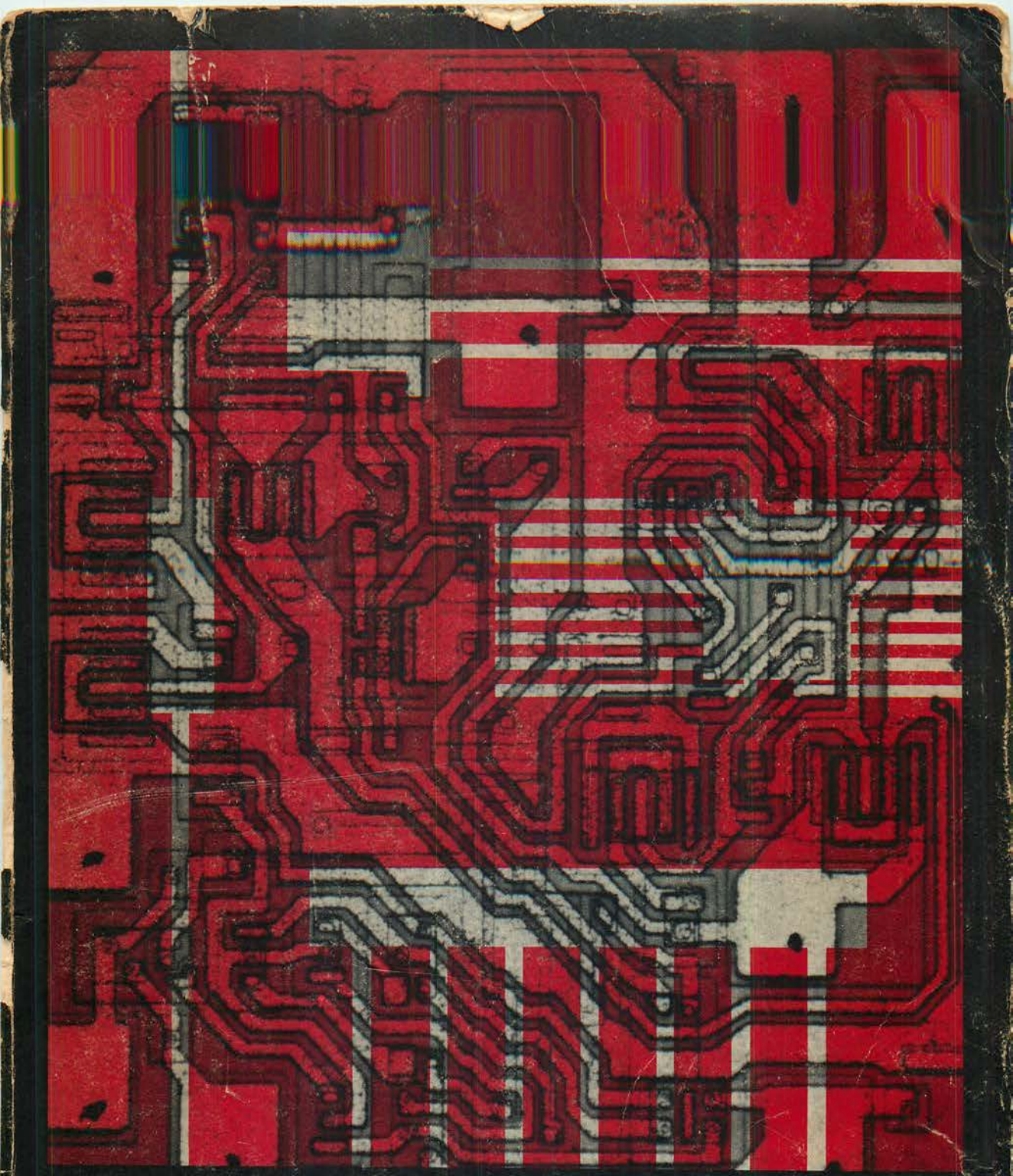


PRODUCT CATALOG 1972/1973

ITT
SEMICONDUCTORS

CONTENTS

725M72

Printed In U.S.A.

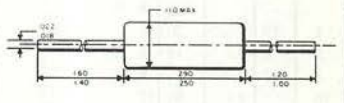
GOLD BOND GERMANIUM DIODES

HOW TO USE THIS BUYING GUIDE

Standard general purpose diodes are listed in numerical order below. Each diode has a line number referenced to the specification tables on pages 2, 3 and 4. Use this buying guide two ways: select the diode by type number, or locate the type number from the specification data.

ITT is the world's leading producer of diodes. Call your ITT sales engineer or distributor for quotation on all your diode needs.

Part No.	Line No.	Part No.	Line No.	Part No.	Line No.	Part No.	Line No.	Part No.	Line No.
1N34	107	1N87	37	1N198B	195	1N497	56	1N3125	69
1N34A	100	1N87A	38	1N265	180	1N498	116	1N3146	45
1N35	78	1N88	169	1N266	98	1N499	147	1N3287	2
1N38	201	1N89	189	1N267	41	1N500	158	1N3287W	3
1N38A	191	1N90	138	1N268	50	1N501	207	USN	
1N38B	192	1N95	140	1N270	166	1N502	219	1N3465	119
1N44	211	1N96	143	1N270JAN	167	1N527	11	1N3466	75
1N45	133	1N96A	111	1N273	55	1N541	76	1N3467	24
1N46	84	1N97	203	1N276	110	1N542	77	1N3468	25
1N47	212	1N98	206	1N276JAN	91	1N567	208	1N3469	63
1N48	172	1N98A	239	1N277	220	1N568	5	1N3470	64
1N49	85	1N99	202	1N277JAN	200	1N569	21	1N3483	9
1N50	86	1N100	205	1N278	108	1N571	20	1N3592	43
1N51	79	1N100A	156	1N279	58	1N616	32	1N3666	165
1N52	173	1N102	229	1N281	148	1N617	210	1N3666M	161
1N52A	171	1N103	15	1N283	47	1N618	213	USN	
1N54	60	1N104	16	1N287	109	1N631	186	1N3666M1	162
1N54A	87	1N107	14	1N288	177	1N632	184	USN	
1N55	234	1N108	93	1N289	175	1N633	222	1N3666M2	163
1N55A	235	1N111	129	1N290	215	1N634	214	USN	
1N55B	238	1N112	130	1N291	217	1N635	236	1N3769	185
1N56	51	1N113	122	1N292	149	1N636	97	1N3773	40
1N56A	72	1N114	123	1N294	126	1N695	34	1N4523	27
1N57	153	1N115	124	1N294A	127	1N695A	42	1N4524	12
1N58	199	1N116	137	1N297	151	1N770	31	G158	26
1N58A	197	1N117	139	1N297A	152	1N771	157	G159	62
1N60	88	1N118	142	1N298	131	1N771A	164	G198	46
1N60A	68	1N118A	146	1N298A	52	1N771B	168	G199	36
1N61	233	1N119	103	1N314	141	1N772	159	G200	29
1N62	209	1N120	105	1N355	193	1N772A	132	G766	35
1N63	227	1N126	136	1N367	23	1N773	120	G788	96
1N63A	196	1N126A	145	1N417	99	1N773A	121	G790	28
1N65	170	1N127	226	1N418	106	1N774	114	G814	19
1N66	101	1N127A	230	1N419	160	1N774A	118	G815	59
1N66A	102	1N128	82	1N447	144	1N775	115	G816	13
1N67	154	1N128A	83	1N448	216	1N776	33	G819	187
1N67A	190	1N133	1	1N449	92	1N777	117	G820	112
1N68	188	1N139	90	1N450	218	1N781	70	G821	65
1N68A	232	1N140	176	1N451	237	1N781A	71	G822	49
1N69	135	1N141	174	1N452	94	1N805	67	G823	39
1N69A	134	1N142	228	1N453	221	1N909	113	G824	30
1N70	224	1N143	231	1N454	150	1N910	74	G825	17
1N70A	225	1N144	57	1N455	95	1N911	54	G844	48
1N71	73	1N145	53	1N476	178	1N933	204	G846	61
1N75	223	1N191	182	1N477	179	1N946	89	G847	10
1N81	20	1N192	128	1N478	198	1N994	8	G868	4
1N81A	81	1N195	66	1N479	181	1N995	22	G869	6
1N84	18	1N198	155	1N480	104	1N996	44		
1N86	125	1N198A	194	1N490	183	1N3110	7		



DIMENSIONS DO-7 (Standard)

MECHANICAL DATA

Case:
Hermetically sealed glass

Finish:
All external surfaces corrosion resistant and leads readily solderable

Leads:
Dumet, tin plated

Weight:
0.135 grams (approx.)

Mounting Position:
Any

Marking:
Diodes carry ITT identification, and are EIA Color Coded. Bands 1, 2, 3 and 4 on the illustration above indicate the first, second, third and fourth digit respectively of the type designation, starting from the cathode end of the diode.

Black.....0	Green.....5
Brown.....1	Blue.....6
Red.....2	Violet.....7
Orange.....3	Gray.....8
Yellow.....4	White.....9

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

PIV	I_F mA	@ V	I_R µA	@ V	Reverse Recovery Time I_FmA	V_R	Rec.to	nsec	Part No.	Line No.
5	3	0.5	300	0.6					1N133	1
6	1	0.3	15	2					1N3287	2
6	100	1	15	2					1N3287W USN	3
6	100	1	15	2					G868	4
7	5	0.32	100	5					1N568	5
7	10	0.5	5	2					G869	6
8	5	0.45	20	8					1N3110	7
			100	8@65°C						
8	10	1	30	6	10	−6	3mA		1N4	8
8	10	0.6	10	3					[illegible]3	9
9	50	0.9	10	5	10		3mA	8	G847	10
10	1	0.3	50	10					1N527	11
10	10	0.65	12	6	10	−6		3	1N4524	12
10	10	0.65	12	6	10		10mA	3	G816	13
10	150	1	200	10					1N107	14
12	30	1	100	5					1N103	15
12	30	1	100	5					1N104	16
12	50	0.7	6	5	10		3mA	6	G825	17
12	60	1	100	5					1N84	18
12	100	0.85	15	5					G814	19
12	200	1	100	10@55°C	100	−5	10kΩ	4	1N571	20
12	250	0.5	50	10					1N569	21
15	10	0.5	10	6	10	−6	3mA	6	1N995	22
15	20	1							1N367	23
15	20	0.5	15	10	10	−6	1Ω	2	1N3467	24
15	20	0.5	60	10	10	−6	1Ω	2	1N3468	25
15	25	0.5	40	15	10	−6	1Ω	2	G158	26
15	100	1	30	10	10	−6		8	1N4523	27
15	100	1	30	10	10		1mA	8	G790	28
15	100	0.65	20	10	2			40	G200	29
18	50	0.76	8	5	2		0V	100	G824	30
20	5	0.42	40	10	5	−10	15[1]	350	1N770	31
20	8	1	400	20					1N616	32
20	50	1	200	10					1N776	33
			500	30						
20	100	1	2	10	5	−20	25kΩ	300	1N695	34
			20	10@70°C						
20	100	0.85	25	10	10		1	50	G766	35
20	100	0.7	10	10	2			50	G199	36
22.5	0.1	0.25	30	1.5					1N87	37
22.5	0.1	0.25			(subminiature 1N87)				1N87A	38
24	50	0.65	5	5	2	[2]	0V	80	G823	39
25	2	0.35	4	3	2	2mA	0V	40	1N3773	40
25	3.5	1	12	10					1N267	41
25	10	1	2	10			0.2mA[3]	300	1N695A	42
			20	10@70°C						
25	15	0.5	4	4.5	2	0.2mA[2]		40	1N3592	43
25	40	0.8	15	5	5	−10	0.5mA	300	1N996	44
25	50	1	100	20	10	−6	3kΩ	2	1N3146	45
25	100	0.75	5	10	2			60	G198	46
25	200	1	20	10					1N283	47
25	300	1	20	6					G844	48
27	50	0.7	6	5	2		0V	350	G822	49
30	2.5	1	20	10					1N268	50
30	15	1	300	30					1N56	51
30	30	2	250	40					1N298A	52
30	40	1	100	10					1N145	53
30	100	1	10	10					1N911	54
30	100	1	20	20					1N273	55
30	100	1	20	20					1N497	56
30	100	1	200	100					1N144	57
30	100	1	200	20					1N279	58
30	100	0.85	30	20					G815	59
35	5	1	10	10					1N54	60
			100	50						
35	100	1	10	10	10		1mA	150	G846	61
35	600	1	60	20					G159	62
35	600	0.5	15	20					1N3469	63
35	600	0.5	30	20					1N3470	64
36	50	0.62	4	5	2		0V	250	G821	65
40	2	2	10	40				300	1N195	66
40	3	1	100	10					1N805	67
40	4	1	60	10					1N60A	68
40	5	0.4	100	40					1N3125	69
			125	20@71°C						
40	10	0.45	5	10	10	−10	0.1mA	500	1N781	70
			60	10@65°C						
40	10	0.45	5	10	10	−10	100µA	500	1N781A	71
			60	10@65°C						
40	15	1	300	30					1N56A	72
40	15	1	300	30					1N71	73
40	100	1	10	10					1N910	74
40	200	1	15	30					1N3466	75
45	10	2.2	18	10					1N541	76
			150	30						
45	10	2.2	18	10	(matched pair 1N541)				1N542	77
			150	30						
50			200	50	(matched pair)				1N35	78
50	2.5	1	1600	50					1N51	79
50	3	1	10	10					1N81	80
50	3	1	10	10					1N81A	81
50	3	1	10	10					1N128	82
50	3	1	10	10					1N128A	83
50	3	1	1500	50					1N46	84
50	4	1	200	20					1N49	85
50	4	1	80	20					1N50	86
50	5	1	7	10					1N54A	87
			100	50						
50	5	1	40	20					1N60	88
50	10	0.34	10	10					1N949	89
			50	10@55°C						
50	20	1	1500	50					1N139	90
50	40	1	20	10	5	−40		300	1N276JAN	91
			100	10@75°C						
50	50	1	30	30					1N449	92
50	50	1	200	50					1N108	93
50	100	1	30	30					1N452	94
50	300	1	30	30					1N455	95
55	150	1	5	10					G788	96
60	2.5	1	10	10					1N636	97
60	4	1	75	30					1N266	98
60	5	3.54			5	−40		300	1N417	99
60	5	1	30	10					1N34A	100
			500	50						

NOTES: 1. Modified IBM Test Circuit 2. I_R 3. JAN Test Circuit 4. @+55°C

PIV	I_F mA	@ V	I_R μA	@ V	Reverse Recovery Time I_FmA	V_R	Rec.to	nsec	Part No.	Line No.
60	5	1	50	10					1N66	101
			800	50						
60	5	1	50	10					1N66A	102
60	5	1	125	50@55°C	30	−35	50kΩ	500	1N119	103
60	5	1	125	50@55°C	(solder-in 1N119)				1N480	104
60	5	1	250	50@55°C	30	−35	50kΩ	500	1N120	105
60	7	1			5	−40	2kΩ	300	1N418	106
60	8.5	1	15	10					1N34	107
			800	50						
60	20	1	125	50@75°C					1N278	108
60	20	1	1500	50					1N287	109
60	40	1	100	50					1N276	110
			100	10@75°C						
60	40	1	500	50					1N96A	111
60	50	0.7	6	5					G820	112
60	100	1	10	10					1N909	113
60	100	1	15	10					1N774	114
			150	50						
60	100	1	20	10					1N775	115
			250	50						
60	100	1	25	40					1N498	116
60	100	1	25	10	30	−40	400Ω[1]		1N777	117
			125	50@55°C						
60	200	1	15	10					1N774A	118
			150	50						
60	200	1	20	45					1N3465	119
65	100	1	10	10					1N773	120
			100	50						
65	200	1	10	10					1N773A	121
			100	50						
70[3]	2.5	1	25	10@55°C					1N113	122
			125	50@55°C						
70[3]	2.5	1	50	10@55°C					1N114	123
			250	50@55°C						
70[3]	2.5	1	100	10@55°C					1N115	124
			500	50@55°C						
70	4	1	50	10					1N86	125
			833	50						
70	5	1	10	10					1N294	126
			800	50						
70	5	1	10	10					1N294A	127
70	5	1	20	10	30	−35	50kΩ	500	1N192	128
			50	70@50°C						
70[4]	5	1	25	10@55°C					1N111	129
			125	50@55°C						
70[4]	5	1	50	10@55°C					1N112	130
			250	50@55°C						
70	30	2	250	40					1N298	131
70	200	1	50	50					1N772A	132
75	3	1	410	50					1N45	133
75	5	1	30	10					1N69A	134
			500	50						
75	5	1	50	10					1N69	135
			850	50						
75	5	1	50	10					1N126	136
			800	50						
75	5	1	100	50					1N116	137
75	5	1	800	50					1N90	138

PIV	I_F mA	@ V	I_R μA	@ V	Reverse Recovery Time I_FmA	V_R	Rec.to	nsec	Part No.	Line No.
75	10	1	100	50					1N117	139
75	10	1	800	50					1N95	140
75	15	1	50	10					1N314	141
75	20	1	100	50					1N118	142
75	20	1	800	50					1N96	143
75	25	1	20	10					1N447	144
			60	30						
75	25	1	50	10					1N126A	145
			850	50						
75	40	1	100	50					1N118A	146
75	100	1	30	50					1N499	147
75	100	1	30	10	5	−40		300	1N281	148
			500	50						
75	100	1	200	50					1N292	149
75	200	1	50	50					1N454	150
80	3.5	1	10	5					1N297	151
			100	50						
80	3.5	1	10	5					1N297A	152
			100	50						
80	3.6	1	300	75					1N57	153
80	4	1	5	5					1N67	154
80	4	1	10	10					1N198	155
			250	50@75°C						
80	40	1	50	50					1N100A	156
80	100	1	25	50					1N771	157
80	100	1	40	60					1N500	158
80	100	1	50	50					1N772	159
80	125	1	180	90	5	−40		300	1N419	160
80	200	1	10	20	30	−10		300	1N3666M USN	161
			150	20@70°C						
80	200	1	10	20	30	−10		300	1N3666M1 USN	162
			150	20@70°C						
80	200	1	10	20	30	−10		300	1N3666M2 USN	163
			150	20@70°C						
80	200	1	25	50					1N771A	164
80	200	1	25	50	30	−10	500μA	300	1N3666	165
80	200	1	100	50	5	−40		300	1N270	166
80	200	1	100	50					1N270JAN	167
			75	10@75°C						
80	400	1	25	50					1N771B	168
85	2.5	1	100	50					1N88	169
85	2.5	1	200	50					1N65	170
85	4	1	150	50					1N52A	171
85	4	1	833	50					1N48	172
85	5	1	150	50					1N52	173
85	20	1	50	50					1N141	174
85	20	1	50	50					1N289	175
85	40	1	300	50					1N140	176
85	40	1	350	50					1N288	177
90	2.5	1	11	10					1N476	178
			60	10@60°C						
90	2.5	1	11	10					1N477	179
			60	10@60°C						
90	3.2	1	100	60					1N265	180
90	5	1	7	10					1N479	181
90	5	1	25	10	30	−35	50kΩ	500	1N191	182
			125	50@55°C						
90	5	1	250	50@55°C	(solder-in 1N120)				1N490	183

NOTES: 1. Modified IBM Test Circuit 2. I_R 3. JAN Test Circuit 4. @+55°C

ELECTRICAL CHARACTERISTICS, continued

PIV	I_F mA @ V		I_R μA @ V		Reverse Recovery Time I_FmA	V_R	Rec.to	nsec	Part No.	Line No.
90	7	1	120	60	5	−40	0.5mA	300	1N632	184
90	25	0.5	5	5					1N3769	185
			20	65						
90	50	3.5	120	60	5	−40	0.5mA	300	1N631	186
90	50	0.62	4	5					G819	187
100	3	1	625	100					1N68	188
100	3.5	1	8	5					1N89	189
100	4	1	5	5					1N67A	190
			50	50						
100	4	1	6	3					1N38A	191
			500	100						
100	4	1	6	3					1N38B	192
			500	100						
100	4	1	10	10					1N355	193
			50	50						
100	4	1	10	10					1N198A	194
			75	10@75°C						
100	4	1	50	50	2	−6	50k	300	1N198B	195
			250	50@75°C						
100	4	1	50	50					1N63A	196
100	4	1	600	100					1N58A	197
100	5	1	7	10					1N478	198
100	5	1	800	100					1N58	199
100	5	0.5	10	10					1N277JAN	200
			250	50@75°C						
100	7.5	1	25	10					1N38	201
100	10	1	50	50					1N99	202
100	10	1	100	50					1N97	203
100	14	1	10	10	5	−40	0.5mA[3]	400	1N933	204
			75	10@75°C						
100	20	1	5	50					1N100	205
100	20	1	100	50					1N98	206
100	100	1	40	80					1N501	207
100	150	1	150	100					1N567	208
110	5	1	700	125					1N62	209
115	3	1	11	10					1N617	210
			35	75@60°C						

NOTES: 1. Modified IBM Test Circuit 2. I_R 3. JAN Test Circuit 4. @+55°C

PIV	I_F mA @ V		I_R μA @ V		Reverse Recovery Time I_FmA	V_R	Rec.to	nsec	Part No.	Li N
115	3	1	410	50					1N44	2
115	5	1	4	3					1N47	2
			400	50						
115	5	1	70	10					1N618	2
115	50	1	45	45					1N634	2
			100	100						
120	5	1	100	100					1N290	2
120	25	1	30	30					1N448	2
120	40	1	100	100					1N291	2
120	50	1	30	30					1N450	2
			100	100						
120	100	1	50	100					1N502	2
120	100	1	75	10@75°C					1N277	2
120	100	1	100	100					1N453	2
120	125	1	180	90	5	−40	0.5mA[3]	300	1N633	2
125	2.5	1	50	50					1N75	2
125	3	1	25	10					1N70	2
			300	50						
125	3	1	25	10					1N70A	2
			300	50						
125	3	1	25	10					1N127	2
			300	50						
125	4	1	50	50					1N63	2
125	5	1	100	100					1N142	2
125	15	1	3	25					1N102	2
125	25	1	25	10					1N127A	2
			300	50						
125	40	1	100	100					1N143	2
130	3	1	625	100					1N68A	2
130	5	1	300	100					1N61	2
			700	125						
150	3	1	800	150					1N55	2
150	4	1	500	150					1N55A	2
165	50	1	175	150					1N635	2
170	50	1	150	150					1N451	2
190	5	1	500	150					1N55B	2
250	40	1	100	50					1N98A	2

INTRODUCTION

ITT has a wide selection of planar transistor chips and wafers available for those who require devices in this form. Since the large number of JEDEC specifications are derived from a few chip types, many differing applications can be satisfied with a relatively small quantity of basic chip families.

SPECIFICATIONS

The accompanying DC parameters identifying each family are tested on each chip in the wafer. These are the probe specifications. As shipped from our factory, THE PROBE PARAMETERS ARE GUARANTEED TO AN AQL = 2.5%.

The design parameters such as $V_{CE(SAT)}$, t_{on}, t_{off}, C_{ob}, etc. are not probed. These characteristics can best be tested after the chip is suitably mounted; and, therefore, have little significance in chip form.

The chips will have a high yield to the specified limits. The actual yield will vary with the mechanical techniques used to assemble the device, and the type of package used.

In all cases, the lowest useable voltage and the lowest useable h_{FE} should be chosen in specifying chip parameters. This will provide the highest possible yield and the most economical design.

USE

The entire wafer is manufactured with approximately 3000 A° of gold for die attach to a suitable substrate or base. Recommended die attach temperature for all families is 450°C, maximum. 9,000 to 12,000 angstroms of aluminum are deposited on the chip for metalization purposes. ITT recommends aluminum wire for connection to the aluminum base and emitter bonding pads. Ultrasonic techniques may be used for the wire-bond operation.

PACKAGING FOR SHIPMENT

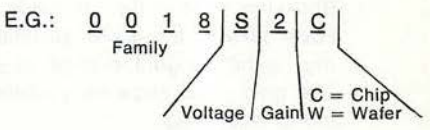
Chips will be shipped in appropriate containers, with the devices packaged to protect them from damage in shipment. Wafers will be shipped in a similar manner. Unless otherwise specified, wafers will not be scribed prior to shipment.

CROSS REFERENCE CHART

The list of JEDEC specifications, together with the respective chip specification, will provide a means of ordering the proper chip required in an application. This chart is not exhaustive, and is provided as a guide. Specific requirements may necessitate a different chip specification from available JEDEC "2N" numbers. In such cases, the accompanying list of chip parameters will provide the necessary information.

ORDERING

All chips and wafers should be ordered according to the alpha-numeric coding system referred to in the specification chart. The four-digit geometry family, together with the voltage letter and DC gain number (from the accompanying geometry parameter chart) will completely determine the specification which ITT will provide. A third letter specifies in which form, chip or wafer, the product is to be shipped.



IDENTIFICATION

All small-signal transistor dice will be identified by the appropriate four-digit family number together with the particular classification code for voltage and current gain.

By way of example:

The 2N2222 is a "0018" chip. The voltage class is "M," the current gain is "A." Therefore, when ordering a 2N2222 in chip or wafer form, the correct part would be a "0018MA" chip. This method applies to dice and to a wafer which has been tested 100%.

