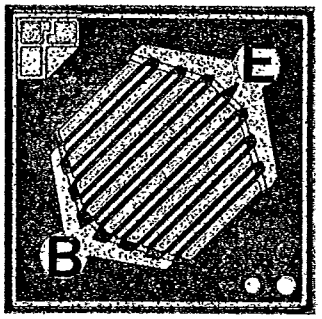
PRODUCT SPECIFICATIONS **SMALL SIGNAL TRANSISTORS**

T-35-17

RAYTHEON

High Current, High Speed Switches

CK NPN



Description

The CK is a gold doped transistor useful for high current, high speed switching and core driver applications. The PNP complement is the GK.

Dimensions

Die Size: 25 x 25 mils
Bonding Pad Size:
Base 4.2 mil Diameter
Emitter 4.2 mil Diameter

Popular Types

2N3724/A
2N3725/A
2N3735/JAN
2N3736
2N3737/JAN
2N4013
2N4014

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

Parameter	Conditions	2N4013, 2N3724			2N4014, 2N3725			Units
		Min	Typ	Max	Min	Typ	Max	
BV_{CEO}	I_C = 10mA, I_E = 0	30	-47		50	56		Volts
BV_{CES}	I_C = 10μA, V_{EB} = 0	50	125		80	135		Volts
BV_{EBO}	I_E = 10μA, I_C = 0	6	7.8		8	7.8		Volts
I_{CES}	V_{CE} = 50V, V_{EB} = 0		0.2	10				μA
I_{CES}	V_{CE} = 80V, V_{EB} = 0,					0.3	10	μA
H_{FE}	I_C = 10mA, V_{CE} = 1V	30	105		30	105		
H_{FE}	I_C = 100mA, V_{CE} = 1V	60	115	150	60	115	150	
H_{FE}	I_C = 100mA, V_{CE} = 1V, T_A = -55°C	30	70		30	70		
H_{FE}	I_C = 300mA, V_{CE} = 1V	40	95		40	90		
H_{FE}	I_C = 500mA, V_{CE} = 1V	35	65		35	60		
H_{FE}	I_C = 500mA, V_{CE} = 1V, T_A = -55°C	20	50		20	50		
H_{FE}	I_C = 800mA, V_{CE} = 2V	25	55		20	50		
H_{FE}	I_C = 1A, V_{CE} = 5V	30	65		25	60		
$V_{CE(SAT)}$	I_C = 10mA, I_B = 1mA		-0.14	-0.25		0.14	0.25	Volts
$V_{CE(SAT)}$	I_C = 100mA, I_B = 10mA		0.14	0.2		0.14	0.26	Volts
$V_{CE(SAT)}$	I_C = 300mA, I_B = 30mA		0.250	0.32		0.26	0.4	Volts
$V_{CE(SAT)}$	I_C = 500mA, I_B = 50mA		0.34	0.42		0.35	0.52	Volts
$V_{CE(SAT)}$	I_C = 800mA, I_B = 80mA		0.44	0.65		0.45	0.8	Volts
$V_{CE(SAT)}$	I_C = 1A, I_B = 100mA		0.55	0.75		0.6	0.95	Volts
$V_{BE(SAT)}$	I_C = 10mA, I_B = 1mA		0.67	0.76		0.67	0.76	Volts
$V_{BE(SAT)}$	I_C = 100mA, I_B = 10mA		0.77	0.86		0.77	0.86	Volts
$V_{BE(SAT)}$	I_C = 300mA, I_B = 30mA		0.86	1.1		0.86	1.1	Volts
$V_{BE(SAT)}$	I_C = 500mA, I_B = 50mA	0.8	0.92	1.1	0.8	0.92	1.1	Volts
$V_{BE(SAT)}$	I_C = 800mA, I_B = 80mA		1.0	1.5		1.0	1.5	Volts
$V_{BE(SAT)}$	I_C = 1A, I_B = 100mA		1.1	1.65		1.1	1.65	Volts
hfe	I_C = 50mA, V_{CE} = 10V, f = 100MHz	3	3.9		3	3.9		
ton	I_C = 500mA, I_{B1} = 50mA (see Fig. 1)		15	35		15	35	nS
toff	I_C = 500mA, I_{B1} = 50mA (see Fig. 1)		50	60		50	60	nS
Cob	I_E = 0, V_{CB} = 10V		3.5	12		3.5	10	pF
Cib	I_C = 0, V_{EB} = 0.5V		40	55		40	55	pF

