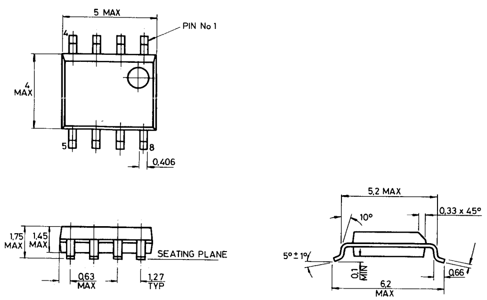
SECTION 4 : PACKAGE OUTLINES

CONTENTS

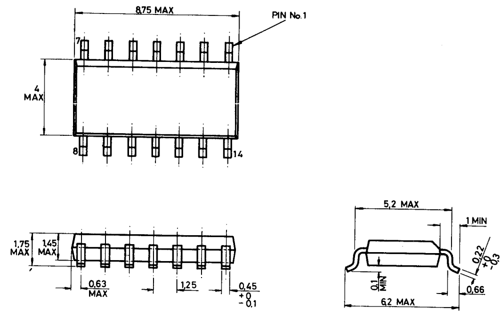
PACKAGE OUTLINES

INTEGRATED CIRCUITS

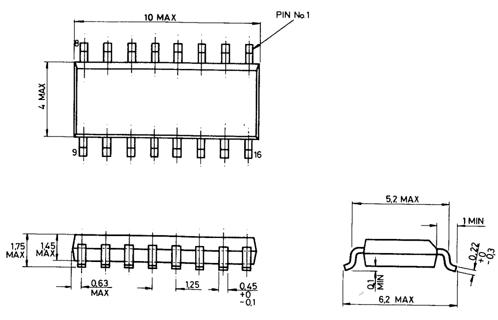
SO PACKAGES



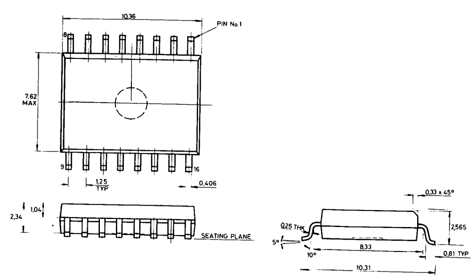
SO-8 (Narrow body)



SO-14 (Narrow body)



SO-16 (Narrow body)

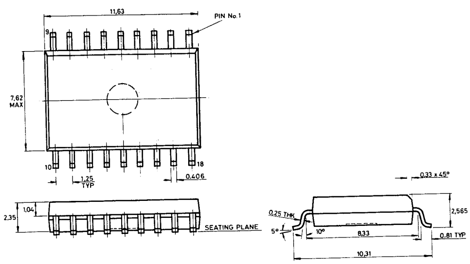


SO-16 (Wide body)

Dimensions in millimetres

PACKAGE OUTLINES

SO PACKAGES



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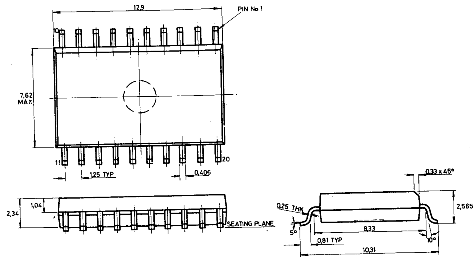
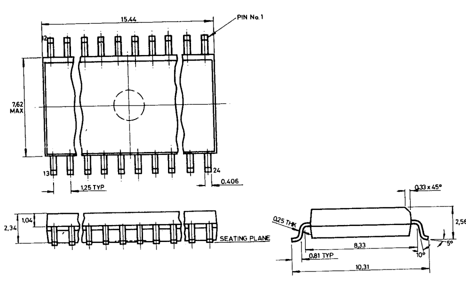
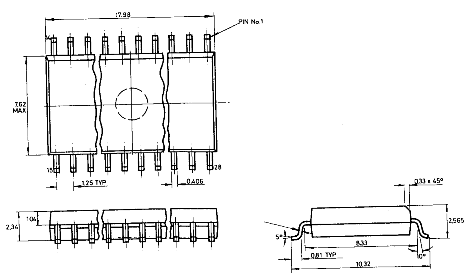


SO-20 (Wide body)



SO-24 (Wide body)



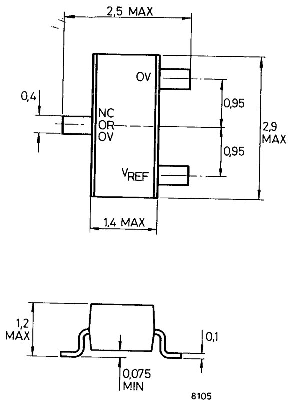
SO-28 (Wide body)

Dimensions in millimetres

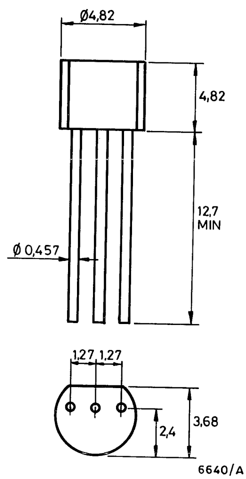
PACKAGE OUTLINES

INTEGRATED CIRCUITS

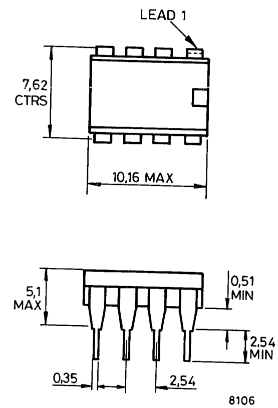
SOT-23, TO-92, DIL



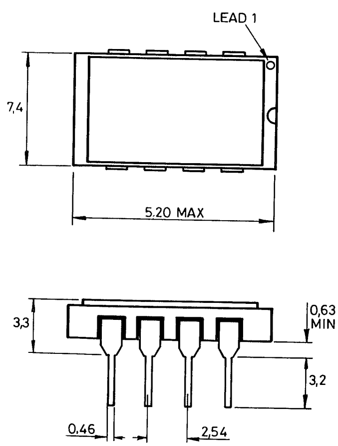
SOT-23 (SR25D)



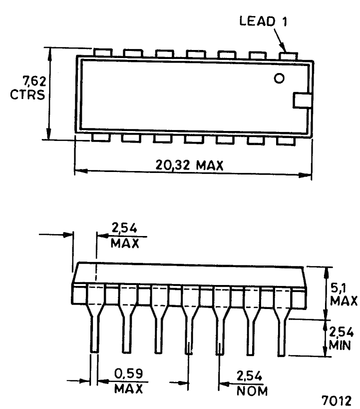
TO-92 (ZN414Z)