If a wafer is needed which does not require all the chips to be tested, then the alpha-numeric suffix will apply. For a 2N2222 device, in wafer form, sample probe-tested only, the proper part number will be a "0018S1."

TRANSISTOR WAFER INSPECTION CRITERIA

MECHANICAL INSPECTION

Measure overall thickness of one (1) wafer if run contains five (5) or less wafers. Measure two (2) wafers if run size is greater than six (6) wafers. Reject the run if any of the measured wafers are not per limits specified in Table I.

Q.C. will 100% measure overall thickness of each wafer in a rejected run.

VISUAL INSPECTION

Inspect ten (10) randomly selected devices on each wafer with no more than three (3) die in any one quadrent using 100X magnification.

TABLE I

UNAIDED EYE INSPECTION

1. Backside gold — the backside gold must cover 90% of the wafer surface. The gold must exhibit a gold, orange, or yellow cast. The gold must show no evidence of peeling or blistering.

MECHANICAL INSPECTION

1. The wafer thickness must be per the following:

   1250 2.6—3.2 mils (67-82 microns)—1½" wafer
   1243
   1718 4.0—4.6 mils (117-133 microns)—2" wafer 1250, 1243
   0016
   1211
   1312
   1913
   All others 4.6—5.2 mils (117-133 microns)

Microscope Inspection (100X) — Combined 1.0% AQL

1. Aluminum bridging—the base metal, emitter metal, and EQR ring metal may not be connected or bridged by unetched or smeared aluminum.
2. Aluminum adherance—the aluminum may show no evidence of peeling, blistering, or flaking.
3. Aluminum color — the aluminum may not be dark brown or black.
4. Aluminum reduction — aluminum fingers must be continuous along 75% of the oxide cutout length nearest the bond pad on metal over oxide devices. Aluminum fingers may not be reduced more than 50% of the oxide cutout width on metal over oxide devices, nor more than 25% in width at an oxide step-down point. Bond pads must not be reduced more than 25% of their intended area. EQR rings may not be discontinuous at more than one place.
5. Oxide holes—silicon may not be exposed within .0002 in. of any junction.
6. Mask misalignment — the outline of one oxide mask definition may not cross over the outline of another mask definition. Aluminum mask outlines must cover more than 50% of the intended oxide cutouts.

TRANSISTOR DIE INSPECTION CRITERIA

Inspect per Table II using 100X to combined 2.5% AQL.

TABLE II

1. Broken die — broken corners, edges, or shell chips may not extend closer than .001" to a junction or bond pad.
2. Cracks—cracks which are not terminated at each end at the periphery of the die may not extend toward a junction or bond pad.

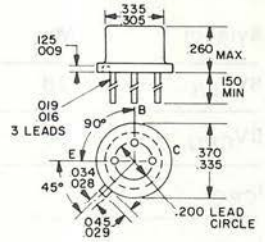
GENERAL PURPOSE NPN SILICON PLANAR EPITAXIAL TRANSISTOR

For Improved Performance See ITT 2N2217.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage	35	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature.. 2N697	200	°C
Operating Junction Temperature.. 2N696	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	2.0	Watts
P_D @ T_A = 25°C	0.6	Watt

DIMENSIONS



TO-5

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	60		Vdc	I_C=100μA
LV_{CER}	40		Vdc	I_C=30mA, R_{BE}=10Ω pulsed
BV_{EBO}	5		Vdc	I_E=100μA
h_{FE} 2N697	40	120		I_C=150mA, V_{CE}=10V pulsed
h_{FE} 2N696	20	60		I_C=150mA, V_{CE}=10V pulsed
V_{CE}(sat)		1.5	Vdc	I_C=150mA, I_B=15mA pulsed
V_{BE}(sat)		1.3	Vdc	I_C=150mA, I_B=15mA pulsed
I_{CBO}		1.0	μA	V_{CB}=30V
I_{CBO}		100	μA	V_{CB}=30V, T_A=+150°C
C_{ob}		35	pF	V_{CB}=10V
h_{fe}	2			I_C=50mA, V_{CE}=10V, f=20MHz

NOTES: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

2N707

NPN SILICON EPITAXIAL TRANSISTOR

Package: TO-18

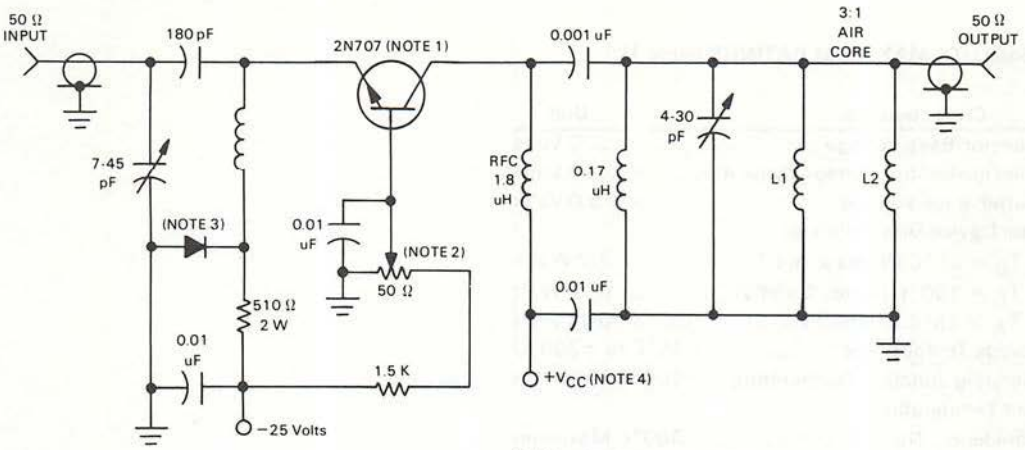
ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	
$R_{BE} \leq 10$ ohms	28 Volts
Collector-Base Voltage	56 Volts
Emitter-Base Voltage	4 Volts
Total Device Dissipation @ $T_A = 25°C$	0.3 Watt
Derate above 25°C	2 mW/°C
Total Device Dissipation @ $T_C = 25°C$	1.0 Watt
Derate above 25°C	6.67 mW/°C
Operating and Storage Junction Temperature Range	−65 to +175°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CER}	28	–	–	Volts	$I_C = 10$ mA, $R_{BE} = 10$ ohms
BV_{CBO}	56	–	–	Volts	$I_C = 10\ \mu A$, $I_E = 0$
I_{CBO}	–	0.005	5.0	μA	$V_{CB} = 15$ Volts, $I_E = 0$
I_{CBO}	–	3.0	–	μA	$V_{CB} = 15$ Volts, $I_E = 0$, $T_A = 150°C$
I_{EBO}	–	–	10	μA	$V_{BE} = 4$ Volts, $I_C = 0$
h_{FE}	9	12	–	–	$I_C = 10$ mA, $V_{CE} = 1$ Volt
$V_{CE(sat)}$	–	0.18	0.6	Volt	$I_C = 10$ mA, $I_B = 1$ mA
$V_{BE(sat)}$	–	0.75	0.9	Volt	$I_C = 10$ mA, $I_B = 1$ mA
f_T	70	350	–	MHz	$I_E = 15$ mA, $V_{CE} = 10$ Volts
f_{max}	–	600	–	MHz	Maximum Frequency of Oscillation
C_{ob}	–	4.0	10.0	pF	$V_{CB} = 10$ Volts, $I_E = 0$
$r_b'C_c$	–	80	–	ps	$I_C = 10$ mA, $V_{CB} = 10$ Volts, $f = 4$ MHz
P_{out}	200	300	–	mW	$V_{CE} = 20$ Volts, $P_{in} = 50$ mW
n	–	38	–	%	$V_{CE} = 28$ Volts, $I_C = 40$ mA

SCHEMATIC



L1 5 TURNS NO. 14 WIRE WOUND ON 1/2 IN DIAMETER
L2 2 TURNS NO. 14 WIRE WOUND ON L1.

NOTE 1 HEAT SINK IS REQUIRED.
NOTE 2 ADJUCT FOR CLASS C OPERATION.
NOTE 3 VERY HIGH CONDUCTANCE SILICON DIODE.
NOTE 4 ADJUST V_{CC} FOR PROPER V_{CE}

FIGURE 1 — 100 MHz, CLASS C, COMMON BASE AMPLIFIER

2N915 Ⓕ

NPN SILICON HIGH FREQUENCY AMPLIFIER TRANSISTOR

Package : TO-18

The ITT 2N915 is a NPN double-diffused silicon planar transistor. This unit is designed for low-power non-saturating switching circuits and low-noise VHF amplifier and oscillator applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	70 Volts
Collector-Emitter Voltage (Note 4)	50 Volts
Emitter-Base Voltage	5.0 Volts
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_C = 100°C (Notes 2 and 3)	0.68 Watt
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	50	110	200	–	I_C = 10 mA, V_{CE} = 5.0 Volts (Note 5)
$V_{BE(sat)}$	–	0.77	0.9	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{CE(sat)}$	–	0.45	1.0	Volt	I_C = 10 mA, I_B = 1.0 mA
h_{fe}	2.5	3.6	–	–	I_C = 10 mA, V_{CE} = 15 Volts
C_{ob}	–	3.0	3.5	pf	I_E = 0, V_{CB} = 10
K_{TE}	–	6.5	10	pf	I_C = 0, V_{EB} = 0.5 Volt
I_{CBO}	–	0.8	10	nA	I_E = 0, V_{CB} = 60 Volts
$I_{CBO(150°C)}$	–	0.5	30	μA	I_E = 0, V_{CB} = 60 Volts
BV_{CBO}	70	–	–	Volts	I_E = 0, I_C = 100 μA
$V_{CEO(sust)}$	50	–	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	–	Volts	I_E = 10 μA, I_C = 0
r_bC_c	–	170	300	psec	I_C = 10 mA, V_{CB} = 10 Volts

SMALL SIGNAL CHARACTERISTICS (f = 1 kc)

Symbol	Min	Typ	Max	Unit	Conditions
h_{fe}	40	115	200	-	I_C = 1.0 mA, V_{CE} = 5.0 Volts
	50	140	250	-	I_C = 5.0 mA, V_{CE} = 5.0 Volts
h_{ie}	–	3.0	6.0	Kohms	I_C = 1.0 mA, V_{CE} = 5.0 Volts
	–	0.7	2.0	Kohms	I_C = 5.0 mA, V_{CE} = 5.0 Volts
h_{oe}	–	12	75	μmho	I_C = 1.0 mA, V_{CE} = 5.0 Volts
	–	45	125	μmho	I_C = 5.0 mA, V_{CE} = 5.0 Volts

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operation.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 145°C/watt (derating factor of 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

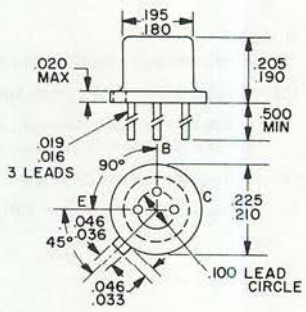
Symbol	Min	Typ	Max	Unit	Conditions
*I_{CBO}	–	0.1	10	nA	I_E = 0, V_{CB} = 30 Volts
I_{CBO}(150°C)	–	0.2	10	μA	I_E = 0, V_{CB} = 30 Volts
BV_{CBO}	45	–	–	Volts	I_C = 10 μA, I_E = 0
V_{CEO} (sust)	25	–	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
$r_b'C_c$	–	200	300	psec	I_C = 10 mA, V_{CB} = 10 Volts

LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS

- **High Gain; 100 min. @ I_c=10 μA**
- **Low Noise; 3dB max. @ I_c=10 μA**
- **High V_{CEO}; 45 Vdc min.**

The ITT 2N929 and 2N930 are NPN silicon planar transistors designed for application in low noise, low level amplifiers in the audio through high frequency range.

DIMENSIONS



TO-18

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	45	Volts
Collector-to-Emitter Voltage (open base)	45	Volts
Emitter-to-Base Voltage	5.0	Volts
Collector Current (continuous)	30	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +200	°C
Total Power Dissipation @ T_C=25°C (derate 4.0 mW/°C above 25°C)	0.6	Watts
Total Power Dissipation @ T_A=25°C (derate 2.0 mW/°C above 25°C)	0.3	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
LV_{CEO}	**45**		**Vdc**	**I_C=10mA**
BV_{EBO}	5.0		Vdc	I_E=10nA
h_{FE}	**40** **100**	**120** **300**		**I_C=10μA V_{CE}=5.0V** **2N929** **2N930**
	60 150			I_C=500μA V_{CE}=5.0V 2N929 2N930
		350 600		I_C=10mA V_{CE}=5.0V 2N929 2N930
	10 20			I_C=10μA V_{CE}=5.0V T_A=−55°C 2N929 2N930
$V_{CE}(sat)$[1]		1.0	Vdc	I_C=10mA I_B=0.5mA
$V_{BE}(sat)$[1]	0.6	1.0	Vdc	I_C=10mA I_B=0.5mA
I_{CBO}		10	nA	V_{CB}=45V
I_{CEO}		2	nA	V_{CE}=5V
I_{EBO}		10	nA	V_{EB}=5V
I_{CES}		10	nA	V_{CE}=45V
I_{CES}		10	μA	V_{CE}=45V T_A=170°C
C_{ob}		8	pF	V_{CB}=5V
h_{fe}	60 150	350 600		I_C=1.0mA V_{CE}=5V f=1KHz 2N929 2N930
	1.0	1.0		I_C=500μA V_{CE}=5V f=30mHz
h_{ib}	25	32	ohms	I_C=1.0mA V_{CB}=5V f=1mHz
h_{ob}		1.0	μmho	I_C=1.0mA V_{CB}=5V f=1mHz
h_{rb}		600	$X10^{-6}$	I_C=1.0mA V_{CB}=5V f=1mHz
NF		**4** **3**	**dB** **dB**	**I_C=10μA V_{CE}=5V R_G=10KΩ** **B.W.=200Hz f=1KHz** **2N929** **2N930**

Notes: 1. Pulse width ≤300 μsec; duty cycle ≤2%.
2. Lowest emitter to collector voltage.

2N2192, 2N2192A, 2N2192B®

Package TO-5

HIGH-SPEED NPN SILICON, HIGH-CURRENT SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	60 Volts
Collector-Emitter Voltage (Note 4)	40 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	1.0 Amp
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	2.8 Watts
T_C = 100°C (Notes 2 and 3)	1.6 Watts
T_A = 25°C (Notes 2 and 3)	0.8 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	−65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 62.5°C/watt (derating factor of 16mW/°C), junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length ≤ 300 μsec, duty cycle ≤ 2%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	100	300	–	I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
h_{FE}	75	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	70	–	–	I_C = 150 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	35	–	–	I_C = 500 mA, V_{CE} = 10 Volts (Note 5)
$h_{FE(-55°C)}$	35	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	15	–	–	I_C = 1.0 A, V_{CE} = 10 Volts (Note 5)
h_{FE}	15	–	–	I_C = 0.1 mA, V_{CE} = 10 Volts
$V_{CE(sat)}$	–	0.35	Volt	I_C = 150 mA, I_B = 15 mA (2N2192)
$V_{CE(sat)}$	–	0.25	Volt	I_C = 150 mA, I_B = 15 mA (2N2192A)
$V_{CE(sat)}$	–	0.18	Volt	I_C = 150 mA, I_B = 15 mA (2N2192B)
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	2.5	–	–	I_C = 50 mA, V_{CE} = 10 Volts f=20MHz
C_{ob}	–	20	pF	I_E = 0, V_{CB} = 10 Volts
I_{CBO}	–	10	nA	I_E = 0, V_{CB} = 30 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$I_{CBO(150°C)}$	–	15	μA	I_E = 0, V_{CB} = 30 Volts
I_{EBO}	–	50	nA	I_C = 0, V_{EB} = 3.0 Volts
BV_{CBO}	60	–	Volts	I_C = 100 μA, I_E = 0
$V_{CEO(sust)}$	40	–	Volts	I_C = 25 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	Volts	I_E = 100 μA, I_C = 0
t_f	–	50	nsec	See Figure 1
t_r	–	70	nsec	See Figure 1
t_s	–	150	nsec	See Figure 1

CIRCUIT DIAGRAM

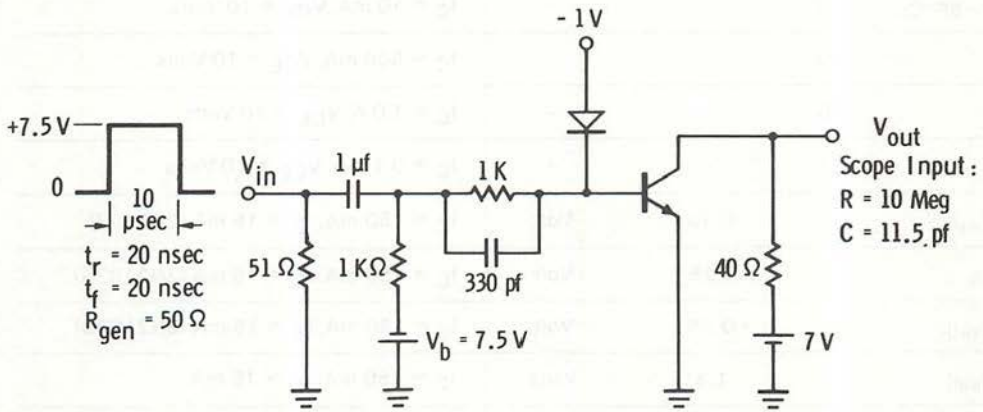


FIGURE 1

HIGH-SPEED NPN SILICON, HIGH-CURRENT SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Units
Collector-Base Voltage	80 Volts
Collector-Emitter Voltage (Note 4)	50 Volts
Emitter-Base Voltage	8.0 Volts
Collector Current	1.0 Amp
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	2.8 Watts
T_C = 100°C (Notes 2 and 3)	1.6 Watts
T_A = 25°C (Notes 2 and 3)	0.8 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	−65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	40	120	–	I_C = 150 mA, V_{CE} = 10 Volts
h_{FE}	30	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	30	–	–	I_C = 150 mA, V_{CE} = 1.0 Volt
$h_{FE(-55°C)}$	20	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	20	–	–	I_C = 500 mA, V_{CE} = 10 Volts
h_{FE}	15	–	–	I_C = 1.0 A, V_{CE} = 10 Volts
h_{FE}	15	–	–	I_C = 0.1 mA, V_{CE} = 10 Volts
$V_{CE(sat)}$	–	0.35	Volt	I_C = 150 mA, I_B = 15 mA (2N2193)
$V_{CE(sat)}$	–	0.25	Volt	I_C = 150 mA, I_B = 15 mA (2N2193A)
$V_{CE(sat)}$	–	0.18	Volt	I_C = 150 mA, I_B = 15 mA (2N2193B)
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	2.5	–	–	I_C = 50 mA, V_{CE} = 10 Volts f = 20 MHz
C_{ob}	–	20	pF	I_E = 0, V_{CB} = 10 Volts f = 1 MHz
I_{CBO}	–	10	nA	I_E = 0, V_{CB} = 60 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$I_{CBO(150°C)}$	–	25	μA	I_E = 0, V_{CB} = 60 Volts
I_{EBO}	–	50	nA	I_C = 0, V_{EB} = 5.0 Volts
BV_{CBO}	80	–	Volts	I_C = 100μA, I_E = 0
$V_{CEO(sust)}$	50	–	Volts	I_C = 25 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	8.0	–	Volts	I_E = 100μA, I_C = 0
t_f	–	50	nsec	See Figure 1
t_r	–	70	nsec	See Figure 1
t_s	–	150	nsec	See Figure 1

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 62.5°C/watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length ≤ 300 usec; duty cycle ≤ 2%.

CIRCUIT DIAGRAM

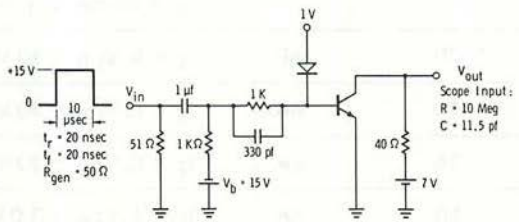


FIGURE 1

HIGH-SPEED NPN SILICON, HIGH-CURRENT SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	60 Volts
Collector-Emitter Voltage (Note 4)	40 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	1.0 Amp
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	2.8 Watts
T_C = 100°C (Notes 2 and 3)	1.6 Watts
T_A = 25°C (Notes 2 and 3)	0.8 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	−65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 62.5°C/watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	20	60	–	I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
h_{FE}	15	–	–	I_C = 150 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	15	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	12	–	–	I_C = 500 mA, V_{CE} = 10 Volts (Note 5)
$V_{CE(sat)}$	–	0.35	Volt	I_C = 150 mA, I_B = 15 mA (2N2194)
$V_{CE(sat)}$	–	0.25	Volt	I_C = 150 mA, I_B = 15 mA (2N2194A)
$V_{CE(sat)}$	–	0.18	Volt	I_C = 150 mA, I_B = 15 mA (2N2194B)
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	2.5	–	–	I_C = 50 mA, V_{CE} = 10 Volts
C_{ob}	–	20	pF	I_E = 0, V_{CB} = 10 Volts
I_{CBO}	–	10	nA	I_E = 0, V_{CB} = 30 Volts
$I_{CBO(150°C)}$	–	25	μA	I_E = 0, V_{CB} = 30 Volts
I_{EBO}	–	50	nA	I_C = 0, V_{EB} = 3.0 Volts
BV_{CBO}	60	–	Volts	I_C = 100 μA, I_E = 0

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CEO(sust)}$	40	–	Volts	I_C = 25 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	Volts	I_E = 100 μA, I_C = 0
t_f	–	50	nsec	See Figure 1
t_r	–	70	nsec	See Figure 1
t_s	–	150	nsec	See Figure 1

CIRCUIT DIAGRAM

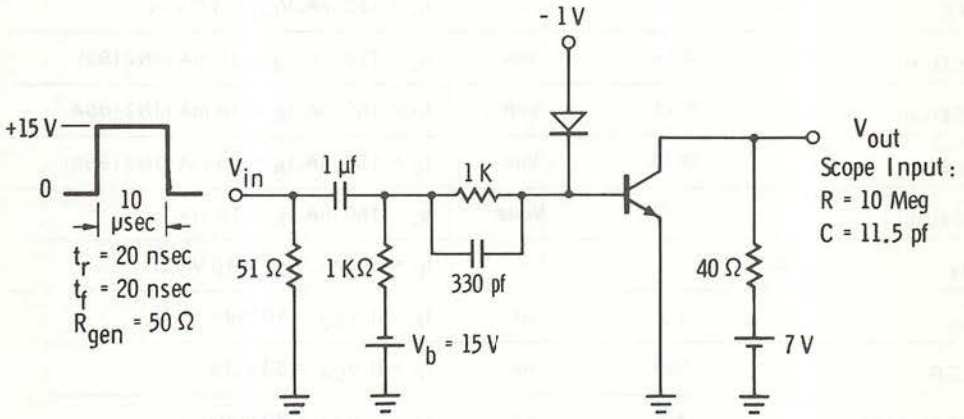


FIGURE 1

HIGH-SPEED NPN SILICON, HIGH-CURRENT SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	45 Volts
Collector-Emitter Voltage (Note 4)	25 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	1.0 Amp
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	2.8 Watts
T_C = 100°C (Notes 2 and 3)	1.6 Watts
T_A = 25°C (Notes 2 and 3)	0.6 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	−65 to +200 °C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 62.5°C/watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 292°C/watt (derating factor of 3.42 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

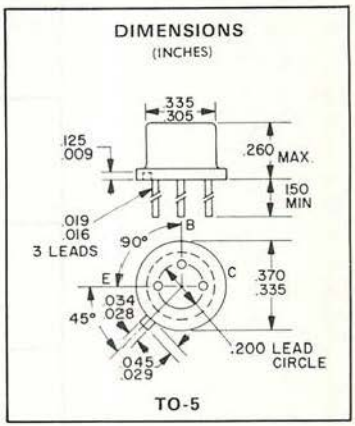
(5) Pulse Conditions: length ≤ 300 μsec, duty cycle ≤ 2%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	20	–	–	I_C = 150 mA, V_{CE} = 10 Volts
h_{FE}	10	–	–	I_C = 150 mA, V_{CE} = 1.0 Volt
$V_{CE(sat)}$	–	0.35	Volt	I_C = 150 mA, I_B = 15 mA (2N2195)
$V_{CE(sat)}$	–	0.25	Volt	I_C = 150 mA, I_B = 15 mA (2N2195A
$V_{CE(sat)}$	–	0.18	Volt	I_C = 150 mA, I_B = 15 mA (2N2195B)
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	2.5	–	–	I_C = 50 mA, V_{CE} = 10 Volts
C_{ob}	–	20	pF	I_E = 0, V_{CB} = 10 Volts
I_{CBO}	–	100	nA	I_E = 0, V_{CB} = 30 Volts
$I_{CBO(150°C)}$	–	50	μA	I_E = 0, V_{CB} = 30 Volts
I_{EBO}	–	100	nA	I_C = 0, V_{EB} = 3.0 Volts
BV_{CBO}	45	–	Volts	I_C = 100 μA, I_E = 0
$V_{CEO(sust)}$	25	–	Volts	I_C = 25 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	Volts	I_E = 100 μA, I_C = 0

GENERAL PURPOSE NPN SILICON PLANAR EPITAXIAL TRANSISTORS

- Low V_{CE} (sat), < 0.4 V @ I_C = 150mA
- High Frequency, f_T = 250 MHz @ I_C = 20mA
- Wide Useful Current Range, 0.1 to 500mA



The ITT 2N2218-19 are NPN silicon planar epitaxial general purpose transistors for applications at current ranges from 0.1 to 500 mA. Low saturation voltage and fast switching times make the 2N2218-19 ideal for core driving. The flat gain over a wide current range gives good linearity in amplifier circuits. High breakdown voltage allows large signal swing in switching and amplifier circuits.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage (open base)	30	Volts
Emitter-to-Base Voltage	5.0	Volts
Collector Current (continuous)	800	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +200	°C
Total Power Dissipation @ T_C = 25°C (derate 20mW/°C above 25°C)	3.0	Watts
Total Power Dissipation @ T_A = 25°C (derate 5.33 mW/°C above 25°C)	0.8	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
h_{FE} [1]				I_C=150mA, V_{CE}=10V
	40	120		2N2218
	100	300		2N2219
				I_C=150mA, V_{CE}=IV
	20			2N2218
	50			2N2219
h_{FE}				I_C=500mA, V_{CE}=10V
	20			2N2218
	30			2N2219
				I_C=10mA, V_{CE}=10V
	35			2N2218
	75			2N2219
				I_C=1mA, V_{CE}=10V
	25			2N2218
	50			2N2219
				I_C=0.1mA, V_{CE}=10V
	20			2N2218
	35			2N2219
V_{CE}(sat)[1]		**0.4**	**Vdc**	**I_C=150mA, I_B=15mA**
		1.6	Vdc	I_C=500mA, I_B=50mA
V_{BE}(sat) [1]		1.3	Vdc	I_C=150mA, I_B=15mA
		2.6	Vdc	I_C=500mA, I_B=50mA
I_{CBO}		10	nA	V_{CB}=50V, I_E=0
		10	μA	V_{CB}=50V, I_E=0, T=150°C
I_{EBO}		10	nA	V_{EB}=3V, I_C=0
f_T	**250**		**MHz**	**I_C=20mA, V_{CE}=20V**
C_{ob}		8	pf	V_{CB}=10V, I_E=0
$R_{e(hie)}$ [2]		60	Ohms	I_C=20mA, V_{CE}=20V, f=300 MHz
BV_{CBO}	60		Vdc	I_C=10μA, I_E=0
V_{CEO}(sust) [1]	30		Vdc	I_C=10mA, I_B=0
BV_{EBO}	5		Vdc	I_E=10μA, I_C=0

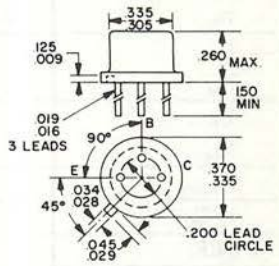
NOTES: 1. Pulse Measurement: width $\leq$ 300μsec, duty cycle $\leq$ 2%.
2. Real part of Common-Emitter high frequency input impedance..

HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	75	Volts
Collector-to-Emitter Voltage	40	Volts
Emitter-to-Base Voltage	6	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	3.0	Watts
P_D @ T_A = 25°C	0.8	Watts

DIMENSIONS



TO-5

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	75		Vdc	I_C = 10μA
LV_{EBO}	40		Vdc	I_C = 10mA pulsed
BV_{EBO}	6		Vdc	I_E = 10μA
h_{FE}	35			I_C = 100μA, V_{CE} = 10V
h_{FE}	50			I_C = 1mA, V_{CE} = 10V
h_{FE}	75			I_C = 10mA, V_{CE} = 10V
h_{FE}	100	300		I_C = 150mA, V_{CE} = 10V pulsed
h_{FE}	40			I_C = 500mA, V_{CE} = 10V pulsed
h_{FE}	50			I_C = 150mA, V_{CE} = 1V pulsed
h_{FE}	35			I_C = 10mA, V_{CE} = 10V, T_A = −55°C
V_{CE}(sat)		0.3	Vdc	I_C = 150mA, I_B = 15mA pulsed
V_{CE}(sat)		1.0	Vdc	I_C = 500mA, I_B = 50mA pulsed
V_{BE}(sat)	0.6	1.2	Vdc	I_C = 150mA, I_B = 15mA pulsed
V_{BE}(sat)		2.0	Vdc	I_C = 500mA, I_B = 50mA pulsed
I_{CBO}		10	nA	V_{CB} = 60V
I_{CBO}		10	μA	V_{CB} = 60V, T_A = 150°C

ELECTRICAL CHARACTERISTICS continued

PARAMETER	MIN.	MAX.	UNIT	CONDITIONS
I_{CEX}		10	nA	$V_{CE}=60V$, $V_{EB}=3V$
I_{EBX}		20	nA	$V_{EB}=3V$, $V_{CB}=60V$
I_{EBO}		10	nA	$V_{EB}=3V$
C_{ob}		8	pF	$V_{CB}=10V$
C_{ib}		25	pF	$V_{EB}=0.5V$
h_{fe}	50	300		$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{fe}	75	375		$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{fe}	3			$I_C=20mA$, $V_{CE}=20V$, f=100MHz
h_{ie}	2	8	K ohms	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{ie}	0.25	1.25	K ohms	$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{re}		8	$x10^{-4}$	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{re}		4	$x10^{-4}$	$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{oe}	5	35	μmho	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{oe}	25	200	μmho	$I_C=10mA$, $V_{CE}=10V$, 1f=KHz
$R_{e(hie)}$		60	omhs	$I_C=20mA$, $V_{CE}=20V$, f=300MHz
$r_b'C_C$		150	ps	$I_C=20mA$, $V_{CE}=20V$, f=31.8MHz
N.F.		4	db	$I_C=100\mu A$, $V_{CE}=10V$, $R_G=1K\Omega$, f=1KHz
T_s		2.5	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_d		10	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_r		25	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_s		225	ns	$I_C=150mA$, $I_{B1}=I_{B2}=15mA$, $V_{CC}=30V$
t_f		60	ns	$I_C=150mA$, $I_{B1}=I_{B2}=15mA$, $V_{CC}=30V$

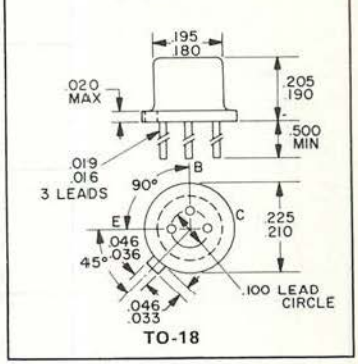
NOTE: Pulse width $\leq$ 30 μsec, duty cycle $\leq$ 2%.

GENERAL PURPOSE NPN SILICON PLANAR EPITAXIAL TRANSISTORS

- Low V_{CE} (sat) < 0.4 V @ $I_C = 150$mA
- High Frequency, $f_T = 250$ MHz @ $I_C = 20$mA
- Wide Useful Current Range, 0.1 to 500mA

The ITT 2N2221-22 are NPN silicon planar epitaxial general purpose transistors for applications at current ranges from 0.1 to 500 mA. Low saturation voltage and fast switching times make the 2N2221-22 ideal for core driving. The flat gain over a wide current range gives good linearity in amplifier circuits. High breakdown voltage allows large signal swing in switching and amplifier circuits.

DIMENSIONS



TO-18

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage (open base)	30	Volts
Emitter-to-Base Voltage	5.0	Volts
Collector Current (continuous)	800	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +300	°C
Total Power Dissipation @ $T_C = 25°C$ (derate 12mW/°C above 25°C)	1.8	Watts
Total Power Dissipation @ $T_A = 25°C$ (derate 3.33 mW/°C above 25°C)	0.5	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
h_{FE} [1]				$I_C=150mA$, $V_{CE}=10V$
	40	120		2N2221
	100	300		2N2222
				$I_C=150mA$, $V_{CE}=IV$
	20			2N2221
	50			2N2222
				$I_C=500mA$, $V_{CE}=10V$
	20			2N2221
	30			2N2222
h_{FE}				$I_C=10mA$, $V_{CE}=10V$
	35			2N2221
	75			2N2222
				$I_C=1mA$, $V_{CE}=10V$
	25			2N2221
	50			2N2222
				$I_C=0.1mA$, $V_{CE}=10V$
	20			2N2221
	35			2N2222
$V_{CE}(sat)$ [1]		**0.4**	**Vdc**	**$I_C=150mA$, $I_B=15mA$**
		1.6	Vdc	$I_C=500mA$, $I_B=50mA$
$V_{BE}(sat)$ [1]		1.3	Vdc	$I_C=150mA$, $I_B=15mA$
		2.6	Vdc	$I_C=500mA$, $I_B=50mA$
I_{CBO}		10	nA	$V_{CB}=50V$, $I_E=0$
		10	μA	$V_{CB}=50V$, $I_E=0$, $T=150°C$
I_{EBO}		10	nA	$V_{EB}=3V$, $I_C=0$
f_T	**250**		**MHz**	**$I_C=20mA$, $V_{CE}=20V$**
C_{ob}		8	pf	$V_{CB}=10V$, $I_E=0$
$R_e(h_{ie})$ [2]		60	Ohms	$I_C=20mA$, $V_{CE}=20V$, $f=300$ MHz
BV_{CBO}	60		Vdc	$I_C=10\mu A$, $I_E=0$
$V_{CEO}(sust)$ [1]	30		Vdc	$I_C=10mA$, $I_B=0$
BV_{EBO}	5		Vdc	$I_E=10\mu A$, $I_C=0$

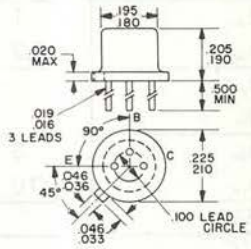
NOTES: 1. Pulse Measurement: width $\leq$ 300μsec, duty cycle $\leq$ 2%.
2. Real part of Common-Emitter high frequency input impedance.

HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	75	Volts
Collector-to-Emitter Voltage	40	Volts
Emitter-to-Base Voltage	6	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.8	Watts
P_D @ T_A = 25°C	0.5	Watt

DIMENSIONS



TO-18

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	75		Vdc	I_C=10μA
LV_{CEO}	40		Vdc	I_C=10mA pulsed
BV_{EBO}	6		Vdc	I_E=10μA
h_{FE}	20			I_C=100μA, V_{CE}=10V
h_{FE}	25			I_C=1mA, V_{CE}=10V
h_{FE}	35			I_C=10mA, V_{CE}=10V
h_{FE}	40	120		I_C=150mA, V_{CE}=10V pulsed
h_{FE}	25			I_C=500mA, V_{CE}=10V pulsed
h_{FE}	20			I_C=150mA, V_{CE}=1V pulsed
h_{FE}	15			I_C=10mA, V_{CE}=10V, T_A= −55°C
V_{CE}(sat)		0.3	Vdc	I_C=150mA, I_B=15mA pulsed
V_{CE}(sat)		1.0	Vdc	I_C=500mA, I_B=50mA pulsed
V_{BE}(sat)	0.6	1.2	Vdc	I_C=150mA, I_B=15mA pulsed
V_{BE}(sat)		2.0	Vdc	I_C=500mA, I_B=50mA pulsed
I_{CBO}		10	nA	V_{CB}=60V
I_{CBO}		10	μA	V_{CB}=60V, T_A=150°C

ELECTRICAL CHARACTERISTICS continued

PARAMETER	MIN.	MAX.	UNIT	CONDITIONS
I_{CEX}		10	nA	$V_{CE}=60V$, $V_{EB}=3V$
I_{EBX}		20	nA	$V_{EB}=3V$, $V_{CB}=60V$
I_{EBO}		10	nA	$V_{EB}=3V$
C_{ob}		8	pF	$V_{CB}=10V$
C_{ib}		25	pF	$V_{EB}=0.5V$
h_{fe}	30	150		$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{fe}	50	300		$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{fe}	2.5			$I_C=20mA$, $V_{CE}=20V$, f=100MHz
h_{ie}	1	3.5	K ohms	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{ie}	0.2	1.0	K ohms	$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{re}		5	$x10^{-4}$	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{re}		2.5	$x10^{-4}$	$I_C=10mA$, $V_{CE}=10V$, f=1KHz
h_{oe}	3	15	μmho	$I_C=1mA$, $V_{CE}=10V$, f=1KHz
h_{oe}	10	100	μmho	$I_C=10mA$, $V_{CE}=10V$, f=1KHz
$R_{e(hie)}$		60	ohms	$I_C=20mA$, $V_{CE}=20V$, f=300MHz
$r_b'C_C$		150	ps	$I_C=20mA$, $V_{CE}=20V$, f=31.8MHz
τ_s		2.5	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_d		10	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_r		25	ns	$I_C=150mA$, $I_{B1}=15mA$, $V_{CC}=30V$, $V_{EB}=0.5V$
t_s		225	ns	$I_C=150mA$, $I_{B1}=I_{B2}=15mA$, $V_{CC}=30V$
t_f		60	ns	$I_C=150mA$, $I_{B1}=I_{B2}=15mA$, $V_{CC}=30V$

NOTES: Pulse width $\leq$ 300 μsec, duty cycle $\leq$ 2%.

2N2242
HIGH-SPEED SILICON SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	15 Volts
Collector-Base Voltage	40 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current — Continuous	225 mA
Total Device Dissipation @ T_A = 25°C	360 mW
Derate above 25°C	2.0 mW/°C
Junction Temperature — Operating	−65 to +200° C
Storage Temperature Range	−65 to +200° C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

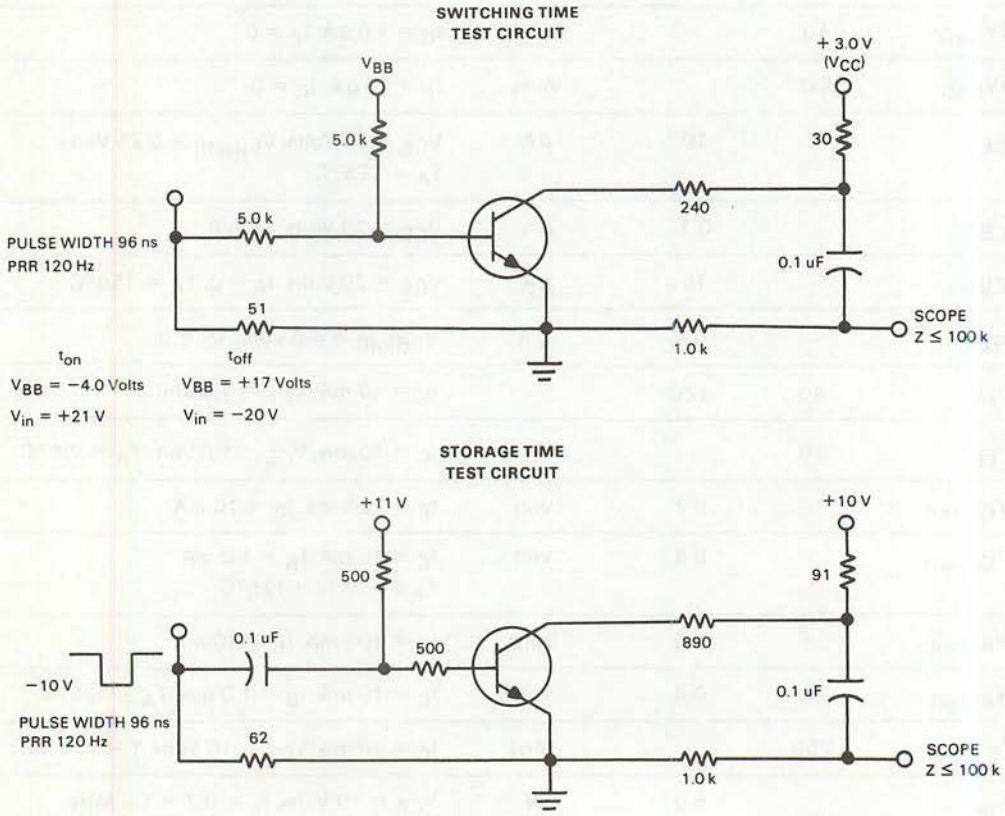
Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	15	–	Volts	I_C = 30 mA, I_E = 0*
BV_{CER}*	20	–	Volts	I_C = 30 mA, R_{BE} = ≤ 10 ohms*
BV_{CBO}	40	–	Volts	I_C = 1.0 μA, I_E = 0
BV_{EBO}	5.0	–	Volts	I_E = 10 μA, I_C = 0
I_{CEX}	–	10	μA	V_{CE} = 20 Volts, $V_{EB(off)}$ = 0.25 Volt, T_A = 125°C
I_{CBO}	–	0.1	μA	V_{CB} = 20 Volts, I_C = 0
I_{CBO}	–	15	μA	V_{CB} = 20 Volts, I_E = 0, T_A = 150°C
I_{EBO}	–	0.1	μA	$V_{EB(off)}$ = 4.0 Volts, I_C = 0
h_{FE}*	40	120	–	I_C = 10 mA, V_{CE} = 1.0 Volt*
h_{FE}*	20	–	–	I_C = 10 mA, V_{CE} = 1.0 Volt, T_A = -55°C
$V_{CE(sat)}$	–	0.7	Volt	I_C = 100 mA, I_B = 10 mA
$V_{CE(sat)}$	–	0.3	Volt	I_C = 10 mA, I_B = 1.0 mA, T_A = -55 to +125°C
$V_{BE(sat)}$	–	1.5	Volts	I_C = 100 mA, I_B = 10 mA
$V_{BE(sat)}$	–	0.8	Volt	I_C = 10 mA, I_B = 1.0 mA, T_A = 125°C
f_T	250	–	MHz	I_C = 20 mA, V_{CE} = 10 Volts, f = 100 MHz
C_{ob}	–	6.0	pF	V_{CB} = 10 Volts, I_E = 0, f = 1.0 MHz

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
t_{on}	–	30	ns	V_{CC} = 3.0 Volts, $V_{BE(off)}$ = +2.0 Volts, I_{B1} = 3.0 mA, I_C = 10 mA
t_{off}	–	50	ns	V_{CC} = 3.0 Volts, I_C = 10 mA, I_{B1} = 3.0 mA, I_{B2} = 1.0 mA
t_s	–	25	ns	I_C = 10 mA, I_{B1} = I_{B2} = 10 mA

* Pulse Test: Pulse Width = 300 μs; Duty Cycle = ≤ 2%

CIRCUIT DIAGRAM



Package: TO-5

NPN HIGH-CURRENT GENERAL PURPOSE SILICON PLANAR TRANSISTOR

The ITT 2N2297 is an NPN double-diffused silicon planar epitaxial transistor with very low saturation resistance, high-current capabilities, typical gain-bandwidth product of 90 megacycles, low C_{ob} and low leakage currents.

This transistor is designed for use in high-performance dc-dc converters, oscillators, high-current memory drivers and computer clock distribution circuits. The 2N2297 is suitable in particular for output stages of servo amplifiers and transceivers where several watts output at high effiency is required.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	80 Volts
Collector-Emitter Voltage (Note 4)	35 Volts
Emitter-Base Voltage	7.0 Volts
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	5.0 Watts
T_C = 100°C (Notes 2 and 3)	2.8 Watts
T_A = 25°C (Notes 2 and 3)	0.8 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	40	55	120	–	I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
$V_{CE(sat)}$	–	0.15	0.2	Volt	I_C = 150 mA, I_B = 15 mA
$V_{CE(sat)}$	–	0.8	1.0	Volt	I_C = 1000 mA, I_B = 100 mA (Note 6)
$V_{CE(sat)}$	–	1.4	1.6	Volts	I_C = 1000 mA, I_B = 100 mA
I_{CBO}	–	0.1	10	nA	I_E = 0, V_{CB} = 60 Volts
I_{EBO}	–	–	10	nA	I_C = 0, V_{EB} = 5.0 Volts
BV_{CBO}	80	–	–	Volts	I_E = 0, I_C = 100 μA
$V_{CEO(sust)}$	35	–	–	Volts	I_B = 0 (pulsed) I_C = 30 mA (Notes 4 and 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	30	50	–	–	I_C = 10 mA, V_{CE} = 10 Volts (Note 5)
h_{FE}	15	30	–	–	I_C = 1.0 A, V_{CE} = 10 Volts (Note 5)
I_{CBO}(150°C)	–	0.2	10	μA	V_{CB} = 60 Volts, I_E = 0
f_T	60	95	–	mc	I_C = 50 mA, V_{CE} = 10 Volts
C_{ob}	–	8.0	12	pf	V_{CB} = 10 Volts, I_E = 0
C_{TE}	–	53	80	pf	V_{EB} = 0.5 Volt, I_C = 0
BV_{EBO}	7.0	–	–	Volts	I_E = 100 μA, I_C = 0
$r_b'C_c$	–	–	800	psec	I_C = 10 mA, V_{CB} = 10 Volts

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 35°C/watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 218°C/watt (derating factor of 4.6 mW/°C).

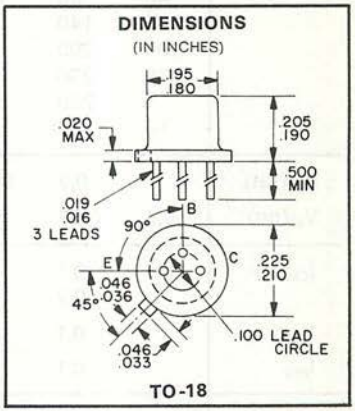
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≤ 1%.

(6) Measured at a point on the leads ≤ "/2 inch from the seating plane of transistor case.

LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS

- **High Gain; 100 Min. @ I_c=10μA (2N2484)**
- **Low noise; 3dB Max. @ I_c=10μA**
- **High V_{CEO}; 60 Vdc Min.**



The ITT 2N2483 and 2N2484 are NPN silicon planar transistors designed for application in low-noise, low-level, high-gain amplifiers in the audio through high frequency range.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage (open base)	60	Volts
Emitter-to-Base Voltage	6	Volts
Collector Current	50	mA
Junction Temperature (op. and stg.)	−65 to +200	°C
Total Power Dissipation @ T_C=25°C	1.2	Watts
(derate 6.9 mW/°C above 25°C)		
@ T_C=100°C.	0.68	Watts
Total Power Dissipation @ T_A=25°C	0.36	Watts
(derate 2.1 mW/°C above 25°C)		

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

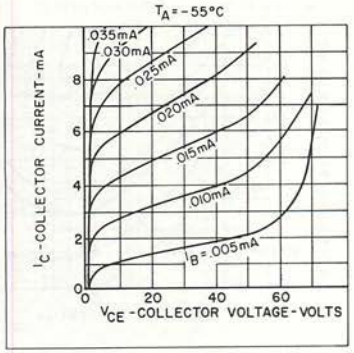
SYMBOL	2N2483 MIN.	2N2483 TYP.	2N2483 MAX.	2N2484 MIN.	2N2484 TYP.	2N2484 MAX.	UNIT	CONDITIONS
BV_{CBO}	60			60			Vdc	$I_C=10\mu A$
LV_{CEO}[1,2]	**60**			**60**			**Vdc**	**$I_C=10mA$**
BV_{EBO}	6.0			6.0			Vdc	$I_C=10\mu A$
h_{FE}				30	200			$I_C=1\mu A$ $V_{CE}=5V$
	40	**80**	**120**	**100**	**290**	**500**		**$I_C=10\mu A$ $V_{CE}=5V$**
	75	140		175	375			$I_C=100\mu A$ $V_{CE}=5V$
	100	200		200	430			$I_C=500\mu A$ $V_{CE}=5V$
	175	230		250	450			$I_C=1mA$ $V_{CE}=5V$
		280	500		430	800		$I_C=10mA$ $V_{CE}=5V$
	10			20				$I_C=10\mu A$ $V_{CE}=5V$ $T_A=-55°C$
$V_{CE}(sat)$		0.2	0.35		0.2	0.35	Vdc	$I_C=1mA$ $I_B=0.1mA$
$V_{BE}(on)$	0.5	0.57	0.7	0.5	0.57	0.7	Vdc	$I_C=100\mu A$ $V_{CE}=5V$
I_{CBO}		0.1	10		0.1	10	nA	$V_{CB}=45V$
		0.2	10		0.2	10	μA	$V_{CB}=45V$ $T_A=150°C$
I_{CEO}		0.1	2.0		0.1	2.0	nA	$V_{CE}=5V$
I_{EBO}		0.1	10		0.1	10	nA	$V_{EB}=5V$
C_{ob}		3.5	6.0		3.5	6.0	pF	$V_{CB}=5V$ f=1mHz
C_{ib}		3.5	6.0		3.5	6.0	pF	$V_{EB}=0.5V$ f=1mHz
h_{fe}	2.4	4.0		3.0	4.0			$I_C=50\mu A$ $V_{CE}=5V$ f=5mHz
	2.0	2.3		2.0	2.6			$I_C=500\mu A$ $V_{CE}=5V$ f=30mHz
	80	280	450	150	400	900		$I_C=1mA$ $V_{CE}=5V$ f=1KHz
h_{ie}	1.5	7.5	13	3.5	15	24	Kohms	$I_C=1mA$ $V_{CE}=5V$ f=1KHz
h_{oe}		11	30		15	40	μmho	$I_C=1mA$ $V_{CE}=5V$ f=1KHz
h_{re}		300	800		425	800	$X10^{-6}$	$I_C=1mA$ $V_{CE}=5V$ f=1KHz
h_{ib}	25	27	32	25	27	32	ohms	$I_C=1mA$ $V_{CE}=5V$ f=1KHz
NF		**1.9**	**4.0**		**1.8**	**3.0**	**dB**	**$I_C=10\mu A$ $V_{CE}=5V$ $R_G=10K\Omega$ B.W.=15.7KHz 3dB @ 10Hz & 10KHz**
		1.9	**4.0**		**1.8**	**3.0**	**dB**	**$I_C=10\mu A$ $V_{CE}=5V$ $R_G=10K\Omega$ f=1KHz B.W.=200Hz (Note 3)**
		0.7	**3.0**		**0.6**	**2.0**	**dB**	**$I_C=10\mu A$ $V_{CE}=5V$ $R_G=10K\Omega$ f=10KHz B.W.=2KHz (Note 3)**
		4.0	**15**		**4.0**	**10**	**dB**	**$I_C=10\mu A$ $V_{CE}=5V$ $R_G=10K\Omega$ f=100Hz B.W.=20Hz (Note 3)**

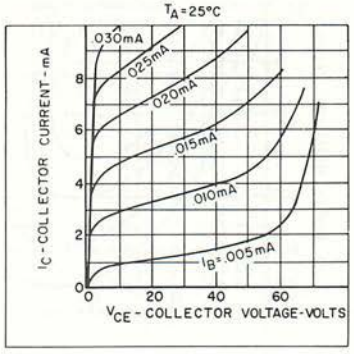
Notes: 1. Pulsed width ≤300 μsec; duty cycle ≤2%.
2. Lowest emitter to collector voltage.
3. Narrow band noise.

