FERRANTI
semiconductors ®

QUICK REFERENCE GUIDE 1983

Discrete semiconductors
Integrated circuits

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Quick Reference Guide

FERRANTI SEMICONDUCTORS

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

2nd Edition
1983

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.

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PRODUCT INDEX – INTEGRATED CIRCUITS

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_l	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 (a) Cavity devices (i) Fine leak (ii) Gross leak (b) Glass encapsulated devices	 1.2.6.14.1 1.2.6.14.2 or 1.2.6.14.3 1.2.6.14.4		X	X	X	
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 1.2.7.3					
	(b) Transistors (ambient rated)	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: $|\Delta V_Z| \leq 1\%$ IVD for devices with tolerance of ±1% or tighter
$|\Delta V_Z| \leq 2\%$ IVD for devices with tolerance wider than ±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

APPROVED PRODUCTS

CONTENTS

DISCRETE COMPONENTS
COMMERCIAL/APPROVED TYPE CROSS REFERENCE INDEX

BS NUMBER	Commercial Equivalent	Approval Status	BS NUMBER	Commercial Equivalent	Approval Status
9300			9300		
C013	ZS104	C	C765	2N2218A	C
C045	ZS102	C	C766	2N2219A	C
C046	ZS106	C	C767	2N2221	C
			C768	2N2222	C
C371	ZT83	R	C769	2N2221A	C
C372	ZT84	C	C770	2N2222A	C
C373	ZT86	C			
			9301		
C404	2N1893	C	F021§	ZC2800H	C
C440	2N1613	C	F022§	ZC2810H	C
C464	2N706A	C	F023§	ZC2811H	C
			F024§	ZC5800H	C
C478	2N918	C			
C479	2N2060	C			
C492	2N929	C	9302		
C493	2N930	C	F001	BAW63	C
C495	2N696	C	F002	BAW63A	C
C496	2N697	C	F003	BAW63B	C
			F004	BAW64	C
C554	2N2475	C	F005	BAW65	C
C555	2N2369A	C	F006	BAW66	C
C580	2N1131	C	F007	BAW67	C
C581	2N1132	C	F008	BAW68	C
			F026§	EXP653	
C632	ZT91	C			
C633	ZT92	C			
C639	ZT90	C	9330		
C642	ZS150	C	F019	ZS100	C
C643	ZS151	C	F020	ZS101	C
C644	ZT89	C	F021	ZS102	C
C646	2N708	C	F022	ZS103	C
C648	BSY95A	C	F023	ZS104	C
C669	2N2904	C	F026	ZS100	C
C670	2N2905	C	F027	ZS101	C
C671	2N2904A	C	F028	ZS102	C
C672	2N2905A	C	F029	ZS103	C
C673	2N2906	C	F030	ZS104	C
C674	2N2907	C			
C675	2N2906A	C	9362		
C676	2N2907A	C	F001	BUY80	C
			F003	BUY81	C
C735	2N1711	C	F005	BUY82	C
C738	2N2484	C			
			9364		
C748	ZT80	C	N007	CV8615	C
C749	ZT180	C	N009	CV8616	C
C750	ZT81	C	N011	CV9507	C
C751	ZT181	C	N013	CV9543	C
C752	ZT82	C			
C753	ZT182	C			
C754	ZT87	C	9365		
C755	ZT187	C	F012	BFY50,1,2	C
C763	2N2218	C	F013	BFS36A	C
C764	2N2219	C	F014	BFS36	C

C = Current   P = Pending   S = Suspended   CAT F-§ indicates full plus additional assessment

BS NUMBER	Commercial Equivalent	Approval Status
9365		
F015	BFS38A	C
F016	BFS38	C
F017§	BFS39	C
F018§	BFS42	C
F019	BFS43	C
F020	BFS40A	C
F021	BFS40	C
F022	BFS41	C
F023	BFS44	C
F024	BFS45	C
F025	BFS37A	C
F026	BFS37	C
F027	BSS47	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
F036	BSV35A	C
F037	BSV35	C
F038	BSV36	C
F039	BSV37	C
F040	ZTX310	C
F041	ZTX311	C
F042	ZTX312	C
F043	ZTX313	C
F044	ZTX314	C
F045	BFS85	C
F046	BFS88	C
F047	BFS46	C
F048	BFS46A	C
F050	2N3866	C
F053	2N3053	R
F054	ZTX341	C
F055	ZTX342	C
F056	BFY90	C
F058	ZT180	C
F059	ZT181	C
F060	ZT182	C
F061	ZT183	C
F062	ZT184	C
F063	ZT187	C
F064	ZT189	C
F065	ZT180	C
F066	ZT181	C
F067	ZT182	C
F068	ZT183	C
F069	ZT184	C
F070	ZT187	C
F071	ZT189	C
F072	ZTX300	C
F073	ZTX301	C
9365		
F074	ZTX302	C
F075	ZTX303	C
F076	ZTX304	C
F077	ZTX300	C
F078	ZTX301	C
F079	ZTX302	C
F080	ZTX303	C
F081	ZTX304	C
F082	BFS96	C
F083	BFS97	C
F084	BFS98	C
F085	BFS96	C
F086	BFS97	C
F087	BFS98	C
F088	ZTX320	C
F089	ZTX321	C
F090	ZTX320	C
F091	ZTX321	C
F092	ZTX330	C
F093	ZTX331	C
F094	ZTX330	C
F095	ZTX331	C
F096	BFS59	C
F097	BFS60	C
F098	BFS61	C
F099	BFS59	C
F100	BFS60	C
F101	BFS61	C
F102	ZTX325	C
F103	ZTX326	C
F104	ZTX325	C
F105	ZTX326	C
F130	ZTX212	C
F131	ZTX213	C
F132	ZTX214	C
F133	BFX34	C
F137	ZTX450	C
F138	ZTX451	C
F139	ZTX450	C
F140	ZTX451	C
F141§	ZTX360	C
F142	ZTX360	C
F143§	ZTX550	C
F144§	ZTX551	C
F153	BUX34	C
F158§	2N3418	C
F159§	2N3419	C
F160§	2N3420	C
F161§	2N3421	C
F171	ZT210	C
F172	ZT211	C
F182§	2N4036	C
F183§	2N4037	C
F192§	ZTX541	C
F193§	ZTX542	C
F194	2N3053	C
F205ϕ	ZTX450	C
	ZTX451	C

C = Current P = Pending S = Suspended

CAT F-§indicates full plus additional assessment

CAT F-ϕindicates full plus additional assessment with long life requirements

CECC Number	Commercial Equivalent	Approval Status
50001		
014	BAT21J	C
015	BAT22J	C
016	BAT23H	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
045	ZC2800	C
045	ZC2810	C
045	ZC2811	C
046	ZC5800	C
048ϕ	HD2A	C
049ϕ	HD3A	C
050ϕ	HD4A	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
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

CECC Number	Commercial Equivalent	Approval Status
50002		
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	C
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§	BC31/32/ 33/71/72	C
116§	BCW60	C
117§	BCW65/66	C
119§	BCX19/20	C
120§	BCX70	C

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CAT F-ϕindicates full plus additional assessment with long life requirements

CECC Number	Commercial Equivalent	Approval Status
50002		
121§	FMMTA95/ A96	C
123§	BFQ31/31A	C
124§	FMMTA12/ A13/A14	C
128§	BFS17/17R	C
137§	ZTX750 Series	C
138§	ZTX650 Series	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
156ϕ	BCY77P	C
157ϕ	BCY78P	C
158ϕ	BCY79P	C
159ϕ	BC212P	C
160ϕ	BC213P	C
161ϕ	BC214P	C
162ϕ	HT3	C
163ϕ	BCW30	P
190§	MPSA92	P
191ϕ	MPSA93	P
50003		
002	BUY90	C
003	BUY92	C
005	BD320	C
006	BD322	C
007	BD321	C
008	BD323	C
010	BUY91	C

CECC Number	Commercial Equivalent	Approval Status
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
019§	FF3725J	C
022	2N2368	C
023	2N2369	C
053§	FMMT2369	C
054§	FMMT3903	C
	FMMT3904	C
055§	FMMT2222 /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	P
081	MPS2369/ 2369A	P
082ϕ	MPS2369/ 2369A	P
086§	BSS69	P
086ϕ	BSS70	P
	2N2894	P
50005		
008	BZX84	C
009ϕ	BZX84	C
50007		
006	2N4427	C

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Type Number	Commercial Equivalent	Approval Status
CV5644	2N697	C
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	C
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
CV8616	2N2369A	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

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TYPE NUMBER	BS/CECC TYPE					CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type		
BAT21J	50001	014	—	—	—	—	C
BAT22J	50001	017	—	—	—	—	C
BAT23H	50001	016	—	—	—	—	C
BAT34H	50001	017	—	—	—	—	C
BAV70	50001	027§	—	—	—	—	C
BAV74	50001	028§	—	—	—	—	C
BAV99	50001	029§	—	—	—	—	C
BAW56	50001	033§	—	—	—	—	C
BAW63	BS9302	—	F001	—	—	—	C
BAW63A	BS9302	—	F002	—	—	—	C
BAW63B	BS9302	—	F003	—	—	—	C
BAW64	BS9302	—	F004	—	—	—	C
BAW65	BS9302	—	F005	—	—	—	C
BAW66	BS9302	—	F006	—	—	—	C
BAW67	BS9302	—	F007	—	—	—	C
BAW68	BS9302	—	F008	—	—	—	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

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TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
BC309P	50002	027	–	–	–	–	C
BC327P	50002	063§	–	–	–	–	C
BC328P	50002	064§	–	–	–	–	C
BC337P	50002	065	–	–	–	–	C
BC338P	50002	066	–	–	–	–	C
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
BC559	50002	049	–	–	–	–	C
BC560P	50002	050	–	–	–	–	C
BCW29	50002	114§	–	–	–	–	C
BCW30	50002	114§	–	–	–	–	C
	50002	163ϕ	–	–	–	–	C
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
BCW70	50002	114§	–	–	–	–	C
BCW71	50002	118§	–	–	–	–	C
BCW72	50002	118§	–	–	–	–	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

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TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
BCY59	50002	031§	–	–	–	–	C
BCY59P	50002	052§	–	–	–	–	C
	50002	152ϕ	–	–	–	–	C
BCY65E	50002	032§	–	–	–	–	C
BCY65EP	50002	053§	–	–	–	–	C
	50002	153ϕ	–	–	–	–	C
BCY70	50002	079§	–	–	–	–	C
BCY71	50002	080§	–	–	–	–	C
BCY72	50002	081§	–	–	–	–	C
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
BFS17	50002	128§	–	–	–	–	C
BFS17R	50002	128§	–	–	–	–	C
BFS36	BS9365	–	F014	–	–	–	C
BFS36A	BS9365	–	F013	–	–	–	C
BFS37	BS9365	–	F026	–	–	–	C
BFS37A	BS9365	–	F025	–	–	–	C
BFS38	BS9365	–	F016	–	–	–	C
BFS38A	BS9365	–	F015	–	–	–	C
BFS39	BS9365	–	F017	–	–	–	C
BFS40	BS9365	–	F021	–	–	–	C
BFS40A	BS9365	–	F020	–	–	–	C
BFS41	BS9365	–	F022	–	–	–	C
BFS42	BS9365	–	F018	–	–	–	C
BFS43	BS9365	–	F019	–	–	–	C
BFS44	BS9365	–	F023	–	–	–	C
BFS45	BS9365	–	F024	–	–	–	C
BFS46	BS9365	–	F047	–	–	–	C
BFS46A	BS9365	–	F048	–	–	–	C
BFS59	BS9365	–	F096	F099	–	–	C
BFS60	BS9365	–	F097	F100	–	–	C
BFS61	BS9365	–	F098	F101	–	–	C
BFS85	BS9365	–	F045	–	–	–	C
BFS88	BS9365	–	F046	–	–	–	C
BFS96	BS9365	–	F082	F085	–	–	C

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BFS97	BS9365	—	F083	F086	—	—	C
BFS98	BS9365	—	F084	F087	—	—	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
BFY90	BS9365	—	F056	—	—	—	C
BSS47	BS9365	—	F027	—	—	—	C
BSS66	50004	069	—	—	—	—	C
BSS67	50004	069	—	—	—	—	C
BSS69	50004	070	—	—	—	—	C
	50004	086§	—	—	—	—	P
BSS70	50004	070	—	—	—	—	C
	50004	086ϕ	—	—	—	—	P
BSV35	BS9365	—	F037	—	—	—	C
BSV35A	BS9365	—	F036	—	—	—	C
BSV36	BS9365	—	F038	—	—	—	C
BSV37	BS9365	—	F039	—	—	—	C
BSV52	50004	071	—	—	—	—	C
BSV64	50004	008	—	—	—	—	C
BSX59	50004	009	—	—	—	—	C
BSX60	50004	010	—	—	—	—	C
BSX61	50004	011	—	—	—	—	C
BSY95A	BS9300	—	—	—	C648	—	C
	—	—	—	—	—	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
	50005	009ϕ	—	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
CV8615	BS9364	N007	—	—	—	—	C
CV8616	BS9364	N009	—	—	—	—	C
CV9507	BS9364	N011	—	—	—	—	C
CV9543	BS9364	N013	—	—	—	—	C
EXP653	BS9302	F026§	—	—	—	—	C
FF3725J	50004	019§	—	—	—	—	C
FMC106J	50001	018	—	—	—	—	C
FMMD914	50001	040§	—	—	—	—	C
FMMT2222	50004	055§	—	—	—	—	C
FMMT2222A	50004	055§	—	—	—	—	C
FMMT2369	50004	053§	—	—	—	—	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
FMMTA55	50002	112§	—	—	—	—	C
FMMTA56	50002	112§	—	—	—	—	C
FST149	50002	142§	—	—	—	—	C
		143ϕ	—	—	—	—	C
FST150	50002	144§	—	—	—	—	C
		145ϕ	—	—	—	—	C
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/	50004	075§	—	—	—	—	C
2222A	50004	076ϕ	—	—	—	—	C
MPS2369/	50004	081§	—	—	—	—	C
2369A	50004	082ϕ	—	—	—	—	C

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TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
MPS2907/	50004	077§	—	—	—	—	C
2907A	50004	078ϕ	—	—	—	—	P
MPSA92/	50002	190§	—	—	—	—	P
MPSA93	50002	191ϕ	—	—	—	—	P
ZC2800	50001	045	—	—	—	—	C
ZC2800H	BS9301	F021§	—	—	—	—	C
ZC2810	50001	045	—	—	—	—	C
ZC2810H	BS9301	F022§	—	—	—	—	C
ZC2811	50001	045	—	—	—	—	C
ZC2811H	BS9301	F023§	—	—	—	—	C
ZC5800	50001	045	—	—	—	—	C
ZC5800H	BS9301	F024§	—	—	—	—	C
ZS100	BS9330	—	F019	F026	—	—	C
ZS101	BS9330	—	F020	F027	—	—	C
ZS102	BS9300	—	—	—	C045	CV7045	C
	BS9330	—	F021	F028	—	—	C
ZS103	BS9330	—	F022	F029	—	—	C
ZS104	BS9300	—	—	—	C013	CV7013	C
	BS9330	—	F023	F030	—	—	C
ZS106	BS9300	—	—	—	C046	CV7046	C
ZS150	BS9300	—	—	—	C642	CV7642	C
ZS151	BS9300	—	—	—	C643	CV7643	C
ZT80	BS9300	—	—	—	C748	CV7748	C
ZT81	BS9300	—	—	—	C750	CV7750	C
	—	—	—	—	—	CV10150	C
ZT82	BS9300	—	—	—	C752	CV7752	C
ZT83	BS9300	—	—	—	C371	CV7371	C
ZT84	BS9300	—	—	—	C372	CV7372	C
ZT86	BS9300	—	—	—	C373	CV7373	C
	—	—	—	—	—	CV8649	C
ZT87	BS9300	—	—	—	C754	CV7754	C
	—	—	—	—	—	CV9888	C
ZT89	BS9300	—	—	—	C644	CV7644	C
ZT90	BS9300	—	—	—	C639	CV7639	C
	—	—	—	—	—	CV10750	C
ZT91	BS9300	—	—	—	C632	CV7632	C
	—	—	—	—	—	CV11096	C
ZT92	BS9300	—	—	—	C633	CV7633	C
	—	—	—	—	—	CV8647	C
ZT93	50002	106	—	—	—	—	C
ZT180	BS9300	—	—	—	C749	CV7749	C
	BS9365	—	F058	F065	—	—	C
ZT181	BS9300	—	—	—	C751	CV7751	C
	BS9365	—	F059	F066	—	—	C
ZT182	BS9300	—	—	—	C753	CV7753	C
	BS9365	—	F060	F067	—	—	C
ZT183	BS9365	—	F061	F068	—	—	C

C = Current P = Pending S = Suspended CAT F-§indicates full plus additional assessment

TYPE NUMBER	BS/CECC TYPE					CV Type Number	Approval Status
	Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type		
ZT184	BS9365	—	F062	F069	—	CV10741	C
ZT187	BS9300	—	—	—	C755	CV7755	C
	BS9365	—	F063	F070	—	—	C
ZT189	BS9365	—	F064	F071	—	—	C
ZT210	BS9365	—	F171	—	—	—	C
ZT211	BS9365	—	F172	—	—	CV9516	C
ZT2477	—	—	—	—	—	CV7593	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	F077	—	—	C
ZTX301	BS9365	—	F073	F078	—	—	C
ZTX302	BS9365	—	F074	F079	—	—	C
ZTX303	BS9365	—	F075	F080	—	—	C
ZTX304	BS9365	—	F076	F081	—	—	C
ZTX310	BS9365	—	F040	—	—	—	C
ZTX311	BS9365	—	F041	—	—	—	C
ZTX312	BS9365	—	F042	—	—	—	C
ZTX313	BS9365	—	F043	—	—	—	C
ZTX314	BS9365	—	F044	—	—	—	C
ZTX320	BS9365	—	F088	F090	—	—	C
ZTX321	BS9365	—	F089	F091	—	—	C
ZTX325	BS9365	—	F102	F104	—	—	C
ZTX326	BS9365	—	F103	F105	—	—	C
ZTX330	BS9365	—	F092	F094	—	—	C
ZTX331	BS9365	—	F093	F095	—	—	C
ZTX341	BS9365	—	F054	—	—	—	C
ZTX342	BS9365	—	F055	—	—	—	C
ZTX360	BS9365	F141§	—	F142	—	—	C
ZTX450	BS9365	—	F137	F139	—	—	C
		F205ϕ	—	—	—	—	C
ZTX451	BS9365	—	F138	F140	—	—	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

C = Current P = Pending S = Suspended
CAT F-§indicates full plus additional assessment
CAT F-ϕindicates full plus additional assessment with long life requirements

TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
ZTX750	50002	137§	—	—	—	—	C
ZTX751	50002	137§	—	—	—	—	C
ZTX752	50002	137§	—	—	—	—	C
ZTX753	50002	137§	—	—	—	—	C
2N696	BS9300	—	—	—	C495	CV7495	C
2N697	BS9300	—	—	—	C496	CV7496	C
2N706	—	—	—	—	—	CV9211	C
2N706A	BS9300	—	—	—	C446	CV8729	C
	—	—	—	—	—	CV7464	C
2N708	BS9300	—	—	—	C646	CV8844	C
	—	—	—	—	—	CV7646	C
2N709	50004	013	—	—	—	—	C
2N918	BS9300	—	—	—	C478	—	C
	—	—	—	—	—	CV7478	C
2N929	BS9300	—	—	—	C492	—	C
	—	—	—	—	—	CV7492	C
2N930	BS9300	—	—	—	C493	CV8467	C
	—	—	—	—	—	CV7493	C
2N1131	BS9300	—	—	—	C580	—	C
	—	—	—	—	—	CV7580	C
2N1132	BS9300	—	—	—	C581	—	C
	—	—	—	—	—	CV7581	C
2N1613	BS9300	—	—	—	C440	CV8843	C
	—	—	—	—	—	CV7440	C
2N1711	BS9300	—	—	—	C735	—	C
	—	—	—	—	—	CV7735	C
2N1893	BS9300	—	—	—	C404	—	C
	—	—	—	—	—	CV7404	C
2N2060	50002	097§	—	—	—	—	C
	BS9300	—	—	—	C479	CV7479	C
2N2102	50002	069	—	—	—	—	C
	—	—	—	—	—	CV9604	C
2N2218	BS9300	—	—	—	C763	—	C
	—	—	—	—	—	CV7763	C
2N2218A	BS9300	—	—	—	C765	—	C
	—	—	—	—	—	CV7765	C
2N2219	BS9300	—	—	—	C764	—	C
	—	—	—	—	—	CV7764	C
2N2219A	BS9300	—	—	—	C766	—	C
	—	—	—	—	—	CV7766	C
2N2221	BS9300	—	—	—	C767	—	C
	—	—	—	—	—	CV7767	C
2N2221A	BS9300	—	—	—	C769	—	C
	—	—	—	—	—	CV7769	C
2N2222	BS9300	—	—	—	C768	—	C
	—	—	—	—	—	CV7768	C
2N2222A	BS9300	—	—	—	C770	—	C
	—	—	—	—	—	CV7770	C
2N2223	50002	097§	—	—	—	—	C

C = Current   P = Pending   S = Suspended   CAT F-§indicates full plus additional assessment

TYPE NUMBER	BS/CECC TYPE Prefix	Cat. F	Cat. P	Cat. Q	Adopted CV Type	CV Type Number	Approval Status
2N2270	50002	070	—	—	—	—	C
	—	—	—	—	—	CV8848	C
2N2368	50004	022	—	—	—	—	C
	—	—	—	—	—	CV9320	C
2N2369	50004	023	—	—	—	—	C
2N2369A	BS9300	—	—	—	C555	—	C
	—	—	—	—	—	CV7555	C
	—	—	—	—	—	CV8616	C
2N2405	50002	082	—	—	—	—	C
2N2475	BS9300	—	—	—	C554	—	C
	—	—	—	—	—	CV7554	C
2N2476	50004	014	—	—	—	—	C
2N2484	BS9300	—	—	—	C738	—	C
	—	—	—	—	—	CV7738	C
2N2604	50002	039	—	—	—	—	C
2N2605	50002	040	—	—	—	—	C
2N2894	50004	—	—	—	—	—	P
	—	—	—	—	—	CV9047	C
2N2904	BS9300	—	—	—	C669	CV7669	C
2N2904A	BS9300	—	—	—	C671	CV7671	C
2N2905	BS9300	—	—	—	C670	CV7670	C
2N2905A	BS9300	—	—	—	C672	CV7672	C
	—	—	—	—	—	CV9507	C
2N2906	BS9300	—	—	—	C673	CV7673	C
2N2906A	BS9300	—	—	—	C675	CV7675	C
2N2907	BS9300	—	—	—	C674	CV7674	C
	—	—	—	—	—	CV9543	C
2N2907A	BS9300	—	—	—	C676	CV7676	C
2N2938	50004	015	—	—	—	—	C
2N3053	BS9365	—	—	F053	—	—	R
	—	F194	—	—	—	—	C
2N3261	50004	002	—	—	—	—	C
2N3418	BS9365	F158§	—	—	—	—	C
2N3419	BS9365	F159§	—	—	—	—	C
2N3420	BS9365	F160§	—	—	—	—	C
2N3421	BS9365	F161§	—	—	—	—	C
2N3512	50004	016	—	—	—	—	S
2N3724	50004	017§	—	—	—	—	P
2N3725	50004	018§	—	—	—	—	P
2N3866	BS9365	—	—	F050	—	—	C
2N4036	BS9365	F182§	—	—	—	—	C
2N4037	BS9365	F183§	—	—	—	—	C
2N4427	50007	006	—	—	—	—	C

C = Current P = Pending S = Suspended CAT F-§indicates full plus additional assessment

INTEGRATED CIRCUITS

BS Type Number	Ferranti Type Number	Approval Status	BS Type Number	Ferranti Type Number	Approval Status
9401			9401		
C077DP	ZN5400E	C	F029	ZN7400	C
C077F	ZN5400F	C	F030	ZN7410	C
C078DP	ZN7400E	C	F031	ZN7420	C
C078F	ZN7400F	C	F032	ZN7430	C
C079DP	ZN5410E	C	F033	ZN7440	C
C079F	ZN5410F	C	F038	ZN54L00J	C
C080DP	ZN7410E	C	F039	ZN54L10J	C
C080F	ZN7410F	C	F040	ZN54L20J	C
C081DP	ZN5420E	C	F041	ZN54L30J	C
C081F	ZN5420F	C	F042	ZN54L86J	C
C082DP	ZN7420E	C	F043	ZN54L00J	C
C082F	ZN7420F	C	F044	ZN54L10J	C
C083DP	ZN5430E	C	F045	ZN54L20J	C
C083F	ZN5430F	C	F046	ZN54L30J	C
C084DP	ZN7430E	C	F047	ZN54L86J	C
C084F	ZN7430F	C	F048	ZN54L00J	C
C085DP	ZN5401E	C	F049	ZN54L10J	C
C085F	ZN5401F	C	F050	ZN54L20J	C
C086DP	ZN7401E	C	F051	ZN54L30J	C
C086F	ZN7401F	C	F052	ZN54L86J	C
C087DP	ZN5402E	C	F053	ZN5400	C
C087F	ZN5402F	C	F054	ZN5410	C
C088DP	ZN7402E	C	F055	ZN5420	C
C088F	ZN7402F	C	F056	ZN5430	C
C089DP	ZN5440E	C	F057	ZN5440	C
C089F	ZN5440F	C	F058	ZN5400	C
C090DP	ZN7440E	C	F059	ZN5410	C
C090F	ZN7440F	C	F060	ZN5420	C
F004	ZN54L00J	C	F061	ZN5430	C
F005	ZN54L10J	C	F062	ZN5440	C
F006	ZN54L20J	C	F063	ZN5400	C
F007	ZN54L30J	C	F064	ZN5410	C
F008	ZN64L00J	C	F065	ZN5420	C
F009	ZN64L10J	C	F066	ZN5430	C
F010	ZN64L20J	C	F067	ZN5440	C
F011	ZN64L30J	C	F068	ZN54L03J	C
F012	ZN74L00J	C	F069	ZN64L03J	C
F013	ZN74L10J	C	F070	ZN74L03J	C
F014	ZN74L20J	C	F071	ZN5486	C
F015	ZN74L30J	C	F072	ZN6486	C
F016	ZN54L86J	C	F073	ZN7486	C
F017	ZN64L86J	C	F078	ZN5401	C
F018	ZN74L86J	C	F079	ZN5403	C
F019	ZN5400	C	F080	ZN5412	C
F020	ZN5410	C	F081	ZN6401	C
F021	ZN5420	C	F082	ZN6403	C
F022	ZN5430	C	F083	ZN6412	C
F023	ZN5440	C	F084	ZN7401	C
F024	ZN6400	C	F085	ZN7403	C
F025	ZN6410	C	F086	ZN7412	C
F026	ZN6420	C	F087	ZN5402	C
F027	ZN6430	C	F088	ZN5425	C
F028	ZN6440	C	F089	ZN5427	C

C = Current   P = Pending   S = Suspended

BS Type Number	Ferranti Type Number	Approval Status	BS Type Number	Ferranti Type Number	Approval Status
9401			9401		
F090	ZN6402	C	F147	ZN5413	C
F091	ZN6425	C	F148	ZN5413	C
F092	ZN6427	C	F149	ZN5413	C
F093	ZN7402	C	F150	ZN5428	C
F094	ZN7425	C	F151	ZN5428	C
F095	ZN7427	C	F152	ZN5428	C
F096	ZN5408	C	F153	ZN5432	C
F097	ZN5409	C	F154	ZN5432	C
F098	ZN6408	C	F155	ZN5432	C
F099	ZN6409	C	F156	ZN5486	C
F100	ZN7408	C	F157	ZN5486	C
F101	ZN7409	C	F158	ZN5486	C
F102	ZN5413	C	F159	ZN54L01J	C
F103	ZN6413	C	F160	ZN64L01J	C
F104	ZN7413	C	F161	ZN74L01J	C
F105	ZN5428	C	F162	ZN54L02J	C
F106	ZN6428	C	F163	ZN64L02J	C
F107	ZN7428	C	F164	ZN74L02J	C
F108	ZN5432	C	F165	ZN54L01J	C
F109	ZN6432	C	F166	ZN54L01J	C
F110	ZN7432	C	F167	ZN54L01J	C
F111	ZN5437	C	F168	ZN54L02J	C
F112	ZN5438	C	F169	ZN54L02J	C
F113	ZN6437	C	F170	ZN54L02J	C
F114	ZN6438	C	F171	ZN54L03J	C
F115	ZN7437	C	F172	ZN54L03J	C
F116	ZN7438	C	F173	ZN54L03J	C
F117	ZN5401	C	F1757	ZN7400	C
F118	ZN5403	C	F1758	ZN7400	C
F119	ZN5412	C	F1759	ZN7401	C
F120	ZN5401	C	F1760	ZN7401	C
F121	ZN5403	C	F1761	ZN7402	C
F122	ZN5412	C	F1762	ZN7402	C
F123	ZN5401	C	F1763	ZN7403	C
F124	ZN5403	C	F1764	ZN7403	C
F125	ZN5412	C	F1765	ZN7410	C
F126	ZN5402	C	F1766	ZN7410	C
F127	ZN5425	C	F1767	ZN7413	C
F128	ZN5427	C	F1768	ZN7413	C
F129	ZN5402	C	F1769	ZN7420	C
F130	ZN5425	C	F1770	ZN7420	C
F131	ZN5427	C	F1771	ZN7430	C
F132	ZN5402	C	F1772	ZN7430	C
F133	ZN5425	C	F1773	ZN7437	C
F134	ZN5427	C	F1774	ZN7437	C
F135	ZN5408	C	F1775	ZN7440	C
F136	ZN5409	C	F1776	ZN7440	C
F137	ZN5408	C	F1777	ZN7486	C
F138	ZN5409	C	F1778	ZN7486	C
F139	ZN5408	C	F1781	ZN74L02	C
F140	ZN5409	C	F1782	ZN74L02	C
F141	ZN5437	C	F1783	ZN74L03	C
F142	ZN5438	C	F1784	ZN74L03	C
F143	ZN5437	C	F1785	ZN74L10	C
F144	ZN5438	C	F1786	ZN74L10	C
F145	ZN5437	C	F1787	ZN74L20	C
F146	ZN5438	C	F1788	ZN74L20	C

C = Current P = Pending S = Suspended

BS Type Number	Ferranti Type Number	Approval Status
9401		
F1789	ZN74L30	C
F1790	ZN74L30	C
F1804	ZN7408	C
F1805	ZN7408	C
F1806	ZN7425	C
F1807	ZN7425	C
F1808	ZN7438	C
F1809	ZN7438	C
9402		
C034	ZSS51A	C
C035	ZSS81A	C
C036	ZSS51B	C
C037	ZSS81B	C
C038	ZSS53A	C
C039	ZSS83A	C
C040	ZSS53B	C
C041	ZSS83B	C
C046	ZSS55A	C
C047	ZSS85A	C
C048	ZSS55B	C
C049	ZSS85B	C
C050	ZSS56B	C
C051	ZSS86B	C
C052	ZSS57B	C
C053	ZSS87B	C
C054	ZST51A	C
C055	ZST81A	C
C056	ZST52A	C
C057	ZST82A	C
C058	ZST52B	C
C059	ZST82B	C
C062	ZSD61A	C
C063	ZSD81A	C
9403		
F001	ZN54L04J	C
F002	ZN64L04J	C
F003	ZN74L04J	C
F004	ZN5404	C
F005	ZN5405	C
F006	ZN6404	C
F007	ZN6405	C
F008	ZN7404	C
F009	ZN7405	C
F010	ZN54L04J	C
F011	ZN54L04J	C
F012	ZN54L04J	C
F013	ZN5404	C
F014	ZN5405	C
F015	ZN5404	C
F016	ZN5405	C
F017	ZN5404	C
F018	ZN5405	C

BS Type Number	Ferranti Type Number	Approval Status
9403		
F235	ZN7404	C
F236	ZN7404	C
F237	ZN7405	C
F238	ZN7405	C
F239	ZN74L04	C
F240	ZN74L04	C
9404		
C042	ZSS54A	C
C043	ZSS84A	C
C044	ZSS54B	C
C045	ZSS84B	C
9405		
F001	ZN54L51J	C
F002	ZN54L54J	C
F003	ZN54L55J	C
F004	ZN64L51J	C
F005	ZN64L54J	C
F006	ZN64L55J	C
F007	ZN74L51J	C
F008	ZN74L54J	C
F009	ZN74L55J	C
F010	ZN5450	C
F011	ZN5451	C
F012	ZN5453	C
F013	ZN5454	C
F014	ZN6450	C
F015	ZN6451	C
F016	ZN6453	C
F017	ZN6454	C
F018	ZN7450	C
F019	ZN7451	C
F020	ZN7453	C
F021	ZN7454	C
F022	ZN54L51J	C
F023	ZN54L54J	C
F024	ZN54L55J	C
F025	ZN54L51J	C
F026	ZN54L54J	C
F027	ZN54L55J	C
F028	ZN54L51J	C
F029	ZN54L54J	C
F030	ZN54L55J	C
F031	ZN5450	C
F032	ZN5451	C
F033	ZN5453	C
F034	ZN5454	C
F035	ZN5450	C
F036	ZN5451	C
F037	ZN5453	C
F038	ZN5454	C
F039	ZN5450	C
F040	ZN5451	C

C = Current P = Pending S = Suspended

BS Type Number	Ferranti Type Number	Approval Status	BS Type Number	Ferranti Type Number	Approval Status
9405			9405		
F041	ZN5453	C	F098	ZN54154	C
F042	ZN5454	C	F099	ZN54154	C
F043	ZN5482	C	F100	ZN54155	C
F044	ZN6482	C	F101	ZN54155	C
F045	ZN7482	C	F102	ZN54155	C
F046	ZN5483A	C	F103	ZN54157	C
F047	ZN6483A	C	F104	ZN54157	C
F048	ZN7483A	C	F105	ZN54157	C
F049	ZN5485	C	F106	ZN54180	C
F050	ZN6485	C	F107	ZN54180	C
F051	ZN7485	C	F108	ZN54180	C
F052	ZN54150	C	F109	ZN54181	C
F053	ZN64150	C	F110	ZN54181	C
F054	ZN74150	C	F111	ZN54181	C
F055	ZN54151A	C	F121	ZN5483	C
F056	ZN64151A	C	F122	ZN6483	C
F057	ZN74151A	C	F123	ZN7483	C
F058	ZN54153	C	F124	ZN5483	C
F059	ZN64153	C	F125	ZN5483	C
F060	ZN74153	C	F126	ZN5483	C
F061	ZN54154	C	F1105	ZN7450	C
F062	ZN64154	C	F1106	ZN7450	C
F063	ZN74154	C	F1107	ZN7451	C
F064	ZN54155	C	F1108	ZN7451	C
F065	ZN64155	C	F1109	ZN7454	C
F066	ZN74155	C	F1110	ZN7454	C
F067	ZN54157	C	F1111	ZN7483	C
F068	ZN64157	C	F1112	ZN7483	C
F069	ZN74157	C	F1113	ZN7485	C
F070	ZN54180	C	F1114	ZN7485	C
F071	ZN64180	C	F1115	ZN74151A	C
F072	ZN74180	C	F1116	ZN74151A	C
F973	ZN54181	C	F1117	ZN74153	C
F074	ZN64181	C	F1118	ZN74153	C
F075	ZN74181	C	F1119	ZN74154	C
F079	ZN5482	C	F1120	ZN74154	C
F080	ZN5482	C	F1123	ZN74157	C
F081	ZN5482	C	F1124	ZN74157	C
F082	ZN5483A	C	F1177	ZN74180	C
F083	ZN5483A	C	F1178	ZN74180	C
F084	ZN5483A	C			
F085	ZN5485	C	9420		
F086	ZN5485	C	F001	ZN54L73J	C
F087	ZN5485	C	F002	ZN64L73J	C
F088	ZN54150	C	F003	ZN74L73J	C
F089	ZN54150	C	F007	ZN5470	C
F090	ZN54150	C	F008	ZN6470	C
F091	ZN54151A	C	F009	ZN7470	C
F092	ZN54151A	C	F010	ZN5472	C
F093	ZN54151A	C	F011	ZN6472	C
F094	ZN54153	C	F012	ZN7472	C
F095	ZN54153	C	F013	ZN5473	C
F096	ZN54153	C	F014	ZN6473	C
F097	ZN54154	C	F015	ZN7473	C

C = Current P = Pending S = Suspended

BS Type Number	Ferranti Type Number	Approval Status	BS Type Number	Ferranti Type Number	Approval Status
9420			9420		
F016	ZN5474	C	F070	ZN54174	C
F017	ZN6474	C	F071	ZN54174	C
F018	ZN7474	C	F072	ZN54174	C
F019	ZN54107	C	F073	ZN54175	C
F020	ZN64107	C	F074	ZN54175	C
F021	ZN74107	C	F075	ZN54175	C
F022	ZN54L73J	C	F076	ZN54L74J	C
F023	ZN54L73J	C	F077	ZN64L74J	C
F024	ZN54L73J	C	F078	ZN74L74J	C
F025	ZN5470	C	F079	ZN54L75J	C
F026	ZN5470	C	F080	ZN64L75J	C
F027	ZN5470	C	F081	ZN74L75J	C
F028	ZN5472	C	F082	ZN54L74J	C
F029	ZN5472	C	F083	ZN54L74J	C
F030	ZN5472	C	F084	ZN54L74J	C
F031	ZN5473	C	F085	ZN54L75J	C
F032	ZN5473	C	F086	ZN54L75J	C
F033	ZN5473	C	F087	ZN54L75J	C
F034	ZN5474	C	F906	ZN74L74	C
F035	ZN5474	C	F907	ZN74L74	C
F036	ZN5474	C	F919	ZN7472	C
F037	ZN54107	C	F920	ZN7472	C
F038	ZN54107	C	F921	ZN7473	C
F039	ZN54107	C	F922	ZN7473	C
F040	ZN5475	C	F923	ZN7474	C
F041	ZN6475	C	F924	ZN7474	C
F042	ZN7475	C	F925	ZN7475	C
F043	ZN5476	C	F926	ZN7475	C
F044	ZN6476	C	F927	ZN74107	C
F045	ZN7476	C	F928	ZN74107	C
F046	ZN54118	C	F929	ZN74174	C
F047	ZN64118	C	F930	ZN74174	C
F048	ZN74118	C			
F049	ZN54119	C	9440		
F050	ZN64119	C	F001	ZN54121	C
F051	ZN74119	C	F002	ZN64121	C
F052	ZN54174	C	F003	ZN74121	C
F053	ZN64174	C	F004	ZN54121	C
F054	ZN74174	C	F005	ZN54121	C
F055	ZN54175	C	F006	ZN54121	C
F056	ZN64175	C	F007	ZN54L95J	C
F057	ZN74175	C	F008	ZN64L95J	C
F058	ZN5475	C	F009	ZN74L95J	C
F059	ZN5475	C	F010	ZN54L64J	C
F060	ZN5475	C	F011	ZN64L164J	C
F061	ZN5476	C	F012	ZN74L164J	C
F062	ZN5476	C	F013	ZN54122	C
F063	ZN5476	C	F014	ZN64122	C
F064	ZN54118	C	F015	ZN74122	C
F065	ZN54118	C	F016	ZN54123J	C
F066	ZN54118	C	F017	ZN64123J	C
F067	ZN54119	C	F018	ZN74123J	C
F068	ZN54119	C	F022	ZN5442A	C
F069	ZN54119	C	F023	ZN6442A	C

C = Current P = Pending S = Suspended

BS Type Number	Ferranti Type Number	Approval Status
9440		
F024	ZN7442A	C
F025	ZN5491A	C
F026	ZN6491A	C
F027	ZN7491A	C
F028	ZN5494	C
F029	ZN6494	C
F030	ZN7494	C
F031	ZN5495A	C
F032	ZN6495A	C
F033	ZN7495A	C
F034	ZN5496	C
F035	ZN6496	C
F036	ZN7496	C
F037	ZN54164J	C
F038	ZN64164J	C
F039	ZN74164J	C
F040	ZN54165	C
F041	ZN64165	C
F042	ZN74165	C
F043	ZN54166	C
F044	ZN64166	C
F045	ZN74166	C
F046	ZN54194	C
F047	ZN64194	C
F048	ZN74194	C
F049	ZN5442A	C
F050	ZN5442A	C
F051	ZN5442A	C
F052	ZN5491A	C
F053	ZN5491A	C
F054	ZN5491A	C
F055	ZN5494	C
F056	ZN5494	C
F057	ZN5494	C
F058	ZN5495A	C
F059	ZN5495A	C
F060	ZN5495A	C
F061	ZN5496	C
F062	ZN5496	C
F063	ZN5496	C
F064	ZN54164	C
F065	ZN54164	C
F066	ZN54164	C
F067	ZN54165	C
F068	ZN54165	C
F069	ZN54165	C
F070	ZN54166	C
F071	ZN54166	C
F072	ZN54166	C
F073	ZN54194	C
F074	ZN54194	C
F075	ZN54194	C
F076	ZN54122	C
F077	ZN54122	C
9440		
F078	ZN54122	C
F079	ZN54123	C
F080	ZN54123	C
F081	ZN54123	C
F082	ZN54L42J	C
F083	ZN64L42J	C
F084	ZN74L42J	C
F085	ZN54L91J	C
F086	ZN64L91J	C
F087	ZN74L91J	C
F088	ZN54L96J	C
F089	ZN64L96J	C
F090	ZN74L96J	C
F091	ZN54L122J	C
F092	ZN64L122J	C
F093	ZN74L122J	C
F094	ZN54L42J	C
F095	ZN54L42J	C
F096	ZN54L42J	C
F097	ZN54L91J	C
F098	ZN54L91J	C
F099	ZN54L91J	C
F100	ZN54L96J	C
F101	ZN54L96J	C
F102	ZN54L96J	C
F103	ZN54L122J	C
F104	ZN54L122J	C
F105	ZN54L122J	C
F106	ZN54L95J	C
F107	ZN54L95J	C
F108	ZN54L95J	C
F109	ZN54L164J	C
F110	ZN54L164J	C
F111	ZN54L164J	C
9440		
F1129	ZN7442A	C
F1130	ZN7442A	C
F1131	ZN7491A	C
F1132	ZN7491A	C
F1135	ZN7495A	C
F1136	ZN7495A	C
F1137	ZN7496	C
F1138	ZN7496	C
F1139	ZN74121	C
F1140	ZN74121	C
F1141	ZN74122	C
F1142	ZN74122	C
F1143	ZN74123	C
F1144	ZN74123	C
F1145	ZN74164	C
F1146	ZN74164	C
F1147	ZN74165	C
F1148	ZN74165	C
F1151	ZN74L95	C
F1152	ZN74L95	C

C = Current P = Pending S = Suspended

BS Type Number	Ferranti Type Number	Approval Status	BS Type Number	Ferranti Type Number	Approval Status
9442			9442		
F001	ZN54L93J	C	F068	ZN64L193J	C
F002	ZN64L93J	C	F069	ZN74L193J	C
F003	ZN74L93J	C	F070	ZN54L90J	C
F004	ZN5493A	C	F071	ZN54L90J	C
F005	ZN6493A	C	F072	ZN54L90J	C
F006	ZN7493A	C	F073	ZN54L192J	C
F007	ZN54L93J	C	F074	ZN54L192J	C
F008	ZN54L93J	C	F075	ZN54L192J	C
F009	ZN54L93J	C	F076	ZN54L193J	C
F010	ZN5493A	C	F077	ZN54L193J	C
F011	ZN5493A	C	F078	ZN54L193J	C
F012	ZN5493A	C	F205	ZN5492	C
F013	ZN5492A	C	F206	ZN6492	C
F014	ZN6492A	C	F207	ZN7492	C
F015	ZN7492A	C	F208	ZN5492	C
F016	ZN5490A	C	F209	ZN5492	C
F017	ZN6490A	C	F210	ZN5492	C
F018	ZN7490A	C	F211	ZN5490	C
F021	ZN74161	C	F212	ZN6490	C
F024	ZN74163	C	F213	ZN7490	C
F025	ZN54191	C	F214	ZN5490	C
F026	ZN64191	C	F215	ZN5490	C
F027	ZN74191	C	F216	ZN5490	C
F028	ZN54192	C	F217	ZN5493	C
F029	ZN64192	C	F218	ZN6493	C
F030	ZN74192	C	F219	ZN7493	C
F031	ZN54193	C	F220	ZN5493	C
F032	ZN64193	C	F221	ZN5493	C
F033	ZN74193	C	F222	ZN5493	C
F037	ZN54161	P	F816	ZN7490A	C
F038	ZN54161	P	F817	ZN7490A	C
F039	ZN54161	P	F818	ZN7493	C
F040	ZN54163	P	F819	ZN7493	C
F041	ZN54163	P	F820	ZN7493A	C
F042	ZN54163	P	F821	ZN7493A	C
F043	ZN54191	C	F826	ZN74193	C
F044	ZN54191	C	F827	ZN74193	C
F045	ZN54191	C	F828	ZN74L90	C
F046	ZN54192	C	F829	ZN74L90	C
F047	ZN54192	C	F830	ZN74L93	C
F048	ZN54192	C	F831	ZN74L93	C
F049	ZN54193	C			
F050	ZN54193	C	9443		
F051	ZN54193	C	F004	ZN54170J	C
F055	ZN54190A	C	F005	ZN64170J	C
F056	ZN5490A	C	F006	ZN74170J	C
F057	ZN5490A	C	F010	ZN54170J	C
F058	ZN5492A	C	F011	ZN54170J	C
F059	ZN5492A	C	F012	ZN54170J	C
F060	ZN5492A	C			
F061	ZN54L90J	C	9450	See Note 1	
F062	ZN64L90J	C	F001	ZN5489	P
F063	ZN74L90J	C	F002	ZN6489	P
F064	ZN54L192J	C	F003	ZN7489	P
F065	ZN64L192J	C	F007	ZN5489	P
F066	ZN74L192J	C	F008	ZN5489	P
F067	ZN54L193J	C	F009	ZN5489	P

C = Current P = Pending S = Suspended

Note 1: These devices are not covered by standard BS9400 groupings. Consequently it is only available as a BS9450 specification which covers all the screening levels indicated.

