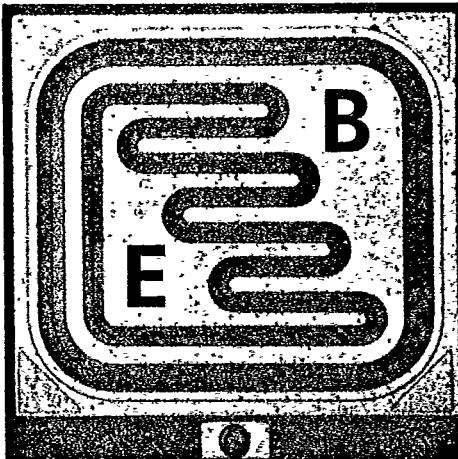


Raytheon

Medium Current General Purpose Amplifiers and Switches

GB PNP**Description**

General purpose medium power amplifier and switch, useful up to 500mA. The NPN complement is the CB.

Dimensions

Die Size: 21 x 21 mils

Bonding Pad Size:

Base — 4 mil diameter

Emitter — 4 mil diameter

Popular Types

2N2907A/JAN

2N2906A/JAN

2N2905A/JAN

2N2904A/JAN

Raytheon Company
Semiconductor Division

350 Ellis Street
Mountain View, CA 94039-7016
(415) 968-9211
TWX: 910-379-6484

65-1006B 4/85

GB PNP

Medium Current General Purpose Amplifier & Switch

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

Parameter	Conditions	2N2904A/JAN 2N2906A/JAN			2N2905A/JAN 2N2907A/JAN			Units
		Min	Typ	Max	Min	Typ	Max	
BV_{CEO}	$I_C = 10\text{mA}, I_B = 0$	-60	-88		-60	-82		V
BV_{CBO}	$I_C = 10\mu\text{A}, I_E = 0$	-60	-110		-60	-105		V
BV_{EBO}	$I_E = -10\mu\text{A}, I_C = 0$	-5	-7.8		-5	-7.8		V
I_{CBO}	$I_E = 0, V_{CB} = -50\text{V}$		0.01	50		0.01	50	nA
I_{CBO}	$I_E = 0, V_{CB} = -50\text{V}, T_A = 150^\circ\text{C}$		0.03	10		0.03	10	μA
I_{EBO}	$I_C = 0, V_{EB} = -3.5\text{V}$		0.01	50		0.01	50	nA
H_{FE}	$I_C = 100\mu\text{A}, V_{CE} = -10\text{V}$	40	80		75	190		
H_{FE}	$I_C = 1\text{mA}, V_{CE} = -10\text{V}$	40	90	75	100	210	450	
H_{FE}	$I_C = 1\text{mA}, V_{CE} = -10\text{V}, T_A = -55^\circ\text{C}$	20	40		50	100		
H_{FE}	$I_C = 10\text{mA}, V_{CE} = -10\text{V}$	40	95		100	220		
H_{FE}	$I_C = 150\text{mA}, V_{CE} = -10\text{V}$	40	85	120	100	195	300	
H_{FE}	$I_C = 500\text{mA}, V_{CE} = -10\text{V}$	40	65		50	100		
$h_{fe(ac)}$	$I_C = 1\text{mA}, V_{CE} = -10\text{V}, \text{Freq} = 1\text{kHz}$	40	100		100	230		
h_{fe}	$I_C = 50\text{mA}, V_{CE} = -20\text{V}, \text{Freq} = 100\text{MHz}$	2	3.2		2	3.4		
$V_{CE(SAT)}$	$I_C = 150\text{mA}, I_B = 15\text{mA}$		-0.25	-0.4		-0.2	-0.4	V
$V_{CE(SAT)}$	$I_C = 500\text{mA}, I_B = 50\text{mA}$		-0.6	-1.6		-0.54	-1.6	V
$V_{BE(SAT)}$	$I_C = 150\text{mA}, I_B = 15\text{mA}$		-0.88	-1.3		-0.88	-1.3	V
$V_{BE(SAT)}$	$I_C = 500\text{mA}, I_B = 50\text{mA}$		-1.0	-2.6		-1.0	-2.6	V
C_{ob}	$V_{CB} = -10\text{V}, I_E = 0$		6	8		6	8	pF
C_{ib}	$V_{EB} = -2\text{V}, I_C = 0$		17	30		17	30	pF
t_{on}	$I_C = 150\text{mA}, I_{B1} = 15\text{mA}$ (see Fig. 1)		18	45		18	45	nS
t_{off}	$I_C = 150\text{mA}, I_{B1} = I_{B2} = 15\text{mA}$ (see Fig. 2)		135	300		135	300	nS