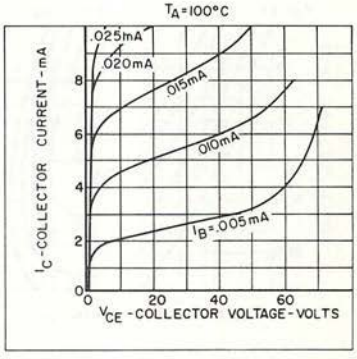
TYPICAL CHARACTERISTICS

2N2483

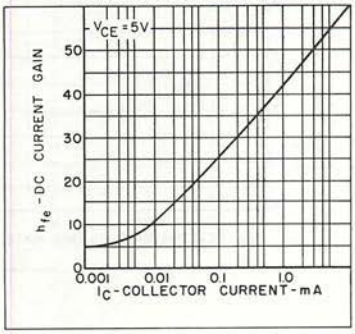
COLLECTOR CHARACTERISTICS



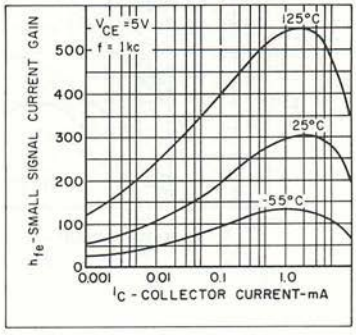




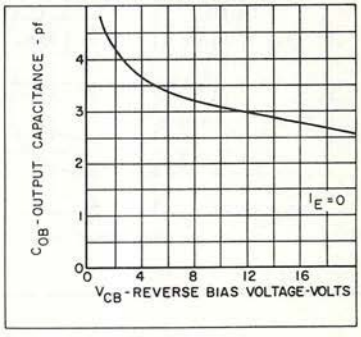
MINIMUM DC CURRENT GAIN AT -55°C
VERSUS COLLECTOR CURRENT



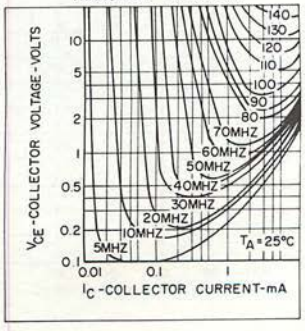
SMALL SIGNAL CURRENT GAIN
VERSUS COLLECTOR CURRENT



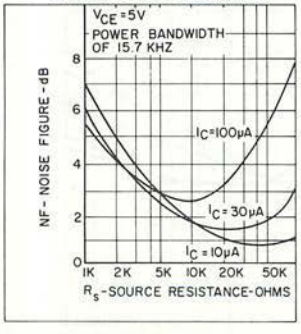
OUTPUT CAPACITANCE
VERSUS REVERSE BIAS VOLTAGE



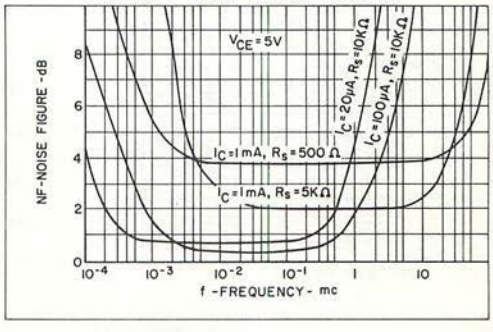
CONTOURS OF CONSTANT
TRANSITION FREQUENCY



AVERAGE NOISE FIGURE
VERSUS SOURCE RESISTANCE



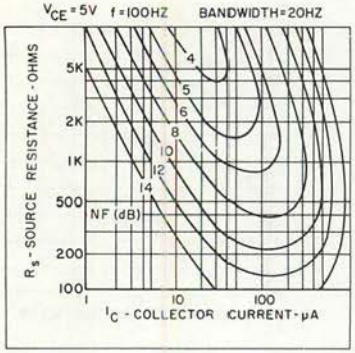
SPOT NOISE FIGURE VERSUS FREQUENCY

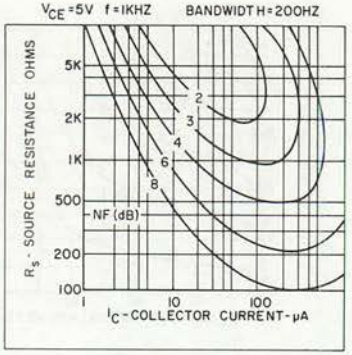


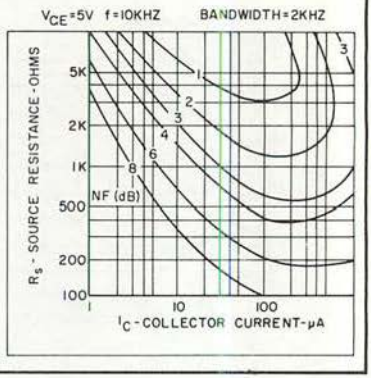
TYPICAL CHARACTERISTICS, continued

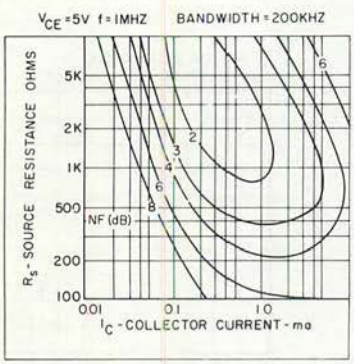
2N2483

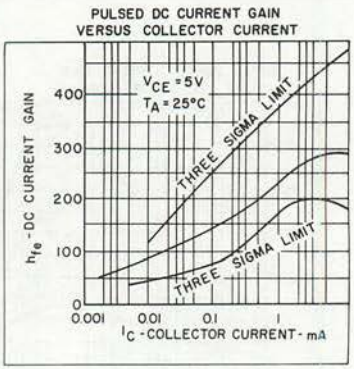
CONSTANT NOISE FIGURE CONTOURS

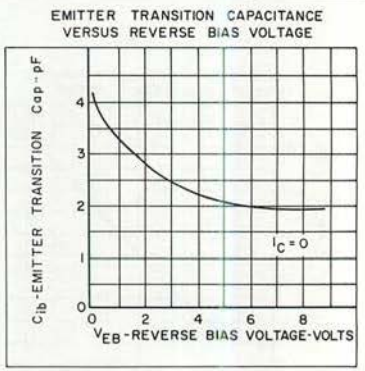




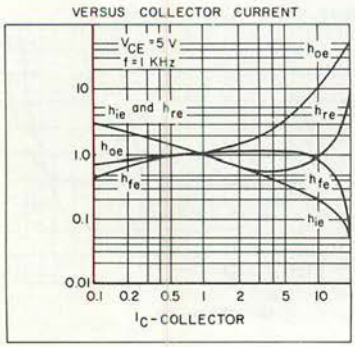


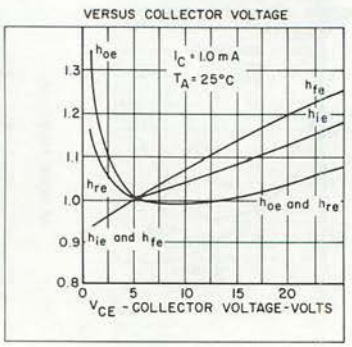


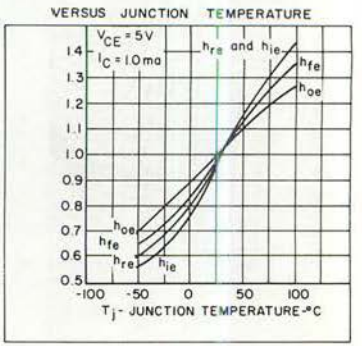




NORMALIZED COMMON EMITTER TRANSFER CHARACTERISTICS



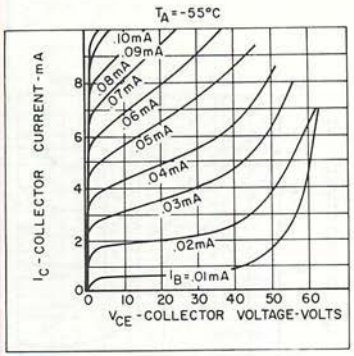


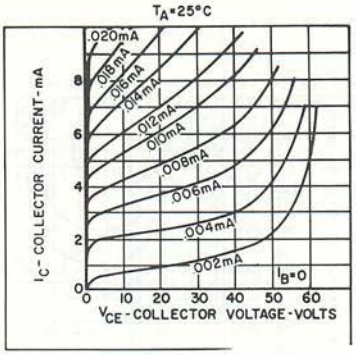


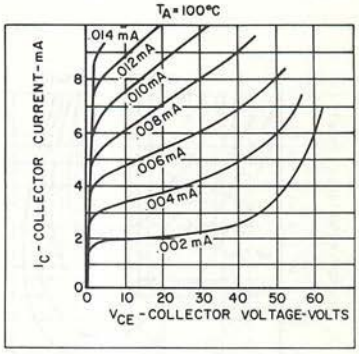
TYPICAL CHARACTERISTICS

2N2484

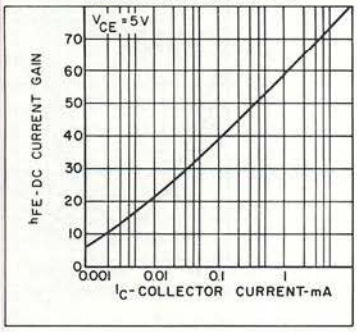
COLLECTOR CHARACTERISTICS



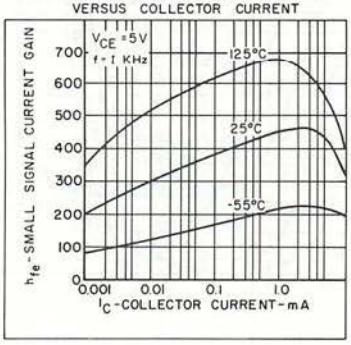




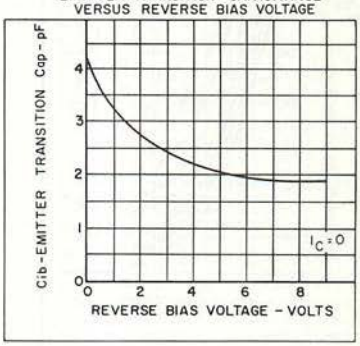
MINIMUM DC CURRENT GAIN AT -55°C VERSUS COLLECTOR CURRENT



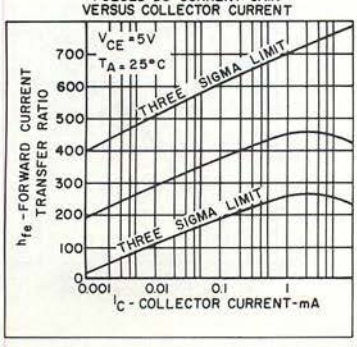
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



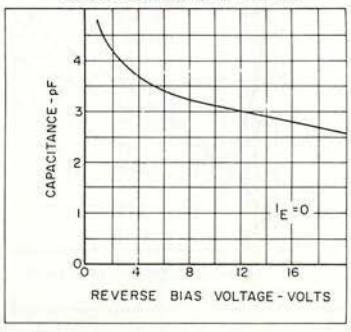
EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



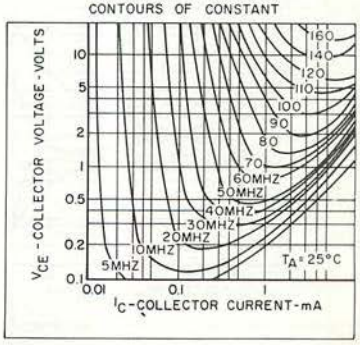
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



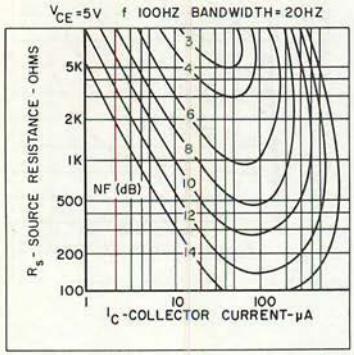
TRANSITION FREQUENCY CONTOURS OF CONSTANT

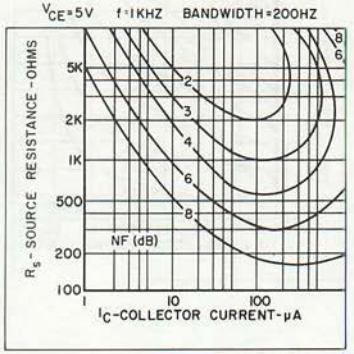


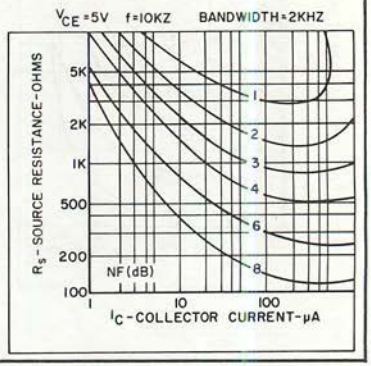
TYPICAL CHARACTERISTICS, continued

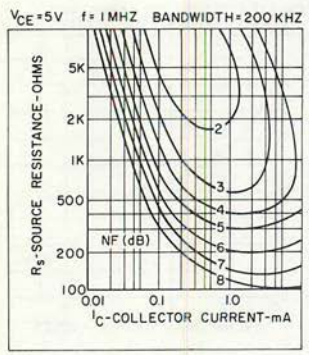
2N2484

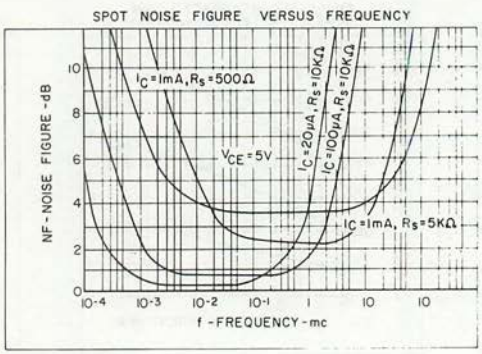
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE

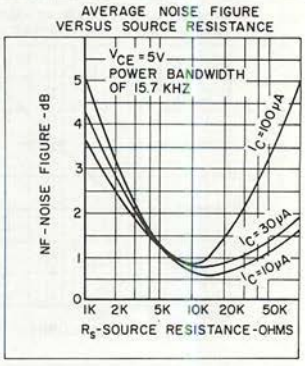




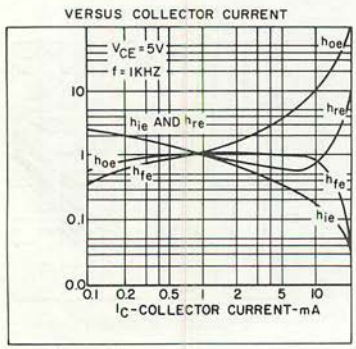


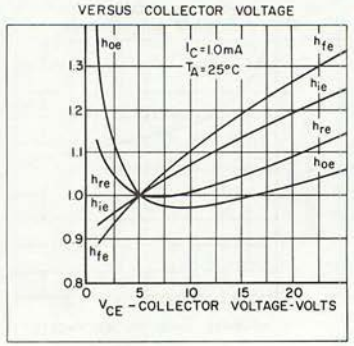


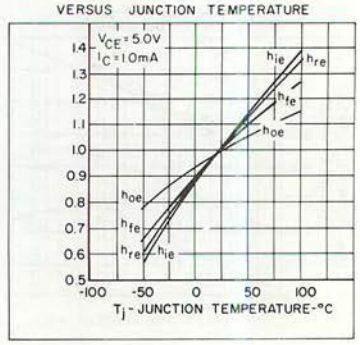




NORMALIZED COMMON EMITTER TRANSFER CHARACTERISTICS







Package TO-18

2N2509®
NPN LOW-LEVEL, LOW-NOISE DIFFUSED SILICON PLANAR TRANSISTOR

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	125 Volts
Collector-Emitter Voltage (Note 4)	80 Volts
Emitter-Base Voltage	7.0 Volts
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_C = 100°C (Notes 2 and 3)	0.68 Watt
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	+200°C

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 145°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

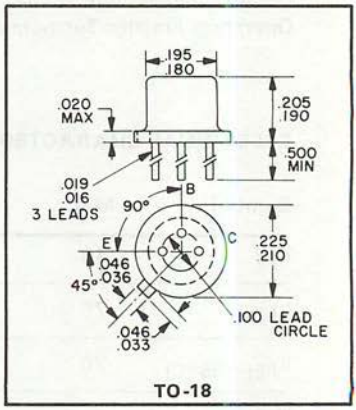
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	40	–	–	I_C = 10 mA, V_{CE} = 5.0 Volts
h_{FE}	25	–	–	I_C = 10 μA, V_{CE} = 5.0 Volts
$h_{FE(-55°C)}$	20	–	–	I_C = 10 mA, V_{CE} = 5.0 Volts
$V_{CE(sat)}$	–	1.0	Volt	I_C = 5.0 mA, I_B = 0.5 mA
$V_{BE(sat)}$	–	0.9	Volt	I_C = 5.0 mA, I_B = 0.5 mA
h_{fe}	1.5	–	–	I_C = 5.0 mA, V_{CE} = 10 Volts f=30MHz
I_{CBO}	–	5.0	nA	I_E = 0, V_{CB} = 100 Volts
$I_{CBO(150°C)}$	–	10	μA	I_E = 0, V_{CB} = 100 Volts
I_{EBO}	–	2.0	nA	I_C = 0, V_{EB} = 5.0 Volts
C_{ob}	–	6.0	pF	I_E = 0, V_{CB} = 5.0 Volts
C_{ib}	–	10	pF	I_C = 0, V_{EB} = 0.5 Volt
NF	–	7.0	dB	I_C = 10 μA, V_{CE} = 5.0 Volts BW = 200 Hz, R_{GT} = 10 kohms
r_bC_C	–	800	ps	I_C = 10 mA, V_{CB} = 10 Volts
BV_{CBO}	125	–	Volts	I_C = 10 μA, I_E = 0
$V_{CEO(sus)}$	80	–	Volts	I_C = 10 mA, I_B = 0 (Note 4)
BV_{EBO}	7.0	–	Volts	I_E = 0.1 μA, I_C = 0

LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS

- **High Gain; 75 min. @ I_c=10μA**
- **Low Noise; 4dB max. @ I_c=10μA**
- **High V_{CEO}; 65 Vdc min.**



TO-18

The ITT 2N2510 is an NPN silicon planar transistor designed for application in low noise, low level amplifiers in the audio through high frequency range.

ABSOLUTE MAXIMUM RATINGS

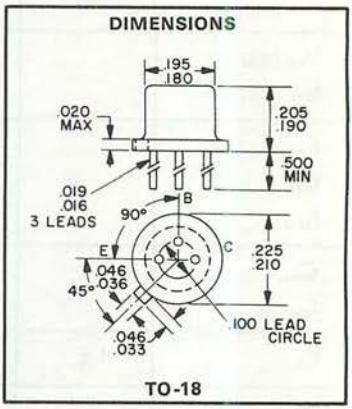
CHARACTERISTICS		UNITS
Collector-to-Base Voltage	100	Volts
Collector-to-Emitter Voltage (open base)	65	Volts
Emitter-to-Base Voltage	7	Volts
Collector Current (continuous)	30	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +200	°C
Total Power Dissipation @ T_C=25°C (derate 6.85 mW/°C above 25°C)	1.2	Watts
Total Power Dissipation @ T_A=25°C (derate 2.06 mW/°C above 25°C)	0.36	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNITS	CONDITIONS
BV_{CBO}	100		Vdc	$I_C = 10\mu A$
LV_{CEO}[1,2]	**65**		**Vdc**	**$I_C = 10mA$**
BV_{EBO}	7.0		Vdc	$I_E = 100nA$
h_{FE}	**75**			**$I_C = 10\mu A$, $V_{CE} = 5V$**
	150	500		$I_C = 10mA$, $V_{CE} = 5V$
	25			$I_C = 10\mu A$, $V_{CE} = 5V$, $T_A = -55°C$
	60			$I_C = 10mA$, $V_{CE} = 5V$, $T_A = -55°C$
V_{CF} (sat)		1.0	Vdc	$I_C = 5mA$, $I_B = 0.5mA$
V_{BE} (sat)		0.9	Vdc	$I_C = 5mA$, $I_B = 0.5mA$
I_{CBO}		5.0	nA	$V_{CB} = 80V$
I_{CBO}		10	μA	$V_{CB} = 80V$, $T_A = 150°C$
I_{EBO}		2.0	nA	$V_{EB} = 5V$
C_{ob}		6.0	pF	$V_{CB} = 5V$, f = 1.0 mHz
C_{ib}		10	pF	$V_{EB} = 0.5V$, f = 1.0 mHz
h_{fe}	1.5			$I_C = 5mA$, $V_{CE} = 10V$, f = 30mHz
		800	psec	$I_C = 10mA$, $V_{CB} = 10V$, f = 4mHz
N.F.		**4**	**dB**	**$I_C = 10\mu A$, $V_{CE} = 5V$, f = 1kHz, R = 10kΩ Bandwidth = 200Hz**

Notes: 1. Pulse width ≤ 300 μsec; duty cycle ≤ 2%.
2. Lowest emitter to collector voltage.

LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS



- **High Gain; 80 min @ $I_c = 1\mu A$**
- **Low Noise; 4 dB max. @ $I_c = 10\mu A$**
- **High V_{CEO}; 50 Vdc min.**

The ITT 2N2511 is an NPN silicon planar transistor designed for application in low noise, low level amplifiers in the audio through high frequency range.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	80	Volts
Collector-to-Emitter Voltage (open base)	50	Volts
Emitter-to-Base Voltage	7	Volts
Collector Current (continuous)	30	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +200	°C
Total Power Dissipation @ $T_C = 25°C$ (derate 6.85 mW/°C above 25°C)	1.2	Watts
Total Power Dissipation @ $T_A = 25°C$ (derate 2.06 mW/°C above 25°C)	0.36	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNITS	CONDITIONS
BV_{CBO}	80		Vdc	$I_C = 10\mu A$
LV_{CEO}[1,2]	**50**		**Vdc**	**$I_C = 10mA$**
BV_{EBO}	7.0		Vdc	$I_E = 100nA$
h_{FE}	**80**			**$I_C = 1\mu A$ $V_{CE} = 5V$**
	120			$I_C = 10\mu A$ $V_{CE} = 5V$
	240	750		$I_C = 10mA$ $V_{CE} = 5V$
	40			$I_C = 10\mu A$ $V_{CE} = 5V$ $T_A = -55°C$
	100			$I_C = 10mA$ $V_{CE} = 5V$ $T_A = -55°C$
$V_{CE}(sat)$		1.0	Vdc	$I_C = 5mA$ $I_B = 0.5mA$
$V_{BE}(sat)$		0.9	Vdc	$I_C = 5mA$ $I_B = 0.5mA$
I_{CBO}		5.0	nA	$V_{CB} = 60V$
I_{CBO}		10	μA	$V_{CB} = 60V$ $T_A = 150°C$
I_{EBO}		2.0	nA	$V_{EB} = 5V$
C_{ob}		6	pF	$V_{CB} = 5V$ $f = 1mHz$
		10	pF	$V_{EB} = 0.5V$ $f = 1mHz$
h_{fe}	1.5			$I_C = 5mA$ $V_{CE} = 10V$ $f = 30mHz$
$r_b{}'C_c$		800	psec	$I_C = 10mA$ $V_{CB} = 10V$ $f = 4mHz$
N.F.		4	**dB**	**$I_C = 10\mu A$ $V_{CE} = 5V$ $f = 1kHz$ $R_G = 10K\Omega$ Bandwidth = 200Hz**

Notes: 1. Pulse width $\leq 300\ \mu sec$; duty cycle $\leq 2\%$.
2. Lowest emitter to collector voltage.

