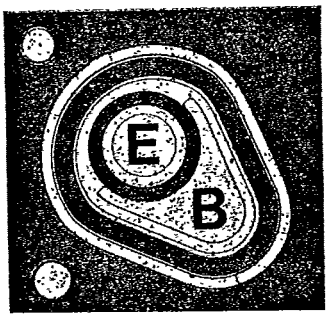
PRODUCT SPECIFICATIONS **Small Signal Transistors**

T-29-27

RAYTHEON

Low Level, Low Noise High Gain Amplifiers

GL PNP



Description

General purpose amplifier for low level, low noise and high gain amplifier applications. The NPN complement is the CL.

Popular Types

2N2604/JAN
2N2605/JAN

Dimensions

Die Size: 17 x 17 mils
Bonding Pad Size:
Base 4 mil Diameter
Emitter 4 mil Diameter

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

Parameter	Conditions	2N2604JAN			2N2605JAN			Units
		Min	Typ	Max	Min	Typ	Max	
BV_{CEO}	I_C = 10mA, I_B = 0	-60	-105		-60	-95		V
BV_{CBO}	I_C = 10μA, I_E = 0	-80	-150		-70	-140		V
BV_{EBO}	I_E = 10μA, I_C = 0	-6	-8.8		-6	-8.8		V
I_{CBO}	I_E = 0, V_{CB} = -50V		0.01	10		0.01	10	nA
I_{CBO}	I_E = 0, V_{CB} = -50V, T_A = 150°C		0.04	5		0.04	5	μA
I_{CES}	V_{EB} = 0, V_{CE} = -50V		0.01	10		0.01	10	nA
I_{EBO}	I_C = 0, V_{EB} = -5V		0.01	2		0.01	2	nA
H_{FE}	I_C = 10μA, V_{CE} = -5V	40	90	120	100	200	300	
H_{FE}	I_C = 10μA, V_{CE} = -5V, T_A = -65°C	15	40		30	92		
H_{FE}	I_C = 500μA, V_{CE} = -5V	60	95		150	210		
H_{FE}	I_C = 10mA, V_{CE} = -5V		80	350		170	600	
$h_{fe(ac)}$	I_C = 1mA, V_{CE} = -5V, Freq = 1KHz	60	87	350	150	220	600	
h_{ie}	I_C = 1mA, V_{CE} = -5V, Freq = 1KHz	1	2.5	10	2	5.5	20	KΩ
h_{oe}	I_C = 1mA, V_{CE} = -5V, Freq = 1KHz		7	40		17	60	μmho
h_{re}	I_C = 1mA, V_{CE} = -5V, Freq = 1KHz		1.0	10		2.4	10	10^{-4}
h_{fe}	I_C = 500μA, V_{CE} = -5V, Freq = 30MHz	1	2.6	8	1	3.0	8	
$V_{CE(SAT)}$	I_C = 10mA, I_B = 500μA		-0.098	-0.5		-0.095	-0.5	V
$V_{BE(SAT)}$	I_C = 10mA, I_B = 500μA	-0.7	-0.76	-0.9	-0.7	-0.76	-0.9	V
NF	I_C = 10μA, V_{CE} = -5V, Freq = 100Hz, R_S = 10KΩ		1.5	5		1.5	5	dB
NF	I_C = 10μA, V_{CE} = -5V, Freq = 1KHz, R_S = 10KΩ		1.3	3		1.3	3	dB
NF	I_C = 10μA, V_{CE} = -5V, Freq = 10KHz, R_S = 10KΩ		0.1	3		0.1	3	dB
C_{ob}	V_{CB} = -5V, I_E = 0		3.5	6		3.5	6	pF

Low Level, Low Noise High Gain Amplifiers

GL Single Transistors

Product Type	Pkg.	Electrical Parameters @ 25°C Ambient Temperature							ft	Cob	NF	
		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	mA/mA	MHz Min	pF Max	dB Max	KHz
2N2604	TO-46	60	45	6	40/120	0.01/5	0.5	10/0.5	30	6	4	15
2N2604J,TX,V	TO-46	80	60	6	40/120	0.01/5	0.5	10/0.5	30	6	4	15
2N2605	TO-46	60	45	6	100/300	0.01/5	0.5	10/0.5	30	6	3	15
2N2605J,TX,V	TO-46	70	60	6	100/300	0.01/5	0.5	10/0.5	30	6	3	15
2N3549	TO-18	60	60	6	100/500	0.01/5	1.0	10/1	60	8	4	15
2N3798	TO-18	60	60	5	150/450	0.5/5	0.25	1/0.1	100	4	2.5	1
2N3798A	TO-18	90	90	5	150/450	0.5/5	0.25	1/0.1	100	4	2.5	1
2N3799	TO-18	60	60	5	300/900	0.5/5	0.25	1/0.1	100	4	1.5	1
2N3964	TO-18	45	45	6	250/500	0.01/5	0.25	10/0.5	50	6	2	1
2N3965	TO-18	60	60	6	250/500	0.01/5	0.25	10/0.5	50	6	2	1