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T-37-17

Low Level, General Purpose Amplifiers & Switches

GB PNP

GB Single Transistors

Product Type	Pkg.	Electrical Parameters @ +25°C Ambient Temperature							f _t MHz	C _{ob} pF	t _{ON} nS	t _{OFF} nS
		BV _{CBO} Min	BV _{CEO} Min	BV _{EBO} Min	h _{FE} @ I _C /V _{CE}		V _{CE(SAT)} @ I _C /I _B					
		@ 10μA	@ 10mA	@ 10μA	Min/ Max	mA/V	Volts Max	mA/mA				
2N721	T0-18	50	35	5	20/45	150/10	1.5	150/15	50	45		
2N722	T0-18	50	35	5	30/90	150/10	1.5	150/15	60	45		
2N722A	T0-18	50	35	5	30/90	150/10	0.5	150/15	60	40		
2N1131	T0-5	50	35	5	20/45	150/10	1.5	150/15	50	45		
2N1131J	T0-5	50	40	5	20/45	150/10	1.5	150/15	50	45		
2N1131A	T0-5	60	40	5	20/45	150/10	1.5	150/15	50	30	45	35
2N1132	T0-5	50	35	5	30/90	150/10	1.5	150/15	60	45		
2N1132J	T0-5	50	40	5	30/90	150/10	1.5	150/15	60	45		
2N1132A	T0-5	60	40	5	20/45	150/10	1.5	150/15	50	30	45	35
2N2904	T0-5	60	40	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2904J,TX,V	T0-5	60	40	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2904A	T0-5	60	60	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2904AJ,TX,V	T0-5	60	60	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2905	T0-5	60	40	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2905J,TX,V	T0-5	60	40	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2905A	T0-5	60	60	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2905AJ,TX,V	T0-5	60	60	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2906	T0-18	60	40	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2906J,TX,V	T0-18	60	40	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2906A	T0-18	60	60	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2906AJ,TX,V	T0-18	60	60	5	40/120	150/10	0.4	150/15	200	8	45	300
2N2907	T0-18	60	40	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2907J,TX,V	T0-18	60	40	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2907A	T0-18	60	60	5	100/300	150/10	0.4	150/15	200	8	45	300
2N2907AJ,TX,V	T0-18	60	60	5	100/300	150/10	0.4	150/15	200	8	45	300
2N3133	T0-5	50	35	4	40/120	150/10	0.6	150/15	200	10	75	150
2N3134	T0-5	50	35	4	100/300	150/10	0.6	150/15	200	10	75	150
2N3135	T0-18	50	35	4	40/120	150/10	0.6	150/15	200	10	75	150
2N3136	T0-18	50	35	4	100/300	150/10	0.6	150/15	200	10	75	150
2N3494	T0-5	80	80	4.5	40/—	50/10	0.3	10/1	200	7	300	1000
2N3502	T0-5	45	45	5	100/300	150/10	0.4	150/15	200	8	40	100
2N3503	T0-5	60	60	5	100/300	150/10	0.4	150/15	200	8	40	100
2N3504	T0-18	45	45	5	100/300	150/10	0.4	150/15	200	8	40	100
2N3505	T0-18	60	60	5	100/300	150/10	0.4	150/15	200	8	40	100
2N4036	T0-5	90	65	7	40/140	150/10	0.65	150/15	60	30	110	700
2N4037	T0-5	60	4	7	50/250	150/10	1.4	150/15	60	30		