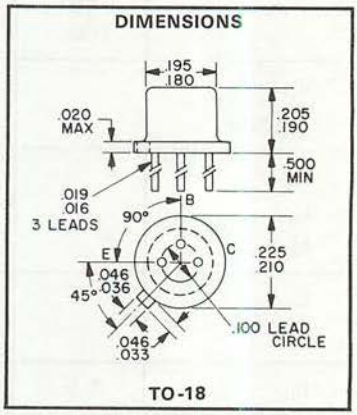
2N2586®

SILICON GENERAL PURPOSE TRANSISTORS

LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS

- **High Gain: 80 min @ $I_c = 1\mu A$**
- **Low Noise; 2dB max. @ $I_c = 1\mu A$**
- **High V_{CEO}; 45 Vdc min.**

The ITT 2N2586 is a NPN silicon planar transistor designed for application in low noise, low level amplifiers in the audio through high frequency range.



ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage (open base)	45	Volts
Emitter-to-Base Voltage	6	Volts
Collector Current (continuous)	30	mA
Junction Temperature (operating)	−65 to +175	°C
(storage)	−65 to +200	°C
Total Power Dissipation @ $T_C = 25°C$ (derate 4.0 mW/°C above 25°C)	0.6	Watts
Total Power Dissipation @ $T_A = 25°C$ (derate 2.0 mW/°C above 25°C)	0.3	Watts

2H

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted

SYMBOL	MIN.	MAX.	UNITS	CONDITIONS
BV_{CBO}	60		Vdc	$I_C = 10\mu A$
LV_{CEO}[1,2]	**45**		**Vdc**	**$I_C = 10mA$**
BV_{EBO}	6.0		Vdc	$I_E = 10\mu A$
h_{FE}	**80**			$I_C = 1\mu A$ $V_{CE} = 5V$
	120	360		$I_C = 10\mu A$ $V_{CE} = 5V$
	150			$I_C = 500\mu A$ $V_{CE} = 5V$
		600		$I_C = 10mA$ $V_{CE} = 5V$
	40			$I_C = 10\mu A$ $V_{CE} = 5V$ $T_A = -55°C$
$V_{CE}(sat)$		0.5	Vdc	$I_C = 10mA$ $I_B = 0.5mA$
$V_{BE}(sat)$	0.7	0.9	Vdc	$I_C = 10mA$ $I_B = 0.5mA$
I_{CBO}		2.0	nA	$V_{CB} = 45V$
I_{CES}		2.0	nA	$V_{CE} = 45V$
I_{CES}		10	μA	$V_{CE} = 45V$ $T_A = 170°C$
I_{CEO}		2.0	nA	$V_{CE} = 5V$
I_{EBO}		2.0	nA	$V_{EB} = 5V$
C_{ob}		7.0	pF	$V_{CB} = 5V$ $f = 1mHz$
h_{fe}	150	600		$I_C = 1mA$ $V_{CE} = 5V$ $f = 1KHz$
	1.5			$I_C = 500\mu A$ $V_{CE} = 5V$ $f = 30mHz$
h_{ie}	4.5	18	kohms	$I_C = 1mA$ $V_{CE} = 5V$ $f = 1KHz$
h_{oe}		100	μmhos	$I_C = 1mA$ $V_{CE} = 5V$ $f = 1KHz$
NF		**2.0**	**dB**	**$I_C = 1\mu A$ $V_{CE} = 5V$ $R_G = 1M\Omega$ $f = 10KHz$**
		2.0	**dB**	**$I_C = 10\mu A$ $V_{CE} = 5V$ $R_G = 10K\Omega$ $f = 10KHz$**
		3.0	**dB**	**$I_C = 10\mu A$ $V_{CE} = 5V$ $R_G = 10K\Omega$ $f = 1KHz$**
		3.5	**dB**	**$I_C = 1\mu A$ $V_{CE} = 5V$ $R_G = 1M\Omega$ $f = 1KHz$**

Notes: 1. Pulse width ≤ 300 μsec; duty cycle $\leq 2\%$.
2. Lowest emitter to collector voltage.

2N3019, 2N3020Ⓕ

NPN SILICON HIGH VOLTAGE SWITCHING AND AMPLIFIER TRANSISTORS

Package: TO-5

The ITT 2N3019 and 2N3020 are NPN silicon planar epitaxial transistors designed primarily for amplifier and switching applications. These devices feature high breakdown voltages, low leakage currents, low capacity and a beta useful over an extremely wide current range. Switching operation at 1.0 ampere is permissible due to the low saturation voltage.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, No Time Limit)	+300°C
Total Device Dissipation	
@ T_C = 25°C (Notes 2 and 3)	5.0 Watts
@ T_A = 25°C (Notes 2 and 3)	0.8 Watt
Collector-Base Voltage	140 Volts
Collector-Emitter Voltage (Note 4)	80 Volts
Emitter-Base Voltage	7.0 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	90	–	–	(2N3019) I_C = 10 mA, V_{CE} = 10 Volts
	40	120	–	(2N3020) (Note 5)
h_{FE}	100	300	–	(2N3019) I_C = 150 mA, V_{CE} = 10 Volts
	40	120	–	(2N3020) (Note 5)
h_{FE}	50	–	–	(2N3019) I_C = 0.1 mA, V_{CE} = 10 Volts
	30	100	–	(2N3020)
h_{FE}	50	–	–	(2N3019) I_C = 500 mA, V_{CE} = 10 Volts
	30	100	–	(2N3020) (Note 5)
h_{FE}	15	–	–	(2N3019) I_C = 1.0 A, V_{CE} = 10 Volts
	15	–	–	(2N3020) (Note 5)
h_{FE}(−55°C)	40	–	–	(2N3019) I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
$V_{CE(sat)}$	–	0.2	Volt	(2N3019) I_C = 150 mA, I_B = 15 mA
	–	0.2	Volt	(2N3020) (Note 5)
$V_{CE(sat)}$	–	0.5	Volt	(2N3019) I_C = 500 mA, I_B = 15 mA
	–	0.5	Volt	(2N3020) (Note 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{BE(sat)}$	–	1.1	Volts	(2N3019) I_C = 150 mA, I_B = 15 mA
	–	1.1	Volts	(2N3020) (Note 5)
h_{fe}	5.0	–	–	(2N3019) I_C = 50 mA, V_{CE} = 10 Volts
	4.0	–	–	(2N3020)
C_{obo}	–	12	pf	(2N3019) I_E = 0, V_{CB} = 10 Volts
	–	12	pf	(2N3020)
C_{ibo}	–	60	pf	(2N3019) I_C = 0, V_{EB} = 0.5 Volt
	–	60	pf	(2N3020)
I_{CBO}	–	10	nA	(2N3019) I_E = 0, V_{CB} = 90 Volts
	–	10	nA	(2N3020)
I_{CBO}(150°C)	–	10	μA	2N3019) I_E = 0, V_{CB} = 90 Volts
	–	10	μA	(2N3020)
I_{EBO}	–	10	nA	(2N3019) I_C = 0, V_{EB} = 5.0 Volts
	–	10	nA	(2N3020)
BV_{CBO}	140	–	Volts	(2N3019) I_C = 100 μA, I_E = 0
	140	–	Volts	(2N3020)
$V_{CEO(sust)}$	80	–	Volts	(2N3019) I_C = 30 mA, I_B = 0
	80	–	Volts	(2N3020) (pulsed) (Notes 4 and 5)
BV_{EBO}	7.0	–	Volts	(2N3019) I_C = 0, I_E = 100 μA
	7.0	–	Volts	(2N3020)
$r_b'C_c$	–	400	psec	(2N3019) I_C = 10 mA, V_{CB} = 10 Volts
	–	400	psec	(2N3020)
NF	–	4	dB	(2N3019) I_C = 100 μA, V_{CE} = 10 Volts (Note 6)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 350°C/Watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 218° C/Watt (derating factor of 4.6 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≤ 1%.

(6) f = 1.0 kc; R_S = 1 KΩ.

2N3053

NPN SILICON SWITCHING AND AMPLIFIER TRANSISTOR

Package: TO-5

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	40 Volts
Collector-Base Voltage	60 Volts
Emitter-Base Voltage	5 Volts
Collector Current — Continuous	700 mA
Total Device Dissipation @ $T_C = 25°C$	5 Watts
Derate above 25°C	28.6 mW/°C
Operating Junction Temperature Range	200 °C
Storage Temperature Range	−65 to +200 °C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	40	–	Volts	$I_C = 100\ \mu A$, $I_E = 0$
BV_{CER}	50	–	Volts	$I_C = 100$ mA, $R_{BE} = 10$ ohms
BV_{CBO}	60	–	Volts	$I_C = 100\ \mu A$, $I_E = 0$
BV_{EBO}	5	–	Volts	$I_E = 100\ \mu A$, $I_C = 0$
I_{CEX}	–	0.25	μA	$V_{CE} = 60$ Volts, $V_{EB(off)} = 1.5$ Volts
I_{BL}	–	0.25	μA	$V_{CE} = 60$ Volts, $V_{EB(off)} = 1.5$ Volts
h_{FE}	25	–	–	$I_C = 150$ mA, $V_{CE} = 2.5$ Volts
h_{FE}	50	250	–	$I_C = 150$ mA, $V_{CE} = 10$ Volts*
$V_{CE(sat)}$	–	1.4	Volts	$I_C = 150$ mA, $I_B = 15$ mA
$V_{BE(sat)}$	–	1.7	Volts	$I_C = 150$ mA, $I_B = 15$ mA
$V_{BE(on)}$	–	1.7	Volts	$I_C = 150$ mA, $V_{CE} = 2.5$ Volts
f_T	100	–	MHz	$I_C = 50$ mA, $V_{CE} = 10$ Volts, $f = 20$ MHz
C_{ob}	–	15	pF	$V_{CB} = 10$ Volts, $I_E = 0$, $f = 140$ kHz
C_{ib}	–	80	pF	$V_{BE} = 0.5$ Volt, $I_C = 0$, $f = 100$ kHz

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%

Package: TO-5

HIGH VOLTAGE NPN SILICON AMPLIFIER AND SATURATED SWITCHING TRANSISTORS

- **High Voltage** ..... LV_{CEO} = 40 Volts (min) (2N3109/10); 60 Volts (min) (2N3107/8)
- **Low Saturation Voltage** ..... $V_{CE(sat)}$ = 1.0 Volt (max) at 1.0 A
- **Low Noise** ..... NF = 7.0 dB (max) at 1.0 kHz
- **Medium Switching Speed** ..... t_{on} = 200 ns (max at 150 mA
  t_{off} = 600 ns (max) at 150 mA
- **High Gain** ..... h_{FE} = 100 - 300 at 150 mA
  h_{FE} = 40 (min) at 500 mA

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 second time limit)	300°C Maximum
Total Device Dissipation (Notes 2 and 3) @:	
T_C = 25°C	5.0 Watts
T_A = 25°C	0.8 Watt
Collector-Base Voltage	
(2N3107, 2N3108)	100 Volts
(2N3109, 2N3110)	80 Volts
Collector-Emitter Voltage (Note 4)	
(2N3107, 2N3108)	60 Volts
(2N3109, 2N3110)	40 Volts
Emitter-Base Voltage	
(2N3107, 2N3108)	7.0 Volts
(2N3109, 2N3110)	7.0 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3107, 2N3109	100	190	300	–	I_C = 150 mA, V_{CE} = 1.0 Volt
	2N3108, 2N3110	40	70	120	–	(Note 5)
h_{FE}	2N3107, 2N3109	40	90	–	–	I_C = 500 mA, V_{CE} = 10 Volts
	2N3108, 2N3110	25	50	–	–	(Note 5)
h_{FE}	2N3107, 2N3109	35	75	–	–	I_C = 0.1 mA, V_{CE} = 10 Volts
	2N3108, 2N3110	20	40	–	–	
$h_{FE(-55°C)}$	2N3107, 2N3109	30	120	–	–	I_C = 150 mA, V_{CE} = 10 Volts
	2N3108, 2N3110	15	26	–	–	(Note 5)
$V_{BE(sat)}$	2N3107, 2N3109	–	0.86	1.1	Volts	I_C = 150 mA, I_B = 15 mA
	2N3108, 2N3110	–	0.86	1.1	Volts	(Note 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
$V_{BE(sat)}$	2N3107, 2N3109	–	1.5	2.0	Volts	I_C = 1.0 A, I_B = 100 mA
	2N3108, 2N3110	–	1.5	2.0	Volts	(Notes 5 and 6)
$V_{CE(sat)}$	2N3107, 2N3109	–	0.16	0.25	Volt	I_C = 150 mA, I_B = 15 mA
	2N3108, 2N3110	–	0.16	0.25	Volt	(Note 5)
$V_{CE(sat)}$	2N3107, 2N3109	–	0.76	1.0	Volt	I_C = 1000 mA, I_B = 100 mA
	2N3108, 2N3110	–	0.76	1.0	Volt	(Notes 5 and 6)
h_{fe}	2N3107, 2N3109	3.5	10	–	–	I_C = 50 mA, V_{CE} = 10 Volts
	2N3108, 2N3110	3.0	4.3	–	–	
C_{obo}	2N3107	–	–	20	pF	I_E = 0, V_{CB} = 10 Volts
	2N3108	–	–	20	pF	
C_{obo}	2N3109	–	–	25	pF	I_E = 0, V_{CB} = 10 Volts
	2N3110	–	–	25	pF	
C_{ibo}	2N3107, 2N3109	–	62	80	pF	I_E = 0, V_{EB} = 0.5 Volt
	2N3108, 2N3110	–	62	80	pF	
I_{CES}	2N3107, 2N3109	–	0.4	10	nA	V_{CE} = 60 Volts, V_{EB} = 0
	2N3108, 2N3110	–	0.4	10	nA	
$I_{CBO(150°C)}$	2N3107, 2N3109	–	0.5	10	μA	V_{CB} = 60 Volts, I_E = 0
	2N3108, 2N3110	–	0.5	10	μA	
I_{EBO}	2N3107, 2N3109	–	0.05	10	nA	I_C = 0, V_{EB} = 5.0 Volts
	2N3108, 2N3110	–	0.05	10	nA	
BV_{CBO}	2N3107	100	–	–	Volts	I_E = 0, I_C = 100μA
	2N3108	100	–	–	Volts	
BV_{CBO}	2N3109	80	–	–	Volts	I_E = 0, I_C = 100μA
	2N3110	80	–	–	Volts	
$V_{CEO(sust)}$	2N3107	60	–	–	Volts	I_B = 0, I_C = 30 mA
	2N3108	60	–	–	Volts	(Notes 4 and 5)
$V_{CEO(sust)}$	2N3109	40	–	–	Volts	I_B = 0, I_C = 30 mA
	2N3110	40	–	–	Volts	(Notes 4 and 5)
BV_{EBO}	2N3107, 2N3109	7.0	–	–	Volts	I_C = 0, I_E = 100μA
	2N3108, 2N3110	7.0	–	–	Volts	
NF	2N3107, 2N3109	–	3.5	7.0	dB	I_C = 30μA, V_{CE} = 10 Volts,
	2N3108, 2N3110	–	3.5	7.0	dB	BW = 200 Hz, R_S = 1.0 k ohm

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
t_{on}	2N3107, 2N3109	–	120	200	ns	$I_C \approx 150$ mA, $I_{B1} \approx 7.5$ mA,
	2N3108, 2N3110	–	120	200	ns	$I_{B2} \approx -7.5$ mA (Note 7)
t_{off}	2N3107, 2N3109	–	–	1000	ns	$I_C \approx 150$ mA, $I_{B1} \approx 7.5$ mA,
	2N3108, 2N3110	–	350	600	ns	$I_{B2} \approx -7.5$ mA (Note 7)

TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

Symbol	2N3107 2N3109	2N3108 2N3110	Units	Conditions
h_{ib}	27	27	ohms	I_C = 1.0 mA, V_{CB} = 5.0 Volts
h_{ob}	0.12	0.12	μmhos	I_C = 1.0 mA, V_{CB} = 5.0 Volts
h_{rb}	1.8	0.5	X10^{-4}	I_C = 1.0 mA, V_{CB} = 5.0 Volts
h_{ie}	5000	1800	ohms	I_C = 1.0 mA, V_{CE} = 5.0 Volts
h_{oe}	20	8.0	μmhos	I_C = 1.0 mA, V_{CE} = 5.0 Volts
h_{re}	6.0	2.1	X10^{-4}	I_C = 1.0 mA, V_{CE} = 5.0 Volts
h_{fe}	170	60	–	I_C = 1.0 mA, V_{CE} = 5.0 Volts

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low-duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 35°C/Watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 218°C/Watt (derating factor of 4.57 mW/°C).

(4) This rating refers to a high-current point where collector to emitter voltage is lowest.

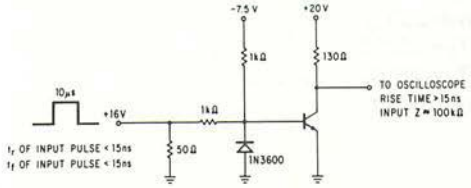
(5) Pulse Conditions: length = 300μs; duty cycle = 1%.

(6) Saturation voltage measured with 1/4" lead length.

(7) See test circuit for exact values of I_C, I_{B1}, and I_{B2}.

SCHEMATIC

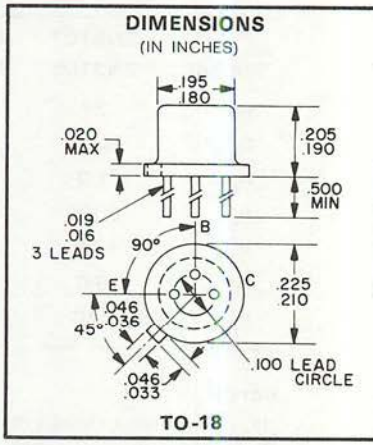
FIGURE 1 – SWITCHING CIRCUIT



LOW LEVEL LOW NOISE NPN SILICON PLANAR TRANSISTORS

- **High Gain; 100 Min. @ $I_c = 1\mu A$**
- **Low noise; 1dB @ $I_c = 5\mu A$**
- **High V_{CEO}; 60 Vdc min.**

The ITT 2N3117 is a double-diffused silicon planar transistor designed for application in low level, low noise amplifier from dc to 60 Hz. Low noise and high gain at 1μA permits microwatt operation where power supply drain is a factor.



ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	60	Volts
Collector-to-Emitter Voltage (open base)	60	Volts
Emitter-to-Base Voltage	6	Volts
Collector Current	50	mA
Junction Temperature (op. and stg.)	−65 to +200	°C
Total Power Dissipation @ $T_C = 25°C$ (derate 6.8 mW/°C above 25°C)	1.2	Watts
@ $T_C = 100°C$	0.68	Watts
Total Power Dissipation @ $T_A = 25°C$ (derate 2.06 mW/°C above 25°C)	0.36	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

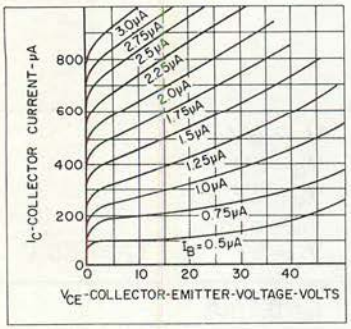
SYMBOL	MIN.	MAX.	UNIT	CONDITION
BV_{CBO}	60		Vdc	$I_C = 10\mu A$
LV_{CEO}[1,2]	**60**		**Vdc**	**$I_C = 10mA$**
BV_{EBO}	6.0		Vdc	$I_C = 10\mu A$
h_{FE}	**100**			**$I_C = 1\mu A$ $V_{CE} = 5V$**
	250	500		$I_C = 10\mu A$ $V_{CE} = 5V$
	300			$I_C = 100\mu A$ $V_{CE} = 5V$
	400			$I_C = 1mA$ $V_{CE} = 5V$
	50			$I_C = 10\mu A$ $V_{CE} = 5V$ $T_A = -55°C$
$V_{CE}(sat)$		0.35	Vdc	$I_C = 1mA$ $I_B = 0.1mA$
V_{BE}		0.7	Vdc	$I_C = 100\mu A$ $V_{CE} = 5.0V$
I_{CBO}		10	nA	$V_{CB} = 45V$
I_{CBO}		10	μA	$V_{CE} = 45V$ $T_A = 150°C$
I_{EBO}		10	nA	$V_{EB} = 5V$
C_{ob}		4.5	pF	$V_{CB} = 5V$ f = 1mHz
C_{ib}		6.0	pF	$V_{EB} = 0.5V$ f = 1mHz
h_{fe}	2			$I_C = 0.5mA$ $V_{CE} = 5V$ f = 30mHz
	400	900		$I_C = 1mA$ $V_{CE} = 5V$ f = 1KHz
h_{ie}	10	24	kohms	$I_C = 1mA$ $V_{CE} = 5V$ f = 1KHz
h_{oe}		40	μmho	$I_C = 1mA$ $V_{CE} = 5V$
h_{re}		800	$X10^{-6}$	$I_C = 1mA$ $V_{CE} = 5V$
NF		**1.0**	**dB**	**$I_C = 5\mu A$ $V_{CE} = 5V$ $R_S = 50K\Omega$ f = 10KHz Bandwidth = 1.0KHz**
		1.0	**dB**	**$I_C = 5\mu A$ $V_{CE} = 5V$ $R_S = 50K\Omega$ f = 1.0KHz Bandwidth = 200Hz**
		4.0	**dB**	**$I_C = 30\mu A$ $V_{CE} = 5V$ $R_S = 10K\Omega$ f = 100Hz Bandwidth = 20Hz**
		15	**dB**	**$I_C = 30\mu A$ $V_{CE} = 5V$ $R_S = 10K\Omega$ f = 10Hz Bandwidth = 2Hz**

Notes: 1. Pulse width ≤300 μsec; duty cycle ≤2%.
2. Lowest emitter to collector voltage.