8 LEAD MOULDED DIL (E8)

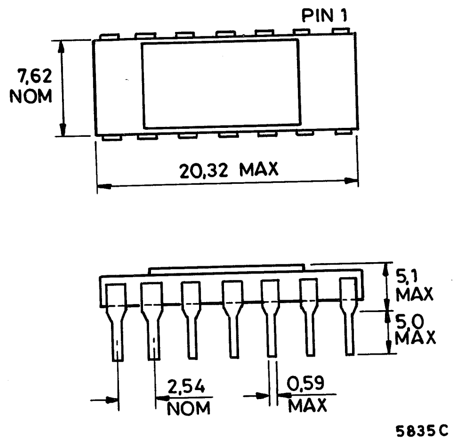


8 LEAD CERAMIC DIL (J8)

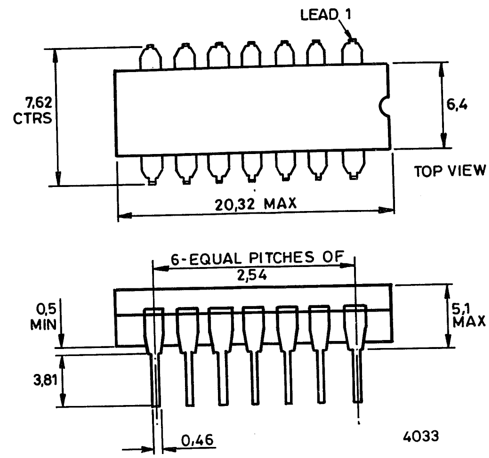


14 LEAD MOULDED DIL (E14)

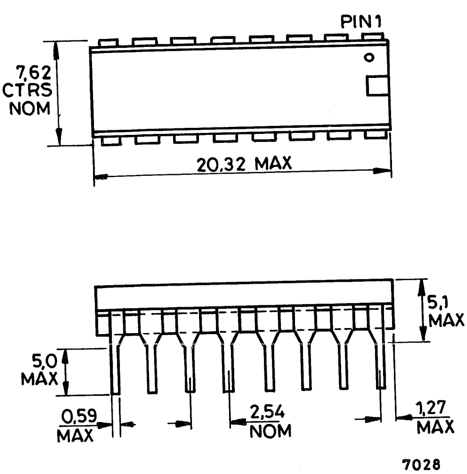
Dimensions in millimetres



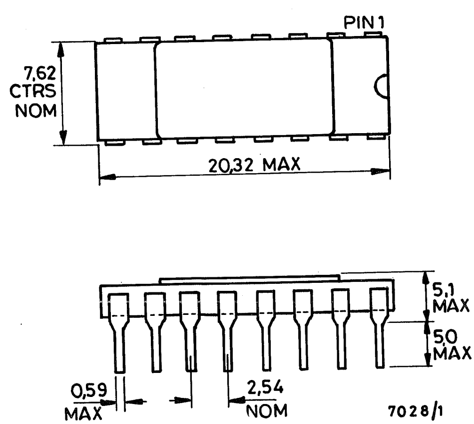
14 LEAD CERAMIC DIL (J14)



14 LEAD CERDIP (H14)



16 LEAD MOULDED (E16)

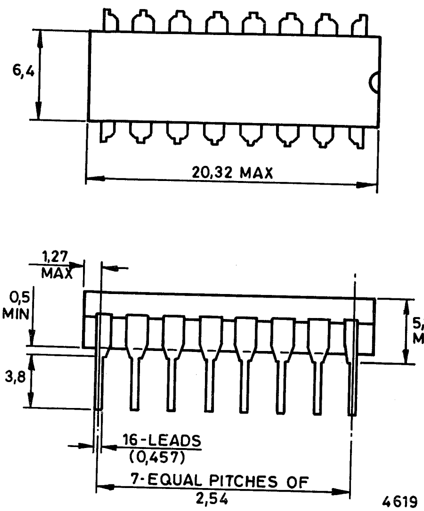


16 LEAD CERAMIC(J16)

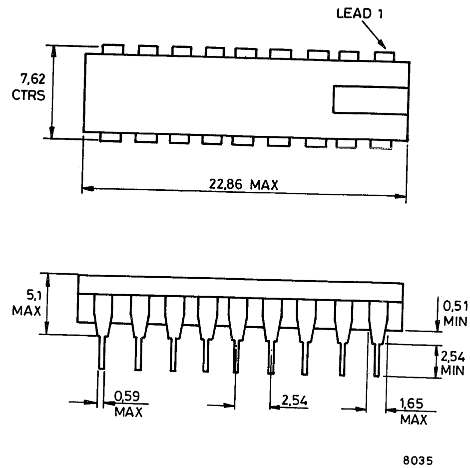
Dimensions in millimetres

PACKAGE OUTLINES

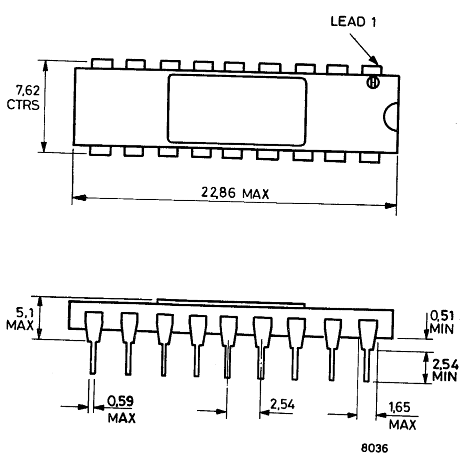
INTEGRATED CIRCUITS



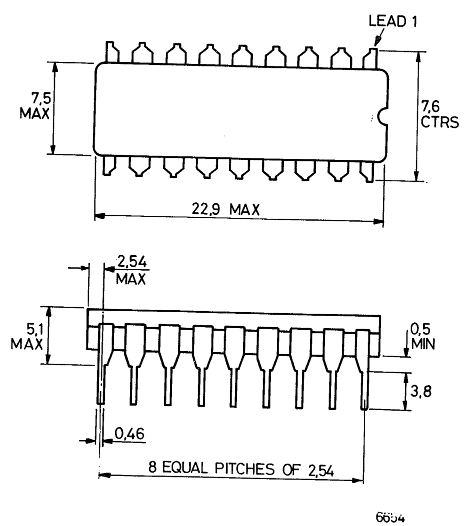
16 LEAD CERDIP(H16)



18 LEAD MOULDED (E18)

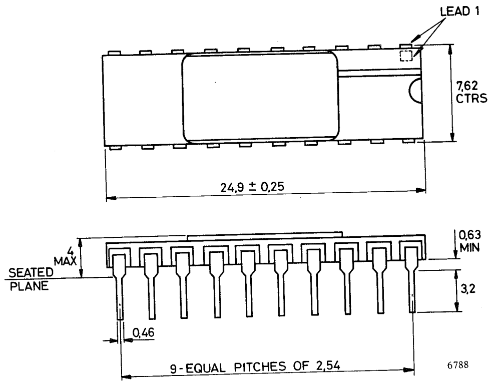


18 LEAD CERAMIC (J18)

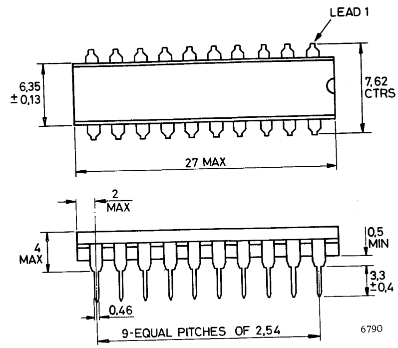


18 LEAD CERDIP (H18)

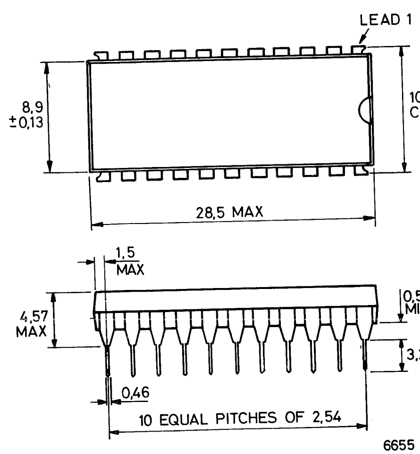
Dimensions in millimetres



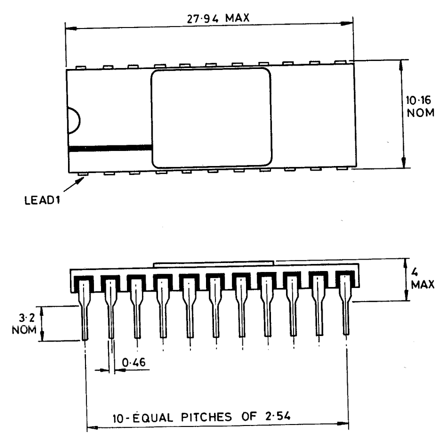
20 LEAD CERAMIC(J20)



