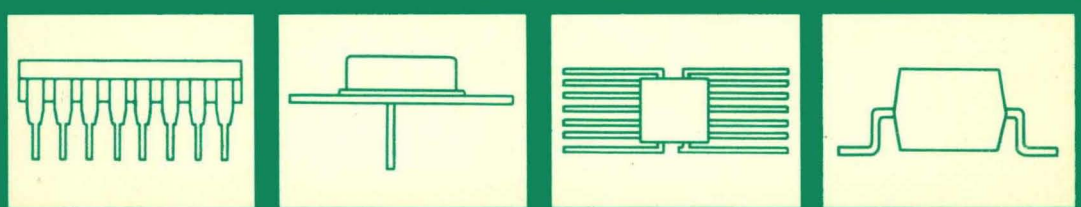
FERRANTI SEMICONDUCTORS

QUICK REFERENCE GUIDE

Discrete Semiconductors
Integrated Circuits
Power Mosfets



FERRANTI
semiconductors
better by design

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

Issue 2, February 1983

Printed in U.S.A.

CONTENTS

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

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

PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

DEVICE TYPE	PAGE(S)	DEVICE TYPE	PAGE(S)	DEVICE TYPE	PAGE(S)
ZN219	IC46	ZN246	IC46	ZN329	IC46
ZN219E	IC46	ZN246E	IC46	ZN329E	IC46
ZN220	IC46	ZN248	IC46	ZN330	IC46
ZN220E	IC46	ZN248E	IC46	ZN330E	IC46
ZN221	IC46	ZN250	IC46	ZN332	IC46
ZN221E	IC46	ZN250E	IC46	ZN332E	IC46
ZN222	IC46	ZN262	IC46	ZN333	IC46
ZN222E	IC46	ZN262E	IC46	ZN333E	IC46
ZN224	IC46	ZN294	IC46	ZN336	IC46
ZN224E	IC46	ZN294E	IC46	ZN336E	IC46
ZN225	IC46	ZN297	IC46	ZN344	IC46
ZN225E	IC46	ZN297E	IC46	ZN344E	IC46
ZN226	IC46	ZN319	IC46	ZN346	IC46
ZN226E	IC46	ZN319E	IC46	ZN346E	IC46
ZN227	IC46	ZN320	IC46	ZN348	IC46
ZN227E	IC46	ZN320E	IC46	ZN348E	IC46
ZN228	IC46	ZN321	IC46	ZN350	IC46
ZN228E	IC46	ZN321E	IC46	ZN350E	IC46
ZN229	IC46	ZN322	IC46	ZN362	IC46
ZN229E	IC46	ZN322E	IC46	ZN362E	IC46
ZN230	IC46	ZN324	IC46	ZN394	IC46
ZN230E	IC46	ZN324E	IC46	ZN394E	IC46
ZN231	IC46	ZN325	IC46	ZN397	IC46
ZN232E	IC46	ZN325E	IC46	ZN397E	IC46
ZN233	IC46	ZN326	IC46	ZN404	IC20
ZN233E	IC46	ZN326E	IC46	ZN409CE	IC36
ZN236	IC46	ZN327	IC46	ZN414Z	IC32
ZN236E	IC46	ZN327E	IC46	ZN415P	IC32
ZN244	IC46	ZN328	IC46	ZN423	IC20
ZN244E	IC46	ZN328E	IC46	ZN424P	IC33

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

DEVICE TYPE	PAGE(S)	DEVICE TYPE	PAGE(S)	DEVICE TYPE	PAGE(S)
ZSF51B	IC45	ZST51A	IC45	ZT183	MC4, MC7, MC9
ZSF51CT	IC45	ZST52A	IC45	ZT184	MC4, MC7, MC9
ZSF81B	IC45	ZST52B	IC45	ZT187	MC4, MC7, MC9
ZSF81CT	IC45	ZST53A	IC45	ZT189	MC4, MC7, MC9
		ZST53B	IC45		
		ZST54A	IC45	ZT210	MC4
ZSS51A	IC45			ZT211	MC4
ZSS51B	IC45	ZST81A	IC45		
ZSS53A	IC45	ZST82A	IC45	ZTX107	E4
ZSS53B	IC45	ZST82B	IC45	ZTX108	E5
ZSS54A	IC45	ZST83A	IC45	ZTX109	E9
ZSS54B	IC45	ZST83B	IC45	ZTX114	E9
		ZST84A	IC45		
ZSS55A	IC45			ZTX212	E6
ZSS55B	IC45	ZT80	MC3, MC6, MC8	ZTX213	E6
ZSS56B	IC45	ZT81	MC3, MC5	ZTX214	E10
ZSS57B	IC45	ZT82	MC3, MC5	ZTX223	E4
ZSS58	IC45	ZT83	MC2, MC5		
ZSS59A	IC45	ZT84	MC2, MC5		
ZSS59B	IC45			ZTX237	E4
		ZT86	MC2, MC5	ZTX238	E5
		ZT87	MC3, MC6	ZTX239	E9
ZSS81A	IC45	ZT88	MC2, MC5		
ZSS81B	IC45	ZT89	MC2, MC5	ZTX300	E5
ZSS83A	IC45	ZT90	MC2, MC8	ZTX301	E5
ZSS83B	IC45			ZTX302	E5
ZSS84A	IC45	ZT91	MC2, MC8, MC11	ZTX303	E5
ZSS84B	IC45	ZT92	MC2, MC8, MC11	ZTX304	E4
		ZT93	MC2, MC8, MC11		
ZSS85A	IC45	ZT94	MC2, MC8	ZTX310	E7
ZSS85B	IC45	ZT95	MC2, MC8	ZTX311	E7
ZSS86B	IC45			ZTX312	E7
ZSS87B	IC45	ZT152	MC4	ZTX313	E7
ZSS88	IC45	ZT180	MC4, MC7, MC9	ZTX314	E7
ZSS89A	IC45	ZT181	MC4, MC7, MC9		
ZSS89B	IC45	ZT182	MC4, MC7, MC9	ZTX320	E13

ALPHA-NUMERIC PRODUCT LIST

ALPHA-NUMERIC PRODUCT LIST

SECTION 1 : DISCRETE COMPONENTS

CONTENTS

PIN CONFIGURATIONS

E-LINE (TO-92 style) transistors are available with a variety of different lead formations denoted by a suffix at the end of the part number:

IN-LINE (CBE)	no suffix
TO-5/TO-39 pin circle	suffix K
TO-18 pin circle	suffix L
Flat mounting	suffix M
Lock-fit	suffix Q
In-line wide spacing	suffix S

E-LINE—THE ULTIMATE TO-92

CONSTRUCTION FOR RELIABILITY

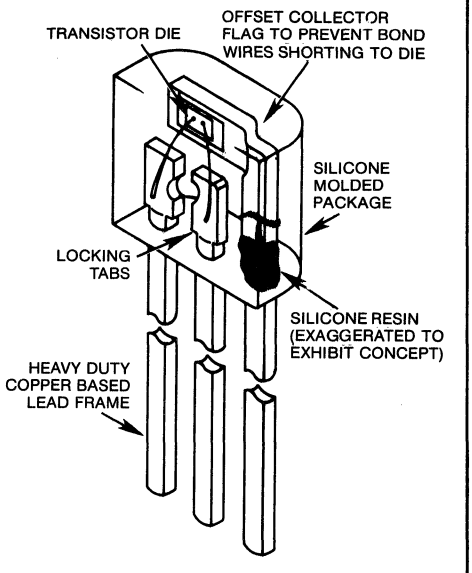
Designed to reproduce the full electrical and environmental performance of hermetic TO-39 and TO-18 transistors, the Ferranti E-LINE, is the result of advanced package engineering, unmatched by so called industry standard TO-92 packaging methods. E-LINE has emerged as the ultimate TO-92 for performance and reliability.

The success of E-LINE commences with 3 new package design concepts—Silicone encapsulation, Silicone resin backfill and heavy duty copper based lead frames.

SILICONE ENCAPSULATION

The E-LINE TO-92 is molded in silicone, not epoxy. The Ferranti silicone material is virtually ion-free compared with the epoxies used in industry standard TO-92's. The absence of ionic contamination allows chip operation up to 200° C Tj without risk of failure due to ionic migration. In regular HTRB tests conducted by the Ferranti Reliability Dept., E-LINE devices are operated at Tj=230° C for 1000 hrs. under reverse bias. All devices must survive without degradation.

In addition to allowing Tj ratings to be raised to 200° C, the silicone material eliminates the thermal intermittency commonly associated with epoxy TO-92 products. Thermal intermittency results from large differential expansion coefficients between the molding material and the die and bonding wire and lead frame. The expansion coefficient of the Ferranti silicone is well matched to those of the other materials in the transistor.



E-LINE—THE ULTIMATE TO-92

SILICONE RESIN BACKFILL

The E-LINE manufacturing process includes a unique step that provides hermeticity similar to that of metal can devices. The process—Silicon Resin Backfill—involves vacuum impregnation of the molded package with silicone resin. Any voids which might exist between the silicone body and lead frame are filled with the resin thereby sealing the chip against moisture and external hazardous contaminants. Package qualification tests include 320 hrs. at 85° C/85% Relative Humidity under bias. Acceptance is on zero failures.

COPPER BASED LEAD FRAME

The heavy duty copper based lead frame used in all Ferranti E-LINE transistors allows device dissipation to exceed the 800mW at T_A=25° C rating of TO-39 transistors (dependant on chip size).

The choice of plating materials reduces intermetallic reactions between lead frame, die attach and die to negligible levels over the specified storage and operating temperature range.

THE RESULT—THE ULTIMATE TO-92

The Ferranti E-LINE TO-92 package exhibits performance and reliability beyond industry standard TO-92 products and metal can transistors. The package is approved over, and beyond, the full military temperature range. Ferranti E-LINE transistors are currently in use in many military applications including weaponry and battlefield communications equipment. In addition Ferranti E-LINE has recently been approved for 20 yr. life application use in telecommunication equipment.

All Ferranti E-LINE transistors are manufactured to full military standards. Parts supplied against military and qualified part numbers are only separated from commercial parts after electrical test. The quantities required for qualified part orders are bonded while environmental and life testing is performed as required by relevant specifications while commercial parts are made available for immediate shipping. Customers for commercial parts thereby enjoy the benefit of continuous batch by batch environmental testing through consistency of high quality and reliability.

A summary report is available on request, describing the Ferranti Quality Program, the results of E-LINE qualification testing and reliability information for the main categories of E-LINE transistors, based on continuous environmental and life testing of production batches.

PERFORMANCE

As a direct result of the unique design features of the E-LINE TO-92 package, Ferranti offers plastic transistors with performance unmatched by similar low cost transistors. In addition to the regular industry standard transistor types, Ferranti has introduced 2 ranges that fully exploit the unique design features of E-LINE:

THE HIGH PERFORMANCE E-LINE RANGE. *THE SUPER E-LINE RANGE.*

* HIGH PERFORMANCE E-LINE

Designated ZTX450 series and ZTX550 series, the range consists of NPN and PNP complementary types featuring the following ratings:

*P_{TOT} at T_{AMB} = 25° C = 1 WATT
*$I_C$max = 1 AMP
*Gain specified at 1 AMP

The ZTX450/550 Series are intended as a full replacement for TO-39 metal can transistors and for medium current applications for which a guaranteed Beta at 1Amp is required. See Pg. E-11 for details.

* SUPER E-LINE

The Ultimate Performance TO-92 Power Range NPN and PNP Series:

- 1 WATT Dissipation at T_A = 25° C.
- 1.5 WATT Dissipation at T_A = 25° C when collector lead is soldered to 1 sq. in. of copper.
- Voltages specified to 100V.
- Beta guaranteed at 2 Amps.
- I_C to 2A continuous, 6A peak.
- Fast Switching.
- Excellent Gain Linearity.

The SUPER E-LINE is designed to replace TO-39, TO-126, TO-202 and TO-220 in free standing applications.

The SUPER E-LINE range fills the gap between conventional TO-92, TO-39 transistors and larger power transistors. There are numerous applications where TO-202 or TO-220 power transistors are used because the application demands a continuous on current of 1 to 2 Amps or a peak current of up to 6 Amps with a steady state dissipation of 1 Watt or less. Until now, the designer has had no choice but to use, and pay for, a device that has a rated power far in excess of the application.

In such applications, SUPER E-LINE gives the performance at a significant cost saving.

For specification details see Page E-12.

E-LINE (TO-92 STYLE) TRANSISTORS

TABLE 1: NPN GENERAL PURPOSE

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

Type	V_{CBO}	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE} at			Min f_T at		P_{tot} at T_{amb} = 25°C	Complement
					I_C	I_B			I_C		I_C		
	V	V	mA	V	mA	mA	Min	Max	mA	MHz	mA	mW	
ZTX453	120	100	1000	0.7	150	15	40	200	150	150	50	1000	—
ZTX452	100	80	1000	0.7	150	15	40	150	150	150	50	1000	ZTX552
MPSA06	80	80	500	0.25	100	10	50	—	100	100	10	750	MPSA56
BC546P	80	65	200	0.25	10	0.5	75	200	2	300*	10	500	BC556P
ZTX451	80	60	1000	0.35	150	15	50	150	150	150	50	1000	ZTX551
BFS61	80	60	1000	0.35	150	15	40	160	150	150	50	500	BFS98
MPS2222A	75	45	800	1.0	500	50	100	300	150	300	20	500	MPS2907A
ZTX304	70	70	500	0.35	50	5	50	300	10	150	10	300	ZTX504
MPSA05	60	60	500	0.25	100	10	50	—	100	100	10	750	—
BCY65EP	60	60	100	0.35	10	0.25	120	460	2	125	10	1000†	BCY77P
BC182P	60	50	200	0.25	10	0.5	100	480	2	150	10	300	BC212P
ZTX107	60	50	100	0.1*	10	1	125	500	2	350*	10	300	ZTX212
ZTX450	60	45	1000	0.25	150	15	100	300	150	150	50	1000	ZTX550
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

NPN GENERAL PURPOSE
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} at Min	Max	I_C mA	Min f_T at MHz	I_C mA	P_{tot} at T_{amb} = 25°C mW	Complement
MPS3704 / ZTX3704	50	30	800	0.6	100	5	100	300	50	100	50	500	MPS3703 / ZTX3703
MPS3705 / ZTX3705	50	30	800	0.8	100	5	50	150	50	100	50	500	MPS3703 / ZTX3703
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 / ZTX3706	40	20	800	1	100	5	30	600	50	100	50	500	MPS3702 / ZTX3702
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 / ZTX3709	30	30	200	1	10	0.5	45	165	1	—	—	500	—
MPS3710 / ZTX3710	30	30	200	1	10	0.5	90	330	1	—	—	500	—
MPS3711 / ZTX3711	30	30	200	1	10	0.5	180	660	1	—	—	500	—
MPS3708 / ZTX3708	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

E-LINE (TO-92 STYLE) TRANSISTORS

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			I_C		I_C		
	V	V	mA	V	mA	mA	Min	Max	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 ZTX3703	50	30	500	0.25	50	5	30	150	50	100	50	500	MPS3704 ZTX3704 MPS3705 ZTX3705
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	MPS30
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 ZTX3702	40	25	500	0.25	50	5	60	300	50	100	50	500	MPS3706 ZTX3706
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			I_C		I_C	t_{on}	t_{off}	I_C	
	V	mA	V	mA	mA	Min	Max	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)			—
MPS2369	15	200	0.25	10	1	40	120	10	—	—	12	18	10	—
ZTX312	12	500	0.24	10	1	40	—	10	400	10	15	20	10	—
ZTX310	12	500	0.6	10	1	20	—	10	200	10	(note 2)			—

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

TABLE 4: PNP SWITCHING

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

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE}		at	Min f_T at		Max. Switching Times at			Complement
				I_C	I_B			I_C		I_C	t_{on}	t_{off}	I_C	
	V	mA	V	mA	mA	Min	Max	mA	MHz	mA	ns	ns	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
				I_C	I_B			I_C		I_C	N	I_C	f	
	V	mA	V	mA	mA	Min	Max	mA	MHz	mA	dB	μA	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 / ZTX3707	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

E-LINE (TO-92 STYLE) TRANSISTORS

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
				I_C	I_B			I_C		I_C	N	I_C	f	
	V	mA	V	mA	mA	Min	Max	mA	MHz	mA	dB	μA	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 1000mW at 25°C ambient temperature.

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

Type	V_{CBO} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	I_B mA	h_{FE} at Min	Max	I_C mA	Min f_T at MHz	I_C mA	P_{tot} at T_{amb} = 25°C mW	Complement
NPN													
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
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	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
ZTX751	80	60	2000	0.3	1000	100	100	300	500	75	50	1000	ZTX651
ZTX551	80	60	1000	0.25	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
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 —SUPER E-LINE RANGE

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

Type	V_{CBO} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	at I_C mA	at I_B mA	h_{FE} Min	h_{FE} Max	h_{FE} at I_C mA	Min f_T MHz	Min f_T at I_C mA	P_{tot} at $T_{amb}=25°C$ mW	Complement
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
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
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

TABLE 9: NPN DARLINGTON TYPES

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

Type	V_{CBO} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	at I_C mA	at I_B mA	h_{FE} Min	h_{FE} Max	h_{FE} at I_C mA	Max. I_{CBO} at nA	at V_{CB} V	P_{tot} at $T_{amb}=25°C$ mW
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} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	I_B mA	Min f_T at MHz	I_C mA	Max. Noise Figure at N dB	I_C μA	f MHz	Max. C_{obo} at 1 MHz pF	V_{CB} V	RF P_O or RF P_G at mW or dB	f MHz
NPN														
ZTX327	30	400	1.0	100	20	800*	25	—	—	—	3.0	30	350mW	400
ZTX3866	30	400	1.0	100	20	700*	25	—	—	—	3.0	30	700mW	400
BF196P†	30	25	—	—	—	400*	4	3	4	35	1.3⊖	10	500mW	--
BF197P†§	25	25	—	—	—	550*	5	—	—	—	1.8⊖	10	500mW	—
ZTX4427	20	400	0.5	100	20	700	25	—	—	—	4.0	12	500mW	175
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	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	I_B mA	h_{FE} at Min	Max	I_C mA	Max I_{CBO} at μA	V_{CB} V	P_{tot} at T_{amb} = 25°C mW	Complement
NPN													
MPSA42	300	300	500	0.5	20	2.0	40	—	10	0.10	200	680	MPSA92
MPSA43	200	200	500	0.4	20	2.0	40	—	10	0.10	160	680	MPSA93
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
MPSA93	200	200	500	0.4	20	2.0	40	—	10	0.25	160	680	MPSA43
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

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.

METAL CAN SIGNAL TRANSISTORS

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

*At T_{case} = 45°C

continued–

NPN LOW LEVEL *Table 1 Continued*

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

*At t_{case} = 45°C

TO-18

TO-39

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	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	at I_C mA	at I_B mA	h_{FE} Min.	h_{FE} Max.	h_{FE} at I_C mA	Min f_T at MHz	Min f_T at I_C mA	P_{tot} at T_{amb} = 25°C mW	Package	Complement
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
				I_C	I_B			I_C		I_C	t_{on}	t_{off}	I_C		
	V	mA	V	mA	mA	Min.	Max.	mA	MHz	mA	ns	ns	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—

METAL CAN SIGNAL TRANSISTORS

NPN SWITCHING *Table 3 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
				I_C	I_B			I_C		I_C	t_{on}	t_{off}	I_C		
	V	mA	V	mA	mA	Min.	Max.	mA	MHz	mA	ns	ns	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 $t_{stg} = 25ns$ Note 3 $t_{stg} = 50ns$

TO-18

TO-39

TABLE 4 – SILICON PLANAR MEDIUM AND HIGH SPEED SWITCHING TRANSISTORS

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

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

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

*Typical

TABLE 5 – NPN SILICON PLANAR LOW NOISE TRANSISTORS

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

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

Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE} at			f_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.

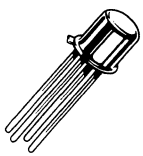
Type	V_{CEO}	Max I_C	Max $V_{CE(sat)}$ at			h_{FE} at			f_T Min at		Noise Figure at			Package	Complement
	V	mA	V	I_C mA	I_B mA	Min.	Max.	I_C mA	MHz	I_C mA	N dB	I_C μA	f Hz		
ZT189	70	500	0.2	50	5	75	250	10	150	10	6	100	1K	TO-18	ZT89
BCY77	60	100	0.25	10	0.25	120	460	2	180*	10	<6	200	1K	TO-18	BCY65E
ZT183	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

TO-18

TO-39

TO-46



TO-72

METAL CAN SIGNAL TRANSISTORS

TABLE 7 – NPN SILICON PLANAR HIGH FREQUENCY TRANSISTORS

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

Type	V_{CB} V	V_{CEO} V	Max. I_C mA	h_{FE} at Min.	h_{FE} at Max.	h_{FE} at I_C mA	f_T Min. at MHz	f_T Min. at I_C mA	Noise Figure at N dB	Noise Figure at I_C mA	Noise Figure at f MHz	C_{obo} Max. at 1MHz pF	C_{obo} Max. at 1MHz V_{CB} V	RF, P_O or RF, P_G at mW or dB	RF, P_O or RF, P_G at f MHz	Package
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 8 – NPN SILICON PLANAR HIGH VOLTAGE (LOW CURRENT) TRANSISTORS

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

Type	V_{CB} V	V_{CEO} V	Max I_C mA	Max $V_{CE(sat)}$ at V	I_C mA	I_B mA	h_{FE} Min.	Max.	at I_C mA	I_{CBO} at μA	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

TABLE 9 – NPN SILICON PLANAR HIGH SPEED CORE DRIVER TRANSISTORS

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

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

CONTENTS

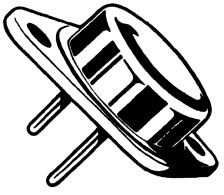
SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

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



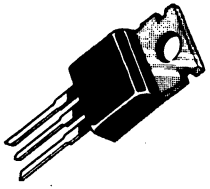
TO-3

TO-66

PLASTIC POWER TRANSISTOR SELECTOR CHART

V_{CEO} Volts	I_C 3 Amps (TIP) I_C 4 Amps (BD)		5 Amps		7 Amps		7 Amps		⩾ 10 Amps
	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP	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
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

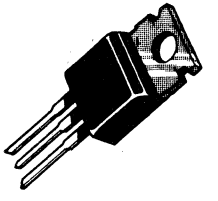
TABLE 2 – NPN EPITAXIAL BASE TRANSISTORS

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)	V_{CER}	V_{CEO}	h_{FE}		at	P_{tot} at T_{case} = 25°C	PNP Complement
	A	V	V	Min.	Max.	I_C A	W	
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

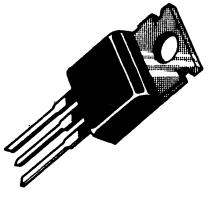
TABLE 3 – PNP EPITAXIAL BASE TRANSISTORS

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)	V_{CER}	V_{CEO}	h_{FE}		at	P_{tot} at T_{case} = 25°C	PNP Complement
						I_C		
	A	V	V	Min.	Max.	A	W	
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

POWER DARLINGTON SELECTOR CHART

Package I_C V_{CEO}, Volts	TO-39 1A	TO-39 2A	TO-220 10A (BDX) 8A (TIP) NPN	 PNP	TO-3 10A
40	–	–	–	–	2N6383
45	BCX21	–	BDX33	BDX34	–
60	BD320 BD322	BD321 BD323	BDX33A TIP120	BDX34A TIP125	2N6384
80	– –	– –	BDX33B TIP121	BDX34B TIP126	2N6385
100	–	–	BDX33C TIP122	BDX34C TIP127	–
120	–	–	BDX33D	–	–

TABLE 4 – PNP SILICON HIGH CURRENT DARLINGTON TRANSISTORS

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

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

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

TABLE 4a – NPN SILICON HIGH CURRENT DARLINGTON TRANSISTORS

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

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

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

HIGH VOLTAGE POWER TRANSISTORS

NPN HIGH VOLTAGE SELECTOR CHART

Package I_C / V_{CEO} Volts	TO-39 <2A	TO-220 2-5A	TO-66 2-5A	TO-3 6A	TO-3 10A
140			2N3441		2N3442
175			2N3583		
250	2N3440		2N3584		
300			2N3585		
350	2N3439				
400		BUX84		BUX82	BUX80

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} at Min	Max	I_C A	P_{tot} at T_{case} =25°C W	Package
BUX80	10	—	400	1.5	5	1000	30†	—	1.2	100	TO-3
2N3442	10	160	160*	1	3	300	20	70	3	117	TO-3
BUX82	6	—	400	1.5	2.5	500	30†	—	0.6	60	TO-3
2N3441	3	160	160*	1	0.5	50	25	100	0.5	25	TO-66
BUX84	2	—	400	0.8	0.3	30	50†	—	0.1	40	TO-220
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

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

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

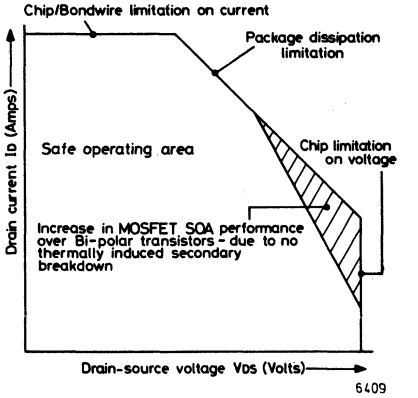
- N-channel, P-channel, Complementary devices
- Drain currents up to 16A continuous, 32A pulsed
- Breakdown voltages up to 650V
- Drain-Source ON-resistances as low as 0.1Ω
- Switching times as low as 4ns
- Power dissipations up to 150W

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.