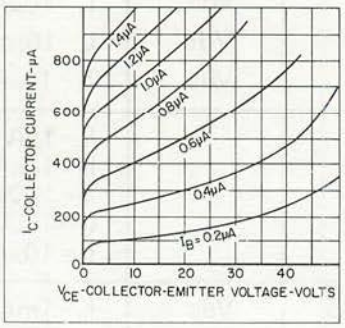
TYPICAL CHARACTERISTICS

COLLECTOR CHARACTERISTICS

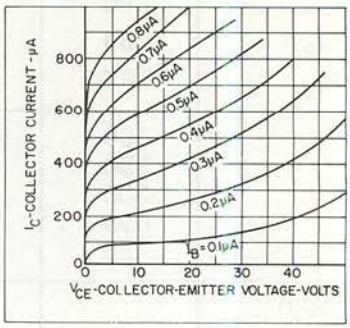
$T_A = -55°C$



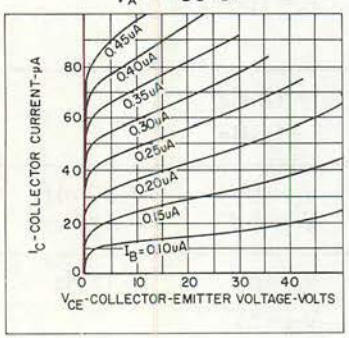
$T_A = 25°C$



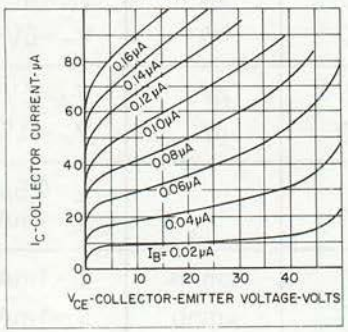
$T_A = 100°C$



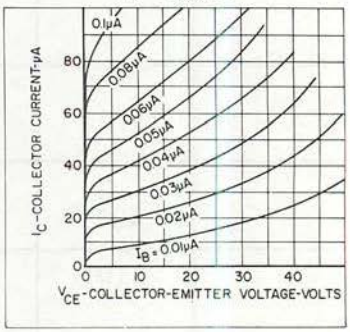
$T_A = -55°C$



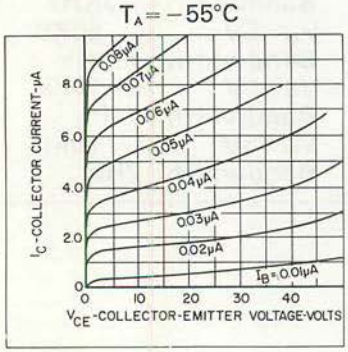
$T_A = 25°C$



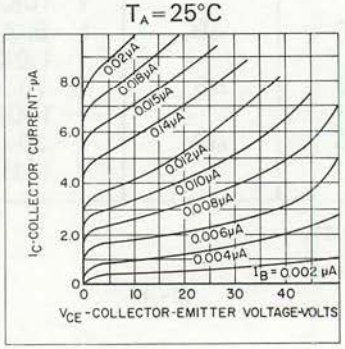
$T_A = 100°C$



$T_A = -55°C$

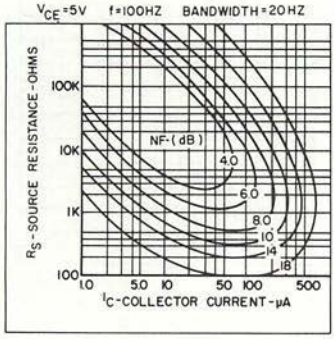


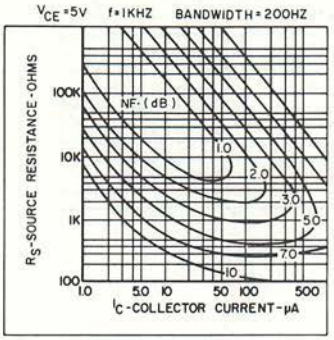
$T_A = 25°C$

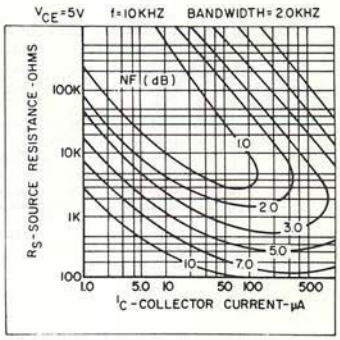


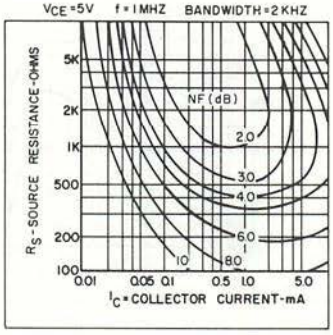
TYPICAL CHARACTERISTICS, continued

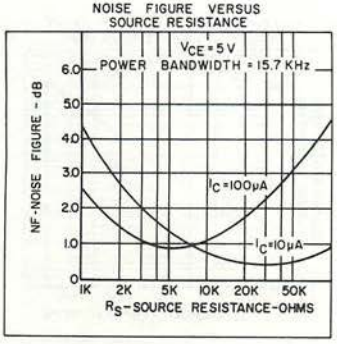
Contours of Constant Narrow Band Noise Figure

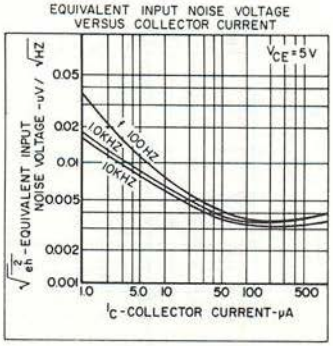


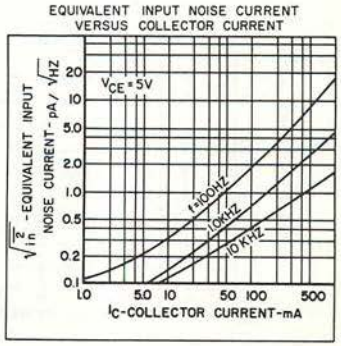






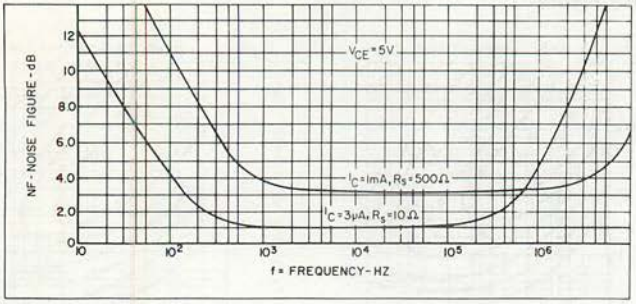




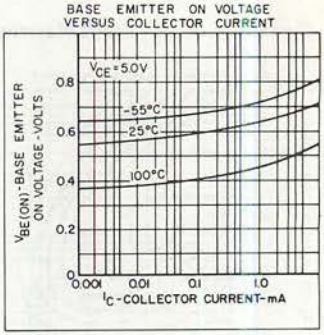


TYPICAL CHARACTERISTICS, continued

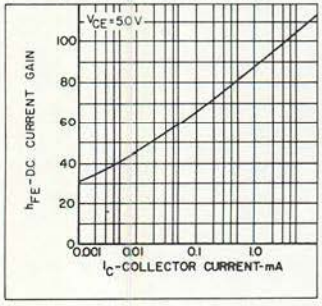
NOISE FIGURE VERSUS FREQUENCY



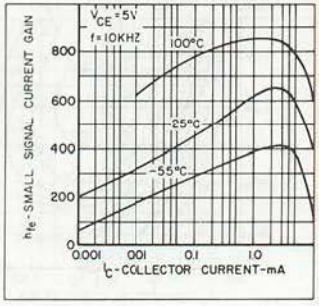
BASE EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



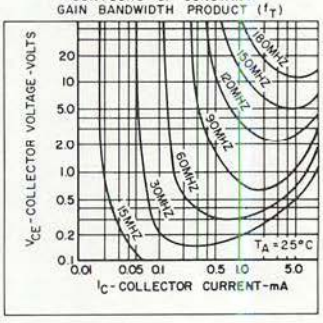
MINIMUM DC CURRENT GAIN AT -55°C VERSUS COLLECTOR CURRENT



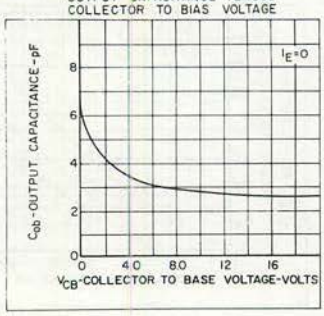
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



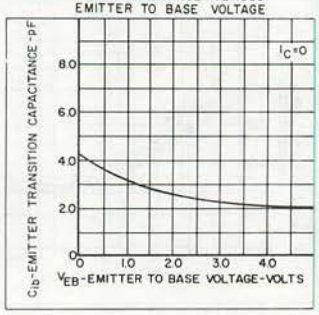
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



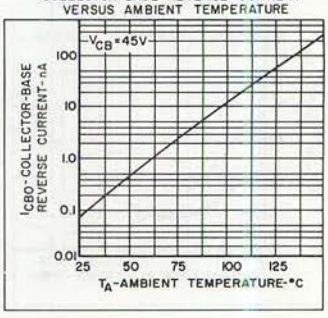
OUTPUT CAPACITANCE VERSUS COLLECTOR TO BIAS VOLTAGE



INPUT CAPACITANCE VERSUS EMITTER TO BASE VOLTAGE

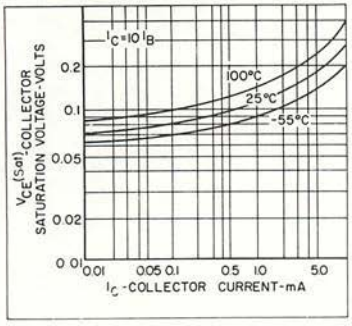


COLLECTOR-BASE REVERSE CURRENT VERSUS AMBIENT TEMPERATURE

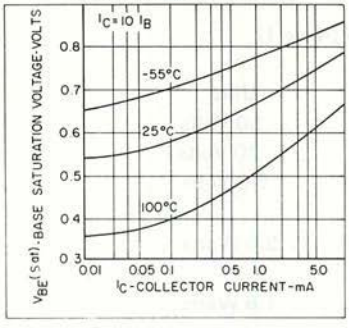


TYPICAL CHARACTERISTICS, continued

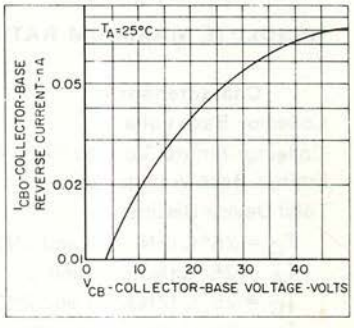
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

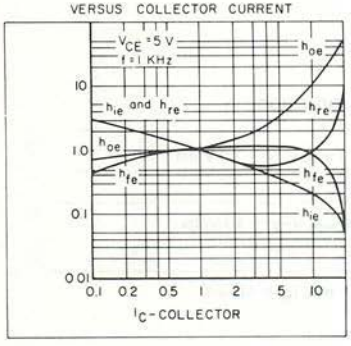


COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE

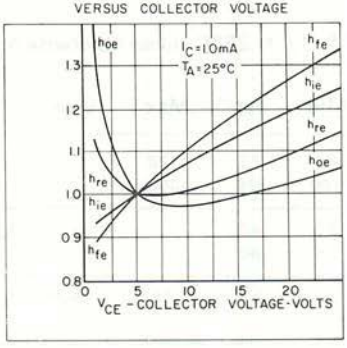


NORMALIZED COMMON EMITTER TRANSFER CHARACTERISTICS

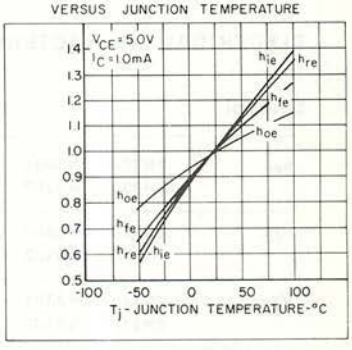
VERSUS COLLECTOR CURRENT



VERSUS COLLECTOR VOLTAGE



VERSUS JUNCTION TEMPERATURE



2N3299, 2N3300, 2N3301, 2N3302 Ⓕ
HIGH-SPEED NPN SILICON RF TRANSISTOR AND SWITCHING TRANSISTOR

Packages:
2N3299, 2N3300 TO-18
2N3301, 2N3302 TO-5

The ITT 2N3299 through 2N3302 are NPN silicon planar epitaxial transistors designed to cover a wide range of RF amplifier and high-speed switching applications. These devices feature a minimum LV_{CEO} of 30 volts, a minimum f_T of 250 Mc at I_C = 50 mA, V_{CE} = 10 volts, together with a maximum $V_{CE(sat)}$ of 0.6 volt at 500 mA and h_{FE} specified from 100 μA to 500 mA collector current.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	60 Volts
Collector-Emitter Voltage (Note 4)	30 Volts
Emitter-Base Voltage	5.0 Volts
Total Device Dissipation @:	
T_C = 25°C (2N3299 and 2N3300)	3.0 Watts
T_A = 25°C (Notes 2 and 3)	
T_C = 25°C (2N3301 and 2N3302)	1.8 Watts
T_A = 25°C (Notes 2 and 3)	
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3299, 2N3301	40	75	120	-	I_C = 150 mA, V_{CE} = 10 Volts*
	2N3300, 2N3302	100	220	300	-	(Note 5)
h_{FE}	2N3299, 2N3301	20	40	-	-	I_C = 100 μA, V_{CE} = 10 Volts
	2N3300, 2N3302	35	80	-	-	
$V_{CE(sat)}$	2N3299, 2N3301	-	0.4	0.6	Volt	I_C = 500 mA, I_B = 50 mA
	2N3300, 2N3302					
$V_{BE(sat)}$	2N3299, 2N3301	-	1.1	1.5	Volts	I_C = 500 mA, I_B = 50 mA
	2N3300, 2N3302					
$V_{CEO(sust)}$	2N3299, 2N3301	30	-	-	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
	2N3300, 2N3302					
I_{CES}	2N3299, 2N3301	-	0.2	10	nA	V_{CE} = 50 Volts, V_{EB} = 0
	2N3300, 2N3302					
h_{FE}	2N3299, 2N3301	35	70	-	-	I_C = 10 mA, V_{CE} = 10 Volts (Note 5)
	2N3300, 2N3302	75	205	-	-	
h_{FE}	2N3299, 2N3301	25	58	-	-	I_C = 1.0 mA, V_{CE} = 10 Volts
	2N3300, 2N3302	50	140	-	-	
h_{FE}	2N3299, 2N3301	20	62	-	-	I_C = 500 mA, V_{CE} = 10 Volts (Note 5)
	2N3300, 2N3302	50	125	-	-	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3299, 2N3301	20	50	-	-	I_C = 150 mA, V_{CE} = 1.0 Volt (Note 5)
	2N3300, 2N3302	50	75	-	-	
$V_{CE(sat)}$	2N3299, 2N3301	-	0.14	0.22	Volt	I_C = 150 mA, I_B = 15 mA
	2N3300, 2N3302					
$V_{BE(sat)}$	2N3300, 2N3301	-	0.9	1.1	Volts	I_C = 150 mA, I_B = 15 mA
	2N3300, 2N3302					
$I_{CES(150°C)}$	2N3299, 2N3301	-	0.2	10	μA	V_{CE} = 50 Volts, V_{EB} = 0
	2N3300, 2N3302					
I_{EBO}	2N3299, 2N3301	-	0.1	10	nA	I_C = 0, V_{EB} = 3.0 Volts
	2N3300, 2N3302					
h_{fe}	2N3299, 2N3301	2.5	4.0	-	-	I_C = 50 mA, V_{CE} = 10 Volts
	2N3300, 2N3302					
C_{obo}	2N3299, 2N3301	-	6.0	8.0	pf	I_E = 0, V_{CB} = 10 Volts
	2N3300, 2N3302					
C_{ibo}	2N3299, 2N3301	-	14	20	pf	I_C = 0, V_{EB} = 2.0 Volts
	2N3300, 2N3302					
t_{on}	2N3299, 2N3301	-	14	60	nsec	I_C = 300 mA, I_{B1} = 30 mA (Note 6)
	2N3300, 2N3302					
t_{off}	2N3299, 2N3301	-	80	150	nsec	I_C = 300 mA, I_{B1} = 30 mA (Note 6)
	2N3300, 2N3302					
BV_{CBO}	2N3299, 2N3301	60	-	-	Volts	I_C = 10 μA, I_E = 0
	2N3300, 2N3302					
BV_{EBO}	2N3299, 2N3301	5.0	-	-	Volts	I_E = 10 μA, I_C = 0
	2N3300, 2N3302					

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance for the 2N3299 and 2N300 of 58.3°C/watt (derating factor of 17.2 mW/°C); for the 2N3301 and 2N3302 97.3°C/watt (derating factor of 10.3 mW/°C). Junction-to-ambient thermal resistance for the 2N3299 and 2N3300 of 219°C/watt (derating factor of 4.56 mW/°C); for the 2N3301 and 2N3302 486°C/watt (derating factor of 2.06 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≤ 2%.

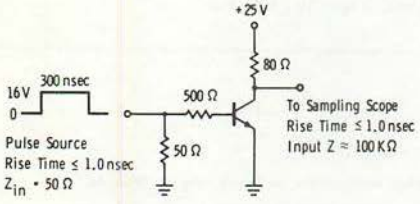
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1 kc)

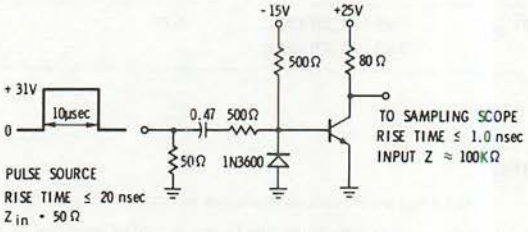
Symbol	V_{CE} = 1.0V, I_C = 10 mA	V_{CE} = 10V, I_C = 10 mA	V_{CE} = 1.0V, I_C = 50 mA	V_{CE} = 10V, I_C = 50 mA	Units
		2N3299 • 2N3301			
h_{ie}	380	460	170	350	Ohms
h_{oe}	410	55	950	405	μmhos
h_{re}	2250	130	2650	500	X 10^{-4}
h_{fe}	72	90	48	97	–
		2N3300 • 2N3302			
h_{ie}	780	950	190	880	Ohms
h_{oe}	440	83	1300	660	μmhos
h_{re}	1900	205	5400	1500	X 10^{-6}
h_{fe}	140	170	53	220	–

SCHEMATIC

t_{on} TEST CIRCUIT



t_{off} TEST CIRCUIT



Package: TO-52

HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	40 Volts
Collector-Emitter Voltage	10 Volts
Emitter-Base Voltage	6 Volts
Collector Current	500 mA
Total Device Dissipation @ T_A = 25°C	360 mW
Derate above 25°C	2.06 mW/°C
Total Device Dissipation @ T_C = 25°C	1.2 Watts
Derate above 25°C	6.9 mW/°C
Junction Temperature, Operating	+200 °C
Storage Temperature Range	−65 to +200 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CEX}	–	0.025	μA	V_{CE} = 10 Volts, $V_{EB(off)}$ = 1 Volt
I_{CEX}	–	50	μA	V_{CE} = 10 Volts, $V_{EB(off)}$ = 1 Volt, T_A = 150°C
I_{BL}	–	0.025	μA	V_{CE} = 10 Volts, V_{OB} = 1 Volt
BV_{CBO}	40	–	Volts	I_C = 10 μA, I_E = 0
BV_{CEO}*	10	–	Volts	I_C = 10 mA, I_B = 0*
BV_{EBO}	6	–	Volts	I_E = 10 μA, I_C = 0
$V_{CE(sat)}$*	–	0.25	Volt	I_C = 10 mA, I_B = 1 mA*
$V_{CE(sat)}$*	–	0.4	Volt	I_C = 150 mA, I_B = 15 mA
$V_{CE(sat)}$*	–	0.6	Volt	I_C = 300 mA, I_B = 30 mA
$V_{BE(sat)}$*	–	0.8	Volt	I_C = 10 mA, I_B = 1 mA
$V_{BE(sat)}$*	0.8	1.0	Volt	I_C = 150 mA, I_B = 15 mA
$V_{BE(sat)}$*	–	1.15	Volts	I_C = 300 mA, I_B = 30 mA
h_{FE}*	12	–	–	I_C = 1.0 mA, V_{CE} = 1 Volt
h_{FE}*	20	–	–	I_C = 10 mA, V_{CE} = 1 Volt
h_{FE}*	25	150	–	I_C = 150 mA, V_{CE} = 1 Volt
h_{FE}*	15	–	–	I_C = 300 mA, V_{CE} = 1 Volt

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
C_{ob}	–	4	pF	V_{CB} = 10 Volts, I_E = 0, f = 100 kHz
C_{ib}	–	8	pF	V_{BE} = 0.5 Volt, I_C = 0, f = 100 kHz
h_{fe}	3.5	–	–	I_C = 15 mA, V_{CE} = 10 Volts, f = 100 MHz
t_d	–	10	ns	I_C = 150 mA, I_{B1} = 15 mA, V_{EB} = 0.5 Volt, V_{CC} = 6 Volts
t_r	–	12	ns	
t_{on}	–	20	ns	
t_s	–	16	ns	I_C = 150 mA, $I_{B1} = -I_{B2}$ = 15 mA, V_{CC} = 6 Volts
t_f	–	12	ns	
t_{off}	–	25	ns	
Q_T	–	300	pC	I_C = 150 mA, I_B = 15 mA, V_{CC} = 6 Volts
h_{fe}	20	150	–	I_C = 1 mA, V_{CE} = 10 Volts, f = 1 kHz
h_{re}	–	25	$X10^{-4}$	I_C = 1 mA, V_{CE} = 10 Volts, f = 1 kHz
h_{ie}	0.6	4.5	kohms	I_C = 1 mA, V_{CE} = 10 Volts, f = 1 kHz
h_{oe}	10	100	μmhos	I_C = 1 mA, V_{CE} = 10 Volts, f = 1 kHz

* Pulse Test: PW $\leq$ 300μs, Duty Cycle $\leq$ 2%

Package: TO-5

NPN SILICON GENERAL PURPOSE AMPLIFIER AND SWITCHING TRANSISTORS

The ITT 2N3665 and 2N3666 are NPN diffused silicon planar epitaxial transistors designed primarily for general purpose amplifier and switching applications. They feature high voltage, low output capacity and a useful beta over a wide current range.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	120 Volts
Collector-Emitter Voltage (Note 4)	80 Volts
Emitter-Base Voltage	10 Volts
Collector Current	1.0 Amp
Total Device Dissipation @ T_C = 25°C	5.0 Watts
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 10 sec Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	40	120	–	(2N3665) I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
	100	300	–	(2N3666)
h_{FE}	30	–	–	(2N3665) I_C = 10 mA, V_{CE} = 10 Volts (Note 5)
	70	–	–	(2N3666)
h_{FE}	25	–	–	(2N3665) I_C = 500 mA, V_{CE} = 10 Volts (Note 5)
	50	–	–	(2N3666)
$h_{FE(-55°C)}$	16	–	–	(2N3665) I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
	40	–	–	(2N3666)
$V_{BE(sat)}$	–	1.8	Volts	(2N3665) I_C = 500 mA, I_B = 50 mA (Note 5)
	–	1.8	Volts	(2N3666)
$V_{BE(sat)}$	–	1.2	Volts	(2N3665) I_C = 150 mA, I_B = 15 mA (Note 5)
	–	1.2	Volts	(2N3666)
$V_{CE(sat)}$	–	1.2	Volts	(2N3665) I_C = 500 mA, I_B = 50 mA (Note 5)
	–	1.2	Volts	(2N3666)
$V_{CE(sat)}$	–	0.5	Volt	(2N3665) I_C = 150 mA, I_B = 15 mA (Note 5)
	–	0.5	Volt	(2N3666)
h_{fe}	3.0	–	–	(2N3665) I_C = 50 mA, V_{CE} = 10 Volts
	3.0	–	–	(2N3666)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
C_{obo}	–	12	pf	(2N3665) I_E = 0, V_{CB} = 10 Volts
	–	12	pf	(2N3666)
C_{ibo}	–	60	pf	(2N3665) I_C = 0, V_{EB} = 0.5 Volt
	–	60	pf	(2N3666)
I_{CEX}	–	50	nA	V_{CE} = 80 Volts, V_{EB} = 0.5 Volt
I_{CBO}	–	50	nA	V_{CB} = 60 Volts, I_E = 0
$I_{CBO(150°C)}$	–	50	μA	V_{CB} = 60 Volts, I_E = 0
I_{BEX}	–	50	nA	V_{CE} = 80 Volts, V_{EB} = 0.5 Volt
I_{EBO}	–	50	nA	I_C = 0, V_{EB} = 5.0 Volts
BV_{CBO}	120	–	Volts	I_C = 100 μA, I_E = 0
$V_{CEO(sust)}$	80	–	Volts	I_C = 10 mA, I_B = 0 (Notes 4 and 5)
BV_{EBO}	10	–	Volts	I_C = 0, I_E = 100 uA
BV_{CER}	90	–	Volts	I_C = 10 mA, R_{BE} = 10 ohms (Notes 4 and 5)
$t_{on} + t_{off}$	–	4.0	μsec	(2N3665) (See Figure 1)
	–	5.0	μsec	(2N3666)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 35°C/watt (derating factor of 28.6 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

SCHEMATIC

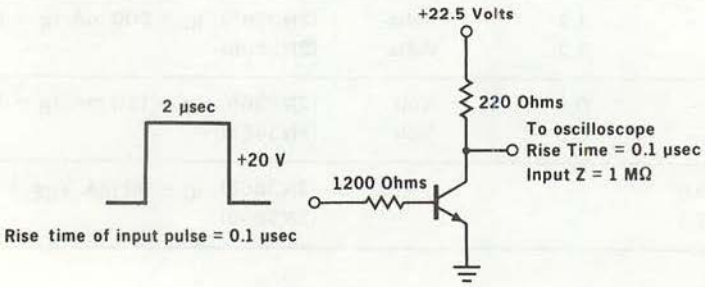


FIGURE 1 – SWITCHING CIRCUIT

Package: TO-18

NPN SILICON HIGH FREQUENCY IF-RF AMPLIFIER TRANSISTORS

The ITT 2N3700 and 2N3701 are NPN diffused silicon planar epitaxial transistors designed primarily for high frequency applications in IF-RF amplifier circuits. The planar structure provides low saturation voltage at high collector currents and low leakage current over a wide range of temperature and bias conditions. Useful frequency range: DC to 100 MHz.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec. time limit)	300°C Maximum
Total Device Dissipation	
@ T_C = 25°C (Notes 2 and 3)	1.8 Watts
@ T_C = 100°C (Notes 2 and 3)	1.0 Watt
@ T_A = 25°C (Notes 2 and 3)	0.5 Watt
Collector-Base Voltage	140 Volts
Collector-Emitter Voltage (Note 4)	80 Volts
Emitter-Base Voltage	7.0 Volts
Collector Current	1.0 Amp.