High Current, High Speed Switches

CK Single Transistors

Product Type	Pkg.	Electrical Parameters @ 25°C Ambient Temperature							f_t	C_{ob}	t_{OFF}
		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	nS Max
2N3252	TO-5	60	30	5	30/-	150/1	0.3	150/15	200	12	70
2N3253	TO-5	75	40	5	25/-	150/1	0.35	150/15	175	12	70
2N3253J	TO-5	75	40	5	25/-	150/1	0.35	150/15	175	12	70
2N3444	TO-5	80	50	5	20/-	150/1	0.35	150/15	150	12	70
2N3444J	TO-5	80	50	5	20/-	150/1	0.35	150/15	175	12	70
2N3554	TO-5	60	30	5	25/-	100/1	0.7	750/75	150	25	105
2N3772	TO-5	80	60	6	40/150	100/1	0.22	100/10	300	10	100
2N3724	TO-5	50	30	6	60/150	100/1	0.2	100/10	300	12	60
2N3724A	TO-5	50	30	6	60/150	100/1	0.2	100/10	300	12	60
2N3725	TO-5	80	50	6	60/150	100/1	0.26	100/10	300	12	60
2N3725A	TO-5	80	50	6	60/150	100/1	0.26	100/10	300	12	60
2N3734	TO-5	50	30	5	40/-	150/1	0.3	150/15	300	9	60
2N2735	TO-5	75	50	5	40/-	150/1	0.3	150/15	250	9	60
2N3735J,TX,V	TO-5	75	50	5	40/-	150/1	0.3	150/15	250	9	60
2N3736	TO-46	50	30	5	40/-	150/1	0.3	150/15	300	9	60
2N3737	TO-46	75	50	5	40/-	150/1	0.3	150/15	250	9	60
2N3737J,TX,V	TO-46	75	50	5	40/-	150/1	0.3	150/15	250	9	60
2N3830	TO-5	80	50	5	30/-	150/1	0.3	150/15	200	12	70
2N3831	TO-5	70	40	5	35/-	150/1	0.3	150/15	200	12	70
2N4013	TO-18	50	30	6	60/150	100/1	0.2	100/10	300	12	60
2N4014	TO-18	80	50	6	60/150	100/1	0.26	100/10	300	10	60
2N4046	TO-5	50	30	6	40/150	100/1	0.2	100/10	250	12	60
2N4047	TO-5	80	50	6	40/150	100/1	0.26	100/10	250	10	60

CK Quad Transistors

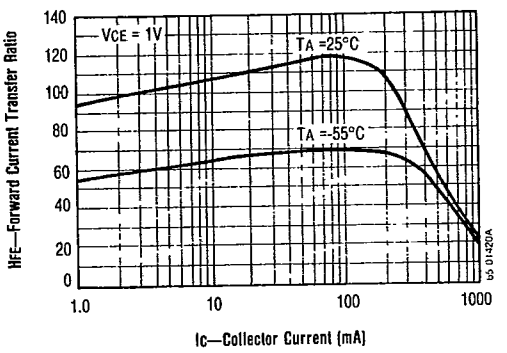
Product Type	Pkg.	Electrical Parameters @ 25°C Ambient Temperature							f_t	C_{ob}	t_{OFF}
		BV_{CBO} Min @ 10μA	BV_{CEO} Min @ 10mA	BV_{EBO} Min @ 10μA	H_{FE} @ I_C/V_{CE} Min/Max	mA/V	$V_{CE(SAT)}$ @ I_C/I_B Volts Max	mA/mA	MHz Min	pF Max	nS Max
SP3724QD	TO-116	50	30	6	60/150	100/1	0.2	100/10	300	12	60
SP3724QDB	TO-116	50	30	6	60/150	100/1	0.2	100/10	300	12	60
SP3724QF	TO-86	50	30	6	60/150	100/1	0.2	100/10	300	12	60
SP3725QD	TO-116	80	50	6.	60/150	100/1	0.26	100/10	300	12	60
SP3725QDB	TO-116	80	50	6	60/150	100/1	0.26	100/10	300	12	60
SP3725QF	TO-86	80	50	6	60/150	100/1	0.26	100/10	300	12	60