GL Dual Transistors

Product Type	Pkg.	Electrical Parameters @ 25°C Ambient Temperature											ft	Cob
		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	mA/mA	$V_{BE(SAT)}$ @ I_C/I_B Volts Max	mA/mA	MHz Min	pF Max
2N3350	TO-78	60	45	6	150/600	1/5	10	5	0.5	1/0.1	0.8	1/0.1	4	30
2N3800	TO-71	60	60	5	150/250	0.1/5			0.25	1/0.1	0.8	1/0.1	4	30
2N3801	TO-71	60	60	5	300/900	0.1/5			0.25	1/0.1	0.8	1/0.1	4	30
2N3802	TO-71	60	60	5	150/450	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	30
2N3803	TO-71	60	60	5	300/900	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	100
2N3804	TO-71	60	60	5	150/450	0.1/5	10	3	0.25	1/0.1	0.8	1/0.1	4	100
2N3804A	TO-71	60	60	5	150/500	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	30
2N3805	TO-71	60	60	5	300/900	0.1/5	10		0.25	1/0.1	0.8	1/0.1	4	30
2N3805A	TO-71	60	60	5	300/900	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	30
2N3806	TO-78	60	60	5	150/450	0.1/5			0.25	1/0.1	0.8	1/0.1	4	100
2N3807	TO-78	60	60	5	300/900	0.1/5			0.25	1/0.1	0.8	1/0.1	4	100
2N3808	TO-78	60	60	5	150/450	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	100
2N3809	TO-78	60	60	5	300/900	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	100
2N3810	TO-78	60	60	5	150/450	0.1/5	10	3	0.25	1/0.1	0.8	1/0.1	4	100
2N3810A	TO-78	60	60	5	150/450	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	100
2N3811	TO-78	60	60	5	300/900	0.1/5	10	3	0.25	1/0.1	0.8	1/0.1	4	100
2N3811A	TO-78	60	60	5	150/450	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	100
2N3812	TO-89	60	60	5	150/450	0.1/5			0.25	1/0.1	0.8	1/0.1	4	100
2N3813	TO-89	60	60	5	300/900	0.1/5			0.25	1/0.1	0.8	1/0.1	4	100
2N3814	TO-89	60	60	5	150/450	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	100
2N3815	TO-89	60	60	5	300/900	0.1/5	20	5	0.25	1/0.1	0.8	1/0.1	4	100
2N3816	TO-89	60	60	5	150/450	0.1/5	10	3	0.25	1/0.1	0.8	1/0.1	4	100
2N3816A	TO-89	60	60	5	150/450	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	100
2N3817	TO-89	60	60	5	300/900	0.1/5	10	3	0.25	1/0.1	0.8	1/0.1	4	100
2N3817A	TO-89	60	60	5	300/900	0.1/5	5	1.5	0.25	1/0.1	0.8	1/0.1	4	100
2N4937	TO-78	50	40	5	40/200	0.1/10	10	3					6	60
2N4938	TO-78	50	40	5	40/200	0.1/10	20	5					5	300
2N4940	TO-89	50	40	5	40/200	0.1/10	20	2					5	300
2N4941	TO-89	50	40	5	40/200	0.1/10	10	3					5	
2N4942	TO-89	50	40	5	40/200	0.1/10							5	300