THERMAL RUNAWAY

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



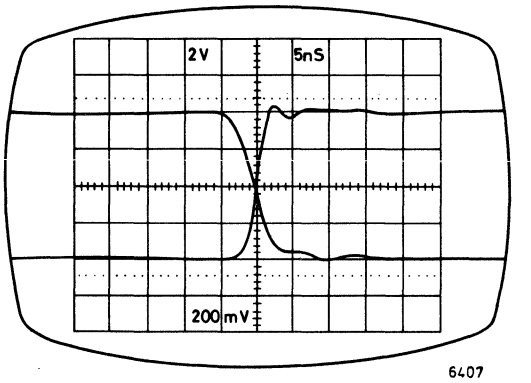
Carrier mobility in a MOSFET channel region decreases with temperature. If localized heating occurs in a MOSFET the carrier mobility decreases in the region affected, and as a consequence, the localized current reduces. This negative feedback mechanism forces overload currents to be uniformly distributed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

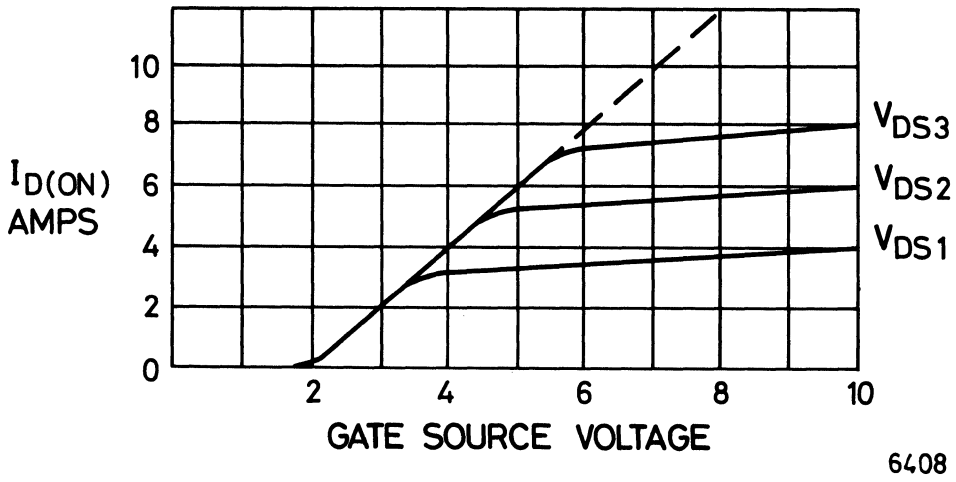
By virtue of the insulated gate structure, input currents are very low, typically a few pico amps at 25°C.

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

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

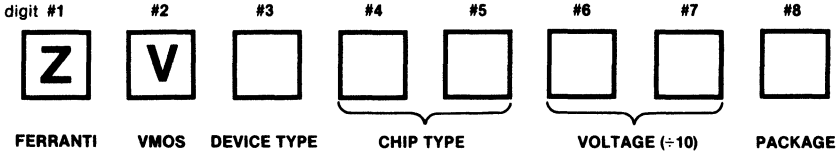
The fast switching speeds, temperature stability, and freedom from thermally induced secondary breakdown are desirable for very fast pulse generators, filament lamp drivers and laser diode drivers.

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.

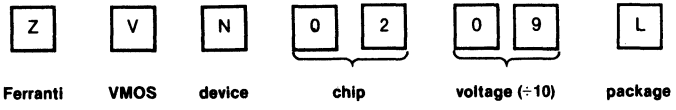
PRODUCT TYPE CODE

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



1st digit: Ferranti Identification — Z
2nd digit: Vertical DMOS Process — V
3rd digit: Device Type — N-Channel
P-Channel
C-Complementary
4th and 5th digits: Chip Type/Mask Designator
—01/02/03/04/05/11/12/13/14
6th and 7th digits: Voltage Rating divided by 10
e.g. A2 = 20 volts
04 = 40 volts
14 = 140 volts
65 = 650 volts
8th digit: Package Code TO-92 style — A
TO-39 — B
Plastic DIL — E
Ceramic DIL — J
TO-202 — K
TO-220 — L
TO-3 — M

EXAMPLE: ZVN0209L



This number refers to an N-Channel device from the ZVN02 product family with Breakdown Voltage (BV_{DSS}) of 90 Volts in a TO-220 package.

PRODUCT RANGE
N-CHANNEL DEVICES

N-CHANNEL

Product Family	Max Continuous Drain-Current Range ID Amps (A)*	Max Pulsed Drain-Current Range IDM Amps (A)*	Min-Breakdown Drain-Source Voltage-BVDSS Volts (V)	Typ. On-State Drain-Source Resistance-RDS (ON) Ohms (Ω)	Typical Transconductance gfs Mhos (Ω)	Package Options					
						TO-3 (M)	TO-39 (B)	TO-92 Style (A)	TO-220 (L)	14 Lead Plastic (E)	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	2.00	●	●		●		●
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	●	●		●	●	●
ZVN11D	5-8	10-16	300,350,400,450	4.0	0.50	●	●		●	●	●
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	.003		●	●			●†
ZVN14B	0.10	0.20	100,140	400.0	.002		●	●			●
ZVN14C	0.10	0.20	160,200	800.0	.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

PRODUCT RANGE

P-CHANNEL DEVICES

Product Family	Max Continuous Drain-Current Range ID Amps (A)*	Max Pulsed Drain-Current Range IDM Amps (A)*	Min-Breakdown Drain-Source Voltage-BVDSS Volts (V)	Typ. On-State Drain-Source Resistance-RDS (ON) Ohms (Ω)	Typical Transconductance gfs Mhos (Ω)	Package Options					
						TO-3 (M)	TO-39 (B)	TO-92 Style (A)	TO-220 (L)	14-Lead Plastic (E)	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	●	●		●	●	●
ZVP11D	5-8	10-16	300,350,400,450	8.0	0.50	●	●		●	●	●
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	.004		●	●			●†
ZVP14B	0.10	0.20	100,140	800.0	.003		●	●			●
ZVP14C	0.10	0.20	160,200	1600.0	.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

HYBRID DEVICES AND SEMICONDUCTORS NETWORKS

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

SOT-23 PLASTIC ENCAPSULATED SEMICONDUCTORS

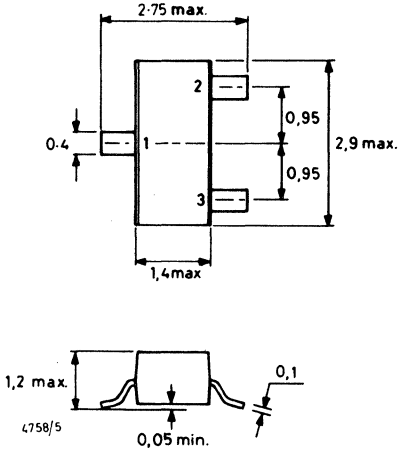
SOT-23 is the internationally standardised semiconductor package for hybrid assembly of transistors and diodes. Designed specifically for use in thick and thin film hybrid circuits the devices offer considerable advantages over other packages and "chip and wire" assembly techniques.

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.

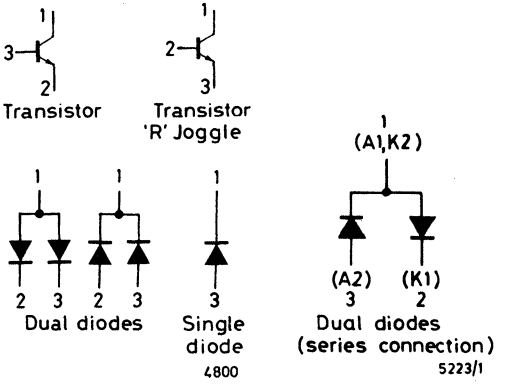
This micro-miniature package provides the optimum cost/real estate solution to high volume hybrid manufacture, whether in commercial, industrial, or military applications.

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	Type	Device marking	Page	CECC number
Transistors				**Transistors**			
BCW29	C1	H5	50002 F114	BFS17	E1	H8	50002 F128†
BCW29R	C4	H5	50002 F114	BFS17R	E4	H8	50002 F128†
BCW30	C2	H5	50002 F114	BFS20	G1	H8	
BCW30R	C5	H5	50002 F114	BFS20R	G4	H8	
BCW31	D1	H5	50002 F115	BSS63	T3	H8	
BCW31R	D4	H5	50002 F115	BSS64	U3	H8	
BCW32	D2	H5	50002 F115	BSS65	L1	H6	
BCW32R	D5	H5	50002 F115	BSS65R	L5	H6	
BCW33	D3	H5	50002 F115	BSS66	M6	H6	50004 F069
BCW33R	D6	H5	50002 F115	BSS66R	M8	H6	50004 F069
BCW60*	AA to AD	H5	50002 F116†	BSS67	M7	H6	50004 F069
BCW61*	BA to BD	H5	50002 F110†	BSS67R	M9	H6	50004 F069
BCW65*	EA to EC	H7	50002 F117†	BSS69	L2	H6	50004 F070
BCW66*	EF to EH	H7	50002 F117†	BSS69R	L6	H6	50004 F070
BCW67*	DA to DC	H7	50002 F108†	BSS70	L3	H6	50004 F070
BCW68*	DF to DH	H7	50002 F108†	BSS70R	L7	H6	50004 F070
BCW69	H1	H5	50002 F113	BSV52	B2	H6	50004 F071
BCW69R	H4	H5	50002 F113	BSV52R	B4	H6	50004 F071
BCW70	H2	H5	50002 F113	FMMT-A05	1H	H7	
BCW70R	H5	H5	50002 F113	FMMT-A06	1G	H7	
BCW71	K1	H5	50002 F118	FMMT-A12	3W	H8	50004 F124†
BCW71R	K4	H5	50002 F118	FMMT-A13	1M	H8	50004 F124†
BCW72	K2	H5	50002 F118	FMMT-A14	1N	H8	50004 F124†
BCW72R	K5	H5	50002 F118	FMMT-A20	1C	H5	
BCX17	T1	H7	50002 F109†	FMMT-A42	1D	H8	
BCX17R	T4	H7	50002 F109†	FMMT-A43	1E	H8	
BCX18	T2	H7	50002 F109†	FMMT-A55	2H	H7	
BCX18R	T5	H7	50002 F109†	FMMT-A56	2G	H7	
BCX19	U1	H7	50002 F119†	FMMT-A92	2D	H8	
BCX19R	U4	H7	50002 F119†	FMMT-A93	2E	H8	
BCX20	U2	H7	50002 F119†	FMMT918	3B	H8	
BCX20R	U5	H7	50002 F119†	FMMT2222	1B	H6	50004 F055†
BCX70*	AG to AK	H5	50002 F120†	FMMT2222A	1P	H6	50004 F055†
BCX71*	BG to BK	H5	50002 F111†	FMMT2369	1J	H6	50004 F053†
BFQ31	S2	H8	50002 F123†	FMMT2907	2B	H6	50004 F057†
BFQ31R	S3	H8	50002 F123†	FMMT2907A	2F	H6	50004 F057†
BFQ31A	S4	H8	50002 F123†	FMMT3903	1W	H5	50004 F054†
BFQ31AR	S5	H8	50002 F123†	FMMT3904	1A	H5	50004 F054†
				FMMT3905	2W	H5	50004 F056†
				FMMT3906	2A	H5	50004 F056†

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

DEVICE IDENTIFICATION MARKINGS

Type	Device marking	Page	CECC number	Type	Device marking	Page	CECC number
Diodes				**Diodes**			
BAV70	A4	H9	50001 F027†	BZX84-C33	X3	H9	
BAV74	JA	H9	50001 F028†	BZX84-C36	X4	H9	
BAV99	A7	H9	50001 F029†	BZX84-C39	X5	H9	
BAW56	A1	H9	50001 F033†				
BZX84-C2V7	W4	H9	50005 F007	BZX84-C43	X6	H9	
				BZX84-C47	X7	H9	
BZX84-C3V0	W5	H9					
BZX84-C3V3	W6	H9		FMMD109	4A	H10	
BZX84-C3V6	W7	H9		FMMD914	5D	H9	
BZX84-C3V9	W8	H9		FMMD3102	4C	H10	
BZX84-C4V3	W9	H9		ZC830	J1	H10	
BZX84-C4V7	Z1	H9		ZC831	J3	H10	
BZX84-C5V1	Z2	H9		ZC832	J4	H10	
BZX84-C5V6	Z3	H9		ZC833	A2	H10	
BZX84-C6V2	Z4	H9		ZC834	J5	H10	
BZX84-C6V8	Z5	H9		ZC835	J6	H10	
BZX84-C7V5	Z6	H9		ZC836	J7	H10	
BZX84-C8V2	Z7	H9					
				ZC2800E	E6	H10	50001 F044
BZX84-C9V1	Z8	H9		ZC2810E	E7	H10	50001 F044
BZX84-C10	Z9	H9		ZC2811E	E8	H10	50001 F044
BZX84-C11	Y1	H9		ZC5800E	E9	H10	50001 F044
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					

*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.	h_{FE} at I_C/V_{CE} mA/volts	$V_{CE(sat)}$ max at I_C/I_B Volts	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 = 100 MHz

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

PNP GENERAL PURPOSE

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min./max.	h_{FE} at I_C/V_{CE} mA/volts	$V_{CE(sat)}$ max at I_C/I_B Volts	mA	f_T at $I_C=10mA$ MHz(typ)	Complement
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 = 100 MHz

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 at I_C/I_B Volts	mA	f_T at $I_C=10$mA MHz(min)	Switching Times t_{on}/t_{off} at $I_C/I_{B1}I_{B2}$ ns(max)	mA	Complement
BSS66/66R	40	200	300	50/150	10/1	0.2	10/1	250	70/225	10/1	BSS69/69R
BSS67/67R	40	200	300	100/300	10/1	0.2	10/1	300	70/250	10/1	BSS70/70R
FMMT2222A	40	600	300	100/300	150/10	0.3	150/15	300†	35/285	150/15	FMMT2907A
FMMT2222	30	600	300	100/300	150/10	0.4	150/15	250†	35/285	150/15	FMMT2907
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 $10\times8\times0.6$mm ceramic substrate.
†Min at $I_C=20$mA, $V_{CE}=20$V, 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 at I_C/I_B Volts	mA	f_T at $I_C=10$mA MHz(min)	Switching Times t_{on}/t_{off} at $I_C/I_{B1}I_{B2}$ ns(max)	mA	Complement
FMMT2907A	60	600	300	100/300	150/10	0.4	150/15	200†	50/110	150/15	FMMT2222A
FMMT2907	40	600	300	100/300	150/10	0.4	150/15	200†	50/110	150/15	FMMT2222
BSS69/69R	40	200	300	50/150	10/1	0.25	10/1	200	70/260	10/1	BSS66/66R
BSS70/70R	40	200	300	100/300	10/1	0.25	10/1	250	70/300	10/1	BSS67/67R
BSS65/65R	12	200	200	40/150	30/0.5	0.25	30/3	400	60/90	30/1.5	–

*Device mounted on $10\times8\times0.6$mm ceramic substrate.
†Min at $I_C=50$mA, $V_{CE}=20$V, f = 100MHz.

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 at I_C/I_B Volts	mA	f_T at $I_C=20$mA MHz(min)	Noise Figure at $I_C=0.2$mA dB(max)	Complement
FMMTA06	80	80	500	350	50/–	10/1	0.25	100/10	100§	–	FMMTA56
BCW66F	75	45	1000	350	100/250	100/1	0.3	100/10	100	10	BCW68F
BCW66G	75	45	1000	350	160/400	100/1	0.3	100/10	100	10	BCW68G
BCW66H	75	45	1000	350	250/630	100/1	0.3	100/10	100	10	BCW68H
FMMTA05	60	80	500	350	50/–	10/1	0.25	100/10	100§	–	FMMTA55
BCW65A	60	32	1000	350	100/250	100/1	0.3	100/10	100	10	BCW67A
BCW65B	60	32	1000	350	160/400	100/1	0.3	100/10	100	10	BCW67B
BCW65C	60	32	1000	350	250/630	100/1	0.3	100/10	100	10	BCW67C
BCX19/19R	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 $I_C=10$mA, $V_{CE}=2$V, f = 100MHz

PNP MEDIUM POWER

Type	V_{CES} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min/max at I_C/V_{CE} mA/Volts		$V_{CE(sat)}$ max at I_C/I_B Volts	mA	f_T at $I_C=20$mA MHz(min)	Noise Figure at $I_C=0.2$mA dB(max)	Complement
FMMTA56	80	80	500	350	50/–	10/1	0.25	100/10	100§	–	FMMTA06
BCW68F	60	45	1000	350	100/250	100/1	0.3	100/10	100	10	BCW66F
BCW68G	60	45	1000	350	160/400	100/1	0.3	100/10	100	10	BCW66G
BCW68H	60	45	1000	350	250/630	100/1	0.3	100/10	100	10	BCW66H
FMMTA55	60	60	500	350	50/–	10/1	0.25	100/10	100§	–	FMMTA05
BCW67A	45	32	1000	350	100/250	100/1	0.3	100/10	100	10	BCW65A
BCW67B	45	32	1000	350	160/400	100/1	0.3	100/10	100	10	BCW65B
BCW67C	45	32	1000	350	250/630	100/1	0.3	100/10	100	10	BCW65C
BCX17/17R	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 $I_C=10$mA, $V_{CE}=2$V, f = 100MHz.

DARLINGTON – NPN

RATINGS AND CHARACTERISTICS at 25°C ambient temperature.

Type	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_{tot}* mW	h_{FE} min	h_{FE} at I_C/V_{CE} mA/Volts	I_{CBO} at V_{CB} nA	I_{CBO} 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	h_{FE} at I_C/V_{CE} mA/Volts	$V_{CE(sat)}$ max. Volts	$V_{CE(sat)}$ at I_C/I_B mA	Max. I_{CBO} μA	Max. I_{CBO} 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
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

NPN HIGH FREQUENCY

Type	V_{CBO} V	V_{CEO} V	I_C mA	P_{tot}* mW	h_{FE} min/max	h_{FE} at I_C/V_{CE} mA/V	f_T MHz (Typ.)	f_T at I_C mA	C_{ib} at 1MHz pF (max.)	C_{ib} at 1MHz at V_{CE} V	C_{obo} at 1MHz pF (max.)	C_{obo} at 1MHz 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 A	Max. V_F at I_F=50mA Volts	Max. Reverse Recovery Time t_{rr} at I_F=10mA V_R=1V R_L=100Ω I_R=1mA ns
FMMD914	Single diode	75	75	225	—	1.0†	4
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
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

*I_F=100mA
†I_F=10mA

SILICON PLANAR REFERENCE DIODES

Ratings and Characteristics at 25°C ambient temperature

Type	Reference Voltage at I_Z=5mA Volts Nom.	Min.	Max.	Differential Resistance at I_Z=5mA Ohms Max.	Temperature Coefficient at I_Z=5mA %/°C Typical	Reverse Current at V_R μA Max.	Volts
BZX84-C2V7	2.7	2.5	2.9	120	−0.07	25.0	1
BZX84-C3V0	3.0	2.8	3.2	120	−0.07	5.0	1
BZX84-C3V3	3.3	3.1	3.5	110	−0.06	3.0	1
BZX84-C3V6	3.6	3.4	3.8	105	−0.07	3.0	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	8
BZX84-C15	15	13.8	15.6	30	+0.075	0.05	10.5
BZX84-C16	16	15.3	17.1	40	+0.08	0.05	11.2
BZX84-C18	18	16.8	19.1	45	+0.08	0.05	12.6
BZX84-C20	20	18.8	21.2	55	+0.08	0.05	14.0
BZX84-C22	22	20.8	23.3	55	+0.08	0.05	15.4
BZX84-C24	24	22.8	25.6	70	+0.08	0.05	16.8
	I_Z=2mA			I_Z=2mA	I_Z=2mA	I_Z=2mA	
BZX84-C27	27	25.1	28.9	80	+0.08	0.05	18.9
BZX84-C30	30	28	32	80	+0.08	0.05	21.0
BZX84-C33	33	31	35	80	+0.08	0.05	23.1
BZX84-C36	36	34	38	90	+0.08	0.05	25.2
BZX84-C39	39	37	41	130	+0.08	0.05	27.3
BZX84-C43	43	40	46	150	+0.08	0.05	30.1
BZX84-C47	47	44	50	170	+0.08	0.05	32.9

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 I_R		C_T at V_R min.	C_T at V_R max.		Capacitance Ratio		Q min. at V_R/f	
	V	μA	pF	pF	V	min.	max.		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.
ZC830	25	9.0	10	11.0	4.5	6.0	300
ZC831	25	13.5	15	16.5	4.5	6.0	300
ZC832	25	19.8	22	24.2	5.0	6.5	200
ZC833	25	29.7	33	36.3	5.0	6.5	200
ZC834	25	42.3	47	51.7	5.0	6.5	200
ZC835	25	61.2	68	74.8	5.0	6.5	100
ZC836	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 = 10μA 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. ΔV = 20mV, I_F = 0.5 to 5.0mA
Max. ΔC = 0.2pF, V_R = 0V

ZC2810 – ZC2811
Max. ΔV = 20mV, I_F = 1 to 10mA
Max. ΔC = 0.2pF, V_R = 0V

The majority of Ferranti discrete semiconductors are available in unencapsulated slice or dice form. Transistor and diode wafers can be supplied by Ferranti as either 100% probed wafers with reject dice ink marked, or in the form of 100% probed wafers ready scribed, broken into individual dice and mounted on a dice carrying diaphragm. Ferranti die have aluminum top metalisation contacts and are gold backed suitable for eutectic or conductive epoxy die attach methods.

To assist in the specification and procurement of semiconductor dice, please consult the Ferranti dice specification FSD1001 which contains details of the electrical and physical properties of the available dice, the processing routes and quality inspection levels.

For more specific information please contact Ferranti Electric Inc., (516-543-0200) or your local Ferranti sales representative.

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	
FF5859J	Ceramic DIL	4 isolated n-p-n transistors similar to 2N5859	

Ratings and Characteristics

at 25°C ambient temperature (each transistor)

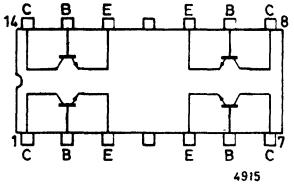
Type	Maximum Ratings				h_{FE}		max		min f_T	
	V_{CBO} Volts	V_{CEO} Volts	I_C mA	P_D* mW	min/max at	I_C mA	$V_{CE(sat)}$ Volts	at I_C mA	MHz at	I_C mA
FF2221E	60	40	500	400	40/—	150	0.4	150	200	20.0
FF2221J	60	40	600	750	40/—	150	0.4	150	200	20.0
FF2222E	60	40	500	400	100/—	150	0.4	150	200	20.0
FF2222J	60	40	600	750	100/—	150	0.4	150	200	20.0
FF2483E	60	40	100	400	150/—	1	0.35	1	175†	0.5
FF2483J	60	40	100	600	150/—	1	0.35	1	175†	0.5
FF2484E	60	40	100	400	300/—	1	0.35	1	175†	0.5
FF2484J	60	40	100	600	300/—	1	0.35	1	175†	0.5
FF2906E	−60	−40	−600	600	40/—	−150	−0.4	−150	200	−50.0
FF2906J	−60	−40	−600	750	40/—	−150	−0.4	−150	200	−50.0
FF2907E	−60	−40	−600	600	100/—	−150	−0.4	−150	200	−50.0
FF2907J	−60	−40	−600	750	100/—	−150	−0.4	−150	200	−50.0
FF3467J	−40	−40	−1000	900	20/—	−500	−0.5	−500	190†	−50.0
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
FF5859J	60	40	1500	750	35/250	100	0.26	100	325†	50.0

*Power dissipation per transistor. †Typical

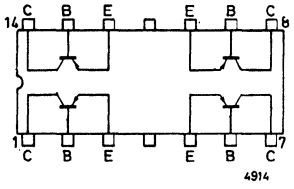
Pin configurations overleaf.

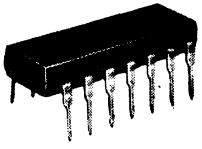
STANDARD PRODUCTS – SILICON PLANAR QUAD TRANSISTORS
Pin Configuration

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		Operating temperature range °C
		Max. V_{RWM} Volts	Max. mean forward current $I_F(Av)$ mA	
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
BAT23	Moulded flat pack	60	300	−55 to +150
BAT23H	Ceramic flat pack	60	300	−65 to +200
BAT24	Moulded flat pack	40	300	−55 to +150
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
BAT27	Moulded flat pack	60	300	−55 to +150
BAT28	Moulded flat pack	40	300	−55 to +150

CORE DRIVER DIODE ARRAYS (con't)

Electrical Characteristics

at 25°C ambient temperature (single diode)

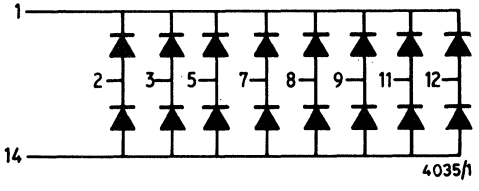
Type	Max. I_R at V_R		Max. V_F at $I_F = 100mA$ Volts	Max. Reverse Recovery Time T_{rr}* at $I_F = I_{RM} = 200mA$ $R_L = 100\Omega$ ns
	μA	Volts		
BAT21	0.1	40	1.0	20
BAT21J	0.1	40	1.0	20
BAT22	0.1	25	1.1	20
BAT22J	0.1	25	1.1	20
BAT23	0.1	40	1.0	20
BAT23H	0.1	40	1.0	20
BAT24	0.1	25	1.1	20
BAT24H	0.1	25	1.1	20
BAT25	0.1	40	1.0	20
BAT26	0.1	25	1.1	20
BAT27	0.1	40	1.0	20
BAT28	0.1	25	1.1	20

*Time to recover to 10% of I_R Peak.