20 LEAD CERDIP (H20)

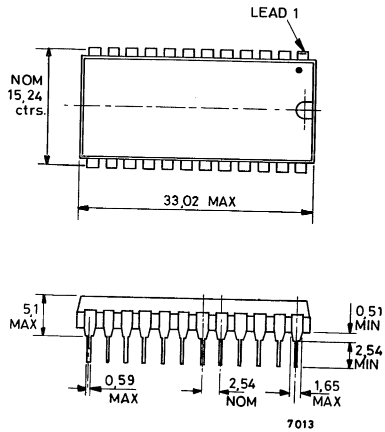


22 LEAD MOULDED (E22)

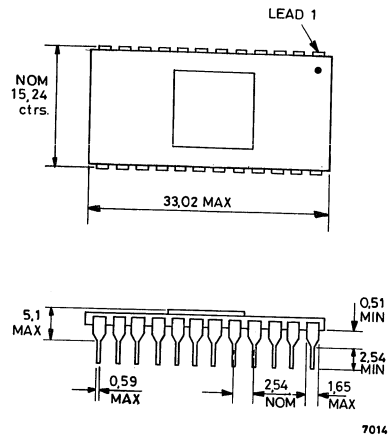


22 LEAD CERAMIC(J22)

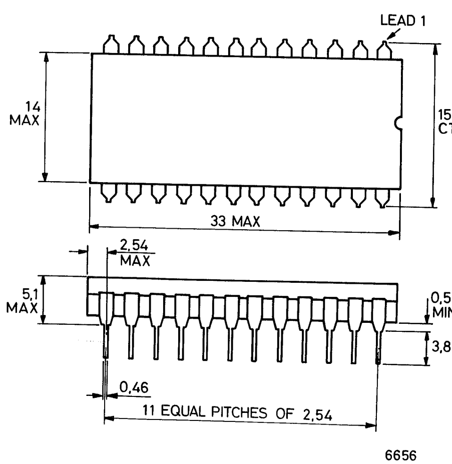
Dimensions in millimetres



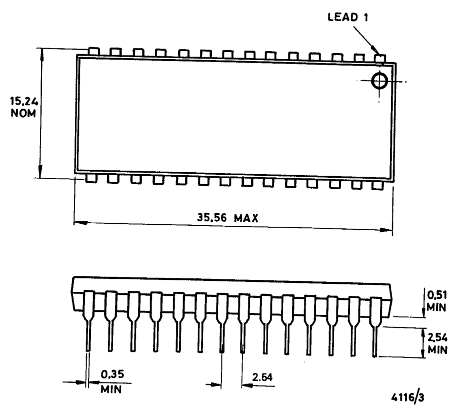
24 LEAD MOULDED (E24)



24 LEAD CERAMIC (J24)



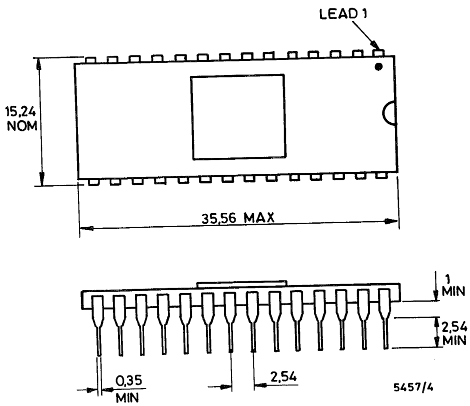
24 LEAD CERDIP (H24)



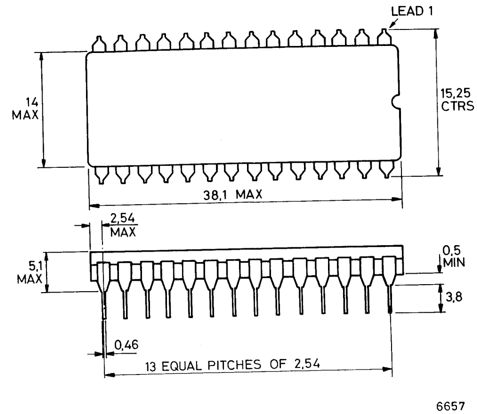
28 LEAD MOULDED (E28)

Dimensions in millimetres

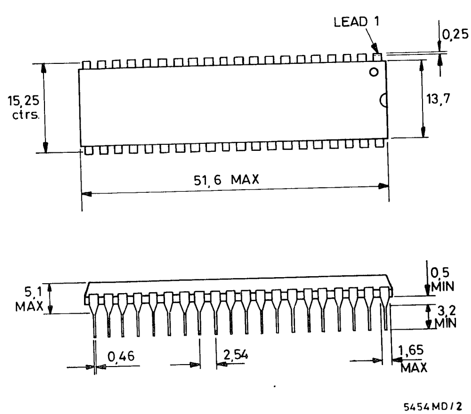
INTEGRATED CIRCUITS



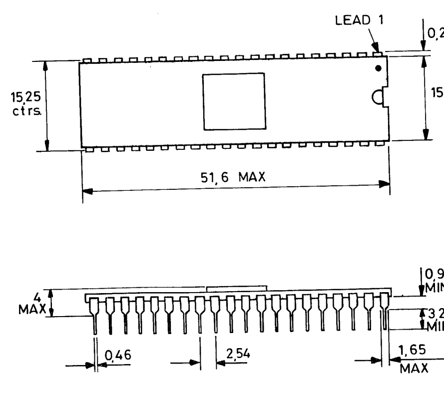
28 LEAD CERAMIC(J28)



28 LEAD CERDIP (H28)



40 LEAD MOULDED (E40)



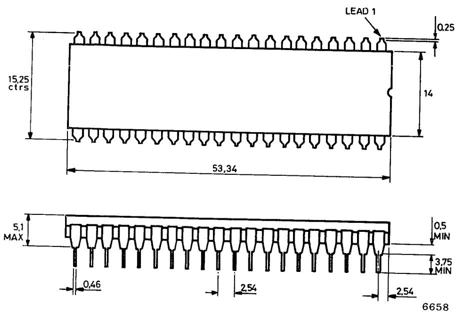
40 LEAD CERAMIC (J40)