Low Level, Low Noise High Gain Amplifiers

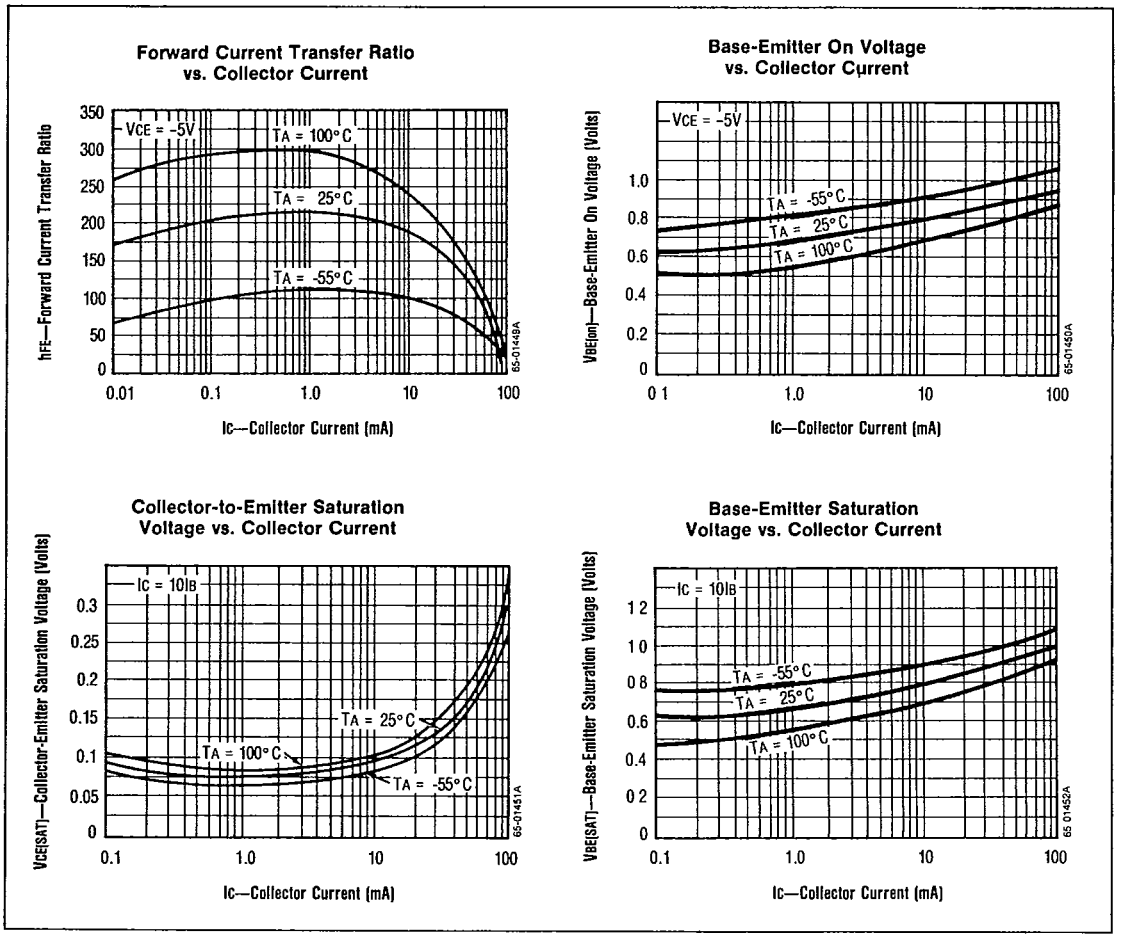
T-29-27

GL Quad Transistors

Product Type	Pkg.	Electrical Parameters @ 25°C Ambient Temperature							ft	Cob
		BVCBO Min @ 10μA	BVCEO Min @ 10mA	BVEBO Min @ 10μA	HFE @ Ic/VCE Min/Max	mA/V	VCE(SAT) @ Ic/Ib Volts Max	mA/mA	MHz Min	pF Max
SP2604QD	TO-116	80	60	6	40/120	0.01/5	0.5	10/0.5	6	30
SP2604QDB	TO-116	80	60	6	40/120	0.01/5	0.5	10/0.5	6	30
SP2604QF	TO-86	80	60	6	40/120	0.01/5	0.5	10/0.5	6	30
SP2605QD	TO-116	70	60	6	100/300	0.01/5	0.5	10/0.5	6	30
SP2605QDB	TO-116	70	60	6	100/300	0.01/5	0.5	10/0.5	6	30
SP2605QF	TO-86	70	60	6	100/300	0.01/5	0.5	10/0.5	6	30