Circuit configurations

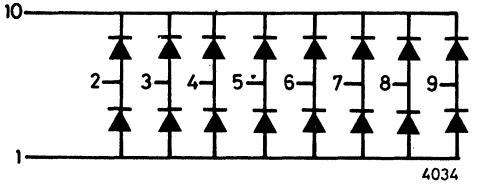
BAT21, BAT22/BAT21J, BAT22J

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



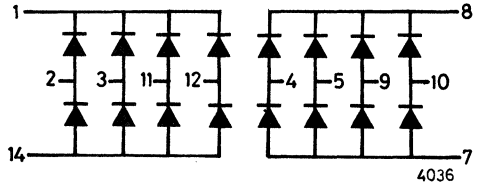
BAT23, BAT24/BAT23H, BAT24H

10 lead flat-pack



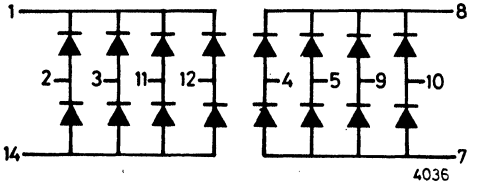
BAT25, BAT26

14 lead DIL
leads 6 and 13 not connected



BAT27, BAT28

14 lead flat-pack
leads 6 and 13 not connected



CONTENTS

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 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 $R_S = 50\Omega$ $V_{CE} = 5.0V$ $I_C = 2.0mA$	175mW at 500MHz $P_{in} = 25mW$ $V_{CE} = 13.5V$	TO-72
ZTX325	30	15	2.5			E-line†
ZTX326	25	12	2.5	6dB at 500MHz $R_S = 50\Omega$ $V_{CE} = 5.0V$ $I_C = 2.0mA$	$G_P = 10dB$ min. $f = 500MHz$ $I_C = 15mA$ $V_{CE} = 5V$	E-line†
ZTX326A§	25	12	2.5			E-line†
BFX89	30	15	2.5			TO-72
BFS17	25	15	2.5	4.5dB at 500MHz $R_S = 50\Omega$ $V_{CE} = 5.0V$ $I_C = 2.0mA$	$G_P = 10dB$ min. $f = 500MHz$ $I_C = 15mA$ $V_{CE} = 5V$	SOT-23†
BFS17R*	25	15	2.5			SOT-23†

*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

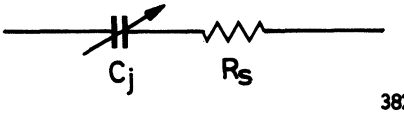
Suitable for drivers and general purpose RF amplifiers.

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.

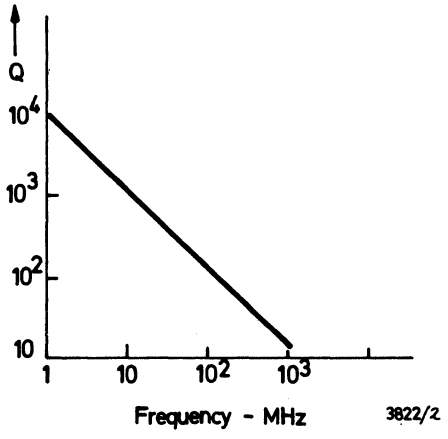


Fig. 2 – Variation of Q with frequency

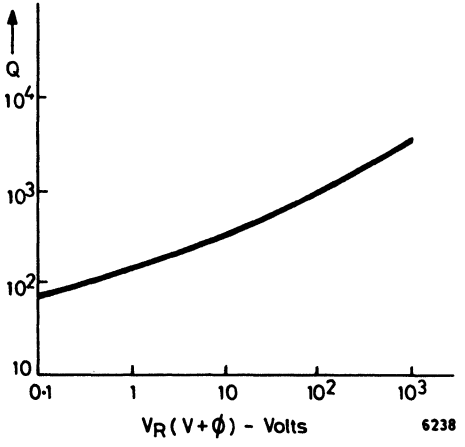


Fig. 3 – Variation of Q with bias voltage

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.

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 = 1MHz pF			Min. C_2/C_{30} at f = 1MHz	Min. Q at V_R = 4V f = 50MHz	Package	
		Min.	Typ.	Max.			ZC700 to ZC714	ZC740 to ZC754
							Glass	Plastic
ZC700	ZC740	6.12	6.8	7.48	2.7	450	DO-7	E-line
ZC701	ZC741	7.4	8.2	9.1	2.7	450	DO-7	E-line
ZC702	ZC742	9.0	10.0	11.0	2.7	400	DO-7	E-line
ZC703	ZC743	10.8	12.0	13.2	2.8	400	DO-7	E-line
ZC704	ZC744	13.5	15.0	16.5	2.8	400	DO-7	E-line
ZC705	ZC745	16.2	18.0	19.8	2.8	350	DO-7	E-line
ZC706	ZC746	19.8	22.0	24.2	2.8	350	DO-7	E-line
ZC707	ZC747	24.3	27.0	29.7	2.8	300	DO-7	E-line
ZC708	ZC748	29.7	33.0	36.3	2.8	200	DO-7	E-line
ZC709	ZC749	35.1	39.0	42.9	2.8	150	DO-7	E-line
ZC710	ZC750	42.3	47.0	51.7	2.8	150	DO-7	E-line
ZC711	ZC751	50.4	56.0	61.6	2.8	150	DO-7	E-line
ZC712	ZC752	61.2	68.0	74.8	2.8	150	DO-7	E-line
ZC713	ZC753	73.8	82.0	90.2	2.8	100	DO-7	E-line
ZC714	ZC754	90.0	100.0	110.0	2.8	100	DO-7	E-line

ZC100 Series

Designed for L-Band electronic tuning applications.

Type	V_R(volts) Max.	Capacitance 1MHz pF Min.	Capacitance 1MHz pF Max.	Capacitance Measurement Test Voltage V_R(volts)	Capacitance Ratio		Package
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

SILICON ION IMPLANTED HYPERABRUPT TUNER DIODES

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

Ion implantation is a semiconductor doping technique enabling close control of doping and profile. Its use enables devices to be produced with consistant characteristics to closely controlled tolerances.

Applications of the technique to the manufacture of Hyperabrupt tuner diodes guarantees long term stability in the uniformity of the capacitance/voltage characteristics of these devices.

To appreciate the advantages of the Hyperabrupt tuner diodes ZC800 series, over conventional types when used in electronic tuning applications it is advantageous to consider the theory of the tuner diode.

As detailed in the conventional variable capacitance tuner diode section, the relationship between capacitance and bias voltage is given by:

$$C_{jv} = \frac{C_{jO}}{\left(1 + \frac{V_R}{\varnothing}\right)^N}$$

where C_{jO} = junction capacitance at 0V
C_{jv} = junction capacitance at applied bias voltage V_R
V_R = applied bias voltage
$\varnothing$ = contact potential
N = power law of the junction or slope factor

This may be simplified to the form $C \propto \frac{1}{V^N}$

For a conventional tuner diode, the value of N is typically 0.47. Fig. 4 shows the typical straight line graph for a ZC712 conventional ½ law tuner diode. It can be seen that by changing the applied bias voltage from 2 to 30 volts, the capacitance is reduced from 100pF to 33pF, representing a capacitance ratio of 3 to 1.

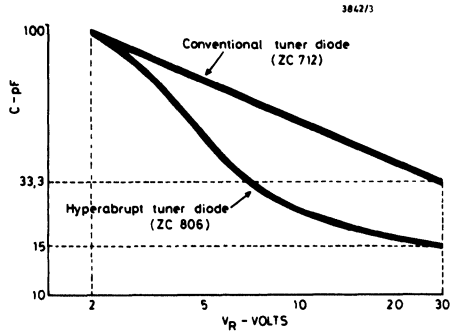


Fig. 4
Comparison of the C/V relationships of the Hyperabrupt and a conventional tuner diode.

By modifying the design of the diode it is possible to make N greater than 0.5, so providing a greater capacitance ratio for a given voltage change. As can be seen from Fig. 4, the 2 to 20V capacitance ratio for a ZC700 series diode is 2.8, whereas for the ZC806 hyperabrupt diode it is 6.5. In an LC tuned circuit in which the resonant frequency is proportional to $C^{-\frac{1}{2}}$, the use of the ZC800 series of hyperabrupt diodes allows a frequency tuning ratio in excess of 2:1 for an 18V change in bias voltage. For a similar 2:1 change in frequency a ZC700 (an abrupt) diode would demand a voltage change of greater than 40V.

TABLE 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

CHARACTERISTICS *(Continued)*

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	
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 = 1MHz		C_{3V}/C_{25V} f = 1MHz		$V_R = 3V$ f = 1MHz
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 $V_R = 28V$

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.

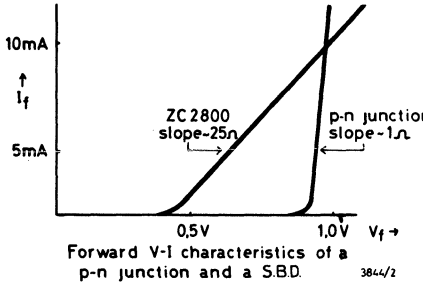


Fig. 5

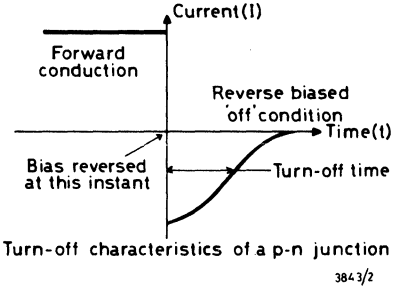


Fig. 6

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	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	$V_R = 0V$, $f = 1MHz$
	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	

CONTENTS

SEE REAR SECTION OF BOOK FOR PACKAGE OUTLINES

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	μA/mW/cm²	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 100μW/cm² 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 thickness of Chance Bros. infra-red filter type OX5; radiation limited to wavelengths beyond 0.75μm.

BPX63 LOW LEAKAGE PHOTODIODE

A silicon planar photodiode having an extremely low level of dark leakage current together with the capability, when used in the photovoltaic mode, of generating a high open circuit voltage under low illumination intensities.

The device has an n-type substrate with a thin p-conducting region limited to a depth of 0.8 microns, thus giving a high response to the short wavelength end of the visible spectrum. It is well suited therefore for use in exposure meters and related photographic equipment.

CHARACTERISTICS (at 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Wavelength of peak sensitivity	$\lambda_{S\ max}$	—	800	—	nm
Sensitivity (Tungsten filament source at 2854°K)	S	8	10	—	nA/lux.
Absolute sensitivity, at 800nm	S	—	0.47	—	A/W
Quantum efficiency, at 800nm (Electrons per photon)	η	—	0.73	—	
Dark leakage current ($V_R = 1V$, $E_V = 0$)	I_R	—	5	20	pA
Forward voltage ($E_V = 0$, $I_F = 1pA$, $T = 50°C$)	V_F	0.5	1	—	mV
Response times ($R_L = 1k\Omega$, $V_R = 0V$) ($R_L = 1k\Omega$, $V_R = 5V$)	 t_r, t_f t_r, t_f	 — —	 1.3 1.0	 — —	 μs μs
Maximum reverse voltage	V_R	—	—	7	V
Active area	A_a	—	1	—	mm^2

MS700/701 LARGE AREA, LOW LEAKAGE PHOTODIODES

A p on n, planar photodiode of large active area providing an extremely low level of dark leakage current together with good linearity of short circuit current over the range of 10^{-3} to 10^3 lux.

The MS700 is particularly suitable for use with tungsten or near infra-red sources whilst the spectral response of the MS701 is optimised towards the detection of lower wavelength visible light.

Both devices are available in hermetic, TO-5, flat window packages.

CHARACTERISTICS (at 25°C)

Parameter		Min.	Typ.	Max.	Unit
Wavelength of peak sensitivity	MS700 MS701	— —	850 550	— —	nm nm
Sensitivity to Standard Illuminant 'A' (Tungsten filament lamp at 2856°K)	MS700 MS701	20 5	33 10	— —	na/lux. na/lux.
Dark leakage current at $V_R = 1V$		—	40	100	pA
Reverse voltage		—	—	10	V

SILICON PLANAR PHOTOTRANSISTORS

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.

ZMX130 SERIES – MICRO-E PLASTIC (ZMX130/131/132/133)

A phototransistor/photodarlington encapsulated in a clear plastic micro-miniature package especially suitable for mounting onto p.c.b.s down to 0.1 inch centres. The absence of a lens simplifies the design of the optical interface.

ZMX140 SERIES – TO-18 PLASTIC LENS (ZMX140/141)

A phototransistor/photodarlington mounted in an economical TO-18 header having a clear plastic lens for general purpose applications.

ZMX150 SERIES – MICRO-P PLASTIC (ZMX150/151)

A two lead micro-miniature package, housing a photodarlington/phototransistor specifically designed for array building where a high packing density is required.

A lens is provided to increase sensitivity and reduce channel to channel cross-talk.

GENERAL APPLICATIONS OF FERRANTI PHOTOTRANSISTORS

Alarm Systems, Process Control, Edge and Position Sensing, Optical Character Recognition, Tape Readers, Card Readers, Electronic Flash Control, etc.

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
ZMX130/1†	35	6	100	0.025	8
ZMX132/3†	35	10	100	1.0	50
ZMX140	35	10	200	1.0	125
ZMX141	35	5	200	0.025	20
ZMX150	35	–	100	1.0	320
ZMX151	35	–	100	0.025	26

*Illumination source is a tungsten filament lamp at 2856°K colour temperature.

†ZMX131 and ZMX133 are provided without a base connection.

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 30% fixed hysteresis in 4 lead TO-72 cans with glass window.

For economic applications the ZNP108 and 109 are available packaged in a 4 lead TO-72 can with a plastic lens.

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 ZNP100/2/3 ZNP108/9	 10* 2.9	 — —	 10,000† 2,900	 $\mu W/cm^2$	 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 ZNP100/2/3 ZNP108/9	 — —	 — —	 70 60	 °C	

*Typical RC = 40k × 100,000pF. †Typical RC = 3k × 2,200pF.

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

INFRA-RED PHOTODETECTOR

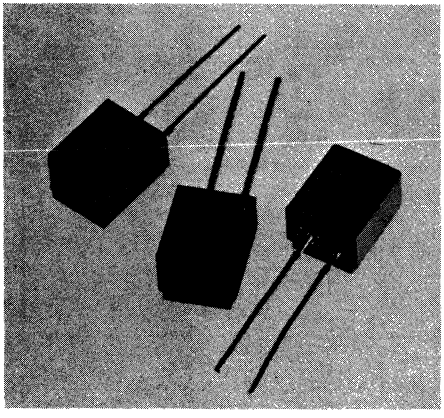
The BPW41 is a large area, silicon p.i.n. photodiode having a low junction capacitance and consequently capable of fast response times. The active chip is packaged in a plastic moulding which contains a near infra-red transmissive filter such that the device is sensitive to infra-red radiation only, and has a high rejection of wavelengths below 700nm. The BPW41 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	$V_R = 5V$ $E_e = 1mW/cm^2$ $\lambda p = 950nm$ (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	

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 to 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.

(See inside rear cover for spectral response).

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, a fact 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 is contained within the hand-book "Active Semiconductors for Hybrid Circuits" also available on request.

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
BPW16	Phototransistor	ZMX151
BPW17	Phototransistor	ZMX151
BPW20	Photodiode	MS700
BPW21	Visible Response Photodiode	MS701
BPW23	Phototransistor	ZMX151
BPW30	Photodarlington	ZM100
BPW41	Infra-red Response Photodiode	BPW41
BPX25	Phototransistor	BPX25
BPX29	Phototransistor	BPX29
BPX31	Phototransistor	ZM110
BPX43	Phototransistor	ZM110
BPX63	Low Leakage Photodiode	BPX63
BPX70	Phototransistor	ZMX141
BPX72	Phototransistor	ZMX141
BPX81	Phototransistor	ZMX151
BPX95	Phototransistor	ZMX141
BPX99	Phototransistor	ZM110
BPY62	Phototransistor	ZM110
FPT100	Phototransistor	ZMX141
FPT100A	Phototransistor	ZMX141
FPT100B	Phototransistor	ZMX141
FPT110	Phototransistor	ZMX141
FPT110A	Phototransistor	ZMX141
FPT110B	Phototransistor	ZMX141
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
FPT630	Phototransistor	ZMX151
IPL15	Light Activated Photoswitch	ZNP108/109
IPL17	Light Activated Photoswitch	ZNP108/109

COMPETITOR CROSS REFERENCE LIST

(Continued)

Competitive Part Number	Device Type	Ferranti Equivalent
MRD150	Phototransistor	ZMX151
MRD300	Phototransistor	ZM110
MRD310	Phototransistor	ZM110
MRD370	Photodarlington	ZM100
MRD450	Phototransistor	ZMX151
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
MT8020	Phototransistor	ZMX151
OSD5-3	Photodiode	MS700
OSD5-5	Photodiode	MS700
OSD-5E	Visible Response Photodiode	MS601
SFH205	Infra-red Response Photodiode	BPW41
TIL78	Phototransistor	ZMX151
TIL81	Phototransistor	ZM110
TIL100	Infra-red Response Photodiode	BPW41

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/ft²)

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/cm² (W/cm²).

Illumination The density of luminous flux incident on a surface and expressed in lux (lumens/m²), phot (lumens/cm²) or lumens/ft².

Incident Falling, striking or landing on.

Irradiance Radiant energy striking a given surface being the radiometric equivalent to illumination and expressed as Watts/cm².

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/m².

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.

SECTION 2: INTEGRATED CIRCUITS

INTEGRATED CIRCUITS

CONTENTS

*ADVANCED PRODUCT INFORMATION

MONOLITHIC A/D CONVERTERS

DESCRIPTION	TYPE	USEFUL RESOLUTION (bits)	RELATIVE ACCURACY (% FS)	CONVERSION TIME	OUTPUT	INPUT RANGES
Successive Approximation	ZN432J-10	10	±0.05	20μs	Binary or Offset Binary	Selectable
	ZN432BJ-10	10	±0.05			
	ZN432CJ-10	10	±0.05			
	ZN432E	10	.1	15μs		
Tracking	ZN433J-10	10	±0.05		Binary or Offset Binary	Selectable
	ZN433BJ-10	10	±0.05	1μs		
	ZN433CJ-10	10	±0.05			
Successive Approximation	ZN442CJ††	10	±.05	15μs	Three-State Binary or Offset Binary	Selectable
8 Bit Microprocessor Compatible	ZN427J-8	8	±0.2		Three-State Binary or Offset Binary	Selectable
	ZN427E-8	8	±0.2	10μs		
8 Bit Low Cost General Purpose & Counting	ZN425J-8	8	±0.2		Binary	Selectable
	ZN425E-8	8	±0.2	1ms		
Tracking	ZN435E-8††	8	±0.2	1μs	Binary or Offset Binary	Selectable
	ZN435J-8	8	±0.2			
Parallel (Flash) ADC	ZN440CJ	6	±0.8	55ns	Binary	-4 to +0.5V
Successive Approximation	ZN441CJ††	10	±0.8	100ns	Binary	-4 to +0.5V
	ZN447E-8	8	±0.1		Three-State Binary or Offset Binary	Selectable
	ZN447J-8	8	±0.1	9μs		
	ZN448E-8	8	±0.2		Three-State Binary or Offset Binary	Selectable
	ZN448J-8	8	±0.2	9μs		
	ZN449E-8	8	±0.4		Three-State Binary or Offset Binary	Selectable
	ZN449J-8	8	±0.4	9μs		
Single Chip Charge Balancing 3½ Digit DVM	ZN450E/451E	na	±.025	300ms	7 seg	±200mV

MONOLITHIC D/A CONVERTERS

				SETTLING TIME		OUTPUT** OUTPUT**
8 Bit Microprocessor Compatible	ZN428E-8	8	±0.2	800ns	Voltage	0 to +2.5v
	ZN428J-8	8	±0.2			
8 Bit Low Cost Low Power	ZN426E-8	8	±0.2		Voltage	0 to +2.5v
	ZN426J-8	8	±0.2	1μs		
8 Bit Low Cost Low Power	ZN429E-8	8	±0.2		Voltage	0 to +2.5v
	ZN429J-8	8	±0.2	1μs		
8 Bit Low Cost Counting	ZN425E-8	8	±0.2		Voltage	0 to +2.5v
	ZN425J-8	8	±0.2	1μs		
Multi-Purpose Data Converter System	ZN435E-8	8	±0.2	800 ns	Voltage	0 to +2.5v
	ZN435J-8††	8	±0.2			
8 Bit Microprocessor Compatible	ZN438	8	±0.015	1μs	Voltage	0 to +2.5v
6 Bit Low Cost	ZN436	6	±.08	2μs	Voltage	0 to 2.53v
4 Bit Low Cost	ZN434	4	±.06	300ns	Voltage	0 to 2.456v

†At stated useful resolution. All 10 and 8 bit devices are also available with ±1 bit and ±2 bit linearity.
*Excluding reference. **Other output ranges including bipolar may be obtained with ext. buffer amplifier.
††Advanced Product Information.

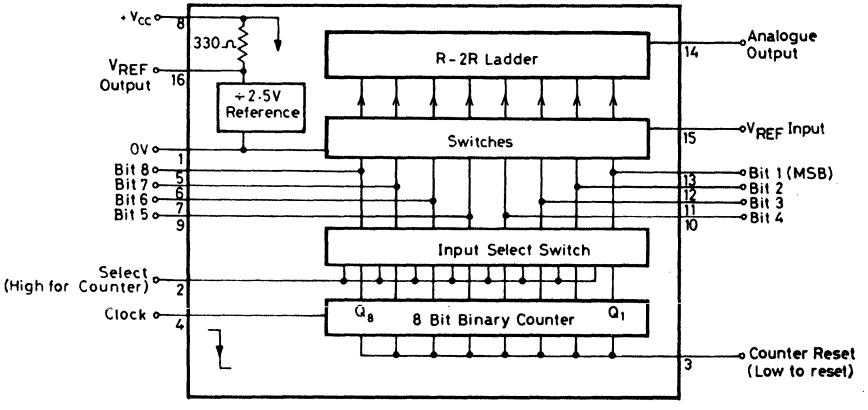
LINEARITY †	GAIN* T.C.	TEMP RANGE	POWER RAILS	PACKAGE	FEATURES
±½ LSB ±½ LSB ±½ LSB ±1 LSB	10ppm/°C 10ppm/°C 10ppm/°C 20ppm/°C	-55° to +125°C -40° to +85°C 0° to +70°C 0°C to 70°C	±5v ±5v	28 pin DIP 28 pin plastic DIP	Serial or parallel O/P on-chip reference TTL & CMOS COMPATIBLE Low Cost
±½ LSB ±½ LSB ±½ LSB	10ppm/°C	-55° to +125°C -40° to +85°C 0° to +70°C	±5v	28 pin DIP	As above
±½ or ±1	10ppm/°C	0° to +70°C -40° to +85°C	±5v	28 pin plastic or Ceramic DIL	On-chip reference Three-State Output Reference Amplifier
±½ LSB +½ LSB	2.5ppm/°C	-55° to ±125°C 0° to +70°C	+5v -3v to -30v	18 pin DIP	On-chip reference Three-State outputs
±½ LSB ±½ LSB	3ppm/°C	-55° to +125°C 0° to +70°C	+5v	16 pin DIP	On-chip reference On-chip 5MHz 8 bit counter
±½ LSB ±½ LSB	3ppm/°C	0° to +70°C -55° to +125°C	+5v	18 pin DIP	On-chip reference On-chip clock TTL & CMOS COMPATIBLE
±½ LSB	na	0° to +70°C	±5v	24 pin DIP	Can digitize up to 7MHz Sine wave without sample and hold @ 18 mega samples per second
±½ LSB	na	0° to +70°C	±5v	24 pin DIP	Low Cost
±¼ LSB ±¼ LSB	2.5ppm/°C	0° to +70°C -55° to +125°	+5V	18 pin DIP	
+½ LSB +½ LSB	2.5ppm/°C	0° to +70°C -55° to +125°C	+5V	18 pin DIP	On-chip reference On-chip clock 3-state outputs
±1 LSB ±1 LSB	2.5ppm/°C	0° to +70°C -55° to +125°C	+5V	18 pin DIP	
±½ LSB	80ppm/°C	0° to -70°C	On Chip 5V Shunt Regulator	40 pin DIP	On-chip reference On-chip clock Direct drive 3½ dig LC display Under/over range indicator Low power consumption
±½ LSB ±½ LSB	2ppm/°C	0° to +70°C -55° to +125°C	+5v	16 pin DIP	On-chip reference Latched inputs
±½ LSB ±½ LSB	3ppm/°C	0° to +70°C -55° to +125°C	+5v	14 pin DIP	On-chip reference Low cost
±½ LSB ±½ LSB	3ppm/°C	0° to +70°C -55° to +125°C	+5v	14 pin DIP	Lowest cost
±½ LSB ±½ LSB	3ppm/°C	0° to +70°C -55° to +125°C	+5v	16 pin DIP	On-chip reference & 5MHz 8 bit counter
±½ LSB ±½ LSB	3ppm/°C	0° to +70°C -55° to +125°C	+5v	18 pin DIP	8 bit DAC with On-chip reference On-chip clock On-chip up/down counter
±⅛ LSB	2ppm/°C	0° to +70°C -40 +85	+5v	22 pin plastic DIL	On-chip Trimmable Output Buffer Latched Inputs
±.5 LSB	3ppm/°C	0° +70°C -55 + 125	+5v	14 pin plastic or Ceramic DIL	TTL and 5v CMOS Compatible +5v Supply Low Cost
±¼ LSB	3ppm/°C	0° to +70°C -40° to +85°C	±5v	14 pin plastic or Ceramic DIL	TTL and 5v CMOS Compatible +5v Supply Low Cost

8-BIT DUAL MODE A/D AND D/A 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 of 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 pin plastic or ceramic D.I.L.



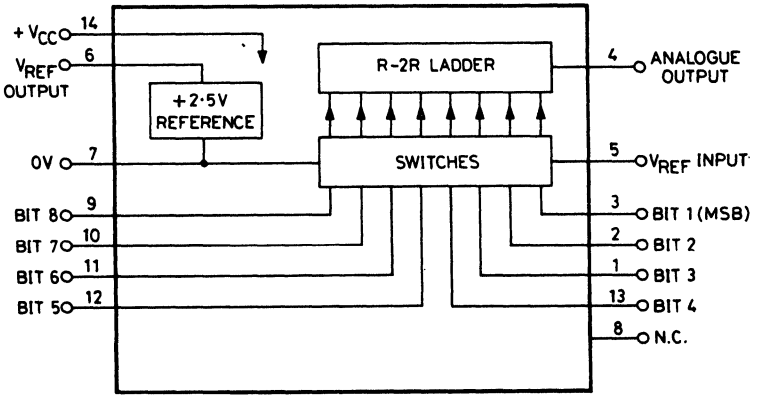
System Diagram

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 ZN426s.

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 pin plastic or ceramic D.I.L.