T-37-17

GB PNP

Medium Current General Purpose Amplifier & Switch

GB Dual Transistors

Product Type	Pkg.	Electrical Parameters @+25°C Ambient Temperature											f _t MHz	C _{ob} pF	NF dB
		BV _{CEO} Min	BV _{CEO} Min	BV _{EBO} Min	H _{FE} @ I _C /V _{CE}		Matching		V _{CE(SAT)} @ I _C /I _B		V _{BE(SAT)} @ I _C /I _B				
		@ 10μA	@ 10mA	@ 10μA	Min/ Max	mA/V	H _{FE} %	V _{BE} mV	Volts Max	I _C /I _B mA/mA	Volts Max	I _C /I _B mA/mA			
2N2802	T0-78	25	20	5	20/200	1/5	10	5	0.5	10/1	0.9	10/1	60	8	4
2N2803	T0-78	25	20	5	20/200	1/5	20	10	0.5	10/1	0.9	10/1	60	8	4
2N2804	T0-78	25	20	5	20/200	1/5			0.5	10/1	0.9	10/1	60	8	4
2N2805	T0-78	25	20	5	40/200	1/5	10	5	0.5	10/1	0.9	10/1	60	8	4
2N2806	T0-78	25	20	5	40/200	1/5	20	10	0.5	10/1	0.9	10/1	60	8	4
2N2807	T0-78	25	20	5	40/200	1/5			0.5	10/1	0.9	10/1	60	8	4
2N3726	T0-78	50	50	5	135/420	1/10	10	5	0.25	50/2.5	1.0	50/2.5	60	8	4
2N3727	T0-78	50	50	5	135/420	1/10	10	2.5	0.25	50/2.5	1.0	50/2.5	60	8	4
2N5795	T0-78	60	60	5	40/120	150/10			0.4	150/15	1.3	150/15	200	8	
2N5796	T0-78	60	60	5	100/200	150/10			0.4	150/15	1.3	150/15	200	8	
SP2904F	T0-89	60	40	5	40/120	150/10			0.4	150/15	1.3	150/15	200	8	
SP2904AF	T0-89	60	60	5	40/120	150/10			0.4	150/15	1.3	150/15	200	8	
SP2905F	T0-89	60	40	5	100/300	150/10			0.4	150/15	1.3	150/15	200	8	
SP2905AF	T0-89	60	60	5	100/300	150/10			0.4	150/15	1.3	150/15	200	8	
SP2906F	T0-89	60	40	5	40/120	150/10			0.4	150/15	1.3	150/15	200	8	
SP2906AF	T0-89	60	60	5	40/120	150/10			0.4	150/15	1.3	150/15	200	8	
SP2907F	T0-89	60	40	5	100/300	150/10			0.4	150/15	1.3	150/15	200	8	
SP2907AF	T0-89	60	60	5	100/300	150/10			0.4	150/15	1.3	150/15	200	8	
SP3133F	T0-89	50	35	4	40/120	150/10			0.6	150/15	1.5	150/15	200	10	
SP3134F	T0-89	50	35	4	100/300	150/10			0.6	150/15	1.5	150/15	200	10	
SP3135F	T0-89	50	35	4	40/120	150/10			0.6	150/15	1.5	150/15	200	8	
SP3136F	T0-89	50	35	4	100/300	150/10			0.6	150/15	1.5	150/15	200	8	