QD = QUAD DIP (CERAMIC); QDB = QUAD DIP (PLASTIC); QF = QUAD FLATPAK

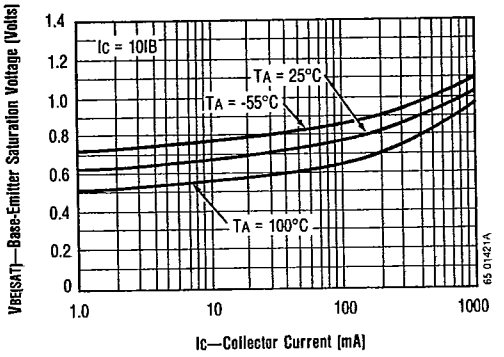
High Current, High Speed Switches

Typical Performance Characteristics

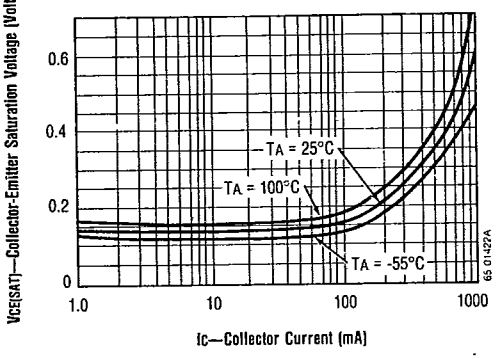
Forward Current Transfer Ratio vs. Collector Current



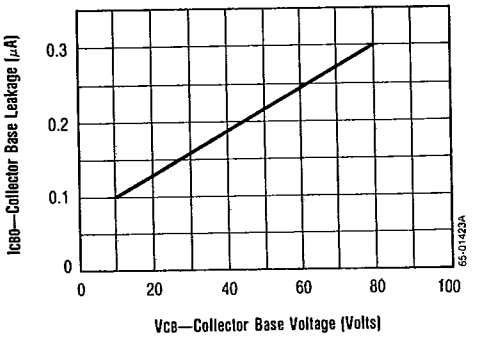
Base-Emitter Saturation Voltage vs. Collector Current



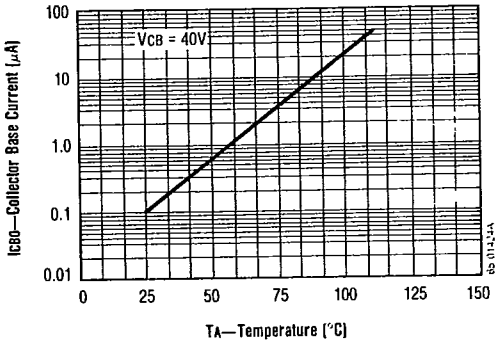
Collector-Emitter Saturation Voltage vs. Collector Current



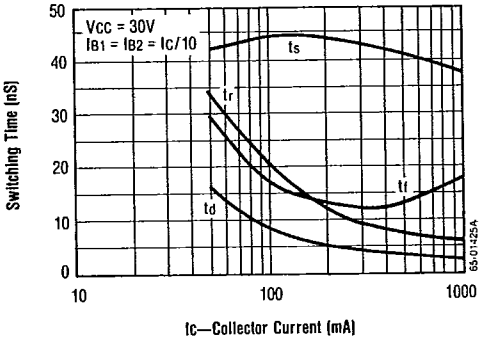
Collector Base Leakage Current vs. Reverse Bias Voltage