System Diagram

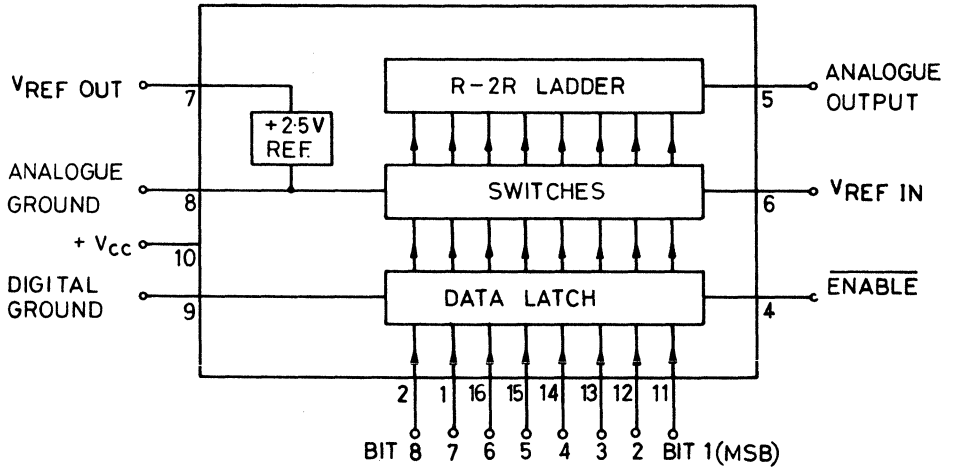
8-BIT MICROPROCESSOR COMPATIBLE D TO A CONVERTER

ZN428 SERIES

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
- 800 ns 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 pin plastic or ceramic D.I.L.



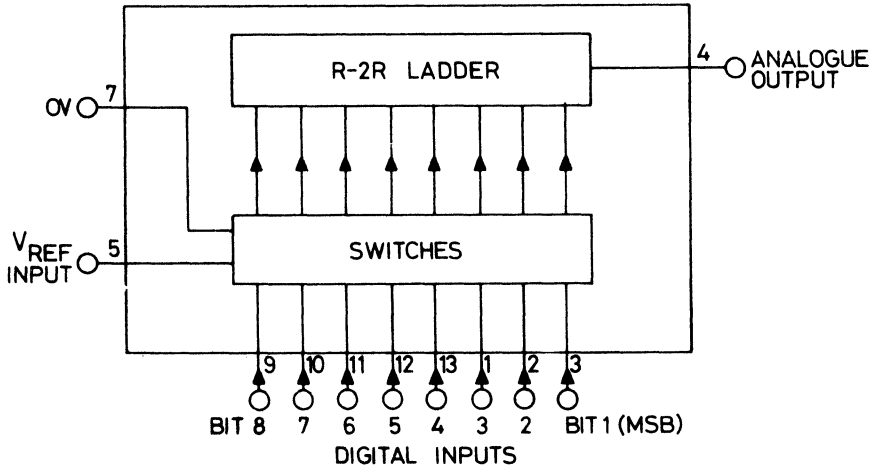
System Diagram

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 pin plastic or ceramic D.I.L.



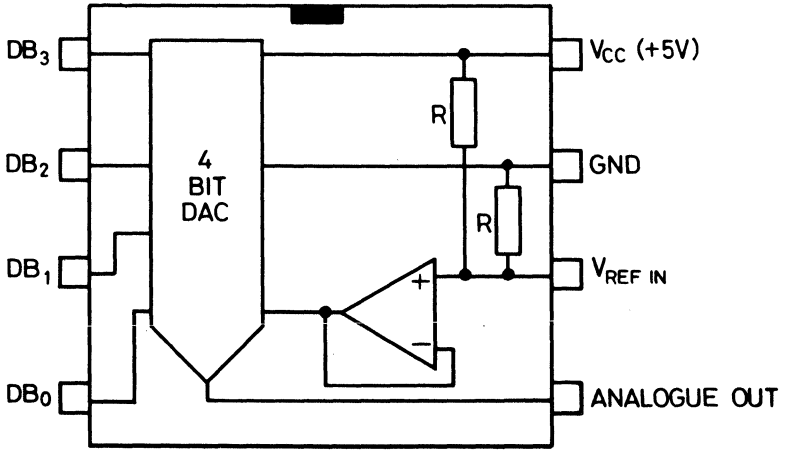
System Diagram

LOW COST 4-BIT D TO A CONVERTER ZN434 SERIES

The ZN434 is a monolithic, 4-bit D to A Converter designed for cost-conscious applications such as automotive and consumer products. It contains an 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 IC to function with no external components.

FEATURES

- 4 bit resolution
- 1/4 LSB linearity
- Voltage output
- 300ns settling time
- TTL and CMOS compatible
- Single + 5V supply
- On-chip $\frac{V_{CC}}{2}$ reference
- Temperature ranges, 0°C to +70°C, -40°C to +85°
- 8 pin plastic D.I.L.



SYSTEM DIAGRAM

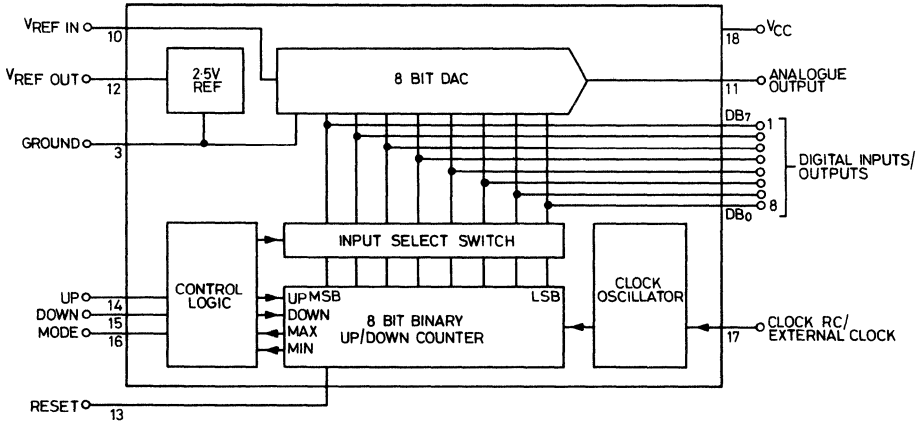
ADVANCED PRODUCT INFORMATION

8-BIT MULTIFUNCTION A/D AND D/A CONVERTER ZN435 SERIES

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
- Temperature Ranges, 0 to 70°C, -55 to +125°C
- 18 pin plastic or ceramic D.I.L.



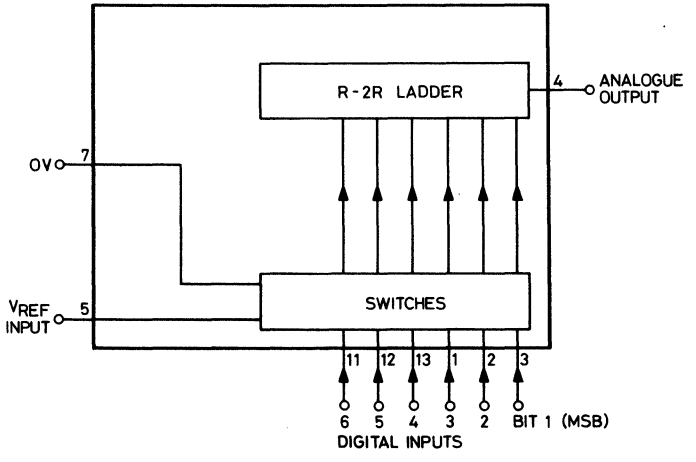
SYSTEM DIAGRAM

LOW COST 6-BIT D to A CONVERTER ZN436 SERIES

The ZN436 is a monolithic, 6-bit D to A converter designed for cost-conscious applications such as automotive and consumer products. It contains an R-2R ladder network of diffused resistors with precision bipolar switches.

FEATURES

- 6-bit Accuracy
- TTL and 5V CMOS Compatible
- Single +5V Supply
- Settling Time 1μsec. Typical
- Designed for low-cost applications
- Temperature Ranges, 0 to +70°C, -55 to +125°C
- 14 pin plastic or ceramic D.I.L.



SYSTEM DIAGRAM

ADVANCED PRODUCT INFORMATION

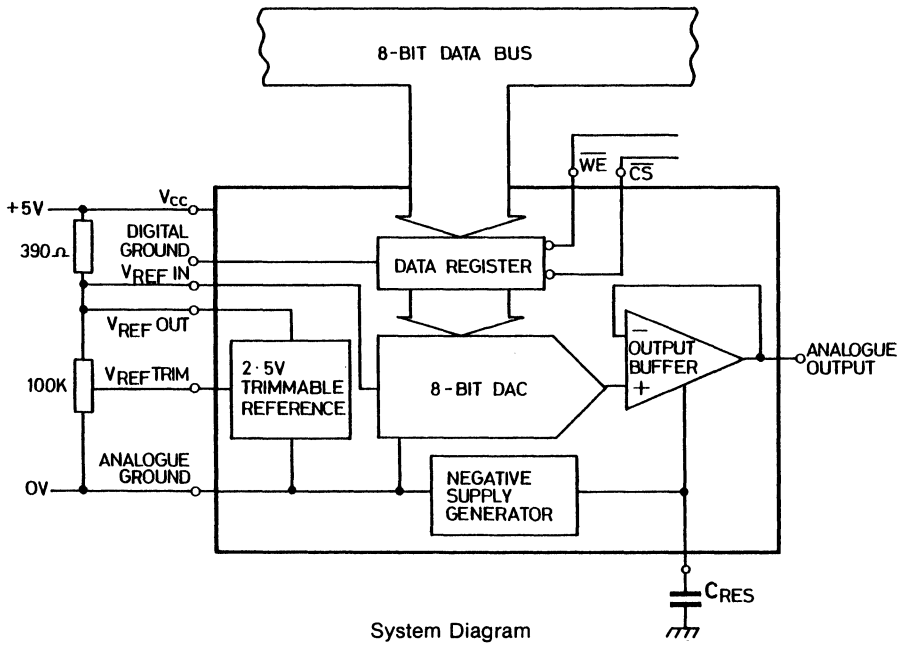
8-BIT MICROPROCESSOR COMPATIBLE D TO A CONVERTER

ZN438 SERIES

The ZN438 is a monolithic, 8-bit DAC designed for easy interfacing with microprocessors requiring minimal external components. Only a reference bias resistor and trimpot are needed to provide an accurate 2.55V output with 10mA sink and source capability. Multiple chip selects are provided for easy μp interfacing.

FEATURES

- 1/8 LSB Linearity
- 1μs Settling time
- Voltage Output, ON-CHIP buffer amp sources or sinks 10ma.
- μP, TTL and CMOS compatible
- ON-CHIP Trimmable reference. Only a trimpot needed for calibration.
- Single +5V supply
- ON-CHIP negative supply generator
- Temperature Ranges, 0 to 70°, -40 to +85°C
- 22 pin plastic or ceramic D.I.L.



System Diagram

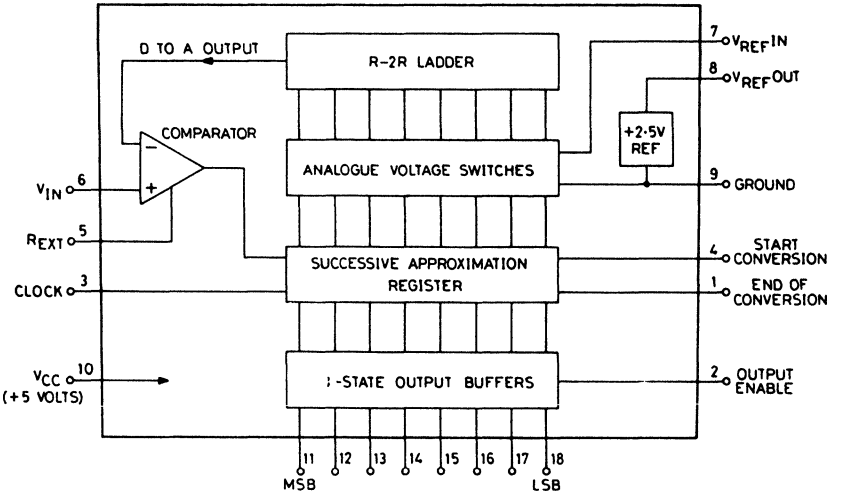
8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN427 SERIES

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
- 10 μs typical conversion time
- Microprocessor, TTL and CMOS compatible
- Optional on-chip reference
- Temperature ranges 0 to +70°C, –55 to +125°C
- 18 pin plastic or ceramic D.I.L.



System Diagram

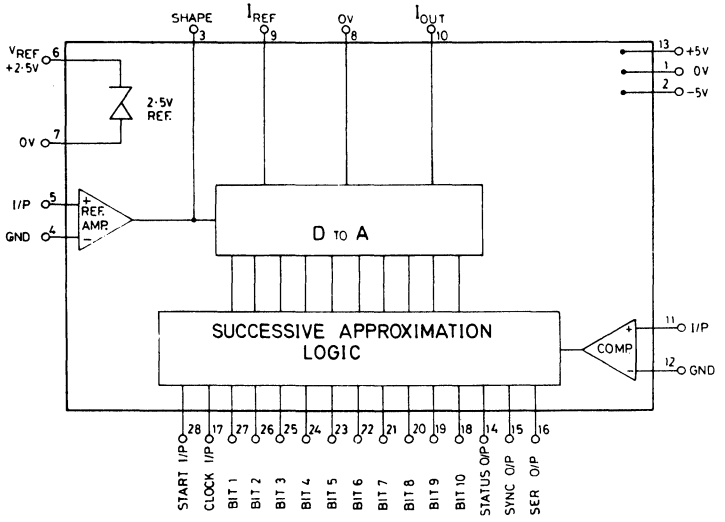
10-BIT SUCCESSIVE APPROXIMATION A TO D CONVERTER

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 pin plastic or ceramic D.I.L.



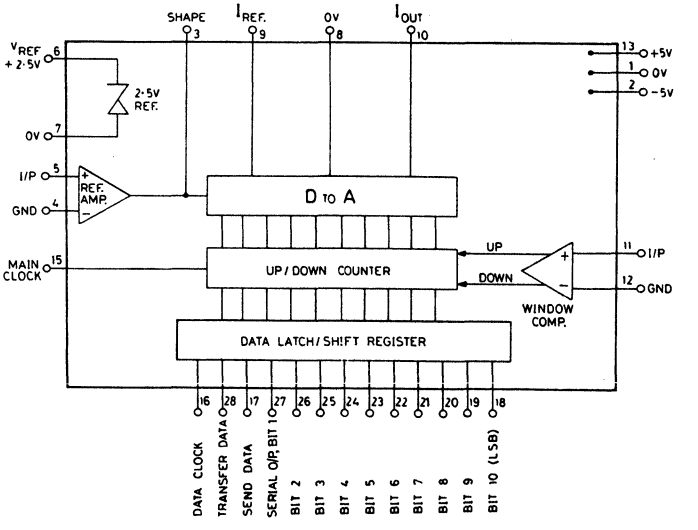
System Diagram

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
- 1μs update time
- Parallel and serial data outputs
- TTL and CMOS compatible
- ±5V supplies
- Optional on-chip reference
- Temperature ranges, 0 to +70°C, –40 to +85°C, –55 to +125°C
- 28 pin ceramic D.I.L.



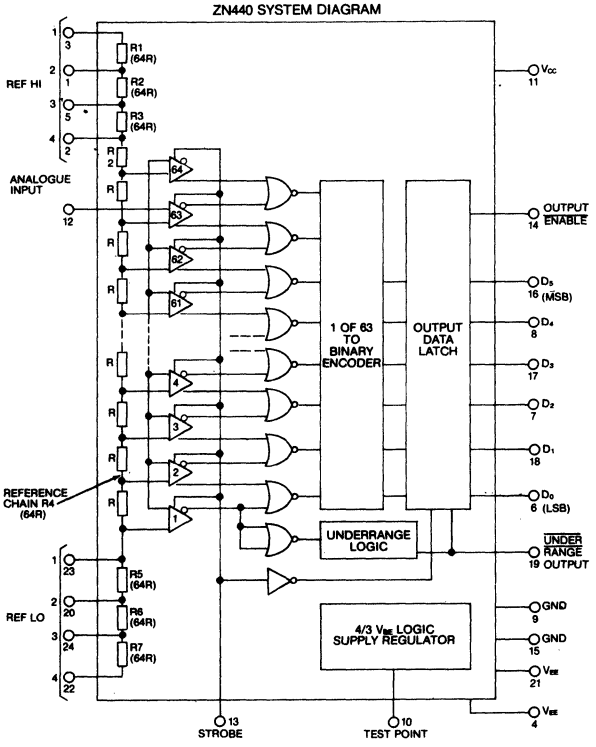
System Diagram

6 BIT PARALLEL (FLASH) A/D CONVERTER ZN440/441 SERIES

The ZN440 Series is a high speed 6 bit parallel A/D converter capable of being stacked to 7 or 8 bits. It provides 18 mega samples per second and can deliver up to a 7 megahertz sine wave without sample and hold.

FEATURES

- ZN440-18 million conversions per second
- ZN441-10 million conversions per second
- Can digitize up to a 7 MHz sine wave
- 6 bit resolution
- Expandable 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
- Temperature range 0 to 70° C
- 24 pin ceramic D.I.L.



System Diagram

ADVANCED PRODUCT INFORMATION

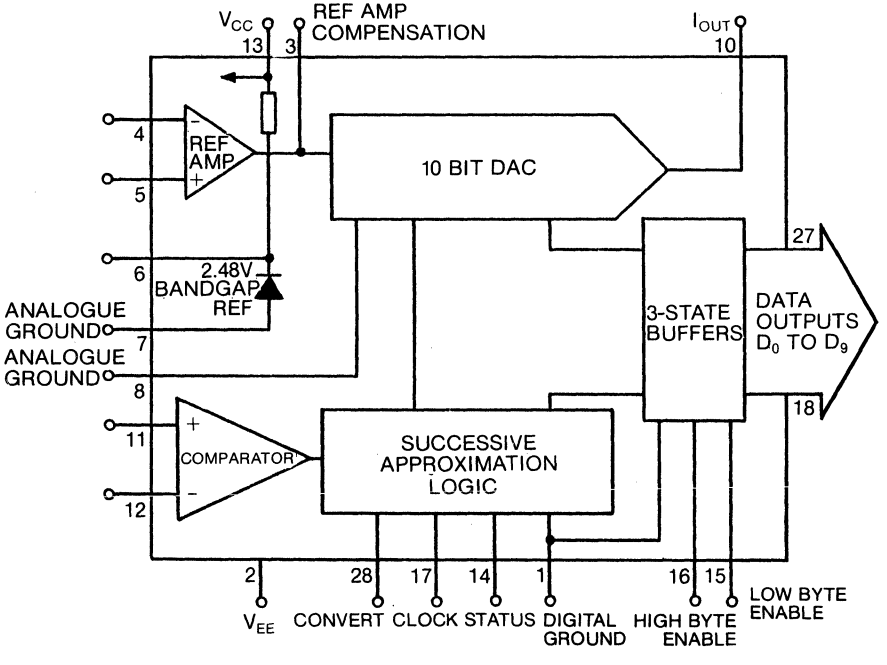
10-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

ZN442 SERIES

The ZN442 is a monolithic, 10-bit, Bus Compatible, successive approximation A to D converter. It contains a 10-bit current output DAC, successive approximation logic, comparator, 2.5V precision reference, reference amplifier and tri state buffers, all on a single chip.

FEATURES

- 1/2 or 1 LSB linearity
- 15 μs conversion time
- Bus compatible outputs available as high and low byte or 10-bit word
- ON-CHIP bandgap reference
- ±5V supplies
- Temperature Ranges, 0 to 70°C, -40 to +85°C, -55 to +125°C
- 28 Pin Plastic or ceramic D.I.L.



System Diagram

8-BIT MICROPROCESSOR COMPATIBLE A TO D CONVERTER

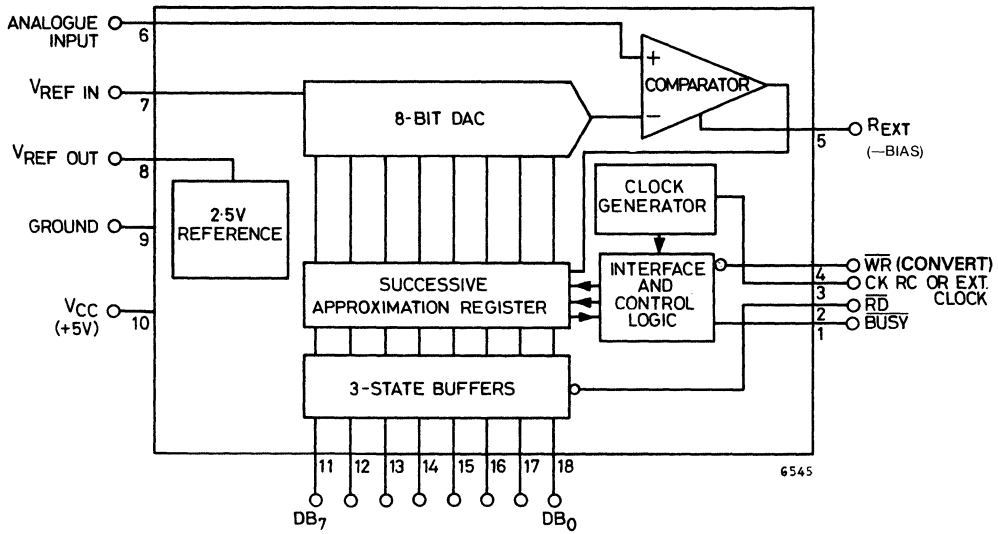
ZN447/8/9 SERIES

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, -8 and 9 are the most complete 8-bit monolithic ADCs available.

FEATURES

- Easy interfacing to microprocessors or operates as a 'stand alone' converter
- Fast 9 μs conversion time guaranteed
- Choice of linearity: ¼LSB—ZN447, ½LSB—ZN448, 1LSB—ZN449
- On-chip clock
- Choice of on-chip or external reference voltage
- Unipolar or bipolar input ranges
- Temperature ranges, 0 to 70° C, -55 to +125° C
- 18 pin plastic or ceramic D.I.L.



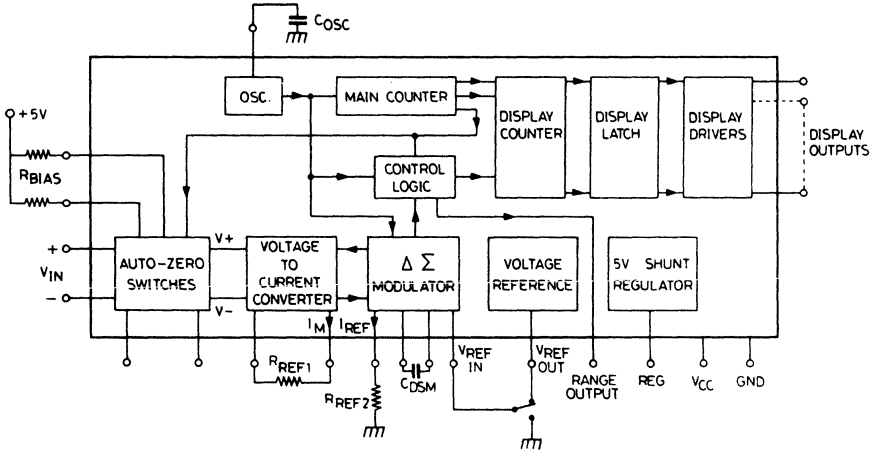
SYSTEM DIAGRAM

SINGLE CHIP 3½ DIGIT D.V.M. ZN450 SERIES

The ZN450 is a complete digital voltmeter fabricated on a monolithic chip and requires only ten external, passive components for operation. An innovative Delta-Sigma Modulation 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

- 199.9 mV 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
- Low power consumption, less than 25 mW
- Wide supply voltage range, single supply rail
- No external active circuits
- Temperature range 0 to +70° C
- 40 pin plastic D.I.L.



System Diagram

SINGLE CHIP 3½ DIGIT D.V.M. WITH EXTERNAL AUTO-ZERO

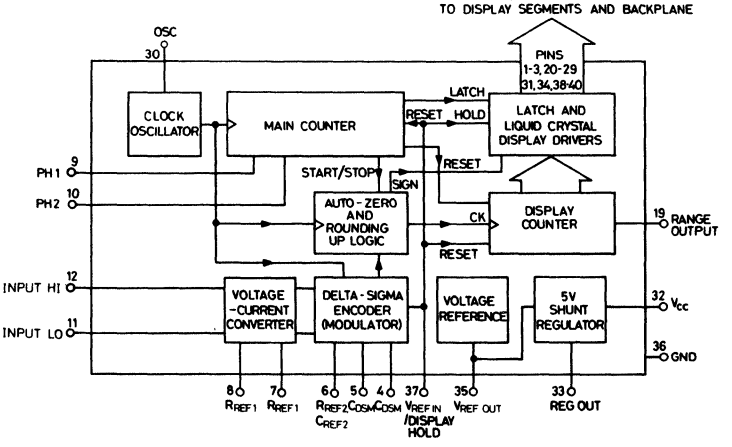
ZN451 SERIES

The ZN451 is a complete digital voltmeter fabricated on a monolithic chip and requires only ten external, passive components for operation. A highly accurate 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.

This 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 35 mW
- Wide supply voltage range, single supply rail
- Temperature range 0 to 70°C
- 40 pin plastic D.I.L.



ZN451 SYSTEM DIAGRAM

PRECISION, MONOLITHIC LOW VOLTAGE REFERENCE SOURCES

- Two terminal designs allow positive or negative fixed output operation.
- Three terminal designs allow positive or negative trimmable output operation.
- Off the shelf Δ Vo as low as 25 ppm/° C with any combination of Tc, line and load within specified limits.
- Wide reference current ranges, from 150 μA to 120 mA.
- Slope resistance as low as 0.2Ω.
- RMS noise less than 10 μV.
- Excellent long term stability, 10 ppm/ 1000 hrs.
- Selected tolerances on initial setting and T_C available on special request.