Type Number	Ferranti Type Number	Approval Status	Type Number	Ferranti Type Number	Approval Status
CN34	ZSS51A	C	CN90DP	ZN7440E	C
CN35	ZSS81A	C	CN90F	ZN7440F	C
CN36	ZSS51B	C	CN91DP	ZN5451E	C
CN37	ZSS81B	C	CN91F	ZN5451F	C
CN38	ZSS53A	C	CN92DP	ZN7451E	C
CN39	ZSS83A	C	CN92F	ZN7451F	C
CN40	ZSS53B	C	CN93DP	ZN5450E	C
CN41	ZSS83B	C	CN93F	ZN5450F	C
CN42	ZSS54A	C	CN94DP	ZN7450E	C
CN43	ZSS84A	C	CN94F	ZN7450F	C
CN44	ZSS54B	C	CN95DP	ZN5454E	C
CN45	ZSS84B	C	CN95F	ZN5454F	C
CN46	ZSS55A	C	CN96DP	ZN7454E	C
CN47	ZSS85A	C	CN96F	ZN7454F	C
CN48	ZSS55B	C	CN97DP	ZN5453E	C
CN49	ZSS85B	C	CN97F	ZN5453F	C
CN50	ZSS56B	C	CN98DP	ZN7453E	C
CN51	ZSS86B	C	CN98F	ZN7453F	C
CN52	ZSS57B	C	CN99DP	ZN5460E	C
CN53	ZSS87B	C	CN99F	ZN5460F	C
CN54	ZST51A	C	CN100DP	ZN7460E	C
CN55	ZST81A	C	CN100F	ZN7460F	C
CN56	ZST52A	C	CN101DP	ZN5470E	C
CN57	ZST82A	C	CN101F	ZN5470F	C
CN58	ZST52B	C	CN102DP	ZN7470E	C
CN59	ZST82B	C	CN102F	ZN7470F	C
CN60	ZSF51B	C	CN103DP	ZN5472E	C
CN61	ZSF81B	C	CN103F	ZN5472F	C
CN62	ZSD51A	C	CN104DP	ZN7472E	C
CN63	ZSD81A	C	CN104F	ZN7472F	C
CN77DP	ZN5400E	C	CN105DP	ZN54107E	C
CN77F	ZN5400F	C	CN105F	ZN54107F	C
CN78DP	ZN7400E	C	CN106DP	ZN74107E	C
CN78F	ZN7400F	C	CN106F	ZN74107F	C
CN79DP	ZN5410E	C	CN107DP	ZN5474E	C
CN79F	ZN5410F	C	CN107F	ZN5474F	C
CN80DP	ZN7410E	C	CN108DP	ZN7474E	C
CN80F	ZN7410F	C	CN108F	ZN7474F	C
CN81DP	ZN5420E	C	CN113DP	ZN230E	C
CN81F	ZN5420F	C	CN113F	ZN230	C
CN82DP	ZN5420E	C	CN114DP	ZN230E	C
CN82F	ZN7420F	C	CN115DP	ZN262E	C
CN83DP	ZN5430E	C	CN115F	ZN262	C
CN83F	ZN5430F	C	CN116DP	ZN262E	C
CN84DP	ZN7430E	C	CN117DP	ZN246E	C
CN84F	ZN7430F	C	CN117F	ZN246	C
CN85DP	ZN5401E	C	CN118DP	ZN246E	C
CN85F	ZN5401F	C	CN119DP	ZN224E	C
CN86DP	ZN7401E	C	CN119F	ZN224	C
CN86F	ZN7401F	C	CN120DP	ZN224E	C
CN87DP	ZN5402E	C	CN121DP	ZN233E	C
CN87F	ZN5402F	C	CN121F	ZN233	C
CN88DP	ZN7402E	C	CN122DP	ZN233E	C
CN88F	ZN7402F	C	CN123DP	ZN232E	C
CN89DP	ZN5440E	C	CN123F	ZN232	C
CN89F	ZN5440F	C			

C = Current   P = Pending   S = Suspended

Type Number	Ferranti Type Number	Approval Status	Type Number	Ferranti Type Number	Approval Status
CN124DP	ZN232E	C	CN511T	ZST53A	C
CN125DP	ZN244E	C	CN512T	ZST83A	C
CN125F	ZN244	C	CN513T	ZST54A	C
CN126DP	ZN244E	C	CN514T	ZST84A	C
CN127DP	ZN220E	C	CN515T	ZLD709	C
CN127F	ZN220	C			
CN128DP	ZN220E	C	CN624DP	ZN330E	C
CN129DP	ZN219E	C	CN626DP	ZN362E	C
CN129F	ZN219	C	CN628DP	ZN346E	C
CN130DP	ZN219E	C	CN630DP	ZN324E	C
CN131DP	ZN221E	C	CN632DP	ZN333E	C
CN131F	ZN221	C	CN634DP	ZN332E	C
CN132DP	ZN221E	C	CN636DP	ZN344E	C
CN133DP	ZN248E	C	CN638DP	ZN320E	C
CN133F	ZN248	C	CN640DP	ZN319E	C
CN134DP	ZN248E	C	CN642DP	ZN321E	C
CN135DP	ZN222E	C	CN644DP	ZN348E	C
CN135F	ZN222	C	CN646DP	ZN322E	C
CN136DP	ZN222E	C			
			CN663T	ZST53B	C
CN275DP	ZN5473E	C	CN664T	ZST83B	C
CN276DP	ZN7473E	C			
CN281DP	ZN5475E	C	CN665DP	ZN236E	C
CN282DP	ZN7475E	C	CN665F	ZN236	C
CN359DP	ZN5476E	C	CN666DP	ZN236E	C
CN360DP	ZN7476E	C	CN668DP	ZN336E	C
CN361DP	ZN5404E	C	CN669DP	ZN226E	C
CN362DP	ZN7404E	C	CN669F	ZN226	C
CN363DP	ZN5405E	C	CN670DP	ZN226E	C
CN364DP	ZN7405E	C	CN672DP	ZN326E	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type	CN Type Number	App. Status
ZN219	—	—	—	—	—	—	CN129F	C
ZN219E	—	—	—	—	—	—	CN129DP	C
	—	—	—	—	—	—	CN130DP	C
ZN220	—	—	—	—	—	—	CN127F	C
ZN220E	—	—	—	—	—	—	CN127DP	C
	—	—	—	—	—	—	CN128DP	C
ZN221	—	—	—	—	—	—	CN131F	C
ZN221E	—	—	—	—	—	—	CN131DP	C
	—	—	—	—	—	—	CN132DP	C
ZN222	—	—	—	—	—	—	CN135F	C
ZN222E	—	—	—	—	—	—	CN135DP	C
	—	—	—	—	—	—	CN136DP	C
ZN224	—	—	—	—	—	—	CN119F	C
ZN224E	—	—	—	—	—	—	CN119DP	C
	—	—	—	—	—	—	CN120DP	C
ZN226	—	—	—	—	—	—	CN669F	C
ZN226E	—	—	—	—	—	—	CN669DP	C
	—	—	—	—	—	—	CN670DP	C
ZN230	—	—	—	—	—	—	CN113F	C
ZN230E	—	—	—	—	—	—	CN113DP	C
	—	—	—	—	—	—	CN114DP	C
ZN232	—	—	—	—	—	—	CN123F	C
ZN232E	—	—	—	—	—	—	CN123DP	C
	—	—	—	—	—	—	CN124DP	C
ZN233	—	—	—	—	—	—	CN121F	C
ZN233E	—	—	—	—	—	—	CN121DP	C
	—	—	—	—	—	—	CN122DP	C
ZN236	—	—	—	—	—	—	CN665F	C
ZN236E	—	—	—	—	—	—	CN665DP	C
	—	—	—	—	—	—	CN666DP	C
ZN244	—	—	—	—	—	—	CN125F	C
ZN244E	—	—	—	—	—	—	CN125DP	C
	—	—	—	—	—	—	CN126DP	C
ZN246	—	—	—	—	—	—	CN117F	C
ZN246E	—	—	—	—	—	—	CN117DP	C
	—	—	—	—	—	—	CN118DP	C
ZN248	—	—	—	—	—	—	CN133F	C
ZN248E	—	—	—	—	—	—	CN133DP	C
	—	—	—	—	—	—	CN134DP	C
ZN262	—	—	—	—	—	—	CN115F	C
ZN262E	—	—	—	—	—	—	CN115DP	C
	—	—	—	—	—	—	CN116DP	C
ZN319E	—	—	—	—	—	—	CN640DP	C
ZN320E	—	—	—	—	—	—	CN638DP	C
ZN321E	—	—	—	—	—	—	CN624DP	C
ZN322E	—	—	—	—	—	—	CN646DP	C
ZN324E	—	—	—	—	—	—	CN630DP	C
ZN326E	—	—	—	—	—	—	CN672DP	C
ZN330E	—	—	—	—	—	—	CN624DP	C
ZN332E	—	—	—	—	—	—	CN634DP	C
ZN333E	—	—	—	—	—	—	CN632DP	C
ZN336E	—	—	—	—	—	—	CN668DP	C
ZN344E	—	—	—	—	—	—	CN636DP	C
ZN346E	—	—	—	—	—	—	CN628DP	C
ZN348E	—	—	—	—	—	—	CN644DP	C
ZN362E	—	—	—	—	—	—	CN626DP	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN5400	9401	F019	F053	F058	F063	—	—	C
ZN5400E	9401	—	—	—	—	C077DP	CN77DP	C
ZN5400F	9401	—	—	—	—	C077F	CN77F	C
ZN5401	9401	F078	F117	F120	F123	—	—	C
ZN5401E	9401	—	—	—	—	C085DP	CN85DP	C
ZN5401F	9401	—	—	—	—	C085F	CN85F	C
ZN5402	9401	F087	F126	F129	F132	—	—	C
ZN5402E	9401	—	—	—	—	C087DP	CN87DP	C
ZN5402F	9401	—	—	—	—	C087F	CN87F	C
ZN5403	9401	F079	F118	F121	F124	—	—	C
ZN5404	9403	F004	F013	F015	F017	—	—	C
ZN5404E	—	—	—	—	—	—	CN361DP	C
ZN5405	9403	F005	F014	F016	F018	—	—	C
ZN5405E	—	—	—	—	—	—	CN363DP	C
ZN5408	9401	F096	F135	F137	F139	—	—	C
ZN5409	9401	F097	F136	F138	F140	—	—	C
ZN5410	9401	F020	F054	F059	F064	—	—	C
ZN5410E	9401	—	—	—	—	C079DP	CN79DP	C
ZN5410F	9401	—	—	—	—	C079F	CN79F	C
ZN5412	9401	F080	F119	F122	F125	—	—	C
ZN5413	9401	F102	F147	F148	F149	—	—	C
ZN5420	9401	F021	F055	F060	F065	—	—	C
ZN5420E	9401	—	—	—	—	C081DP	CN81DP	C
ZN5420F	9401	—	—	—	—	C081F	CN81F	C
ZN5425	9401	F088	F127	F130	F133	—	—	C
ZN5427	9401	F089	F128	F131	F134	—	—	C
ZN5428	9401	F105	F150	F151	F152	—	—	C
ZN5430	9401	F022	F056	F061	F066	—	—	C
ZN5430E	9401	—	—	—	—	C083DP	CN83DP	C
ZN5430F	9401	—	—	—	—	C083F	CN83F	C
ZN5432	9401	F108	F153	F154	F155	—	—	C
ZN5437	9401	F111	F141	F143	F145	—	—	C
ZN5438	9401	F112	F142	F144	F146	—	—	C
ZN5440	9401	F023	F057	F062	F067	—	—	C
ZN5440E	9401	—	—	—	—	C089DP	CN89DP	C
ZN5440F	9401	—	—	—	—	C089F	CN89F	C
ZN5442	9440	F022	F049	F050	F051	—	—	C
ZN5450	9405	F010	F031	F035	F039	—	—	C
ZN5450E	—	—	—	—	—	—	CN93DP	C
ZN5450F	—	—	—	—	—	—	CN93F	C
ZN5451	9405	F011	F032	F036	F040	—	—	C
ZN5451E	—	—	—	—	—	—	CN91DP	C
ZN5451F	—	—	—	—	—	—	CN91F	C
ZN5453	9405	F012	F033	F037	F041	—	—	C
ZN5453E	—	—	—	—	—	—	CN97DP	C
ZN5453F	—	—	—	—	—	—	CN97F	C
ZN5454	9405	F013	F034	F038	F042	—	—	C
ZN5454E	—	—	—	—	—	—	CN95DP	C
ZN5454F	—	—	—	—	—	—	CN95F	C
ZN5460E	—	—	—	—	—	—	CN99DP	C
ZN5460F	—	—	—	—	—	—	CN99F	C
ZN5470	9420	F007	F025	F026	F027	—	—	C
ZN5470E	—	—	—	—	—	—	CN101DP	C
ZN5470F	—	—	—	—	—	—	CN101F	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type	CN Type Number	App. Status
ZN5472	9420	F010	F028	F029	F030	—	—	C
ZN5472E	—	—	—	—	—	—	CN103DP	C
ZN5472F	—	—	—	—	—	—	CN103F	C
ZN5473	9420	F013	F031	F032	F033	—	—	C
ZN5473E	—	—	—	—	—	—	CN275DP	C
ZN5474	9420	F016	F034	F035	F036	—	—	C
ZN5474E	—	—	—	—	—	—	CN107DP	C
ZN5474F	—	—	—	—	—	—	CN107F	C
ZN5475	9420	F040	F058	F059	F060	—	—	C
ZN5476	9420	F043	F061	F062	F063	—	—	C
ZN5482	9405	F043	F079	F080	F081	—	—	C
ZN5483	9405	F121	F124	F125	F126	—	—	C
ZN5483A	9405	F046	F082	F083	F084	—	—	C
ZN5485	9405	F049	F085	F086	F087	—	—	C
ZN5486	9401	F071	F156	F157	F158	—	—	C
ZN5490	9442	F211	F214	F215	F216	—	—	C
ZN5490A	9442	F016	F055	F056	F057	—	—	C
ZN5491A	9440	F025	F052	F053	F054	—	—	C
ZN5492	9442	F205	F208	F209	F210	—	—	C
ZN5492A	9442	F013	F058	F059	F060	—	—	C
ZN5493	9442	F217	F220	F221	F222	—	—	C
ZN5493A	9442	F004	F010	F011	F012	—	—	C
ZN5494	9440	F028	F055	F056	F057	—	—	C
ZN5495A	9440	F031	F058	F059	F060	—	—	C
ZN5496	9440	F034	F061	F062	F063	—	—	C
ZN54107	9420	F019	F037	F038	F039	—	—	C
ZN54107E	—	—	—	—	—	—	CN105DP	C
ZN54107F	—	—	—	—	—	—	CN105F	C
ZN54118	9420	F046	F064	F065	F066	—	—	C
ZN54119	9420	F049	F067	F068	F069	—	—	C
ZN54121	9440	F001	F004	F005	F006	—	—	C
ZN54122	9440	F013	F076	F077	F078	—	—	C
ZN54123J	9440	F016	F079	F080	F081	—	—	C
ZN54150	9405	F052	F088	F089	F090	—	—	C
ZN54151A	9405	F055	F091	F092	F093	—	—	C
ZN54153	9405	F058	F094	F095	F096	—	—	C
ZN54154	9405	F061	F097	F098	F099	—	—	C
ZN54155	9405	F064	F100	F101	F102	—	—	C
ZN54157	9405	F067	F103	F104	F105	—	—	C
ZN54164J	9440	F037	F064	F065	F066	—	—	C
ZN54165	9440	F040	F067	F068	F069	—	—	C
ZN54166	9440	F043	F070	F071	F072	—	—	C
ZN54170J	9443	F004	F010	F011	F012	—	—	C
ZN54174	9420	F052	F070	F071	F072	—	—	C
ZN54175	9420	F055	F073	F074	F075	—	—	C
ZN54180	9405	F070	F106	F107	F108	—	—	C
ZN54181	9405	F073	F109	F110	F111	—	—	C
ZN54191	9442	F025	F043	F044	F045	—	—	C
ZN54192	9442	F028	F046	F047	F048	—	—	C
ZN54193	9442	F031	F049	F050	F051	—	—	C
ZN54194	9440	F046	F073	F074	F075	—	—	C
ZN54L00J	9401	F004	F038	F043	F048	—	—	C
ZN54L01J	9401	F159	F165	F166	F167	—	—	C
ZN54L02J	9401	F162	F168	F169	F170	—	—	C
ZN54L03J	9401	F068	F171	F172	F173	—	—	C
ZN54L04J	9403	F001	F010	F011	F012	—	—	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN54L10J	9401	F005	F039	F044	F049	–	–	C
ZN54L20J	9401	F006	F040	F045	F050	–	–	C
ZN54L30J	9401	F007	F041	F046	F051	–	–	C
ZN54L42J	9440	F082	F094	F095	F096	–	–	C
ZN54L51J	9405	F001	F022	F025	F028	–	–	C
ZN54L54J	9405	F002	F023	F026	F029	–	–	C
ZN54L55J	9405	F003	F024	F027	F030	–	–	C
ZN54L73J	9420	F001	F022	F023	F024	–	–	C
ZN54L74J	9420	F076	F082	F083	F084	–	–	C
ZN54L75J	9420	F079	F085	F086	F087	–	–	C
ZN54L85J	9405	F115	F118	F119	F120	–	–	C
ZN54L86J	9401	F016	F042	F047	F052	–	–	C
ZN54L90J	9442	F061	F070	F071	F072	–	–	C
ZN54L91J	9440	F085	F097	F098	F099	–	–	C
ZN54L93J	9442	F001	F007	F008	F009	–	–	C
ZN54L95J	9440	F007	F106	F107	F108	–	–	C
ZN54L96J	9440	F088	F100	F101	F102	–	–	C
ZN54L122J	9440	F091	F103	F104	F105	–	–	C
ZN54L164J	9440	F010	F109	F110	F111	–	–	C
ZN54L192J	9442	F064	F073	F074	F075	–	–	C
ZN54L193J	9442	F067	F076	F077	F078	–	–	C
ZN6400	9401	F024	–	–	–	–	–	C
ZN6401	9401	F081	–	–	–	–	–	C
ZN6402	9401	F090	–	–	–	–	–	C
ZN6403	9401	F082	–	–	–	–	–	C
ZN6404	9403	F006	–	–	–	–	–	C
ZN6405	9403	F007	–	–	–	–	–	C
ZN6408	9401	F098	–	–	–	–	–	C
ZN6409	9401	F099	–	–	–	–	–	C
ZN6410	9401	F025	–	–	–	–	–	C
ZN6412	9401	F083	–	–	–	–	–	C
ZN6413	9401	F103	–	–	–	–	–	C
ZN6420	9401	F026	–	–	–	–	–	C
ZN6425	9401	F091	–	–	–	–	–	C
ZN6427	9401	F092	–	–	–	–	–	C
ZN6428	9401	F106	–	–	–	–	–	C
ZN6430	9401	F027	–	–	–	–	–	C
ZN6432	9401	F109	–	–	–	–	–	C
ZN6437	9401	F113	–	–	–	–	–	C
ZN6438	9401	F114	–	–	–	–	–	C
ZN6440	9401	F028	–	–	–	–	–	C
ZN6442	9440	F023	–	–	–	–	–	C
ZN6450	9405	F014	–	–	–	–	–	C
ZN6451	9405	F015	–	–	–	–	–	C
ZN6453	9405	F016	–	–	–	–	–	C
ZN6454	9405	F017	–	–	–	–	–	C
ZN6470	9420	F008	–	–	–	–	–	C
ZN6472	9420	F011	–	–	–	–	–	C
ZN6473	9420	F014	–	–	–	–	–	C
ZN6474	9420	F017	–	–	–	–	–	C
ZN6475	9420	F041	–	–	–	–	–	C
ZN6476	9420	F044	–	–	–	–	–	C
ZN6482	9405	F044	–	–	–	–	–	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN6483	9405	F122	—	—	—	—	—	C
ZN6483A	9405	F047	—	—	—	—	—	C
ZN6485	9405	F050	—	—	—	—	—	C
ZN6486	9401	F072	—	—	—	—	—	C
ZN6490	9442	F212	—	—	—	—	—	C
ZN6490A	9442	F017	—	—	—	—	—	C
ZN6491A	9440	F026	—	—	—	—	—	C
ZN6492	9442	F206	—	—	—	—	—	C
ZN6492A	9442	F014	—	—	—	—	—	C
ZN6493	9442	F218	—	—	—	—	—	C
ZN6493A	9442	F005	—	—	—	—	—	C
ZN6494	9440	F029	—	—	—	—	—	C
ZN6495A	9440	F032	—	—	—	—	—	C
ZN6496	9440	F035	—	—	—	—	—	C
ZN64017	9420	F020	—	—	—	—	—	C
ZN64118	9420	F047	—	—	—	—	—	C
ZN64119	9420	F050	—	—	—	—	—	C
ZN64121	9440	F002	—	—	—	—	—	C
ZN64122	9440	F014	—	—	—	—	—	C
ZN64123J	9440	F017	—	—	—	—	—	C
ZN64150	9405	F053	—	—	—	—	—	C
ZN64151A	9405	F056	—	—	—	—	—	C
ZN64153	9405	F059	—	—	—	—	—	C
ZN64154	9405	F062	—	—	—	—	—	C
ZN64155	9405	F065	—	—	—	—	—	C
ZN64157	9405	F068	—	—	—	—	—	C
ZN64164J	9440	F038	—	—	—	—	—	C
ZN64165	9440	F041	—	—	—	—	—	C
ZN64166	9440	F044	—	—	—	—	—	C
ZN64170J	9443	F005	—	—	—	—	—	C
ZN64174	9420	F053	—	—	—	—	—	C
ZN64175	9420	F056	—	—	—	—	—	C
ZN64180	9405	F071	—	—	—	—	—	C
ZN64181	9405	F074	—	—	—	—	—	C
ZN64191	9442	F026	—	—	—	—	—	C
ZN64192	9442	F029	—	—	—	—	—	C
ZN64193	9442	F032	—	—	—	—	—	C
ZN64194	9440	F047	—	—	—	—	—	C
ZN64L00J	9401	F008	—	—	—	—	—	C
ZN64L01J	9401	F160	—	—	—	—	—	C
ZN64L02J	9401	F163	—	—	—	—	—	C
ZN64L03J	9401	F069	—	—	—	—	—	C
ZN64L04J	9403	F002	—	—	—	—	—	C
ZN64L10J	9401	F009	—	—	—	—	—	C
ZN64L20J	9401	F010	—	—	—	—	—	C
ZN64L30J	9401	F011	—	—	—	—	—	C
ZN64L42J	9440	F083	—	—	—	—	—	C
ZN64L51J	9405	F004	—	—	—	—	—	C
ZN64L54J	9405	F005	—	—	—	—	—	C
ZN64L55J	9405	F006	—	—	—	—	—	C
ZN64L73J	9420	F002	—	—	—	—	—	C
ZN64L74J	9420	F077	—	—	—	—	—	C
ZN64L75J	9420	F080	—	—	—	—	—	C
ZN64L85J	9405	F116	—	—	—	—	—	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN64L86J	9401	F017	—	—	—	—	—	C
ZN64L90J	9442	F062	—	—	—	—	—	C
ZN64L91J	9440	F086	—	—	—	—	—	C
ZN64L93J	9442	F002	—	—	—	—	—	C
ZN64L95J	9440	F008	—	—	—	—	—	C
ZN64L96J	9440	F089	—	—	—	—	—	C
ZN64L122J	9440	F092	—	—	—	—	—	C
ZN64L164J	9440	F011	—	—	—	—	—	C
ZN64L192J	9442	F065	—	—	—	—	—	C
ZN64L193J	9442	F068	—	—	—	—	—	C
ZN7400	9401	F029	—	—	—	—	—	C
ZN7400E	9401	—	—	—	—	C078DP	CN78DP	C
ZN7400F	9401	—	—	—	—	C078F	CN78F	C
ZN7401	9401	F084	—	—	—	—	—	C
ZN7401E	9401	—	—	—	—	C086DP	CN86DP	C
ZN7401F	9401	—	—	—	—	C086F	CN86F	C
ZN7402	9401	F093	—	—	—	—	—	C
ZN7402E	9401	—	—	—	—	C088DP	CN88DP	C
ZN7402F	9401	—	—	—	—	C088F	CN88F	C
ZN7403	9401	F085	—	—	—	—	—	C
ZN7404	9403	F008	—	—	—	—	—	C
ZN7404E	—	—	—	—	—	—	CN362DP	C
ZN7405	9403	F009	—	—	—	—	—	C
ZN7405E	—	—	—	—	—	—	CN364DP	C
ZN7408	9401	F100	—	—	—	—	—	C
ZN7409	9401	F101	—	—	—	—	—	C
ZN7410	9401	F030	—	—	—	—	—	C
ZN7410E	9401	—	—	—	—	C080DP	CN80DP	C
ZN7410F	9401	—	—	—	—	C080F	CN80F	C
ZN7412	9401	F086	—	—	—	—	—	C
ZN7413	9401	F104	—	—	—	—	—	C
ZN7420	9401	F031	—	—	—	—	—	C
ZN7420E	9401	—	—	—	—	C082DP	CN82DP	C
ZN7420F	9401	—	—	—	—	C082F	CN82F	C
ZN7425	9401	F094	—	—	—	—	—	C
ZN7427	9401	F095	—	—	—	—	—	C
ZN7428	9401	F107	—	—	—	—	—	C
ZN7430	9401	F032	—	—	—	—	—	C
ZN7430E	9401	—	—	—	—	C084DP	CN84DP	C
ZN7430F	9401	—	—	—	—	C084F	CN84F	C
ZN7432	9401	F110	—	—	—	—	—	C
ZN7437	9401	F115	—	—	—	—	—	C
ZN7438	9401	F116	—	—	—	—	—	C
ZN7440	9401	F033	—	—	—	—	—	C
ZN7440E	9401	—	—	—	—	C090DP	CN90DP	C
ZN7440F	9401	—	—	—	—	C090F	CN90F	C
ZN7442	9440	F024	—	—	—	—	—	C
ZN7450	9405	F018	—	—	—	—	—	C
ZN7450E	—	—	—	—	—	—	CN94DP	C
ZN7450F	—	—	—	—	—	—	CN94F	C
ZN7451	9405	F019	—	—	—	—	—	C
ZN7451E	—	—	—	—	—	—	CN92DP	C
ZN7451F	—	—	—	—	—	—	CN92F	C
ZN7453	9405	F020	—	—	—	—	—	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN7453E	–	–	–	–	–	–	CN98DP	C
ZN7453F	–	–	–	–	–	–	CN98F	C
ZN7454	9405	F021	–	–	–	–	–	C
ZN7454E	–	–	–	–	–	–	CN96DP	C
ZN7454F	–	–	–	–	–	–	CN96F	C
ZN7460E	–	–	–	–	–	–	CN100DP	C
ZN7460F	–	–	–	–	–	–	CN100F	C
ZN7470	9420	F009	–	–	–	–	–	C
ZN7470E	–	–	–	–	–	–	CN102DP	C
ZN7470F	–	–	–	–	–	–	CN102F	C
ZN7472	9420	F012	–	–	–	–	–	C
ZN7472E	–	–	–	–	–	–	CN104DP	C
ZN7472F	–	–	–	–	–	–	CN104F	C
ZN7473	9420	F015	–	–	–	–	–	C
ZN7473E	–	–	–	–	–	–	CN276DP	C
ZN7474	9420	F018	–	–	–	–	–	C
ZN7474E	–	–	–	–	–	–	CN108DP	C
ZN7474F	–	–	–	–	–	–	CN108F	C
ZN7475	9420	F042	–	–	–	–	–	C
ZN7476	9420	F045	–	–	–	–	–	C
ZN7482	9405	F045	–	–	–	–	–	C
ZN7483	9405	F123	–	–	–	–	–	C
ZN7483A	9405	F048	–	–	–	–	–	C
ZN7485	9405	F051	–	–	–	–	–	C
ZN7486	9401	F073	–	–	–	–	–	C
ZN7490	9442	F213	–	–	–	–	–	C
ZN7490A	9442	F018	–	–	–	–	–	C
ZN7491A	9440	F027	–	–	–	–	–	C
ZN7492	9442	F207	–	–	–	–	–	C
ZN7492A	9442	F015	–	–	–	–	–	C
ZN7493	9442	F219	–	–	–	–	–	C
ZN7493A	9442	F006	–	–	–	–	–	C
ZN7494	9440	F030	–	–	–	–	–	C
ZN7495A	9440	F033	–	–	–	–	–	C
ZN7496	9440	F036	–	–	–	–	–	C
ZN74107	9420	F021	–	–	–	–	–	C
ZN74107E	–	–	–	–	–	–	CN106DP	C
ZN74107F	–	–	–	–	–	–	CN106F	C
ZN74118	9420	F048	–	–	–	–	–	C
ZN74119	9420	F051	–	–	–	–	–	C
ZN74121	9440	F003	–	–	–	–	–	C
ZN74122	9440	F015	–	–	–	–	–	C
ZN74123J	9440	F018	–	–	–	–	–	C
ZN74150	9405	F054	–	–	–	–	–	C
ZN74151A	9405	F057	–	–	–	–	–	C
ZN74153	9405	F060	–	–	–	–	–	C
ZN74154	9405	F063	–	–	–	–	–	C
ZN74155	9405	F066	–	–	–	–	–	C
ZN74157	9405	F069	–	–	–	–	–	C
ZN74161	9442	F021	–	–	–	–	–	C
ZN74163	9442	F024	–	–	–	–	–	C
ZN74164J	9440	F039	–	–	–	–	–	C
ZN74165	9440	F042	–	–	–	–	–	C
ZN74166	9440	F045	–	–	–	–	–	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZN74170J	9443	F006	—	—	—	—	—	C
ZN74174	9420	F054	—	—	—	—	—	C
ZN74175	9420	F057	—	—	—	—	—	C
ZN74180	9405	F072	—	—	—	—	—	C
ZN74181	9405	F075	—	—	—	—	—	C
ZN74191	9442	F027	—	—	—	—	—	C
ZN74192	9442	F030	—	—	—	—	—	C
ZN74193	9442	F033	—	—	—	—	—	C
ZN74194	9440	F048	—	—	—	—	—	C
ZN74L00J	9401	F012	—	—	—	—	—	C
ZN74L01J	9401	F161	—	—	—	—	—	C
ZN74L02J	9401	F164	—	—	—	—	—	C
ZN74L03J	9401	F070	—	—	—	—	—	C
ZN74L04J	9403	F003	—	—	—	—	—	C
ZN74L10J	9401	F013	—	—	—	—	—	C
ZN74L20J	9401	F014	—	—	—	—	—	C
ZN74L30J	9401	F015	—	—	—	—	—	C
ZN74L42J	9440	F084	—	—	—	—	—	C
ZN74L51J	9405	F007	—	—	—	—	—	C
ZN74L54J	9405	F008	—	—	—	—	—	C
ZN74L55J	9405	F009	—	—	—	—	—	C
ZN74L73J	9420	F003	—	—	—	—	—	C
ZN74L74J	9420	F078	—	—	—	—	—	C
ZN74L75J	9420	F081	—	—	—	—	—	C
ZN74L85J	9405	F117	—	—	—	—	—	C
ZN74L86J	9401	F018	—	—	—	—	—	C
ZN74L90J	9442	F063	—	—	—	—	—	C
ZN74L91J	9440	F087	—	—	—	—	—	C
ZN74L93J	9442	F003	—	—	—	—	—	C
ZN74L95J	9440	F009	—	—	—	—	—	C
ZN74L96J	9440	F090	—	—	—	—	—	C
ZN74L122J	9440	F093	—	—	—	—	—	C
ZN74L164J	9440	F012	—	—	—	—	—	C
ZN74L192J	9442	F066	—	—	—	—	—	C
ZN74L193J	9442	F069	—	—	—	—	—	C
ZSD51A	9402	—	—	—	—	C062	CN62	C
ZSD81A	9402	—	—	—	—	C063	CN63	C
ZSF51B	—	—	—	—	—	—	CN60	C
ZSF81B	—	—	—	—	—	—	CN61	C
ZSS51A	9402	—	—	—	—	C034	CN34	C
ZSS51B	9402	—	—	—	—	C036	CN36	C
ZSS53A	9402	—	—	—	—	C038	CN38	C
ZSS53B	9402	—	—	—	—	C040	CN40	C
ZSS54A	9404	—	—	—	—	C042	CN42	C
ZSS54B	9404	—	—	—	—	C044	CN44	C
ZSS55A	9402	—	—	—	—	C046	CN46	C
ZSS55B	9402	—	—	—	—	C048	CN48	C
ZSS56B	9402	—	—	—	—	C050	CN50	C
ZSS57B	9402	—	—	—	—	C052	CN52	C
ZSS81A	9402	—	—	—	—	C035	CN35	C
ZSS81B	9402	—	—	—	—	C037	CN37	C
ZSS83A	9402	—	—	—	—	C039	CN39	C
ZSS83B	9402	—	—	—	—	C041	CN41	C

C = Current P = Pending S = Suspended

FERRANTI TYPE NUMBER	BS TYPE						CN Type Number	App. Status
	Prefix	Full Assess.	Cat. S1	Cat. S2	Cat. S3	Adopted CN Type		
ZSS84A	9404	–	–	–	–	C043	CN43	C
ZSS84B	9404	–	–	–	–	C045	CN45	C
ZSS85A	9402	–	–	–	–	C047	CN47	C
ZSS85B	9402	–	–	–	–	C049	CN49	C
ZSS86B	9402	–	–	–	–	C051	CN51	C
ZSS87B	9402	–	–	–	–	C053	CN53	C
ZST51A	9402	–	–	–	–	C054	CN54	C
ZST52A	9402	–	–	–	–	C056	CN56	C
ZST52B	9402	–	–	–	–	C058	CN58	C
ZST53A	–	–	–	–	–	–	CN511T	C
ZST53B	–	–	–	–	–	–	CN633T	C
ZST54A	–	–	–	–	–	–	CN513T	C
ZST81A	9402	–	–	–	–	C055	CN55	C
ZST82A	9402	–	–	–	–	C057	CN57	C
ZST82B	9402	–	–	–	–	C059	CN59	C
ZST83A	–	–	–	–	–	–	CN512T	C
ZST83B	–	–	–	–	–	–	CN664T	C
ZST84A	–	–	–	–	–	–	CN514T	C

C = Current P = Pending S = Suspended

TELECOMMUNICATIONS TYPES

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

C = Current P = Pending S = Suspended

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

C = Current P = Pending S = Suspended

SECTION 2 : DISCRETE COMPONENTS

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

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

3 POWER TRANSISTORS

4 HYBRID CIRCUIT SEMICONDUCTORS
SOT-23, MICRO-E, MULTICHIP, DICE

5 FSD1001

6 R.F. TRANSISTORS AND DIODES

7 OPTO ELECTRONICS

8 DIODES (ALL TYPES)

E-LINE (TO-92 STYLE) TRANSISTORS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

TAPED PRODUCT

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	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	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
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
MPS6565	60	45	200	0.4	10	1	40	160	10	–	–	500	–
MPS6566	60	45	200	0.4	10	1	100	400	10	–	–	500	–
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
MPS6531	60	40	600	0.3	100	10	90	270	100	390	50	500	MPS6534
MPS6530	60	40	600	0.5	100	10	40	120	100	390	50	500	MPS6533
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
MPS3416	50	50	500	0.3	50	3	75	225	2	–	–	500	–
MPS3417	50	50	500	0.3	50	3	180	540	2	–	–	500	–
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	–

*Typical †T_{case} = 45°C

TABLE 1 – continued

Type	V_{CBO} 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	Min f_T MHz	at I_C mA	P_{tot} at T_{amb} = 25°C mW	Complement
MPS3704	50	30	800	0.6	100	5	100	300	50	100	50	500	MPS3703
MPS3705	50	30	800	0.8	100	5	50	150	50	100	50	500	MPS3703
MPS6532	50	30	600	0.5	100	10	30	–	100	390	50	500	MPS6535
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
MPS3693	45	45	50	–	–	–	40	160	10	200	10	500	–
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
MPS3706	40	20	800	1	100	5	30	600	50	100	50	500	MPS3702
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
MPS3709	30	30	200	1	10	0.5	45	165	1	–	–	500	–
MPS3710	30	30	200	1	10	0.5	90	330	1	–	–	500	–
MPS3711	30	30	200	1	10	0.5	180	660	1	–	–	500	–
MPS3708	30	30	200	1	10	0.5	45	660	1	–	–	500	–
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
MPS3414	25	25	500	0.3	50	3	75	225	2	–	–	500	–
MPS3415	25	25	500	0.3	50	3	180	540	2	–	–	500	–
ZTX300	25	25	500	0.35	10	1	50	300	10	150	10	300	ZTX500
MPS5172	25	25	100	0.25	10	1	100	500	10	120*	2	500	–
MPS3394	25	25	100	–	–	–	55	110	2	–	–	500	–
MPS2923	25	25	100	–	–	–	90	180	2	–	–	500	–
MPS3393	25	25	100	–	–	–	90	180	2	–	–	500	–
MPS2924	25	25	100	–	–	–	150	300	2	–	–	500	–
MPS3392	25	25	100	–	–	–	150	300	2	–	–	500	–
MPS2925	25	25	100	–	–	–	235	470	2	–	–	500	–
MPS3395	25	25	100	–	–	–	150	500	2	–	–	500	–
MPS2711	18	18	100	–	–	–	30	90	2.5	–	–	500	–
MPS2712	18	18	100	–	–	–	75	225	2.5	–	–	500	–
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
					I_C	I_B	Min	Max	I_C		I_C		
	V	V	mA	V	mA	mA			mA	MHz	mA	mW	
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
MPS3703	50	30	500	0.25	50	5	30	150	50	100	50	500	MPS3704, MPS3705
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
MPS6534	40	40	600	0.3	100	10	90	270	100	260	50	500	MPS6531
MPS6533	40	40	600	0.5	100	10	40	120	100	260	50	500	MPS6530
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
MPS3702	40	25	500	0.25	50	5	60	300	50	100	50	500	MPS3706
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
MPS6535	30	30	600	0.5	100	10	30	—	100	260	50	500	MPS6532
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
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
				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	
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
MPS3641	30	500	0.22	150	15	40	120	150	–	–	14	80	300	–
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	–
MPS2713	18	200	0.3	50	3	30	90	2	250*	10	13	21	10	–
MPS2714	18	200	0.3	50	3	75	225	2	250*	10	13	21	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
	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	
MPS2907A	60	600	1.6	500	50	100	300	150	200	50	50	110	150	MPS2222A
MPS3645	60	500	0.4	150	15	100	300	150	–	–	40	100	300	–
BCY77P	60	100	0.25	10	0.25	120	460	2	180*	10	85	150	10	BCY65EP
MPS3644	45	500	0.4	150	15	100	300	150	–	–	40	100	300	–
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
MPS3638A	25	500	1	300	30	100	–	50	150	15	75	170	300	–
MPS3638	25	500	1	300	30	30	–	50	100	15	75	170	300	–
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
MPS2484	60	50	0.35	1	0.1	100	500	0.01	60	0.5	3	200	30 – 15k	–
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
MPS6565	45	200	0.4	10	1	40	160	10	–	–	4*	200	30 – 15k	–
MPS6566	45	200	0.4	10	1	100	400	10	–	–	4*	200	30 – 15k	–
BC414P	45	100	0.25	10	0.5	200	800	2	250*	10	3	200	30 – 15k	BC416P
MPS3693	45	50	–	–	–	40	160	10	200	10	4*	200	1k	–
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
MPS3707	30	200	1	10	0.5	100	550	0.1	–	–	5	200	30 – 15k	–
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
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
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
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_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Min f_T	at	P_{tot} at T_{amb} = 25°C	Complement
					I_C	I_B	Min	Max	I_C		I_C		
	V	V	mA	V	mA	mA			mA	MHz	mA	mW	
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	50	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	50	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	50	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	50	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	50	1000	ZTX653
ZTX752	100	80	2000	0.3	1000	100	100	300	500	75	50	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	50	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	50	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_{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	
NPN													
ZTX653	120	100	2000	0.3	1000	100	100	300	500	100	50	1000	ZTX753
ZTX652	100	80	2000	0.3	1000	100	100	300	500	100	50	1000	ZTX752
ZTX651	80	60	2000	0.3	1000	100	100	300	500	100	50	1000	ZTX751
ZTX650	60	45	2000	0.3	1000	100	100	300	500	100	50	1000	ZTX750
ZTX649	35	25	2000	0.3	1000	100	100	300	1000	150	100	1000	ZTX749
PNP													
ZTX753	120	100	2000	0.3	1000	100	100	300	500	75	50	1000	ZTX653
ZTX752	100	80	2000	0.3	1000	100	100	300	500	75	50	1000	ZTX652
ZTX751	80	60	2000	0.3	1000	100	100	300	500	75	50	1000	ZTX651
ZTX750	60	45	2000	0.3	1000	100	100	300	500	75	50	1000	ZTX650
ZTX749	35	25	2000	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_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Max. I_{CBO}	at	P_{tot} at T_{amb} = 25°C
	V	V	mA	V	I_C mA	I_B mA	Min	Max	I_C mA	nA	V_{CB} V	mW
ZTX600	160	140	1000	1.2	1000	10	2K	100K	500	100	140	1000
ZTX601	180	160	1000	1.2	1000	10	2K	100K	500	100	160	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
ZTX325‖	15	50	0.4	10	1.0	1300	25	<5	2	500	1.5	10	175mW	500
ZTX326‖	12	50	0.4	10	1.0	1000	2	<6	2	500	1.5	10	26.5dB	100
ZTX326A⊕‖	12	50	0.4	10	1.0	1000	2	<6	2	500	1.5	10	26.5dB	100
PNP														
ZTX510	12	200	0.2	30	3	400	30	–	–	–	6.0	5	300mW	–

*Typical

⊙C_{re} = 0.2pF (typical)

‖C_{re} = 0.8pF (maximum)

⊕High d.c. gain device.

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

§C_{re} = 0.3pF (typical)

⊖Refers to C_{oe}

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													
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
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
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													
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
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
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

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).

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.

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.