Collector Base Leakage Current vs. Temperature



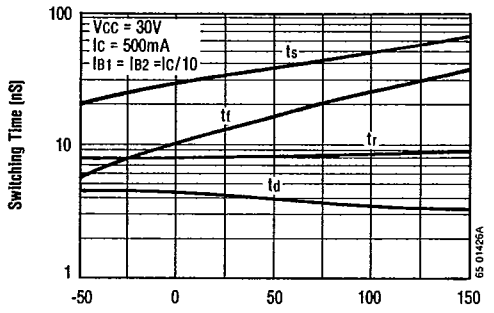
Switching Time vs. Collector Current



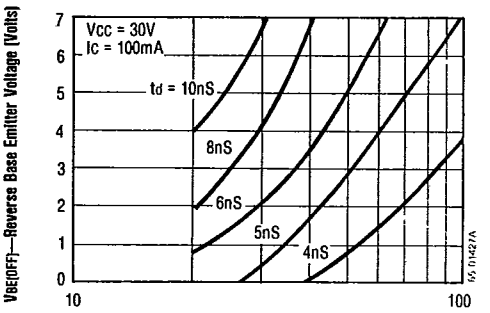
High Current, High Speed Switches

Typical Performance Characteristics (Continued)

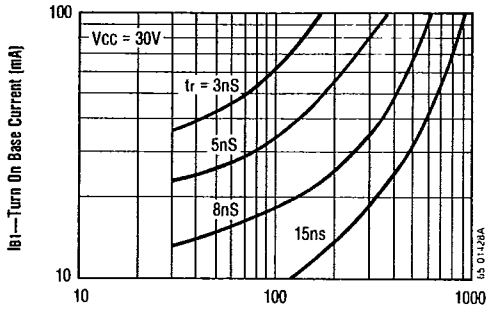
Switching Time vs. Ambient Temperature



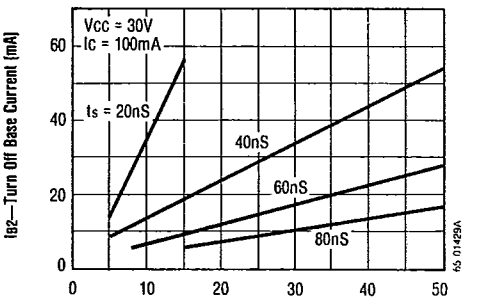
Delay Time vs. Turn On Base Current and Reverse Base Emitter Voltage



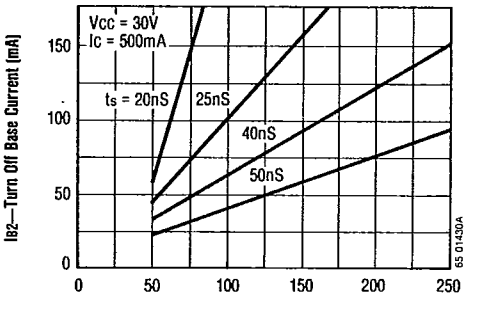
Rise Time vs. Collector and Turn On Base Currents



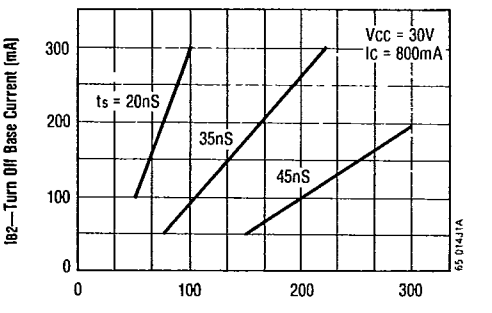
Storage time vs. Turn On and Turn Off Base Currents