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

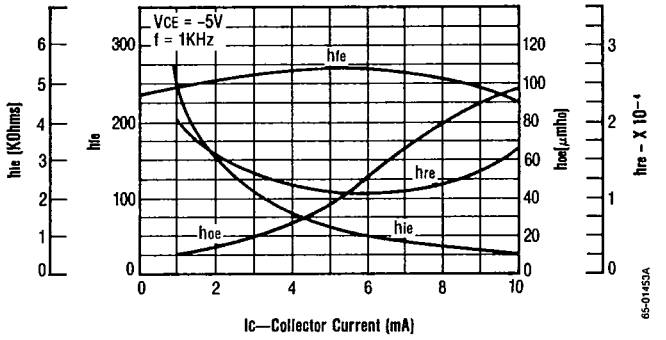
Typical Performance Characteristics



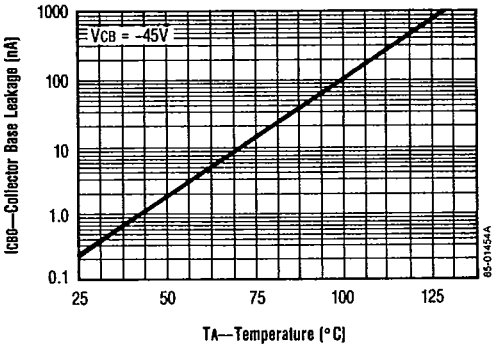
Low Level, Low Noise High Gain Amplifiers

Typical Performance Characteristics (Continued)

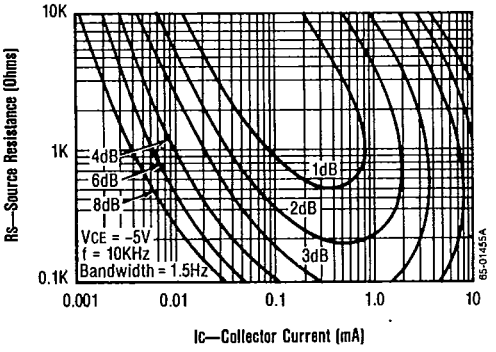
Common Emitter Small Signal Characteristics vs. Collector Current



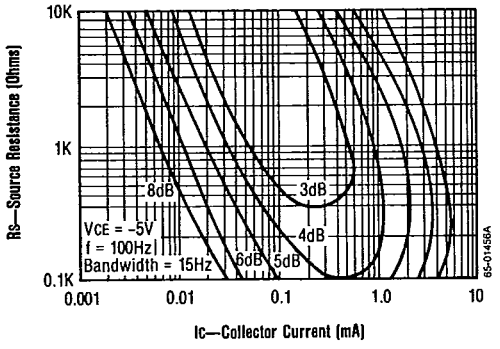
Collector-Base Leakage Current vs. Temperature



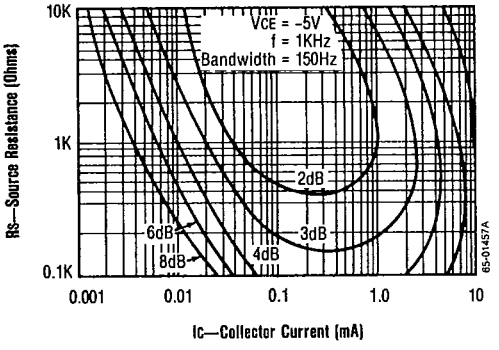
Contours of Constant Narrow Band Noise Figure



Contours of Constant Narrow Band Noise Figure



Contours of Constant Narrow Band Noise Figure



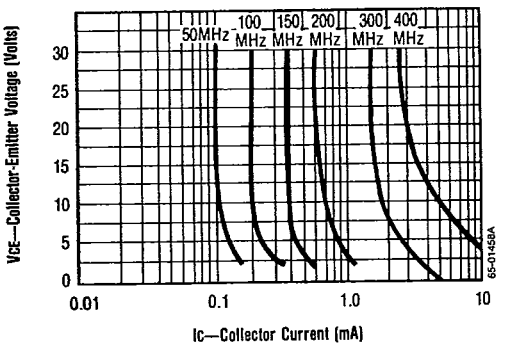
RAYTHEON

Low Level, Low Noise High Gain Amplifiers

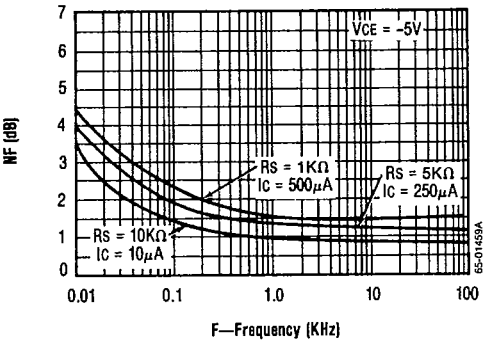
T-29-27

Typical Performance Characteristics (Continued)