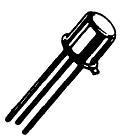
Type	V_{CB}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Min f_T at		P_{tot} at T_{amb} = 25°C	Package	Complement
	V	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	mW		
ZT92	120	100	1000	1.2	200	20	65	200	200	60	50	1000	TO-39	–
ZT91	120	100	1000	1.2	200	20	40	120	200	60	50	1000	TO-39	–
2N2405	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 –

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		
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



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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
ZT152	20	20	500	0.2	10	1	50	200	10	–	–	300	TO-18	–

*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	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		
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

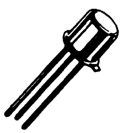
*Typical. Note 1 $t_{tot} = 30$ ns

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
2N2220	30	800	0.4	150	15	20	60	150	250	20	20*	213*	150	TO-18	–
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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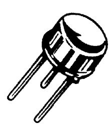

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TABLE 4 – SILICON PLANAR MEDIUM AND HIGH SPEED SWITCHING TRANSISTORS

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_TMin 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		
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 particular 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_T Min 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

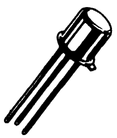
TABLE 6 – PNP SILICON PLANAR LOW NOISE TRANSISTORS

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}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	f_T Min 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		
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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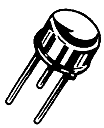

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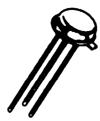

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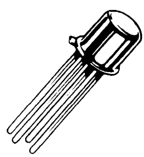


TO-72

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_{CEO}	Max. I_C	h_{FE}		at	f_T Min.	at	Noise Figure	at		C_{obo} Max. at 1 MHz		RF, P_O or RF, P_G at		Package
	V	V	mA	Min.	Max.	I_C mA	MHz	I_C mA	N dB	I_C mA	f MHz	pF	V_{CB} V	mW or dB	f MHz	
BFY90	30	15	50	25	150	2	1300	25	<5	2	500	1.5	10	175mW	500	TO-72
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 – LOW NOISE VHF/UHF TRANSISTORS

Type	V_{CBO} Volts Max.	V_{CEO} Volts Max.	V_{EBO} Volts Max.	Noise Figure Max.	R.F. Power Output Min.	Package
BFY90	30	15	2.5	5dB at 500MHz $R_S = 50\Omega$ $V_{CE} = 5.0V$ $I_C = 2.0mA$	175mW at 500MHz $P_{in} = 25mW$ $V_{CE} = 13.5V$	TO-72
BFX89	30	15	2.5	6dB at 500MHz $R_S = 50\Omega$ $V_{CE} = 5.0V$ $I_C = 2.0mA$	$G_P = 10dB$ min. f = 500MHz $I_C = 15mA$ $V_{CE} = 5V$	TO-72

TABLE 7b – 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

TABLE 7c – R.F. POWER TRANSISTORS TO 3 WATTS

Intended for use as drivers for professional and military applications.

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	
2N3553	65	40	28.0	2.5	10.0	175	TO-39
ZT6255	36	18	12.5	3.0	7.8	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 $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min.	h_{FE} Max.	at I_C mA	I_{CBO} µA	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 $V_{CE(sat)}$ V	at I_C mA	at I_B mA	h_{FE} Min.	h_{FE} Max.	at I_C mA	Switching Times (Max) t_{on} ns	t_{off} ns	at 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_{CEO}	Max. I_C	Max $V_{CE(sat)}$	at		h_{FE}		at	Max C_{obo} at 1MHz	at	Max. I_{CBO}	at	P_{tot} at T_{amb} = 25°C	Package
	V	V	A	V	I_C A	I_B mA	Min.	Max.	I_C A	pF	V_{CB} V	μA	V_{CB} V	W	
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	V_{CEO} V	Max I_C A	Max $V_{CE(sat)}$† at V	I_C A	I_B A	h_{FE} Min.	Max.	at I_C A	Switching Times (Typ) at t_{on} ns	t_{off} ns	I_C A	P_{tot} at T_{case} = 25°C W	Package	Comple-ment
BUY82	150	60	10	1	10	1	40 15	– –	1.5 10	320	245	10	30	TO-39	BUY92
BUY81	150	60	7.5	1	7.5	0.75	40 10	– –	1 7.5	160	430	5	24	TO-39	BUY91
BUY80	150	60	5	1	5	0.5	40 15	– –	0.5 5	170	200	5	20	TO-39	BUY90
2N3419	125	80	5*	1	5	0.5	20	60	1	300	1200	1	30	TO-39	–
2N3421	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	–
2N3418	85	60	5*	1	5	0.5	20	60	1	300	1200	1	30	TO-39	–
2N3420	85	60	5*	1	5	0.5	40	120	1	300	1200	1	30	TO-39	–

*I_{CM} †Pulsed 300μs

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 tabie 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	V_{CEO} V	Max I_C A	Max $V_{CE(sat)}$† at V	I_C A	I_B A	h_{FE} Min.	Max.	at I_C A	Switching Times (Typ) at t_{on} ns	t_{off} ns	I_C A	P_{tot} at T_{case} = 25°C W	Package	Comple-ment
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 300μs

POWER TRANSISTORS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

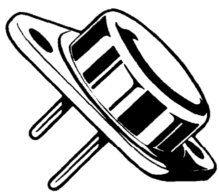
NPN DIFFUSED JUNCTION

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



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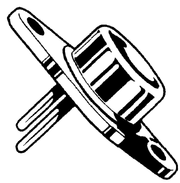
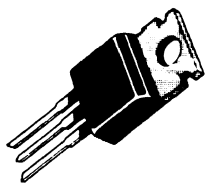


TO-66

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

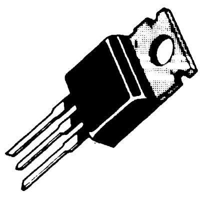
TABLE 2 – NPN EPITAXIAL BASE TRANSISTORS

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

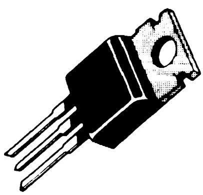
TABLE 3 – PNP EPITAXIAL BASE TRANSISTORS

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)	V_{CBO}	V_{CEO}	Max $V_{CE(sat)}$	at		h_{FE}		at	P_{tot} at T_{case} = 25°C	Package	Complement
	A	V	V	V	I_C A	I_B mA	Min	Max	I_C A	W		
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) 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
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.

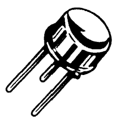
Type	I_C (Max) cont. A	V_{CBO} V	V_{CEO} V	$V_{CE(sat)}$ at V	I_C A	I_B mA	h_{FE} Min	Max	at I_C A	P_{tot} at T_{case} =25°C W	Package
2N3442	10	160	160*	1	3	300	20	70	3	117	TO-3
2N3441	3	160	160*	1	0.5	50	25	100	0.5	25	TO-66
2N3585	2	500	300	0.75	1	125	25	100	1	35	TO-66
2N3584	2	375	250	0.75	1	125	25	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	2N3418 2N3420 BUY90*	BUX34 BUY80 BUY91*	BUY81 BUY92*	BUY82
80	2N4000		2N3419 2N3421			
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
				I_C	I_B			I_C	t_{on}	t_{off}	I_C		
	A	V	V	A	A	min.	max.	A	ns	ns	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
2N3419	3	80	0.5	2	0.2	20	60	1	300	1200	1	30	TO-39
2N3420	3	80	0.5	2	0.2	40	120	1	300	1200	1	30	TO-39
2N3418	3	60	0.5	2	0.2	20	60	1	300	1200	1	30	TO-39
2N3421	3	60	0.5	2	0.2	40	120	1	300	1200	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
				I_C	I_B			I_C	t_{on}	t_{off}	I_C		
	A	V	V	A	A	min.	max.	A	ns	ns	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

MAXIVOLT SERIES

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} Min.	at I_C	at V_{CE}	Max. $V_{CE(sat)}$ V	at I_C	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	100	TO-220
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

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

Our new generation of Power MOSFETS offer today the performance required for designs of tomorrow...

Ferranti Power 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 interdigitated geometries. In common with all MOSFET power devices they do not exhibit thermal runaway and thermally induced secondary breakdown.

Ferranti Power MOSFETS have a major advantage over competitive approaches which use either Vgroove or Ugroove techniques. The key factor is that the 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 Power 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.

Ferranti Power MOSFETS will directly interface with Microprocessors and all IC logic families including CMOS, TTL, PMOS and NMOS.

FEATURES

- N-channel, P-channel, Complementary devices
- Drain currents up to 16A continuous, 32A pulsed
- Breakdown voltages up to 650V
- Drain-Source ON-resistances as low as 0.1Ω
- Switching times as low as 4ns
- Power dissipations up to 150W

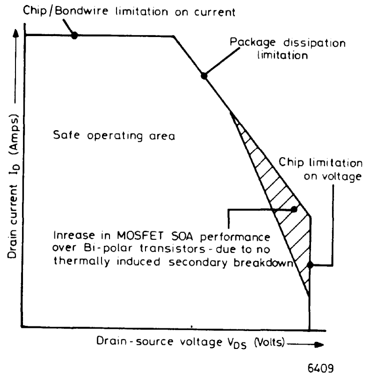
PROCESS HIGHLIGHTS

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 Interdigitated Geometries**
   Compact interdigitated transistor chip designs enable low "on-resistances" to be achieved without incurring the disadvantage of high input capacitance associated with alternative overlay designs.

POWER MOSFETS

THERMAL RUNAWAY

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



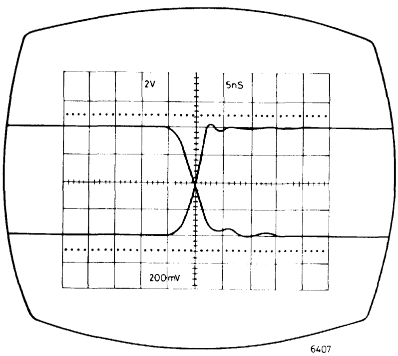
Carrier mobility in a MOSFET channel region decreases with temperature. If localized heating occurs in a MOSFET the carrier mobility decreases in the region affected, and as a consequence, the localized current reduces. This negative feedback mechanism forces overload currents to be uniformly distributed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

HIGH INPUT IMPEDANCE

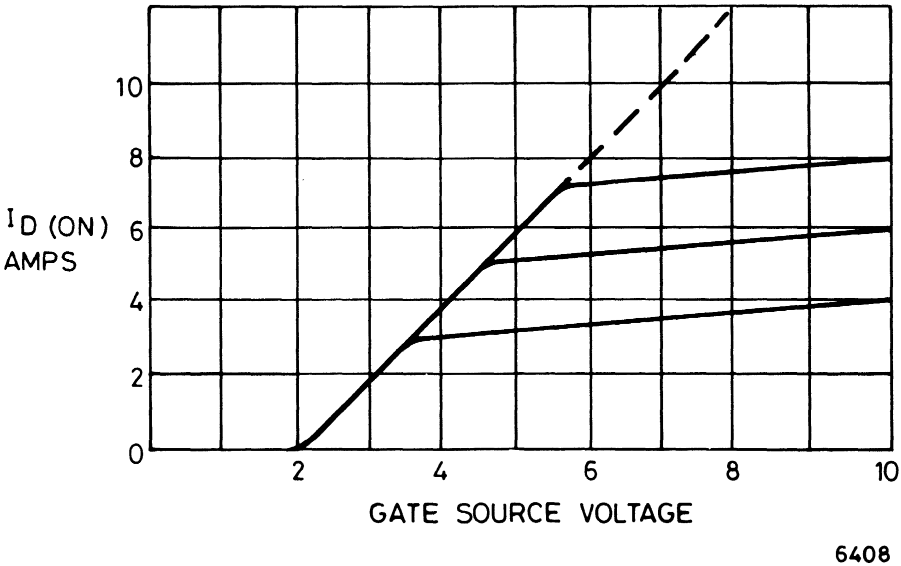
By virtue of the insulated gate structure, input currents are very low, typically a few pico amps at 25°C.

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

POWER MOSFETS

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.

COMPARISON OF EXISTING POWER TRANSISTORS

CHARACTERISTIC	BIPOLAR	MOSFET
Input Impedance	$10^3 - 10^5\Omega$	$10^9 - 10^{11}\Omega$
Current Gain	100 – 1000	$10^5 - 10^6$
Breakdown Performance	2000V	650V
Ruggedness	POOR	GOOD
Parallel Operation	Requires special techniques	YES
Switching Performance		
Turn-on	Moderate 50 – 500ns	Fast 10ns
Turn-off	Slow 0.5 – 2μs	Fast 10ns
On-resistance	Very low	Low

APPLICATIONS OF POWER 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.

PRODUCT TYPE CODE

All Ferranti Power 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: 01/02/03/04/05/11/12/13/14

VOLTAGE (÷ 10)

A2	04	10
A3	06	
	08	14
	09	
16	30	50
	35	55
20	40	60
	45	65

PACKAGE CODE:

E-line	A
TO-39	B
TO-220	L
TO-3	M
Dice	D

EXAMPLE

[Z]	[V]	[N]	[0][2]	[0][9]	[L]
Ferranti	VMOS	Channel	Chip Type	Voltage (÷ 10)	Package Code

This number refers to an N-channel device with a 6 AMP max I_D and a 90V V_{DS} breakdown in a TO-220 package.

POWER MOSFETS

PRODUCT RANGE

N-CHANNEL DEVICES

Product Family	Max. Continuous Drain Current Range I_D Amps (A)*	Max. Pulsed Drain Current Range I_{DM} Amps (A)*	Min. Breakdown Drain Source Voltage BV_{DSS} Volts (V)	Typ. ON-state Drain Source Resistance $R_{DS}(ON)$ ohms (Ω)	Typical Trans-conductance gfs Mhos (℧)	Package Options TO-3 (M)	TO-39 (B)	E-line (A)	TO-220 (L)	Dice (D)
ZVN01AA	1-3	2-5	20,30	1.0	0.50		•	•	•	•
ZVN01A	1-3	2-5	40,60,80,90	2.0	0.40		•	•	•	•†
ZVN01B	1-3	2-5	100,140	4.5	0.33		•	•	•	•
ZVN01C	1-3	2-5	160,200	8.0	0.15		•	•	•	•
ZVN02AA	4-6	8-12	20,30	0.5	1.20	•	•		•	•†
ZVN02A	4-6	8-12	40,60,80,90	1.2	0.90	•	•		•	•
ZVN02B	4-6	8-12	100,140	2.2	0.60	•	•		•	•
ZVN02C	4-6	8-12	160,200	4.0	0.40	•	•		•	•
ZVN03D	6	12	300,350,400,450	2.0	2.50	•	•		•	•
ZVN03E	6	12	500,550,600,650	3.0	1.40	•	•		•	•
ZVN04D	16	32	300,350,400,450	0.4	9.00	•				•
ZVN04E	16	32	500,550,600,650	1.0	8.00	•				•
ZVN05D	1-2	2-4	300,350,400,450	40.0	0.20		•	•	•	•
ZVN11AA	5-8	10-16	20,30	0.3	3.00	•	•		•	•
ZVN11A	5-8	10-16	40,60,80,90	0.7	2.00	•	•		•	•†
ZVN11B	5-8	10-16	100,140	1.0	1.50	•	•		•	•
ZVN11C	5-8	10-16	160,200	2.0	1.00	•	•		•	•
ZVN12AA	8-16	16-32	20,30	0.1	6.00	•	•		•	•
ZVN12A	8-16	16-32	40,60,80,90	0.2	4.50	•	•		•	•†
ZVN12B	8-16	16-32	100,140	0.4	2.50	•	•		•	•
ZVN12C	8-16	16-32	160,200	0.5	2.00	•	•		•	•
ZVN13A	1-1.5	2-3	40,60,80,90	4.0	0.25		•	•		•†
ZVN13B	1-1.5	2-3	100,140	10.0	0.18		•	•		•
ZVN13C	1-1.5	2-3	160,200	20.0	0.09		•	•		•
ZVN14A	0.10	0.20	40,60,80,90	200.0	0.003		•	•		•†
ZVN14B	0.10	0.20	100,140	400.0	0.002		•	•		•
ZVN14C	0.10	0.20	160,200	800.0	0.001		•	•		•

*The Power Dissipation capability of a packaged device may result in lower practical continuous and pulsed drain currents.

†Not available in this form at $V_{DS} = 90V$

ʼRODUCT RANGE *(continued)*
ʼ-CHANNEL DEVICES

Product Family	Max. Continuous Drain Current Range I_D Amps (A)*	Max. Pulsed Drain Current Range I_{DM} Amps (A)*	Min. Breakdown Drain Source Voltage BV_{DSS} Volts (V)	Typ. ON-state Drain Source Resistance $R_{DS}(ON)$ ohms (Ω)	Typical Trans-conductance gfs Mhos (℧)	Package Options TO-3 (M)	TO-39 (B)	E-line (A)	TO-220 (L)	Dice (D)
ZVP01AA	1-3	2-5	20,30	2.0	0.23		●	●	●	●
ZVP01A	1-3	2-5	40,60,80,90	4.0	0.20		●	●	●	●†
ZVP01B	1-3	2-5	100,140	8.0	0.10		●	●	●	●
ZVP01C	1-3	2-5	160,200	16.0	0.05		●	●	●	●
ZVP02AA	4-6	8-12	20,30	1.0	0.60	●	●		●	●†
ZVP02A	4-6	8-12	40,60,80,90	2.0	0.50	●	●		●	●
ZVP02B	4-6	8-12	100,140	4.0	0.40	●	●		●	●
ZVP02C	4-6	8-12	160,200	8.0	0.30	●	●		●	●
ZVP03D	6	12	300,350,400,450	6.0	0.75	●	●		●	●
ZVP03E	6	12	500,550,600,650	10.0	0.50	●	●		●	●
ZVP04D	12	24	300,350,400,450	1.0	6.00	●				●
ZVP04E	12	24	500,550,600,650	2.0	4.50	●				●
ZVP05D	1-2	2-4	300,350,400,450	100.0	0.75		●	●	●	●
ZVP11AA	5-8	10-16	20,30	0.6	2.00	●	●		●	●
ZVP11A	5-8	10-16	40,60,80,90	1.5	1.50	●	●		●	●†
ZVP11B	5-8	10-16	100,140	2.0	1.00	●	●		●	●
ZVP11C	5-8	10-16	160,200	5.0	0.80	●	●		●	●
ZVP12AA	6-12	12-24	20,30	0.2	3.00	●	●		●	●
ZVP12A	6-12	12-24	40,60,80,90	0.5	2.00	●	●		●	●†
ZVP12B	6-12	12-24	100,140	0.8	1.40	●	●		●	●
ZVP12C	6-12	12-24	160,200	1.6	1.20	●	●		●	●
ZVP13A	1-1.5	2-3	40,60,80,90	20.0	0.10		●	●		●†
ZVP13B	1-1.5	2-3	100,140	40.0	0.07		●	●		●
ZVP13C	1-1.5	2-3	160,200	80.0	0.06		●	●		●
ZVP14A	0.10	0.20	40,60,80,90	400.0	0.004		●	●		●†
ZVP14B	0.10	0.20	100,140	800.0	0.003		●	●		●
ZVP14C	0.10	0.20	160,200	1600.0	0.002		●	●		●

*The Power Dissipation capability of a packaged device may result in lower practical continuous and pulsed drain currents.
†Not available in this form at $V_{DS} = 90V$

POWER MOSFETS

For comprehensive data on the full range of Ferranti DMOS Structure Power Mosfets ask for the:

FERRANTI VMOS DATA BOOK

HYBRID DEVICES

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

SOT-23 PLASTIC ENCAPSULATED SEMICONDUCTORS

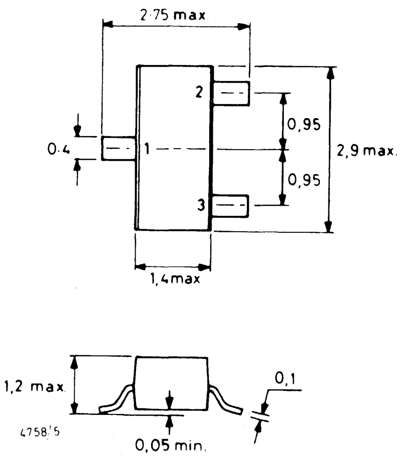
SOT-23 is the internationally standardised semiconductor package for hybrid assembly of transistors and diodes. Designed specifically for use in thick and thin film hybrid circuits the devices offer considerable advantages over other packages and "chip and wire" assembly techniques.

The wide range of available types gives the hybrid designer maximum flexibility in designing new hybrids and minimum redesign time in translating printed circuit board layouts to thick or thin film.

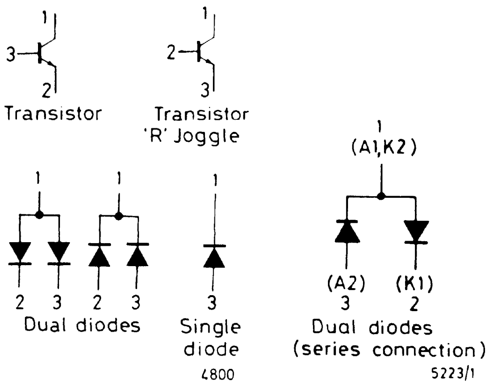
This micro-miniature package provides the optimum cost/real estate solution to high volume hybrid manufacture, whether in commercial, industrial, or military applications.

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

SOT-23 PACKAGE OUTLINE



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.

MAXIMUM THERMAL RATINGS

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

DEVICE IDENTIFICATION MARKINGS

Type	Device marking	Page	CECC number
Transistors			
BCW29	C1	H5	50002 F114
BCW29R	C4	H5	50002 F114
BCW30	C2	H5	50002 F114
BCW30R	C5	H5	50002 F114
BCW31	D1	H5	50002 F115
BCW31R	D4	H5	50002 F115
BCW32	D2	H5	50002 F115
BCW32R	D5	H5	50002 F115
BCW33	D3	H5	50002 F115
BCW33R	D6	H5	50002 F115
BCW60*	AA to AD	H5	50002 F116†
BCW61*	BA to BD	H5	50002 F110†
BCW65*	EA to EC	H7	50002 F117†
BCW66*	EF to EH	H7	50002 F117†
BCW67*	DA to DC	H7	50002 F108†
BCW68*	DF to DH	H7	50002 F108†
BCW69	H1	H5	50002 F113
BCW69R	H4	H5	50002 F113
BCW70	H2	H5	50002 F113
BCW70R	H5	H5	50002 F113
BCW71	K1	H5	50002 F118
BCW71R	K4	H5	50002 F118
BCW72	K2	H5	50002 F118
BCW72R	K5	H5	50002 F118
BCW89	H3	H5	–
BCW89R	H6	H5	–
BCX17	T1	H7	50002 F109†
BCX17R	T4	H7	50002 F109†
BCX18	T2	H7	50002 F109†
BCX18R	T5	H7	50002 F109†
BCX19	U1	H7	50002 F119†
BCX19R	U4	H7	50002 F119†
BCX20	U2	H7	50002 F119†
BCX20R	U5	H7	50002 F119†
BCX70*	AG to AK	H5	50002 F120†
BCX71*	BG to BK	H5	50002 F111†
BFQ31	S2	H8	50002 F123†
BFQ31R	S3	H8	50002 F123†
BFQ31A	S4	H8	50002 F123†
BFQ31AR	S5	H8	50002 F123†

Type	Device marking	Page	CECC number
Transistors			
BFS17	E1	H8	50002 F128†
BFS17R	E4	H8	50002 F128†
BFS20	G1	H8	
BFS20R	G4	H8	
BSS63	T3	H8	
BSS64	U3	H8	
BSS65	L1	H6	
BSS65R	L5	H6	
BSS66	M6	H6	50004 F069
BSS66R	M8	H6	50004 F069
BSS67	M7	H6	50004 F069
BSS67R	M9	H6	50004 F069
BSS69	L2	H6	50004 F070
BSS69R	L6	H6	50004 F070
BSS70	L3	H6	50004 F070
BSS70R	L7	H6	50004 F070
BSV52	B2	H6	50004 F071
BSV52R	B4	H6	50004 F071
FMMT-A05	1H	H7	
FMMT-A06	1G	H7	
FMMT-A12	3W	H8	50004 F124†
FMMT-A13	1M	H8	50004 F124†
FMMT-A14	1N	H8	50004 F124†
FMMT-A20	1C	H5	
FMMT-A42	1D	H8	
FMMT-A43	1E	H8	
FMMT-A55	2H	H7	
FMMT-A56	2G	H7	
FMMT-A92	2D	H8	
FMMT-A93	2E	H8	
FMMT918	3B	H8	
FMMT2222	1B	H6	50004 F055†
FMMT2222A	1P	H6	50004 F055†
FMMT2369	1J	H6	50004 F053†
FMMT2907	2B	H6	50004 F057†
FMMT2907A	2F	H6	50004 F057†
FMMT3903	1W	H5	50004 F054†
FMMT3904	1A	H5	50004 F054†
FMMT3905	2W	H5	50004 F056†
FMMT3906	2A	H5	50004 F056†
HT2	2T	H8	50002 F139
HT3	3T	H8	50002 F140

*Available in selected gain categories. †Indicates full plus additional assessment.

DEVICE IDENTIFICATION MARKINGS

Type	Device marking	Page	CECC number
Diodes			
BAS16	A3	H9	
BAV70	A4	H9	50001 F027†
BAV74	JA	H9	50001 F028†
BAV99	A7	H9	50001 F029†
BAW56	A1	H9	50001 F033†
BZX84-C2V7	W4	H9	50005 F008†
BZX84-C3V0	W5	H9	
BZX84-C3V3	W6	H9	
BZX84-C3V6	W7	H9	
BZX84-C3V9	W8	H9	
BZX84-C4V3	W9	H9	
BZX84-C4V7	Z1	H9	
BZX84-C5V1	Z2	H9	
BZX84-C5V6	Z3	H9	
BZX84-C6V2	Z4	H9	
BZX84-C6V8	Z5	H9	
BZX84-C7V5	Z6	H9	
BZX84-C8V2	Z7	H9	
BZX84-C9V1	Z8	H9	
BZX84-C10	Z9	H9	
BZX84-C11	Y1	H9	
BZX84-C12	Y2	H9	
BZX84-C13	Y3	H9	
BZX84-C15	Y4	H9	
BZX84-C16	Y5	H9	
BZX84-C18	Y6	H9	
BZX84-C20	Y7	H9	
BZX84-C22	Y8	H9	
BZX84-C24	Y9	H9	
BZX84-C27	X1	H9	
BZX84-C30	X2	H9	

Type	Device marking	Page	CECC number
Diodes			
BZX84-C33	X3	H9	
BZX84-C36	X4	H9	
BZX84-C39	X5	H9	
BZX84-C43	X6	H9	
BZX84-C47	X7	H9	
FMMD109	4A	H10	50001 F040†
FMMD914	5D	H9	
FMMD3102	4C	H10	
HD2A	5D	H9	50001 F041†
HD3A	4D	H9	50001 F042†
HD4A	7D	H9	50001 F043†
ZC830A	J1	H10	
ZC831A	J3	H10	
ZC832A	J4	H10	
ZC833A	A2	H10	
ZC834A	J5	H10	
ZC835A	J6	H10	
ZC836A	J7	H10	
ZC2800E	E6	H10	50001 F044
ZC2810E	E7	H10	50001 F044
ZC2811E	E8	H10	50001 F044
ZC5800E	E9	H10	50001 F044

*Available in selected gain categories. †Indicates full plus additional assessment.

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.	at I_C/V_{CE} mA/volts	$V_{CE(sat)}$ max Volts	at I_C/I_B mA	f_T at I_C = 10mA MHz(typ)	Complement
FMMT3903	60	40	200	300	50/150	10/1	0.2	10/1	250§	FMMT3905
FMMT3904	60	40	200	300	100/300	10/1	0.2	10/1	300§	FMMT3906
BCW71/71R	50	45	200	300	110/220	2/5	0.25	10/0.5	300	BCW69/69R
BCW72/72R	50	45	200	300	200/450	2/5	0.25	10/0.5	300	BCW70/70R
BCX70G	45	45	200	300	120/220	2/5	0.35	10/0.25	250	BCX71G
BCX70H	45	45	200	300	180/310	2/5	0.35	10/0.25	250	BCX71H
BCX70J	45	45	200	300	250/460	2/5	0.35	10/0.25	250	BCX71J
BCX70K	45	45	200	300	380/630	2/5	0.35	10/0.25	250	BCX71K
BCW60A	32	32	200	300	120/220	2/5	0.35	10/0.25	250	BCW61A
BCW60B	32	32	200	300	180/310	2/5	0.35	10/0.25	250	BCW61B
BCW60C	32	32	200	300	250/460	2/5	0.35	10/0.25	250	BCW61C
BCW60D	32	32	200	300	380/630	2/5	0.35	10/0.25	250	BCW61D
BCW31/31R	30	20	200	300	110/220	2/5	0.25	10/0.5	300	BCW29/29R
BCW32/32R	30	20	200	300	200/450	2/5	0.25	10/0.5	300	BCW30/30R
BCW33/33R	30	20	200	300	420/800	2/5	0.25	10/0.5	300	–
FMMT-A20	–	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 = 100MHz

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

PNP GENERAL PURPOSE

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 at I_C = 10mA MHz(typ)	Complement
BCW89/89R	80	60	200	300	120/260	2/5	0.3	10/0.5	150	–
BCW69/69R	50	45	200	300	120/260	2/5	0.3	10/0.5	150	BCW71/71R
BCW70/70R	50	45	200	300	215/500	2/5	0.3	10/0.5	150	BCW72/72R
BCX71G	45	45	200	300	120/220	2/5	0.25	10/0.25	180	BCX70G
BCX71H	45	45	200	300	180/310	2/5	0.25	10/0.25	180	BCX70H
BCX71J	45	45	200	300	250/460	2/5	0.25	10/0.25	180	BCX70J
BCX71K	45	45	200	300	380/630	2/5	0.25	10/0.25	180	BCX70K
FMMT3905	40	40	200	300	50/150	10/1	0.25	10/1.0	200§	FMMT3903
FMMT3906	40	40	200	300	100/300	10/1	0.25	10/1.0	250§	FMMT3904
BCW61A	32	32	200	300	120/220	2/5	0.25	10/0.25	180	BCW60A
BCW61B	32	32	200	300	180/310	2/5	0.25	10/0.25	180	BCW60B
BCW61C	32	32	200	300	250/460	2/5	0.25	10/0.25	180	BCW60C
BCW61D	32	32	200	300	380/630	2/5	0.25	10/0.25	180	BCW60D
BCW29/29R	30	20	200	300	120/260	2/5	0.3	10/0.5	150	BCW31/31R
BCW30/30R	30	20	200	300	215/500	2/5	0.3	10/0.5	150	BCW32/32R

*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	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 $I_C = 10mA$ MHz(min)	Switching Times t_{on}/t_{off} ns(max)	at $I_C/I_{B1}I_{B2}$ mA	Compler
BSS66/66R	40	200	300	50/150	10/1	0.2	10/1	250	70/225	10/1	BSS69/
BSS67/67R	40	200	300	100/300	10/1	0.2	10/1	300	70/250	10/1	BSS70/
FMMT2222A	40	600	300	100/300	150/10	0.3	150/15	300†	35/285	150/15	FMMT29
FMMT2222	30	600	300	100/300	150/10	0.4	150/15	250†	35/285	150/15	FMMT29
FMMT2369A	15	200	200	40/120	10/1	0.25	10/1	–	12/18	10/3/1.5	–
FMMT2369	15	200	200	40/120	10/1	0.2	10/1	–	12/18	10/3/1.5	–
BSV52/52R	12	200	200	40/120	10/1	0.25	10/1	400	12/18	10/13	–

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

PNP SWITCHING

Type	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 $I_C = 10mA$ MHz(min)	Switching Times t_{on}/t_{off} ns(max)	at $I_C/I_{B1}I_{B2}$ mA	Complen
FMMT2907A	60	600	300	100/300	150/10	0.4	150/15	200†	50/110	150/15	FMMT22
FMMT2907	40	600	300	100/300	150/10	0.4	150/15	200†	50/110	150/15	FMMT22
BSS69/69R	40	200	300	50/150	10/1	0.25	10/1	200	70/260	10/1	BSS66/6
BSS70/70R	40	200	300	100/300	10/1	0.25	10/1	250	70/300	10/1	BSS67/6
BSS65/65R	12	200	200	40/150	30/0.5	0.25	30/3	400	60/90	30/1.5	–

*Device mounted on 10 × 8 × 0.6mm ceramic substrate.
†Min at $I_C = 50mA$, $V_{CE} = 20V$, f = 100MHz.

SOT-23 TRANSISTORS

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 $I_C = 20mA$ MHz(min)	Noise Figure at $I_C = 0.2mA$ 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
BCX19/19R	50	45	1000	350	100/600	100/1	0.62	500/50	200†	–	BCX17/17R
BCX20/20R	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 $I_C = 10mA$, $V_{CE} = 2V$, $f = 100MHz$

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 $I_C = 20mA$ MHz(min)	Noise Figure at $I_C = 0.2mA$ 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
BCX17/17R	50	45	1000	350	100/600	100/1	0.62	500/50	100†	–	BCX19/19R
BCX18/18R	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 $I_C = 10mA$, $V_{CE} = 2V$, $f = 100MHz$.

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	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	300	300	20K	10/5	100	15

*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	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	500	350	40/–	10/10	0.5	20/2.0	0.1	200	FMMTA92
FMMTA43	200	200	500	350	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	500	350	40/–	10/10	0.5	20/2.0	0.25	200	FMMTA42
FMMTA93	200	200	500	350	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

NPN HIGH FREQUENCY

Type	V_{CBO} V	V_{CEO} V	I_C mA	P_{tot}* mW	h_{FE} min/max	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
BFS17/17R	25	15	50	200	20/150	2/1	1000	2	0.65	5.0	1.5	10
BFS20/20R	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 BFS17 and 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	Maximum Ratings V_R Volts	$I_{F(AV)}$ mA	I_{FRM} mA	Max. I_R at V_R μA	Max. V_F at $I_F = 50mA$ Volts	Max. Reverse Recovery Time × ns
BAS16	Single diode	75	100	200	1.0	1.1	6
FMMD914	Single diode	75	75	225	—	1.0†	4
HD3A	Single diode	75	100	225	1.0	1.0†	6
BAV70	Dual diode with common cathode	70	100	200	5.0	1.1	6
BAV74	Dual diode with common cathode	50	150	200	0.1	1.0*	4
HD2A	Dual diode with common cathode	75	100	200	1.0	1.0†	6
BAV99	Dual diode with series connection	70	100	200	2.5	1.1	6
BAW56	Dual diode with common anode	70	100	200	2.5	1.1	6
HD4A	Dual diode with common anode	75	100	200	1.0	1.0†	6

*$I_F = 100mA$ †$I_F = 10mA$ × t_{rr} at $I_F = 10mA$, $V_R = 1V$, $R_L = 100\Omega$, $I_R = 1mA$.

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.

Type	$V_{(BR)}$ min. at V	I_R µA	C_T at V_R min. pF	max. pF	V	Capacitance Ratio min.	max.	Q min. at V_R/f	V/MHz
FMMD109	30	0.1	26	32	3	5.0	6.5	280	3/50
FMMD3102	30	0.1	20	25	3	4.5	–	300	3/50

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 ±5% add suffix B to the device type number.

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
ZC2810E	410	20	100	15	35	1.2
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. $\Delta C = 0.2pF$, $V_R = 0V$

ZC2810 – ZC2811
Max. $\Delta V = 20mV$, $I_F = 1$ to $10mA$
Max. $\Delta C = 0.2pF$, $V_R = 0V$

MICRO-E PLASTIC ENCAPSULATED SEMICONDUCTORS

Ferranti Micro-E components are designed specifically for use in thin and thick film hybrid circuits where the use of a small encapsulated device of proven reliability, together with a guaranteed specification, offers advantages over the use of silicon dice or the larger conventional plastic packages.

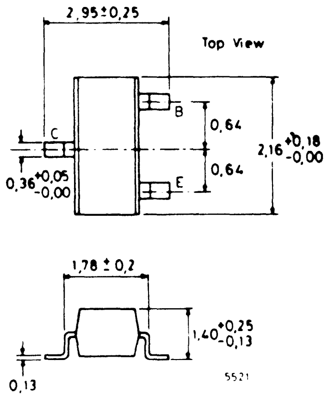
Ferranti have been successful in achieving the standards of quality and reliability necessary for the release of Micro-E components to the appropriate British Standards Specification for electronic components of assessed quality. B.S. approved Micro-E components are available to category P.*

Further information regarding BS9300 and Micro-E reliability is available on request.

*B.S. references—page H12.

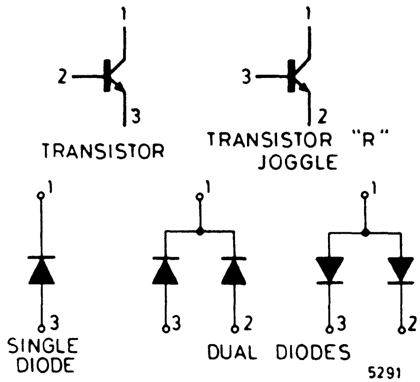
MICRO-E PACKAGE OUTLINE

TRANSISTOR



Dimensions in millimetres

PIN CONNECTIONS



Devices are supplied in a plastic carrier bearing the full type number. The device body is stamped with a letter and a number according to the table on page H12.

MAXIMUM THERMAL RATINGS

*Dissipation (All types except BFS42, 43, 44, 45)	550mW
*Dissipation (BFS42, 43, 44, 45)	710mW
Junction Temperature	+175°C
Operating and Storage Temperature	−55°C to +175°C
Lead Temperature (t<10sec)	240°C

*This rating is calculated by assuming that the external resistances are negligible compared with the internal thermal resistances (e.g. the device is mounted on a large substrate and encapsulated). Derate linearly to zero +175°C.

MICRO-E

MICRO-E PRODUCT LIST

Where approval for military use has been obtained the appropriate British Standards number is indicated under B.S. number.

Transistors					Diodes			
Type	Device marking	Nearest metal can or E-line equivalent	B.S. number*	Page	Type	Device marking	BS/CECC number	Page
BFS36	L1	2N930	BS9365 F014	13	BAW63	D1	BS9302 F001*	15
BFS36A	L2	2N929	BS9365 F013	13	BAW63A	D2	BS9302 F002*	15
BFS37	L3	2N2605	BS9365 F026	13	BAW63B	D3	BS9302 F003*	15
BFS37A	L4	2N2604	BS9365 F025	13	BAW64	D4	BS9302 F004*	15
BFS38	C2	ZT82	BS9365 F016	13	BAW65	D5	BS9302 F005*	15
BFS38A	C1	ZT80	BS9365 F015	13	BAW66	D6	BS9302 F006*	15
BFS39	C3	ZT83	BS9365 F017	13	BAW67	D7	BS9302 F007*	15
BFS40	C5	ZT182	BS9365 F021	13	BAW68	D8	BS9302 F008*	15
BFS40A	C4	ZT180	BS9365 F020	13	BZX88-C2V7	W4		15
BFS41	C6	ZT183	BS9365 F022	13	BZX88-C3V0	W5		15
BFS42	P1	ZT93	BS9365 F018	13	BZX88-C3V3	W6		15
BFS43	P2	ZT90	BS9365 F019	13	BZX88-C3V6	W7		15
BFS44	P3	ZT210	BS9365 F023	13	BZX88-C3V9	W8		15
BFS45	P4	ZT211	BS9365 F024	13	BZX88-C4V3	W9		15
BFS46	H1	2N918	BS9365 F047	14	BZX88-C4V7	Z1		15
BFS46A	H2	ZTX321	BS9365 F048	14	BZX88-C5V1	Z2		15
BFS85	H3	ZTX326	BS9365 F045	14	BZX88-C5V6	Z3		15
BFS88	H4	BFY90	BS9365 F046	14	BZX88-C6V2	Z4		15
BFT27	L5	2N2484		13	BZX88-C6V8	Z5		15
BSS47	L6	ZTX342	BS9365 F027	13	BZX88-C7V5	Z6		15
BSS56	L7	ZTX341		13	BZX88-C8V2	Z7		15
BSV35	S2	2N2369	BS9365 F037	14	BZX88-C9V1	Z8		15
BSV35A	S1	2N708	BS9365 F036	14	BZX88-C10	Z9		15
BSV36	S3	2N2475	BS9365 F038	14	BZX88-C11	Y1		15
BSV37	S4	2N2894	BS9365 F039	14	BZX88-C12	Y2		15
					BZX88-C13	Y3		15
					BZX88-C15	Y4		15
					BZX88-C16	Y5		15
					BZX88-C18	Y6		15
					BZX88-C20	Y7		15
					BZX88-C22	Y8		15
					BZX88-C24	Y9		15
					BZX88-C27	X1		15
					BZX88-C30	X2		15
					BZX88-C33	X3		15
					BZX88-C36	X4		15
					BZX88-C39	X5		15
					BZX88-C43	X6		15
					BZX88-C47	X7		15

*Category P.

SILICON PLANAR LOW-LEVEL TRANSISTORS

Designed for low level amplification and low noise applications
Ratings and Characteristics at 25°C ambient temperature

Type	Maximum Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	h_{FE} Min.	Max.	at I_C mA	and V_{CE} Volts	$V_{CE(sat)}$ at I_C = 10mA I_B = 0.5mA Volts (max.)	F_T at I_C = 0.5mA MHz (min.)	Noise Figure (N) at I_C = 0.1mA F = 1kHz dB (max.)
n-p-n										
BFT27	60	60	500	100	500	0.01	5	0.35*	30	4
BFS36	45	45	500	100	300	0.01	5	1.0	30	4
BFS36A	30	30	500	100	400	0.10	5	1.0	30	4
p-n-p										
BFS37	45	45	500	100	300	0.01	5	1.0	30	4
BFS37A	30	30	500	100	400	0.10	5	1.0	30	4

*I_C = 1mA, I_B = 100μA.