Storage Time vs. Turn On and Turn Off Base Currents

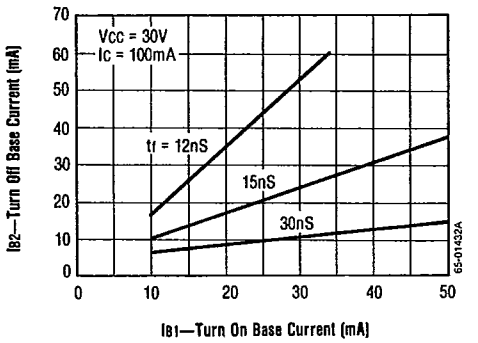


Storage Time vs. Turn On and Turn Off Base Currents

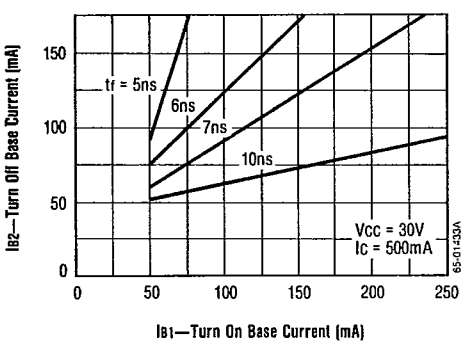


Typical Performance Characteristics (Continued)

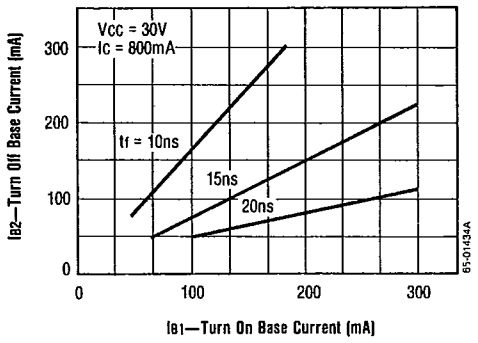
Fall Time vs. Turn On and Turn Off Base Currents



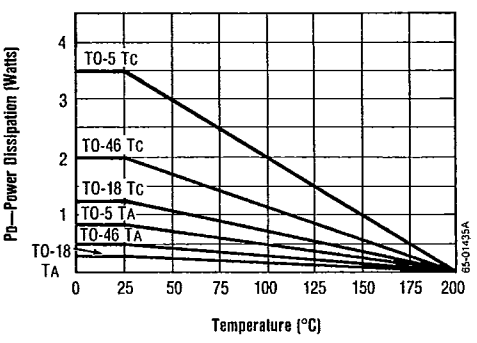
Fall Time vs. Turn On and Turn Off Base Currents



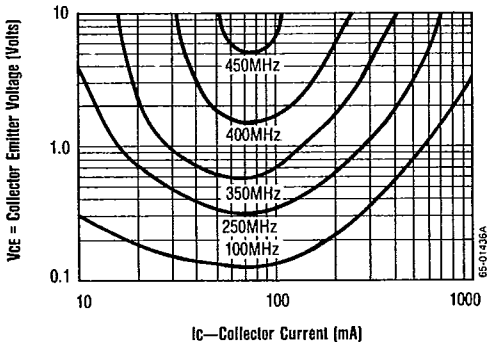
Fall Time vs. Turn On and Turn Off Base Currents