Dimensions in millimetres

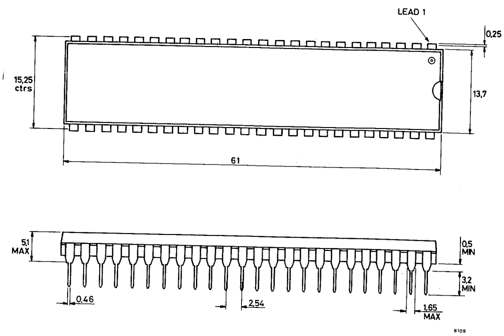
PACKAGE OUTLINES

INTEGRATED CIRCUITS

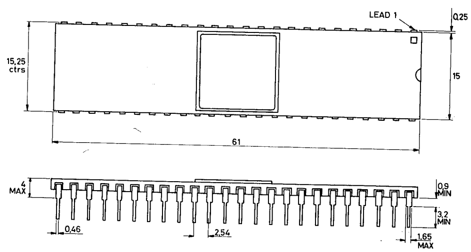
DIL



40 LEAD CERDIP (H40)



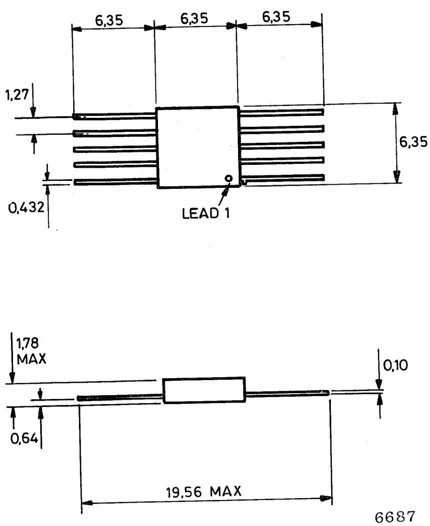
48 LEAD MOULDED (E48)



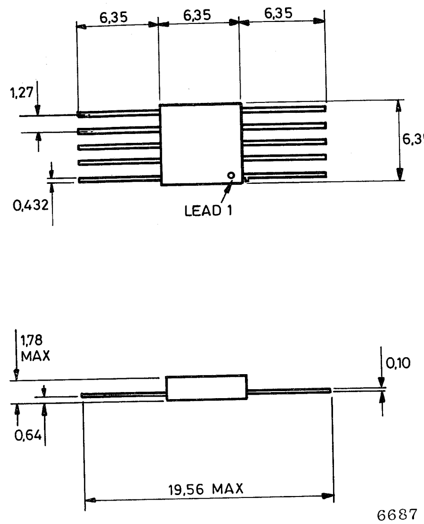
48 LEAD CERAMIC (J48)

Dimensions in millimetres

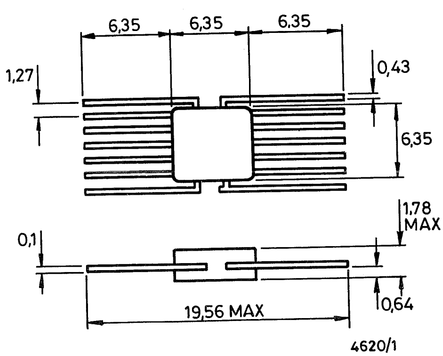
INTEGRATED CIRCUITS



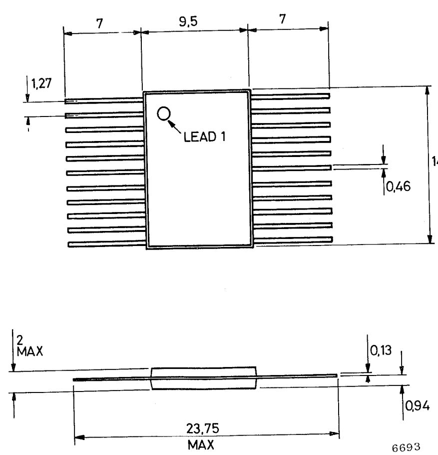
10 LEAD CERAMIC(F10)



10 LEAD CERPACK (FM10)



14 LEAD CERAMIC (F14)



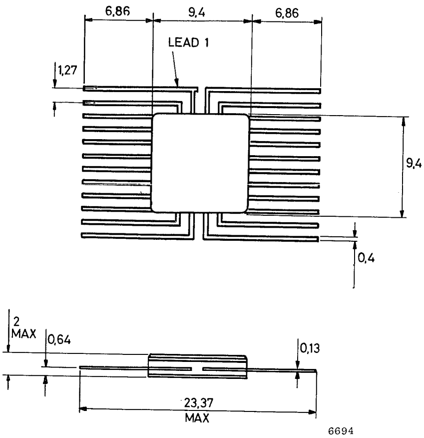
22 LEAD MOULDED (G22)

Dimensions in millimetres

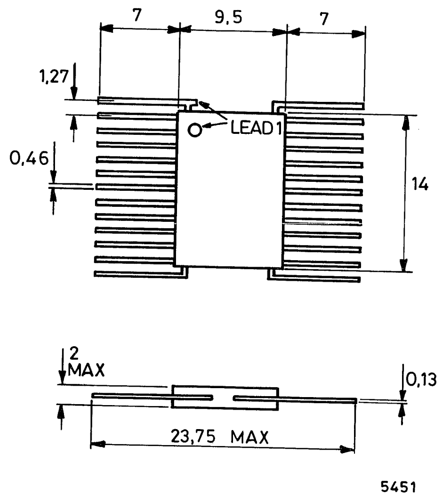
PACKAGE OUTLINES

INTEGRATED CIRCUITS

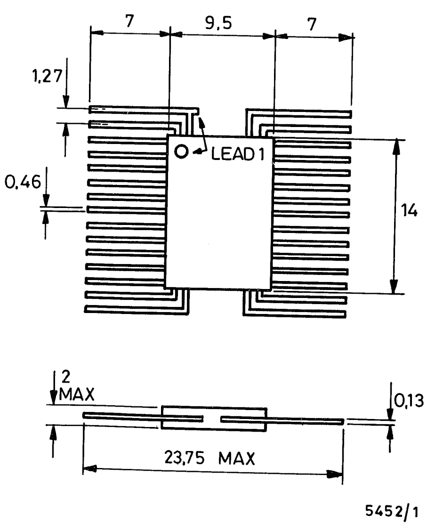
FLAT-PACKS



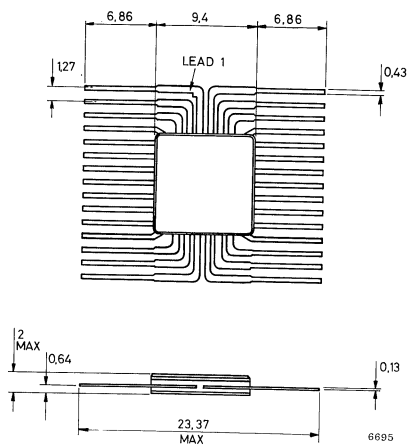
24 LEAD CERAMIC (F24)