SILICON PLANAR GENERAL-PURPOSE TRANSISTORS

Designed for medium current, medium power applications
Ratings and Characteristics at 25°C ambient temperature

Type	Maximum Ratings V_{CBO} Volts	V_{CEO} Volts	I_C Amps	h_{FE} Min.	Max.	at I_C mA	and V_{CE} Volts	$V_{CE(sat)}$ Volts (max.)	at I_C mA	and I_B mA	f_T MHz (min.)	at I_C mA
n-p-n												
BFS38	45	35	0.5	100	300	10	6	0.25	50	5	150	10
				50	—	50	6					
BFS38A	25	25	0.5	50	300	10	6	0.35	10	1	150	10
BFS39	60	45	0.5	40	120	10	6	0.25	50	5	150	10
BFS42	60	30	1.0	40	120	150	10*	0.4	150	15*	60	50
				15	—	500	10*					
BFS43	60	60	1.0	60	200	150	10*	0.4	150	15*	60	50
				25	—	500	10*					
p-n-p												
BFS40	45	35	0.5	100	300	10	6	0.25	50	5	150	10
				50	—	50	6					
BFS40A	25	25	0.5	50	300	10	6	0.35	10	1	150	10
BFS41	45	45	0.5	40	120	10	6	0.25	50	5	150	10
BFS44	60	30	1.0	40	120	150	10*	0.4	150	15*	60	50
				15	—	500	10*					
BFS45	60	60	1.0	60	200	150	10*	0.4	150	15*	60	50
				25	—	500	10*					

*Measured under pulsed conditions

SILICON PLANAR HIGH-VOLTAGE TRANSISTORS (n-p-n)

Designed for driving numerical indicator tubes, neon lamps and other high voltage applications
Ratings and Characteristics at 25°C ambient temperature

Type	Maximum Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	h_{FE} Min.	at I_C mA	and V_{CE} Volts	$V_{CE(sat)}$ Volts (max.)	at I_C mA	and I_B mA	I_{CER} μA (max.)	at V_{CE} Volts
BSS47	120	120	500	30	2	1	0.5	2	0.1	0.5	100
BSS56	100	100	500	30	2	1	0.5	2	0.1	0.5	80

MICRO-E

SILICON PLANAR HIGH-SPEED SWITCHING TRANSISTORS

Designed for high-speed switching and high frequency amplifier applications

Ratings and Characteristics at 25°C ambient temperature

Type	Maximum Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	h_{FE} Min.	Max.	at I_C mA	and V_{CE} Volts	$V_{CE(sat)}$ at $I_C = 10mA$ $I_B = 1mA$ Volts (max.)	f_T MHz (min.)	at I_C mA	Switching Characteristics t_{on} ns (max.)	t_{off} ns (max.)	at I_C mA	and I_{B1} mA	I_{B2} mA
n-p-n															
BSV35	40	15	500	40	120	10	1.0	0.24	500	10	12	18	10	3	1.5
BSV35A	25	12	500	20	–	10	1.0	0.6	300	10	40	75	10	3	1.5
BSV36	15	6	500	30	150	20	0.4	0.25	600	20	20	15	10	3	1.5
p-n-p															
BSV37	12	12	500	40	150	30	0.5	0.15	400	30	60	90	30	1.5	1.5

SILICON PLANAR VHF and UHF TRANSISTORS (n-p-n)

Designed for high-frequency operation. Application areas include amplifiers, switches and oscillators

Ratings and Characteristics at 25°C ambient temperature

Type	Maximum Ratings V_{CBO} Volts	V_{CEO} Volts	I_C mA	h_{FE} at $V_{CE} = 1V$ Min.	Max.	at I_C mA	f_T MHz (min.)	at I_C mA	C_{ob} at f = 1MHz $V_{CB} = 10V$ pF (max.)	RF Power Output or Power Gain dB	mW	at f MHz	Noise Figure (N) dB (max.)	at I_C mA	and MHz
BFS46	30	15	500	20	–	3	600	4	1.7	15	–	200	6	1	60
BFS46A	30	15	500	20	–	3	600	4	1.7	15	–	200	6	1	60
BFS85	25	12	50	25	150	2	1000	2	1.5	–	175	500	6	2	500
BFS88	30	12	50	25	150	2	1300	25	1.5	–	175	500	5	2	500

SILICON PLANAR HIGH-SPEED SWITCHING DIODES

Ratings and Characteristics at 25°C ambient temperature

Type	Description	Max. V_{RWM} Volts	Max. Forward Current per diode mA	Max. Forward Current per common lead* mA	Max. I_R at V_{RWM} μA	Max. V_F at $I_F = 10mA$ Volts	Max. Reverse Recovery Time t_{rr}† at $I_F = 10mA$, $V_R = 5V$, $R_L = 50\Omega$ ns
BAW63	Single diode	60	200	–	1.0	0.9	4
BAW63A	Single diode	30	200	–	1.0	0.9	4
BAW63B	Single diode	15	200	–	1.0	0.9	4
BAW64	Common cathode diode pair	60	200	250	1.0	0.9	4
BAW65	Common cathode diode pair	30	200	250	1.0	0.9	4
BAW66	Common anode diode pair	30	200	250	1.0	0.9	4
BAW67	Common cathode diode pair	15	200	250	1.0	0.9	4
BAW68	Common anode diode pair	15	200	250	1.0	0.9	4

*Based on maximum dissipation. †Time to recover to 10% of I_R peak.

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.	Slope 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
BZX88-C2V7	2.7	2.5	2.9	120	−0.07	20.0	1
BZX88-C3V0	3.0	2.8	3.2	120	−0.07	10.0	1
BZX88-C3V3	3.3	3.1	3.5	110	−0.06	5.0	1
BZX88-C3V6	3.6	3.4	3.8	105	−0.07	5.0	1
BZX88-C3V9	3.9	3.7	4.1	100	−0.055	3.0	1
BZX88-C4V3	4.3	4.0	4.6	90	−0.045	3.0	1
BZX88-C4V7	4.7	4.4	5.0	80	−0.025	3.0	2
BZX88-C5V1	5.1	4.8	5.4	60	+0.02	2.0	2
BZX88-C5V6	5.6	5.2	6.0	40	+0.03	1.0	2
BZX88-C6V2	6.2	5.8	6.6	10	+0.04	3.0	4
BZX88-C6V8	6.8	6.4	7.2	15	+0.045	2.0	4
BZX88-C7V5	7.5	7.0	7.9	15	+0.05	1.0	5
BZX88-C8V2	8.2	7.7	8.7	15	+0.055	0.7	5
BZX88-C9V1	9.1	8.5	9.6	15	+0.06	0.5	6
BZX88-C10	10	9.4	10.6	20	+0.065	0.2	7
BZX88-C11	11	10.4	11.6	20	+0.07	0.1	8
BZX88-C12	12	11.4	12.7	25	+0.075	0.1	8
BZX88-C13	13	12.4	14.1	30	+0.075	0.1	9
BZX88-C15	15	13.8	15.6	30	+0.075	0.05	10
BZX88-C16	16	15.3	17.1	40	+0.08	0.05	11
BZX88-C18	18	16.8	19.1	45	+0.08	0.05	13
BZX88-C20	20	18.8	21.2	55	+0.08	0.05	14
BZX88-C22	22	20.8	23.3	55	+0.08	0.05	15
BZX88-C24	24	22.8	25.6	70	+0.08	0.05	17
	$I_Z = 2mA$			$I_Z = 2mA$	$I_Z = 2mA$	$I_Z = 2mA$	
BZX88-C27	27	25.1	28.9	80	+0.08	0.05	19
BZX88-C30	30	28	32	80	+0.08	0.05	21
BZX88-C33	33	31	35	80	+0.08	0.05	23
BZX88-C36	36	34	38	90	+0.08	0.05	25
BZX88-C39	39	37	41	130	+0.08	0.05	27
BZX88-C43	43	40	46	150	+0.08	0.05	30
BZX88-C47	47	44	50	170	+0.08	0.05	32

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 British Standards specification BS9300 C479

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

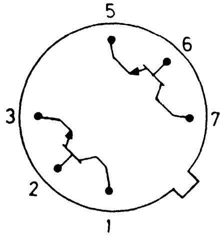
*Measured under pulsed conditions

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 $\mu V/°C$
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

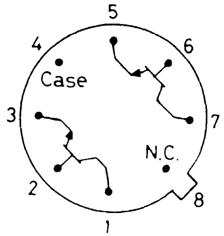
Pin Configuration

2N2060, 2N2223, 2N2223A

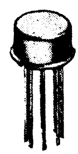


6 Lead TO-5 Pins 4 and 8 omitted
All leads electrically isolated from case.

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.

- FF3725J Approval British Standards/CECC Specification 50004 019(F)

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
FF3725E FF3725J	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 V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_D* mW	h_{FE} min/max	at I_C mA	max $V_{CE(sat)}$ Volts	at I_C mA	min f_T 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
FF3725E	60	40	500	600	35/200	100	0.3	100	250	50.0
FF3725J	60	40	1500	750	35/250	100	0.26	100	325†	50.0

*Power dissipation per transistor. †Typical

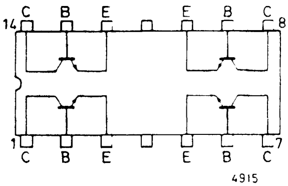
Pin configurations overleaf.

SEMICONDUCTOR NETWORKS

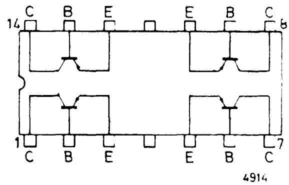
STANDARD PRODUCTS – SILICON PLANAR QUAD TRANSISTORS

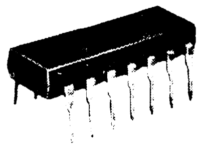
Pin Configuration

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.

- BAT21J Approved to British standards/CECC Specification 50001 014(F)
- BAT22J Approved to British standards/CECC Specification 50001 015(F)
- BAT23H Approved to British standards/CECC Specification 50001 016(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
BAT21	Moulded DIL	60	400	−55 to +150
BAT21J	Ceramic DIL	60	400	−65 to +200
BAT22	Moulded DIL	40	400	−55 to +150
BAT22J	Ceramic DIL	40	400	−65 to +200
BAT23H	Ceramic flat pack	60	300	−65 to +200
BAT24H	Ceramic flat pack	40	300	−65 to +200
BAT25	Moulded DIL	60	400	−55 to +150
BAT26	Moulded DIL	40	400	−55 to +150
BAT27H	Ceramic flat pack	60	300	−65 to +200
BAT28H	Ceramic flat pack	40	300	−65 to +200

Electrical Characteristics

at 25°C ambient temperature (single diode)

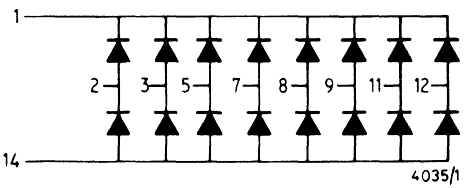
Type	Max. I_R at V_R		Max. V_F at $I_F = 100mA$	Max. Reverse Recovery Time T_{rr}* at $I_F = I_{RM} = 200mA$ $R_L = 100\Omega$
	μA	Volts	Volts	ns
BAT21	0.1	40	1.0	20
BAT21J	0.1	40	1.0	20
BAT22	0.1	25	1.1	20
BAT22J	0.1	25	1.1	20
BAT23H	0.1	40	1.0	20
BAT24H	0.1	25	1.1	20
BAT25	0.1	40	1.0	20
BAT26	0.1	25	1.1	20
BAT27H	0.1	40	1.0	20
BAT28H	0.1	25	1.1	20

*Time to recover to 10% of I_R Peak.

Circuit configurations

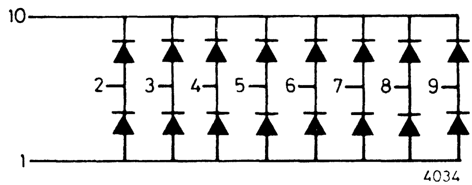
BAT21, BAT22/BAT21J, BAT22J

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



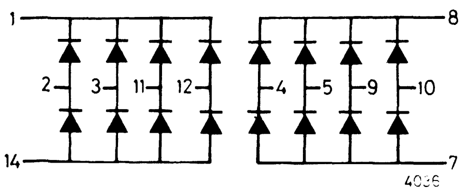
BAT23H, BAT24H

10 lead flat-pack



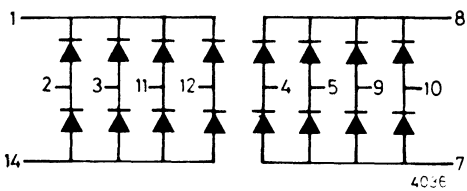
BAT25, BAT26

14 lead DIL
leads 6 and 13 not connected



BAT27H, BAT28H

14 lead 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.

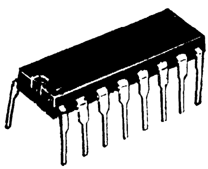
RELIABILITY AND TESTING

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.

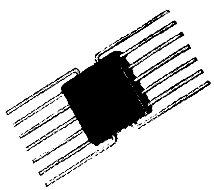
SPECIFICATION

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

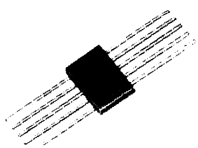
- **Package outline**
- **Pinning preference**
- **Temperature and dissipation requirements**
- **Ferranti device type numbers, if known**
- **Additional environmental requirements or tests**



16 Lead DIL



14 Lead 6.35mm × 6.35mm Ceramic Flat Pack



10 Lead 6.35mm × 4.44mm Ceramic Flat Pack

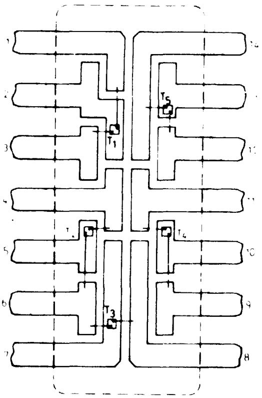
SEMICONDUCTOR NETWORKS

TYPICAL CUSTOM DESIGNED NETWORKS

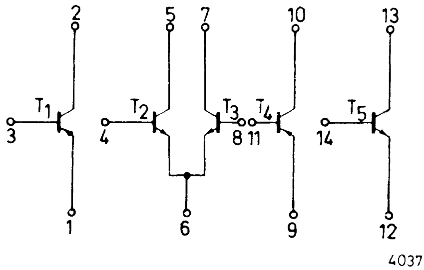
The following diagrams depict typical network layouts and associated circuitry. In each case the lead frame is designed to key with the encapsulant and to give maximum rigidity to the pins. Unused pins are designed out unless otherwise specified.

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.**

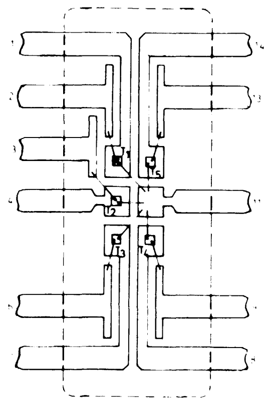


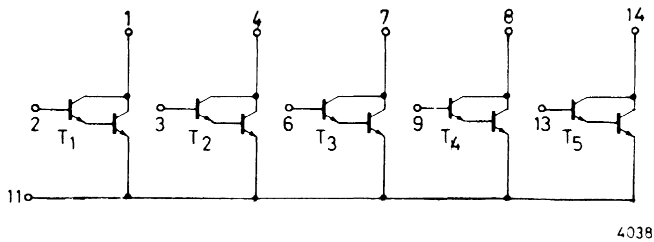
T_2 T_3 and T_5 are n-p-n transistors
T_1 and T_4 are p-n-p transistors



Circuit diagram.

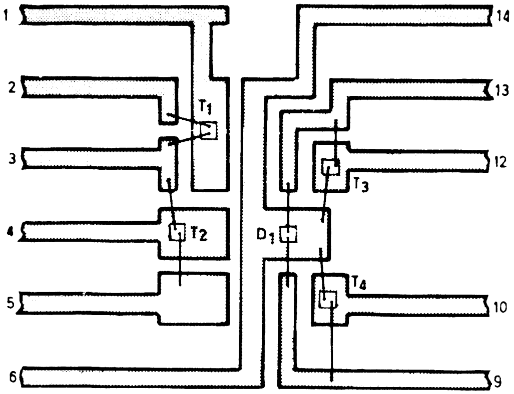
Circuit 2 – **An array of 5 monolithic darlington pairs encapsulated in modified 14 lead D.I.L.**

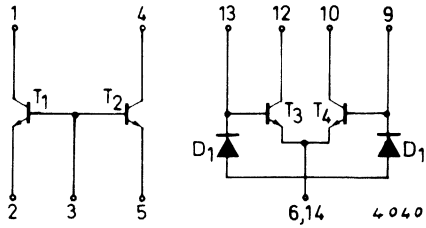




T_1 to T_5 are monolithic darlington pairs.

Circuit 3 – **A transistor and diode array encapsulated in modified 14 lead ceramic flat-pack (6.35 mm × 6.35 mm)**

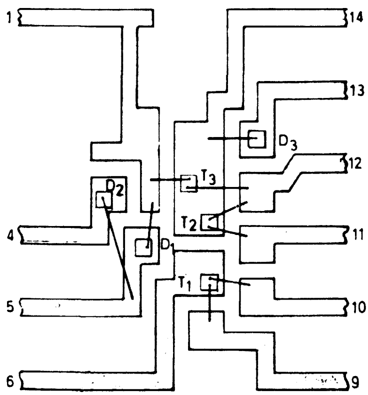


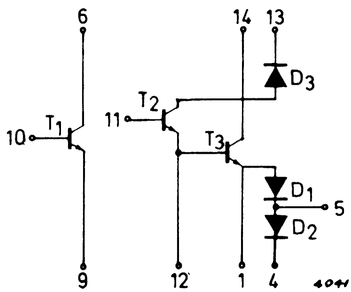


T_1 to T_4 are n-p-n transistors
D_1 is a dual diode common anode.

Circuit diagram.

Circuit 4 – **A transistor and diode array encapsulated in modified 14 lead ceramic flat-pack (6.35 mm × 4.44 mm)**





T_1 to T_3 are n-p-n transistors
D_1 to D_3 are diodes.

Circuit diagram.

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 = 1MHz	550MHz $I_C = 5mA$ $V_{CE} = 10V$ f = 100MHZ	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 = 10.7MHz	400MHz $I_C = 4mA$ $V_{CE} = 10V$ f = 100MHz	E-line (TO-92 style)
BF197P§	40	25	4.0	25	0.3pF $I_C = 1mA$ $V_{CE} = 10V$ f = 10.7MHz	550MHz $I_C = 5mA$ $V_{CE} = 10V$ f = 100MHz	E-line (TO-92 style)

*Suffix R denotes reversed base and emitter lead connections. †BF196P Device has AGC characteristics.
§Pin connections for these devices are: c-e-b.

TABLE 2 : LOW NOISE VHF/UHF TRANSISTORS

Many of the devices in this table are available tested to BS9365 and are widely used in modern military applications.

Type	V_{CBO} Volts Max.	V_{CEO} Volts Max.	V_{EBO} Volts Max.	Noise Figure Max.	R.F. Power Output Min.	Package
BFY90	30	15	2.5	5dB at 500MHz	175mW at 500MHz	TO-72
ZTX325	30	15	2.5	$R_S = 50\Omega$	$P_{in} = 25mW$	E-line†
BFS88	30	15	2.5	$V_{CE} = 5.0V$	$V_{CE} = 13.5V$	μE†
				$I_C = 2.0mA$		
ZTX326	25	12	2.5	6dB at 500MHz	$G_P = 10dB$ min.	E-line†
ZTX326A§	25	12	2.5	$R_S = 50\Omega$	$f = 500MHz$	E-line†
BFS85	25	12	2.5	$V_{CE} = 5.0V$	$I_C = 15mA$	μE†
BFX89	30	15	2.5	$I_C = 2.0mA$	$V_{CE} = 5V$	TO-72
BFS17	25	15	2.5	4.5dB at 500MHz	$G_P = 10dB$ min.	SOT-23†
				$R_S = 50\Omega$	$f = 500MHz$	
BFS17R*	25	15	2.5	$V_{CE} = 5.0V$	$I_C = 15mA$	
				$I_C = 2.0mA$	$V_{CE} = 5V$	

*Suffix R denotes reversed base and emitter lead connections. †denotes Plastic Encapsulation.
§High Gain device, $h_{FE} = 100$ to 250.

TABLE 3 : R.F. TRANSISTORS UP TO 1 WATT

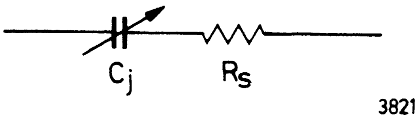
Suitable for drivers and general purpose RF amplifiers.

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
ZTX3866	55	30	28.0	0.7	8.5	400	E-line
2N4427	40	20	12.0	1.0	10.0	175	TO-39
ZTX4427	40	20	12.0	1.0	10.0	175	E-line

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.

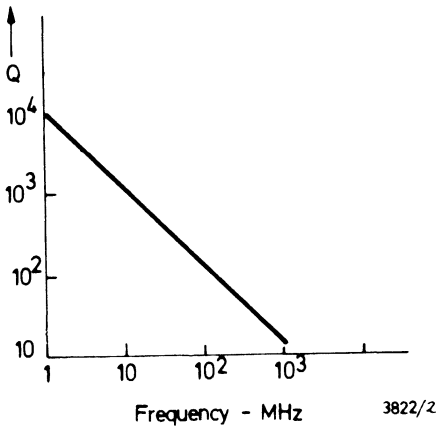


Fig. 2 – Variation of Q with frequency

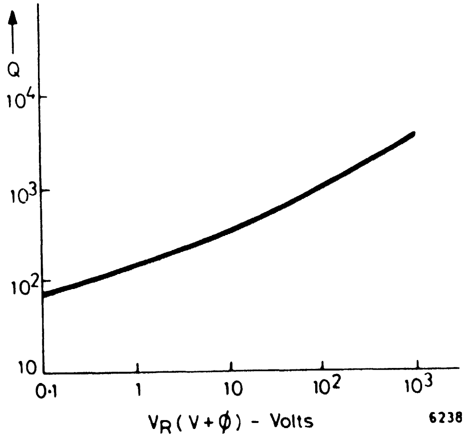


Fig. 3 – Variation of Q with bias voltage

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 $C \alpha \frac{1}{V^N}$

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.

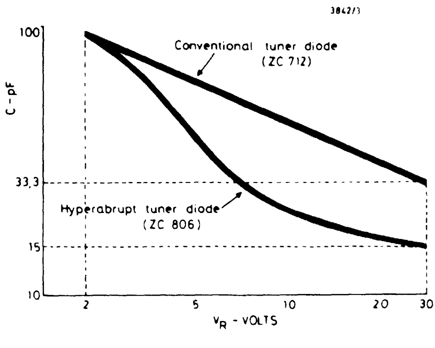


Fig. 4
Comparison of the C/V relationships of the Hyperabrupt and a conventional tuner diode.

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 4 : 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 = 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

ZC100 Series

Designed for L-Band electronic tuning applications.

Type	V_R(volts) Max.	Capacitance 1 MHz		Capacitance Measurement Test Voltage V_R(volts)	Capacitance Ratio		Package
		pF Min.	pF Max.				
ZC101	20	24	30	4	1.43	C_4/C_{10}	E-line
ZC102	20	30	37	4	1.43	C_4/C_{10}	E-line
ZC110	30	27	31	3	2.65	C_3/C_{30}	E-line
ZC111	30	29	33	3	2.65	C_3/C_{30}	E-line
ZC150	25	44	51	2	2.65	C_2/C_{25}	E-line
ZC151	25	49	56	2	2.65	C_2/C_{25}	E-line

TABLE 5 : 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	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.

CHARACTERISTICS (at 25°C ambient temperature).

Type		Nominal Capacitance in pF V_R = 2V, f = 1MHz			Minimum Q at V_R = 3V f = 50MHz	Capacitance Ratio C_2/C_{20}, f = 1MHz	
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 = 0.02μA at V_R = 20V

To order devices with 2V nominal capacity ± 10% add suffix A

± 5% add suffix B

continued

VARIABLE CAPACITANCE TUNER DIODES
(HYPERABRUPT TYPE)

CHARACTERISTICS *(Continued)*

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	
SOT-23	Min.	Nom.	Max.		Min.	Max.
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 ± 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.

HIGH PERFORMANCE TYPES

These types offer a higher reverse voltage, and a low reverse leakage current.

Symbol		V_{BR}	I_R	C_T		T_R		Q
Parameter		Reverse breakdown voltage	Reverse leakage current	Diode capacitance		Capacitance ratio		Figure of merit
Unit		V	μA	pF				
Conditions		$I_R = 10\mu A$	$V_R = 25V$	$V_R = 3V$ f = 1 MHz		C_{3V}/C_{25V} f = 1 MHz		$V_R = 3V$ f = 50 MHz
Package	Type	Min.	Max.	Min.	Max.	Min.	Max.	Min.
E-line	**ZC209**	30	0.1*	26	32	5.0	6.5	200
E-line	**ZC3102**	30	0.1*	20	25	4.5	–	300
SOT-23	**FMMD109**	30	0.1*	26	32	5.0	6.5	280
SOT-23	**FMMD3102**	30	0.1*	26	25	4.5	–	300

*at $V_R = 28V$

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.

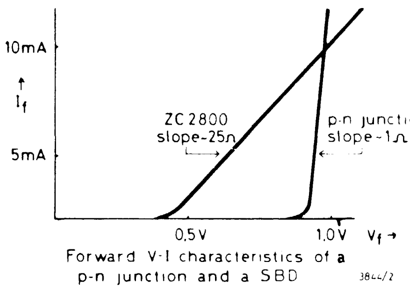


Fig. 5

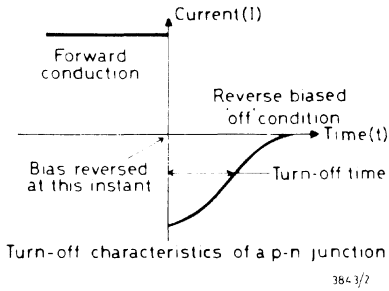


Fig. 6

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 6 : 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)
DO-35 AXIAL GLASS (BS approved)
SOT-23 MICROMINIATURE

ABSOLUTE MAXIMUM RATINGS (DO-35, 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.
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. $\Delta C = 0.2pF$, $V_R = 0V$

SCHOTTKY BARRIER DIODES

CHARACTERISTICS (at 25°C ambient temperature) DO–35, 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

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.

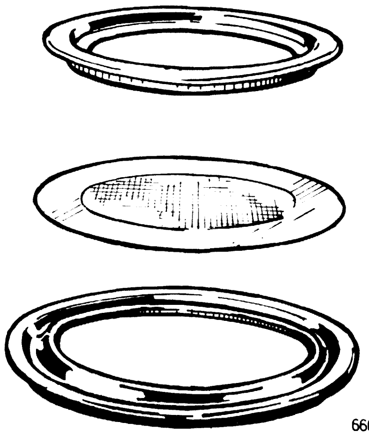
   Probed slices or wafers are tested to the major d.c. parameters for discrete devices and functional for integrated circuits, rejects being automatically inked. In both cases unscribed slices or wafers are shipped in specially designed plastic boxes offering the highest degree of protection and preventing 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



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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'

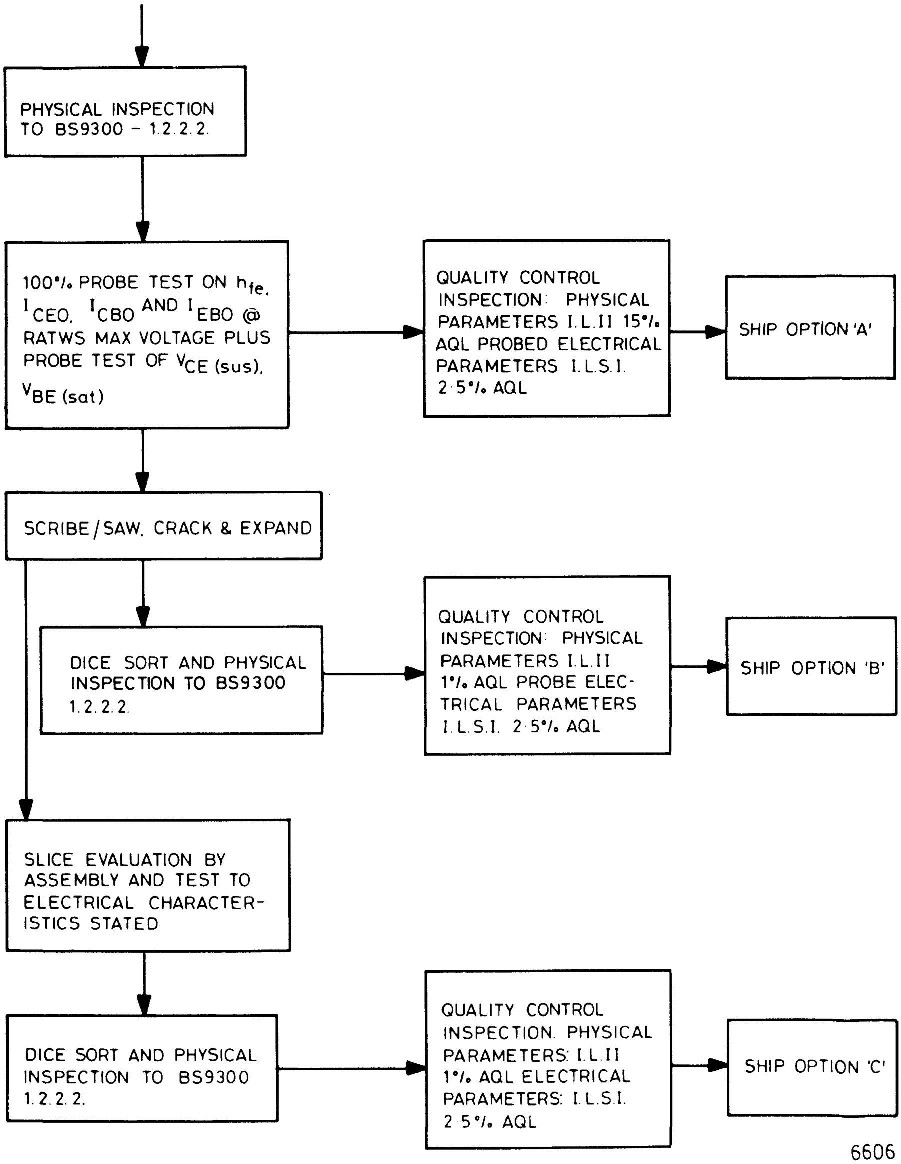
Any Release Note requirement should be quoted.

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.

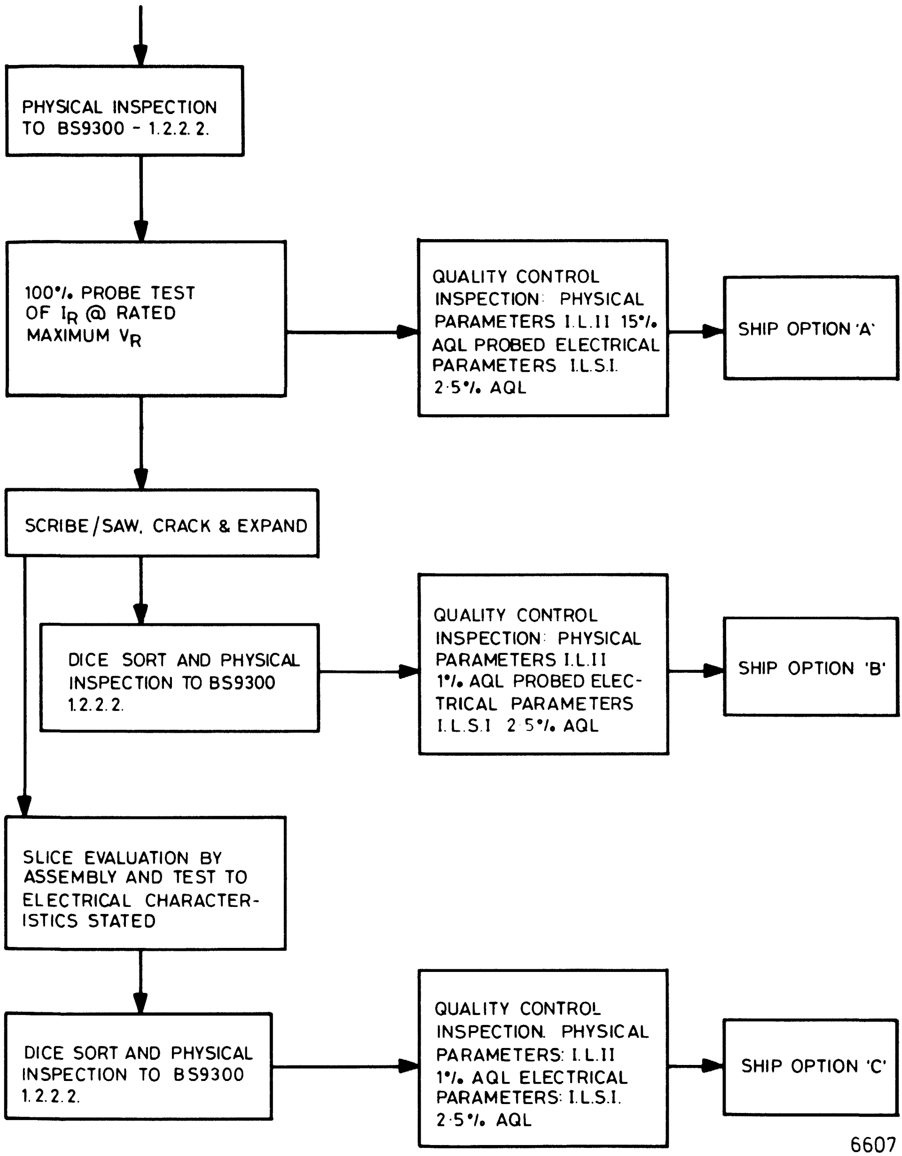
PROCESS CHARTS

(a) TRANSISTOR DICE PROCESS CHART

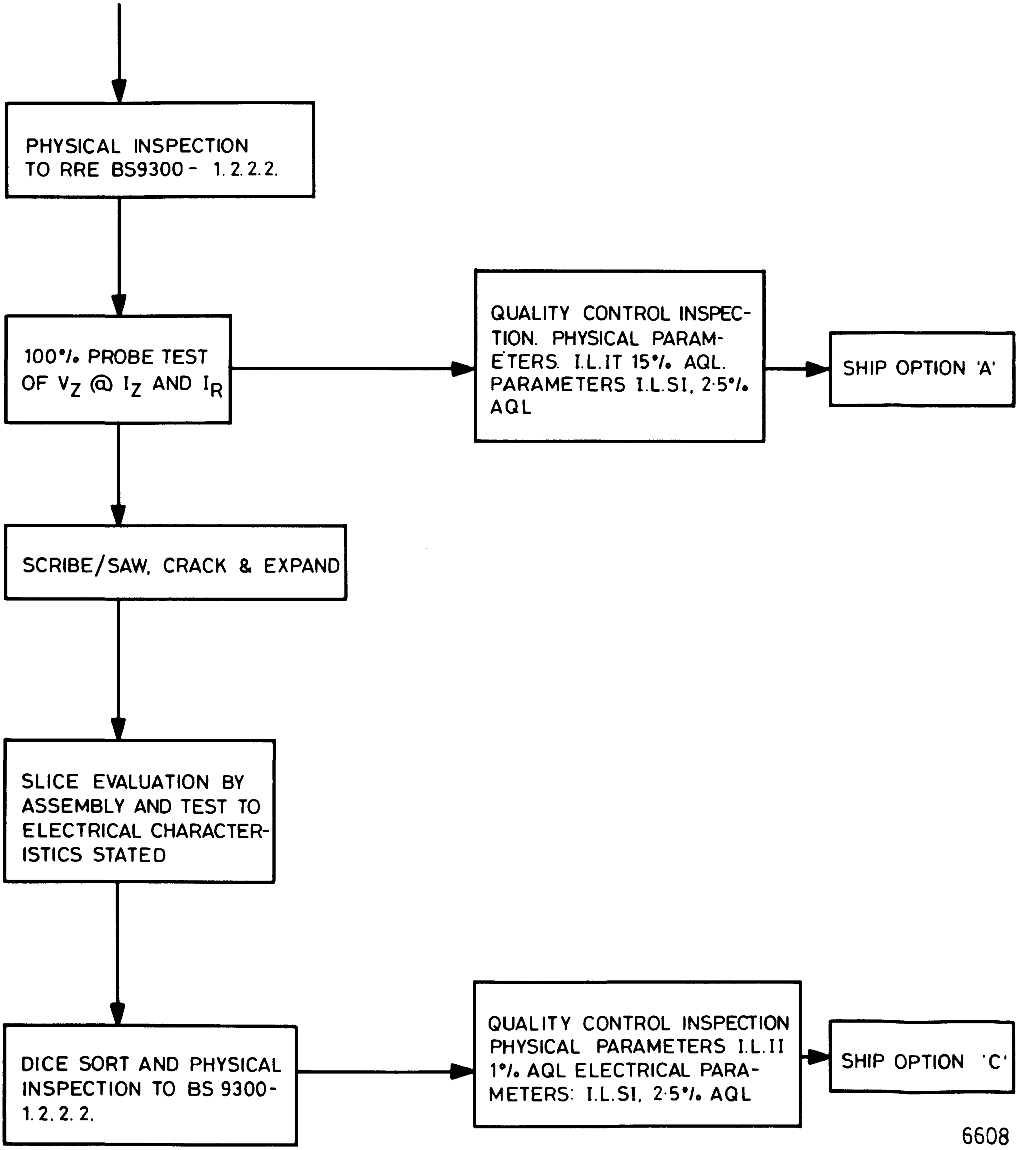


6606

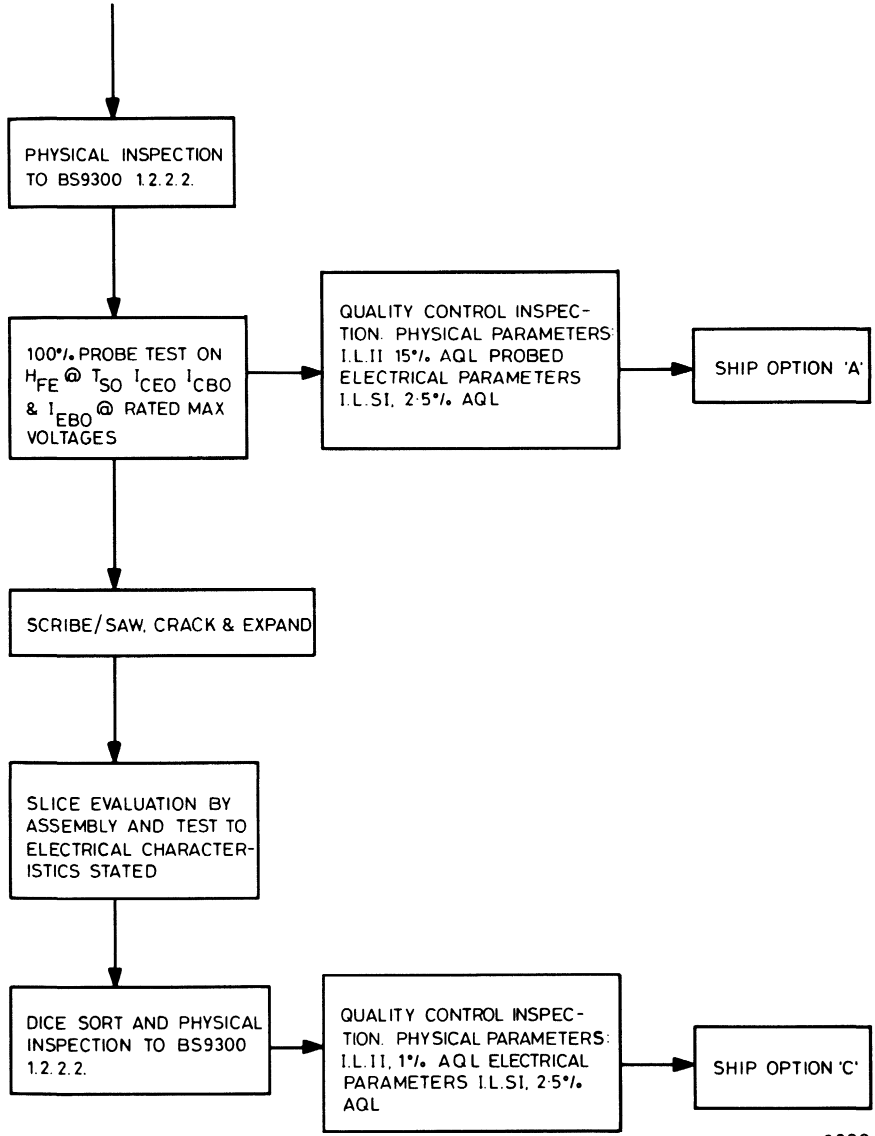
(b) GENERAL PURPOSE DIODE PROCESS CHART



(c) REFERENCE DIODE PROCESS CHART

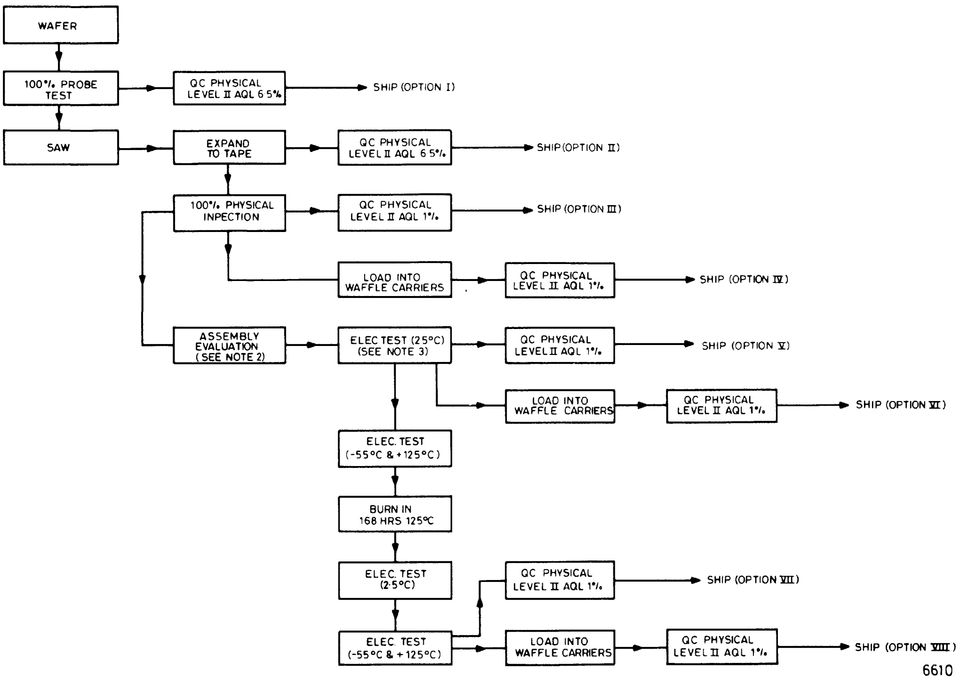


(d) PHOTO TRANSISTOR DICE PROCESS CHART



6609

(e) INTEGRATED CIRCUIT DICE PROCESS CHART



NOTE 1 All physical inspection in accordance with BS9400 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	G5
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	G5
2N3905	40	40	50†	30†	40	–	1	1	0.25	10	1.0	200	4.5	G5
2N3906	40	40	50†	30†	80	–	1	1	0.25	10	1.0	250	4.5	G5
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	G5
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	G4
BC182	60	50	15	50	100	480	2	5	0.25	10	0.5	150	5	G3
2N3903	60	40	50†	30†	50	150	10	1	0.2	10	1.0	250	4	G5
2N3904	60	40	50†	30†	100	300	10	1	0.2	10	1.0	300	4	G5
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	G3
BC550C	50	45	15	30	420	800	2	5	0.25	10	0.5	300§	4.5	G3
BCY59A	45	45	10*	45*	120	220	2	5	0.35	10	0.25	125	6	G4
BCY59B	45	45	10*	45*	180	310	2	5	0.35	10	0.25	125	6	G4
BCY59C	45	45	10*	45*	250	460	2	5	0.35	10	0.25	125	6	G4
BCY59D	45	45	10*	45*	380	630	2	5	0.35	10	0.25	125	6	G4
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	G3
BC184	45	30	15	30	250	—	2	5	0.25	10	0.5	150	5	G3
BCY58A	32	32	10*	32*	120	220	2	5	0.35	10	0.25	125	6	G4
BCY58B	32	32	10*	32*	180	310	2	5	0.35	10	0.25	125	6	G4
BCY58C	32	32	10*	32*	250	460	2	5	0.35	10	0.25	125	6	G4
BCY58D	32	32	10*	32*	380	630	2	5	0.35	10	0.25	125	6	G4
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	G3
BC549C	30	30	15	30	420	880	2	5	0.25	10	0.5	300§	4.5	G3
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	–	G19
ZTX453	120	100	100	100	40	200	150	10	0.7	150	15	150	15	G6
ZTX652	100	80	100	80	100	300	500	2	0.5	2000	200	140	–	G19
ZTX452	100	80	100	80	40	150	150	10	0.7	150	15	150	15	G6
MPSA06	80	80	100	80	50	–	100	1	0.25	100	10	100	–	G6
ZTX651	80	60	100	60	100	300	500	2	0.5	2000	200	140	–	G19
ZTX451	80	60	100	60	50	150	150	10	0.35	150	15	150	15	G6
BFY50	80	35	500	80	30	–	150	10	0.1	10	1	60	12	G6
MPSA05	60	60	100	60	50	–	100	1	0.25	100	10	100	–	G6
ZTX650	60	45	100	45	100	300	500	2	0.5	2000	200	140	–	G19
ZTX450	60	45	100	45	100	300	150	10	0.25	150	15	150	15	G6
BFY51	60	30	500	60	40	–	150	10	0.15	10	1	50	12	G6
BC337A	50	45	100*	45	100	250	100	1	0.7	500	50	100	12	G6
BC337B	50	45	100*	45	160	400	100	1	0.7	500	50	100	12	G6
BC337C	50	45	100*	45	250	630	100	1	0.7	500	50	100	12	G6
BFY52	40	20	500	40	60	–	150	10	0.15	10	1	50	12	G6
BC338A	30	25	100*	25	100	250	100	1	0.7	500	50	100§	12§	G6
BC338B	30	25	100*	25	160	400	100	1	0.7	500	50	100§	12§	G6
BC338C	30	25	100*	25	250	630	100	1	0.7	500	50	100§	12§	G6

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	–	G18
ZTX752	100	80	100	80	100	300	500	2	0.5	2000	200	100	–	G18
ZTX552	100	80	100	80	40	150	150	10	0.7	150	15	150	25	G8
MPSA56	80	80	100	80	50	–	100	1	0.25	100	10	100	–	G8
ZTX751	80	60	100	60	100	300	500	2	0.5	2000	200	100	–	G18
ZTX551	80	60	100	60	50	150	150	10	0.35	150	15	150	25	G8
MPSA55	60	60	100	60	50	–	100	1	0.25	100	10	100	–	G8
ZTX750	60	45	100	45	100	300	500	2	0.5	2000	200	100	–	G18
ZTX550	60	45	100	45	100	300	150	10	0.25	150	15	150	25	G8
BC327A	50	45	100*	45	100	250	100	1	0.7	500	50	100§	12§	G8
BC327B	50	45	100*	45	160	400	100	1	0.7	500	50	100§	12§	G8
BC327C	50	45	100*	45	250	630	100	1	0.7	500	50	100§	12§	G8
BC328A	30	25	100*	25	100	250	100	1	0.7	500	50	100§	12§	G8
BC328B	30	25	100*	25	160	400	100	1	0.7	500	50	100§	12§	G8
BC328C	30	25	100*	25	250	630	100	1	0.7	500	50	100§	12§	G8

$V_{CE(sat)}$, 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	G7
2N2219A	75	40	35	285	100	300	150	10	0.3	150	15	300	8	G7
2N2221A	75	40	35	285	40	120	150	10	0.3	150	15	250	8	G7
2N2222A	75	40	35	285	100	300	150	10	0.3	150	15	300	8	G7
2N2218	60	30	35	285	40	120	150	10	0.4	150	15	250	8	G7
2N2219	60	30	35	285	100	300	150	10	0.4	150	15	250	8	G7
2N2221	60	30	35	285	40	120	150	10	0.4	150	15	250	8	G7
2N2222	60	30	35	285	100	300	150	10	0.4	150	15	250	8	G7
2N2369	40	15	12	18	40	120	10	1	0.24	10	1	500	4	G20
2N2369A	40	15	12	18	40	120	10	1	0.2	10	1	500	4	G20

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	G9
2N2907	60	40	45	100	100	300	150	10	0.4	150	15	200	8	G9
2N2894	12	12	60	90	40	150	30	0.5	0.5	100	10	400	6	G10

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	G16
BFY90	30	15	25	2	1	175	500	13.5	1.3	5	G17

$V_{CE(sat)}$, 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§	G13
BUY81	150	60	40	1.0	5	10	7.5	5	1.0	7.5	0.75	60§	G14
BUY82	150	60	40	1.5	5	15	10.0	5	1.0	10.0	1.0	60§	G15

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§	G11
BUY91	100	60	40	1.0	5	15	5.0	5	1.0	5.0	0.5	60§	G12
BUY92	100	60	40	1.0	5	15	7.5	5	1.0	7.5	0.75	60§	G15

$V_{CE(sat)}$ 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	GH
ND3V0	3.0	3.0	3.6	5	120	5	−0.07	5	10	1	GH
ND3V3	3.3	2.9	3.6	5	110	5	−0.06	5	5	1	GH
ND3V6	3.6	3.2	4.0	5	105	5	−0.07	5	5	1	GH
ND3V9	3.9	3.5	4.3	5	100	5	−0.055	5	3	1	GH
ND4V3	4.3	3.9	4.7	5	90	5	−0.045	5	3	1	GH
NC4V7	4.7	4.4	5.0	5	80	5	−0.025	5	3	2	GH
NC5V1	5.1	4.8	5.4	5	60	5	+0.02	5	2	2	GH
NC5V6	5.6	5.2	6.0	5	40	5	+0.03	5	1	2	GH
NC6V2	6.2	5.8	6.6	5	10	5	+0.04	5	3	4	GH
NC6V8	6.8	6.4	7.2	5	15	5	+0.045	5	2	4	GH
NC7V5	7.5	7.0	7.9	5	15	5	+0.05	5	1	5	GH
NC8V2	8.2	7.7	8.7	5	15	5	+0.055	5	0.7	5	GG
NC9V1	9.1	8.5	9.6	5	115	5	+0.06	5	0.5	6	GG
NC10	10	9.4	10.6	5	20	5	+0.065	5	0.2	7	GG
NC11	11	10.4	11.6	5	20	5	+0.07	5	0.1	8	GG
NC12	12	11.4	12.7	5	25	5	+0.075	5	0.1	8	GG
NC13	13	12.4	14.1	5	30	5	+0.075	5	0.1	9	GG
NC15	15	13.8	15.6	5	30	5	+0.075	5	0.05	10	GG
NC16	16	15.3	17.1	5	40	5	+0.08	5	0.05	11	GG
NC18	18	16.8	19.1	5	45	5	+0.08	5	0.05	13	GG
NC20	20	18.8	21.2	5	55	5	+0.08	5	0.05	14	GG
NC22	22	20.8	23.3	5	55	5	+0.08	5	0.05	15	GG
NC24	24	22.8	25.6	5	70	5	+0.08	5	0.05	17	GG
NC27	27	25.1	28.9	2	80	2	+0.08	2	0.05	19	GG
NC30	30	28.0	32.0	2	80	2	+0.08	2	0.05	21	GG
NC33	33	31.0	35.0	2	80	2	+0.08	2	0.05	23	GG
NC36	36	34.0	38.0	2	90	2	+0.08	2	0.05	25	GG
NC39	39	37.0	41.0	2	130	2	+0.08	2	0.05	27	GG
NC43	43	40.0	46.0	2	150	2	+0.08	2	0.05	30	GG
NC47	47	44.0	50.0	2	170	2	+0.08	2	0.05	33	GG

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 BS3494.

