Raytheon

7-27-21
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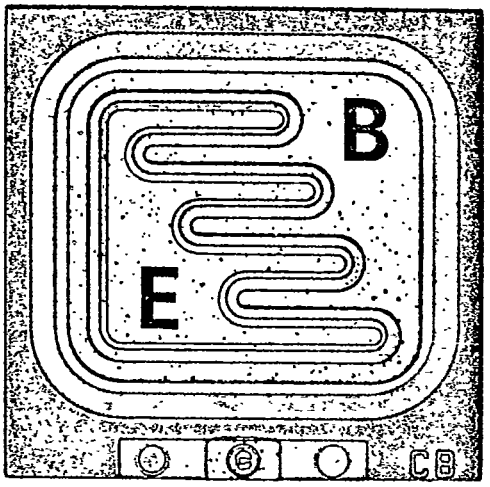
Medium Current General Purpose Amplifiers and Switches

CB NPN



Description

General purpose medium power amplifier and switch, useful up to 500mA. The PNP compliment is the GB.

Dimensions

Die Size: 21 x 21 mils
Bonding Pad Size:
Base — 4 mil diameter
Emitter — 4 mil diameter

Popular Types

2N2222A/JAN
2N2221A/JAN
2N2219A/JAN
2N2218A/JAN

Raytheon Company
Semiconductor Division

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(415) 968-9211
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65-1012B 4/85

9000-0898

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Electrical Characteristics (+25°C ambient temperature unless otherwise stated)

Parameter	Conditions	2N2221A/JAN 2N2218A/JAN			2N2222A/JAN 2N2219A/JAN			Units
		Min	Typ	Max	Min	Typ	Max	
BV_{CEO}	I_C = 10mA, I_B = 0	50	68		50	58		V
BV_{CBO}	I_C = 10μA, I_E = 0	75	126		75	122		V
BV_{EBO}	I_E = 10μA, I_C = 0	6	8.0		6	8.1		V
I_{CBO}	I_E = 0, V_{CB} = 60V		0.02	10		0.02	10	nA
I_{CBO}	I_E = 0, V_{CB} = 60V, T_A = 150°C		0.065	10		0.070	10	μA
I_{EBO}	I_C = 0, V_{EB} = 4V		0.04	10		0.03	10	nA
H_{FE}	I_C = 0.1mA, V_{CE} = 10V	30	55		50	150		
H_{FE}	I_C = 1mA, V_{CE} = 10V	35	70	150	75	180	325	
$h_{fe(ac)}$	I_C = 1mA, V_{CE} = 10V, f = 1kHz	30	80		30	190		
H_{FE}	I_C = 10mA, V_{CE} = 10V	40	80		100	200		
H_{FE}	I_C = 10mA, V_{CE} = 10V, T_A = -55°C	15	45		35	115		
H_{FE}	I_C = 150mA, V_{CE} = 10V	40	90	120	100	210	300	
H_{FE}	I_C = 500mA, V_{CE} = 10V	20	40		30	90		
h_{fe}	I_C = 20mA, V_{CE} = 20V, f = 100MHz	2.5	3.5		2.5	4.0		
$V_{CE(SAT)}$	I_C = 150mA, I_B = 15mA		0.180	0.3		0.133	0.3	V
$V_{CE(SAT)}$	I_C = 500mA, I_B = 50mA		0.480	1		0.360	1	V
$V_{BE(SAT)}$	I_C = 150mA, I_B = 15mA	0.6	0.847	1.2	0.6	0.842	1.2	V
$V_{BE(SAT)}$	I_C = 500mA, I_B = 50mA		1.02	2		0.993	2	V
C_{ob}	V_{CB} = 10V, I_E = 0, f = 1MHz		3.58	8		3.75	8	pF
C_{ib}	V_{EB} = 0.5V, I_C = 0, f = 1MHz		22.0	25		21.5	25	pF
t_{on}	I_C = 150mA, I_{B1} = 15mA (see Fig. 1)		16	35		15	35	nS
t_{off}	I_C = 150mA, I_{B1} = I_{B2} = 15mA (see Fig. 2)		220	300		240	300	nS