26 LEAD MOULDED (G26)



30 LEAD MOULDED (G30)

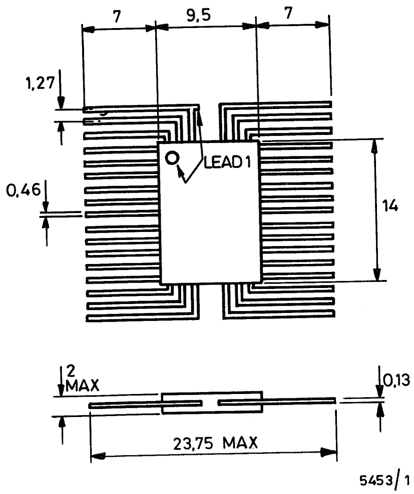


30 LEAD CERAMIC (F30)

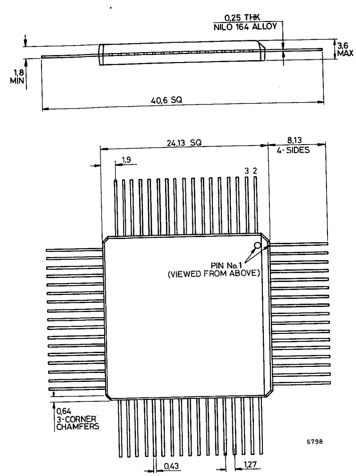
Dimensions in millimetres

INTEGRATED CIRCUITS

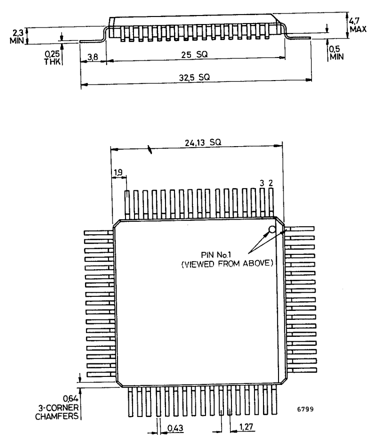
FLAT-PACKS



34 LEAD CERAMIC (G34)



68 LEAD MOULDED (GU68)
(Unjoggled)



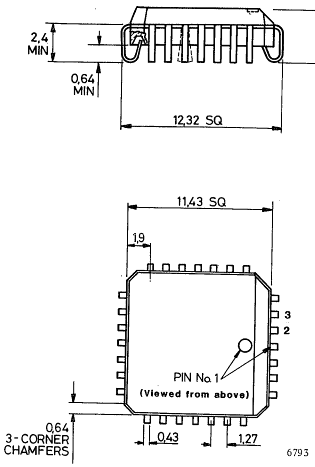
68 LEAD CERAMIC (GJ68)
(Joggled)

Dimensions in millimetres

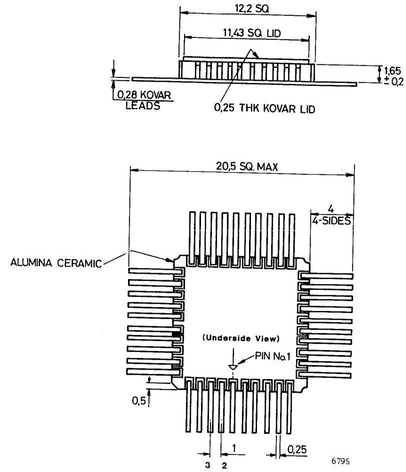
PACKAGE OUTLINES

INTEGRATED CIRCUITS

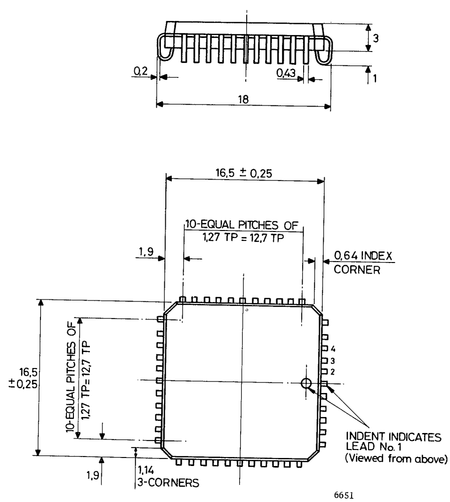
LEADED CHIP CARRIERS



24 LEAD MOULDED (Q28)

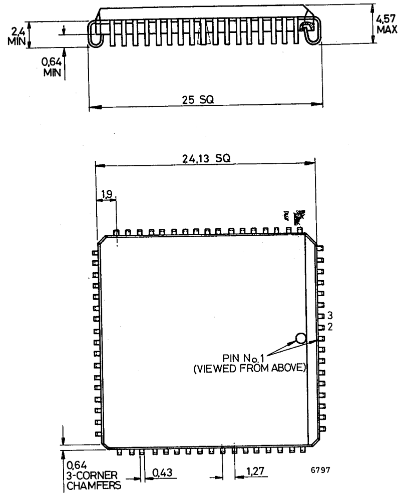


40 LEAD CERAMIC (F40)

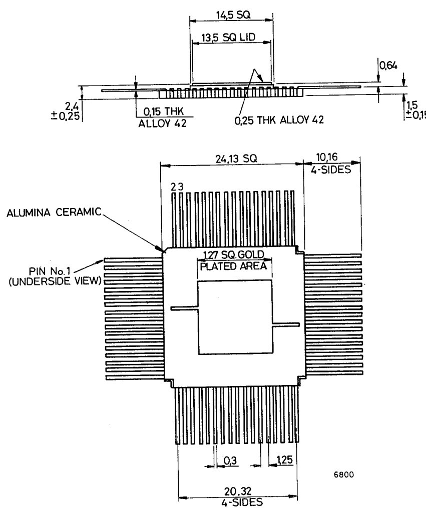


44 LEAD MOULDED (Q44)

Dimensions in millimetres



68 LEAD MOULDED (Q68)



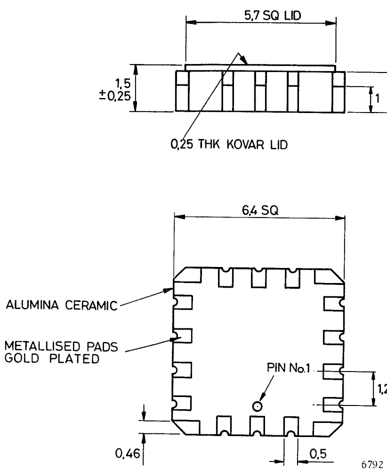
68 LEAD CERAMIC (F68)

Dimensions in millimetres

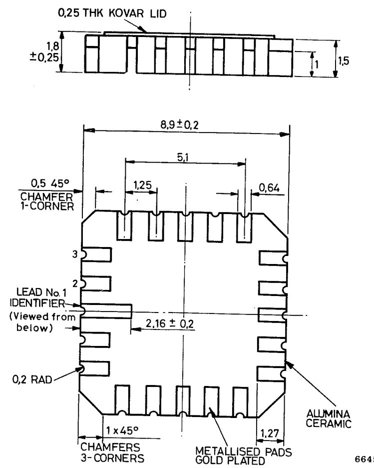
PACKAGE OUTLINES

INTEGRATED CIRCUITS

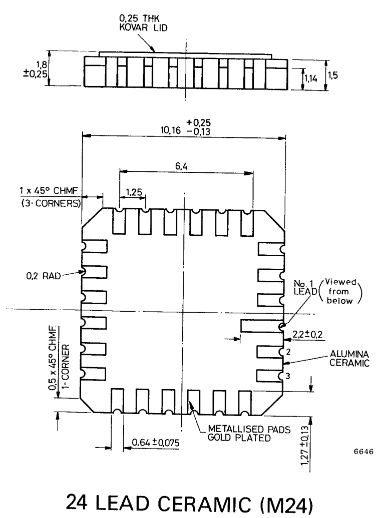
LEADLESS CHIP CARRIERS



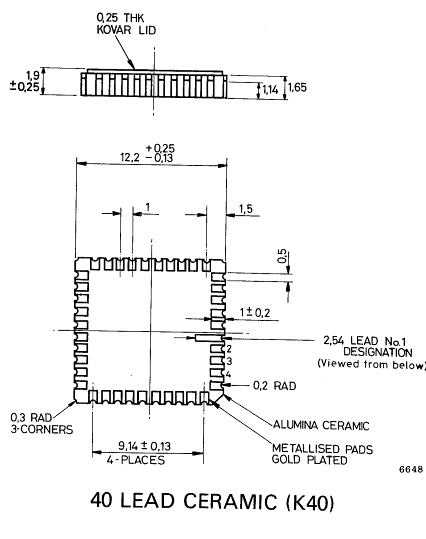
18 LEAD CERAMIC (M18)