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 97°C/watt (derating factor of 10.3 mW/°C); junction-to-ambient thermal resistance of 350°C/watt (derating factor of 2.85 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≤ 1%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	100	300	–	(2N3700) I_C = 150 mA, V_{CE} = 10 Volts
	40	120	–	(2N3701) (Note 5)
h_{FE}	90	–	–	(2N3700) I_C = 10 mA, V_{CE} = 10 Volts
	40	120	–	(2N3701) (Note 5)
h_{FE}	50	–	–	(2N3700) I_C = 0.1 mA, V_{CE} = 10 Volts
	30	100	–	(2N3701) (Note 5)
h_{FE}	50	–	–	(2N3700) I_C = 500 mA, V_{CE} = 10 Volts
	30	100	–	(2N3701) (Note 5)
h_{FE}	15	–	–	(2N3700) I_C = 1.0 A, V_{CE} = 10 Volts
	15	–	–	(2N3701) (Note 5)
h_{FE}(−55°C)	40	–	–	(2N3700) I_C = 150 mA, V_{CE} = 10 Volts
	–	–	–	(2N3701) (Note 5)
$V_{BE(sat)}$	–	1.1	Volts	(2N3700) I_C = 150 mA, I_B = 15 mA
	–	1.1	Volts	(2N3701)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CE(sat)}$	–	0.2	Volt	(2N3700) I_C = 150 mA, I_B = 15 mA
	–	0.2	Volt	(2N3701) (Note 5)
$V_{CE(sat)}$	–	0.5	Volt	(2N3700) I_C = 500 mA, I_B = 50 mA
	–	0.5	Volt	(2N3701) (Note 5)
h_{fe}	5.0	10	–	(2N3700) I_C = 50 mA, V_{CE} = 10 Volts
	4.0	10	–	(2N3701)
h_{fe}	80	400	–	(2N3700) I_C = 1.0 mA, V_{CE} = 5.0 Volts
	30	200	–	(2N3701)
C_{obo}	–	12	pf	(2N3700) I_E = 0, V_{CB} = 10 Volts
	–	12	pf	(2N3701)
C_{ibo}	–	60	pf	(2N3700) I_C = 0, V_{EB} = 0.5 Volt
	–	60	pf	(2N3701)
$r_b'C_c$	25	400	psec	(2N3700) I_C = 10 mA, V_{CB} = 10 Volts
	25	400	psec	(2N3701)
I_{CBO}	–	10	nA	(2N3700) I_E = 0, V_{CB} = 90 Volts
	–	10	nA	(2N3701)
I_{CBO}(150°C)	–	10	μA	(2N3700) I_E = 0, V_{CB} = 90 Volts
	–	10	μA	(2N3701)
I_{EBO}	–	10	nA	(2N3700) I_C = 0, V_{EB} = 5.0 Volts
	–	10	nA	(2N3701)
BV_{CBO}	140	–	Volts	(2N3700) I_C = 100μA, I_E = 0
	140	–	Volts	(2N3701)
$V_{CEO(sust)}$	80	–	Volts	(2N3700) I_C = 30 mA, I_B = 0 (Notes 4 and 5)
	80	–	Volts	(2N3701)
BV_{EBO}	7.0	–	Volts	(2N3700) I_C = 0, I_E = 100μA
	7.0	–	Volts	(2N3701)
NF	–	4.0	dB	(2N3700) I_C = 100μA, V_{CE} = 10 Volts, f = 1 KHz, R_G = 1 KΩ

Package: To-92

2N5209, 2N5210

LOW-LEVEL, LOW-NOISE NPN SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	50 Vdc
Collector-Base Voltage	50 Vdc
Emitter-Base Voltage	4.5 Vdc
Collector Current - Continuous	50 mAdc
Peak	100 mAdc

Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	50	–	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{CBO}	50	–	–	Vdc	I_C = 0.1 mAdc, I_E = 0
I_{CBO}	–	–	10	nAdc	V_{CB} = 10 Vdc, I_E = 0
	–	–	50		V_{CB} = 35 Vdc, I_E = 0
I_{EBO}	–	–	50	nAdc	V_{BE} = 3.0 Vdc, I_C = 0
	–	–	100		V_{BE} = 4.5 Vdc, I_C = 0
h_{FE}	100	–	300	–	I_C = 100 uAdc, V_{CE} = 5.0 Vdc 2N5209
	200	–	600		2N5210
	150	–	–		I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc 2N5209
	250	–	–		2N5210
	150	–	–		I_C = 10 mAdc, V_{CE} = 5.0 Vdc 2N5209
	250	–	–		2N5210
$V_{CE(sat)}$	–	–	0.7	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(on)}$	–	–	0.85	Vdc	I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc
f_T	30	80	–	MHz	I_C = 500 uAdc, V_{CE} = 5.0 Vdc, f = 20 MHz
C_{cb}	–	–	4.0	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz emitter guarded
h_{fe}	150	–	600	–	I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz 2N5209
	250	–	900		2N5210
NF	–	–	3.0	dB	I_C = 20 uAdc, V_{CE} = 5.0 Vdc, R_S = 22 k ohms, f = 10 Hz to 15.7 kHz 2N5209
	–	–	2.0		2N5210
	–	1.6	4.0		I_C = 20 uAdc, V_{CE} = 5.0 Vdc, R_S = 10 k ohms, f = 1.0 kHz 2N5209
	–	1.4	3.0		2N5210

2N5219

Package: To-92

GENERAL PURPOSE NPN SILICON TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	15 Vdc
Collector-Base Voltage	20 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current - Continuous	100 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	15	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{CBO}	20	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 10 Vdc, I_E = 0
I_{EBO}	–	500	nAdc	V_{BE} = 2.0 Vdc, I_C = 0
h_{FE}	35	500	–	I_C = 2.0 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.4	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$	–	1.0	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	150	–	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	35	1500	–	I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

Package: To-92

2N5220

LOW-POWER GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	15 Vdc
Collector-Base Voltage	15 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current - Continuous	500 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	15	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CBO}	15	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 10 Vdc, I_E = 0
I_{EBO}	–	100	nAdc	V_{BE} = 3.0 Vdc, I_C = 0
h_{FE}	25	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
	30	600		I_C = 50 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.5	Vdc	I_C = 150 mAdc, I_B = 15 mAdc
$V_{BE(sat)}$	–	1.1	Vdc	I_C = 150 mAdc, I_B = 15 mAdc
f_T	100	–	MHz	I_C = 20 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	10	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	30	1800	–	I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

2N5223

Package: To-92

LOW-LEVEL GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	20 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current	100 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	20	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{CBO}	25	–	Vdc	I_C = 100 μAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 μAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 10 Vdc, I_E = 0
I_{EBO}	–	500	nAdc	V_{BE} = 3.0 Vdc, I_C = 0
h_{FE}	50	800	–	I_C = 2.0 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.7	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$	–	1.2	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	150	–	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	50	1600	–	I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

Package: To-92

MEDIUM POWER NPN SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	25 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current	500 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	25	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CBO}	25	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	300	nAdc	V_{CB} = 15 Vdc, I_E = 0
I_{EBO}	–	500	nAdc	V_{BE} = 4.0 Vdc, I_C = 0
h_{FE}	25	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
	30	600		I_C = 50 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.8	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(sat)}$	–	1.0	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
f_T	50	–	MHz	I_C = 20 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	20	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	30	1800	–	I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

2N5368 thru 2N5371
GENERAL PURPOSE NPN SILICON TRANSISTORS

Package : TO-92

ABSOLUTE MAXIMUM RATINGS @ 25°C (free air)

Characteristics	Unit
Storage temperature range	-55 to +150 °C
Operating Collector Junction Temperature	+150 °C
Lead temperature 1/16" from case 10 seconds max.	+260 °C
Collector current	500 mA
Continuous device dissipation at or below 25°C free-air temperature	360 mW
Linear derating factor above 25°C	2.87 mW/°C
Emitter-base voltage	5 V
Collector-base voltage	60 V
Collector-base voltage (2N5371)	40 V
Collector-emitter voltage (Applicable from I_C = 0 mA to I_C = 10 mA)	30 V

ELECTRICAL CHARACTERISTICS @ 25°C free-air temperature

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	50	nA	2N5368, 2N5369, 2N5370 V_{CB} = 40 V, I_E = 0
	–	50	nA	2N5371 V_{CB} = 30 V, I_E = 0
I_{EBO}	–	50	nA	V_{EB} = 3 V, I_C = 0
BV_{CBO}	60	–	V	2N5368, 2N5369, 2N5370 I_C = 10 uA, I_E = 0
	40	–	V	2N5371 I_C = 10 uA, I_E = 0
BV_{EBO}	5	–	V	I_E = 10 uA, I_C = 0
BV_{CEO}	30	–	V	I_C = 10 mA, I_B = 0 (Note 1)
h_{FE}	20	–	–	2N5368
	50	–	–	2N5369
	75	–	–	2N5370 V_{CE} = 10 V, I_C = 1 mA
	20	–	–	2N5371
h_{FE}	40	–	–	2N5368
	75	–	–	2N5369
	150	–	–	2N5370 V_{CE} = 10 V, I_C = 10 mA, (Note 1)
	40	–	–	2N5371
h_{FE}	60	200	–	2N5368
	100	300	–	2N5369
	200	600	–	2N5370 V_{CE} = 10 V, I_C = 150 mA (Note 1)
	60	600	–	2N5371
V_{BE}	–	1.2	V	V_{CE} = 10 V, I_C = 150 mA (Note 1)
$V_{BE(sat)}$	–	1.3	V	I_C = 150 mA, I_B = 15 mA (Note 1)
$V_{CE(sat)}$	–	0.3	V	I_C = 150 mA, I_B = 15 mA (Note 1)
C_{cb}	–	8	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz (Note 2)
$[h_{fe}]$	2.5	–	–	V_{CE} = 10 V, I_C = 20 mA, f = 100 MHz
t_{on}	–	40	nsec	I_C = 150 mA, V_{CC} = 30 V, I_{B1} = 15 mA, (see fig. 1)
t_{off}	–	350	nsec	2N5368, 2N5369 I_C = 150 mA, V_{CC} = 30 V,
	–	400	nsec	2N5370, 2N5371 I_{B1} = I_{B2} = 15 mA (see fig. 2)

NOTES: 1. Pulse test: PW = 300 usec, duty cycle ≤ 2%.
2. C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

Package: TO-92

GENERAL PURPOSE NPN SILICON TRANSISTORS

ABSOLUTE MAXIMUM RATINGS @ 25°C (free air)

Characteristics	Unit
Storage temperature range	-55 to +150 °C
Operating Collector Junction Temperature	+150 °C
Lead temperature 1/16" from case 10 seconds max.	+260 °C
Emitter-base voltage	5 V
Collector-base voltage	60 V
Collector-emitter voltage (Applicable from I_C = 0 mA, to I_C = 10 mA)	30 V
Collector current	500 mA
Continuous device dissipation at or below 25°C free-air temperature	360 mW
Linear derating factor above 25°C	2.87 mW/°C

ELECTRICAL CHARACTERISTICS @ 25°C free-air temperature

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	10	nA	V_{CB} = 30 V, I_E = 0
BV_{CBO}	60	–	V	I_C = 10 *u*A, I_E = 0
BV_{EBO}	5	–	V	I_E = 100 nA, I_C = 0
BV_{CEO}	30	–	V	I_C = 10 mA, I_B = 0 (Note 1)
h_{FE}	100	500	–	2N5376 V_{CE} = 5 V, I_C = 10 *u*A
	40	200	–	2N5377 V_{CE} = 5 V, I_C = 10 *u*A
h_{FE}	120	600	–	2N5376 V_{CE} = 5 V, I_C = 1 mA
	100	500	–	2N5377 V_{CE} = 5 V, I_C = 1 mA
h_{FE}	150	–	–	2N5376 V_{CE} = 5 V, I_C = 10 mA (Note 1)
	120	–	–	2N5377
$V_{BE(sat)}$	0.65	0.80	V	I_C = 10 mA, I_B = 1 mA
$V_{CE(sat)}$	–	0.2	V	I_C = 10 mA, I_B = 1 mA
h_{ib}	20	32	Ohms	I_C = 1 mA, V_{CE} = 5 V, f = 1 kHz
h_{ob}	0.05	0.2	*u*mhos	I_C = 1 mA, V_{CE} = 5 V, f = 1 kHz
h_{fe}	120	1000	–	2N5376 I_C = 1 mA, V_{CE} = 5 V, f - 1 kHz
	100	900	–	2N5377
C_{cb}	–	8	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz (Note 2)
$[h_{fe}]$	30	150	–	V_{CE} = 5 V, I_C = 500 *u*A, f = 10 MHz
NF	–	2.0	dB	2N5376 I_C = 10 *u*A, V_{CE} = 5 V, Rg = 10 Ohms,
	–	3.0	dB	2N5377 Bandwith = 10 Hz to 15.7 kHz

NOTES: 1. Pulse test: Pulse width = 300 usec, duty cycle $\leq$ 2 %.

2. C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter shall be connected to the guard terminal of the bridge.

2N5449, 2N5450, 2N5451
NPN SILICON AMPLIFIER TRANSISTORS

Package: To-92

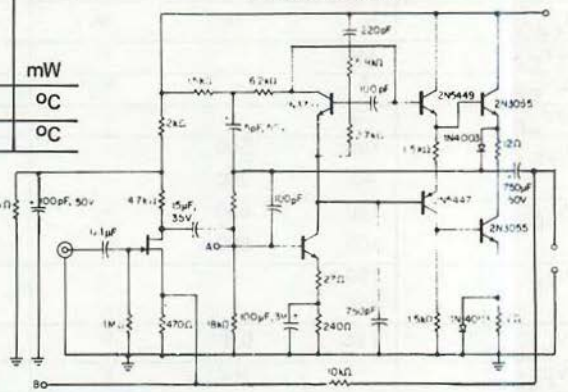
ABSOLUTE MAXIMUM RATINGS at 25°C free-air temperature (unless otherwise noted)

Characteristic	2N5449 2N5450	2N5451	Unit
Collector-Base Voltage	50	40	V
Collector-Emitter Voltage (See Note 1)	30	20	V
Emitter-Base Voltage	5	5	V
Continuous Collector Current	800		mA
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 2)	360		mW
Continuous Device Dissipation at (or below) 25°C Lead Temperature (See Note 3)	500		mW
Storage Temperature Range	-65 to 150		°C
Junction Temperature-Operating	260		°C

NOTES:

1. These values apply when the base-emitter diode is open-circuited.
2. Derate linearly to 150°C free-air temperature at the rate of 2.88 mW/deg.
3. Derate linearly to 150°C lead temperature at the rate of 4 mW/deg. Lead temperature is measured on the collector lead 1/16 inch from the case.

SILICON 15-WATT QUASI-COMPLEMENTARY POWER AMPLIFIER



***ELECTRICAL CHARACTERISTICS** AT 25°C FREE-AIR TEMPERATURE

Symbol	2N5449 Min	2N5449 Max	2N5450 Min	2N5450 Max	2N5451 Min	2N5451 Max	Unit	Test Conditions
$V_{(BR)CBO}$	50		50		40		V	I_C = 100 uA, I_E = 0
$V_{(BR)CEO}$	30		30		20		V	I_C = 10 mA, I_B = 0, See Note 4
$V_{(BR)EBO}$	5		5		5		V	I_E = 100 uA, I_C = 0
I_{CBO}		100		100		100	nA	V_{CB} = 20 V, I_B = 0
I_{EBO}		100		100		100	nA	V_{EB} = 3 V, I_C = 0
h_{fe}	100	300	50	150	30	600		V_{CE} = 2 V, I_C = 50 mA, See Note 4
V_{BE}	0.5	1	0.5	1	0.5	1	V	V_{CE} = 2 V, I_C = 100 mA, See Note 4
$V_{CE(sat)}$		0.6		0.8		1	V	I_B = 5 mA, I_C = 100 mA, See Note 4
$[h_{fe}]$	5		5		5			V_{CE} = 2 V, I_C = 50 mA, f = 20 MHz
C_{cb}		12		12		12	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz, See Note 5

NOTES: 4. These parameters must be measured using pulse techniques. Ip = 300 us, duty cycle — 3%.
5. C_{cb} is measured using three-terminal measurement techniques with the emitter guarded.

Package: To-92

NPN SILICON AUDIO TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic		Unit
Collector-Emitter Voltage	60	Vdc
Collector-Base Voltage	60	Vdc
Emitter-Base Voltage	4.0	Vdc
Collector Current - Continuous	500	MAdc
Total Device Dissipation		
@ T_A = 25°C	500	mW
Derate above 25°C	4.54	mW/°C
Total Device Dissipation		
@ T_C = 25°C	800	mW
Derate above 25°C	7.27	mW/°C
Operating and Storage Junction		
Temperature Range	-55 to +135	°C
Thermal Resistance, Junction		
to Case	0.137	°C/mW
Thermal Resistance, Junction		
to Ambient	0.220	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	60	–	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{EBO}	4.0	–	–	Vdc	I_E = 100 μAdc, I_C = 0
I_{CBO}	–	–	100	nAdc	V_{CB} = 60 Vdc, I_E = 0
h_{FE}	50	125	–	–	I_C = 10 mAdc, V_{CE} = 1.0 Vdc
	50	150	–		I_C = 100 mAdc, V_{CE} = 1.0 Vdc
	–	90	–		I_C = 350 mAdc, V_{CE} = 1.0 Vdc
$V_{CE(sat)}$	–	0.08	0.25	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(sat)}$	–	0.75	–		I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(on)}$	–	0.7	1.2	Vdc	I_C = 100 mAdc, V_{CE} = 1.0 Vdc
f_T	50	200	–	MHz	I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz
C_{ob}	–	6.0	–	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
C_{ib}	–	15	–	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz

MPS-A10

GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTORS

Package: To-92

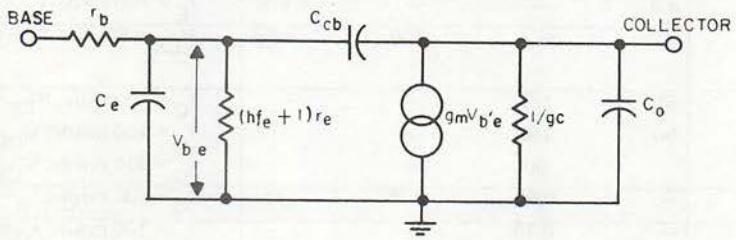
ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	40 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current - Continuous	100 mAdc
Total Device Dissipation @ T_A = 25°C	300 mW
Derate above 25°C	2.73 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.367 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	40	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 30 Vdc, I_E = 0
h_{FE}	40	400	–	I_C = 5.0 mAdc, V_{CE} = 10 Vdc
f_T	50	–	MHz	I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz
C_{ob}	–	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz

Figure 1—Simplified AC Equivalent Circuit (Common Emitter)



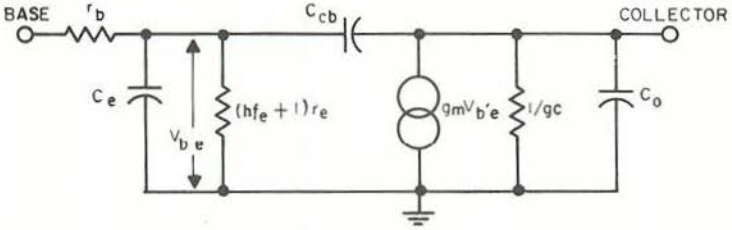
ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	40 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current - Continuous	100 mAdc
Total Device Dissipation @ T_A = 25°C	300 mW
Derate above 25°C	2.73 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.367 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	40	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 30 Vdc, I_E = 0
h_{FE}	40	400	–	I_C = 5.0 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.25	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	125	–	MHz	I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
C_{ob}	–	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz

Figure 1–Simplified AC Equivalent Circuit (Common Emitter)



MPS2711, MPS2712
LOW-POWER NPN SILICON SMALL-SIGNAL TRANSISTOR

Package: To-92

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	18 Vdc
Collector-Base Voltage	18 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	100 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Total Device Dissipation @ T_C = 60°C	210 mW
Operating Junction Temperature	135 °C
Storage Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	0.5	*u*Adc	V_{CB} = 18 Vdc, I_E = 0
	–	1.5		V_{CB} = 18 Vdc, I_E = 0, T_A = 100°C
I_{EBO}	–	0.5	*u*Adc	V_{EB} = 5 Vdc, I_C = 0
h_{FE}	30	90	–	V_{CE} = 4.5 Vdc, I_C = 2 mAdc MPS2711
	75	225		MPS2712
C_{ob}	–	4.0	pF	V_{CB} = 10 V, I_E = 0 f = 1 MHz
h_{fe}	30	120	–	V_{CE} = 10 Vdc, I_C = 2 mAdc, f = 1 kHz MPS2711
	80	200		MPS2712

Package: To-92 GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Base Voltage	25 Vdc
Collector-Emitter Voltage	25 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector dc Current	100 mAdc
Total Device Dissipation	200 mW
@ 25°C Ambient Temperature	
Derating Factor above 25°C	2.67 mW/°C
Total Device Dissipation	120 mW
@ 55°C Ambient Temperature	
Derating Factor above 25°C	2.67 mW/°C
Junction Temperature-Operating	100 °C
Storage Temperature Range	-30 to +125 °C

ELECTRICAL CHARACTERISTICS (Tc = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	0.5	uA	V_{CB} = 25 V, I_E = 0
	–	15	uA	V_{CB} = 25 V, I_E = 0, T_A = 100°C
I_{EBO}	–	0.5	uA	V_{EB} = 5 V
h_{fe}			–	V_{CE} = 10 V, I_C = 2 mA
	90	180		MPS2923
	150	300		MPS2924
	235	470		MPS2925
C_{ob}	–	12	pF	V_{CB} = 10 V, I_E = 0, f = MHz

MPS2926, MPS3721

Package: To-92

GENERAL PURPOSE NPN SILICON TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	18 Vdc
Collector-Base Voltage	18 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	100 mAdc
Total Device Dissipation @ 25°C Ambient Temperature	310 mW
Total Device Dissipation @ 60°C Ambient Temperature	210 mW
Thermal Resistance, Junction to Ambient	0.357 °C/mW
Junction Temperature, Operating	135 °C
Storage Temperature Range	-55 to +135 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
I_{CBO}	–	–	0.5	uA	V_{CB} = 18 Vdc, I_E = 0
	–	–	15		V_{CB} = 18 Vdc, I_E = 0, T_A = 100°C
I_{EBO}	–	–	0.5	uA	V_{EB} = 5 Vdc, I_C = 0
f_T	–	300	–	MHz	I_C = 4 mA, V_{CE} = 5 V MPS 2926
C_{ob}	–	–	3.5	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz
h_{fe}	35	–	470	–	V_{CE} = 10 V, I_C = 2 mA, f = 1 kHz MPS2926
	60	–	660		MPS3721

Package: To-92

NPN SILICON SMALL-SIGNAL AUDIO TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	25 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	100 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Total Device Dissipation @ T_C = 60°C	210 mW
Operating Junction Temperature	135 °C
Storage Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	25	–	Vdc	I_C = 1 mAdc, I_B = 0
I_{CBO}	–	0.1	uAdc	V_{CB} = 18 Vdc, I_E = 0
I_{EBO}	–	0.1	uAdc	V_{EB} = 5 Vdc, I_C = 0
h_{FE}	150	300	–	V_{CE} = 4.5 Vdc, I_C = 2 mAdc MPS3392
	90	180		MPS3393
	55	110		MPS3394
	150	500		MPS3395
C_{ob}	–	3.5	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz
h_{fe}	150	500	–	V_{CE} = 4.5 V, I_C = 2 mA, f = 1 kHz MPS3392
	90	400		MPS3393
	55	300		MPS3394
	150	800		MPS3395

MPS3693

Package: To-92

GENERAL PURPOSE NPN SILICON RFAMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	45 Vdc
Collector-Base Voltage	45 Vdc
Emitter-Base Voltage	4.0 Vdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
$BV_{CEO(sus)}$*	45	–	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CBO}	45	–	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	4.0	–	–	Vdc	I_E = 10 uAdc, I_C = 0
I_{CBO}	–	–	50	nAdc	V_{CB} = 35 Vdc, I_E = 0
	–	–	5.0	uAdc	V_{CB} = 35 Vdc, I_E = 0, T_A = 65°C
h_{FE}	40	–	160	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
f_T	200	–	–	MHz	I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 100 MHz
C_{ob}	–	–	3.5	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
r'_bC_c	–	–	55	ps	I_E = 10 mAdc, V_{CB} = 15 Vdc, f = 31.8 MHz
NF	–	4.0	–	dB	I_C = 3.0 mAdc, V_{CE} = 10 Vdc, R_S = 300 ohms, f = 1.0 MHz

*Pulse Test: Pulse Width ≤ 300 us; Duty Cycle ≤ 1.0%.

ABSOLUTE MAXIMUM RATINGS

Characteristics	MPS3704 MPS3705	MPS3706	Unit
Collector-Emitter Voltage ...	30	20	Vdc
Collector-Base Voltage	50	40	Vdc
Emitter-Base Voltage	5.0		Vdc
Collector Current - Continuous	600		mAdc
Total Device Dissipation			
@ T_A = 25°C	310		mW
Derate above 25°C	2.81		mW/°C
Operating and Storage Junction			
Temperature Range	-55 to +135		°C
Thermal Resistanct, Junction			
to Ambient	0.357		°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	30	–	Vdc	I_C = 10 mAdc, I_E = 0	MPS3704
	30	–			MPS3705
	20	–			MPS3706
BV_{CBO}	50	–	Vdc	I_C = 100 uAdc, I_E = 0	MPS3704
	50	–			MPS3705
	40	–			MPS3706
BV_{EBO}	5.0	–	Vdc	I_E = 100 uAdc, I_C = 0	
I_{CBO}	–	100	nAdc	V_{CB} = 20 Vdc, I_E = 0	
I_{EBO}	–	100	nAdc	V_{BE} = 3 Vdc, I_C = 0	
h_{FE}*	100	300	–	I_C = 50 mAdc, V_{CE} = 2 Vdc	MPS3704
	50	150			MPS3705
	30	600			MPS3706
$V_{CE(sat)}$*	–	0.6	Vdc	I_C = 100 mAdc, I_B = 5 mAdc	MPS3704
	–	0.8			MPS3705
	–	1.0			MPS3706
$V_{BE(on)}$*	0.5	1.0	Vdc	I_C = 100 mAdc, V_{CE} = 2 Vdc	
f_T	100	–	MHz	I_C = 50 mAdc, V_{CE} = 2 Vdc, f = 20 MHz	
C_{ob}	–	12	pF	V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz	

*Pulse Test: Pulse Width = 300 us; Duty Cycle = 2%.