Medium Current General Purpose Amplifier & Switch

GB PNP

T-37-17

GB Quad Transistors

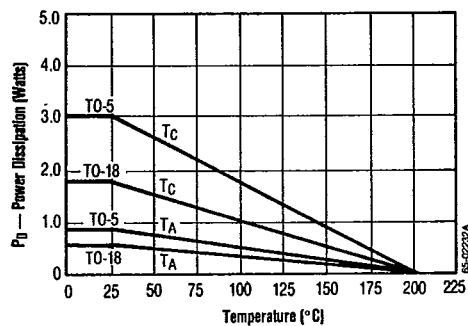
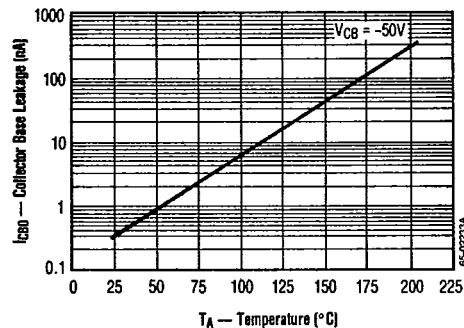
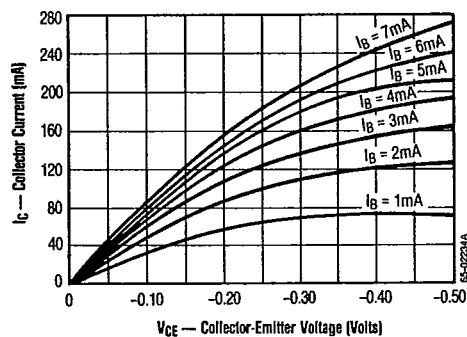
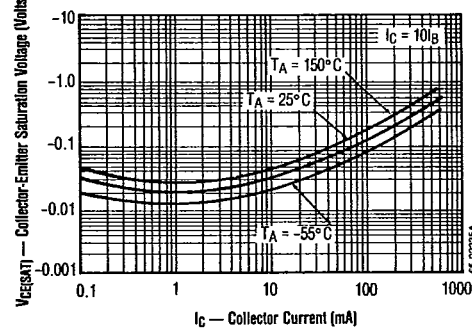
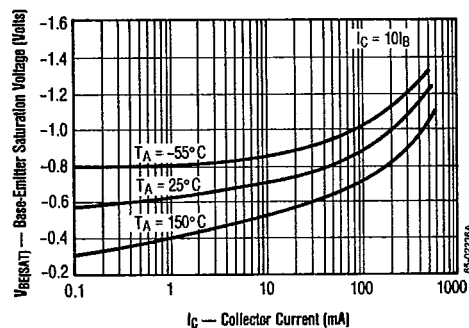
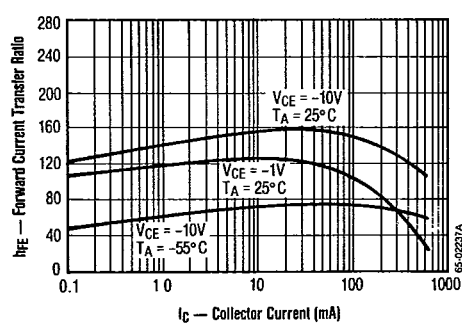
Product Type	Pkg.	Electrical Parameters @ +25°C Ambient Temperature							f _t MHz Min	C _{ob} pF Max
		BV _{CBO} Min	BV _{CEO} Min	BV _{EBO} Min	H _{FE} @ I _C /V _{CE}	V _{CE(SAT)} @ I _C /I _B	I _B mA/mA			
		@ 10μA	@ 10mA	@ 10μA	Min/ Max	mA/V		Volts Max		
SP2904QD	TO-116	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2904QDB	TO-116	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2904QF	TO-86	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2904AQD	TO-116	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2904AQDB	TO-116	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2904AQF	TO-86	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2905QD	TO-116	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2905QDB	TO-116	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2905QF	TO-86	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2905AQD	TO-116	60	60	5	100/300	150/10	0.4	150/15	200	8
SP2905AQDB	TO-116	60	60	5	100/300	150/10	0.4	150/15	200	8
SP2905AQF	TO-86	60	60	5	100/300	150/10	0.4	150/15	200	8
SP2906QD	TO-116	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2906QDB	TO-116	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2906QF	TO-86	60	40	5	40/120	150/10	0.4	150/15	200	8
SP2906AQD	TO-116	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2906AQDB	TO-116	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2906AQF	TO-86	60	60	5	40/120	150/10	0.4	150/15	200	8
SP2907QD	TO-116	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2907QDB	TO-116	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2907QF	TO-86	60	40	5	100/300	150/10	0.4	150/15	200	8
SP2907AQD	TO-116	60	60	5	100/300	150/10	0.4	150/15	200	8
SP2907AQDB	TO-116	60	60	5	100/300	150/10	0.4	150/15	200	8
SP2907AQF	TO-86	60	60	5	100/300	150/10	0.4	150/15	200	8