20 LEAD CERAMIC (M20)

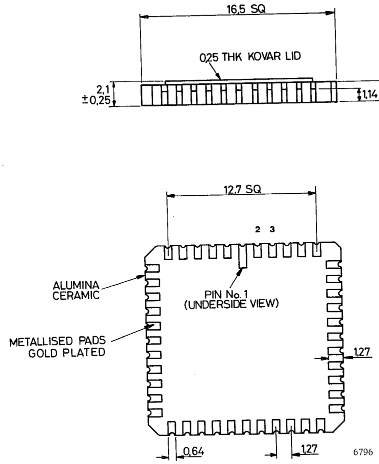


24 LEAD CERAMIC (M24)

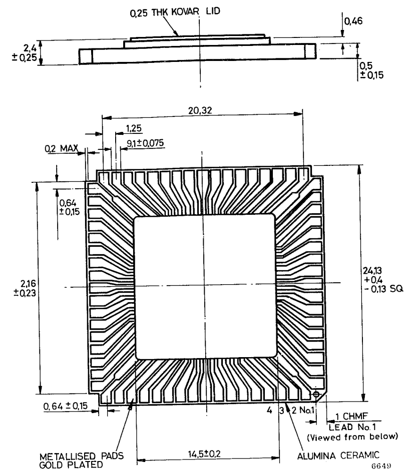


40 LEAD CERAMIC (K40)

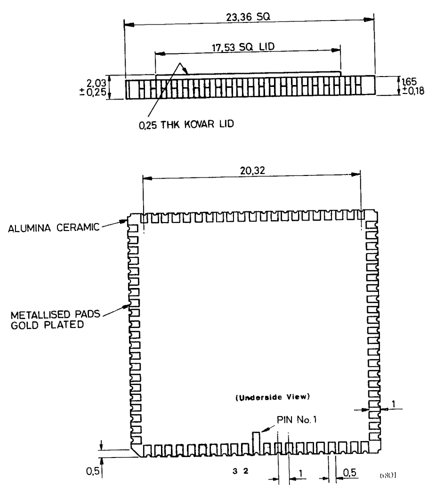
Dimensions in millimetres



44 LEAD CERAMIC (M44)

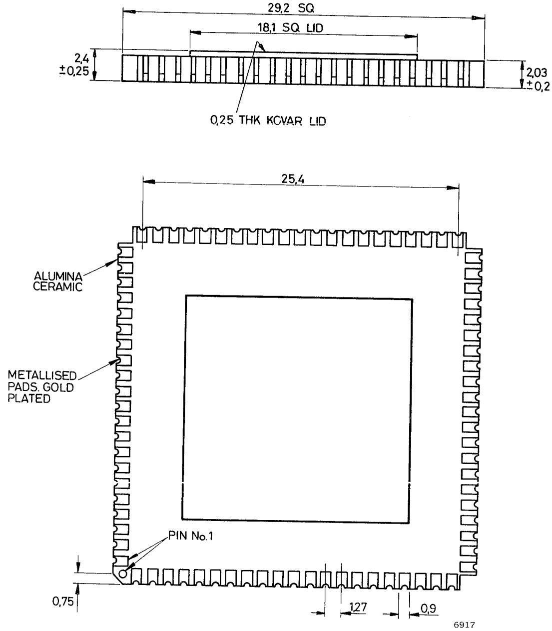


68 LEAD CERAMIC (M68)



84 LEAD CERAMIC (K84)

Dimensions in millimetres



84 LEAD CERAMIC (M84)

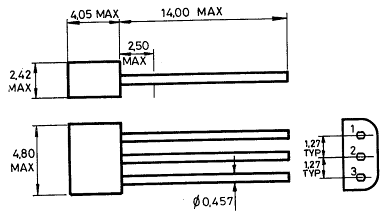
Dimensions in millimetres

PACKAGE OUTLINES

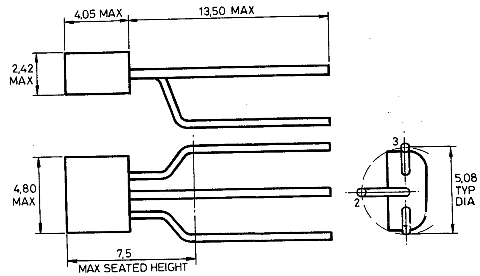
DISCRETE COMPONENTS

3 LEAD PLASTIC E-LINE (TO-92)

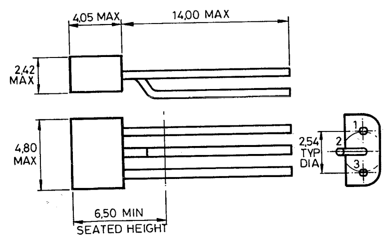
Devices can be ordered with the following lead configurations by adding the indicated suffix to the part number



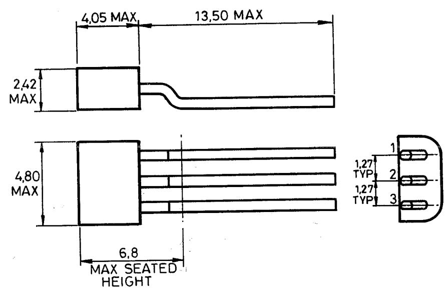
STANDARD PACKAGE
BS3934 SO-94



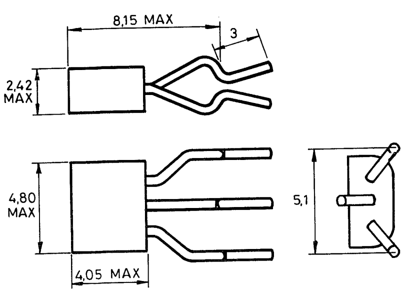
'K' LEAD INFORMATION
for TO-5 and TO-39 compatibility
BS3934 SO-95



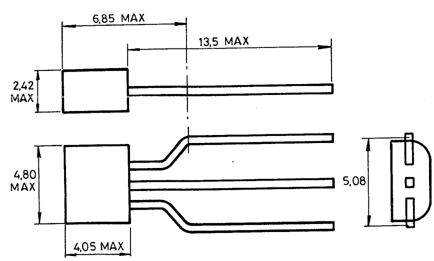
'L' LEAD FORMATION
for TO-18 compatibility
BS3934 SO-97



'M' LEAD FORMATION
for flat mounting
BS3934 SO-96



'Q' LEAD FORMATION
(Lockfit)



'S' LEAD FORMATION

Dimensions in millimetres

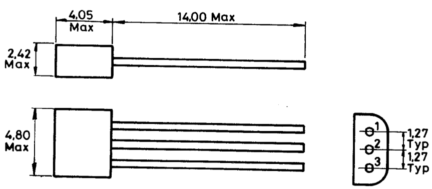
The 'S' type lead formation is pin compatible with the popular TO-202 Plastic Power Transistor

PACKAGE OUTLINES

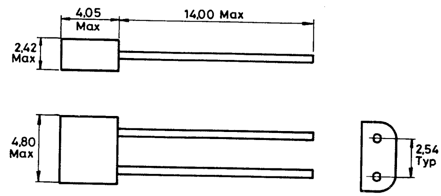
DISCRETE COMPONENTS

2 LEAD PLASTIC E-LINE (TO-92)

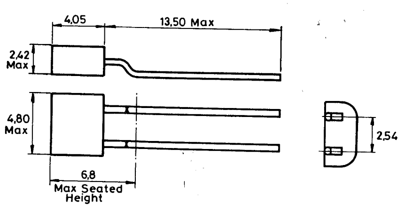
Devices can be ordered with the following lead configurations by adding the indicated suffix to the part number