TWO TERMINAL FIXED OUTPUT DEVICES
2-PIN TO-18 PACKAGE

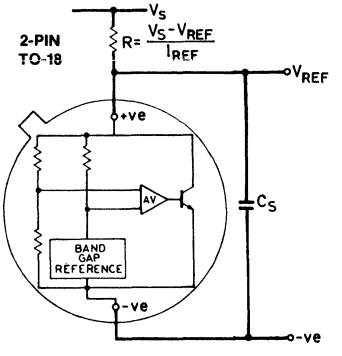
PN	Vo	I_{REF}	SLOPE RESISTANCE	Tc 0°C to 70°C
ZN423	1.26 ±4.76%	1.5-12mA	1.0Ω max	30ppm max
ZN404	2.45 ±2.86%	2-120mA	0.4Ω max	200ppm max
ZN458	2.45 ±1.43%	2-120mA	0.2Ω max	100ppm max
ZN458A	2.45 ±1.43%	2-120mA	0.2Ω max	50ppm max
ZN458B	2.45 ±1.43%	2-120mA	0.2Ω max	30ppm max

THREE TERMINAL TRIMMABLE OUTPUT DEVICES
3-PIN TO-18 PACKAGE

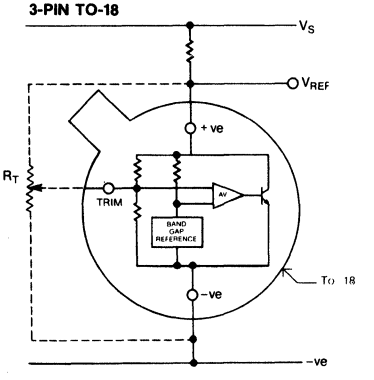
P/N	Vo	I_{REF}	SLOPE RESISTANCE	Tc 0°C to 70°C	RANGE TRIM
ZNREF025	2.5V±1%	0.15-2mA	2Ωmax	15ppm typ 25 max	±5%
ZNREF040	4.0V±1%	0.15-15mA	3Ωmax	15ppm typ 25 max	±5%
ZNREF050	5.0V±1%	0.15-15mA	2Ωmax	15ppm typ 25 max	±5%
ZNREF062	6.2V±1%	0.15-15mA	3Ωmax	15ppm typ 25 max	±5%
ZNREF100	10.0V±1%	0.15-15mA	4Ωmax	15ppm typ 25 max	±2.5%

Custom voltages up to 10V available on special request.

TWO TERMINAL FIXED OUTPUT SCHEMATIC



THREE TERMINAL TRIMMABLE OUTPUT SCHEMATIC



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.

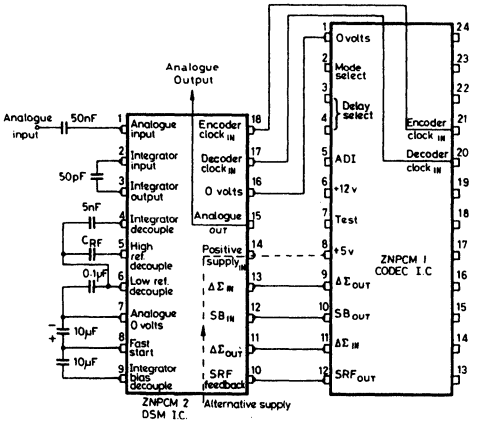
FEATURES

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 (2,048 kHz external clock) or up to 2,048K bit/s (2,048 kHz 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
- Temperature range 0 to +70° C
- 24 pin plastic or ceramic D.I.L.

ZNPCM2E/ZNPCM2J

- Converts analogue (300-3,400 Hz) 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
- Temperature range 0 to +70° C
- 18 pin plastic or ceramic D.I.L.



ZNPCM1/ZNPCM2 Interface

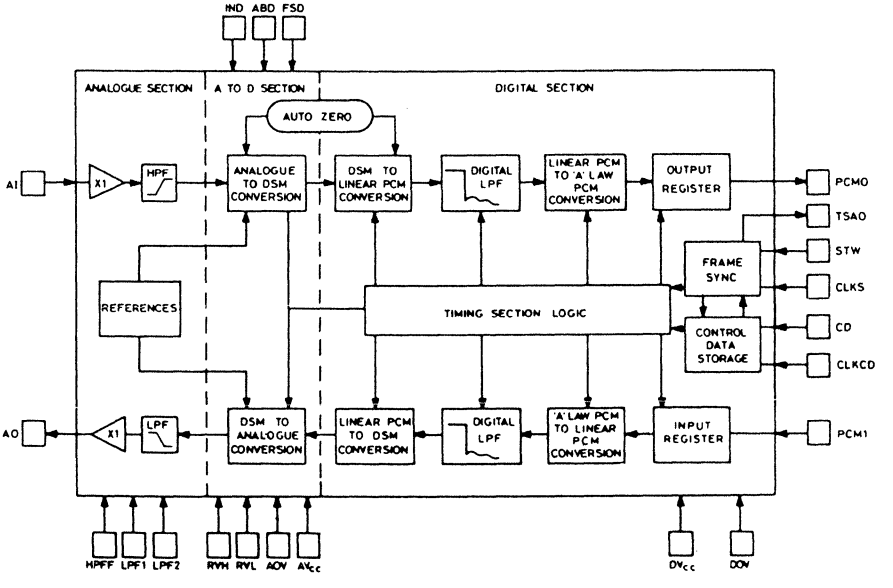
ADVANCED PRODUCT INFORMATION

SINGLE CHIP SYNCHRONOUS CODEC SYSTEM — ZNPCM3 SERIES

The ZNPCM3 is a single chip monolithic integrated circuit. Developed for use in single channel codec systems, the device converts unfiltered audio signals into 8k samples/sec compressed 'A'-Law pcm, the reverse function being performed in the decode direction.

FEATURES

- Converts analog voice signal into compressed pcm and vice-versa, using an on-chip delta sigma modulated (DSM) code converter.
- On-chip 3rd order analog input high pass filter (HPF).
- A-law companding characteristic.
- Low power dissipation—250 mW (active), 20 mW (power down)
- Minimal external components.
- Single +5V power supply.
- On-chip voltage references—wide band, low noise.
- On-chip time-slot assignment circuitry
- Temperature range, 0°C to 70°C
- 24 pin plastic D.I.L.



ZNPCM3 BLOCK DIAGRAM

ADVANCED PRODUCT INFORMATION

SINGLE CHIP ASYNCHRONUS CODEC — ZNPCM4 SERIES

The ZNPCM4 is a single chip monolithic circuit developed for use in single channel codec systems. The device converts unfiltered audio signals into 8K samples/sec compressed "A"-law PCM, the reverse function being performed in the decode direction.

FEATURES

- Same as ZNPCM3 but operates in an Asynchronus Mode.

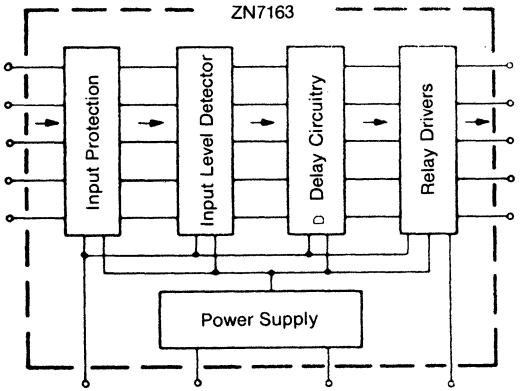
ADVANCED PRODUCT INFORMATION

FIVE CHANNEL RELAY DRIVER — ZN7163 SERIES

The ZN7163 is a pin compatable replacement for ITT7163. It is a monolithic relay driver circuit designed to be an interface between relays powered by a -50V (nominal) battery and TTL or DTL logic circuits.

FEATURES

- 70 mA drive capability per element
- Outputs can be paralleled for increased current capability
- Non-destructive avalanche characteristics
- Output protection against short circuits
- TTL-compatible inputs
- Input noise rejection
- All inputs both current and voltage limited for complete protection
- All DC supply connections are internally current-limited for the highest in-circuit reliability
- Low junction temperature for the highest reliability
- Internal input pull-up resistors
- 14-pin cerdip case or 14-pin plastic package TO-116



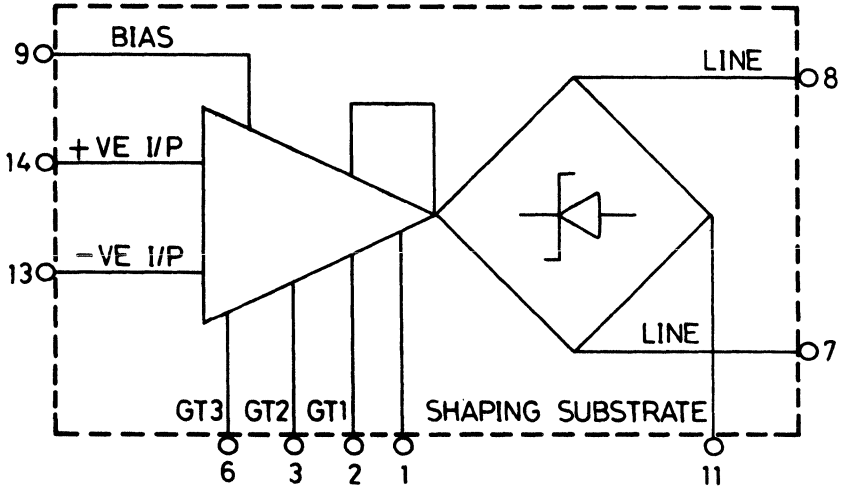
System Diagram

MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS ZN470 SERIES

The ZN470AE was developed for use with an electret transducer, to replace the carbon transmitter in telefony systems. 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.

FEATURES

- On-Chip Lightning Strike Protection
- Dual Supply Polarity Operation
- High Input Impedance Allows Direct Matching with Electret Elements not containing Built-In FET's
- 4 Gain Settings by Adjustable Links Provides 25dB Nominal
- Operates over 1 mA to 100 mA Line Current
- 220 mA Continuous Overload Capacity
- Low Noise
- Low Distortion
- Powered from Telephone Lines
- Monolithic Construction
- Minimum External Components in Telephone Circuits
- -20 to +80° C Operation
- 14 Pin Plastic D.I.L.



System Diagram

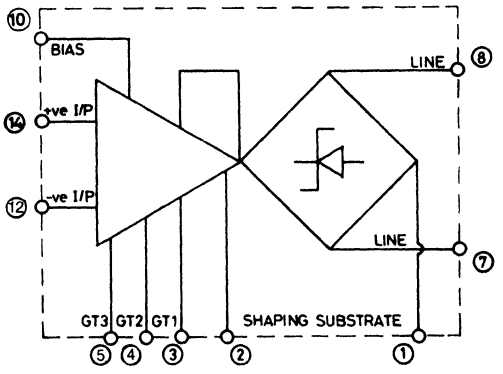
ADVANCED PRODUCT INFORMATION

MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS ZN472 SERIES

The ZN472 was developed for use with an electret transducer, to replace the carbon transmitter in telephony systems. 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 472 also offers an improvement in the total harmonic distortion over the ZN470, and except for the pin outs is identical.

FEATURES:

- Improved Total Hormonic distortion
- On-chip lightning strike protection
- Dual Supply Polarity Operation
- High Input Impedance allows direct matching to electrets without Built-in FET's
- 25 dB Max. Adjustable Gain
- 4 Gain Settings by Adjustable Links
- Operates over 1 mA to 100 mA Line Current
- 220 mA Continuous Overload Capacity
- Low Noise
- Powered from Telephone Lines
- Monolithic Construction
- Minimum External Components in Telephone Circuits
- -20 to +80°C operation
- 14 pin plastic D.I.L.



System Diagram

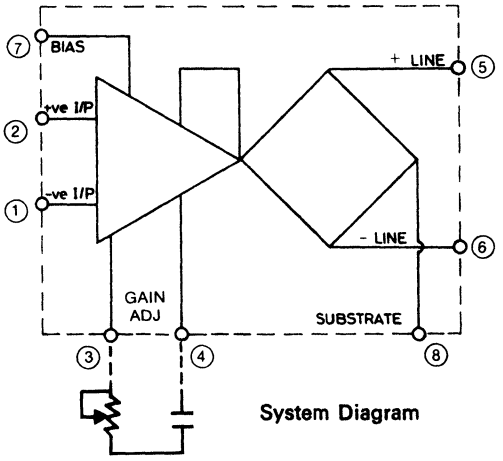
ADVANCED PRODUCT INFORMATION

HIGH GAIN MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS ZN475 SERIES

The ZN475 was developed for use with an electret transducer, to replace the carbon transmitter in telephone systems. The high input impedance makes it suitable for use with high or low impedance microphones providing the microphone gives a high output voltage. An external series resistor and capacitor allow gain adjustment to 50 db max.

FEATURES

- 50 dB adjustable gain
- On-chip lightning strike protection
- Direct Matching to Electret Transducers
- Operates over 1 mA to 100 mA Line Current
- 220 mA Continuous Overload Capacity
- Low Noise
- Low Distortion
- Powered from Telephone Lines
- Monolithic Construction
- Minimum External Components in Telephone Circuits
- All other parameters are identical to the ZN472
- -20 to +80° Operation
- 8 pin plastic D.I.L.



System Diagram

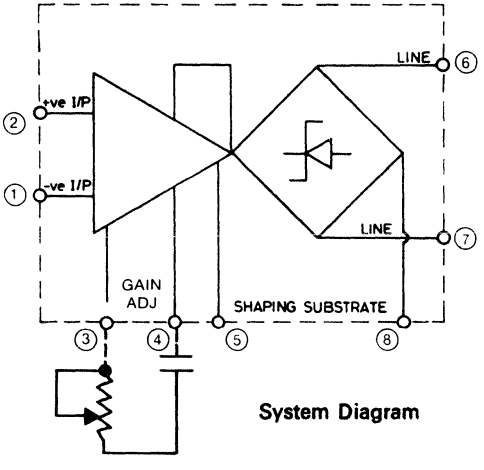
ADVANCED PRODUCT INFORMATION

HIGH GAIN, LOW IMPEDANCE MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN476 SERIES

The ZN476 was developed for use with moving coil or electric transducers with built-in FET's to replace the carbon transmitter in telephony systems. The amplifier contains a bridge to allow dual polarity operation.

FEATURES

- On-chip lightning strike protection
- Dual Supply Polarity Operation
- Low Input Impedance Version for Electrets with built-in FET's and moving coil transducers.
- 50 dB Max. Gain Externally Adjustable with Series resistor and capacitor
- Operates over 1 mA to 100 mA Line Current
- 220 mA Continuous Overload Capacity
- Low Noise
- Low Distortion
- Monolithic Construction
- Minimum External Components in Telephone Circuits
- All other parameters same as ZN472
- -20 to +80°C operation
- 8 pin plastic D.I.L.



System Diagram

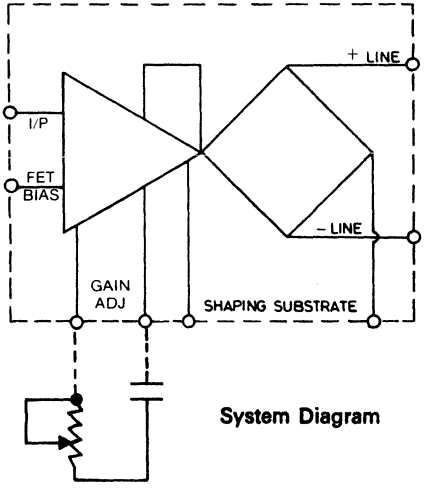
ADVANCED PRODUCT INFORMATION

HIGH GAIN LOW IMPEDANCE MICROPHONE AMPLIFIER FOR TELEPHONE CIRCUITS — ZN477 SERIES

The ZN477 was developed to replace the carbon transmitter in telephony systems with an electret that has a built-in FET, for which the IC provides bias.

FEATURES

- On-chip lightning strike protection
- Low Impedance Version with Bias for electrets with FET's
- 50 dB Gain Externally Adjustable
- Operates over 1 mA to 100 mA Line Current
- 220 mA Continuous Overload Capacity
- Low Noise
- Low Distortion
- Powered from Telephone Lines
- Monolithic Construction
- Minimum External Components in Telephone Circuits
- -20 to +80°C operation
- 8 pin D.I.L.



System Diagram

ADVANCED PRODUCT INFORMATION

TONE CALLER INTEGRATED CIRCUIT — ZN473 SERIES

Designed to be an improved replacement for the Texas Instrument TCM1512, the ZN473E integrated circuit tone caller is intended to replace existing electromechanical bells in telephone handsets.

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

A standard 560 KHz 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 10 Hz to give a warble tone.

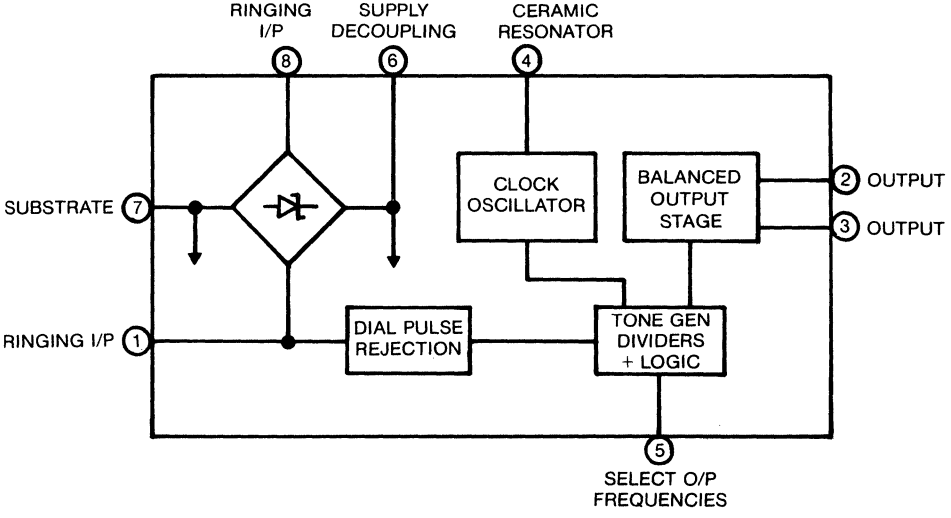
Pin 5 is used to select output frequencies of either 1000 Hz and 1250 Hz or 1167 Hz and 1333 Hz.

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

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

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 lighting protection.
- Low external component count.
- Built-in supply voltage regulator.
- Supply voltage threshold.
- Low cost 8 pin D.I.L. package.



System Diagram

ADVANCED PRODUCT INFORMATION

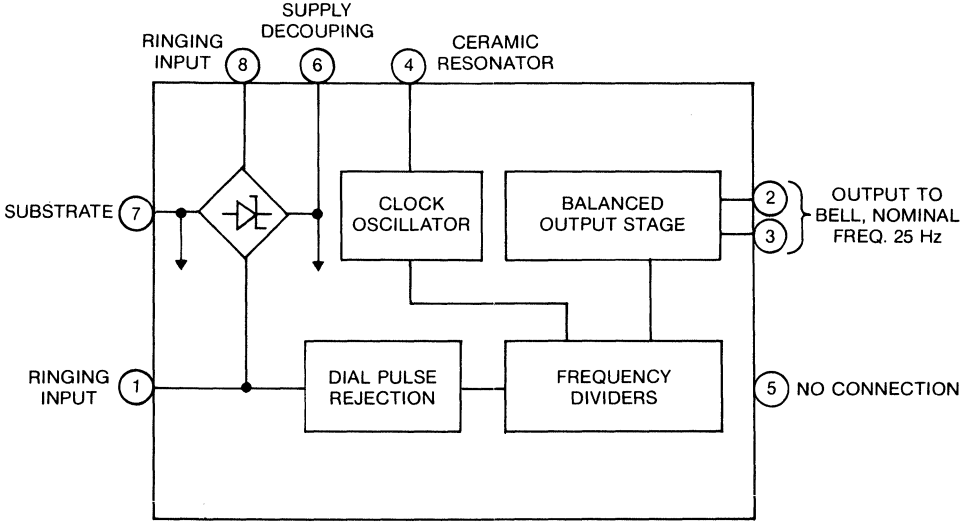
TRANSZAT IC FOR TELEPHONE BELL CIRCUITS ZN474 SERIES

The ZN474 is designed to be connected between existing low impedance bell ringers and the ring signal in subscriber handsets.

This is to prevent current hogging by low impedance bells enabling them to operate in parallel with higher impedance bell ringers or electronic tone callers such as the ZN473.

FEATURES

- Enables low impedance telephone bells to operate in parallel with electronic tone callers
- Full rectifier bridge for direct operation from ringing supply.
- Digital dial pulse rejection.
- Built-in lightening protection.
- Low external component count.
- Low cost 8 pin D.I.P. package.



System Diagram

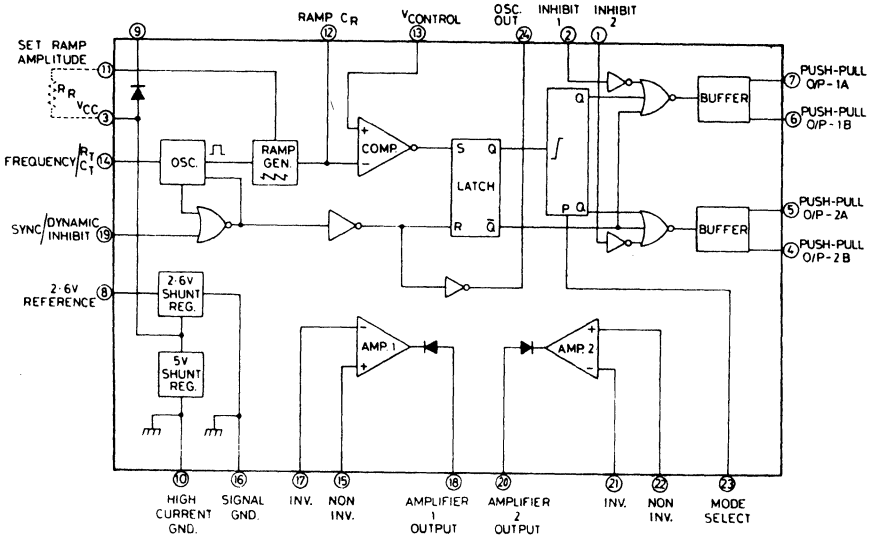
SWITCHED MODE POWER SUPPLY CONTROL CIRCUIT ZN1066 SERIES

The ZN1066 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
- -40 to +85° C and -55 to +125° C operation
- 24 pin plastic or ceramic D.I.L.



System Diagram

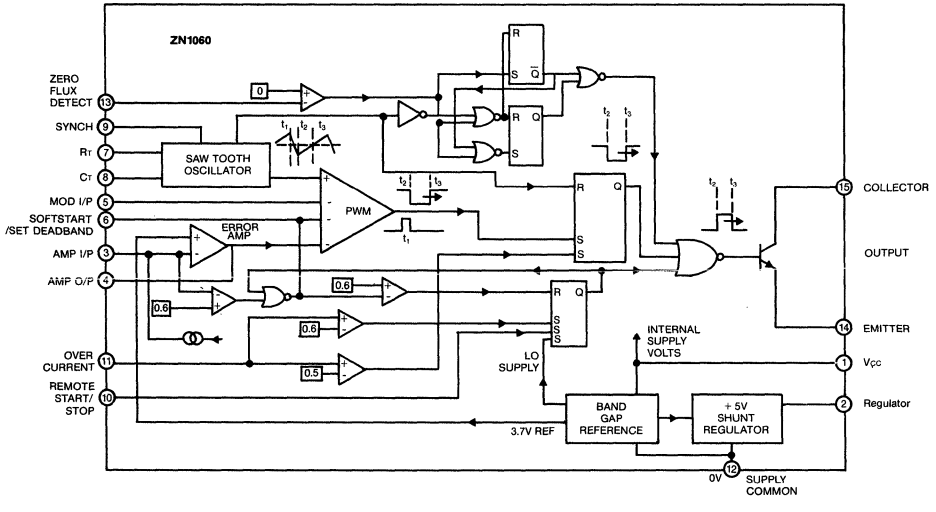
MONOLITHIC SWITCHING REGULATOR CONTROL CIRCUIT

ZN1060 SERIES

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, D.C./D.C. converters, motor speed control. However, its primary application is in fly back and forward transfer Switch Mode Power Supplies.

FEATURES

- PIN compatibility with NE/SE5560
- 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
- Loop fault protection
- Uncommitted error amplifier
- Overvoltage protection
- Remote On/Off switching
- Secondary current monitoring
- Multiple device synchronisation
- Core saturation protection
- -20 to +85°C operation
- 16 pin plastic D.I.L.

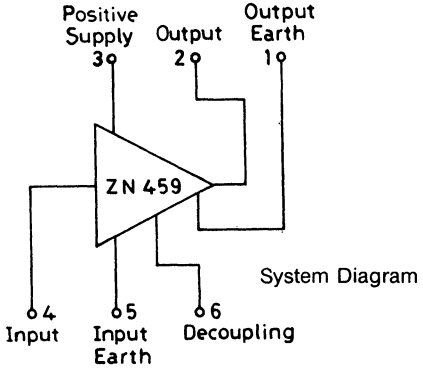


ULTRA LOW NOISE WIDEBAND AMPLIFIER — ZN459 SERIES

The ZN459 is an ultra low noise amplifier with remarkable noise performance, very high unity gain bandwidth (100 MHz), 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, 40Ω equivalent or 800 pV/$\sqrt{Hz}$
- High bandwidth, 15 MHz typical
- High, well controlled gain, 60 dB ±2 dB
- Low supply current, <3 mA from 5V
- 0 to +70°C and -55 to +125°C operation
- Small package, 6 lead TO-71 or 8 lead plastic D.I.L.