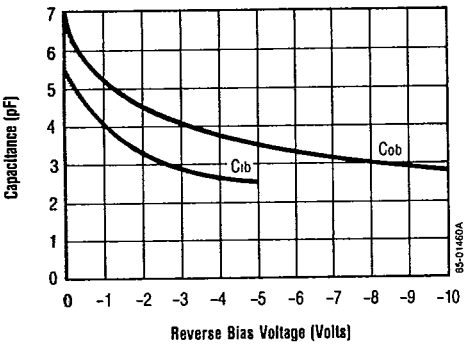
ft—Constant Gain Bandwidth Products Contours



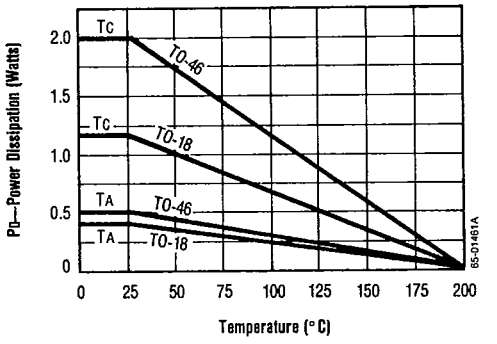
Noise Figure vs. Frequency



Output and Input Capacitance vs. Reverse Bias Voltage



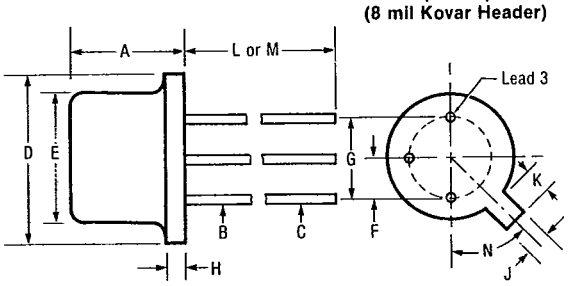
Power Derating Curves



Low Level, Low Noise High Gain Amplifiers

Packaging Information

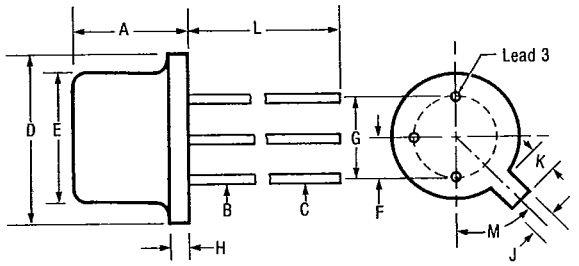
In accordance with JEDEC (TO-18) outline (8 mil Kovar Header)



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	

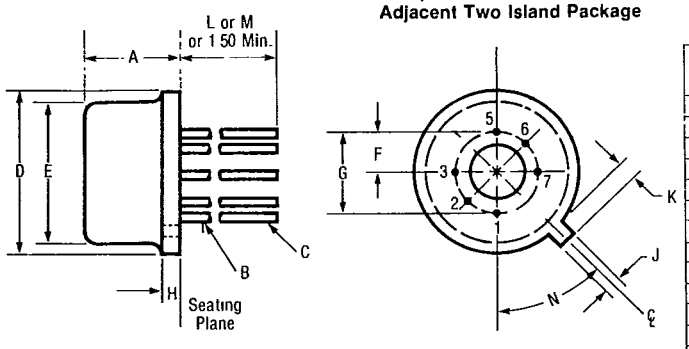
In accordance with JEDEC (TO-46) outline (45 mil Kovar Header)



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

Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	065	085	1 65	2 15
B	.012	.019	30	48
C	.012	.021	30	.53
D	209	.230	5 30	5 84
E	.178	.195	4.52	4 95
F	.050BSC		1 27BSC	
G	.100BSC		2.54BSC	
H		.040		1.02
J	036	046	.91	1.16
K	.028	048	.71	1 21
L	500		12.70	
M	45° BSC		45° BSC	

In accordance with JEDEC (TO-71) outline (8 mil Kovar Header) Adjacent Two Island Package



Notes: Lead No 3 internally connected to one island
Lead No 7 internally connected to other island
Kovar island thickness is 15 mils