Medium Current General Purpose Amplifier & Switch CB NPN

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CB Single Transistors

Product Type	Pkg.	Electrical Parameters @ +25°C Ambient Temperature										
		BV_{CBO} Min	BV_{CEO} Min	BV_{EBO} Min	H_{FE} @ I_C/V_{CE}		$V_{CE(SAT)}$ @ I_C/I_B		f_t MHz	C_{ob} pF	t_{ON} nS	t_{OFF} nS
		@ 10μA	@ 10mA	@ 10μA	Min/ Max	mA/V	Volts Max	mA/mA	Min	Max	Max	Max
2N2217	TO-5	60	30	5	20/60	150/10	0.4	150/15	250	8		
2N2218	TO-5	60	30	5	40/120	150/10	1.6	500/50	250	8		
2N2218J.TX.V	TO-5	60	30	5	40/120	150/10	1.6	500/50	250	8	40	250
2N2218A	TO-5	75	40	6	40/120	150/10	1.0	500/50	250	8	35	285
2N2218AJ.TX.V	TO-5	75	50	6	40/120	150/10	1.0	500/50	250	8	35300	
2N2219	TO-5	60	30	5	100/300	150/10	1.6	500/50	250	8		
2N2219J.TX.V	TO-5	60	30	5	100/300	150/10	1.6	500/50		8	40	250
2N2219A	TO-5	75	40	6	100/300	150/10	1.0	500/50	250	8	35	300
2N2219AJ.TX.V	TO-5	75	50	6	100/300	150/10	1.0	500/50		8	35	300
2N2220	TO-18	60	30	5	20/60	150/10	0.4	150/15	250	8		
2N2221	TO-18	60	30	5	40/120	150/10	1.6	500/50	250	8		
2N2221J.TX.V	TO-18	60	30	5	40/120	150/10	1.6	500/50		8	40	250
2N2221A	TO-18	75	40	6	100/300	150/10	1.0	500/50	250	8	35	285
2N2221AJ.TX.V	TO-18	75	50	6	100/300	150/10	1.0	500/50		8	35	300
2N2222	TO-18	60	30	5	100/300	150/10	1.6	500/50	250	8		
2N2222J.TX.V	TO-18	60	30	5	100/300	150/10	1.6	500/50	250	8	40	250
2N2222A	TO-18	75	40	6	100/300	150/10	1.0	500/50	250	8	35	285
2N2222AJ.TX.V	TO-18	75	50	6	100/300	150/10	1.0	500/50		8	35	300
2N2236	TO-5	40	20	6	15/60	100/1	0.25	100/20	50	35	30	600
2N2237	TO-5	40	20	6	40/125	100/1	0.25	100/20	50	35	30	600
2N2380	TO-5	80	40	5	20/120	150/10	1.3	150/15	100	14		195
2N2380A	TO-5	80	40	5	20/120	150/10	1.3	150/15	100	14		195
2N2479	TO-5	80	40	5	30/120	150/1.5	0.85	150/15	150	18	100	185
2N2958	TO-5	60	20	5	40/120	150/10	0.5	150/15	250	8	95	500
2N2959	TO-5	60	20	5	100/300	150/10	0.5	150/15	250	8	95	500
2N2960	TO-5	60	30	5	100/300	150/10	0.5	150/15	250	8	95	500
2N2961	TO-5	60	30	5	100/300	150/10	2.6	500/50	250	8	95	500
2N3115	TO-18	60	20	5	40/120	150/10	0.5	150/15	250	8		
2N3116	TO-18	60	30	5	100/300	150/10	0.5	150/15	250	8		
2N3299	TO-5	60	30	5	40/120	150/10	0.6	500/50	250	8	60	150
2N3300	TO-5	60	30	5	100/300	150/10	0.6	500/50	250	8	60	150
2N3301	TO-18	60	30	5	40/120	150/10	0.6	500/50	250	8	60	150
2N3302	TO-18	60	30	5	100/300	150/10	0.6	500/50	250	8	60	150
2N3326	TO-5	60	45	5	40/120	150/10	1.6	500/50	250	8	45	340