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	GA

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	GD

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	GC
FD2B	30	1.2	110	1	30	4	GC
FD2RA	60	1.2	110	1	60	7	GB
FD2RB	30	1.2	110	1	30	7	GB

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	GF
FD4B	35	1	110	1	35	4	GF
FD4RA	50	1	110	1	50	6	GF
FD4RB	35	1	110	1	35	6	GF

*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	GB
LD2RA	100	1.2	200	5	100	GB
LD4A	100	1.2	200	1	100	GE
LD4RA	100	1.2	200	5	100	GE

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	GI
ZM110	35	35	0.025	400*	1200*	5	2	5	GJ
ZM210	35	35	0.10	400*	1200*	5	2	14	GK

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}.

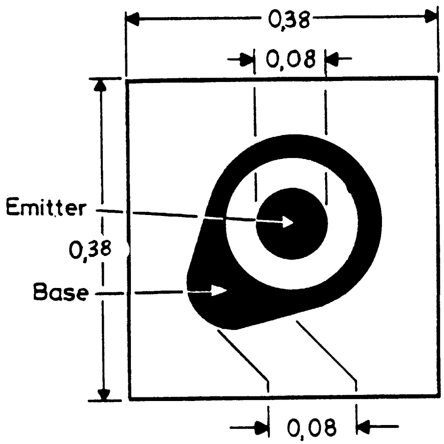
GUARANTEED ELECTRICAL CHARACTERISTICS (BASIC GATE).

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

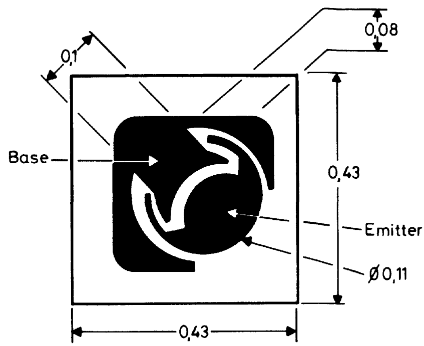
†Typical characteristics are at $V_{CC}=5.0V$, $T_{amb}=25°C$.

DICE GEOMETRIES

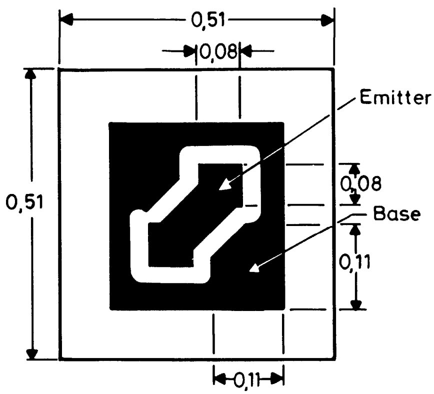
(a) TRANSISTOR GEOMETRIES



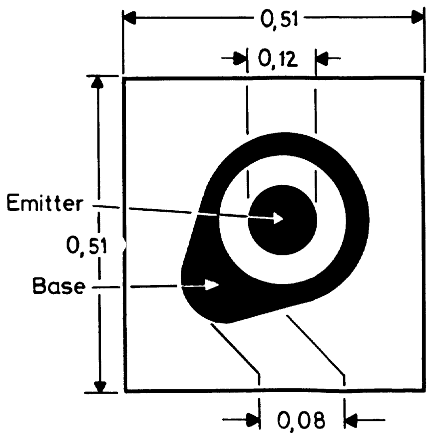
GEOMETRY 1



GEOMETRY 2



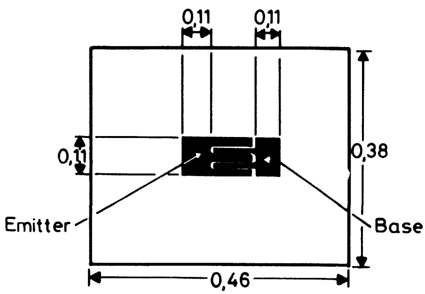
GEOMETRY 3



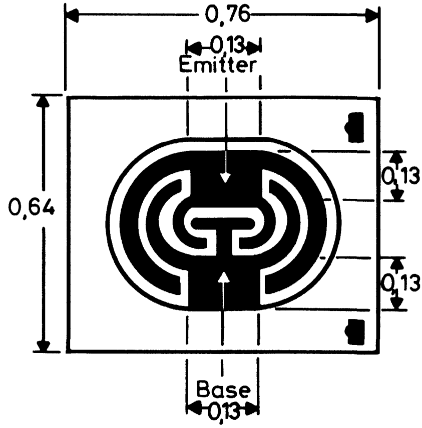
GEOMETRY 4

Dimensions in millimetres

DICE GEOMETRIES



GEOMETRY 5



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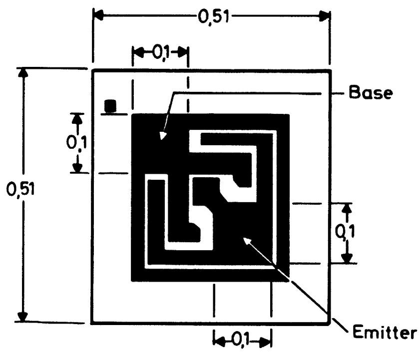
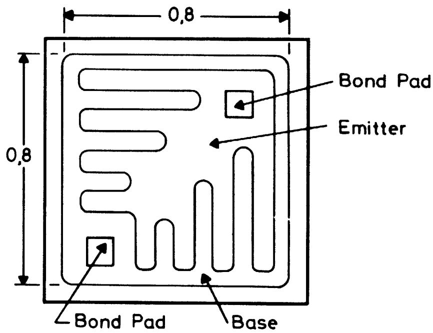


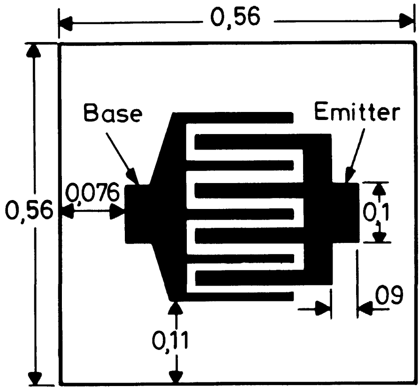
GEOMETRY 7



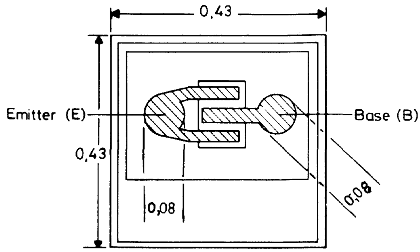
GEOMETRY 8

Dimensions in millimetres

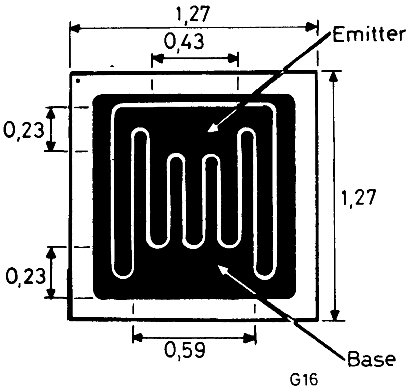
DICE GEOMETRIES



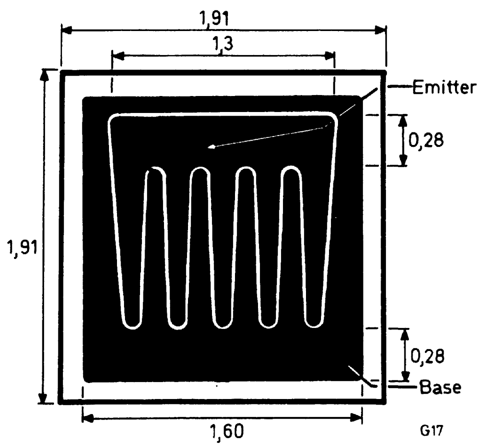
GEOMETRY 9



GEOMETRY 10



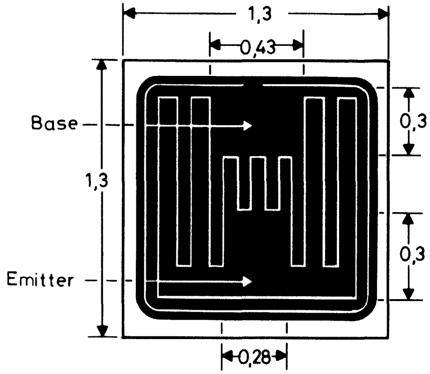
GEOMETRY 11



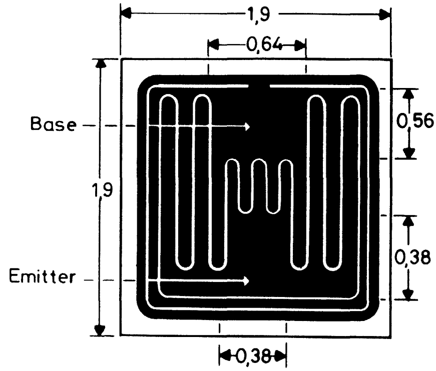
GEOMETRY 12

Dimensions in millimetres

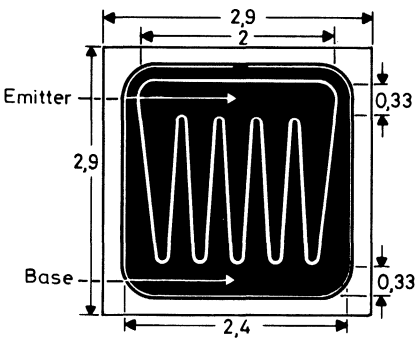
DICE GEOMETRIES



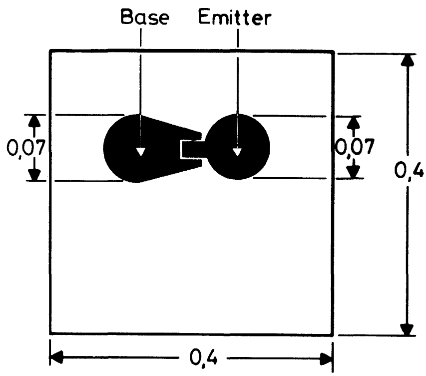
GEOMETRY 13



GEOMETRY 14



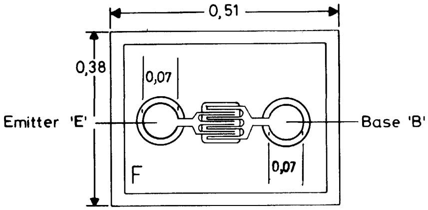
GEOMETRY 15



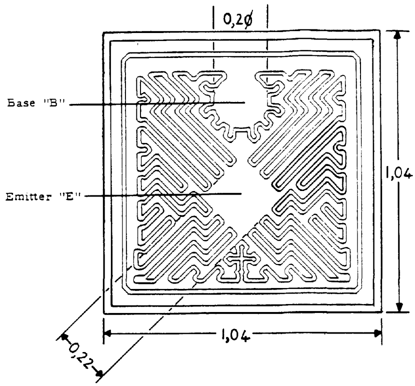
GEOMETRY 16

Dimensions in millimetres

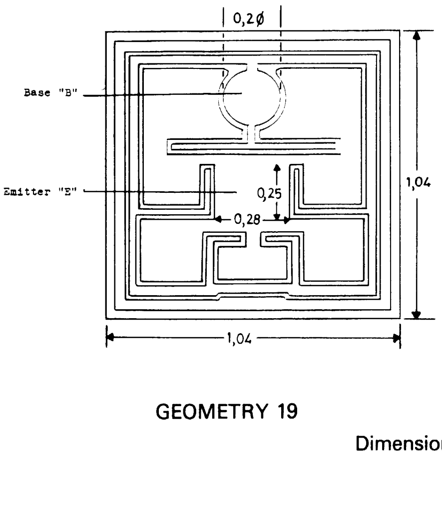
DICE GEOMETRIES



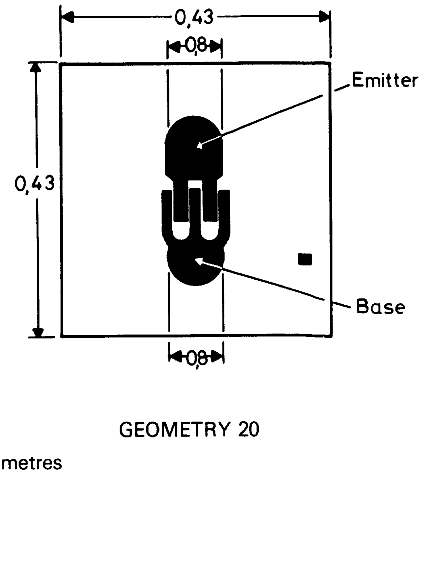
GEOMETRY 17



GEOMETRY 18



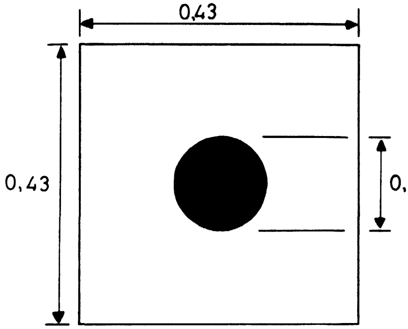
GEOMETRY 19



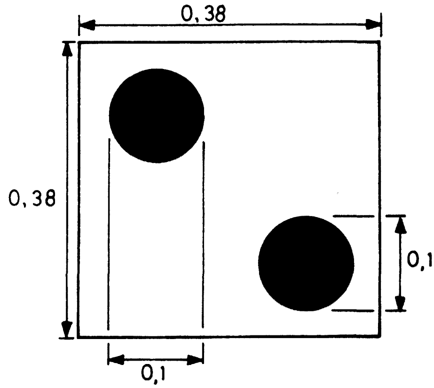
GEOMETRY 20

Dimensions in millimetres

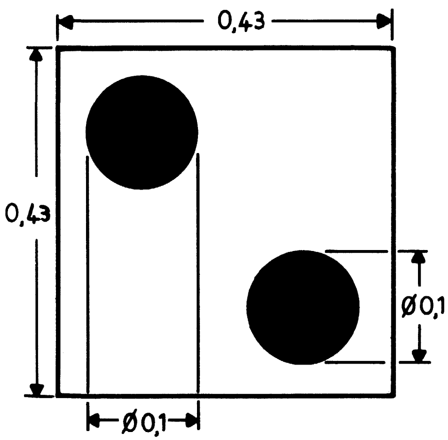
(b) DIODE GEOMETRIES



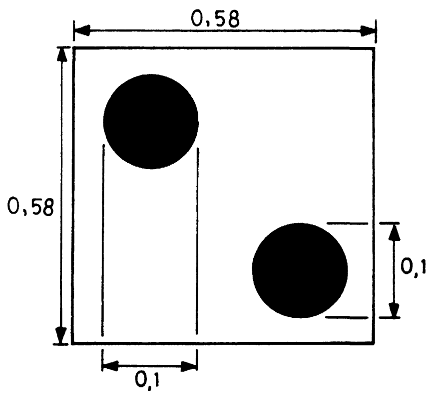
GEOMETRY A



GEOMETRY B



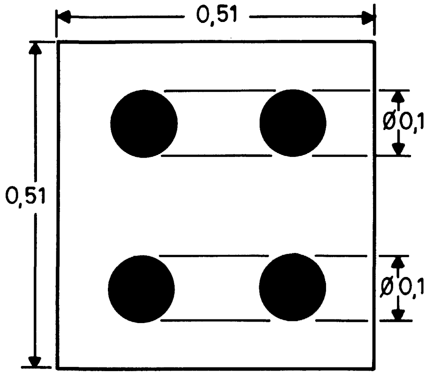
GEOMETRY C



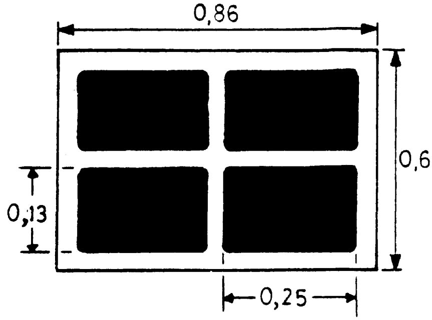
GEOMETRY D

Dimensions in millimetres

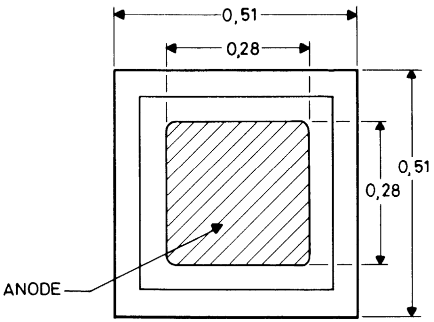
DICE GEOMETRIES



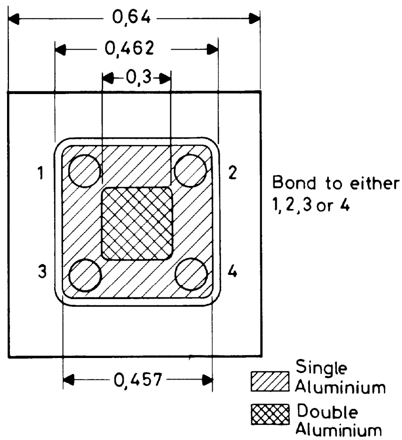
GEOMETRY E



GEOMETRY F



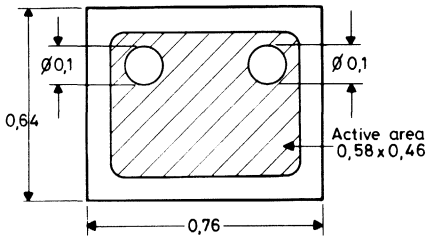
GEOMETRY G



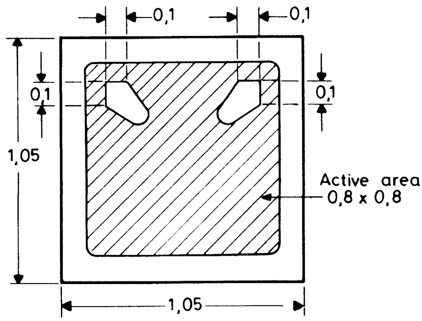
GEOMETRY H

Dimensions in millimetres

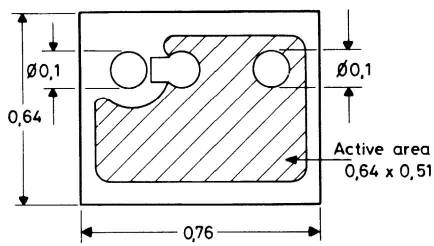
(c) PHOTO-TRANSISTOR GEOMETRIES



GEOMETRY I



GEOMETRY J



GEOMETRY K

Dimensions in millimetres

DICE GEOMETRIES

(d) INTEGRATED CIRCUIT DICE SIZES

Type No.	Description	Die Size (th)
ZN7400	Quad 2-Input NAND Gate	40 × 40
ZN7401	Quad 2-Input NAND Gate (with Free Collectors)	40 × 40
ZN7402	Quad 2-Input NOR Gate	40 × 40
ZN7403	Quad 2-Input NAND Gate (with Free Collectors)	40 × 40
ZN7404	Hex Inverter	40 × 40
ZN7405	Hex Inverter (with Free Collectors)	40 × 40
ZN7408	Quad 2-Input AND Gate	44 × 44
ZN7409	Quad 2-Input AND Gate (with Free Collectors)	44 × 44
ZN7410	Triple 3-Input NAND Gate	40 × 40
ZN7412	Triple 3-Input NAND Gate (with Free Collectors)	40 × 40
ZN7413	Dual 4-Input Schmitt Trigger	44 × 44
ZN7420	Dual 4-Input NAND Gate	40 × 40
ZN7425	Dual 4-Input NOR Gate with Strobe	44 × 44
ZN7427	Triple 3-Input NOR Gate	40 × 40
ZN7428	Quad 2-Input NOR Buffer	44 × 44
ZN7430	Single 8-Input NAND Gate	40 × 40
ZN7432	Quad 2-Input OR Gate	44 × 44
ZN7437	Quad 2-Input NAND Buffer	44 × 44
ZN7438	Quad 2-Input NAND Buffer (with Free Collectors)	44 × 44
ZN7440	Dual 4-Input NAND Buffer	44 × 44
ZN7442	BCD – Decimal Decoder	65 × 65
ZN7450	Dual 2-Wide 2-Input AND-OR-INVERT Gate (Expansible)	44 × 44
ZN7451	Dual 2-Wide 2-Input AND-OR-INVERT Gate	44 × 44
ZN7453	4-Wide 2-Input AND-OR-INVERT Gate (Expansible)	44 × 44
ZN7454	4-Wide AND-OR-INVERT Gate	44 × 44
ZN7470	J K Bistable	44 × 44
ZN7472	Master Slave J K Bistable	44 × 44
ZN7473	Dual Master-Slave J K Bistable (Ground Pin 11)	50 × 50
ZN7474	Dual D-Type Bistable	40 × 40
ZN7475	Quad Latch	57 × 57
ZN7476	Dual Master-Slave J K Bistable with Separate Preset + Clear	50 × 50
ZN7482	2-Bit Binary Full Adder	50 × 50
ZN7483A	4-Bit Binary Full Adder	65 × 65
ZN7485	4-Bit Comparator	65 × 65
ZN7486	Quad 2-Input Exclusive-OR Gate	44 × 44
ZN7489	64-Bit RAM	104 × 64
ZN7490A	BCD Decade Counter	57 × 57
ZN7491A	8-Bit Shift Register	65 × 65
ZN7492A	Divide-by-12 Counter	57 × 57
ZN7493A	Divide-by-16 Counter	57 × 57
ZN7494	4-Bit Shift Register PISO	57 × 57
ZN7495A	4-Bit UP/DOWN Shift Register PIPO	78 × 57
ZN7496	5-Bit Shift Register PIPO	85 × 85
ZN74107	Dual Master-Slave J K Bistable (Ground Pin 7)	50 × 50
ZN74118	Hex S-R Latch	50 × 50
ZN74119	Hex S-R Latch	65 × 65
ZN74121	Monostable Multivibrator (with Schmitt-Trigger Inputs)	39 × 47
ZN74122	Monostable Multivibrator (Retriggerable)	44 × 44
ZN74123	Dual Monostable Multivibrator (Retriggerable)	57 × 57

INTEGRATED CIRCUIT DICE SIZES *(continued)*

Type No.	Description	Die Size (th)
ZN74150	16-to-1 line Data Selector/Multiplexer	65 × 65
ZN74151	8-to-1 line Data Selector/Multiplexer	65 × 65
ZN74153	Dual 4-to-1 line Data Selector/Multiplexer	65 × 65
ZN74154	4-to-16 line Decoder/Demultiplexer	74 × 74
ZN74155	Dual 2-to-4 line Decoder/Demultiplexer	65 × 65
ZN74157	Quad 2-to-1 line Data Selector/Multiplexer	50 × 50
ZN74161	Synchronous Binary Counter	74 × 74
ZN74163	Synchronous Binary Counter	74 × 74
ZN74164	8-Bit Shift Register SIPO	65 × 65
ZN74165	8-Bit Shift Register PISO	74 × 74
ZN74166	8-Bit Shift Register PISO	85 × 85
ZN74170	4-by-4 Register File	85 × 85
ZN74174	Hex D-Type Bistable	65 × 65
ZN74175	Quad D-Type Bistable	65 × 65
ZN74180	8-Bit Parity Generator	57 × 57
ZN74181	4-Bit Arithmetic Logic Unit	74 × 74
ZN74184	BCD-to Binary Converter	79 × 74
ZN74191	Reversible Binary Counter	85 × 85
ZN74192	Reversible Decade Counter	85 × 85
ZN74193	Reversible Binary Counter	85 × 85
ZN74194	4-bit Shift Register PIPO	78 × 57
ZN74L00	Quad 2-Input NAND Gate	40 × 40
ZN74L01	Quad 2-Input NAND Gate (with Free Collectors)	40 × 40
ZN74L02	Quad 2-Input NOR Gate	40 × 40
ZN74L03	Quad 2-Input NAND Gate (with Free Collectors)	40 × 40
ZN74L04	Hex Inverter	40 × 40
ZN74L10	Triple 3-Input NAND Gate	40 × 40
ZN74L20	Dual 4-Input NAND Gate	40 × 40
ZN74L30	Single 8-Input NAND Gate	40 × 40
ZN74L42	BCD-Decimal Decoder	65 × 65
ZN74L51	Dual 2-Wide AND-OR-INVERT Gate	40 × 40
ZN74L54	4-Wide AND-OR-INVERT Gate	40 × 40
ZN74L55	2-Wide 4-Input AND-OR-INVERT Gate	40 × 40
ZN74L73	Dual Master-Slave J K Bistable	50 × 50
ZN74L74	Dual D-Type Bistable	41 × 39
ZN74L75	Quad Latch	57 × 57
ZN74L85	4-Bit Comparator	74 × 74
ZN74L86	Quad 2-Input Exclusive OR Gate	44 × 44
ZN74L90	BCD-Decade Counter	67 × 48
ZN74L91	8-Bit Shift Register SISO	58 × 52
ZN74L93	Divide-by-16 Counter	50 × 49
ZN74L95	4-Bit UP/DOWN Shift Register PIPO	65 × 65
ZN74L96	5-Bit Shift Register PIPO	85 × 85
ZN74L122	Monostable Multivibrator (Retriggerable)	38 × 39
ZN74L164	8-Bit Shift Register SIPO	65 × 65
ZN74L192	Reversible Decade Counter	85 × 85
ZN74L193	Reversible Binary Counter	85 × 85

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SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

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	
MS3B	10.11 × 1.68	500	2.6	350	0.17	
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	
MS10	5.0 × 4.6	500	2.0	350	0.1	
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.

MS600/601 VISIBLE SPECTRUM PHOTODETECTORS

The MS600 range of silicon, planar photodiodes has been developed to meet a wide cross-section of requirements for detectors of the shorter wavelength, visible spectrum.

Silicon photodetectors are, in general, more sensitive to the longer wavelengths, the standard Ferranti photocell peaking at 0.85 microns. The MS600 range however features a major suppression of response above 0.6 microns.

For the general detection and measurement of light containing a high level of visible wavelengths the MS600, housed in a TO-5 can with a Quartz window, may be used.

Where the simulation of human eye response is required however, in applications such as colour measurement, photometry and photographic light meters, the MS601, having a specially designed "eye-corrected" filter, is recommended.

CHARACTERISTICS (at 25°C)

Parameter	MS600	MS601	Units	Notes
	RADIOMETRIC SENSITIVITY			See Note 1
Short circuit photo-current sensitivity at: 0.412μm	0.09	0.07	A/W	typical
0.500μm	0.25	0.22	A/W	typical
1.035μm	0.06	0.002	A/W	typical
Absolute sensitivity at: 0.607μm	40	28	$\mu A/mW/cm^2$	minimum
Open circuit voltage	300	280	mV	typical (see Note 2)
Wavelength of peak sensitivity	0.62	0.56	μm	typical
Dark leakage current at 1 volt reverse bias	0.2	0.2	μA	maximum

Note 1. The Radiometric Sensitivity is measured using a calibrated monochromatic radiation source.

Note 2. The open circuit voltage is measured using monochromatic radiation of intensity $100\mu W/cm^2$ at wavelength of 0.5μm.

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	Min. Reverse Resistance $V_R = 4.5V$	Max. c_j $V=0$ $f=1kHz$	Minimum Open Circuit Voltage Source Intensity (foot candles)*			Peak Spectral Response
	mm	ohms	pF	0.5	1.0	1.5	
MS15	12.7 × 12.7	75000	8000	28mV	35mV	40mV	0.9μ

*This is the illumination intensity of a tungsten source at 2870°K; cells covered with 2mm thckness 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 $RC = 40k \times 100{,}000pF$. †Typical $RC = 3k \times 2{,}200pF$.

Note 1. The illumination source is an unfiltered tungsten filament at a colour temperature of 2856°K.

BPW41D

INFRA-RED PHOTODETECTOR

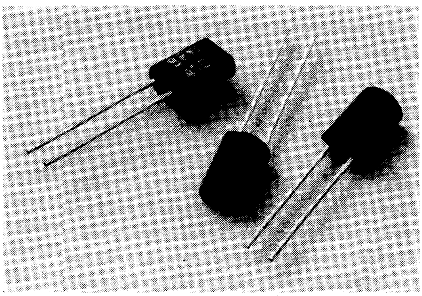
The BPW41D is a large area, silicon p.i.n. photodiode having a low junction capacitance and consequently capable of fast response times. The active chip is packaged in a plastic moulding which contains a near infra-red transmissive filter such that the device is sensitive to infra-red radiation only, and has a high rejection of wavelengths below 700nm. 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	$V_R = 5V$ $E_e = 1 mW/cm^2$ $\lambda p = 950nm$ (See note 2)
Reverse breakdown voltage	V_{BR}	32	—	—	V	$I_R = 100\mu A$, $E = 0$
Junction capacitance	C_j	—	25	40	pF	$V_R = 3V$, $f = 1MHz$ $E = 0$
Noise equivalent power	N.E.P.	—	10^{-14}	—	$WHz^{-0.5}$	
Turn-on time	t_{on}	—	50	—	ns	$V_R = 10V$, $R_L = 1k\Omega$
Turn-off time	t_{off}	—	50	—	ns	$V_R = 10V$, $R_L = 1k\Omega$

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 950nm.



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 t 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.

ZME SERIES, GaAs I.R. LIGHT EMITTING DIODES

Infra-red light emitting diodes for use as sources in fibre-optic data transmission links and I.R. remote control systems. The diode package is similar to that used for the Ferranti phototransistor range, which simplifies the physical interfacing of emitter and detector in certain applications (e.g. card readers, tape readers, opto-couplers etc.). For advice on the matching of emitters and detectors please contact Discrete Component Marketing.

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.

CUSTOM DESIGN SERVICE

The Ferranti opto-electronic custom design service exists to provide customers with advice on the design and assembly of opto-electronic products and systems that are non standard within the Ferranti range. Advice is available concerning the compatibility of components to form complete systems, on the development of new devices to fulfill specific requirements, and, on the photovoltaic cell side, multi cell arrays can be assembled and encapsulated to suit the power requirements of given applications.

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
OSD-5E	Visible Response Photodiode	MS601
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.

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SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

PLEASE NOTE:

UNENÇAPSULATED 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.

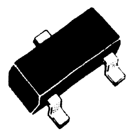
BZX84 SERIES SOT-23 ZENERS

TABLE 1a

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 at V_R		Device Marking
	Nom.	Min.	Max.	Max.	Typical	μA Max.	Volts	
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

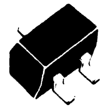
For additional specification details at $I_Z = 1mA$ and 20mA etc. please refer to individual data sheets.
Further details of SOT-23 devices are contained in the Hybrid section.

BZX88 SERIES MICRO-E ZENERS

TABLE 1b

The BZX88 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 specified at $I_Z = 5mA$.

Encapsulated in the Ferranti Micro-E package, these devices are designed specifically for use in thin and thick film hybrid circuits where the use of a small encapsulated device of proven reliability, together with a guaranteed specification, offers advantages over the use of silicon dice and the larger conventional plastic packages.



MICRO-E

ELECTRICAL CHARACTERISTICS (at 25°C ambient temperature).

BZX88 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

Further details on Micro-E devices are contained in the Hybrid section.

SWITCHING DIODES

TABLE 2 – SILICON PLANAR EPITAXIAL HIGH SPEED SWITCHING DIODES

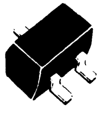
The **BAV** and **BAW** series of micro-miniature plastic encapsulated single diode and double diode pairs are primarily intended for use in thick and thin film hybrid circuits. Application areas include fast switching and general logic use. The BAW63 series of Micro-E diodes is BS APPROVED for use in MILITARY and PROFESSIONAL equipments.

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.

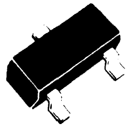
Type	Description	Max. V_{RWM} V	Max. $I_{F(AV)}$ mA	Max. I_R(at V_{RWM}) μA	Max V_F at V	I_F mA	Max. t_{rr}† ns	Package	Device Marking
ZDX6	Series diode pair	70	250	1.0	0.855	10	6	E-line	ZDX6
BAV70	Common cathode diode pair	70	100	5.0	0.855	10	6	SOT-23	A4
BAV99	Series diode pair	70	100	2.5	0.855	10	6	SOT-23	A7
BAW56	Common anode diode pair	70	100	2.5	0.855	10	6	SOT-23	A1
BAW63	Single diode	60	200*	0.5	0.9	20	4	Micro-E	D1
BAW64	Common cathode diode pair	60	200*	0.5	0.9	20	4	Micro-E	D4
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
BAW63A	Single diode	30	200*	0.5	0.9	20	4	Micro-E	D2
BAW65	Common cathode diode pair	30	200*	0.5	0.9	20	4	Micro-E	D5
BAW66	Common anode diode pair	30	200*	0.5	0.9	20	4	Micro-E	D6
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
BAW63B	Single diode	15	200*	0.5	0.9	20	4	Micro-E	D3
BAW67	Common cathode diode pair	15	200*	0.5	0.9	20	4	Micro-E	D7
BAW68	Common anode diode pair	15	200*	0.5	0.9	20	4	Micro-E	D8
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.

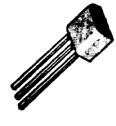
N.B. Refer to Package Outlines section for pinning details.



MICRO-E



SOT-23



E-LINE (TO-92)

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. $I_{F(AV)} = 400$mA
Max. $I_{FRM} = 4$A
Max. V_F (at $I_F = 400$mA) = 1V

ZS120 Series

Max. $I_{F(AV)} = 250$mA
Max. $I_{FRM} = 1.25$A
Max. V_F (at $I_F = 250$mA) = 1.1V

LOW LEAKAGE DIODES

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

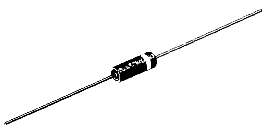
I_R (at V_{RWM}) / V_{RWM}	1nA	5nA	100nA
50V	ZS150	ZDX3F/3R ZS152	ZS154
100V	ZS151	ZDX4F/4R ZS153	ZS155

ZS150 Series

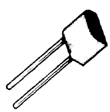
Max. $I_{F(AV)} = 250mA$
Max. $I_{FSM} = 3A$
Max. V_F (at $I_F = 200mA$) = 1.2V
Typ. $t_{rr} = 250ns$
(at $I_F = 600mA$, $I_R = 100mA$)
Max. $t_{fr} = 10ns$
(at $I_F = 10mA$)

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

Designed for L-Band electronic tuning applications. Especially suitable for use in thick or thin film applications.

Type	V_R(volts) Max.	Capacitance at 1 MHz		Capacitance Measurement Test Voltage V_R(volts)	Capacitance Ratio		Package
		pF Min.	pF Max.				
ZC101	20	24	30	4	1.43	C_4/C_{10}	E-line
ZC102	20	30	37	4	1.43	C_4/C_{10}	E-line
ZC110	30	27	31	3	2.65	C_3/C_{30}	E-line
ZC111	30	29	33	3	2.65	C_3/C_{30}	E-line
ZC150	25	44	51	2	2.65	C_2/C_{25}	E-line
ZC151	25	49	56	2	2.65	C_2/C_{25}	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

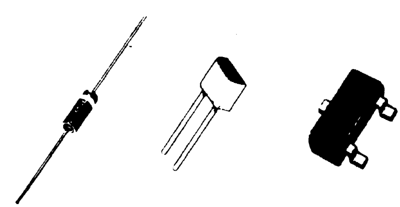
A series of professional range devices for very high frequency range operation.

- Available in three package options:

    Economical plastic E-line package

    Microminiature SOT-23

    High reliability glass DO-7



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.

HYPERABRUPT VARIABLE CAPACITANCE TUNER DIODES

TABLE 6c – HIGH PERFORMANCE ECONOMY SERIES

- Ion implanted hyperabrupt tuning diodes for VHF operation
- Plug in E-line package
- High Q

Symbol		V_{BR}	I_R	C_T		T_R		Q
Parameter		Reverse breakdown voltage	Reverse leakage current	Diode capacitance		Capacitance ratio		Figure of merit
Unit		V	μA	pF				
Conditions		$I_R = 10\mu A$	$V_R = 25V$	$V_R = 3V$ f = 1 MHz		C_{3V}/C_{25V} f = 1 MHz		$V_R = 3V$ f = 50 MHz
Limit		Min.	Max.	Min.	Max	Min.	Max.	Min.
Type	**ZC209**	30	0.1*	26	32	5	6.5	200
	ZC3102	30	0.1*	20	25	4.5	–	300

*at $V_R = 28V$

TABLE 6d – HIGH PERFORMANCE TYPES FOR USE IN THICK FILM APPLICATIONS

- Ion implanted hyperabrupt types
- Closely controlled tuning ratio
- High Q
- Microminiature SOT-23 package

Symbol		V_{BR}	I_R	C_T		T_R		Q	
Parameter		Reverse breakdown voltage	Reverse leakage current	Diode capacitance		Capacitance ratio		Figure of merit	Device Marking
Unit		V	μA	pF					
Conditions		$I_R = 10\mu A$	$V_R = 25V$	$V_R = 3V$ f = 1 MHz		C_{3V}/C_{25V} f = 1 MHz		$V_R = 3V$ f = 50 MHz	
Limit		Min.	Max.	Min.	Max	Min.	Max.	Min.	
Type	**FMMD109**	30	0.1*	26	32	5	6.5	280	4A
	FMMD3102	30	0.1*	20	25	4.5	–	300	4C

*at $V_R = 28V$

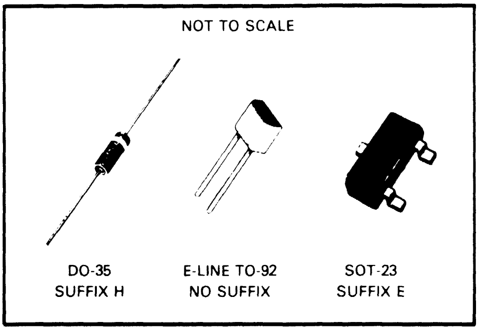
TABLE 7 – SILICON PLANAR EPITAXIAL SCHOTTKY BARRIER DIODES

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
  High Reliability Glass DO-35
- Low Leakage Current
- Low Forward Voltage
- Ultra High Speed Switching



ABSOLUTE MAXIMUM RATINGS (DO-35, 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) DO-35, SOT-23 and E-line.