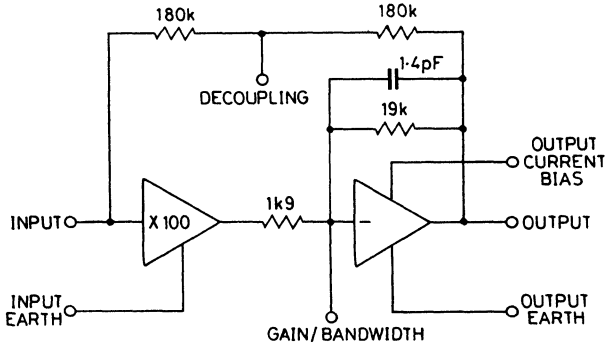
System Diagram

ULTRA LOW NOISE WIDEBAND PRE-AMPLIFIER — ZN460 SERIES

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 : 60 dB ±1 dB typical
- Programmable gain : 50-60 dB typical
- Low Noise : 40Ω Equivalent Noise Resistance, or 800 pV/$\sqrt{Hz}$
- Programmable Bandwidth : From 6 MHz downwards
- Low Supply Current : <3 mA from 5V
- 0 to +70°C and -55 to +125°C operation
- Available in 8-lead plastic D.I.L. or 8-lead TO-78



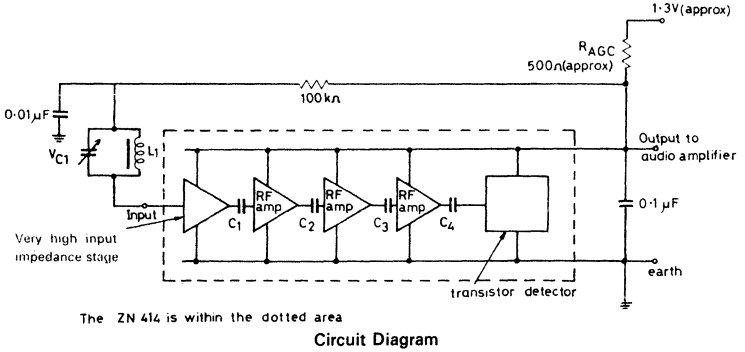
System Diagram

A.M. RADIO RECEIVER ZN414Z

The ZN414Z provides a complete RF amplifier, detector and AGC circuit in a 3 pin TO-92 package, and needs only six external components to give a high quality a.m. tuner. Effective AGC action is available and is adjusted by altering one external resistor. The 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
- 0·4 mA current consumption
- Full medium and long wave operation
- No alignment
- Effective and variable AGC action
- 20 mV r.m.s. output
- Excellent audio quality, low noise design
- 72 dB power gain
- 0 to +70°C operation
- 3 pin TO-92 plastic package



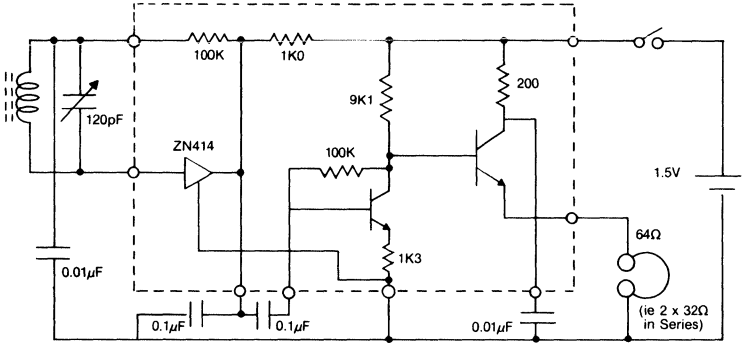
Circuit Diagram

IMPROVED A.M. RADIO RECEIVER ZN415P

The ZN415P provides a complete RF amplifier, detector, AGC, and audio amplifier circuit in a 8 pin plastic D.I.L. and provides the basis for a high quality AM tuner both in design and assembly while supplying enough output power to drive earphones or small speakers directly without sacrificing audio quality.

FEATURES

- 1.2 to 1.6 volt operation
- On-chip audio amp drives headphones
- Full medium and long wave operation
- No alignment
- Effective and variable ACG action
- Excellent audio quality, low noise design
- 0 to +70° C operation
- 8 pin plastic D.I.L.



System Diagram

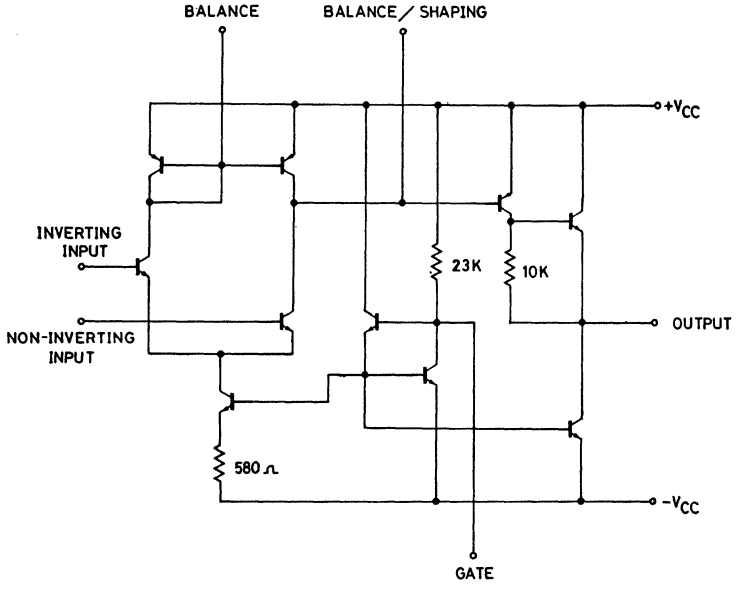
GATED LINEAR AMPLIFIER

ZN424 SERIES

The provision of the gating facility on the ZN424P 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

- 86 dB 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
- 0 to +70° C operation
- 8 pin plastic D.I.L.



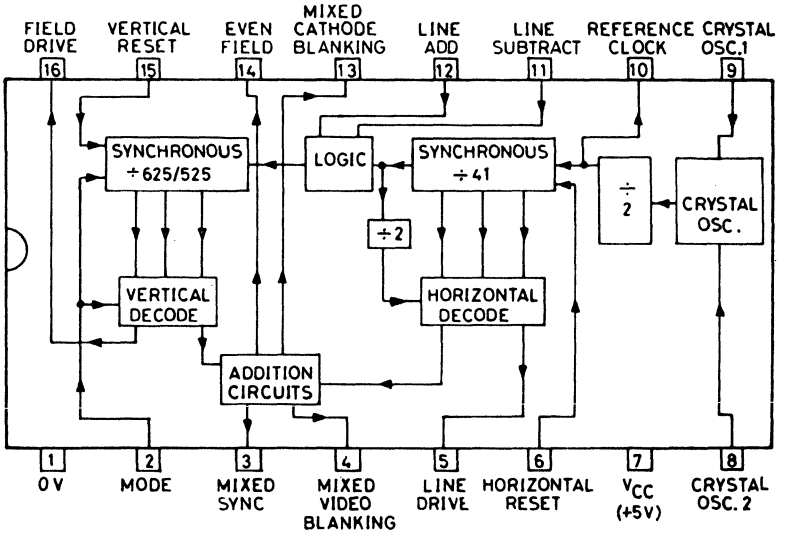
System Diagram

TV SYNCHRONISING PULSE GENERATOR ZNA134 SERIES

The ZNA134 integrated circuit utilizes a 2.5 MHz crystal to generate all the horizontal, vertical, mixed blanking and synchronising pulses necessary for faster 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.

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
- 0 to +70°C operation*
- 16 pin plastic or ceramic D.I.L.



System Diagram

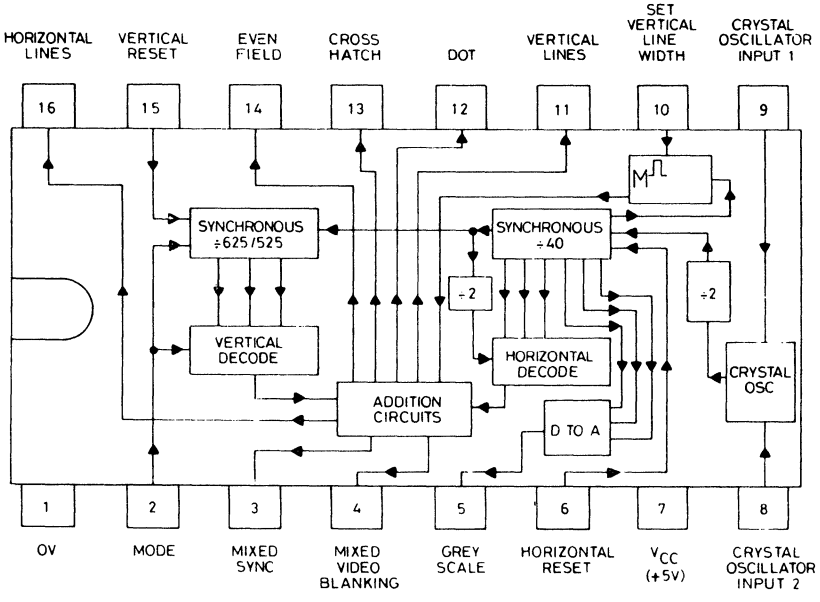
*Can be selected for extended temperature range operation

TV CROSSHATCH GENERATOR ZNA234 SERIES

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 2.5 MHz 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.

FEATURES

- Single 5 volt 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
- 0 to +70°C operation*
- 16 pin plastic D.I.L.
- Separate outputs for:
  - Crosshatch
  - Dot
  - Vertical Lines
  - Horizontal Lines
  - Greyscale
  - Mixed Sync
  - Mixed Video Blanking



System Diagram

*Can be selected for extended temperature range operation.

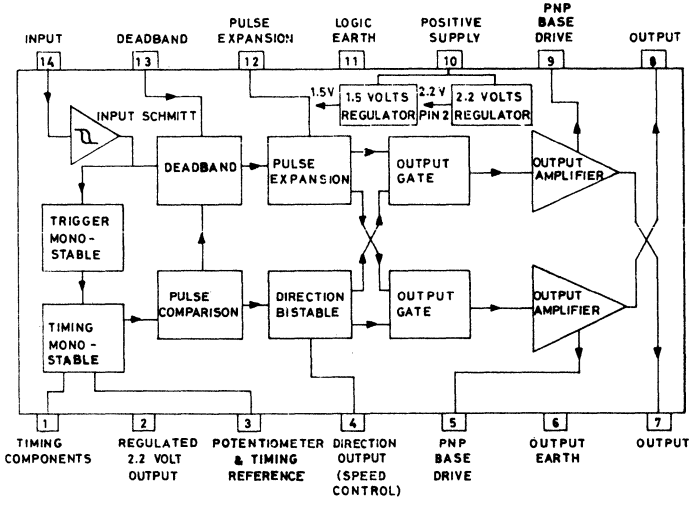
PRECISION SERVO CONTROLLER INTEGRATED CIRCUIT

ZN409 SERIES

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.

FEATURES

- Low External Component Count
- Low Quiescent Current (7 mA 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)
- -20 to +65°C operation
- 14 pin plastic D.I.L.



System Diagram

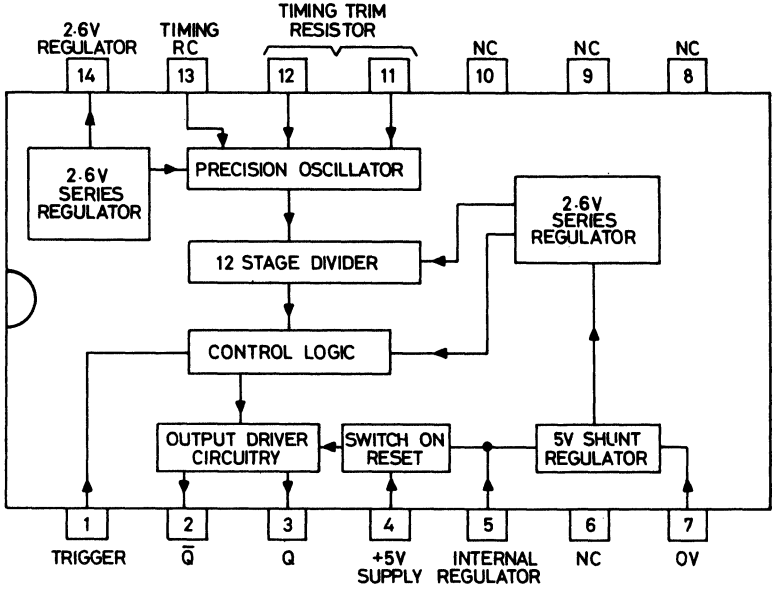
PRECISION COUNTER TIMER IC ZN1034 SERIES

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 is own voltage regulator and two modes of operation can be used.

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 5 mA allows battery operation. Output current capability of 25 mA
- Excellent temperature stability <0.01%/°C
- Accurate repetitive timing 0.01% typical
- On-chip regulator or TTL supply option
- Complementary TTL compatible outputs
- 0 to 70°C operation
- 14 pin plastic D.I.L.



System Diagram

ADVANCED PRODUCT INFORMATION

PROGRAMMABLE LONG RANGE MICROPOWER TIMER/COUNTER

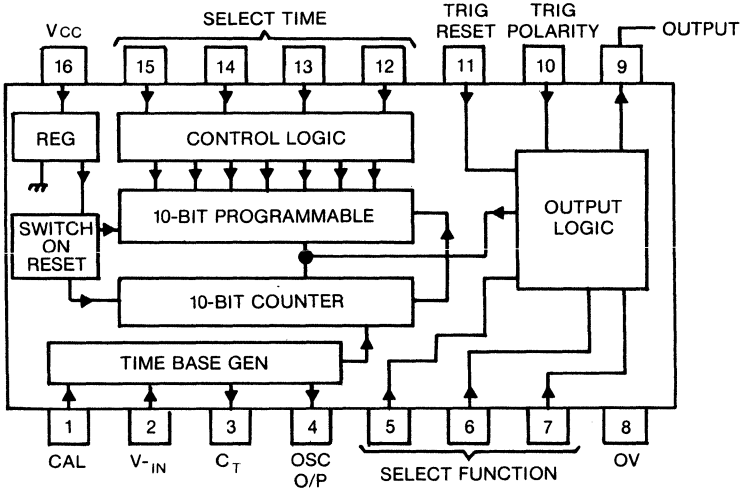
ZN1035 SERIES

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 preselected 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 can be cascaded to produce a cycling timer, or time delays in excess of 34 years.

FEATURES

- Programmable Time Delays . . . 15 Ranges
- Programmable Operation . . . 12 Functions
- Time Range . . . 0.01 sec. to 3 Months
- Can be cascaded for longer time delays on more complex timing functions.
- On-chip Regulator or TTL supply option
- High Accuracy . . . 0.1%
- Low Temperature Coefficient 50ppm/°C
- Low Power Consumption . . . 1.5mW
- Temperature Ranges, 0 to 70°C, -55 to +125°C
- 16 pin plastic or ceramic D.I.L.



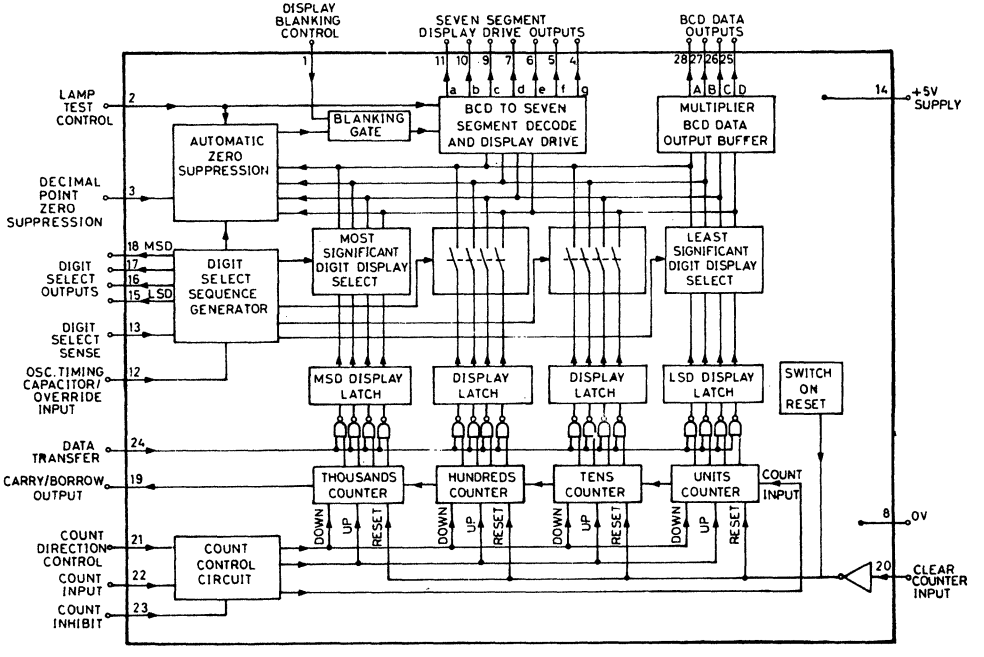
System Diagram

DC TO 5MHz UP/DOWN COUNTER DISPLAY DRIVER ZN1040 SERIES

The counter offers such functions as up/down synchronous counting, a 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. An anticipatory carry/borrow output and clearing counter are internal to the ZN1040.

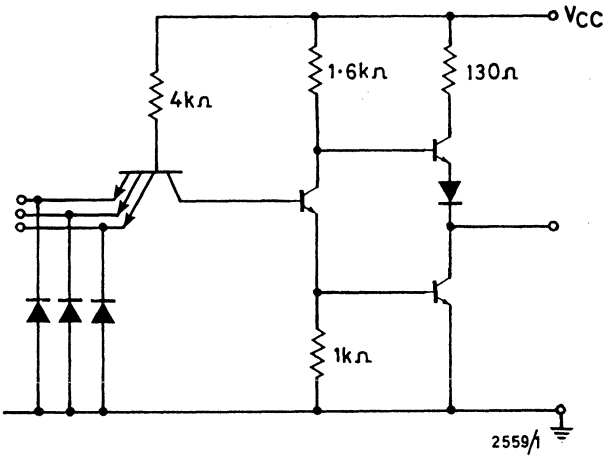
FEATURES

- 4 digits of synchronous reversible count, up to 5 MHz
- Multiplexed B.C.D. outputs
- Large output drive capability, 80 mA with 0.4V drop on segment outputs and 16 mA at 0.4V on others
- Direct cascading for extra digits
- Fully TTL compatible, single 5V supply
- 0 to + 70° C operation
- 24 pin plastic D.I.L.



System Diagram

SERIES 5400/7400



Equivalent Basic Function

FEATURES

- High speed (typical propagation delay 10 ns) combined with low power dissipation (typically 10 mW 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	10 ns	−55 to +125°C	Ceramic Dual in-line
Series 5400F	10 ns	−55 to +125°C	Flat-Pack
Series 7400			
Series 7400E	10 ns	0 to +70°C	Moulded Dual in-line
Series 7400J	10 ns	0 to +70°C	Ceramic Dual in-line

PRODUCT RANGE

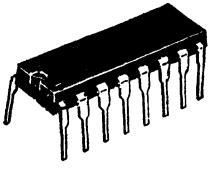
Series 5400	Series 7400	Description
ZN5400	ZN7400	Quad 2-Input NAND Gate
ZN5401	ZN7401	Quad 2-Input NAND Gate (with Free Collectors)
ZN5402	ZN7402	Quad 2-Input NOR Gate
ZN5403	ZN7403	Quad 2-Input NAND Gate (with Free Collectors)
ZN5404	ZN7404	Hex Inverter
ZN5405	ZN7405	Hex Inverter (with Free Collectors)
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 Exculsive-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	ZM7496	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

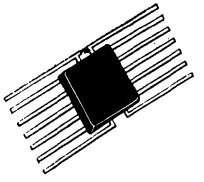
PRODUCT RANGE *(continued)*

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 PIPO

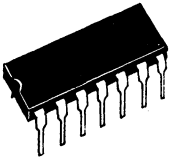
AVAILABLE PACKAGES



16 Lead D.I.L.

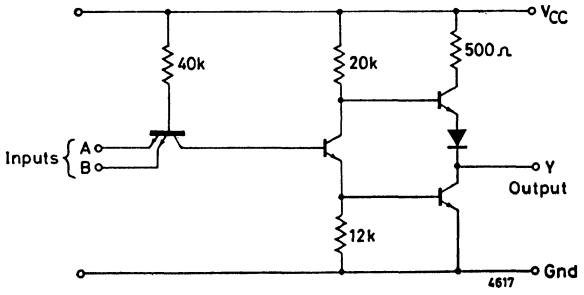


14 Lead Flat-Pack



14 Lead D.I.L.

SERIES 54L00/74L00



Equivalent Basic Function

FEATURES

- Very low power dissipation – typically 1 mW per gate at 50% duty cycle
- Relatively high speed – typical gate 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
Series 74L00			
Series 74L00E	33 ns	0 to +70°C	Moulded Dual in-line
Series 74L00J	33 ns	0 to +70°C	Ceramic Dual in-line

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

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

FEATURES

- Pin compatible with 930 DTL
- Supply voltage 4.5V
- Power dissipation 19 mW
- 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

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

	Typical Propagation Delay	Temperature Range	Package
MICRONOR 2 High Speed DTL			
Series 50	9 ns	–55 to +125°C	TO-99
Series 80	9 ns	0 to +70°C	TO-99
Series 200	9 ns	–55 to +125°C	Flat-Pack
Series 200E	9 ns	0 to +70°C	Dual in-Line
MICRONOR 2 DTL			
Series 300	15 ns	–55 to +125°C	Flat-Pack
Series 300E	15 ns	0 to +70°C	Dual in-Line

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

SECTION 3 : UNCOMMITTED LOGIC ARRAYS

This section contains brief details of the Ferranti ULA product range and it's capabilities. For more detailed information or for technical assistance please contact the Ferranti ULA Design Center at (516) 543-0200 where a team of experienced ULA personnel will be pleased to assist you.

THE ULA CONCEPT

The economic and performance advantages provided by custom LSI circuits make them essential for today's electronic systems and the ULA* is one of the most cost effective techniques for designing and producing LSI for a customer's specific application.

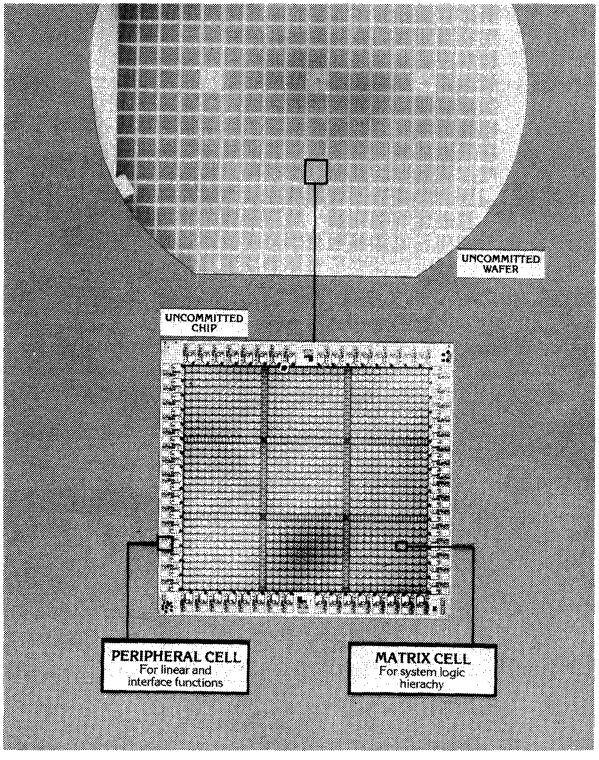
There are over 50 bipolar arrays in the Ferranti ULA family. They cover virtually all combinations of speed, complexity, linear and I/O content at minimum system power levels, ensuring that almost all applications can be satisfied by a 'no-compromise' approach on performance combined with the best possible economic solution.

The family comprises ULA GATE ARRAYS for systems of 100 to 10,000 gates with performance from CMOS power levels to ECL speeds and ULA DIGILIN** ARRAYS combining high complexity digital and high performance linear functions on the same chip.

LSI design using the ULA can be carried out either by the customer or Ferranti and is fully supported by a CAD facility with all the specialized automation software necessary to specify, design and verify ULA LSI and VLSI systems. In addition, the ULA DESIGNER***, a low cost remote interactive design system, is available with all the CAD facilities necessary for ULA design whilst located on the customers premises.

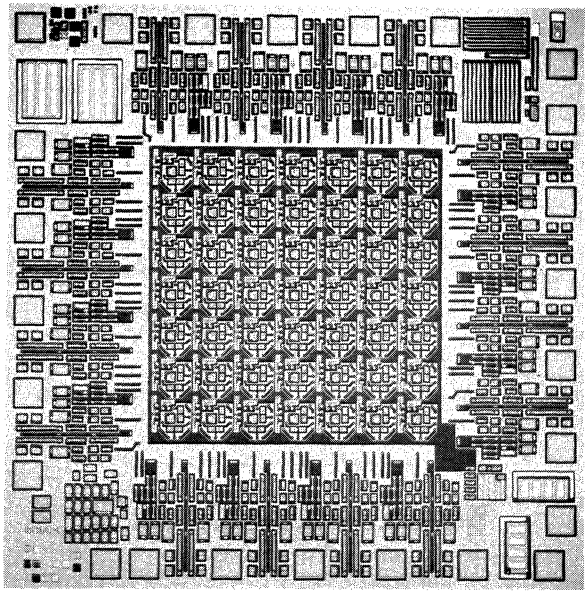
ULA CHIP ORGANIZATION

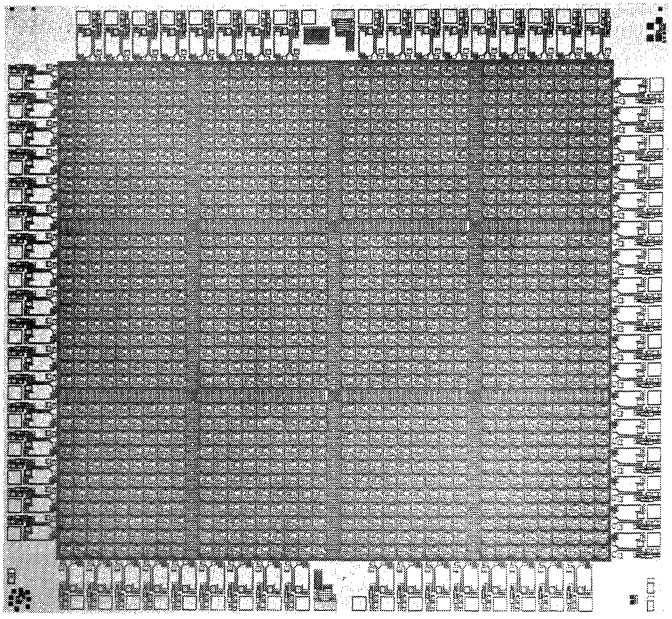
Each ULA chip has a matrix of identical cells, containing uncommitted components, whose function is to satisfy the logic hierarchy of an LSI system, surrounded by peripheral cells of uncommitted components for I/O's and linear functions. An interconnection pattern is derived from the customer's system description and applied via a single metallisation mask to convert the uncommitted chip to an LSI circuit.