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CB Dual Transistors

Product Type	Pkg.	Electrical Parameters @ +25°C Ambient Temperature													
		BV_{CBO} Min @ 10μA	BV_{CEO} Min @ 10mA	BV_{EBO} Min @ 10μA	H_{FE} @ I_C/V_{CE} Min/ Max	mA/V	Matching H_{FE} %	Matching V_{BE} mV	$V_{CE(SAT)}$ @ I_C/I_B Volts Max	I_C/I_B mA/mA	$V_{BE(SAT)}$ @ I_C/I_B Volts Max	I_C/I_B mA/mA	f_t MHz Min	C_{ob} pF Max	NF dB Max
2N3728	TO-78	60	30	5	80/280	150/5	20	5	0.22	150/15	1.1	150/15	250	8	7
2N3729	TO-78	60	30	5	80/280	150/5	10	3	0.22	150/15	1.1	150/15	250	8	7
2N5793J, TX,V	TO-78	75	40	6	40/120	150/10			0.3	150/15	1.2	150/15	200	8	
2N5794J, TX,V	TO-78	75	40	6	100/300	150/10			0.3	150/15	1.2	150/15	200	8	
SP2218AF	TO-89	75	40	6	40/120	150/10			0.4	150/15	1.3	150/15	250	8	
SP2219F	TO-89	60	30	5	100/300	150/10			0.4	150/15	1.3	150/15	250	8	
SP2219AF	TO-89	75	40	6	100/300	150/10			0.4	150/15	1.3	150/15	250	8	
SP2221F	TO-89	60	30	5	40/120	150/10			0.4	150/15	1.3	150/15	250	8	
SP2221AF	TO-89	75	50	6	40/120	150/10			0.3	150/15	1.2	150/15	250	8	
SP2222F	TO-89	60	30	5	100/300	150/10			0.4	150/15	1.3	150/15	250	8	
SP2222AF	TO-89	75	50	6	100/300	150/10			0.3	150/15	1.2	150/15	250	8	

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CB Quad Transistors

Product Type	Pkg.	Electrical Parameters @ +25°C Ambient Temperature								
		BV_{CBO} Min @ 10μA	BV_{CEO} Min @ 10mA	BV_{EBO} Min @ 10μA	H_{FE} @ I_C/V_{CE} Min/ Max	mA/V	$V_{CE(SAT)}$ @ I_C/I_B Volts Max	I_C/I_B mA/mA	f_t MHz Min	C_{ob} pF Max
SP2218QD	TO-116	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2218QDB	TO-116	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2218QF	TO-86	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2218AQD	TO-116	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2218AQDB	TO-116	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2218AQF	TO-86	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2219QD	TO-116	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2219QDB	TO-116	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2219QF	TO-86	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2219AQD	TO-116	75	40	6	100/300	150/10	0.4	150/15	250	8
SP2219AQDB	TO-116	75	40	6	100/300	150/10	0.4	150/15	250	8
SP2219AQF	TO-86	75	40	6	100/300	150/10	0.4	150/15	250	8
SP2221QD	TO-116	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2221QDB	TO-116	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2221QF	TO-86	60	30	5	40/120	150/10	0.4	150/15	250	8
SP2221AQD	TO-116	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2221AQDB	TO-116	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2221AQF	TO-86	75	40	6	40/120	150/10	0.4	150/15	250	8
SP2222QD	TO-116	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2222QDB	TO-116	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2222QF	TO-86	60	30	5	100/300	150/10	0.4	150/15	250	8
SP2222AQD	TO-116	75	40	6	100/300	150/10	0.4	150/15	250	8
SP2222AQDB	TO-116	75	40	6	100/300	150/10	0.4	150/15	250	8
SP2222AQF	TO-86	75	40	6	100/300	150/10	0.4	150/15	250	8

QD = Quad DIP (Ceramic); QDB = Quad DIP (Plastic); QF = Quad Flatpack

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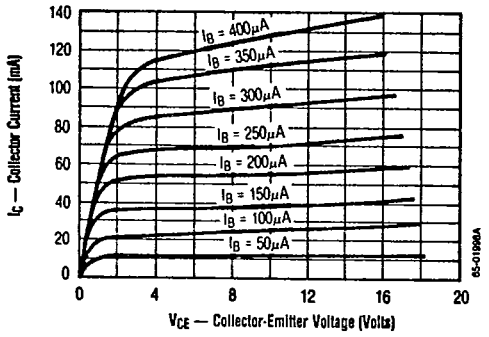
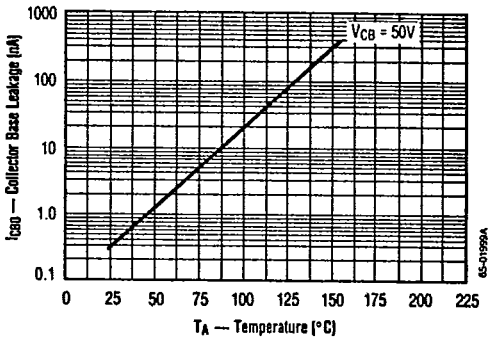
Typical Performance Characteristics