Parameter	Type	Symbol	Min.	Max.	Unit	Test Conditions
Breakdown Voltage	ZC2800	V_{BR}	70	–	V	$I_R = 10\mu A$
	ZC2810		20	–	V	
	ZC2811		15	–	V	
	ZC5800		50	–	V	
Reverse leakage current	ZC2800	I_R	–	200	nA	$V_R = 50V$
	ZC2810		–	100	nA	$V_R = 15V$
	ZC2811		–	100	nA	$V_R = 10V$
	ZC5800		–	200	nA	$V_R = 35V$
Forward voltage	ZC2800	V_F	–	410	mV	$I_F = 1mA$
	ZC2810		–	410	mV	
	ZC2811		–	410	mV	
	ZC5800		–	410	mV	
Forward current	ZC2800	I_F	15	–	mA	$V_F = 1V$
	ZC2810		35	–	mA	
	ZC2811		20	–	mA	
	ZC5800		15	–	mA	
Capacitance	ZC2800	C_T	–	2.0	pF	$V_R = 0V$ f = 1 MHz
	ZC2810		–	1.2	pF	
	ZC2811		–	1.2	pF	
	ZC5800		–	2.0	pF	
Effective minority lifetime	ZC2800	τ	–	100	ps	$I_F = 5mA$ Krakauer method
	ZC2810		–	100	ps	
	ZC2811		–	100	ps	
	ZC5800		–	100	ps	

Note: Matched pairs or quads of diodes can be supplied on request.
The DO-35 is available to BS release.

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 3 : INTEGRATED CIRCUITS

CONTENTS

See rear section of book for package details

ARRAYS: THE ULA

The ULA provides a fast and low cost route to high performance custom LSI/VLSI.

The timescale into production is short and prices are competitive from small to very large volumes.

A family of digital ULA's covers system complexities of up to 10,000 gates and requirements from ECL speeds to CMOS power levels.

A family of Digilin ULA's are designed to provide high complexity digital and high performance linear functions on the same chip.

ULA CONCEPT

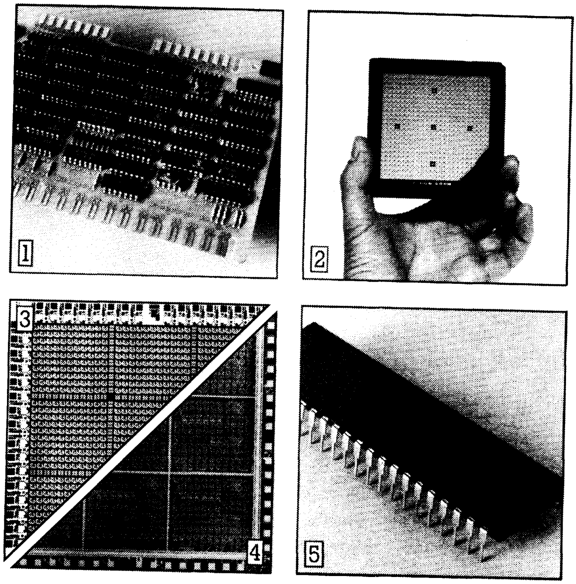
The ULA is a silicon chip fully processed with the exception of a single layer interconnection pattern.

Every chip in the ULA family employs a common design concept.

- The production of only a single mask for system integration.
- An "on-chip" component interconnection technique giving high chip utilisation and complexity.
- A regular matrix of cells. Each cell containing a number of uncommitted components whose prime function is to satisfy the logic hierarchy of an LSI system.
- Peripheral cells also containing a number of uncommitted components to facilitate interfacing with all other commonly used device technologies: bipolar, MOS and CMOS, and the implementation of high performance linear functions.

N.B "ULA" and "Digilin" are trademarks of Ferranti plc.

ARRAYS: THE ULA



1. Customers existing or proposed MSI system.
2. Single ULA interconnection mask derived from MSI system.
3. Uncommitted ULA chip held as stock item.
4. ULA chip completed using single layer interconnection mask.
5. Finished ULA LSI product.

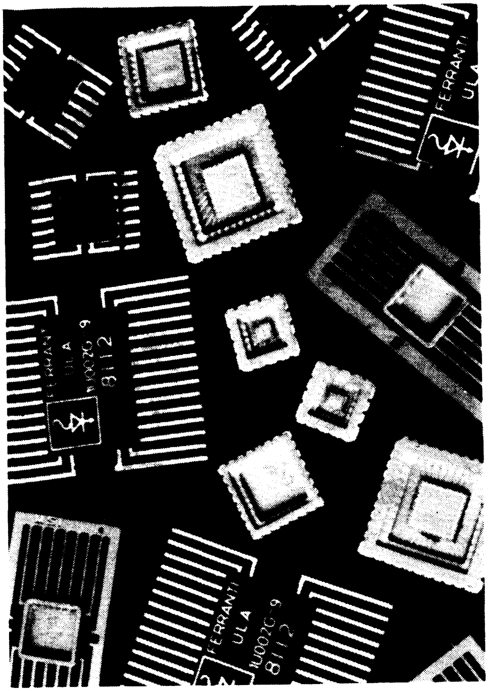
The Ferranti ULA provides an economic LSI solution to a customer's requirement in a fixed, fast and dependable timescale, whatever the market sector.

The ULA family is a range of bipolar LSI chips. Each chip contains an array of 'uncommitted' active and passive components fully processed except for the final, single layer, aluminium interconnection stage.

The interconnection pattern connecting the individual components to provide system integration, is generated from the user's specification either by Ferranti or by the customer himself.

The functional packing density is equivalent to full custom design, and the ULA is therefore competitive at all volume levels, including very large volume.

ARRAYS: THE ULA



Finished Product

The ULA is designed to operate over the military temperature range $-55°C$ to $+125°C$, thus embracing the various industrial temperature ranges.

The package in which the ULA chip is supplied can be plastic or ceramic dual in-lines, flat-packs or chip carriers ranging from 14 to 68 pins.

ULA PERFORMANCE

All ULAs have the facility for combining both digital and linear functions on the same chip, providing the opportunity for total system integration. The range of ULAs enables an LSI/VLSI solution to be realised with system complexities of up to 10,000 gates.

DIGITAL PERFORMANCE

All commonly used logic functions can be implemented with system clock gates up to, and under correct conditions in excess of 60 MHz.

LINEAR PERFORMANCE

A very extensive range of high performance linear functions can be implemented such as precision references, voltage regulators, comparators, op-amps, analogue switches, oscillators and A/D converters, etc.

INTERFACE CAPABILITY

The uncommitted components available in both the matrix and peripheral cells provide I/P and O/P interfacing capability for TTL, MOS and CMOS technologies, triacs, relays, LEDs and LCDs, transistors, phototransistors, switch and toch switch inputs, etc.

ARRAYS: THE ULA

PRODUCT DATA SUMMARY — ULA GATE ARRAYS

Array Type	Gate Count	Clock Rate (MHz)	Gate Delay (ns)	Gate Power (μW)	Package Pin Count
ULA2N	450	6	25.0	70	14 to 40
ULA2C	450	20	8.0	250	14 to 40
ULA5RC	500	10	15.0	30	24 to 40
ULA5RB	500	20	7.5	100	24 to 40
ULA5RA	500	60	2.5	300	24 to 40
ULA5N	900	6	25.0	70	24 to 68
ULA5C	900	20	8.0	250	24 to 68
ULA9RC	900	10	15.0	30	24 to 68
ULA9RB	900	20	7.5	100	24 to 68
ULA9RA	900	60	2.5	300	24 to 68
ULA12RC	1200	10	15.0	30	24 to 68
ULA12RB	1200	20	7.5	100	24 to 68
ULA12RA	1200	60	2.5	300	24 to 68
ULA16RC	1600	10	15.0	30	24 to 68
ULA16RB	1600	20	7.5	100	24 to 68
ULA16RA	1600	60	2.5	300	24 to 68
ULA18RC	1800	10	15.0	30	24 to 68
ULA18RB	1800	20	7.5	100	24 to 68
ULA18RA	1800	60	2.5	300	24 to 68
ULA9C	2000	20	8.0	120	24 to 68
ULA20RC	2000	10	15.0	30	24 to 68
ULA20RB	2000	20	7.5	100	24 to 68
ULA20RA	2000	60	2.5	300	24 to 68
ULA24RC	2400	10	15.0	30	24 to 68
ULA24RB	2400	20	7.5	100	24 to 68
ULA24RA	2400	60	2.5	300	24 to 68
ADVANCED PRODUCT INFORMATION (available for design during 1982)					
ULA40RA	4000	60	2.5	300	40 to 68
ULA100RA	10000	60	2.5	300	40 to 68

PRODUCT DATA SUMMARY – ULA DIGILIN ARRAYS

Array Type	Gate Count	Gate Power (μW)	No. of Active Components	No. of Passive Components	Package Pin Count
ULA1G	100	1.9	356	531	14 to 28
ULA1L	150	180.0	384	696	14 to 28
ULA2G	160	1.9	647	704	14 to 30
ULA1U	280	3.4	676	741	14 to 40
ULA2L	340	200.0	715	1205	14 to 40
ULA2M	500	0.4	1184	968	14 to 40
ULA2U	510	3.4	1152	1096	14 to 40
ULA3U	580	3.4	1348	1443	14 to 40
ULA5L	730	200.0	1644	2660	24 to 40

The number of active and passive components given in the table above are the total number of components contained in both the matrix and peripheral cells. The data sheet for each array should be consulted for the precise component content. However, each array contains a variety of transistors from high gain, low current devices to 100mA drive transistors. The resistors range in value from 100Ω to 1MΩ. Many of the arrays contain on-chip bandgap references, series and shunt regulators, shaping capacitors, etc.

SUPPLY VOLTAGE

The Digilin ULA's are designed to operate from supply voltages of 1.0V to 5.5V whilst the ULA gate arrays will operate from 3.3V to 5.5V. By suitable interconnection of the on-chip components, regulation is readily achieved allowing the ULA's to operate from any supply rail by using minimal external components.

ARRAYS: THE ULA

ULA DESIGN ROUTE

Only one interconnection mask is needed to convert the uncommitted ULA chip to the required Custom LSI circuit. Development costs are therefore low and development and production lead times are very short. The ULA design can be carried out by Ferranti or the customer supported by one of the most advanced ULA CAD facilities in operation.

Over 40 man years of ULA specialised automation software is available and in use. The software programmes include layout and design rule checking, logic checking and simulation, automatic layout aids, high level test language and test programme and test schedule verification.

THE ULA DESIGNER

The ULA Designer is an interactive design system consisting of a powerful minicomputer, edit terminal, control console, digitiser and plotter. Installed in the customer's premises it provides the customer's engineer with all the CAD facilities necessary to specify, design and verify ULA LSI and VLSI circuits.

N.B. "ULA Designer" is a trademark of Ferranti plc.

Design by Ferranti: The customer provides system specification and description including logic diagram and Ferranti carry out the complete ULA design cycle.

Design by Customer: There are three design options fully supported by comprehensive documents, design manuals and design courses, available to the customer who needs to carry out his own ULA design.

OPTION 1

The customer provides an integration package of logic diagram, layout routing and test and device specification.

OPTION 2

The customer who has installed the ULA DESIGNER carries out the complete design cycle on his own premises. When the design is complete and verified, the layout, logic and test schedules are transmitted via a modem link to the ULA CAD Complex for prototype manufacture.

OPTION 3

ULA software programmes can be purchased for customers with Applicon and Calma Graphics Systems. Interface to the Ferranti ULA CAD Complex is by magnetic tape.

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) on 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 only the aluminium interconnection custom designed. Short development and production timescales result from this single mask customisation.

COMPONENT LIST FOR LINEAR MONOCHIPS

Type	MOA	MOB	MOC	MOD	MOE	MOF	MOG	MOH	MOJ	MOL	MOM
NPN Transistor, small	57	69	22	50	48	92	56	70	36	76	137
NPN Transistor, 100mA								2	2	2	4
NPN Transistor, 200mA	2					4	2			2	4
NPN Transistor, low noise											4
PNP Transistor, single	18	12	8								
PNP Transistor, dual				16	15	36	18	22	12	22	44
PNP Transistor, quad										4	8
PNP Transistor, vertical											4
Schottky Diodes	15	16	6								
15Ω N+ Resistors								4		8	15
Base Resistors											
200Ω	16	27	8	15	8	18	19	29	8	23	60
450Ω	43	44	18	30	32	88	68	82	34	103	188
900Ω	43	45	20	28	28	68	65	75	30	77	140
1.8kΩ	29	39	13	29	25	61	44	54	24	53	104
3.6kΩ	28	36	12	24	26	61	27	36	20	36	84
Total Base Resistance (kΩ)	214	265	94	180	180	433	269	337	159	345	712
Pinch Resistors											
30kΩ B/E	4	6	2		5	9					
100kΩ B/E	4	6									
2 × 60kΩ B/E							4	4	2	5	8
60kΩBulk				2							
Pads	16	24	14	16	18	24	18	18	18	24	28
Size (mils)	71 × 81	81 × 81	51 × 56	80 × 80	70 × 70	91 × 110	75 × 78	77 × 88	61 × 65	81 × 100	101 × 151

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)

ARRAYS: THE MONOCHIP

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 linear 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 an 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 ratio so that a large range of values can be generated by series and parallel connection. The absolute tolerance of diffused resistors is $\pm 25\%$ 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.

AMPLIFIERS

OPERATIONAL AMPLIFIER — ZLD709

The well-known 709 Op-Amp is available in a variety of options ranging from the commercial temperature range device to the approved military device in a hermetic metal-can package.

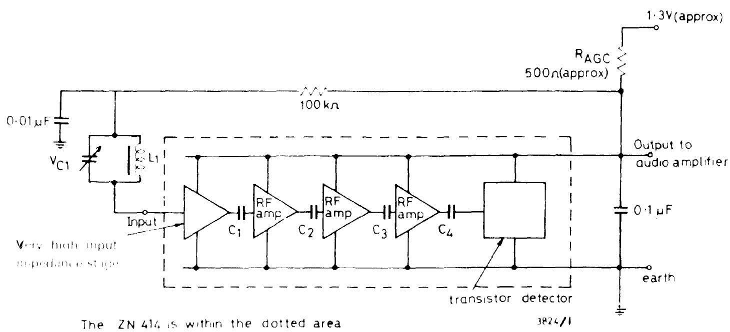
Type	Temperature Range (°C)	Package Style
ZLD709	−55 to +125	TO-99 (T8a)
ZLD709C	0 to +70	TO-99 (T8a)
CN515T	−55 to +125	TO-99 (T8a)

A.M. RADIO RECEIVER — ZN414

The ZN414 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 ZN414 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
- 20mV r.m.s. output
- Excellent audio quality, low noise design
- 72dB power gain
- 3 pin TO-92 plastic package
- 0 to +70°C operation



Circuit Diagram

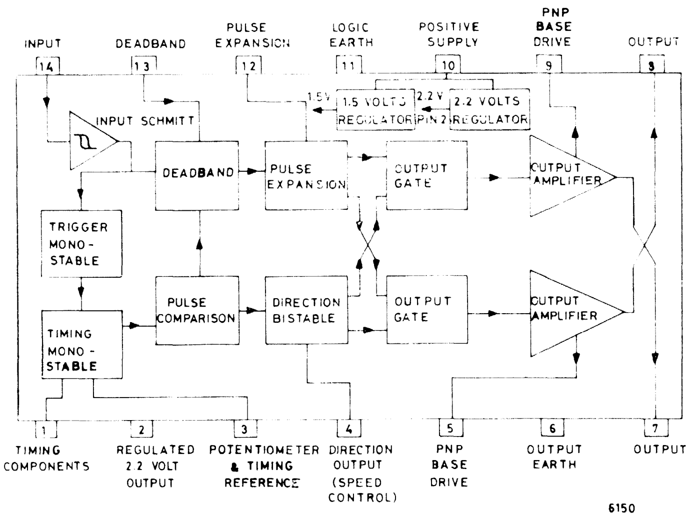
PRECISION SERVO INTEGRATED CIRCUIT — ZN409CE

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 reduced length and 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 (7mA typical at 4.8V)
- 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

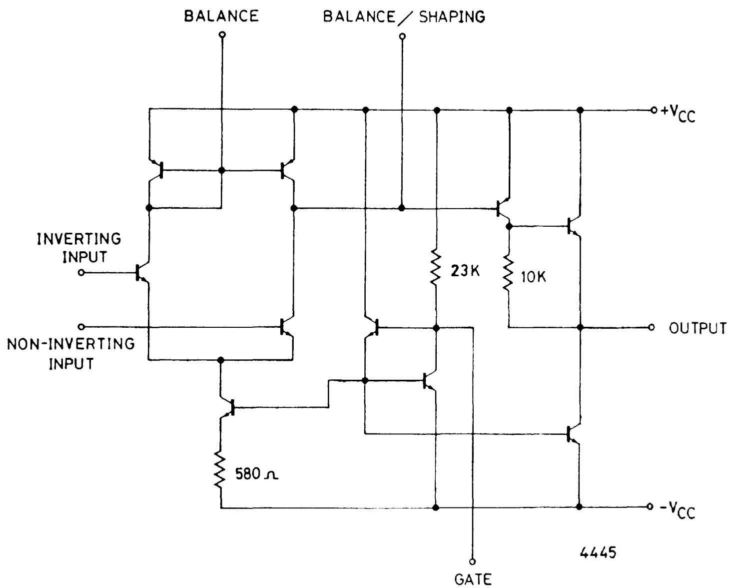
AMPLIFIERS

GATED LINEAR AMPLIFIER ZN424P

The provision of the gating facility on the ZN424 allows it to be used both as a switch and as an amplifier. With the gating signal applied, isolation between inputs is provided, and each input is isolated from the output. With no gating signal applied, the device functions as a low distortion operational amplifier.

FEATURES

- 86dB Gain
- Input-output isolation gating facility
- DTL/TTL Compatibility (5V operation)
- Logic gate current drive capability
- Low noise and open-loop distortion
- Class A output — no crossover distortion
- 8 lead moulded D.I.L. package (E8)



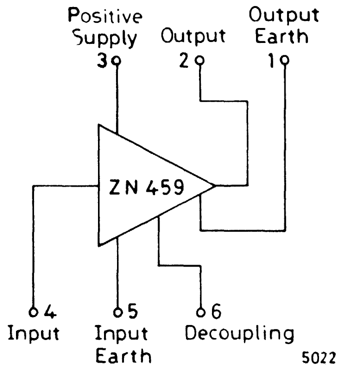
Circuit Diagram

ULTRA LOW NOISE WIDEBAND AMPLIFIER — ZN459/C/CP

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

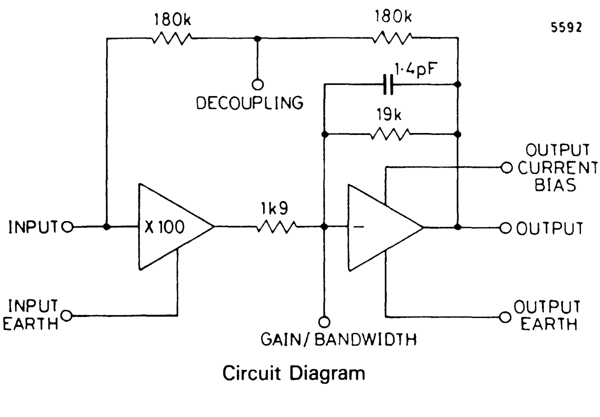


ULTRA LOW NOISE WIDEBAND PRE–AMPLIFIER — ZN460/ZN460C/ZN460CP

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/$\sqrt{Hz}$
- 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

REFERENCES

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%, 2% and 3% tolerance versions available
- No external stabilising capacitor required (except for ZNREF025 in some cases)

ZNREF RANGE

Type Number	Nominal V_{REF} (V)	I_{REF} (max.) (mA)	Dynamic Impedance (Ω)		Trim Range	Package
			Typ.	Max.		
ZNREF025	2.49	10	1.5	2	±5%	TO-18 (T3)
ZNREF040	4.01	75	2.0	3	±5%	TO-18 (T3)
ZNREF050	4.98	60	1.5	2	±5%	TO-18 (T3)
ZNREF062	6.17	50	2.0	3	±5%	TO-18 (T3)
ZNREF100	9.96	60	3.0	4	±2.5%	6-lead TO−39 (T6b)

ZNREF ORDERING INFORMATION

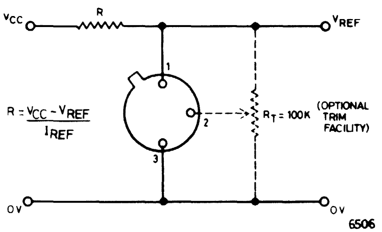
e.g. ZNREF xxx A 1

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

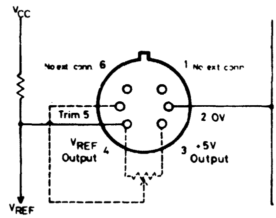
ZNREF V_{REF} TEMPERATURE COEFFICIENTS AND RANGES

V_{REF} Initial tolerance	Grade A Military −55 to +125°C		Grade B Industrial −20 to +85°C		Grade C Commercial 0 to +70°C	
	Typ.	Max.	Typ.	Max.	Typ.	Max.
1%	35	50	20	30	15	25
2%	35	50	20	30	15	25
3%	57	80	26	40	19	30

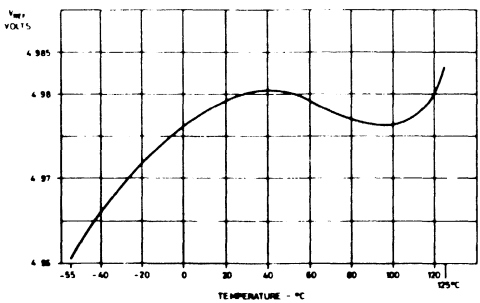
ZNREF TRIM CIRCUITS



ZNREF RANGE (except ZNREF100)
TO-18 (viewed from below)



ZNREF100
6-lead TO-39 (viewed from below)



TYPICAL TEMPERATURE CHARACTERISTIC

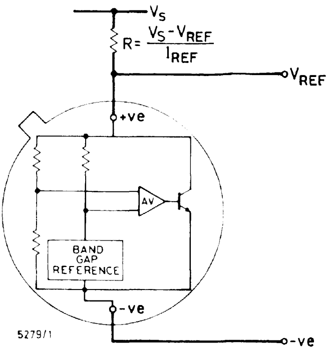
REFERENCES

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
- Two lead (TO-18) package (T2)



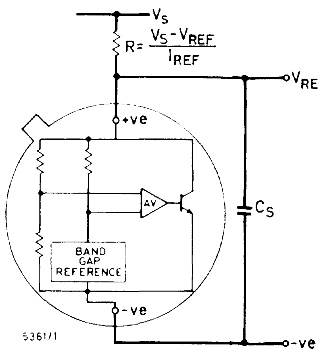
Circuit diagram

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
- Two lead (TO-18) package (T2)



Circuit Diagram

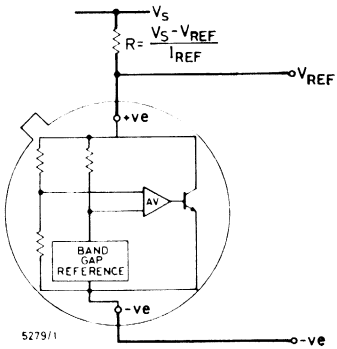
REFERENCE/pA DIODE

PRECISION 2.45V REFERENCE SOURCE — ZN458

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)
- Wide operating current 2 – 120mA

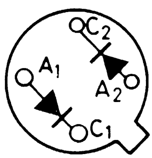


Circuit diagram

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)



5653

Pin	Out
1	C_1
2	A_1
3	C_2
4	A_2

Substrate Connected to Pin 3
TO-72

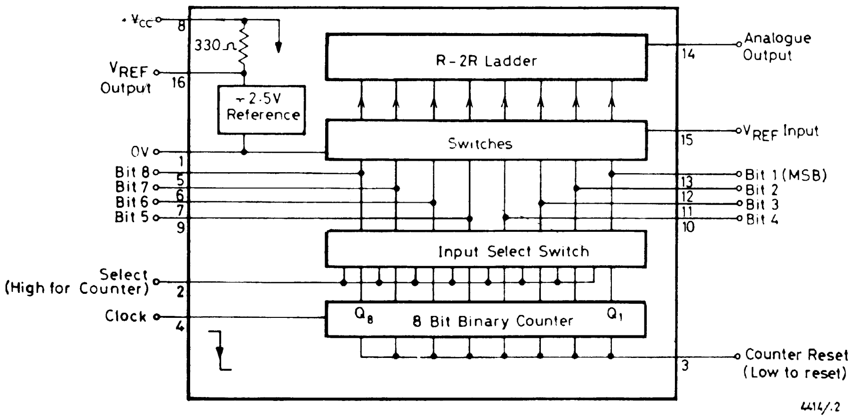
CONVERTERS

8-BIT D TO A/A TO D CONVERTER — ZN425 SERIES

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
- 8, 7 and 6 bit versions
- Temperature ranges 0 to +70°C, −55 to +125°C
- 16 lead moulded (E16) or ceramic D.I.L. (H16) package



System Diagram

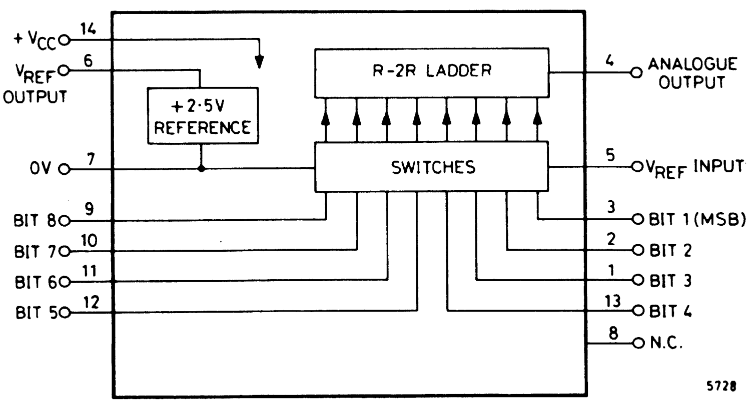
GENERAL PURPOSE 8-BIT D TO A CONVERTER

ZN426 SERIES

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
- 8, 7 and 6 bit versions
- Temperature ranges 0 to +70°C, −55 to +125°C
- 14 lead moulded (E14) or ceramic D.I.L. (H14) package



System Diagram

CONVERTERS

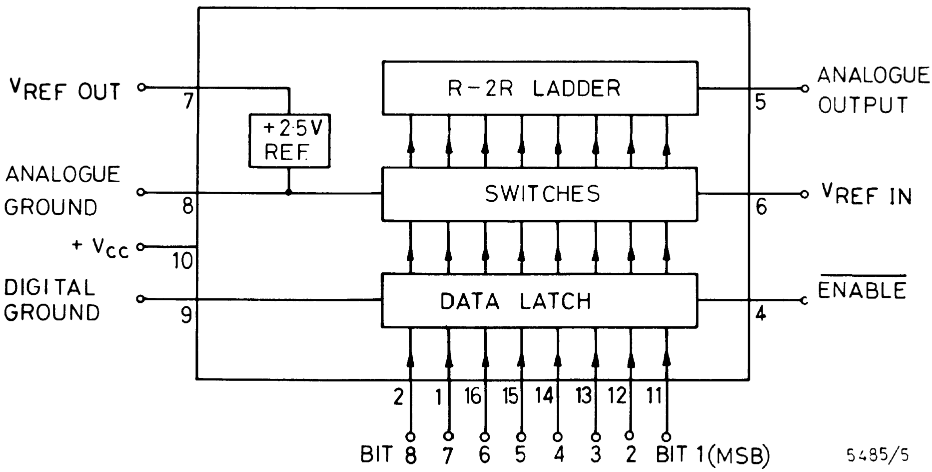
8-BIT MICROPROCESSOR COMPATIBLE D TO A CONVERTER

ZN428E-8/ZN428J-8

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) or ceramic D.I.L. (H16) package



System Diagram

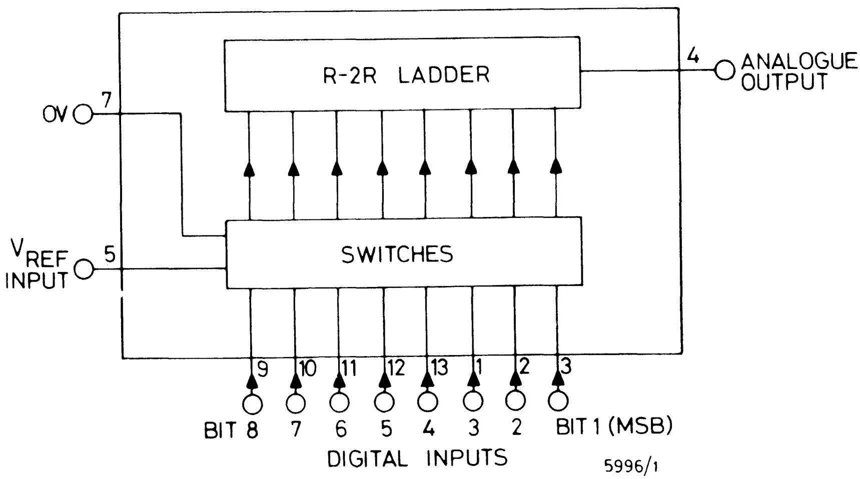
LOW COST 8-BIT D TO A CONVERTER

ZN429 SERIES

The ZN429 is a monolithic 8-bit D to A converter designed for cost-conscious 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
- 8, 7 and 6 bit versions
- Temperature ranges 0 to +70°C, −55 to +125°C
- 14 lead moulded (E14) or ceramic D.I.L. (H14) package



System Diagram

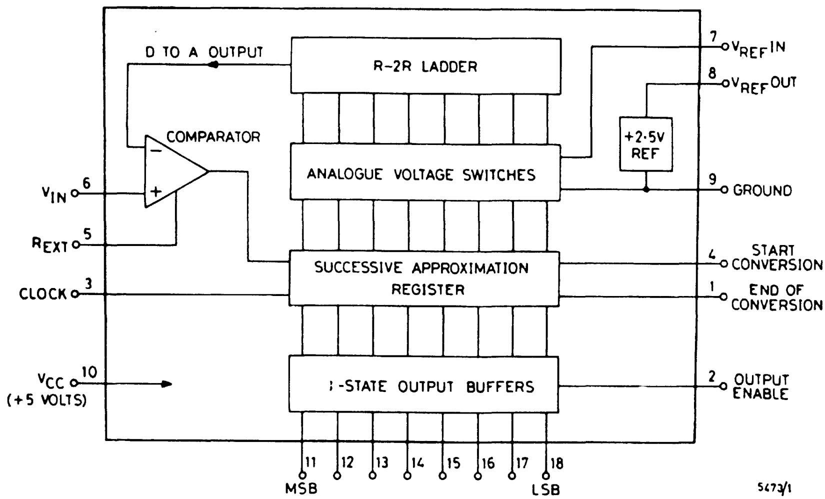
8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN427E-8/ZN427J-8

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 typical conversion time
- 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) or ceramic D.I.L. (H18) package



System Diagram

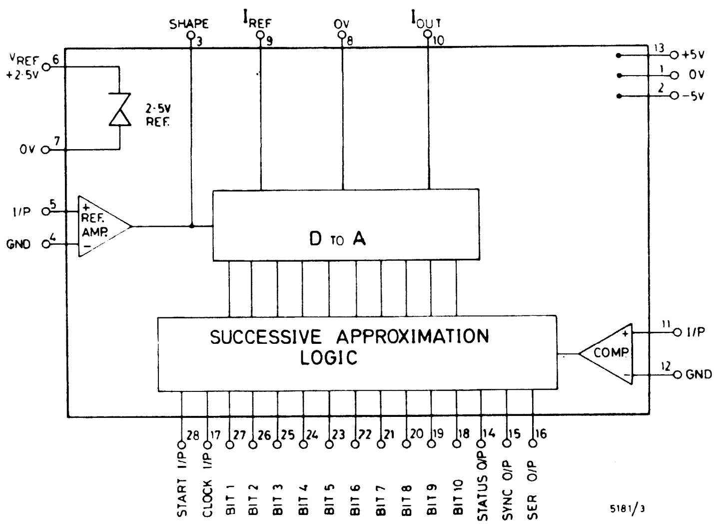
10-BIT SUCCESSIVE APPROXIMATION A TO D CONVERTER

ZN432 SERIES

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
- Parallel and serial data outputs
- TTL and CMOS compatible
- ±5V supplies
- Optional on-chip reference
- 10, 9 and 8 bit versions
- Temperature ranges 0 to +70°C, −40 to +85°C, −55 to +125°C
- 28 lead ceramic (H28) or moulded D.I.L. (E28) package



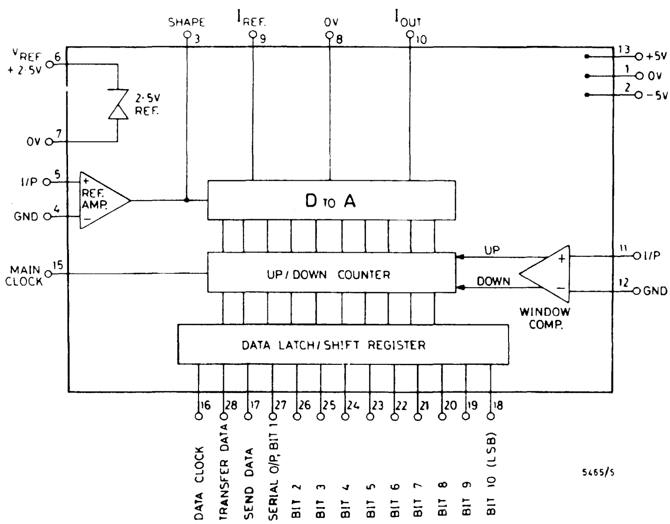
System Diagram

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 300Hz bandwidth, without the need for a sample and hold circuit.

FEATURES

- No missing codes over full temperature range
- 1 μs update time
- Parallel and serial data outputs
- TTL and CMOS compatible
- $\pm$5V supplies
- Optional on-chip reference
- Temperature ranges 0 to +70°C, −40 to +85°C, −55 to +125°C
- 28 lead ceramic (H28) or moulded D.I.L. (E28) package



System Diagram

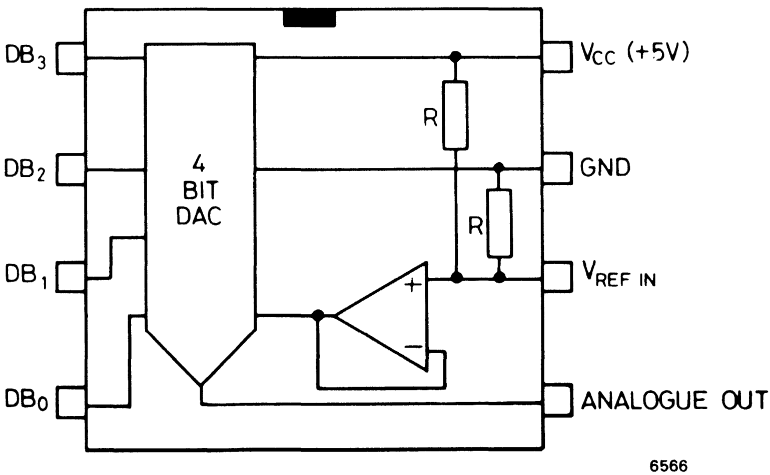
LOW COST 4-BIT D TO A CONVERTER

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 D.I.L. (E8) package



System Diagram

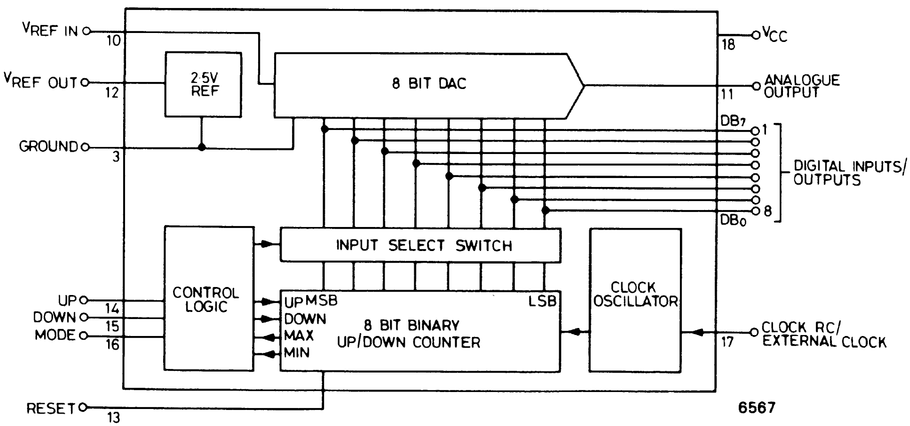
8-BIT MULTIFUNCTION DATA CONVERTER

ZN435E/ZN435J

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 settling 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 D.I.L. (H18) package



System Diagram

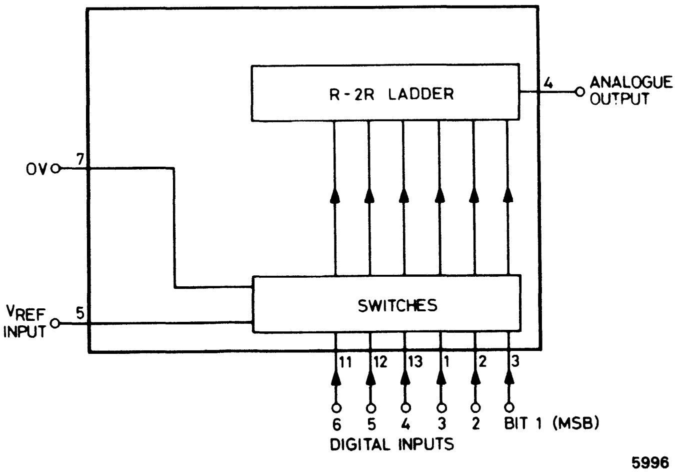
LOW COST 6-BIT MONOLITHIC D TO A CONVERTER

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
- 1μs settling time (typical)
- Designed for low cost applications
- 14 lead moulded (E14) or ceramic D.I.L. (H14) package



System Diagram

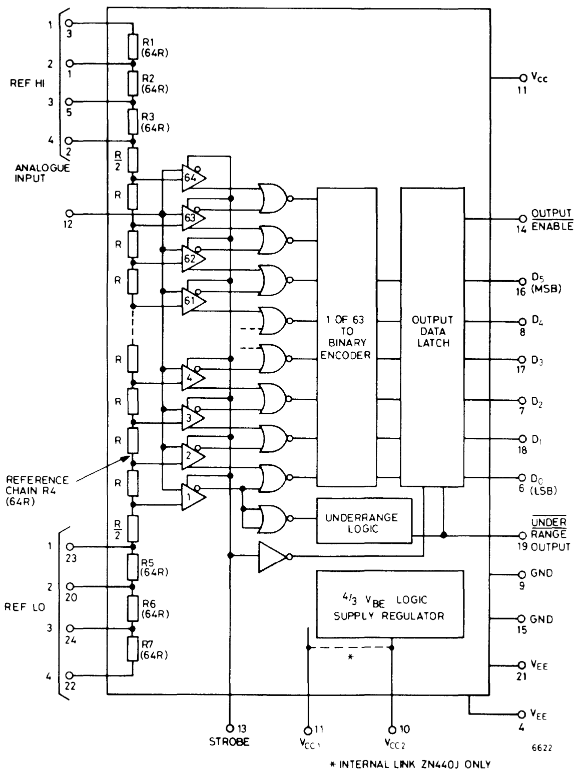
6-BIT MONOLITHIC ULTRA-FAST A TO D CONVERTER ZN440/1

The ZN440/1 is a high-speed, 6-bit parallel A to D converter capable of digitising an analogue signal at rates from d.c. to 18 megasamples per second. A.C. signals with frequency components up to several MHz can be accurately digitised without the need for an external 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.