*ULA is a trade mark of Ferranti plc for semiconductor devices.
**DIGILIN is a trade mark of Ferranti plc.
***ULA DESIGNER is a trade mark of Ferranti plc.

ULA DIGILIN ARRAY: ULA1G with over 50% of the chip available for linear functions



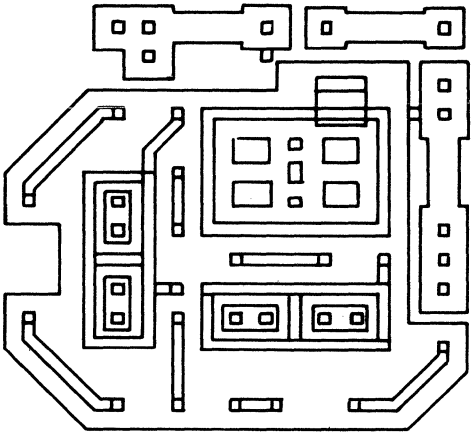


MATRIX CELLS

The number of matrix cells on any given array determines the logic complexity as well as the level of system complexity that can be achieved.

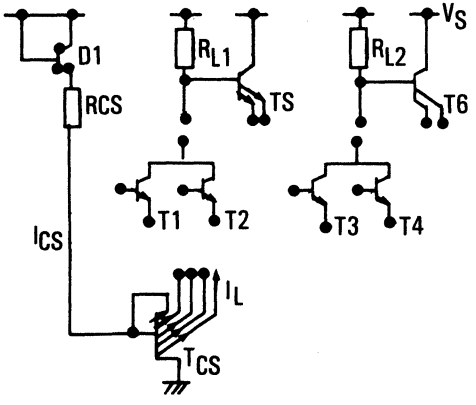
Each matrix cell contains a number of uncommitted components ensuring maximum design flexibility, which when connected in their basic form provide two 2-I/P NOR gates.

There are 3 types of matrix cell—RTL, CML and buffered CML, each of which provide performance advantages depending on the particular application.



LAYOUT CONFIGURATION OF THE BUFFERED CML MATRIX CELL

COMPONENT CONTENT OF THE BUFFERED CML MATRIX CELL

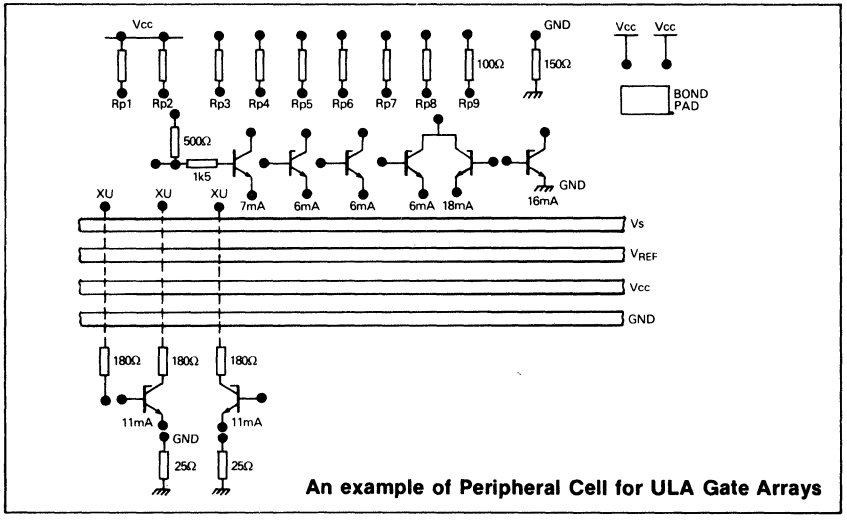


PERIPHERAL CELLS

These cells around the periphery of the chip facilitate I/O interfacing and the implementation of high performance linear functions. The number of peripheral cells is determined by the chip edge length and relates to array complexity.

PERIPHERAL CELLS FOR ULA GATE ARRAYS

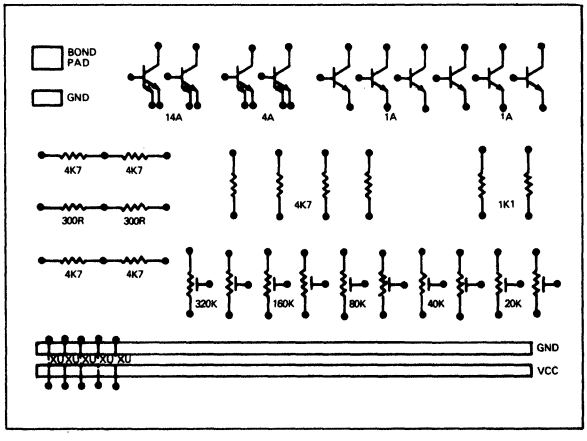
The peripheral cell components provide I/O interface capability with bipolar, MOS and CMOS technologies, triacs, relays, LED, LCD, transistors, photo-transistors, switches and touch switches, etc. In addition, they will provide linear functions such as Schmitt trigger inputs, crystal controlled oscillators, R.C. controlled oscillators, etc. frequently needed for the total integration of digital systems.



An example of Peripheral Cell for ULA Gate Arrays

PERIPHERAL CELLS FOR ULA DIGILIN ARRAYS

The components within these cells are designed to provide high performance linear functions, e.g. precision analogue switches, comparators, voltage reference amplifiers, precision oscillators, op-amps, etc. as well as digital I/Os. In addition, the peripheral area contains special purpose elements—voltage reference sources, high current drive transistors and shaping capacitors.



An example of Peripheral Cell for ULA Digilin Arrays

ULA PRODUCT RANGE

ULA GATE ARRAYS

System Speeds to 80MHz

ARRAY TYPE	GATE COUNT	GATE DELAY (ns)	GATE POWER (μW)	I/O PADS	MAX PINS
ULA5RA	500	2.5	300	38	40
ULA9RA	900	2.5	300	48	50
ULA12RA	1200	2.5	300	52	58
ULA16RA	1600	2.5	300	62	68
ULA18RA	1800	2.5	300	64	72
ULA20RA	2000	2.5	300	72	80
ULA24RA	2400	2.5	300	80	88
ULA30RA	3000	2.5	300	82	96
ULA40RA	4000	2.5	300	118	130
*ULA100RA	10000	2.5	300	138	150

***ADVANCE PRODUCT INFORMATION**

System Speeds to 20MHz

ARRAY TYPE	GATE COUNT	GATE DELAY (ns)	GATE POWER (μW)	I/O PADS	MAX PINS
ULA2C	450	8.0	250	39	40
ULA5RB	500	7.5	100	38	40
ULA5C	900	8.0	250	48	52
ULA9RB	900	7.5	100	48	50
ULA12RB	1200	7.5	100	52	58
ULA16RB	1600	7.5	100	62	68
ULA18RB	1800	7.5	100	64	72
ULA9C	2000	8.0	120	64	64
ULA20RB	2000	7.5	100	72	80
ULA24RB	2400	7.5	100	80	88
ULA12C	2400	8.0	120	68	70
ULA30RB	3000	7.5	100	82	96
ULA40RB	4000	7.5	100	118	130
*ULA100RB	10000	7.5	100	138	150

***ADVANCE PRODUCT INFORMATION**

ULA GATE ARRAYS

System Speeds to 10MHz

ARRAY TYPE	GATE COUNT	GATE DELAY (ns)	GATE POWER (μW)	I/O PADS	MAX PINS
ULA5RC	500	15	30	38	40
ULA9RC	900	15	30	48	50
ULA12RC	1200	15	30	52	58
ULA16RC	1600	15	30	62	68
ULA18RC	1800	15	30	64	72
ULA20RC	2000	15	30	72	80
ULA24RC	2400	15	30	80	88
ULA30RC	3000	15	30	82	96
ULA40RC	4000	15	30	118	130
*ULA100RC	10000	15	30	138	150

***ADVANCE PRODUCT INFORMATION**

System Speeds to 5MHz

ARRAY TYPE	GATE COUNT	GATE DELAY (ns)	GATE POWER (μW)	I/O PADS	MAX PINS
ULA2N	450	25	70	39	40
ULA5RD	500	50	8	38	40
ULA2M	510	2.0 (μs)	0.4	40	40
ULA5N	900	25	70	48	52
ULA9RD	900	50	8	48	50
ULA12RD	1200	50	8	52	58
ULA16RD	1600	50	8	62	68
ULA18RD	1800	50	8	64	72
ULA20RD	2000	50	8	72	80
ULA9N	2000	25	35	64	64
ULA24RD	2400	50	8	80	88
ULA12N	2400	25	35	68	70
ULA30RD	3000	50	8	82	96
ULA40RD	4000	50	8	118	130
*ULA100RD	10000	50	8	130	150

***ADVANCE PRODUCT INFORMATION**

ULA PRODUCT RANGE

ULA DIGILIN ARRAYS

ULA DIGILIN arrays are designed to combine both linear and digital functions.

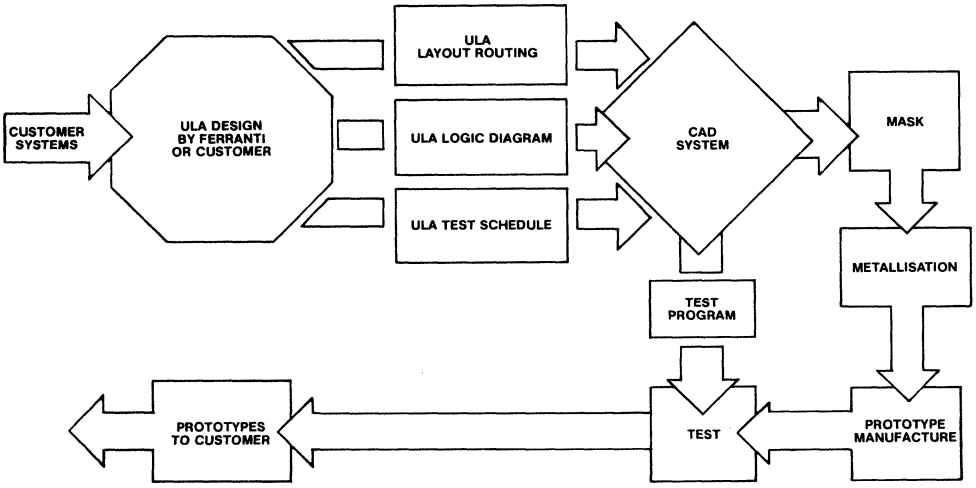
The matrix cells provide the digital functions at very low gate power levels, down to 2μW.

The peripheral cells have high performance with matched transistors and resistors to provide linear functions such as comparators, analogue switches, op-amps, sample-and-hold-circuits, oscillators,—many of the ULAs contain on-chip references, regulators, shaping capacitors and 100mA drive transistors.

ARRAY TYPE	GATE COUNT	ACTIVE COMPONENTS	PASSIVE COMPONENTS	I/O PADS	MAX PINS
ULA1G	100	356	531	16	25
ULA1L	150	384	696	28	28
ULA2G	160	647	704	20	28
ULA1U	280	676	741	26	30
ULA2L	340	715	1205	40	40
ULA2U	510	1152	1096	40	40
ULA3U	580	1348	1143	40	40
ULA5L	730	1644	2660	48	48

THE DESIGN ROUTE

The design route requires 3 steps, definition of logic, interconnect layout and generation of the test schedule. This information is entered into the CAD system and the layout and test schedules are verified using the logic diagram as the reference data base. The production test programme and the data for the mask production are generated from the verified test schedule and layout respectively.



DESIGN BY FERRANTI

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

DESIGN BY THE CUSTOMER

There are three design options fully supported by comprehensive documentation, 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 consisting of logic diagram, layout routing, test and device specification.

OPTION 2

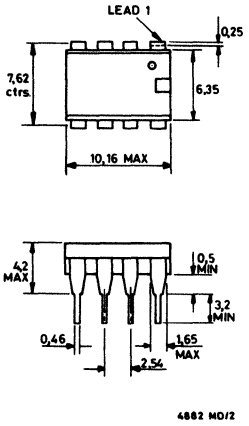
The customer who has installed a 'ULA DESIGNER' carries out the complete design cycle on his own premises. When the design is complete and verified, the layout, logic and test schedules are transmitted via a modem link to the ULA CAD Complex for prototype manufacture.

OPTION 3

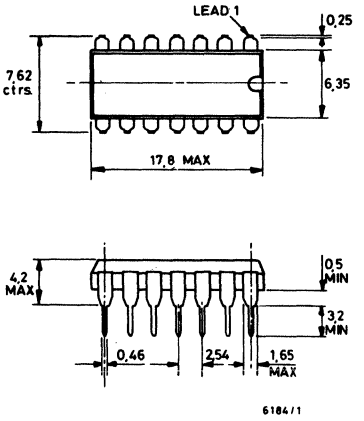
ULA software programmes can be purchased for customers with their own CAD graphics system. Inferface to the Ferranti ULA CAD Complex is by magnetic tape.

SECTION 4 : PACKAGE OUTLINES

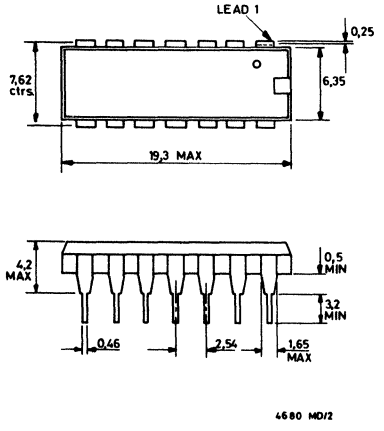
PACKAGE OUTLINES



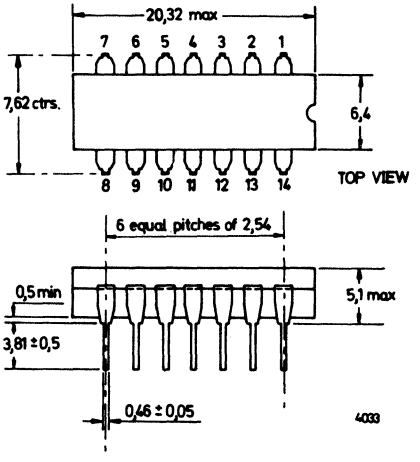
8 LEAD MOULDED DIL



REDUCED LENGTH 14 LEAD MOULDED DIL

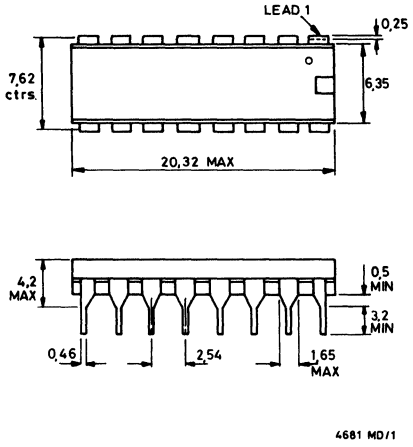


14 LEAD MOULDED DIL

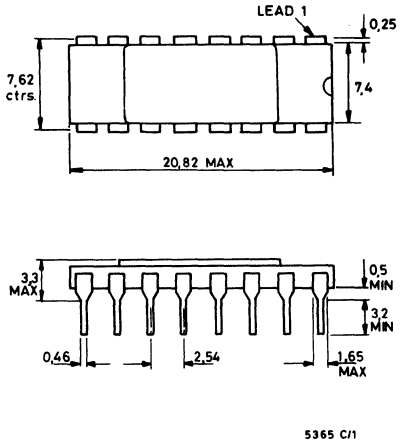


14 LEAD CERAMIC DIL

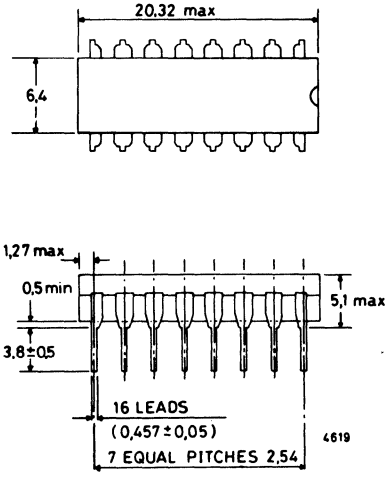
Dimensions in millimetres



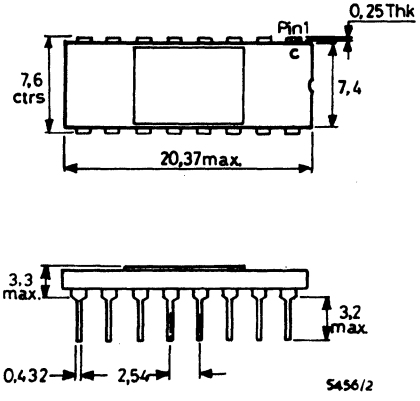
16 LEAD MOULDED DIL



16 LEAD CERAMIC DIL (ZN425)



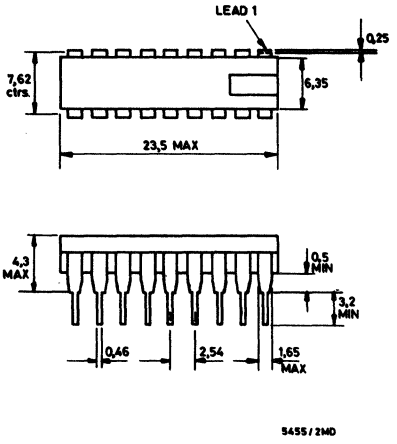
16 LEAD CERAMIC DIL (SO-87C)



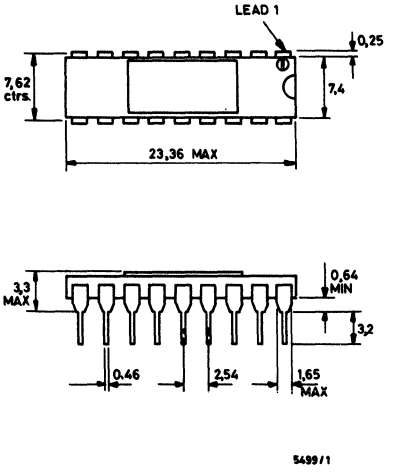
16 LEAD CERAMIC DIL (SO-87E)

Dimensions in millimetres

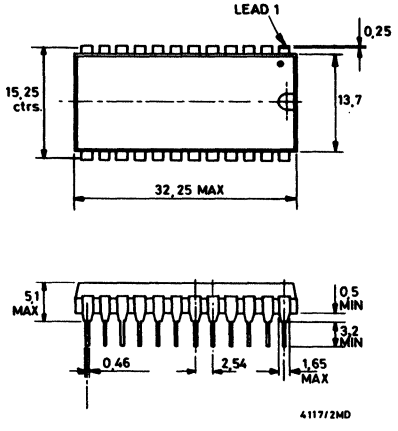
PACKAGE OUTLINES



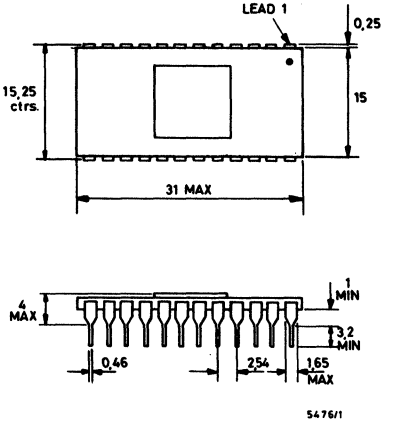
18 LEAD MOULDED DIL



18 LEAD CERAMIC DIL

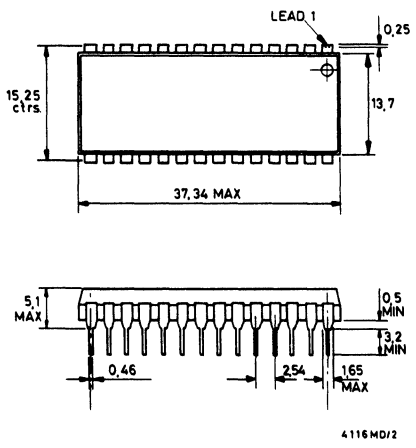


24 LEAD MOULDED DIL

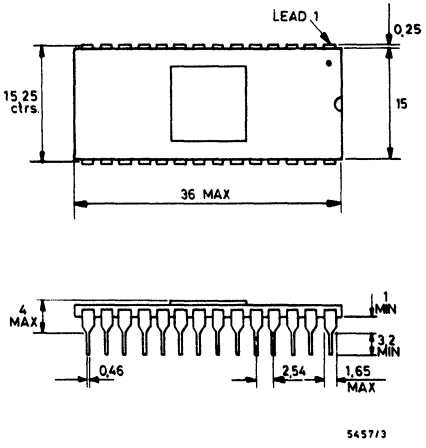


24 LEAD CERAMIC DIL

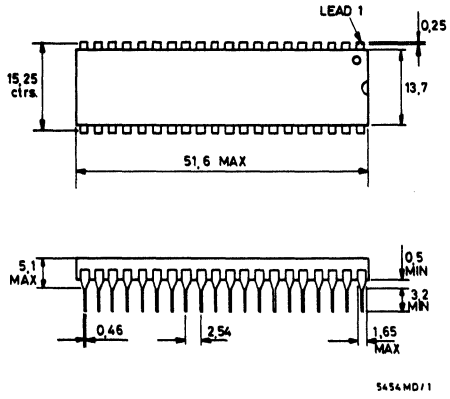
Dimensions in millimetres



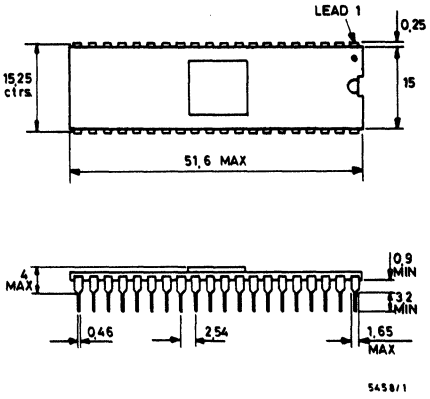
28 LEAD MOULDED DIL



28 LEAD CERAMIC DIL



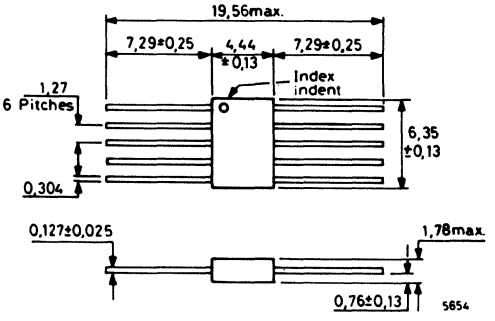
40 LEAD MOULDED DIL



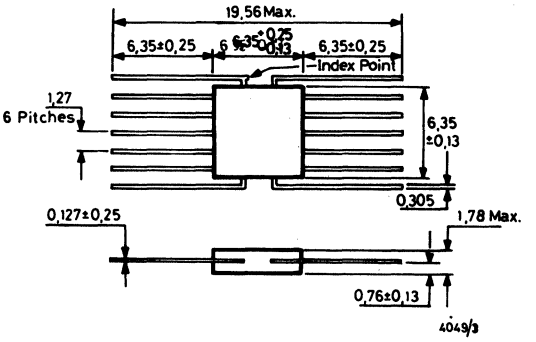
40 LEAD CERAMIC DIL

Dimensions in millimetres

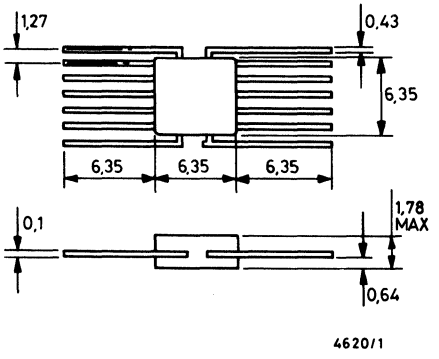
PACKAGE OUTLINES



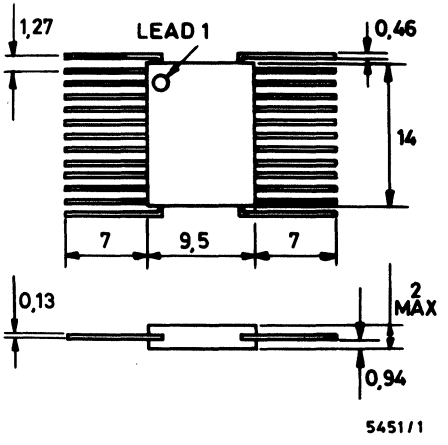
10 LEAD PLASTIC FLAT-PACK
Also available in ceramic