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

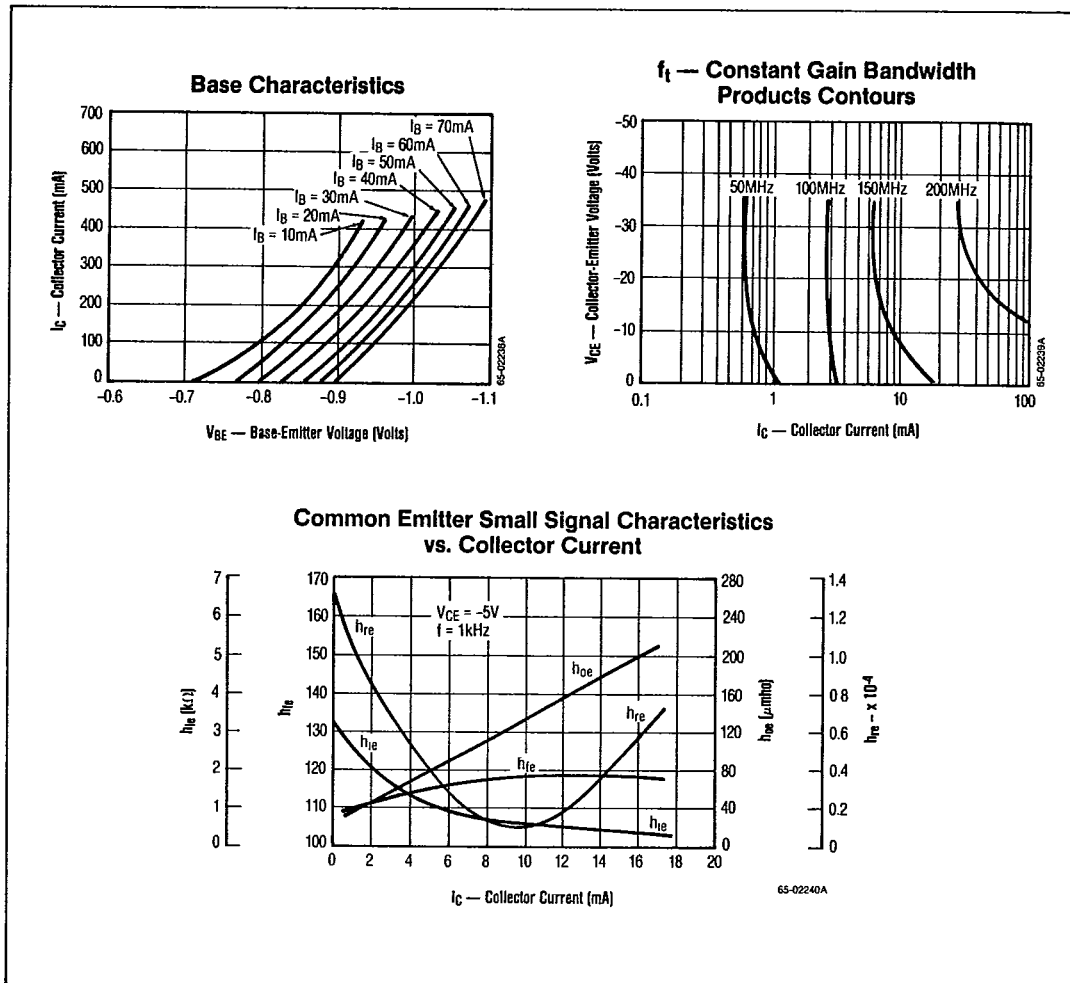
T-37-17

GB PNP

Medium Current General Purpose Amplifier & Switch

Typical Performance Characteristics**Power Derating Curves****Collector-to-Base Leakage Current vs. Temperature****Collector Characteristics (Saturation Region)****Collector-to-Emitter Saturation Voltage vs. Collector Current****Base-to-Emitter Saturation Voltage vs. Collector Current****Forward Current Transfer Ratio vs. Collector Current**

Typical Performance Characteristics (Continued)



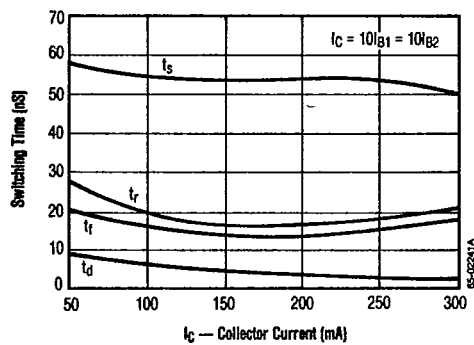
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GB PNP

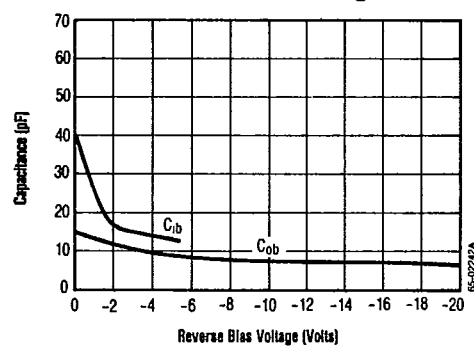
Medium Current General Purpose Amplifier & Switch

Typical Performance Characteristics (Continued)