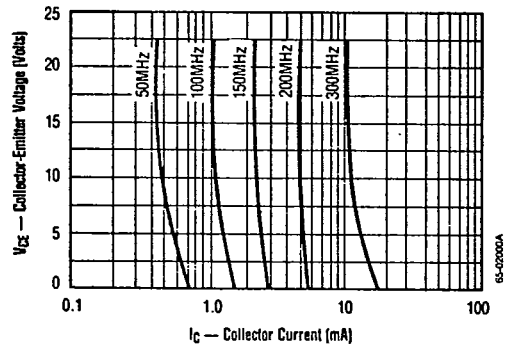
Collector Characteristics (Active Region)



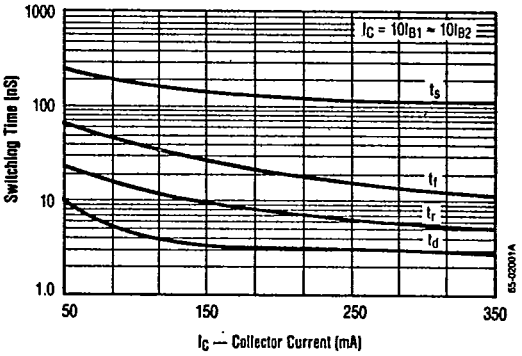
Collector-Base Leakage Current vs. Temperature



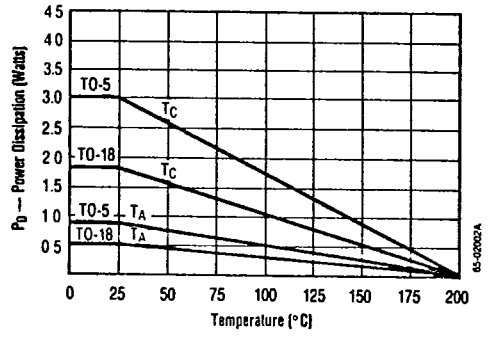
f_t — Constant Gain Bandwidth Products Contours



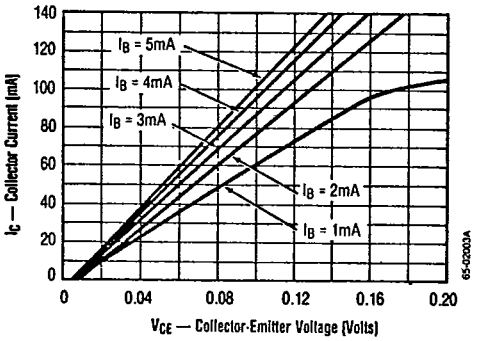
Switching Time vs. Collector Current



Power Derating Curves

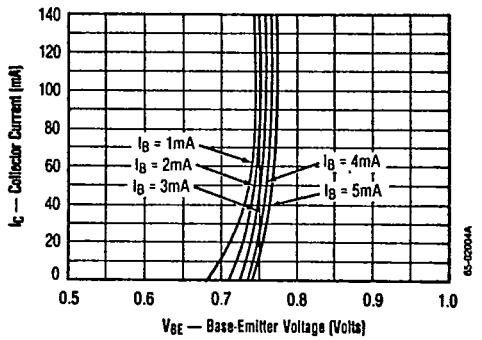


Collector Characteristics (Saturation Region)

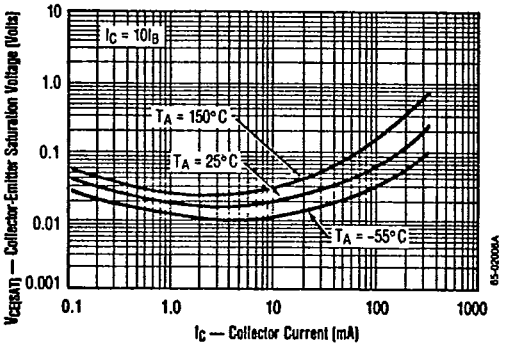


Typical Performance Characteristics (Continued)