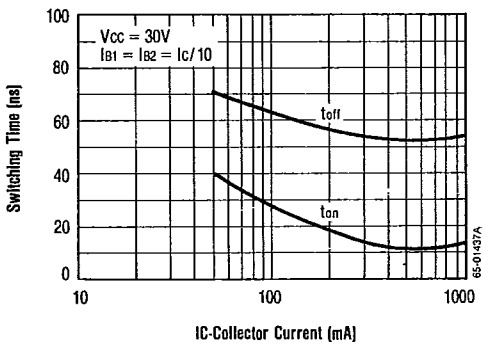
Power Derating Curves



ft—Constant Gain Bandwidth Products Contours

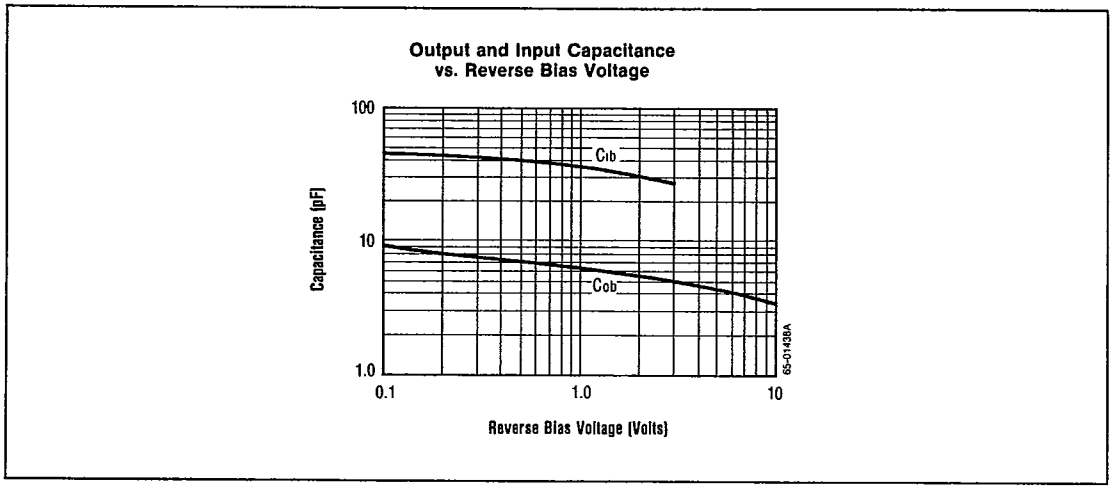


Turn-On and Turn-Off Times vs. Collector Current



High Current, High Speed Switches

Typical Performance Characteristics (Continued)