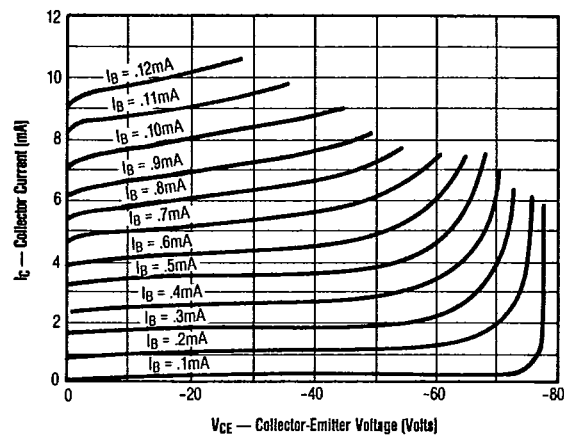
Switching Time vs. Collector Current



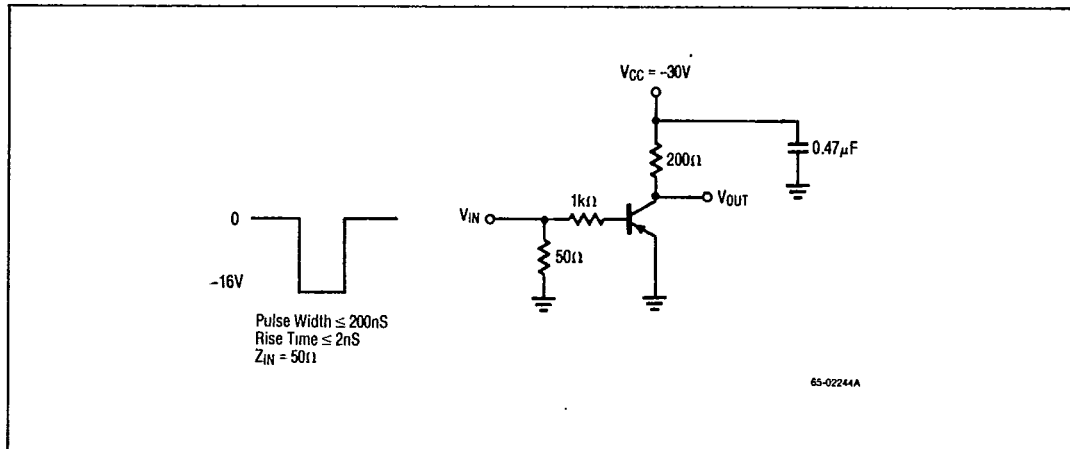
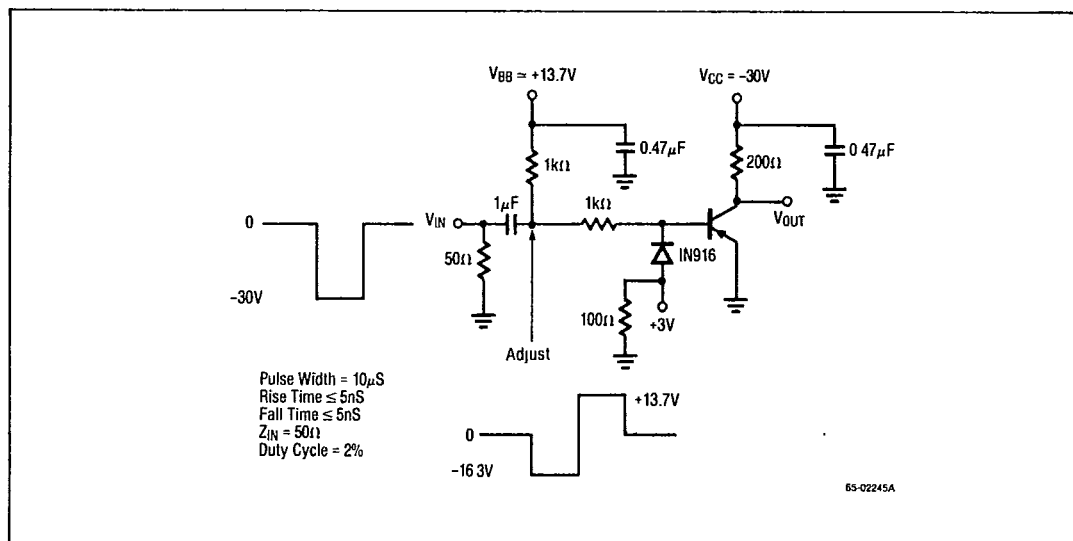
Output and Input Capacitance vs. Reverse Bias Voltage



Collector Characteristics (Active Region)



Switching Measurement Circuits

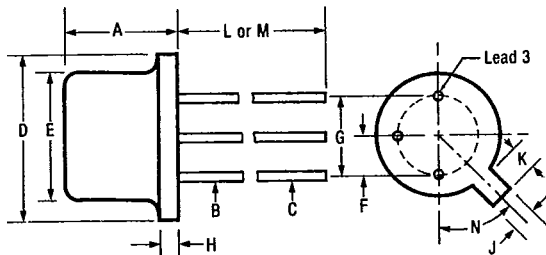
Figure 1. t_{ON} SwitchingFigure 2. t_{OFF} Switching