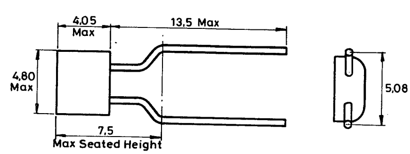
IN-LINE
DOUBLE DIODE



IN-LINE
DIODE



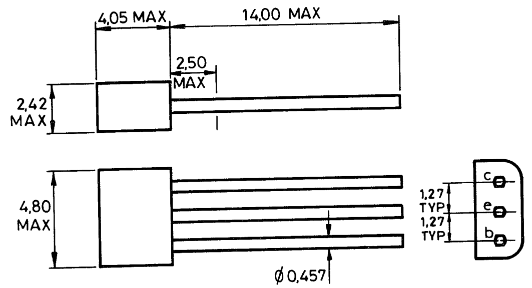
SUFFIX M
(Flat mounting)



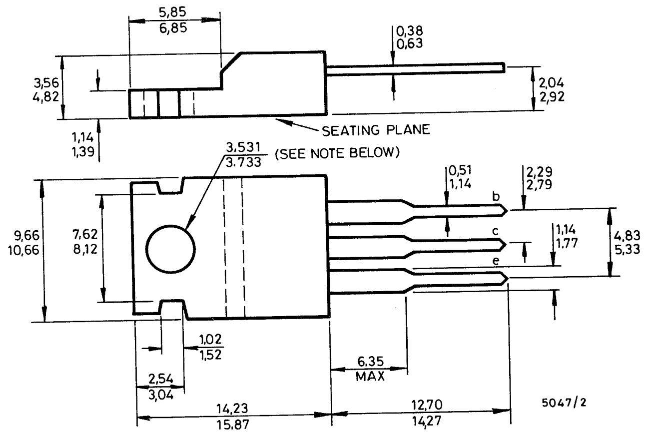
SUFFIX N
(DO-35)

Dimensions in millimetres

N.B. The cathode lead is indicated by a red spot on top of the package



ZTX196, ZTX197*
*BF196P and BF197P lead configuration is not as per normal E-Line. The emitter is the centre lead



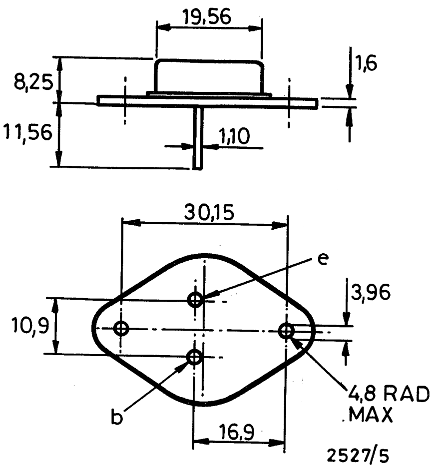
Note: The tab is connected to collector
TO-220

Dimensions in millimetres

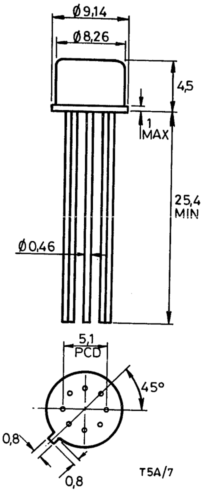
PACKAGE OUTLINES

DISCRETE COMPONENTS

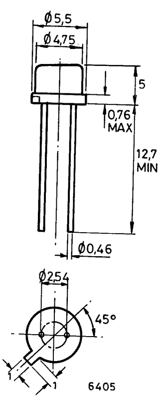
METAL CAN



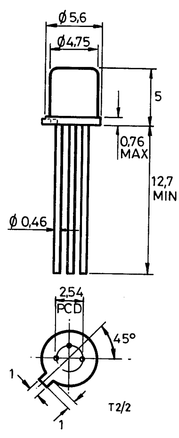
TO-3



TO-5 (ZNP100 8 Lead Glass Window)



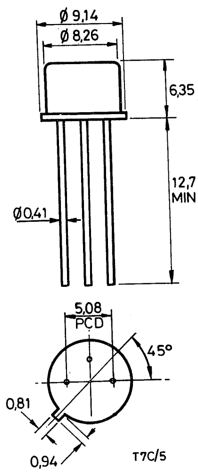
TO-18 (2 Lead)
(T2)



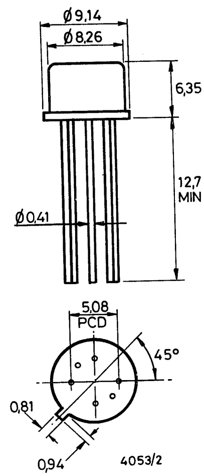
TO-18
(T3)

Dimensions in millimetres

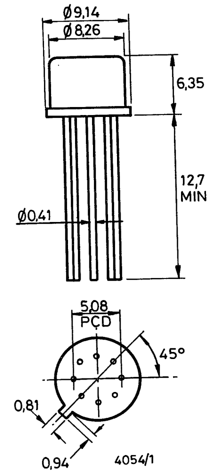
DISCRETE COMPONENTS



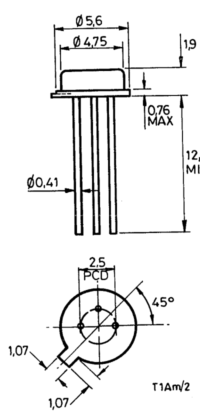
TO-39 (3 Lead)



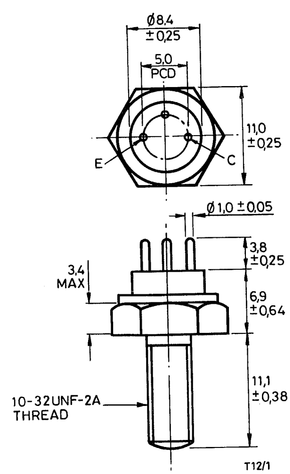
TO-39 (6 Lead) (T6b)



TO-39 (8 Lead) (T8b)



TO-46



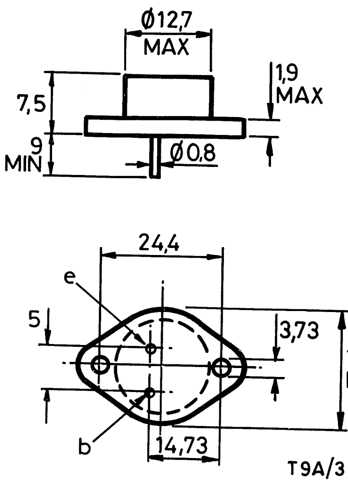
TO-60

Dimensions in millimetres

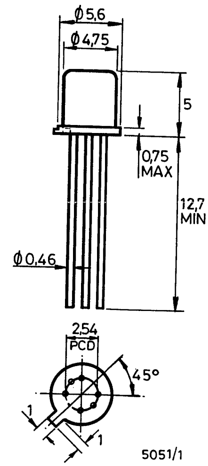
PACKAGE OUTLINES

DISCRETE COMPONENTS

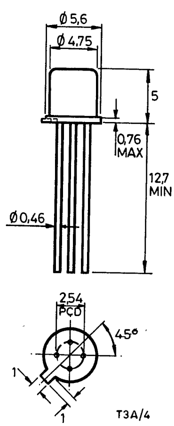
METAL CAN



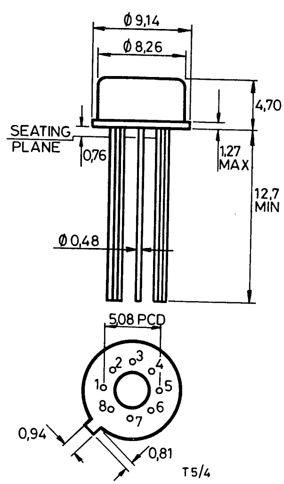
TO-66



TO-71 (6 Lead)
(T6a)