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

FEATURES

- 18 million conversions per second
- 6-bit resolution
- Expansible to 7 or 8-bits
- ± ½ LSB linearity
- No sample-and-hold required
- Unipolar or bipolar input range
- TTL compatible
- ±5V supply
- 1W power dissipation
- 24 lead moulded (E24) or ceramic D.I.L. (F24) package



System Diagram

8-BIT UP COMPATIBLE A TO D CONVERTERS

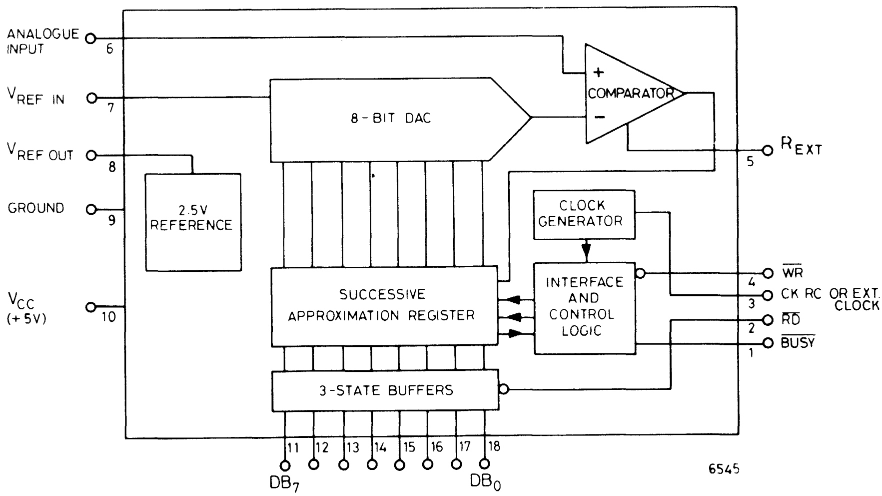
ZN447E/J
ZN448E/J
ZN449E/J

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 (E18) or ceramic D.I.L. (H18) package



System Diagram

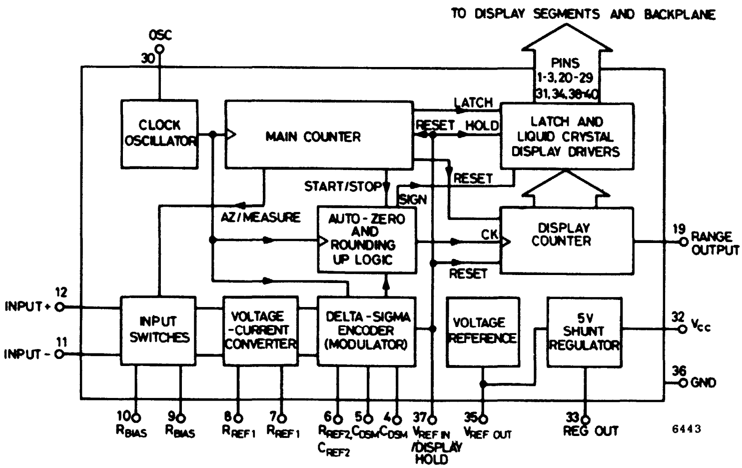
D.V.M.S

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, less than 35mW
- Wide supply voltage range, single supply rail
- No external active circuits required
- 40 lead moulded (E40) or ceramic (H40) D.I.L. package



System Diagram

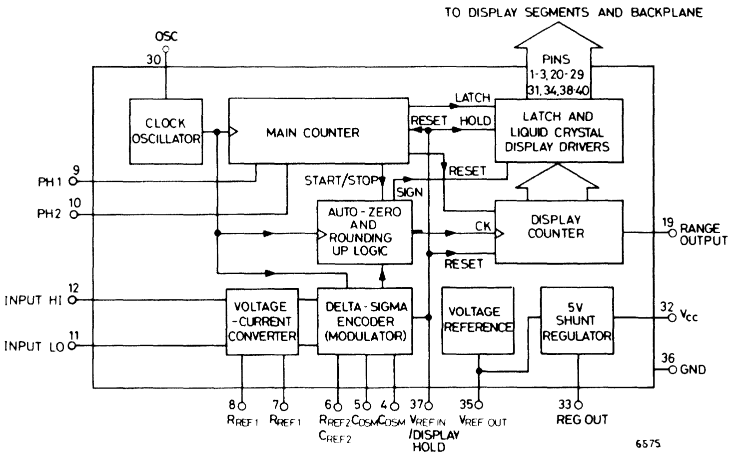
3½ DIGIT D.V.M. I.C. WITH EXTERNAL AUTO-ZERO — ZN451/ZN451CJ

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, less than 35mW
- Wide supply voltage range, single supply rail
- 40 lead moulded (E40) or ceramic (H40) D.I.L. package



System Diagram

D.V.M.S

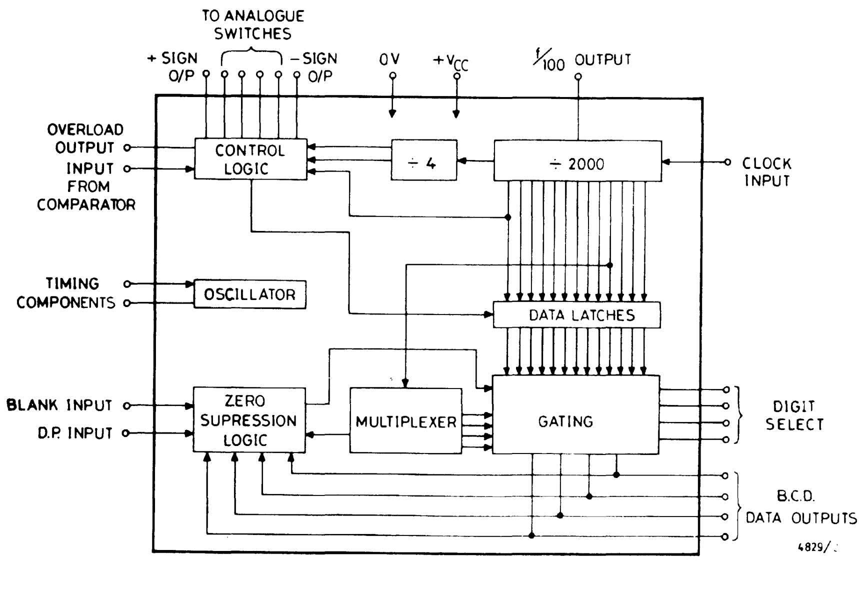
3½ DIGIT D.V.M LOGIC

ZNA116E

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 D.I.L. (E24) package



System Diagram

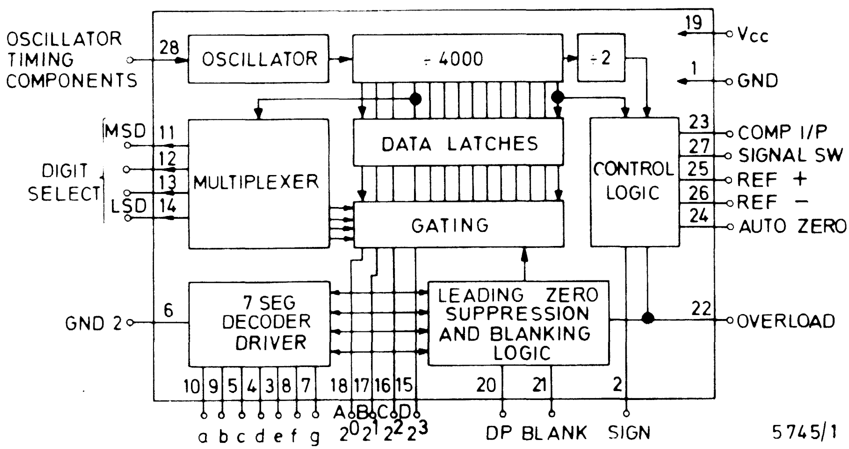
3¾ DIGIT D.V.M LOGIC

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 D.I.L. (H28) package



System Diagram

TELECOMMUNICATIONS CIRCUITS

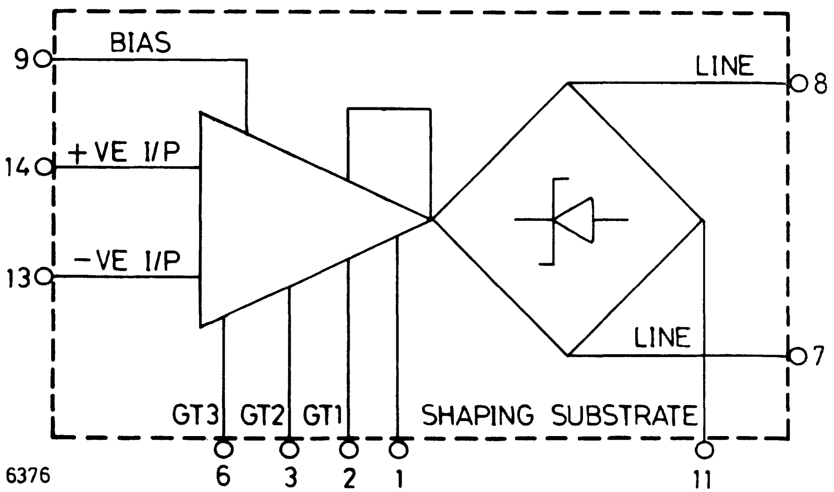
MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN470E

A microphone amplifier developed in conjunction with British Telecom for use with an electret transducer, to replace the carbon transmitter. The amplifier contains a bridge to allow dual polarity operation. The high input impedance makes it suitable for use with high or low impedance microphones providing the microphone gives a high output voltage.

The ZN470 is available in a 14 lead, high dissipation moulded D.I.L. (E14).

FEATURES

- 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
- Monolithic construction
- 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.

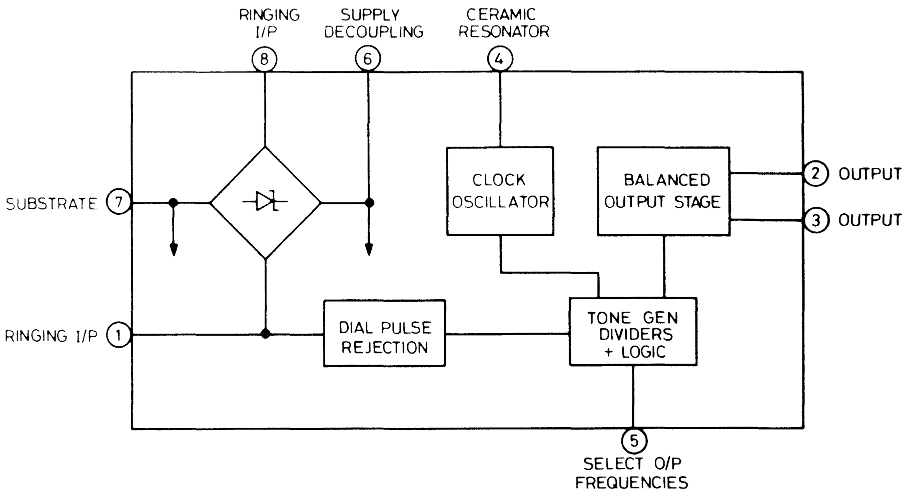
To prevent operation of the circuit on dial pulses from parallel telephones, a digital dial pulse rejection circuit inhibits the output except in the presence of the ringing supply.

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 D.I.L. 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 D.I.L. (E8) 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 pulse 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 D.I.L. packages respectively and moulded or cerdip versions are available.

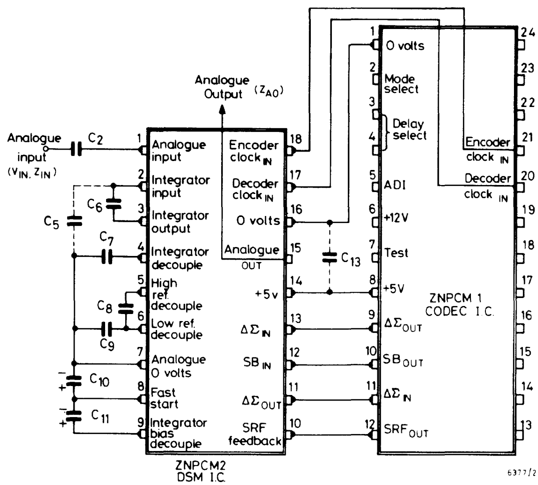
FEATURES

ZNPCM1E/ZNPCM1J

- Converts a delta-sigma modulated digital pulse stream into compressed 'A' law pcm and vice-versa
- Enables realisation of a single-channel codec circuit with minimum component usage
- 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 (2,048kHz 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/ZNPCM2J

- Converts analogue (300-3,400Hz) signals into a delta-sigma modulated pulse stream and vice versa
- Complementary 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.

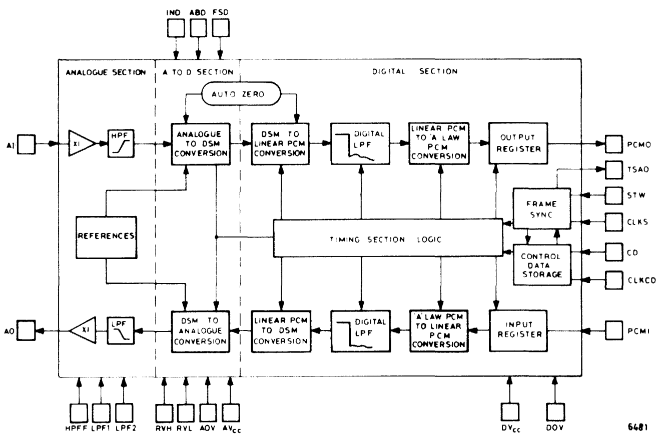
The ZNPCM3 operates from a 2048kHz system clock in the synchronous mode. Operating from a single +5V supply the ZNPCM3 dissipates 250mW when active and 20mW when powered down. It is available in a 28 lead D.I.L package (E28) or (H28) or a moulded chip carrier (Q28) and is designed to operate over the 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 in 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 signal into compressed pcm, and vice-versa, using an on-chip delta-sigma modulated (DSM) code converter
- 'A' law companding characteristic
- Low power dissipation: 250mW (active), 20mW (power down)
- Incorporates ADI
- Minimal external components
- Single +5V supply
- On-chip voltage references: wideband, low noise
- On-chip time-slot assignment circuitry
- On-chip 3rd order analogue input high-pass filter (HPF)



System Diagram

CONTROL CIRCUITS

PRECISION TIMER

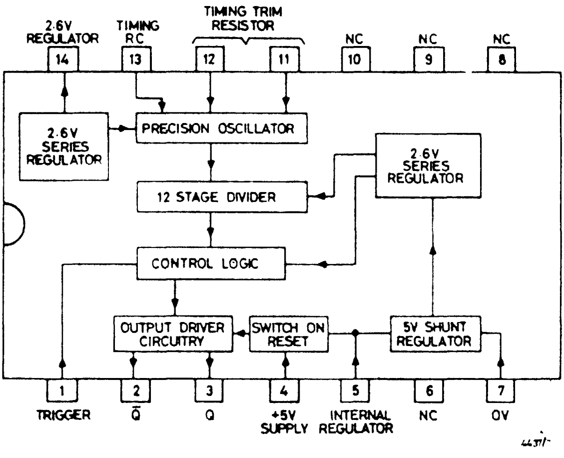
ZN1034E/ZN1034P

The device allows easy construction of simple but precise timing functions which will be ideal in a host of applications.

The frequency of an on-chip oscillator is determined by an externally connected capacitor and adjustable/fixed resistor. In addition, fine adjustment can be achieved by connection of a calibration timing potentiometer. Pulses from the oscillator feed through a 12 stage binary divider which times-out after 4095 counts. The I.C. incorporates its own voltage regulator and two modes of operation can be used. The ZN1034E is contained in a 14 lead moulded D.I.L. (E14) and the ZN1034P is contained in an 8 lead moulded D.I.L. (E8).

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
- −20 to +85°C operation



System Diagram for ZN1034E

ADVANCE INFORMATION
PROGRAMMABLE LONG RANGE MICROPOWER TIMER/COUNTER

ZN1035E

By combining complex linear and digital functions on the same silicon chip, the ZN1035E enables the construction of precision timers to be greatly simplified using low cost components. In most timer applications it provides a direct replacement for mechanical or electromechanical devices.

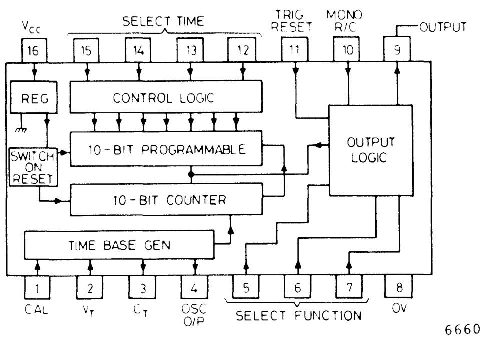
Any one of fifteen different time delays from milliseconds to months can be pre-selected by connecting each of the four SELECT TIME DELAY pins to either the chip supply, pin 16 (HI) or to 0V, pin 8 (LO). Similarly a number of different output modes, Astable, Monostable, Delay On Energise, Interval, Pulsed Interval, Delay to Off and Store Timer, etc. can be programmed by binary coding the three Function Select pins with a HI or LO. Two ZN1035E's can be cascaded to produce a cycling timer, or time delays in excess of 34 years.

The circuit contains a unique high noise immunity time base oscillator, a 7-bit pre-divide counter, a 10-bit programmable counter, control logic, an output buffer latch, a buffered oscillator output, reset and triggering logic.

The control circuitry enables the timing to begin when either (a) with trigger input open circuit the supply goes HI (supply initiation), or (b) with supply HI the trigger input goes from LO to HI (trigger initiation). The I.C. can operate from any voltage in the range of 4.5V to 5.5V d.c. or from any higher voltage by using a suitable voltage dropping resistor.

FEATURES

- Programmable time delays — 15 ranges
- Programmable operation — 12 functions
- Time range — 0.01sec to 3 months
- On-chip regulator or TTL supply option
- 16 lead moulded D.I.L. (E16) package
- High accuracy — 0.1%
- Low temperature coefficient 50ppm/°C
- Low power consumption — 1.5mW
- Wide temperature range −55 to +125°C



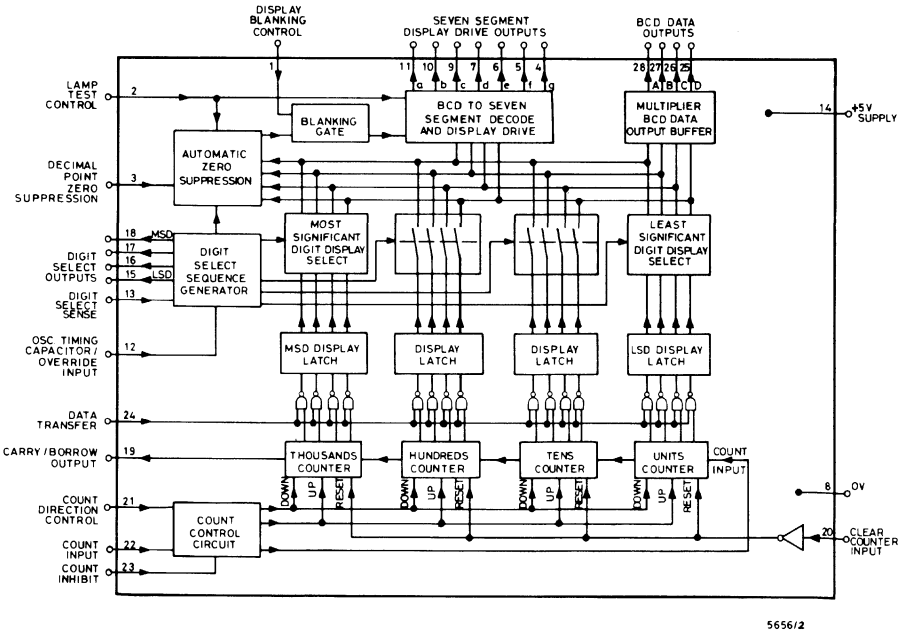
System Diagram

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
- 24 lead moulded D.I.L. (E24) package



System Diagram

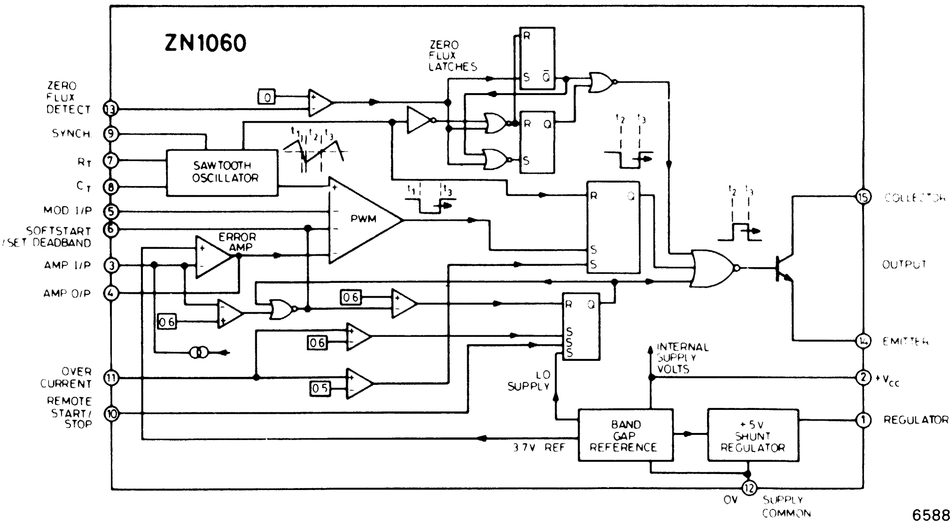
ADVANCE INFORMATION
MONOLITHIC SWITCHING REGULATOR CONTROL CIRCUIT ZN1060

The ZN1060 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 D.I.L. (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

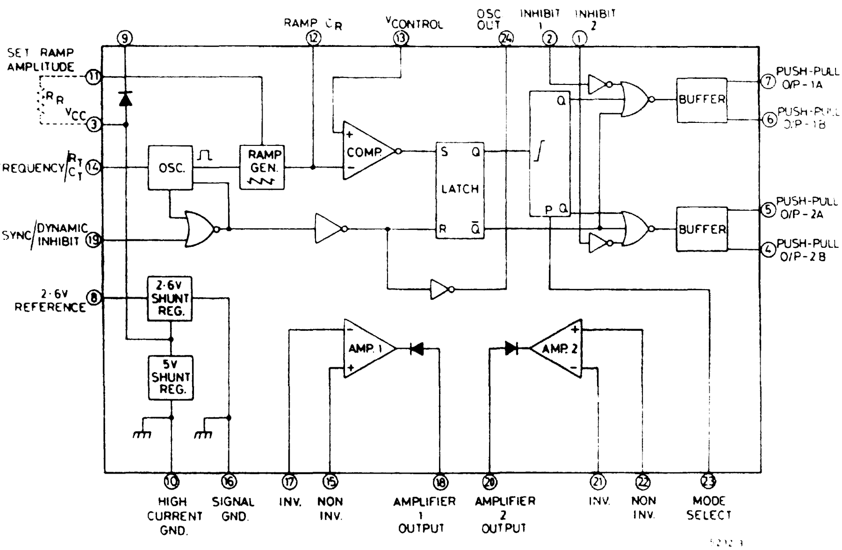
SWITCHED MODE POWER CONTROL CIRCUIT — ZN1066E/ZN1066J

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
- All contained within a 24 lead D.I.L. (E24)
- Inherently hardened to Nuclear Radiation
- Full military performance: ZN1066J
- 24 lead moulded D.I.L. (E24)



System Diagram

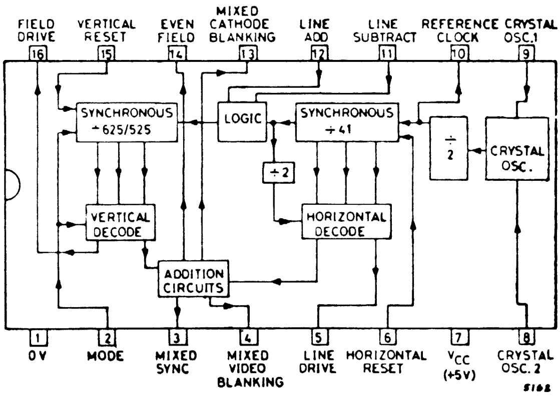
TV SYNCHRONISING PULSE GENERATOR — ZNA134J

The ZNA134J 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 D.I.L. (H16).

*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

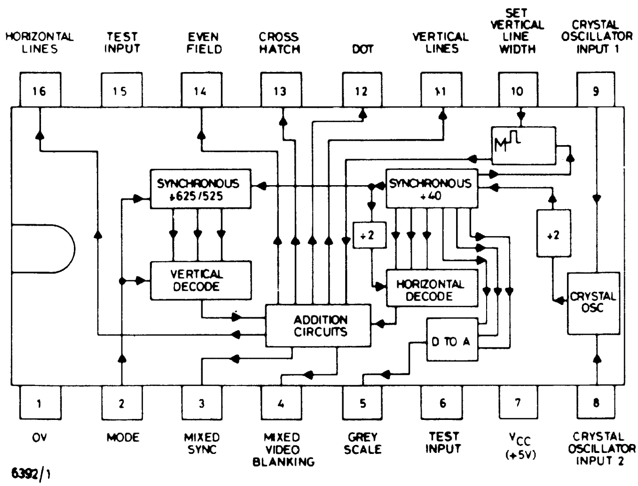
CONTROL CIRCUITS

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 VHF modulator/oscillator for connection to the aerial socket. The device is contained within a 16 lead D.I.L. moulded package (E16).

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

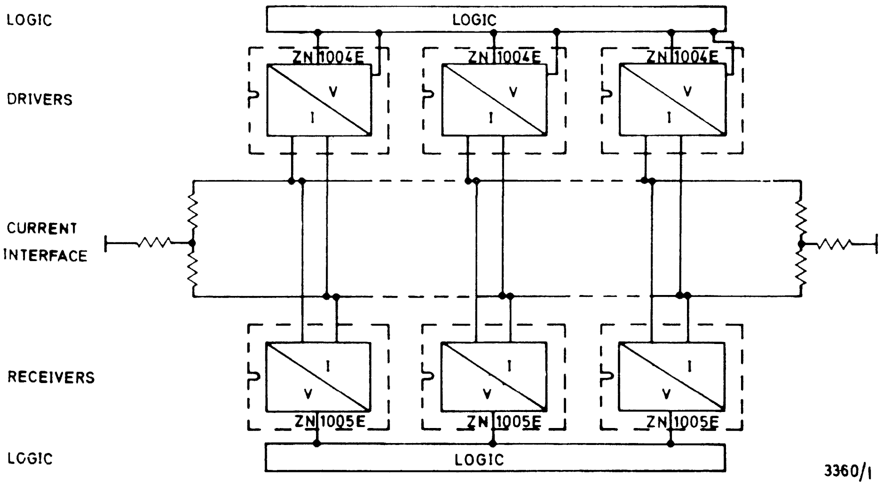
LINE DRIVER AND RECEIVER

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 D.I.L. 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.

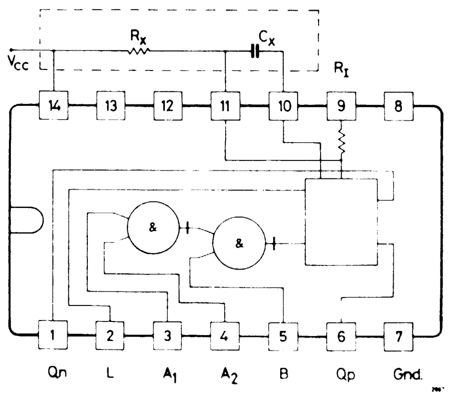
Internal compensation results in excellent pulse width stability with respect to temperature and supply voltage. Typical figures are: ±0.2% of the pulse width at 25°C over the temperature range 0 to +70°C, and a 0.25% variation over the supply voltage range +4.75V to +5.25V.

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

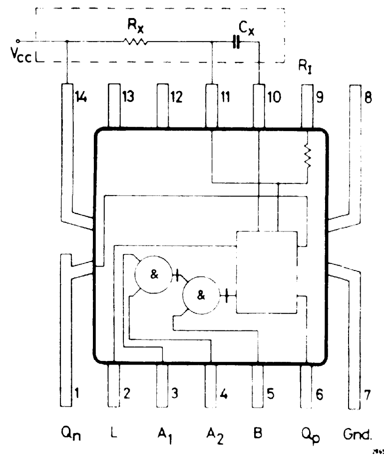
Device packages: ZN1010E/2010E — 14 lead moulded D.I.L. (E14), ZN1010F/2010F — 14 lead ceramic flat-pack (F14)

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

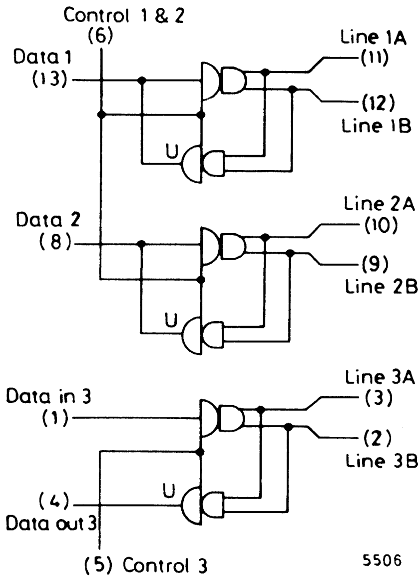
The ZN1025 is basically a triple line-driver/receiver designed for interfacing between control processor units on a common biased highway. The device operates at very fast speeds giving a typical delay, between the input of the transmitter and the output of the receiver, of 22ns. This, combined with 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 D.I.L. (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

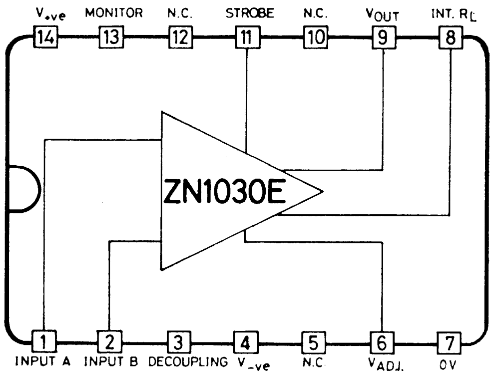
INTERFACE CIRCUITS

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 D.I.L. package (E14).

FEATURES

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

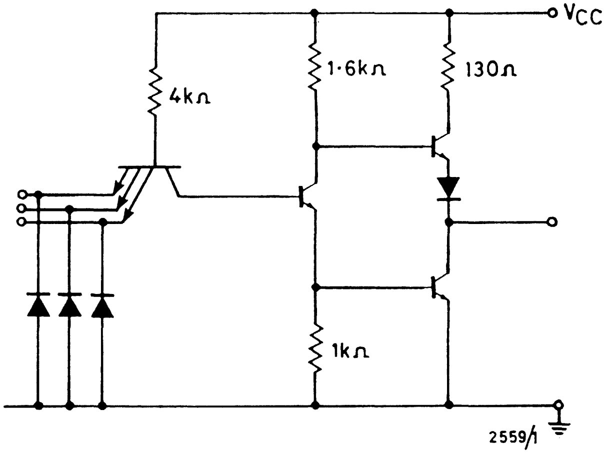


3224/1

INTERFACE CIRCUITS

Type No.	Description	Package	Temperature Range
ZN5524E	Dual Sense Amplifier	Moulded D.I.L.	−55 to +125°C
ZN5524J	Dual Sense Amplifier	Ceramic D.I.L.	−55 to +125°C
ZN55234E	Dual Sense Amplifier	Moulded D.I.L.	−55 to +125°C
ZN55234J	Dual Sense Amplifier	Ceramic D.I.L.	−55 to +125°C
ZN7524E	Dual Sense Amplifier	Moulded D.I.L.	0 to +70°C
ZN7524J	Dual Sense Amplifier	Ceramic D.I.L.	0 to +70°C
ZN75234E	Dual Sense Amplifier	Moulded D.I.L.	0 to +70°C
ZN75234J	Dual Sense Amplifier	Ceramic D.I.L.	0 to +70°C

SERIES 5400/7400



Equivalent Basic Function

FEATURES

- High speed (typical propagation delay 10ns) combined with low power dissipation (typically 10mW per gate)
- High fan-out — maximum 10
- High noise immunity — typically 1V at $T_{amb} = 25°C$
- Low output impedance in both states
- Supply voltage of 5V
- Choice of three packages

	Typical Propagation Delay	Temperature Range	Package
Series 5400			
Series 5400J	10ns	−55 to +125°C	Ceramic Dual In-line (H14)
Series 5400F	10ns	−55 to +125°C	Flat-pack (F14)
Series 7400			
Series 7400J	10ns	0 to +70°C	Ceramic Dual In-line (H14)
Series 7400E	10ns	0 to +70°C	Moulded Dual In-line (E14)

TTL

PRODUCT RANGE

Series 5400	Series 7400	Description
ZN5400	ZN7400	Quad 2-Input NAND Gate
ZN5401	ZN7401	Quad 2-Input NAND Gate (with Free Collectors)
ZN5402	ZN7402	Quad 2-Input NOR Gate
ZN5403	ZN7403	Quad 2-Input NAND Gate (with Free Collectors)
ZN5404	ZN7404	Hex Inverter
ZN5405	ZN7405	Hex Inverter (with Free Collectors)
ZN5408	ZN7408	Quad 2-Input AND Gate
ZN5409	ZN7409	Quad 2-Input AND Gate (with Free Collectors)
ZN5410	ZN7410	Triple 3-Input NAND Gate
ZN5412	ZN7412	Triple 3-Input NAND Gate (with Free Collectors)
ZN5413	ZN7413	Dual 4-Input Schmitt Trigger
ZN5420	ZN7420	Dual 4-Input NAND Gate
ZN5425	ZN7425	Dual 4-Input NOR Gate with Strobe
ZN5427	ZN7427	Triple 3-Input NOR Gate
ZN5428	ZN7428	Quad 2-Input NOR Buffer
ZN5430	ZN7430	Single 8-Input NAND Gate
ZN5432	ZN7432	Quad 2-Input OR Gate
ZN5437	ZN7437	Quad 2-Input NAND Buffer
ZN5438	ZN7438	Quad 2-Input NAND Buffer (with Free Collectors)
ZN5440	ZN7440	Dual 4-Input NAND Buffer
ZN5442	ZN7442	BCD — Decimal Decoder
ZN5450	ZN7450	Dual 2-Wide 2-Input AND-OR-INVERT Gate (Expansible)
ZN5451	ZN7451	Dual 2-Wide 2-Input AND-OR-INVERT Gate
ZN5453	ZN7453	4-Wide 2-Input AND-OR-INVERT Gate (Expansible)
ZN5454	ZN7454	4-Wide AND-OR-INVERT Gate
ZN5470	ZN7470	J K Bistable
ZN5472	ZN7472	Master-Slave J K Bistable
ZN5473	ZN7473	Dual Master-Slave J K Bistable (Ground Pin 11)
ZN5474	ZN7474	Dual D-Type Bistable
ZN5475	ZN7475	Quad Latch
ZN5476	ZN7476	Dual Master-Slave J K Bistable with separate Preset and Clear
ZN5482	ZN7482	2-bit Binary Full Adder
ZN5483A	ZN7483A	4-bit Binary Full Adder
ZN5485	ZN7485	4-bit Comparator
ZN5486	ZN7486	Quad 2-Input Exclusive-OR Gate
ZN5489	ZN7489	64-bit RAM
ZN5490A	ZN7490A	BCD Decade Counter
ZN5491A	ZN7491A	8-bit Shift Register
ZN5492A	ZN7492A	Divide-by-12 Counter
ZN5493A	ZN7493A	Divide-by-16 Counter
ZN5494	ZN7494	4-bit Shift Register PISO
ZN5495A	ZN7495A	4-bit Up/Down Shift Register PIPO
ZN5496	ZN7496	5-bit Shift Register PIPO
ZN54107	ZN74107	Dual Master-Slave J K Bistable (Ground Pin 7)
ZN54118	ZN74118	Hex S-R Latch
ZN54119	ZN74119	Hex S-R Latch
ZN54121	ZN74121	Monostable Multivibrator (with Schmitt Trigger Inputs)
ZN54122	ZN74122	Monostable Multivibrator (Retriggerable)

Continued overleaf

PRODUCT RANGE *(continued)*

Series 5400	Series 7400	Description
ZN54123	ZN74123	Dual Monostable Multivibrator (Retriggerable)
ZN54150	ZN74150	16-to-1-line Data Selector/Multiplexer
ZN54151	ZN74151	8-to-1-line Data Selector/Multiplexer
ZN54153	ZN74153	Dual 4-to-1-line Data Selector/multiplexer
ZN54154	ZN74154	4-16-line Decoder/Demultiplexer
ZN54155	ZN74155	Dual 2-to-4-line Decoder/Demultiplexer
ZN54157	ZN74157	Quad 2-to-1-line Data Selector/Multiplexer
ZN54161	ZN74161	Synchronous Binary Counter
ZN54163	ZN74163	Synchronous Binary Counter
ZN54164	ZN74164	8-bit Shift Register SIPO
ZN54165	ZN74165	8-bit Shift Register PISO
ZN54166	ZN74166	8-bit Shift Register PISO
ZN54170	ZN74170	4-by-4 Register File
ZN54174	ZN74174	Hex D-Type Bistable
ZN54175	ZN74175	Quad D-Type Bistable
ZN54180	ZN74180	8-bit Parity Generator
ZN54181	ZN74181	4-bit Arithmetic Logic Unit
ZN54184	ZN74184	BCD-to-Binary Converter
ZN54191	ZN74191	Reversible Binary Counter
ZN54192	ZN74192	Reversible Decade Counter
ZN54193	ZN74193	Reversible Binary Counter
ZN54194	ZN74194	4-bit Shift Register

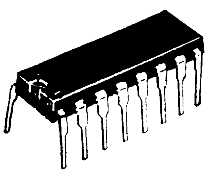
BS9000 TTL

A list of Ferranti types which are approved to BS9000 can be found in the Approved Products section of this handbook.

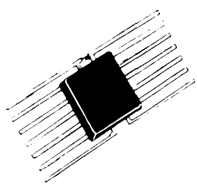
This list also includes BSS11 and BSS12 approved ZN74 Series TTL types which are equivalent to British Telecom D3000A and D3000B Specifications.

Further information can be found in the "Ferranti Electronics BS9000/CN Qualified Approvals for Integrated Circuits" leaflet available on request from Ferranti Electronics Limited.

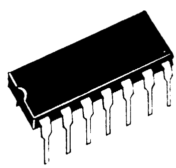
AVAILABLE PACKAGES



16 Lead D.I.L.



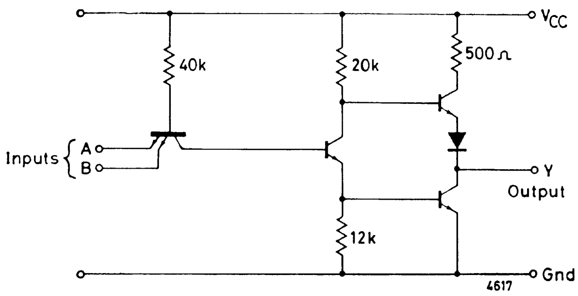
14 Lead Flat-Pack



14 Lead D.I.L

LOW POWER TTL

SERIES 54L00/74L00



Equivalent Basic Function

FEATURES

- Very low power dissipation — typically 1 mW per gate at 50% duty cycle
- Relatively high speed — typical propagation delay time of 33 ns
- High noise immunity — typically 1V at $T_{amb} = 25°C$
- Low output impedance in both states
- High fan-out — maximum 10
- Compatible with most other logic families — supply voltage 5V
- Choice of ceramic or moulded D.I.L. package

	Typical Propagation Delay	Temperature Range	Package
Series 54L00			
Series 54L00J	33 ns	−55 to +125°C	Ceramic Dual In-line (H14)
Series 74L00			
Series 74L00E	33 ns	0 to +70°C	Moulded Dual In-line (E14)
Series 74L00J	33 ns	0 to +70°C	Ceramic Dual In-line (H14)

PRODUCT RANGE

Series 54L00	Series 74L00	Description
ZN54L00	ZN74L00	Quad 2-Input NAND Gate
ZN54L01	ZN74L01	Quad 2-Input NAND Gate (with Free Collectors)
ZN54L02	ZN74L02	Quad 2-Input NOR Gate
ZN54L03	ZN74L03	Quad 2-Input NAND Gate (with Free Collectors)
ZN54L04	ZN74L04	Hex Inverter
ZN54L10	ZN74L10	Triple 3-Input NAND Gate
ZN54L20	ZN74L20	Dual 4-Input NAND Gate
ZN54L30	ZN74L30	Single 8-Input NAND Gate
ZN54L42	ZN74L42	BCD Decimal Decoder
ZN54L51	ZN74L51	Dual 2-Wide AND-OR-INVERT Gate
ZN54L54	ZN74L54	4-Wide AND-OR-INVERT Gate
ZN54L55	ZN74L55	2-Wide 4-Input AND-OR-INVERT Gate
ZN54L73	ZN74L73	Dual Master-Slave J K Bistable
ZN54L74	ZN74L74	Dual D-Type Bistable
ZN54L75	ZN74L75	Quad Latch
ZN54L85	ZN74L85	4-bit Comparator
ZN54L86	ZN74L86	Quad 2-Input Exclusive-OR Gate
ZN54L90	ZN74L90	BCD Decade Counter
ZN54L91	ZN74L91	8-bit Shift Register SISO
ZN54L93	ZN74L93	Divide-by-16 Counter
ZN54L95	ZN74L95	4-bit Up/Down Shift Register PIPO
ZN54L96	ZN74L96	5-bit Shift Register PIPO
ZN54L122	ZN74L122	Monostable Multivibrator (Retriggerable)
ZN54L164	ZN74L164	8-bit Shift Register SIPO
ZN54L192	ZN74L192	Reversible Decade Counter
ZN54L193	ZN74L193	Reversible Binary Counter

BS9000 LOW POWER TTL

A list of Ferranti LTTL types which are approved to BS9000 can be found in the Approved Products section of this handbook.

This list also includes BSS11 and BSS12 approved ZN74 Series LTTL types which are equivalent to British Telecom D3000A and D3000B Specifications.

Further information can be found in the "Ferranti Electronics BS9000/CN Qualified Approvals for Integrated Circuits" leaflet available on request from Ferranti Electronics Limited.

DTL

MICRONOR 2 SERIES

Micronor 2 is a complete series of monolithic diode transistor logic circuits designed to serve a broad range of digital system requirements.

FEATURES

- Supply voltage 4.5V
- Power dissipation 19mW
- Fan-out of 8
- Wire-OR throughout the series
- Noise Immunity 1V
- Multiple circuit functions
- Two compatible speed ranges
- Two temperature ranges for military and industrial usage
- Three package options: TO-99, Flat-pack and low profile Dual In-line
- Pin compatible with 930 DTL
- CN Approved Types (see Approved Products section of book)

DTL PRODUCT RANGE

Series 50	Series 80	Description
ZSD51A	ZSD81A	5-Input Diode OR Expander
ZSF51B	ZSF81B	J K Bistable
ZSF51CT	ZSF81CT	J K Bistable with Set and Reset
ZSS51A	ZSS81A	4-Input NOR Gate
ZSS51B	ZSS81B	4-Input NOR gate
ZSS53A	ZSS83A	Dual 2-Input NOR Gate
ZSS53B	ZSS83B	Dual 2-Input NOR Gate
ZSS54A	ZSS84A	Triple Inverter
ZSS54B	ZSS84B	Triple Inverter
ZSS55A	ZSS85A	5-Input NOR Gate
ZSS55B	ZSS85B	5-Input NOR Gate
ZSS56B	ZSS86B	Equivalence Element
ZSS57B	ZSS87B	4-Input NOR/OR Gate
ZSS58	ZSS88	Dual Interface Gate
ZSS59A	ZSS89A	Dual 2-Input NOR Gate with Extender
ZSS59B	ZSS89B	Dual 2-Input NOR Gate with Extender
ZST51A	ZST81A	5-Input Power NOR Gate
ZST52A	ZST82A	Dual 2-Input Power OR Gate
ZST52B	ZST82B	Dual 2-Input Power OR Gate
ZST53A	ZST83A	Dual 2-Input Power NOR Gate
ZST53B	ZST83B	Dual 2-Input Power NOR Gate
ZST54A	ZST84A	4-Input Power NOR Gate

Note: Unless otherwise stated, suffix 'A' indicates gates with free collector outputs and suffix 'B' indicates gates with internal loads.

DTL PRODUCT RANGE *(continued)*

Series 200	Series 200E*	Series 300	Series 300E*	Description
ZN219	ZN219E	ZN319	ZN319E	Dual 4-Input Power OR Gate with Free Collectors
ZN220	ZN220E	ZN320	ZN320E	Dual 4-Input Power OR Gate
ZN221	ZN221E	ZN321	ZN321E	J K Bistable
ZN222	ZN222E	ZN322	ZN322E	Dual J K Bistable
ZN224	ZN224E	ZN324	ZN324E	Quad 2-Input NOR Gate
ZN225	ZN225E	ZN325	ZN325E	Quad 2-Input NOR Gate
ZN226	ZN226E	ZN326	ZN326E	Hex Inverter with Free Collector Output
ZN227	ZN227E	ZN327	ZN327E	Dual 4-Input NOR Gate
ZN228	ZN228E	ZN328	ZN328E	Triple 3-Input NOR Gate
ZN229	ZN229E	ZN329	ZN329E	Dual 5-Input NOR Gate
ZN230	ZN230E	ZN330	ZN330E	Dual 4-Input NOR Gate
ZN232	ZN232E	ZN332	ZN332E	Dual 4-Input Power NOR Gate with Active Pull-up Output
ZN233	ZN233E	ZN333	ZN333E	Dual 4-Input Diode-OR Expander
ZN236	ZN236E	ZN336	ZN336E	Hex Inverter
ZN244	ZN244E	ZN344	ZN344E	Dual 4 Input Power NOR Gate
ZN246	ZN246E	ZN346	ZN346E	Quad 2-Input NOR Gate
ZN248	ZN248E	ZN348	ZN348E	Master-Slave J K Bistable
ZN250	ZN250E	ZN350	ZN350E	Shift Function
ZN262	ZN262E	ZN362	ZN362E	Triple 3-Input NOR Gate
ZN294	ZN294E	ZN394	ZN394E	Dual Master-Slave Bistable
ZN297	ZN297E	ZN397	ZN397E	Dual Master-Slave Bistable

*Also available in Series 200HE and Series 300HE where supply voltage is 5V.

	Typical Propagation Delay	Temperature Range	Package
MICRONOR 2 High Speed DTL			
Series 50	9ns	−55 to +125°C	TO-99 (T8a)
Series 80	9ns	0 to +70°C	TO-99 (T8a)
Series 200	9ns	−55 to +125°C	Ceramic Flat-pack (F14)
Series 200E	9ns	0 to +70°C	Moulded Dual In-line (E14)
MICRONOR 2 DTL			
Series 300	15ns	−55 to +125°C	Ceramic Flat-pack (F14)
Series 300E	15ns	0 to +70°C	Moulded Dual In-line (E14)

Note: The term TO-99 is used to describe approximate size of can only.

F100-L 16-BIT MICROPROCESSOR SYSTEM

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 possessing a high degree of radiation tolerance which is of paramount importance in modern military and space orientated projects.

The microprocessor is encapsulated in a 40 lead package (H40) or (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 both the F100-L and F101-L.

The clock generator is encapsulated in a 16 lead package (H16) or (M16).

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 package (H40) or (K40).

INTERFACE SET F111-L AND F112-L

An interface set of one F111-L (Control Interface) and two F112-Ls (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 packages (E40), (H40) or (K40).

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 packages (H24) or (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).

All 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. High Reliability Space Specification devices are also available on special request.

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 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 D.I.L'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.

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 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.

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 ZNA5C001) 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 ZNA5C002) 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 (ZNA5C001CJ, ZNA5C002CJ), military temperature range (ZNA5C001AJ, ZNA5C002AJ) and as a special option to the military temperature range with a 160 hour burn-in (ZNA5C001AJ-S4, ZNA5C002AJ-S4). Both devices are encapsulated in 40 lead ceramic packages (H40).

INTERRUPT VECTOR CHIP (ZNA5C038)

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 (H40) to commercial or military temperature range specification (ZNA5C038CJ and ZNA5C038AJ) respectively.

EUROBUS ARBITER CHIP (ZNA5C054)

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.