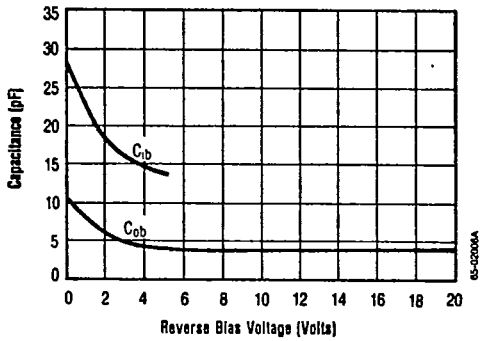
Base Characteristics



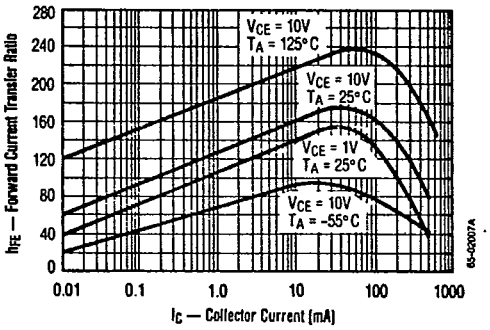
Collector-Emitter Saturation Voltage vs. Collector Current



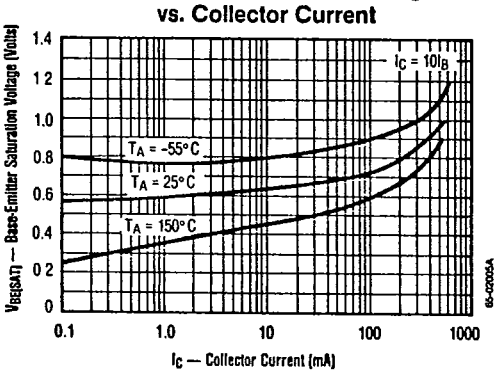
Output and Input Capacitance vs. Reverse Bias Voltage



Forward Current Transfer Ratio vs. Collector Current



Base-Emitter Saturation Voltage vs. Collector Current



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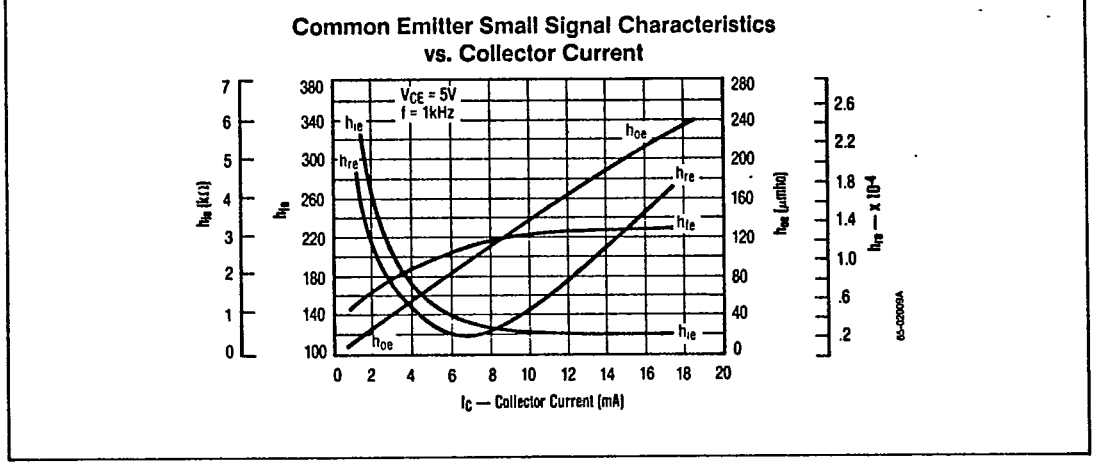
Typical Performance Characteristics (Continued)