TO-72
(T4)



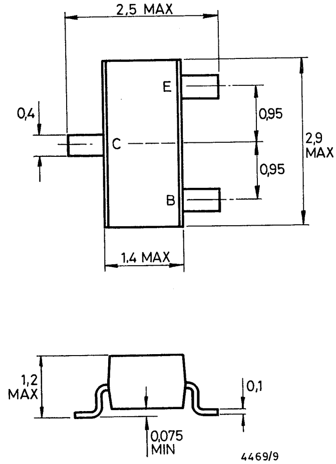
TO-99 (8 Lead)
(T8a)

Dimensions in millimetres

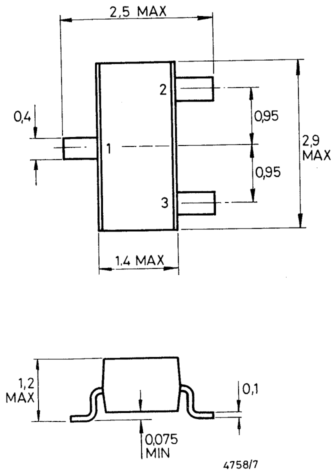
PACKAGE OUTLINES

DISCRETE COMPONENTS

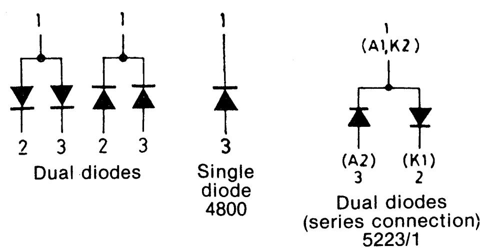
SOT-23



SOT-23 (Transistor)



SOT-23 (Diode)



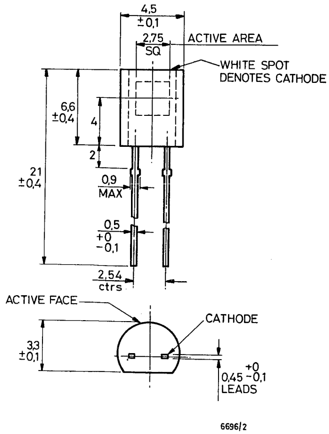
SOT-23 (Diode) Pin Connections

Dimensions in millimetres

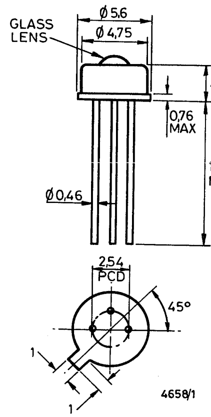
PACKAGE OUTLINES

DISCRETE COMPONENTS

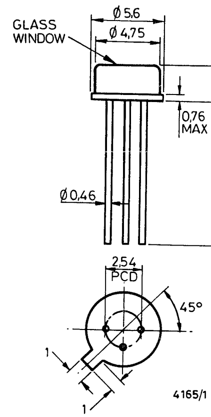
OPTO ELECTRONIC



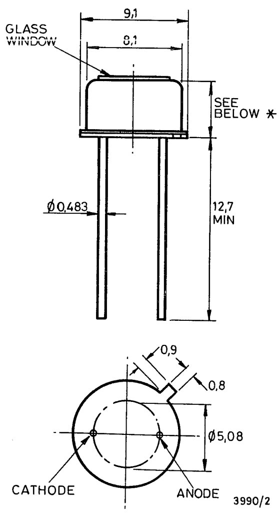
BPW41D



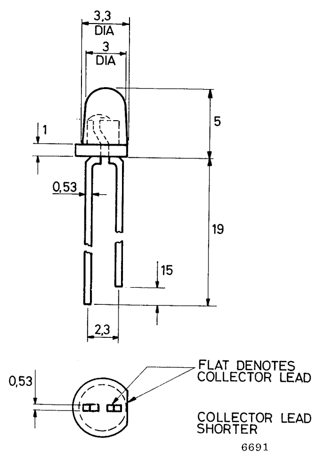
BPX25 ZM100/110



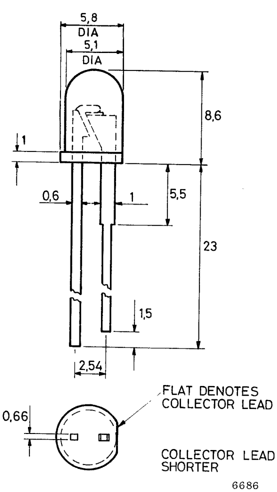
BPX29



MS600/601
MS600 height = 4,8 ± 0,4
MS601 height = 6,7 ± 0,4

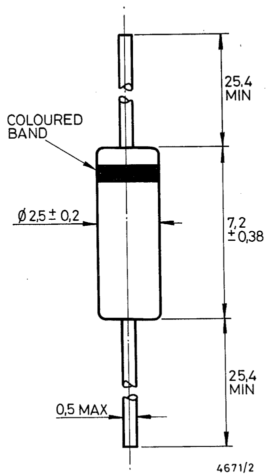


ZMP31

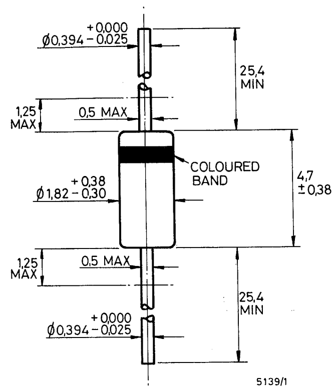


ZMP51

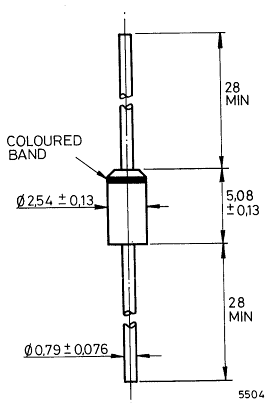
Dimensions in millimetres



DO-7 (Glass)*



DO-35*



DO-41 (Plastic)*

*Cathode end is marked with a coloured band

Dimensions in millimetres

NOTES

CUSTOMER SERVICE INFORMATION

Our Customer Service is designed to deal quickly and efficiently with your enquiries. The services we offer are detailed in the following paragraphs.

DELIVERY ENQUIRIES, TECHNICAL ENQUIRIES AND QUOTATIONS 061-624 0515

Information on the current delivery position of any of our range of products will be given by members of our staff who attend to these questions personally.

In the Sales Department we have a staff of engineers who are able to furnish you with price quotations and with technical advice on problems relating to your individual requirements. These engineers are assigned to specific areas and are thus familiar with many of your company's needs. They are also in constant touch with our **Field Sales Engineers** who will be pleased to call upon you to discuss your semiconductor requirements.

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Orders under £100 in value are dealt with by our distributors, whose addresses are shown below under their geographical areas.

The distributor's area is **not** limited to his geographical location.

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Rode-Kruislaan 119
Postbus 1052

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