14 LEAD PLASTIC FLAT-PACK

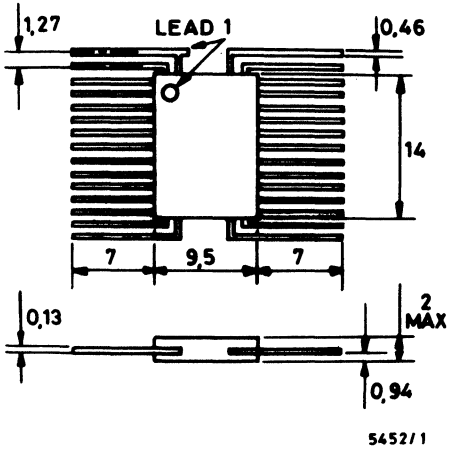


14 LEAD CERAMIC FLAT-PACK

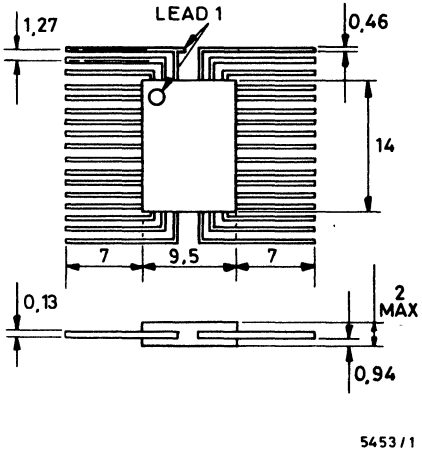


26 LEAD PLASTIC FLAT-PACK

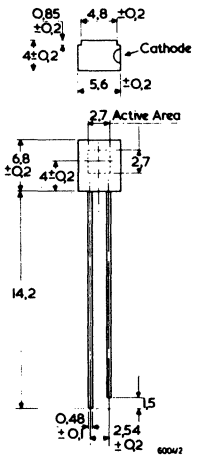
Dimensions in millimetres



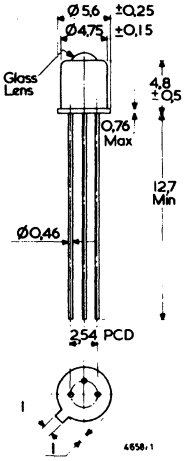
30 LEAD PLASTIC FLAT-PACK



34 LEAD PLASTIC FLAT-PACK



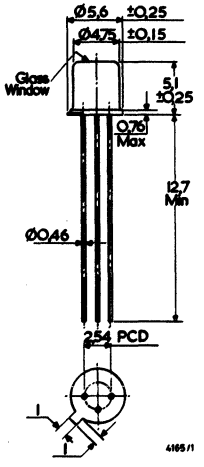
BPW41



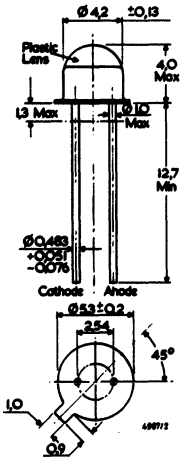
BPX25 ZM100/110

Dimensions in millimetres

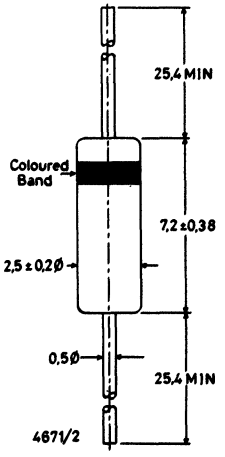
PACKAGE OUTLINES



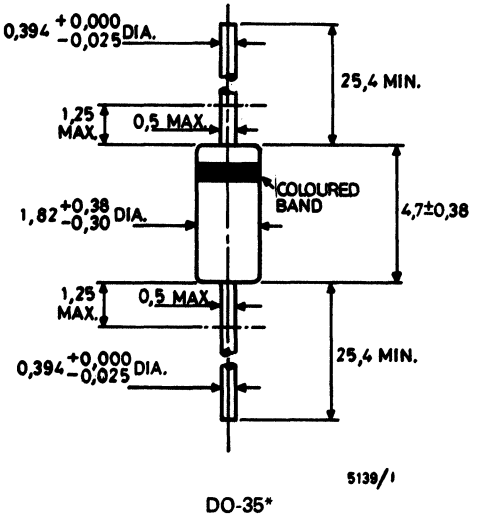
BPX29



BPX63



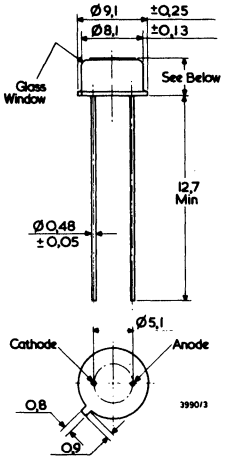
DO-7 (Glass)*



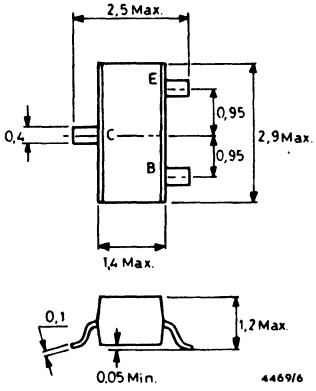
DO-35*

*Cathode end is marked with a coloured band

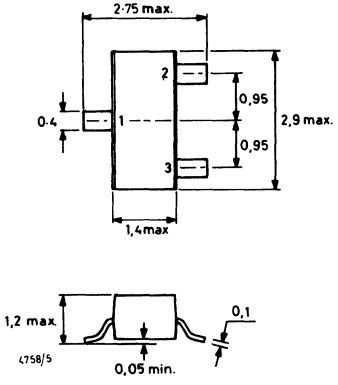
Dimensions in millimetres



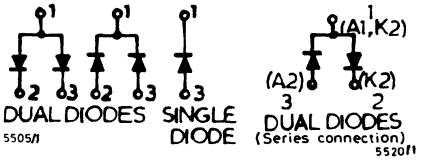
MS600/601 MS700/701
MS600/700 Height = 4.8 ±0.4
MS601/701 Height = 6.7 ±0.4



SOT-23 (Transistor)



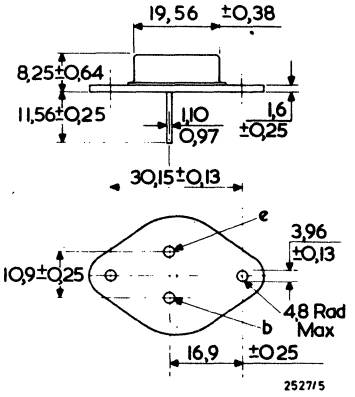
SOT-23 (Diode)



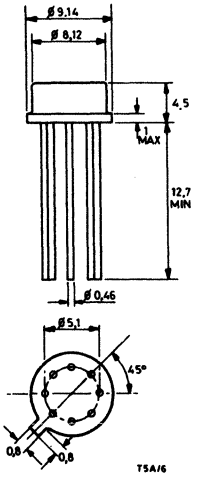
SOT-23 (Diode) Pin Connections

Dimensions in millimetres

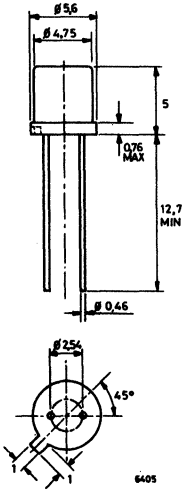
PACKAGE OUTLINES



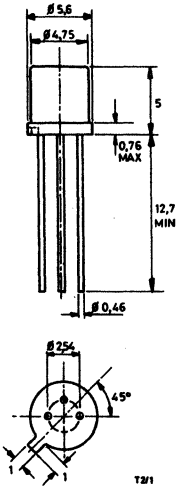
TO-3



TO-5 (ZNP100 8 Lead Glass Window)

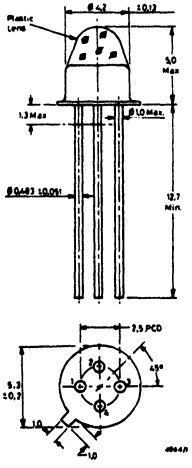


TO-18 (2 Lead)

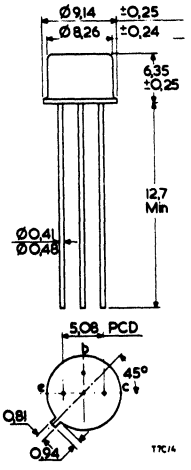


TO-18

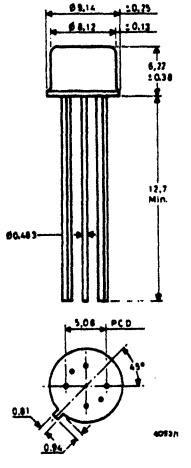
Dimensions in millimetres



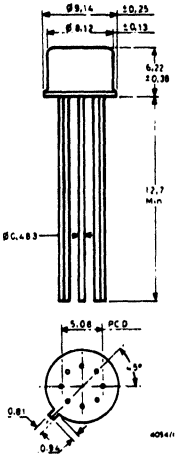
TO-18 (4 Lead Resin Lens)



TO-39 (3 Lead)



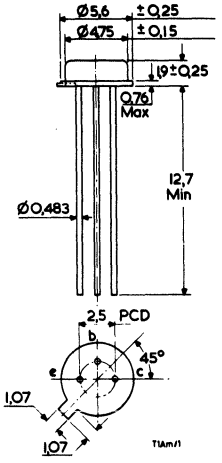
TO-39 (6 Lead)



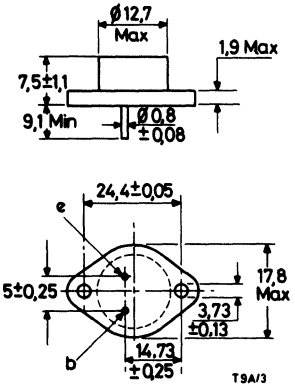
TO-39 (8 Lead)

Dimensions in millimetres

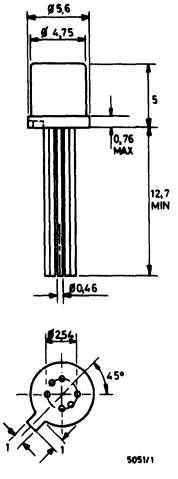
PACKAGE OUTLINES



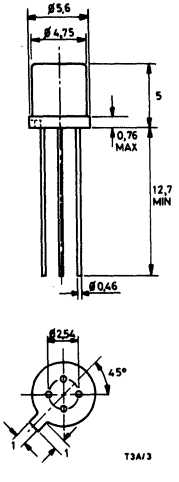
TO-46



TO-66



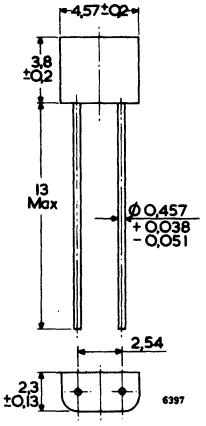
TO-71 (6 Lead)



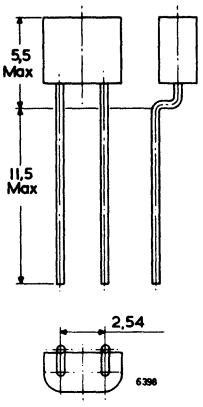
TO-72

Dimensions in millimetres

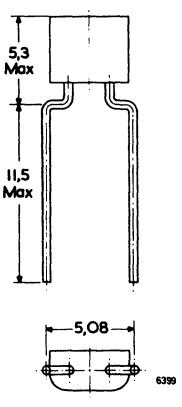
2 LEAD E-LINE (TO-92 STYLE) DIODE PACKAGE



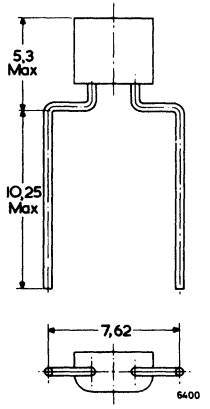
IN LINE



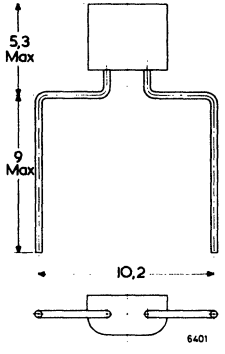
SUFFIX M
(Flat Mounting)



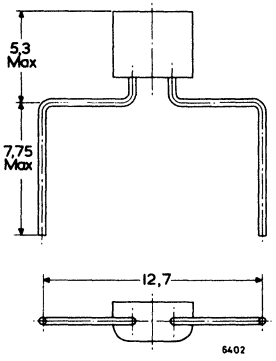
SUFFIX N
(DO-35)



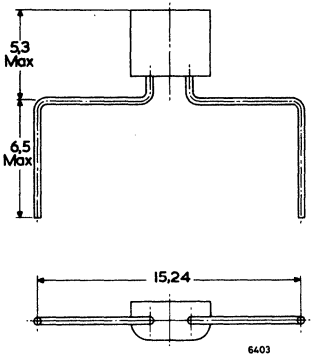
SUFFIX W



SUFFIX P (DO-7)



SUFFIX T

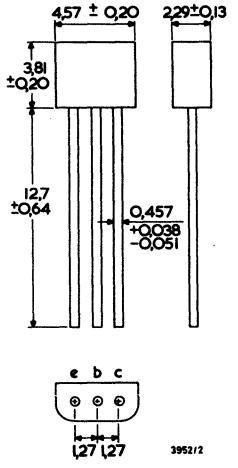


SUFFIX X

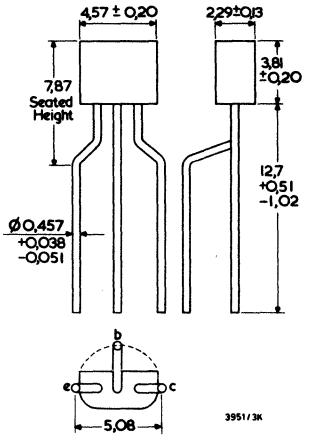
N.B. The cathode lead is indicated by a red spot on top of the package
Dimensions in millimetres

PACKAGE OUTLINES

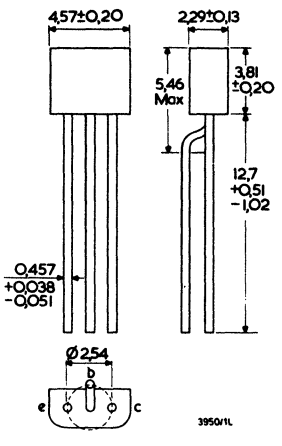
E-LINE (TO-92 STYLE) TRANSISTOR PACKAGE



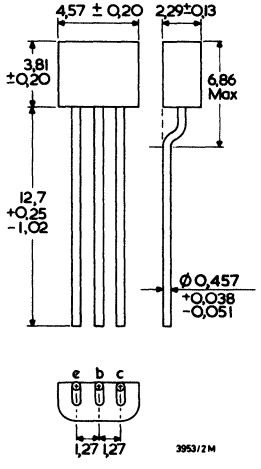
STANDARD PACKAGE
BS 3934 . . SO-94



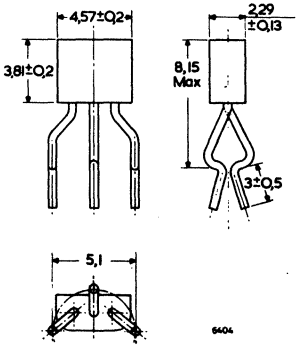
'K' LEAD FORMATION
for TO-5 and TO-39
compatibility
BS 3934 . . SO-95



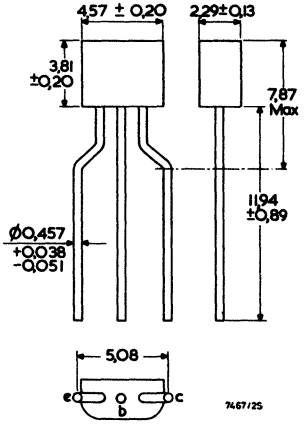
'L' LEAD FORMATION
for TO-18 compatibility
BS 3934 . . SO-97



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

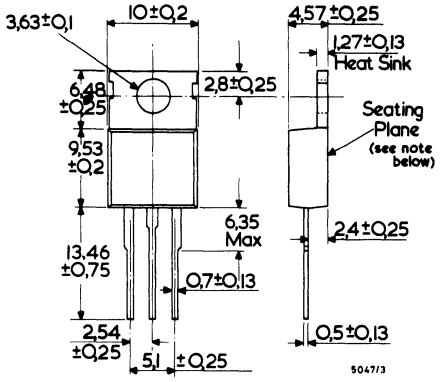


'Q' LEAD FORMATION
(Lockfit)



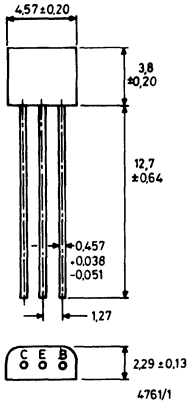
'S' LEAD FORMATION

Dimensions in millimetres



Note: The tab is connected to the collector

TO-220

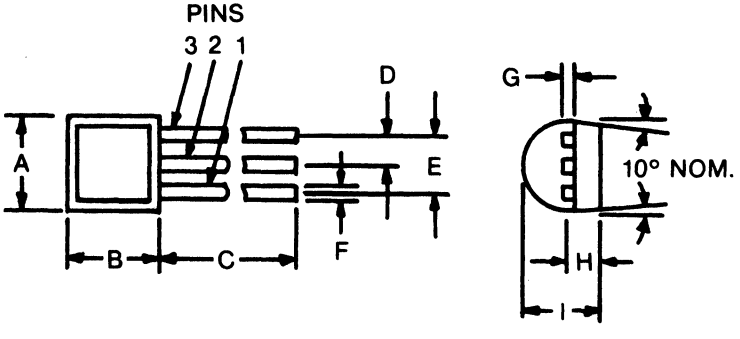


ZTX196, ZTX197

BF196P, BF197P

Dimensions in millimetres

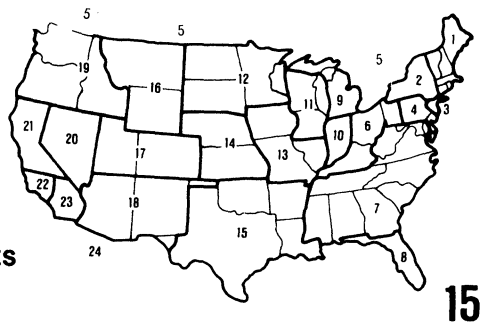
TO-92 Package Code Suffix – A



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.175	.185	4.445	4.699
B	.175	.185	4.445	4.699
C	.500		12.70	
D	.045	.055	1.143	1.397
E	.095	.105	2.413	2.667
F	.015	.020	.381	.508
G	.015	.020	.381	.508
H	.045	.055	1.143	1.397
I	.130	.150	3.302	3.810

SECTION 5 : SALES OFFICES
SALES REPRESENTATIVES
DISTRIBUTOR'S

SALES OFFICES, REPRESENTATIVES & DISTRIBUTORS



SALES REPRESENTATIVES

1 NEW ENGLAND
KSA of New England
624 Worcester Road
Framingham, MA 01701
Tel: (617) 879-3835

2 UPSTATE NEW YORK
ADVANCED COMPONENTS CORP.
P.O. Box 276
N. Syracuse, NY 13212
Tel: (315) 699-2671
TWX: 710-541-0439

ADVANCED COMPONENTS CORP.
Limber Lost Road, RD #1
Clinton, NY 13323
Tel: (315) 853-6438

ADVANCED COMPONENTS CORP.
P.O. Box 142
Scottsville, NY 14546
Tel: (716) 889-1429

ADVANCED COMPONENTS CORP.
P.O. Box 645
Endicott, NY 13760
Tel: (607) 785-3191

ADVANCED COMPONENTS CORP.
188 Thornton Road
Rochester, NY 14617
Tel: (716) 544-7017

3 NEW YORK CITY, LONG ISLAND, WESTCHESTER AND NORTHERN NEW JERSEY
F&F ASSOCIATES
21 Brewster Street
P.O. Box 408
Glen Cove, NY 11542
Tel: (516) 671-8900

4 DELAWARE, SOUTHERN NEW JERSEY AND EASTERN PENNSYLVANIA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

5 CANADA
HALTRONICS LTD.
355 Iroquois Shore Road
Oakville, Ontario, Canada L6H 1M3
Tel: (416) 844-2121
TWX: 610-495-2664

HALTRONICS LTD.
1510 Merivale Road, #4
Ottowa, Ontario, Canada K2G 3J6
Tel: (613) 226-2121

HALTRONICS LTD.
6600 Trans Canada, Suite 750
Pointe Claire, Quebec, Canada H9R 452
Tel: (514) 694-2121
TLX: 05-821762 CANADABIZ PCLR

HALTRONICS LTD.
Suite 300
205 9th Ave. S.E.
Calgary Alberta
Canada T2G 0P8
Tel: 403-264-2121
TLX: 0382159 ALLIED COMM CALGARY

6 KENTUCKY, OHIO AND WESTERN PENNSYLVANIA
G & H SALES CO.
7754 Camargo Road
Cincinatti, OH 45243
Tel: (513) 272-0580
TWX: 810-460-8868

G & H SALES CO.
P.O. Box 91
Grove City, OH 43123
Tel: (614) 878-1128 - (216) 248-8490

7 ALABAMA, GEORGIA, MARYLAND, MISSISSIPPI, NORTH CAROLINA, SOUTH CAROLINA, TENNESSEE, VIRGINIA, WEST VIRGINIA
A.B. ANDREWS & COMPANY INC.
821 Wheeler Avenue
Huntsville, AL 35801
Tel: (205) 539-6817

A.B. ANDREWS & COMPANY INC.
1313 Deer Run Drive
Vinton, VA 24179
Tel: (703) 890-1128

A.B. ANDREWS & COMPANY INC.
P.O. Box 12167
Research Triangle Park, NC 27709
Tel: (919) 549-0563
TLX: 579477 CIRTOURRTPK

8 FLORIDA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

9 MICHIGAN
R.P. URBAN & ASSOCIATES
P.O. Box 7391
Grand Rapids, MI 49510
Tel: (616) 245-0511
TWX: 810-273-6992

R.P. URBAN & ASSOCIATES
13468 Arnold Street
Detroit, MI 48239
Tel: (313) 535-2355

10 INDIANA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

11 NORTHERN ILLINOIS & SOUTHERN WISCONSIN
T-SQUARED ASSOCIATES
465 N. Stark Drive
Palatine, IL 60067
Tel: (312) 991-2144

12 MINNESOTA, NORTH DAKOTA, SOUTH DAKOTA, & NORTHERN WISCONSIN
ELECTRO MARK, INC.
8053 E. Bloomington Freeway
Minneapolis, MN 55420
Tel: (612) 881-3306
TWX: 910-576-1308

13 IOWA & MISSOURI
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

14 KANSAS & NEBRASKA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

15 ARKANSAS, LOUISIANA, OKLAHOMA TEXAS (EXCLUDING EL PASO)
OELER & MENELAIDES INC.
7113 Burnet Rd., Suite 207
Austin, TX 78757
Tel: (512) 453-0275

OELER & MENELAIDES INC.
8340 Medow Rd., Suite 224
Dallas, TX 75231
Tel: (214) 361-8876
TWX: 910-861-4512

OELER & MENELAIDES INC.
P.O. Box 35428
Houston, TX 77035
Tel: (713) 772-0730
TWX: 910-881-7032

16 MONTANA & WYOMING
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

17 COLORADO & UTAH
McCARTHY COMPANY
7549 S. Jackson
Littleton, CO 80122
Tel: (303) 773-0643

18 ARIZONA, NEW MEXICO & EL PASO, TEXAS
SEDCO SALES INC.
1518 N. 26th Street
Mesa, AZ 85203
Tel: (602) 835-6281
TWX: 910-950-1968

19 IDAHO, OREGON & WASHINGTON
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

20 NEVADA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

21 NORTHERN CALIFORNIA
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490

22 SOUTHERN CALIFORNIA—LOS ANGELES, SANTA BARBARA, VENTURA & SAN LUIS OBISPO COUNTIES
MYCO SALES
19300 Romar Street
Northridge, CA 91324
Tel: (213) 886-7101
TLX: 686417 MYCO SALE NTGE

23 SOUTHERN CALIFORNIA—ORANGE, RIVERSIDE & SAN BERNARDINO COUNTIES
ATA ASSOCIATES
503 Via Juarez
San Clemente, CA 92672
Tel: (619) 498-7180

SAN DIEGO & IMPERIAL COUNTIES
ATA ASSOCIATES
4491 Estada Drive
Oceanside, CA 92056
Tel: (714) 433-1235

24 ALASKA, HAWAII, CENTRAL & SOUTH AMERICA, MEXICO
FERRANTI ELECTRIC INC.
Tel: (516) 543-0200
TWX: 510-226-1490
INT. TLX: 6852104FER UW

FRANCHISED DISTRIBUTORS

ALABAMA
A.B. ANDREWS & COMPANY INC.
821 Wheeler Avenue
Huntsville, AL 35801
Tel: (205) 539-6817

ARIZONA
LION ELEC. INC.
2501 W. Behrend Drive
Phoenix, AZ 85027
Tel: (602) 869-9611

NORTHERN CALIFORNIA
PACESETTER ELEC.
543 Weddell Drive
Sunnyvale, CA 94086
Tel: (408) 734-5470

SOUTHERN CALIFORNIA
PACESETTER ELEC.
3137 W. Warner Avenue
Santa Ana, CA 92704
Tel: (714) 557-7131
Tel: (213) 299-7760

MYCO/VICKERS
8040 Deering Ave., Unit 3
Canoga Park, CA 91304
Tel: (213) 340-2025

CONNECTICUT
CRONIN ELEC. LTD.
39 N. Plains Industrial Rd.
Wallingford, CT 06492
Tel: (203) 265-3134

FLORIDA
R.C. SIMON & CO. INC.
4240 N.E. 26th Terrace
Lighthouse Point, FL 33064
Tel: (305) 941-2757
TWX: 510-956-9438

MASSACHUSETTS
CRONIN ELEC. LTD.
77 4th Avenue
Needham, MA 02194
Tel: (617) 449-5000

MICHIGAN
AMBUR ELECTRONICS, INC.
1344 South Commerce Road
Walled Lake, MI 48088
Tel: (313) 669-3710

MINNESOTA
INDUSTRIAL COMPONENTS INC.
5229 Edina Industrial Blvd.
Minneapolis, MN 55435
Tel: (612) 831-2666
TWX: 910-576-3153

NEW JERSEY
J.J.D. ASSOCIATES
63 E. Main Street
Marlton, NJ 08053
Tel: (609) 983-2988

NEW YORK
TRACE ELECTRONICS
30 West Mall
Plainview, NY 11803
Tel: (516) 249-4455
TWX: 510-224-6421

UPSTATE NEW YORK
ADD ELEC. INC.
7 Addler Drive
E. Syracuse, NY 13057
Tel: (315) 437-0300

OHIO
APPLIED DATA MANAGEMENT
435 Dayton Street
Cincinnati, OH 45214
Tel: (513) 579-8108

PENNSYLVANIA
J.J.D. ASSOCIATES
63 E. Main Street
Marlton, NJ 08053
Tel: (609) 983-2988

TEXAS
TEXCOMP
9119 South Gessner
Houston, TX 77074
Tel: (713) 995-5356
TWX: 910-881-7032

CANADA
R-THETA, INC.
100 Amber Street
Markham, Ontario L3R3A2
Tel: (416) 475-8051

FERRANTI
semiconductors better by design

Ferranti Electric Inc., 87 Modular Avenue, Commack, NY 11725, Tel: 516-543-0200, TWX: 510-226-1490