Switching Measurement Circuit

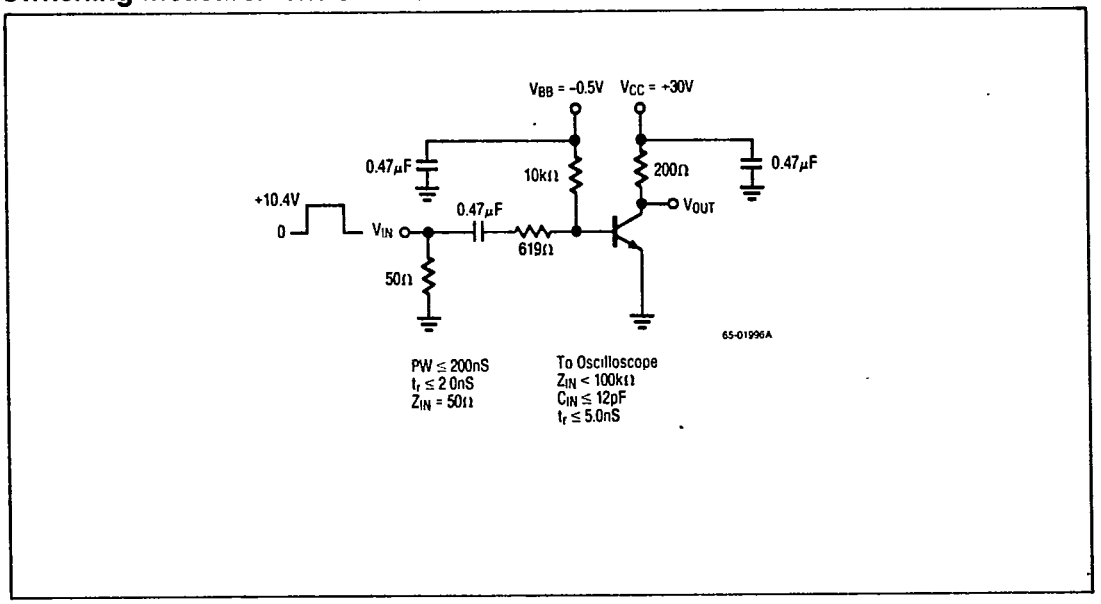
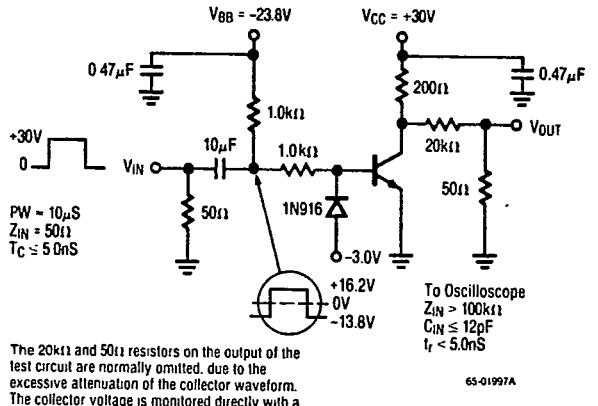


Figure 1. t_{on} Switching

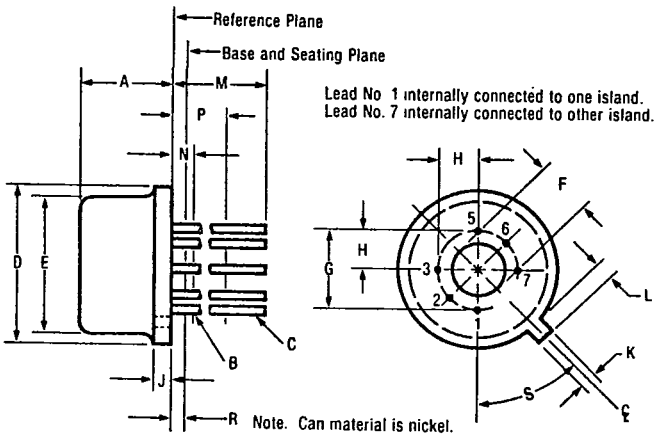


The 20kΩ and 50Ω resistors on the output of the test circuit are normally omitted, due to the excessive attenuation of the collector waveform. The collector voltage is monitored directly with a high impedance oscilloscope probe

Figure 2. t_{off} Switching

Packaging Information

In Accordance With JEDEC (TO-78) Outline
(15 mil Kovar Header Adjacent Two Island Package)