T-37-17

GB PNP

Medium Current General Purpose Amplifier & Switch

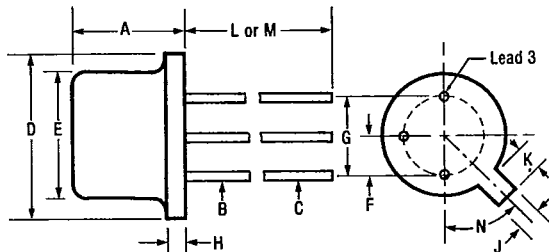
Packaging Information

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	

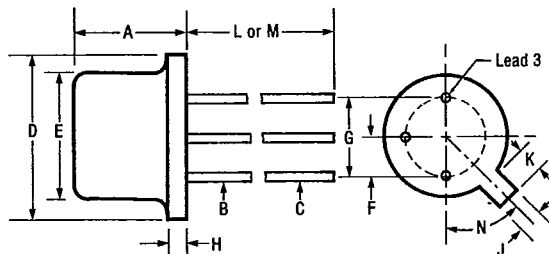
65-01178B

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)

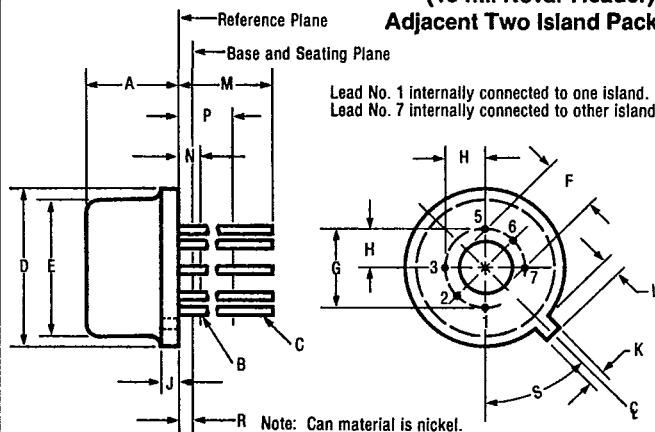
Notes: Lead No. 3 internally connected to case.
Can material is nickel.

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)

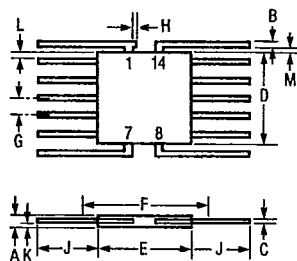
In Accordance With JEDEC (TO-78) Outline
(15 mil Kovar Header)
Adjacent Two Island Package



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

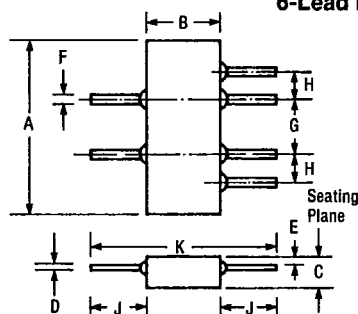
In Accordance With JEDEC (TO-86) Outline
14-Lead Flatpack



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

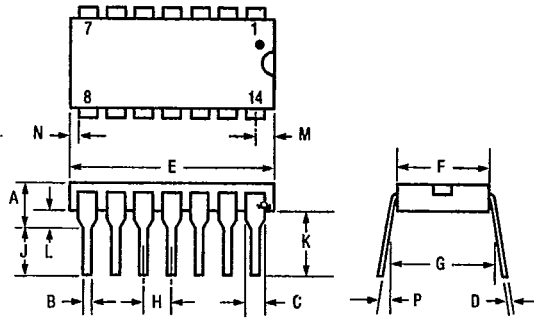
65-01184B

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GB PNP

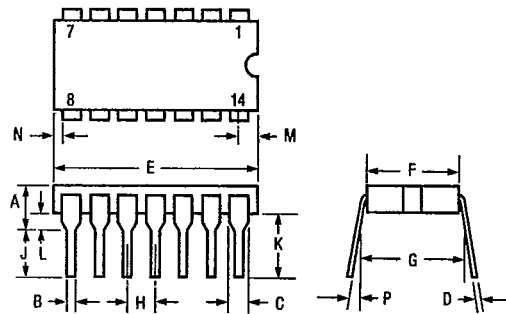
Medium Current General Purpose Amplifier & Switch

Packaging Information (Continued)

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

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		.088		2.49
N	.005		0.13	
P	0°	15°	0°	15°

65-01206B

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