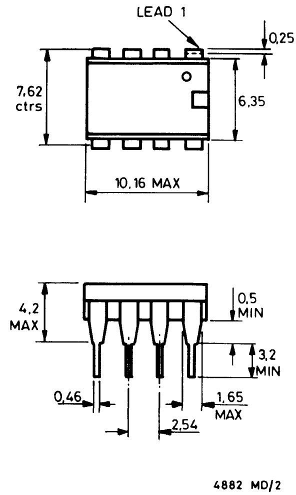
The device is available in a 40 lead pack (H40) for commercial (ZNA5C054CJ) or military (ZNA5C054AJ) temperature range use.

For detailed information on Eurobus and Argus M700 systems please contact:

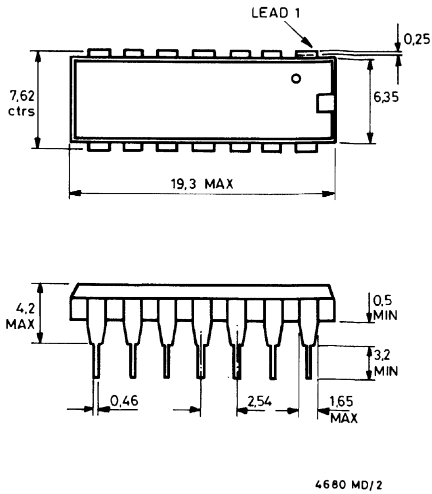
Ferranti Computer Systems Limited, Computer Sales Department, Ty Coch Way, Cwmbran, Gwent, NP44 7XX TEL: CWMBRAN (06333) 71111 TELEX: 497636

SECTION 4 : PACKAGE OUTLINES

PACKAGE OUTLINES



8 LEAD MOULDED DIL (E8)



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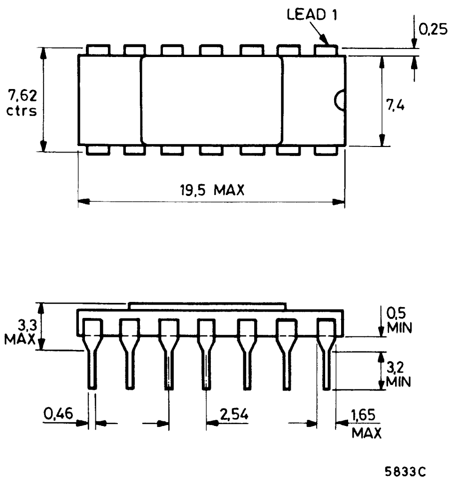
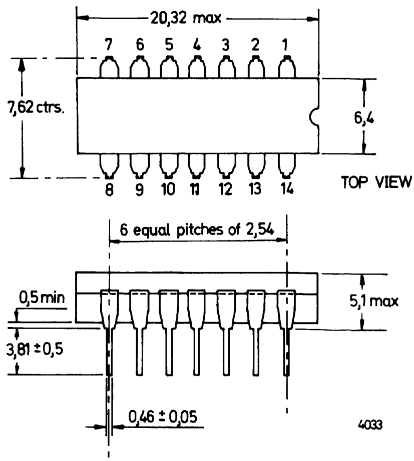


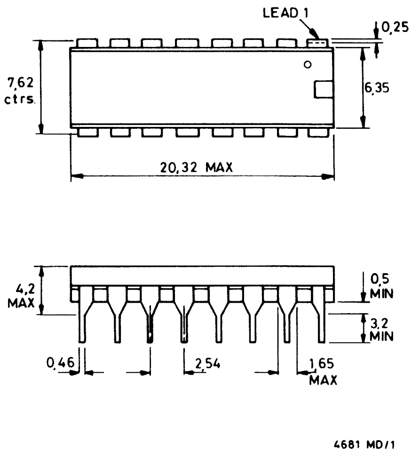
14 LEAD CERAMIC DIL (H14)



14 LEAD CERDIP (J14)

Dimensions in millimetres

PACKAGE OUTLINES



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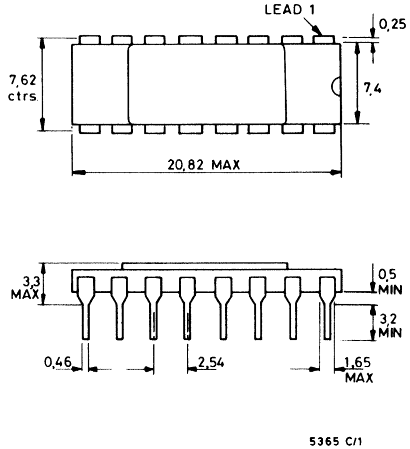

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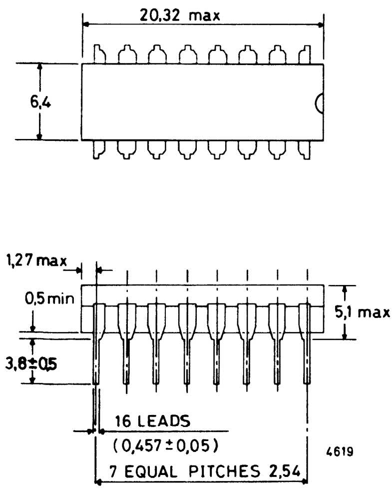

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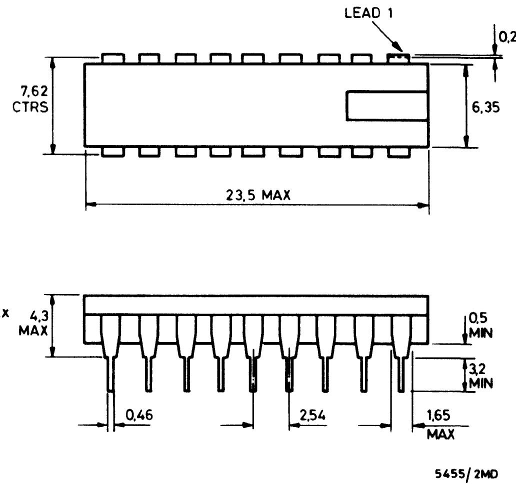
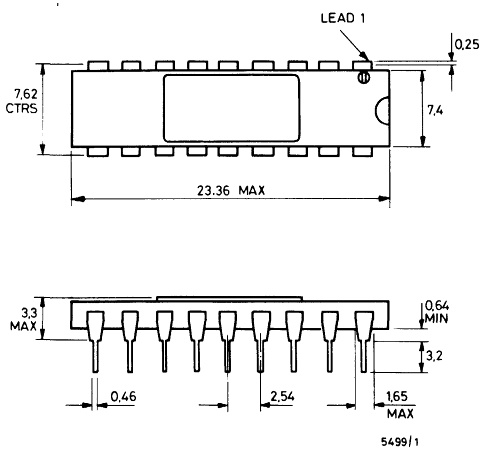


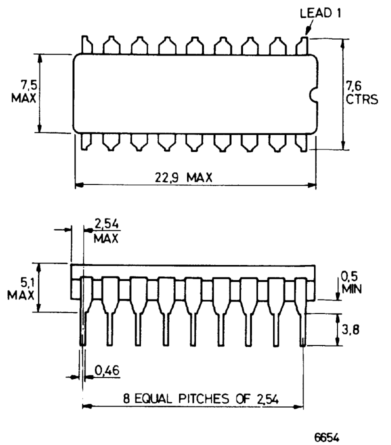
18 LEAD MOULDED DIL (E18)

Dimensions in millimetres

PACKAGE OUTLINES



18 LEAD CERAMIC DIL (H18)



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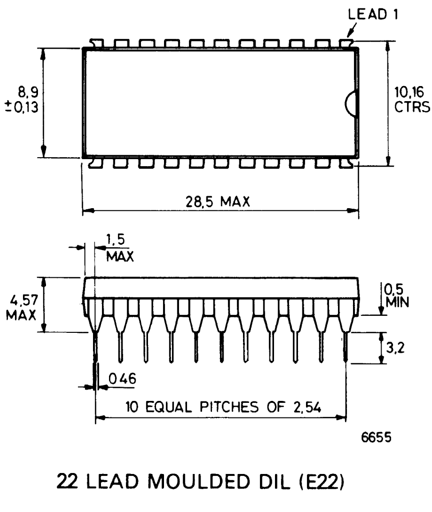

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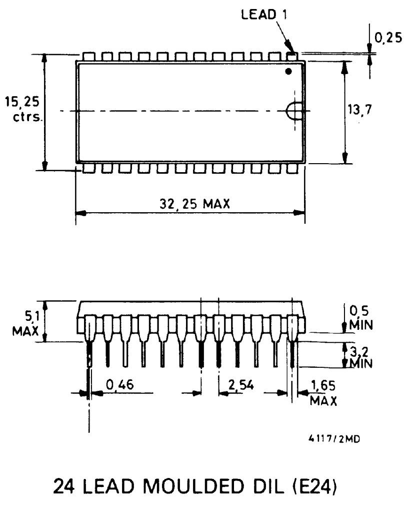
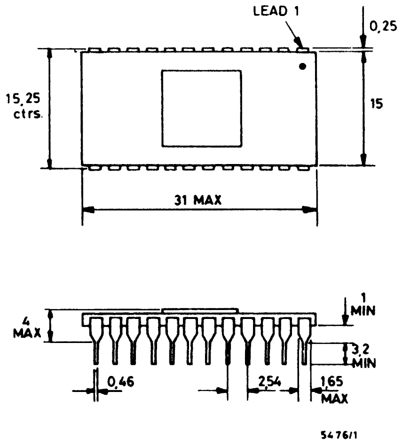


24 LEAD MOULDED DIL (E24)

Dimensions in millimetres



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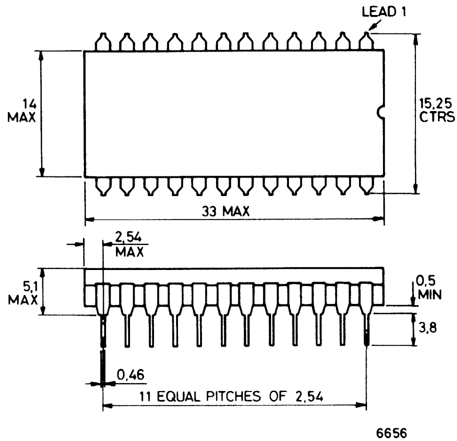
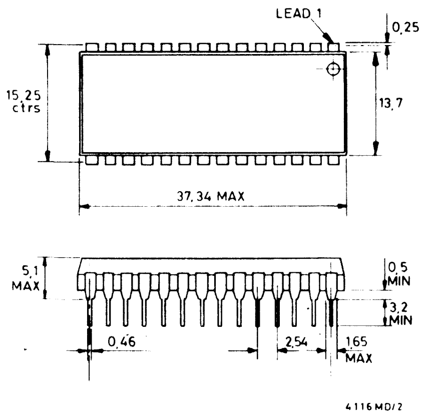


24 LEAD CERDIP DIL (J24)



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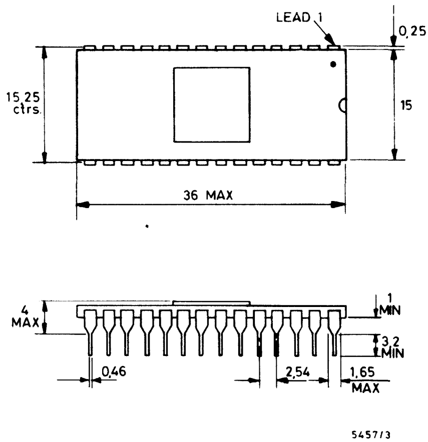
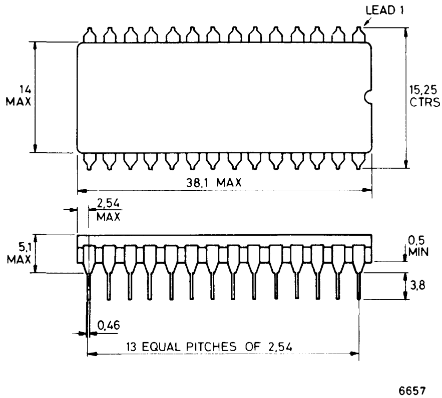


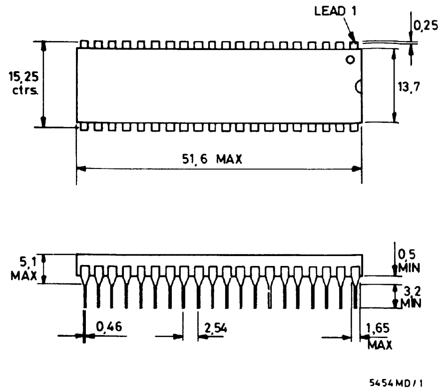
28 LEAD CERAMIC DIL (H28)

Dimensions in millimetres

PACKAGE OUTLINES



28 LEAD CERDIP (J28)



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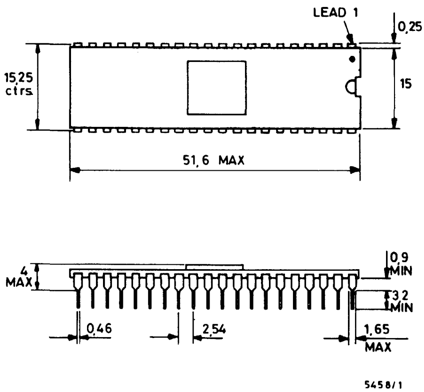

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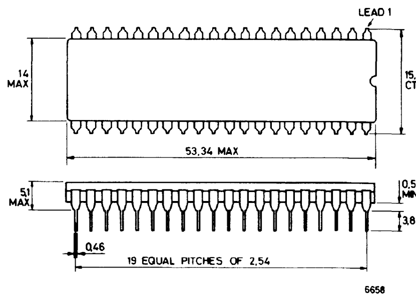
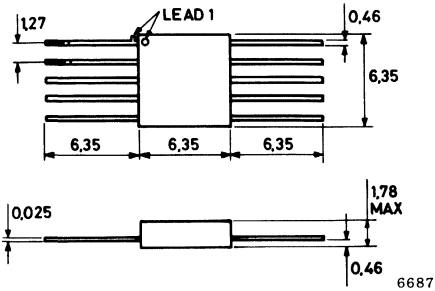
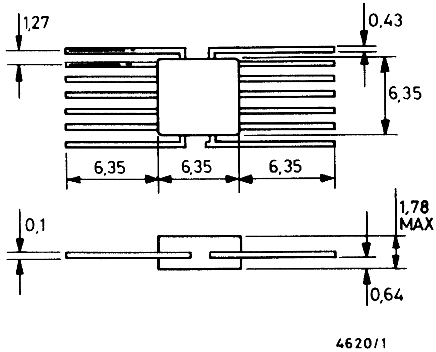


40 LEAD CERDIP (J40)

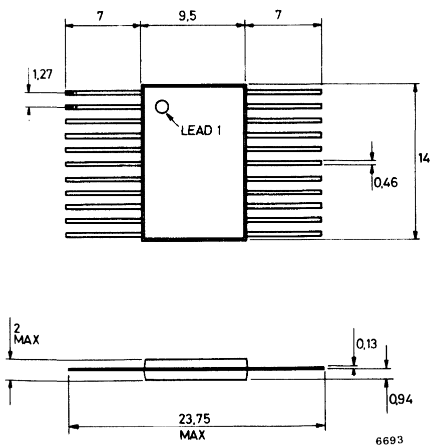
Dimensions in millimetres



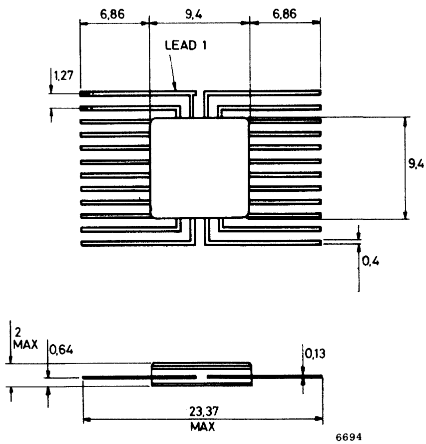
10 LEAD CERAMIC FLAT-PACK (F10)



14 LEAD CERAMIC FLAT-PACK (F14)



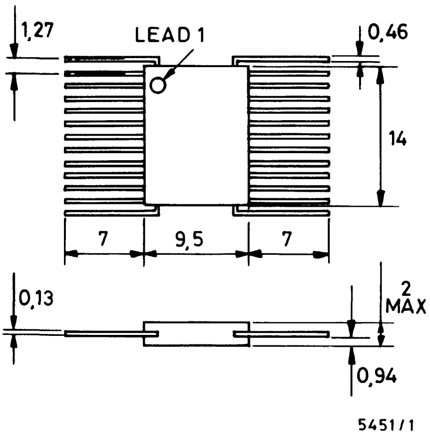
22 LEAD MOULDED FLAT-PACK (G22)



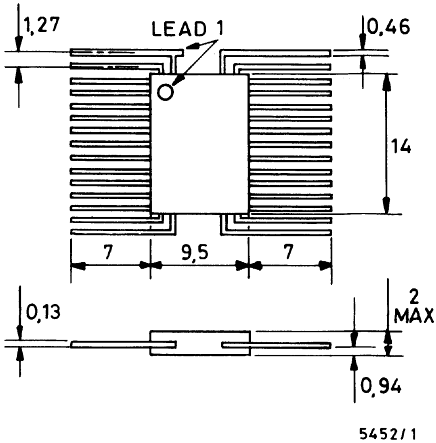
24 LEAD CERAMIC FLAT-PACK (F24)

Dimensions in millimetres

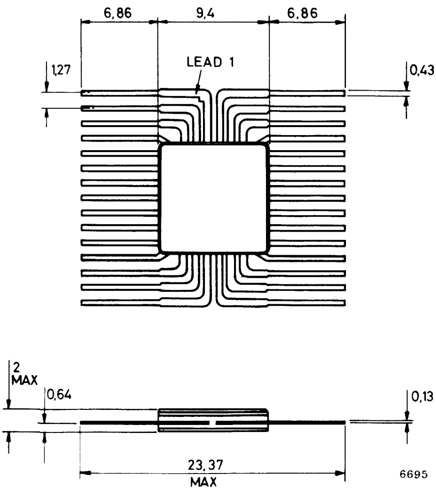
PACKAGE OUTLINES



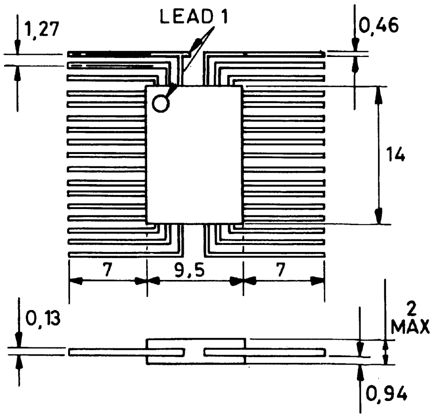
26 LEAD MOULDED FLAT-PACK (G26)



30 LEAD MOULDED FLAT-PACK (G30)



30 LEAD CERAMIC FLAT-PACK (F30)

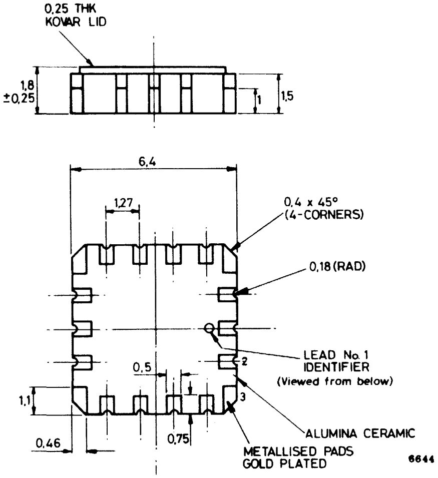


34 LEAD MOULDED FLAT-PACK (G34)

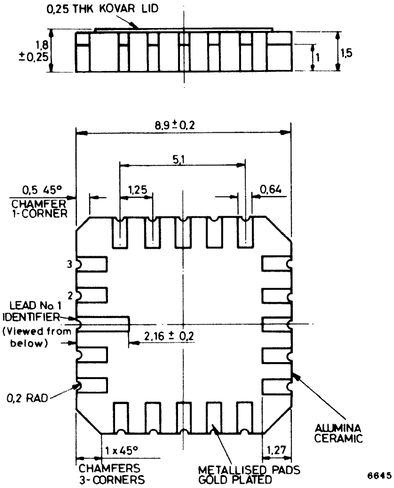
Dimensions in millimetres

PACKAGE OUTLINES

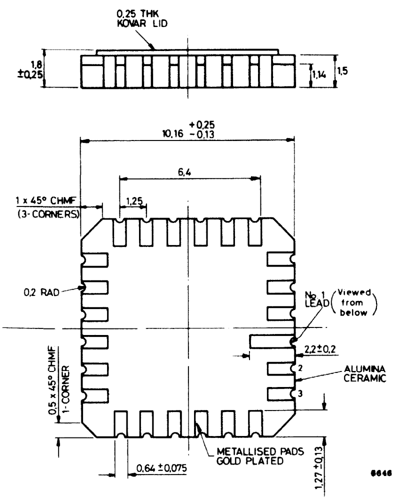
CHIP CARRIERS



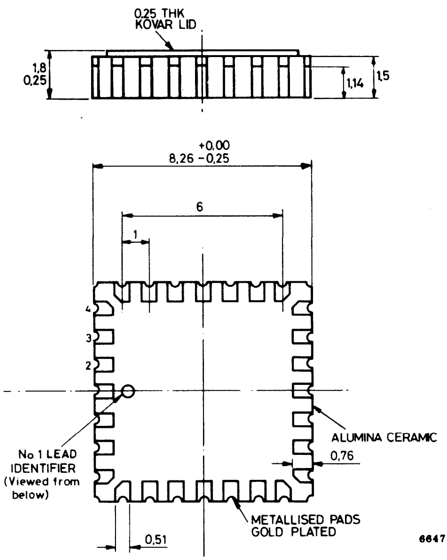
18 LEAD CERAMIC (M18)



20 LEAD CERAMIC (M20)



24 LEAD Ceramic (M24)

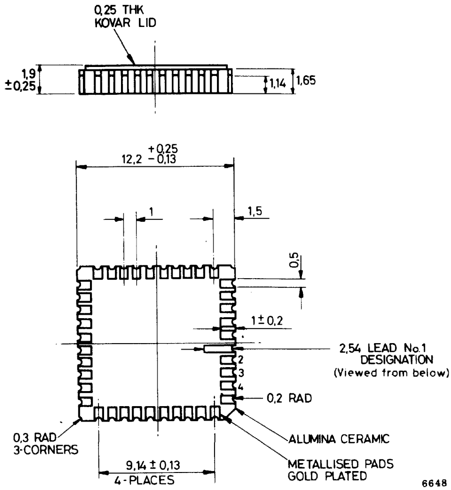


28 LEAD CERAMIC (K28)

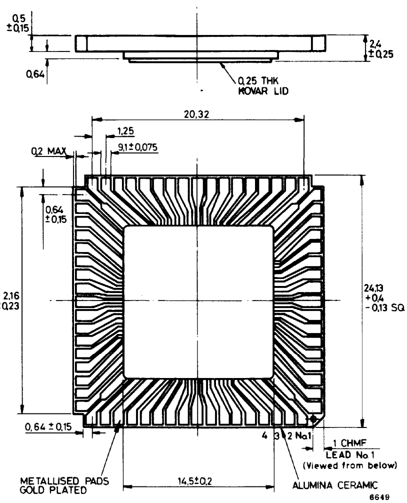
Dimensions in millimetres

PACKAGE OUTLINES

CHIP CARRIERS

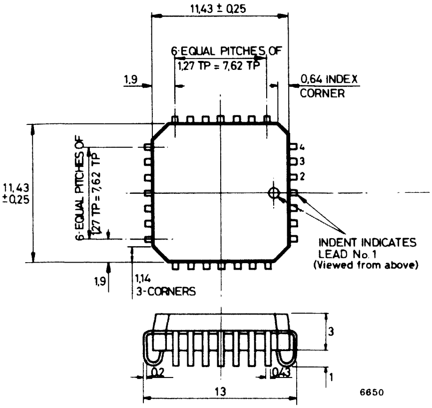


40 LEAD CERAMIC (K40)

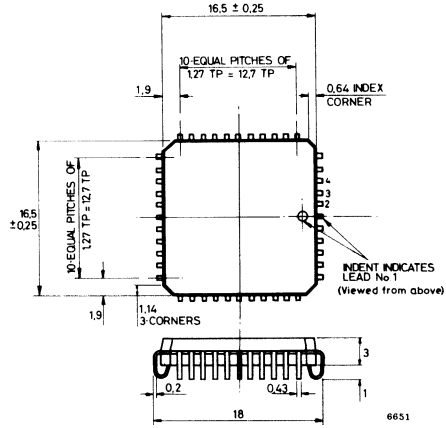


68 LEAD CERAMIC (M68)

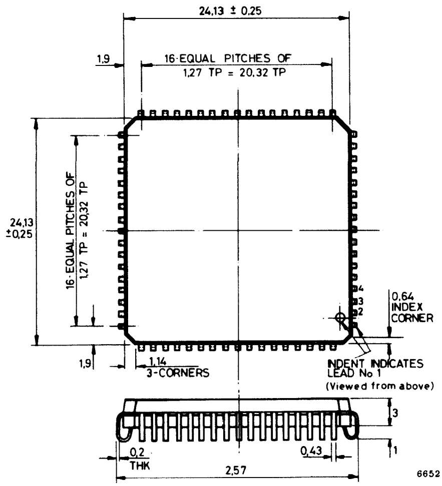
Dimensions in millimetres



28 LEAD MOULDED (Q28)



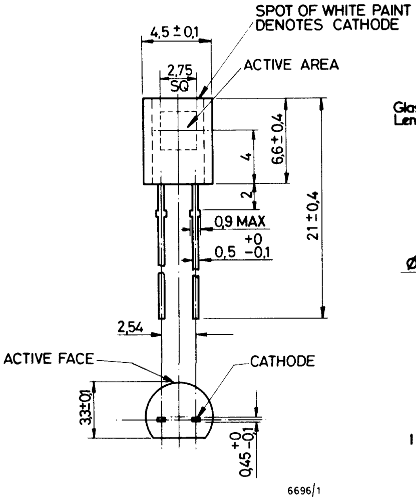
44 LEAD MOULDED (Q44)



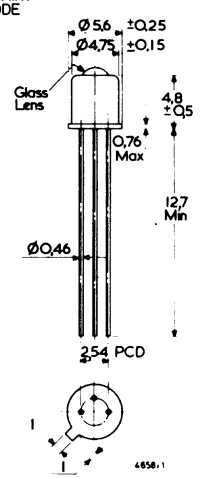
68 LEAD MOULDED (Q68)

Dimensions in millimetres

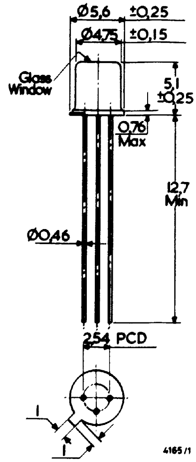
PACKAGE OUTLINES



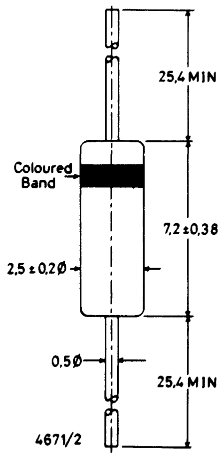
BPW41D



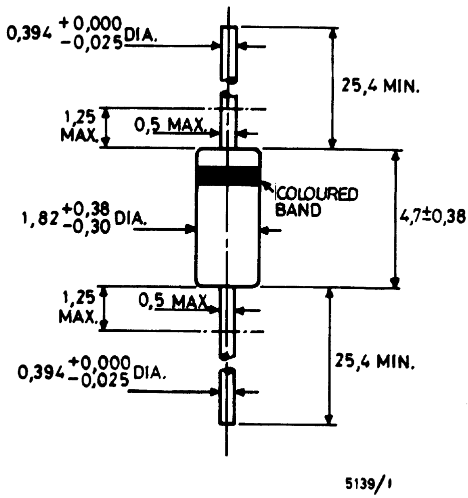
BPX25 ZM100/110



BPX29



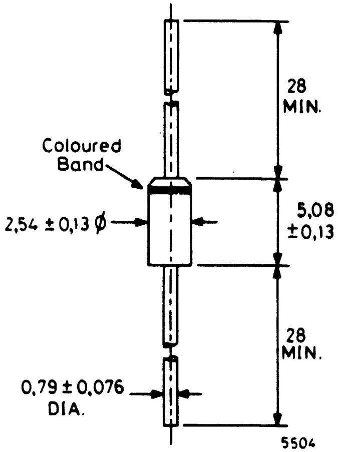
DO-7 (Glass)*



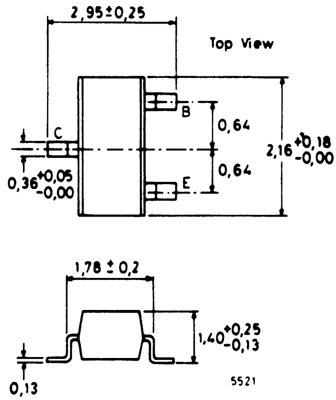
DO-35*

*Cathode end is marked with a coloured band

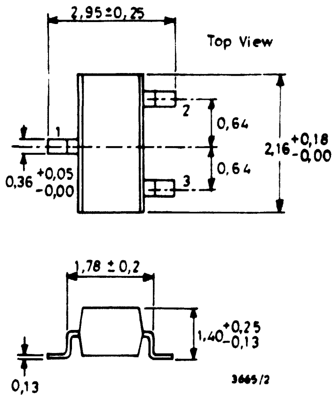
Dimensions in millimetres



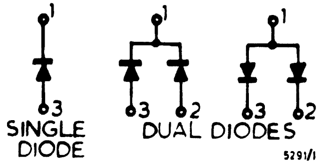
DO-41 (Plastic)*



MICRO-E (Transistor)



MICRO-E (Diode)

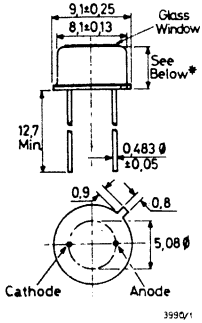


MICRO-E (Diode) Pin Connections

*Cathode end is marked with a coloured band

Dimensions in millimetres

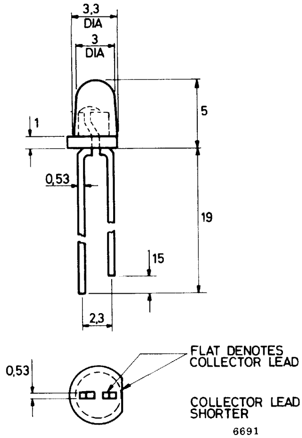
PACKAGE OUTLINES



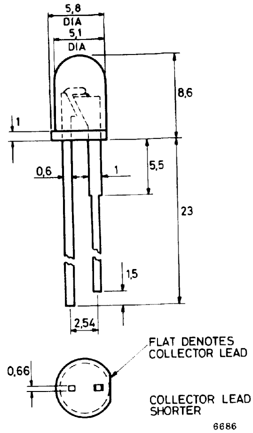
MS600/601

MS600 height = 4,8 ± 0,4

MS601 height = 6,7 ± 0,4



ZMP31



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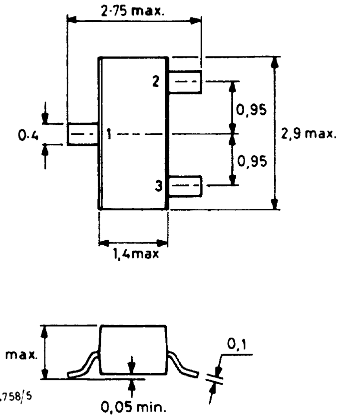
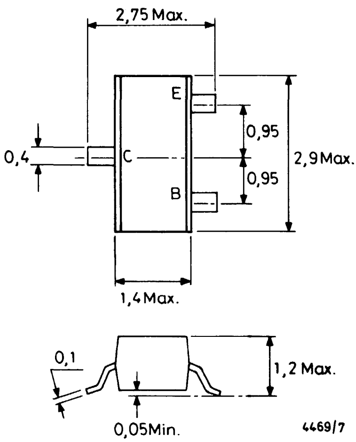
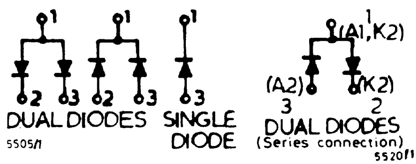


SOT-23 (Transistor)

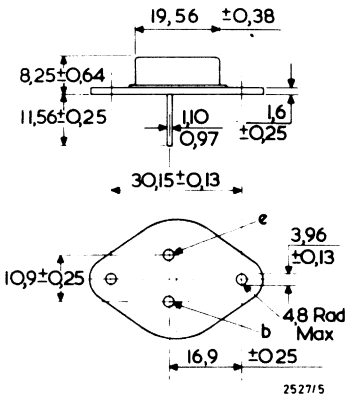


SOT-23 (Diode)

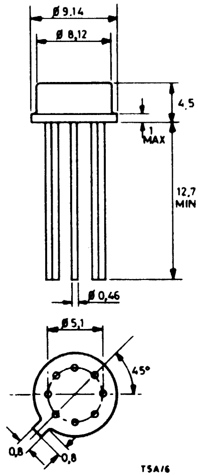


SOT-23 (Diode) Pin Connections

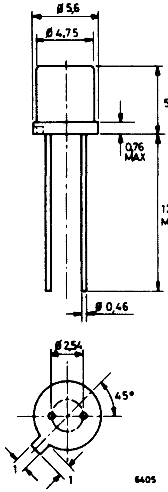
Dimensions in millimetres



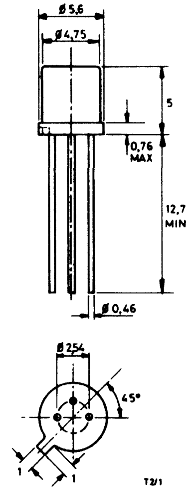
TO-3



TO-5 (ZNP100 8 Lead Glass Window)



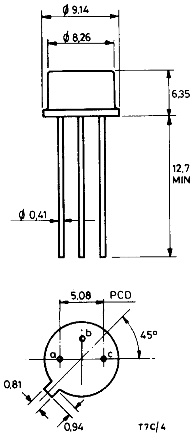
TO-18 (2 Lead)
(T2)



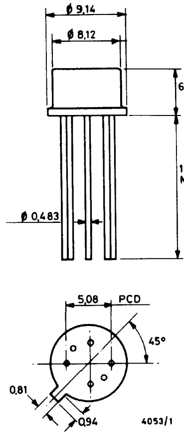
TO-18
(T3)

Dimensions in millimetres

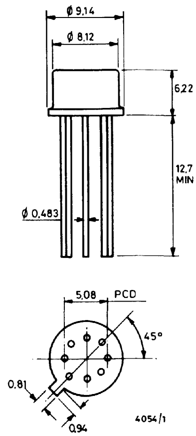
PACKAGE OUTLINES



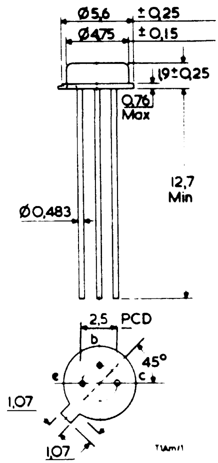
TO-39 (3 Lead)



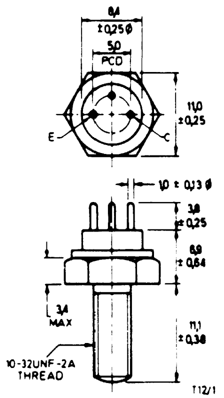
TO-39 (6 Lead)
(T6b)



TO-39 (8 Lead)
(T8b)

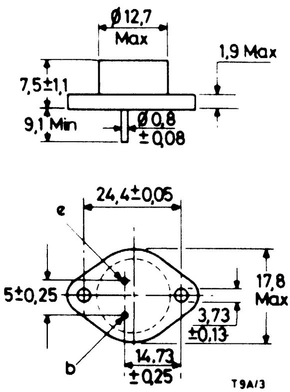


TO-46

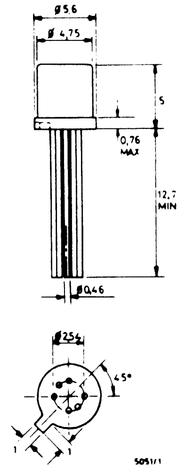


TO-60

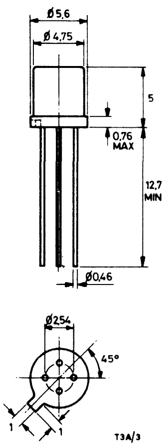
Dimensions in millimetres



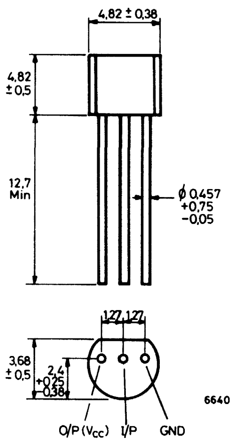
TO-66



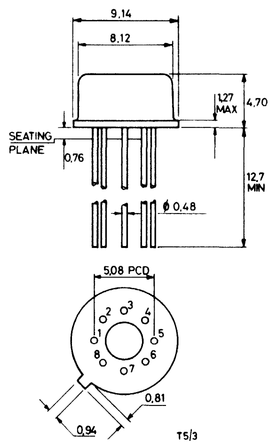
TO-71 (6 Lead)
(T6a)



TO-72
(T4)



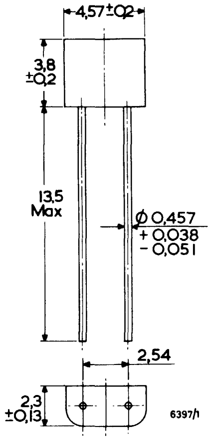
TO-92
(ZN414)



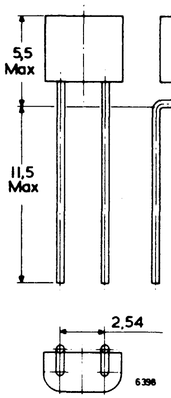
TO-99 (8 Lead)
(T8a)

Dimensions in millimetres

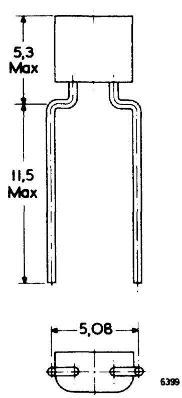
PACKAGE OUTLINES



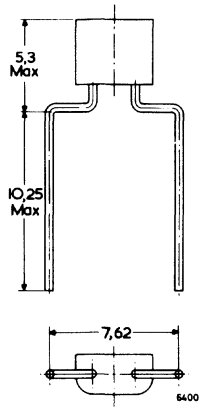
IN-LINE



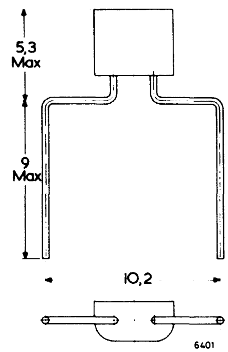
SUFFIX M
(Flat Mounting)



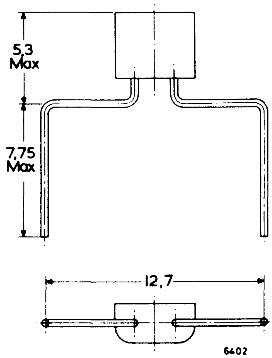
SUFFIX N
(DO-35)



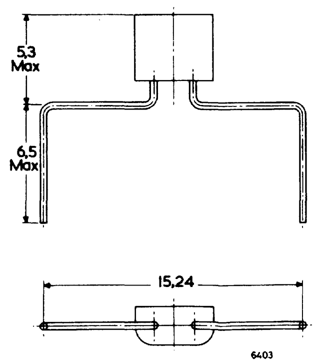
SUFFIX W



SUFFIX P (DO-7)



SUFFIX T

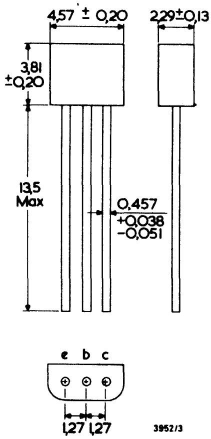


SUFFIX X

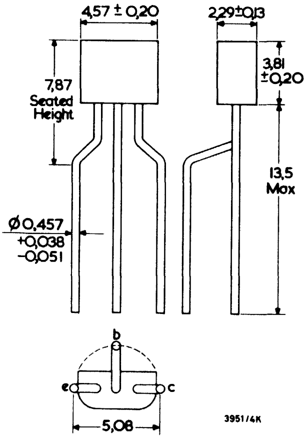
TO-92 (2 Lead Plastic E-line)

N.B. The cathode lead is indicated by a red spot on top of the package
Dimensions in millimetres

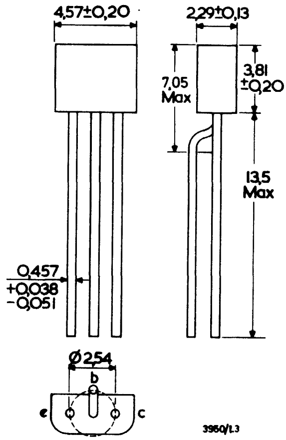
PACKAGE OUTLINES



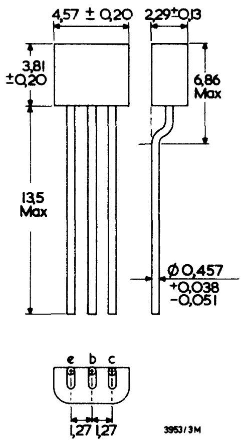
STANDARD PACKAGE
BS 3934 .. SO-94



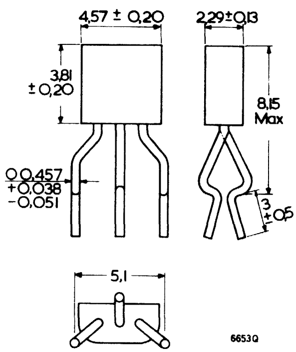
'K' LEAD FORMATION
for TO-5 and TO-39
compatibility
BS 3934 .. SO-95



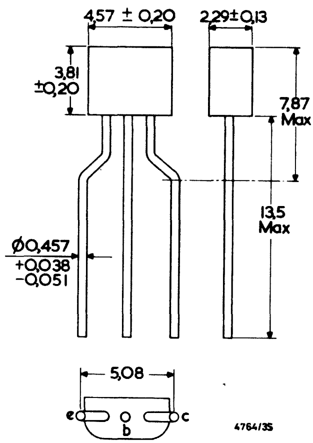
'L' LEAD FORMATION
for TO-18 compatibility
BS 3934 .. SO-97



'M' LEAD FORMATION
for flat mounting
BS 3934 .. SO-96



'Q' LEAD FORMATION
(Lockfit)

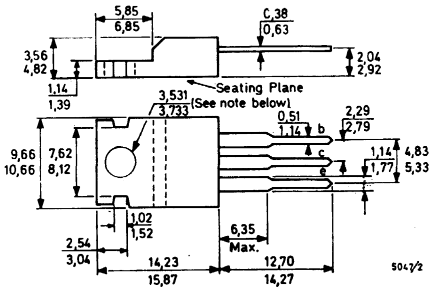


'S' LEAD FORMATION

TO-92

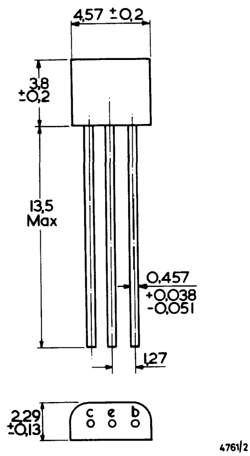
Dimensions in millimetres

PACKAGE OUTLINES



Note: The tab is connected to the collector

TO-220



ZTX196, ZTX197*

*BF196P and BF197P lead configuration is not as per normal E-line. The emitter is the centre lead

Dimensions in millimetres

APPROVED PRODUCTS

E-LINE (TO-92 STYLE) TRANSISTORS

METAL CAN TRANSISTORS

POWER TRANSISTORS

SOT-23 HYBRID DEVICES

R.F. TRANSISTORS AND DIODES

FSD1001

OPTO ELECTRONIC DEVICES

DIODES

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PACKAGE OUTLINES

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