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.165	0.185	4.19	4.70
B	0.016	0.019	0.41	0.48
C	0.016	0.021	0.41	0.53
D	0.335	0.370	8.51	9.40
E	0.305	0.335	7.75	8.51
F	0.120	0.160	3.05	4.06
G	0.200BSC		5.08BSC	
H	0.100BSC		2.54BSC	
J	0.009	0.041	0.23	1.04
K	0.028	0.034	0.71	0.86
L	0.029	0.045	0.74	1.14
M	0.500	0.750	12.70	19.05
N		0.050		1.27
P	0.250		6.35	
R	0.010	0.045	0.25	1.14
S	45° BSC		45° BSC	

65-01188B

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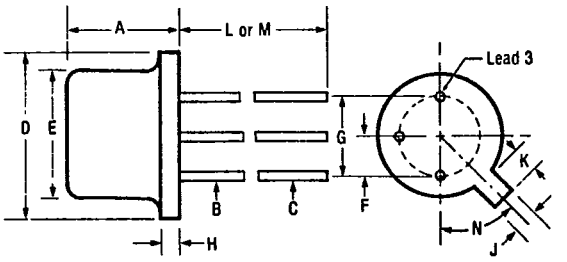
Packaging Information (Continued)

In Accordance With JEDEC (TO-5) Outline (15 mil Kovar Header)

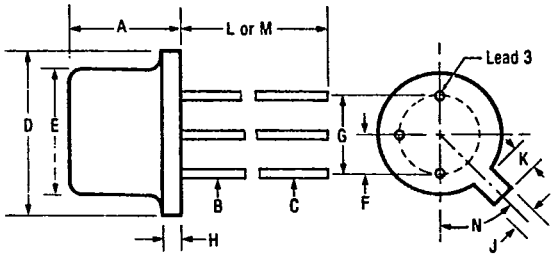


Notes. Lead No 3 internally connected to case.
Can material is nickel.

Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	.240	.260	6.09	6.60
B	.016	019	.41	.48
C	.016	.021	.41	53
D	335	370	8 51	9 40
E	305	.335	7.75	8 51
F	.100BSC		2 54BSC	
G	200BSC		5.08BSC	
H	.009	.125	.22	3.17
J	.028	.034	.71	.86
K	029	.045	.73	1 14
L	.500		12.70	
M	1 500		38.10	
N	45°BSC		45°BSC	

65-01179B

In Accordance With JEDEC (TO-5) Outline (60 mil Kovar or Steel Header)

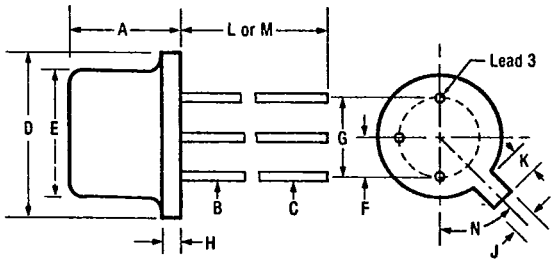


Notes: Lead No. 3 internally connected to case
Can material is nickel.

Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	240	.260	6.09	6 60
B	.016	.019	.41	.48
C	016	.021	41	.53
D	335	.370	8.51	9.40
E	.305	.335	7.75	8 51
F	.100BSC		2 54BSC	
G	200BSC		5.08BSC	
H	.009	.125	.22	3.17
J	.028	.034	.71	.86
K	.029	.045	.73	1.14
L	.500		12.70	
M	1.500		38.10	
N	45°BSC		45°BSC	

65-01180B

In Accordance With JEDEC (TO-18) Outline (8 mil Kovar Header)



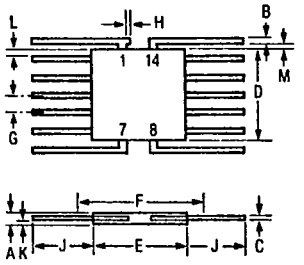
Notes: Lead No 3 internally connected to case
Can material is nickel.

Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	.170	.210	4.31	5.33
B	.016	.019	.41	.48
C	.016	.021	.41	.53
D	209	.230	5.30	5.84
E	.178	.195	4 52	4 95
F	050BSC		1 27BSC	
G	.100BSC		2.54BSC	
H		.030		.76
J	.036	046	.91	1.16
K	.028	.048	.71	1.21
L	.500		12.70	
M	1.500		38.10	
N	45°BSC		45°BSC	

65-01181B

Packaging Information (Continued)

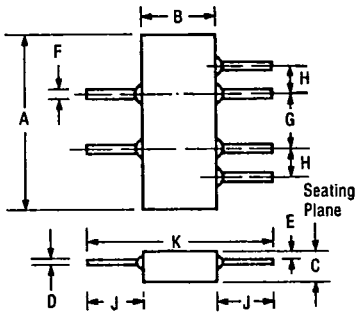
In Accordance With JEDEC (TO-86) Outline
14-Lead Flatpack



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.030	0.070	0.76	1.77
B	0 010	0.019	0.25	0.48
C	0.003	0.006	0.08	0.15
D	0 240	0 275	6.10	6.98
E	0.240	0 260	6.10	6.60
F		0.290		7.37
G	0.050BSC		1.27BSC	
H	0.008	0.015	0.20	0.38
J	0.070		1.78	
K	0 005	0.035	0.13	0.89
L	0 005		0.13	
M	0.004		0.10	

65-01191B

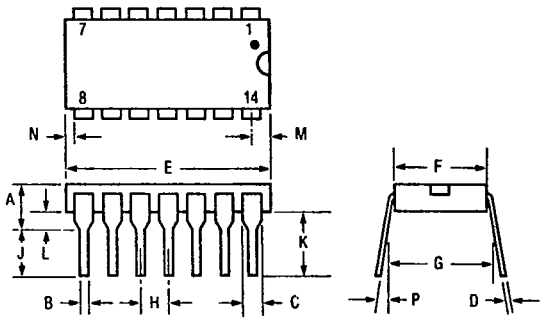
In Accordance With JEDEC (TO-89) Outline
6-Lead Flatpack



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.240	0.290	6.10	7.36
B	0.115	0.160	2.92	3.81
C	0 030	0.080	0.76	2.03
D	0.003	0.006	0 08	0.15
E	0.005	0.035	0.13	0.89
F	0 010	0 019	0.25	0.48
G	0.100BSC		2.54BSC	
H	0 050BSC		1.27BSC	
J	0.070	0.250	1.78	6 35
K	0 260	0.650	6.60	16.51

65-01184B

In Accordance With JEDEC (TO-116) Outline
14-Lead Plastic Dual In-Line Package



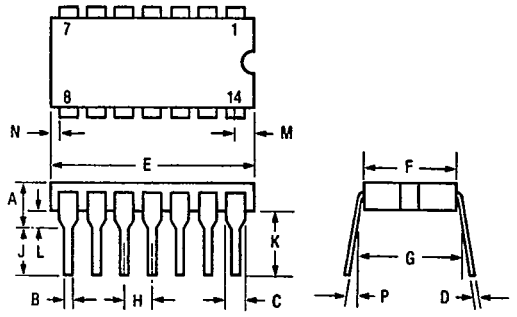
Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A		0.200		5 08
B	0 015	0.023	0.381	0.584
C	0 030	0.070	0.77	1.77
D	0 008	0 015	0.204	0.381
E	0 660	0.785	16 76	19.94
F	0 220	0 280	5.59	7.11
G	0.290	0.310	7.37	7.87
H	0.100BSC		2.54BSC	
J	0.100		2.54	
K	0.120		3.05	
L	0.020		0.51	
M	0 020	0.102	0.51	2.59
N	0 002	0.087	0.051	2.21
P	0°	15°	0°	15°

65-01196B

T-27-21
T-27-27

Packaging Information (Continued)

Similar to JEDEC (TO-116) Outline
14-Lead Ceramic Dual In-Line Package



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A		.200		5 08
B	.014	023	0 36	0.58
C	030	070	0.76	1.78
D	008	.015	0.20	0 38
E		.785		19 94
F	220	310	5 59	7.87
G	290	320	7.37	8 13
H	.100BSC		2 54BSC	
J	125	200	3 18	5 08
K	.150		3 81	
L	015	.060	0 38	1.52
M		098		2.49
N	005		0.13	
P	0°	15°	0°	15°

65-01206B

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