Switching Measurement Circuits

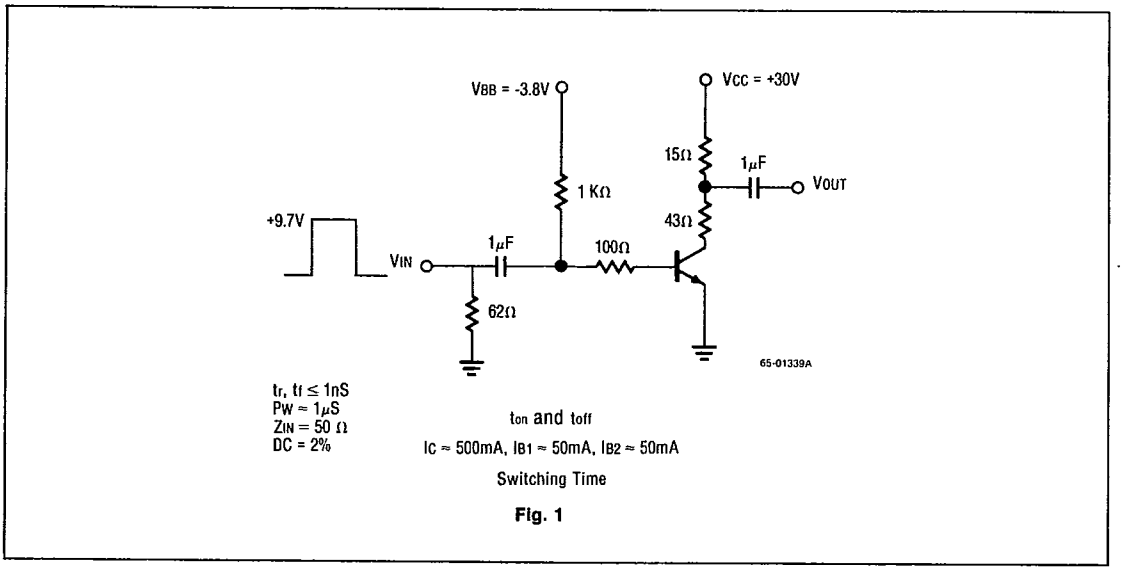


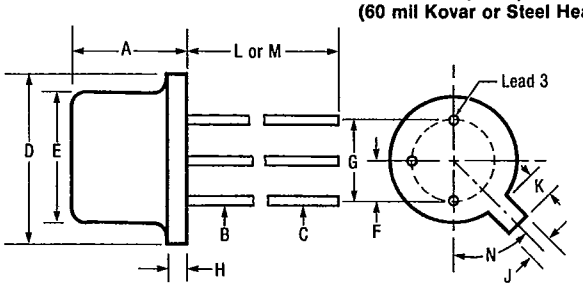
Fig. 1

RAYTHEON

High Current, High Speed Switches

Packaging Information

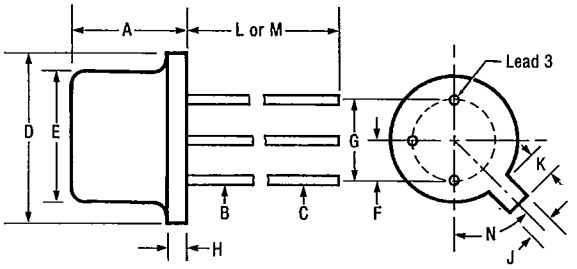
In accordance with JEDEC (TO-5) outline (60 mil Kovar or Steel Header)



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	

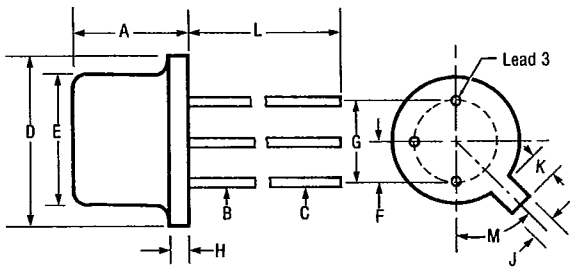
In accordance with JEDEC (TO-18) outline (8 mil Kovar Header)



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)



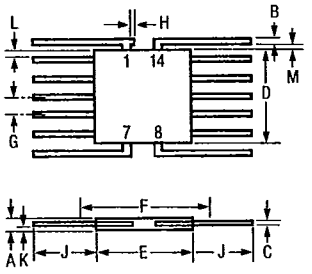
Notes: Lead No. 3 internally connected to case.
Can material is nickel.

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	

High Current, High Speed Switches

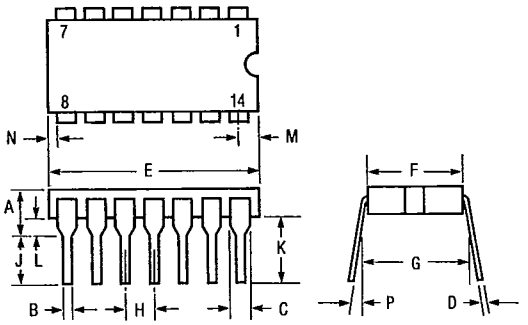
Packaging Information (Continued)

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



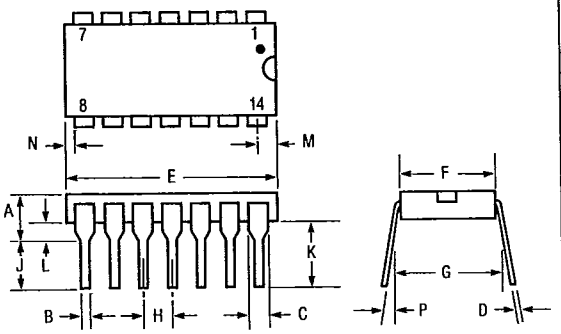
Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.030	0.070	0.76	1.77
B	0.010	0.019	0.25	0.48
C	0.003	0.006	0.08	0.15
D	0.240	0.275	6.10	6.98
E	0.240	0.260	6.10	6.60
F		0.290		7.37
G	0.050BSC		1.27BSC	
H	0.008	0.015	0.20	0 38
J	0.070		1.78	
K	0.005	0.035	0.13	0.89
L	0.005		0.13	
M	0.004		0.10	

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°

RAYTHEON