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	

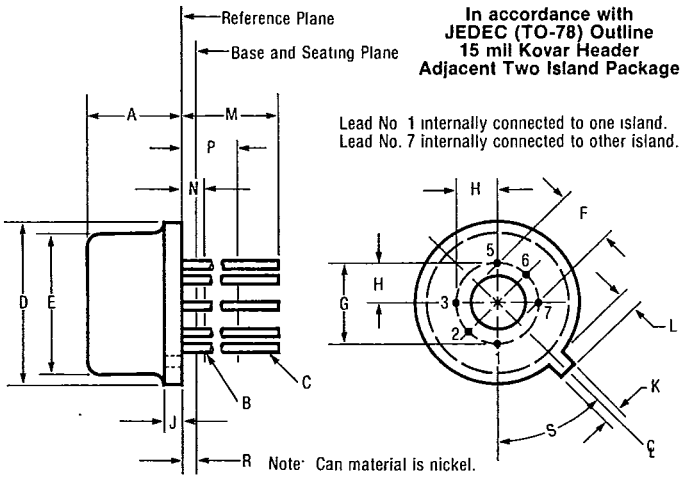
RAYTHEON

Low Level, Low Noise High Gain Amplifiers

T-29-27

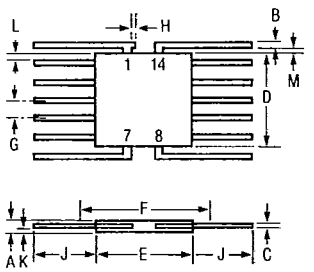
Packaging Information (Continued)

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



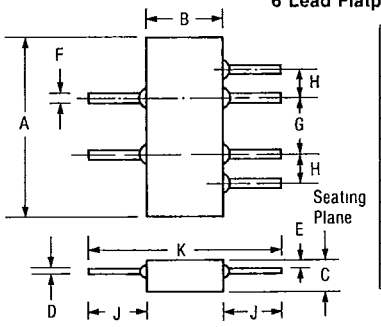
Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.165	0.185	4.19	4.70
B	0.016	0.019	0.41	0.48
C	0.016	0.021	0.41	0.53
D	0.335	0.370	8.51	9.40
E	0.305	0.335	7.75	8.51
F	0.120	0.160	3.05	4.06
G	0.200BSC		5.08BSC	
H	0.100BSC		2.54BSC	
J	0.009	0.041	0.23	1.04
K	0.028	0.034	0.71	0 86
L	0.029	0.045	0.74	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	

In accordance with JEDEC (TO-86) Outline 14 Lead Flatpak



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	

In accordance with JEDEC (TO-89) Outline 6 Lead Flatpak



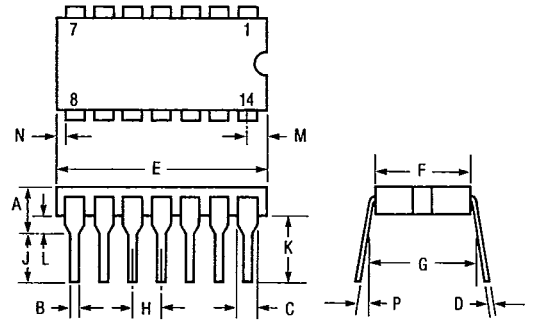
Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0 240	0 290	6.10	7.36
B	0 115	0.160	2 92	3 81
C	0.030	0 080	0.76	2.03
D	0.003	0 006	0 08	0.15
E	0.005	0 035	0 13	0 89
F	0 010	0.019	0 25	0 48
G	0.100BSC		2.54BSC	
H	0 050BSC		1 27BSC	
J	0 070	0 250	1.78	6 35
K	0 260	0 650	6 60	16 51

T-29-27

Low Level, Low Noise High Gain Amplifiers

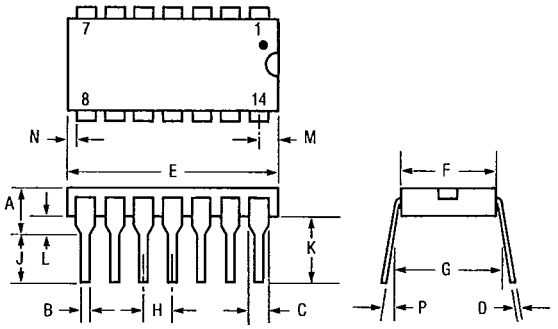
Packaging Information (Continued)

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



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°

In accordance with JEDEC (TO-116) Outline 14-Lead Plastic Dual-in-Line



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°

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8