MPS3707 thru MPS3711

Package: To-92

GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	30 Vdc
Collector-Base Voltage	30 Vdc
Emitter-Base Voltage	6.0 Vdc
Collector Current	30 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Total Device Dissipation @ T_C = 60°C	210 mW
Operating Junction Temperature	135 °C
Storage Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}	30	–	Vdc	I_C = 1 mAdc, I_B = 0	
I_{CBO}	–	100	nAdc	V_{CB} = 20 Vdc, I_E = 0	
I_{EBO}	–	100	nAdc	V_{EB} = 6 Vdc, I_C = 0	
h_{FE}	100	400	–	I_C = 100 uAdc, V_{CE} = 5 Vdc	MPS3707
	45	660		I_C = 1 mAdc, V_{CE} = 5 Vdc	MPS3708
	45	165			MPS3709
	90	330			MPS3710
	180	660			MPS3711
$V_{CE(sat)}$	–	1.0	Vdc	I_C = 10 mAdc, I_B = 0.5 mAdc	
V_{BE}	0.5	1.0	Vdc	I_C = 1 mAdc, V_{CE} = 5 Vdc	
h_{FE}	100	550	–	I_C = 100 uAdc, V_{CE} = 5 Vdc, f = 1 kHz MPS3707	
	45	800		I_C = 1 mAdc, V_{CE} = 5 Vdc, f = 1 kHz MPS3708	
	45	250			MPS3709
	90	450			MPS3710
	180	800			MPS3711
NF	–	5.0	dB	V_{CE} = 5 V, I_C = 100 uA, R_G = 5 kΩ, Noise Bandwidth = 15.7 kHz Note 1	MPS3707

Note 1 Average Noise Figure is measured in an amplifier with low frequency response down 3 dB at 10 Hz.

Package: To-92

GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	25 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current - Continuous	100 mAdc
Total Device Dissipation @ T_A = 25°C	210 mW
Derate above 25°C	1.91 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.524 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	25	–	–	Vdc	I_C = 10 mAdc, I_B = 0
I_{CES}	–	–	100	nAdc	V_{CE} = 25 Vdc, V_{BE} = 0
I_{CBO}	–	–	100	nAdc	V_{CB} = 25 Vdc, I_E = 0
	–	–	10	uAdc	V_{CB} = 25 Vdc, I_E = 0, T_A = 100°C
I_{EBO}	–	–	100	nAdc	V_{BE} = 5.0 Vdc, I_C = 0
h_{FE}	100	–	500	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	–	0.25	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$	–	0.75	–	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(on)}$	0.5	–	1.2	Vdc	I_C = 10 mAdc, V_{CE} = 10 Vdc
f_T	–	120	–	MHz	I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc
C_{cb}	1.6	–	10	pF	V_{CB} = 0, I_E = 0, f = 1.0 MHz
h_{fe}	100	–	750	–	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

MPS6530 thru MPS6532

NPN SILICON AMPLIFIER TRANSISTORS

Package: To-92

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Characteristic			Unit
Collector-Base Voltage			
MPS6530, MPS5631	60		Vdc
MPS6532	50		
MPS6530, MPS6531	40		
MPS6532	30		
Emitter-Base Voltage	5.0	4.0	

Collector Current	600	600	mAdc
Total Device Dissipation			
@ T_A = 60°C	210	210	mW
@ T_A = 25°C	310	310	
Thermal Resistance, Junction to Ambient	0.357	0.357	°C/mW
Junction Temperature	135	135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions	
BV_{CBO}	60	–	–	Vdc	I_C = 10 *u*Adc, I_E = 0	MPS6530, MPS6531
	50	–	–			MPS6532
BV_{CEO}	40	–	–	Vdc	I_C = 10 mAdc, I_B = 0	MPS6530, MPS6531
	30	–	–			MPS6532
BV_{EBO}	5.0	–	–	Vdc	I_B = 10 *u*Adc, I_C = 0	
I_{CBO}	–	–	0.05	*u*Adc	V_{CB} = 40 Vdc, I_E = 0	MPS6530, MPS6531
	–	–	0.1			MPS6532
	–	–	2.0		V_{CB} = 30 Vdc, I_E = 0, T_A = 60°C	MPS6530, MPS6531
	–	–	5.0		V_{CB} = 30 Vdc, I_E = 0, T_A = 60°C	MPS6532
h_{FE}	30	75	–	–	I_C = 10 mAdc, V_{CE} = V_{CE} = 1 Vdc	MPS6530
	60	120	–			MPS6531
	40	85	120		I_C = 100 mAdc, V_{CE} = 1 Vdc	MPS6530
	90	150	270			MPS6531
	30	–	–			MPS6532
	25	60	–		I_C = 500 mAdc, V_{CE} = 10 Vdc	MPS6530
	50	80	–			MPS6531
$V_{CE(sat)}$	–	0.2	0.5	Vdc	I_C = 100 mAdc, I_B = 10 mAdc	MPS6530, MPS6532
	0.13	0.13	0.3			MPS6531
$V_{BE(sat)}$	–	0.82	1.0	Vdc	I_C = 100 mAdc, I_B = 10 mAdc	MPS6530, MPS6531
	–	0.85	1.2			MPS6532
C_{ob}	–	3.5	5.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz	
f_T	–	390	–	MHz	I_C = 50 mAdc, V_{CE} = 10 Vdc	

Package: To-92

GENERAL PURPOSE NPN SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	45 Vdc
Collector-Base Voltage	60 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current - Continuous	200 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	45	–	–	Vdc	I_C = 1 mAdc, I_B = 0
BV_{CBO}	60	–	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	4.0	–	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	–	100	nAdc	V_{CB} = 30 Vdc, I_E = 0
h_{FE}	40	–	160	–	I_C = 10 mAdc, V_{CE} = 10 Vdc MPS6565
	100	–	400		MPS6566
$V_{CE(sat)}$	–	0.1	0.4	Vdc	I_C = 10 mAdc, I_B = 1 mAdc
C_{ob}	–	–	3.5	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
C_{ib}	–	3.7	–	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz
h_{fe}	2.0	–	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
h_{oe}	–	60	–	umhos	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1 kHz
h_{ie}	–	500	–	ohms	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1 kHz
h_{re}	–	2.5	–	$X10^{-4}$	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1 kHz
NF	–	4.0	–	dB	I_C = 100 uAdc, V_{CE} = 5 Vdc, R_S = 1000 ohms, f = 10 Hz to 15.7 kHz

MPS6591®

NPN SILICON AMPLIFIER TRANSISTOR

Package: To-92

High Voltage ..... BV_{CEO} = 80 V (Min) MPS6590
Low Noise ..... NF = 3.0 dB (Typ) Wideband

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	-55 to +150 °C
Operating Junction Temperature	-55 to +150 °C
Total Dissipation (Notes 2 and 3)	
at 25°C Case Temperature	1.0 W
at 25°C Ambient Temperature	.625 W
at 70°C Ambient Temperature	.400 W
Collector to Base Voltage	60 V
Collector to Emitter Voltage (Note 4)	50 V
Emitter to Base Voltage	4.0 V
DC Collector Current	250 mA

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Test Conditions
BV_{CEO}	50			Volts	I_C = 1.0 mA, I_B = 0
BV_{CBO}	60			Volts	I_C = 100 uA, I_E = 0
BV_{EBO}	4.0			Volts	I_E = 100 uA, I_C = 0
I_{CBO}				nA	V_{CB} = 50 V, I_E = 0
I_{CBO}			100	nA	V_{CB} = 30 V, I_E = 0
h_{FE}	40				I_C = 10 mA, V_{CE} = 10 V
$V_{CE(sat)}$			0.6	Volt	I_C = 10 mA, I_B = 1.0 mA
C_{cb}			12	pF	V_{CB} = 10 V, I_E = 0, f = 100 kHz
C_{eb}			50	pF	V_{BE} = 0.5 V, I_C = 0, f = 100 kHz
h_{ie}		1.4		kΩ	I_C = 10 mA, V_{CE} = 5.0 V, f = 1.0 kHz
h_{re}		0.8		X10^{-4}	I_C = 10 mA, V_{CE} = 5.0 V, f = 1.0 kHz
h_{fe}	2.0				I_C = 10 mA, V_{CE} = 10W, f = 30 MHz
h_{oe}		75		umhos	I_C = 10 mA, V_{CE} = 5.0 V, f = 1.0 kHz
NF		3.0		dB	I_C = 100 uA, V_{CE} = 5.0 V, f = 10 Hz to 15.7 kHz, R_s = 4kΩ

NOTES:
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 150°C and junction to case thermal resistance of 125° C/Watt (derating factor of 8.0 mW/°C); junction to ambient thermal resistance of 200°C/Watt (derating factor of 5.0 mW/°C).
(4) Rating refers to a high current point where collector to emitter voltage is lowest.
(5) Pulse conditions: length = 300 us; duty cycle = 1%.

NPN SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	90 Volts
Collector-Emitter Voltage	140 Volts
Collector-Base Voltage	120 Volts
Emitter-Base Voltage	7.0 Volts
Collector Current	1.0 A
Total Device Dissipation @ $T_A = 25°C$	1.0 Watt
Derate above 25°C	5.71 mW/°C
Total Device Dissipation @ $T_C = 25°C$	5.0 Watts
Derate above 25°C	28.6 mW/°C
Operating and Storage Junction Temperature Range	−65 to +200 °C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$BV_{CEO(sus)}$*	90	–	Volts	$I_C = 100$ mA, $I_B = 0$
$BV_{CER(sus)}$	140	–	Volts	$I_C = 100$ mA, $R_{BE} = 10$ ohms
BV_{CBO}	120	–	Volts	$I_C = 100\ \mu A$, $I_E = 0$
BV_{EBO}	7.0	–	Volts	$I_E = 100\ \mu A$, $I_C = 0$
I_{CBO}	–	10	μA	$V_{CB} = 90$ Volts, $I_E = 0$, $T_A = 150°C$
I_{EBO}	–	0.01	μA	$V_{BE} = 5.0$ Volts, $I_C = 0$
h_{FE}*	60	200	–	$I_C = 150$ mA, $V_{CE} = 10$ Volts
$V_{CE(sat)}$	–	0.5	Volt	$I_C = 150$ mA, $I_B = 15$ mA
$V_{BE(sat)}$	–	1.1	Volts	$I_C = 150$ mA, $I_B = 15$ mA
C_{ob}	–	15	pF	$V_{CB} = 10$ Volts, $I_E = o$, 100 kHz ≤ f ≤ 1.0 MHz
C_{ib}	–	85	pF	$V_{BE} = 0.5$ Volts, $I_C = 0$, 100 kHz ≤ f ≤ 1.0 MHz
h_{ib}	4.0	8.0	ohms	$I_C = 5.0$ mA, $V_{CB} = 10$ Volts, f = 1.0 kHz
h_{rb}	–	3.0	$X10^{-4}$	$I_C = 5.0$ mA, $V_{CB} = 10$ Volts, f = 1.0 kHz
h_{fe}	50	275	–	$I_C = 5.0$ mA, $V_{CE} = 5.0$ Volts, f = 1.0 kHz
h_{ob}	–	0.5	μmho	$I_C = 5.0$ mA, $V_{CB} = 10$ Volts, f = 1.0 kHz

* Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%

2N2868Ⓔ

HIGH-SPEED NPN SILICON, HIGH CURRENT SWITCHING TRANSISTOR

Package: TO-5

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, no time limit)	250°C Maximum
Total Device Dissipation	
@ T_C = 25°C (Notes 2 and 3)	2.8 Watts
@ T_C = 100°C (Notes 2 and 3)	1.6 Watts
@ T_A = 25°C (Notes 2 and 3)	0.8 Watt
Collector-Base Voltage	60 Volts
Collector-Emitter Voltage (Note 4)	40 Volts
Emitter-Base Voltage	7.0 Volts
Collector Current	1.0 Amp

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	40	120	–	I_C = 150 mA, V_{CE} = 10 Volts (Note 5)
h_{FE}	30	–	–	I_C = 150 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	30	–	–	I_C = 10 mA, V_{CE} = 10 Volts
h_{FE}	20	–	–	I_C = 500 mA, V_{CE} = 10 Volts (Note 5)
h_{FE}(−55°C)	20	–	–	I_C = 10 mA, V_{CE} = 10 Volts
$V_{CE(sat)}$	–	0.25	Volt	I_C = 150 mA, I_B = 15 mA
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	2.5	–	–	I_C = 50 mA, V_{CE} = 10 Volts
I_{CBO}	–	10	nA	V_{CB} = 30 Volts, I_E = 0
I_{CBO}(150°C)	–	15	μA	V_{CB} = 30 Volts, I_E = 0
I_{EBO}	–	50	nA	V_{EB} = 5.0 Volts, I_C = 0
I_{CEX}	–	100	nA	V_{CE} = 30 Volts, V_{EB} = 3.0 Volts
I_{EBX}	–	100	nA	V_{CE} = 30 Volts, V_{EB} = 3.0 Volts
BV_{CBO}	60	–	Volts	I_C = 100μA, I_E = 0

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CEO(sust)}$	40	–	Volts	I_C = 25 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	7 0	–	Volts	I_E = 100 μA, I_C = 0
C_{ob}	–	20	pf	V_{CB} = 10 Volts, I_E = 0
τ_b	–	2.0	μsec	See Figure I

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

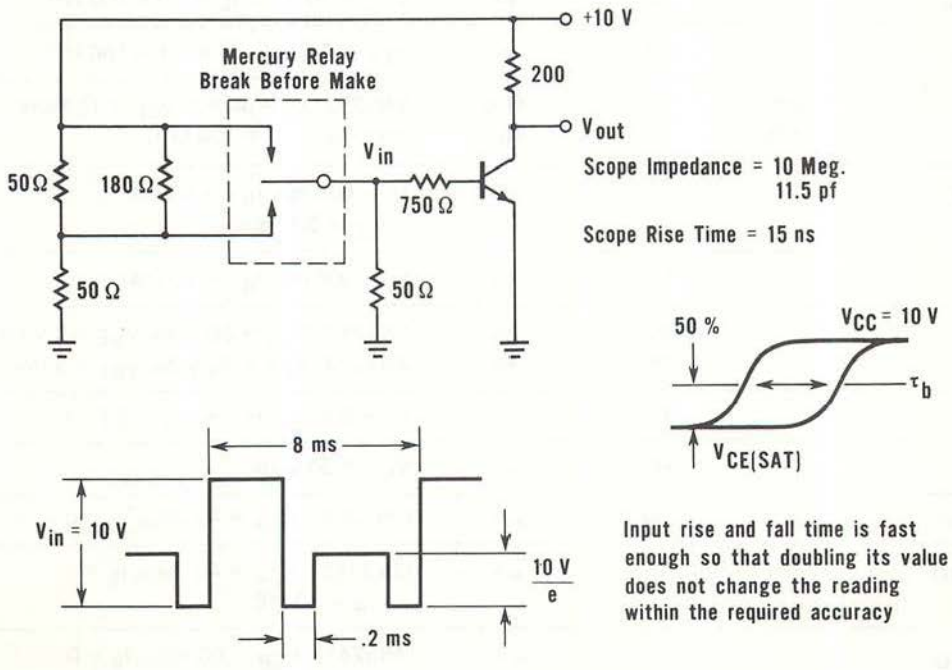
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 62.5°C/Watt (derating factor of 16 mW/°C; junction-to-ambient thermal resistance of 218°C/Watt (derating factor of 4.6 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤300 μsec; duty cycle ≤2%.

FIGURE 1



Input rise and fall time is fast enough so that doubling its value does not change the reading within the required accuracy

2N3252, 2N3253

NPN SILICON HIGH-CURRENT SATURATED SWITCHING AND CORE DRIVER TRANSISTORS

Package: TO-5

ABSOLUTE MAXIMUM RATINGS

Characteristics		Unit
Collector-Base Voltage	2N3252	60 Volts
	2N3253	75 Volts
Collector-Emitter Voltage	2N3252	30 Volts
	2N3253	40 Volts
Emitter-Base Voltage		5 Volts
Total Device Dissipation @ $T_C = 25°C$		5 Watts
Derate above 25°C		28.6 mW/°C
Total Device Dissipation @ $T_A = 25°C$		1.0 Watt
Derate above 25°C		5.71 mW/°C
Junction Operating Temperature Range		−65 to +200 °C
Storage Temperature Range		−65 to +200 °C
Thermal Resistance: 2N3252		35°C/W
Thermal Resistance: 2N3253		0.175°C/mW

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
C_{ob}	–	12	pF	$V_{CB} = 10$ Volts, $I_E = 0$, f= 100 kHz
C_{ib}	–	80	pF	$V_{EB} = 0.5$ Volt, $I_C = 0$, f = 100 kHz
f_T	200	–	MHz	2N3252 $I_C = 50$ mA, $V_{CE} = 10$ Volts,
	175	–	MHz	2N3253 f = 100 MHz
Q_T	–	5	nC	$I_C = 500$ mA, $I_{B1} = 50$ mA, $V_{CC} = 30$ Volts
t_d	–	15	ns	$I_C = 500$ mA, $I_{B1} = 50$ mA
t_r	–	30	ns	2N3252 $V_{CC} = 30$ Volts, $V_{BE} = 2$ Volts
	–	35	ns	2N3253 $V_{CC} = 30$ Volts, $V_{BE} = 2$ Volts
t_s	–	40	ns	$I_C = 500$ mA, $I_{B1} = I_{B2} = 50$ mA
t_f	–	30	ns	$V_{CC} = 30$ Volts
I_{CBO}	–	0.50	μA	(2N3252) $V_{CB} = 40$ Volts, $I_E = 0$
I_{CBO}	–	75	μA	(2N3252) $V_{CB} = 40$ Volts, $I_E = 0$, $T_A = 100°C$
I_{CBO}	–	0.50	μA	(2N3253) $V_{CB} = 60$ Volts, $I_E = 0$

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	75	μA	(2N3253) V_{CB} = 60 Volts, I_E = 0, T_A = 100°C
I_{EBO}	–	0.05	μA	V_{BF} = 4 Volts, I_C = 0
I_{CEX}	–	0.5	μA	(2N3252) V_{CE} = 40 Volts, $V_{EB(off)}$ = 4 Volts
I_{CEX}	–	0.5	μA	(2N3253) V_{CE} = 60 Volts, $V_{EB(off)}$ = 4 Volts
I_{BL}	–	0.50	μA	(2N3252) V_{CE} = 40 Volts, $V_{EB(off)}$ = 4 Volts
I_{BL}	–	0.50	μA	(2N3253) V_{CE} = 60 Volts, $V_{EB(off)}$ = 4 Volts
BV_{CBO}	60	–	Volts	(2N3252) I_C = 10 μA, I_E = 0
	75	–	Volts	(2N3253)
BV_{CEO}*	30	–	Volts	(2N3252) I_C = 10 mA, pulsed, I_B = 0*
	40	–	Volts	(2N3253)
BV_{EBO}	5	–	Volts	I_E = 10 μA, I_C = 0
$V_{CE(sat)}$*	–	0.3	Volt	(2N3252) I_C = 150 mA, I_B = 15 mA*
	–	0.35	Volt	(2N3253)
$V_{CE(sat)}$*	–	0.5	Volt	(2N3252) I_C = 500 mA, I_B = 50 mA
	–	0.60	Volt	(2N3253)
$V_{CE(sat)}$*	–	1.0	Volt	(2N3252) I_C = 1.0 A, I_B = 100 mA
	–	1.2	Volts	(2N3253)
$V_{BE(sat)}$*	–	1.0	Volt	I_C = 150 mA, I_B = 15mA*
$V_{BE(sat)}$*	0.7	1.3	Volts	I_C = 500 mA, I_B = 50 mA
$V_{BE(sat)}$*	–	1.8	Volts	I_C = 1.0 A, I_B = 100 mA
h_{FE}*	30	–	–	(2N3252) I_C = 150 mA, V_{CE} = 1 Volt*
	25	–	–	(2N3253)
h_{FE}*	30	90	–	(2N3252) I_C = 500 mA, V_{CE} = 1 Volt
	25	75	–	(2N3253)
h_{FE}*	25	–	–	(2N3252) I_C = 1 A, V_{CE} = 5 Volts
	20	–	–	(2N3253)

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.

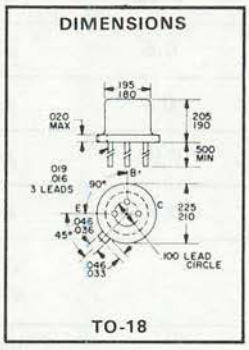
2N3724 2N3725 2N4013 2N4014®

SILICON SWITCHING TRANSISTORS

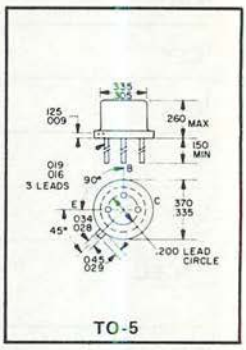
HIGH SPEED NPN SILICON PLANAR EPITAXIAL HIGH-VOLTAGE HIGH-CURRENT TRANSISTORS

- **High Voltage: 80V min. 2N3725, 2N4014**
- **High Gain: 65 typ. @ 1000 mA**
- **Low V_{CE} (sat): 0.5V typ. @ 1000 mA**
- **Low C_{ob}: 4.8 pF typ. @ 10V. 2N3725, 2N4014**
- **Fast t_{on}: 18 nsec typ. @ 500mA**
- **Fast t_{off}: 45 nsec typ. @ 500mA**

2N4013-14



2N3724-25



The ITT 2N3724 • 2N3725 and 2N4013 • 2N4014 are high-voltage, high-current NPN silicon planar epitaxial transistors useful for applications requiring breakdown voltages up to 50V and operating current to one ampere. Low saturation voltage and fast switching times make the transistor ideal for high-frequency amplifiers, core drivers, relay drivers and pulse generators.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	2N3724 2N4013	2N3725 2N4014	UNITS
Collector-to-Base Voltage	50	80	Volts
Collector-to-Emitter Voltage (shorted base)	50	80	Volts
Collector-to-Emitter Voltage (open base)	30	50	Volts
Emitter-to-Base Voltage	6.0	6.0	Volts
Collector Current (300 μsec; 1% duty cycle)	1.0	1.0	Amps
Junction Temperature (op. and stg.)	−65 to +200		°C
Maximum Power Dissipation	**2N4013 2N4014**	**2N3724 2N3725**	
Total Dissipation @ T_C=25°C	1.2	3.5	Watts
(derate above 25°C)	(6.8 mW/°C)	(20mW/°C)	
Total Dissipation @ T_A=25°C	0.36	0.8	Watts
(derate above 25°C)	(2.06 mW/°C)	(4.56 mW/°C)	

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

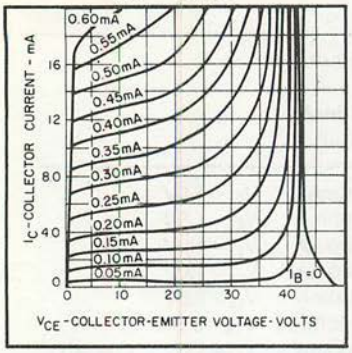
SYMBOL	2N3724 2N4013 MIN.	TYP.	MAX.	2N3725 2N4014 MIN.	TYP.	MAX.	UNIT	CONDITIONS
BV_{CBO}	**50**			**80**			**Vdc**	**I_C=10μA**
BV_{CES}	50			80			Vdc	I_C=10μA
LV_{CEO}[1,2]	**30**			**50**			**Vdc**	**I_C=10mA**
BV_{EBO}	6.0			6.0			Vdc	I_E=10μA
h_{FE}[1]	30	60		30	60			I_C=10mA V_{CE}=1.0V
	60	90	150	60	90	150		I_C=100mA V_{CE}=1.0V
	40	65		40	65			I_C=300mA V_{CE}=1.0V
	35	50		35	50			I_C=500mA V_{CE}=1.0V
	25	45		20	40			I_C=800mA V_{CE}=2.0V
	30	**65**		**25**	**65**			**I_C=1000mA V_{CE}=5.0V**
	30	45		30	40			I_C=100mA V_{CE}=1.0V T_A=−55°C
	20	40		20	35			I_C=500mA V_{CE}=1.0V T_A=−55°C
V_{CE}(sat)[1]		0.11	0.25		0.19	0.25	Vdc	I_C=10mA I_B=1.0mA
		0.13	0.2		0.21	0.26	Vdc	I_C=100mA I_B=10mA
		0.22	0.32		0.31	0.4	Vdc	I_C=300mA I_B=30mA
		0.3	0.42		0.4	0.52	Vdc	I_C=500mA I_B=50mA
		0.4	0.65		0.5	0.8	Vdc	I_C=800mA I_B=80mA
		0.5	**0.75**		**0.6**	**0.95**	**Vdc**	**I_C=1000mA I_B=100mA**
V_{BE} (sat)[1]		0.64	0.76		0.64	0.76	Vdc	I_C=10mA I_B=1.0mA
		0.75	0.86		0.75	0.86	Vdc	I_C=100mA I_B=10mA
		0.89	1.1		0.89	1.1	Vdc	I_C=300mA I_B=30mA
	0.9	0.95	1.2	0.9	0.95	1.2	Vdc	I_C=500mA I_B=50mA
		1.0	1.5		1.0	1.5	Vdc	I_C=800mA I_B=80mA
		1.1	1.7		1.1	1.7	Vdc	I_C=1000mA I_B=100mA
I_{CBO}		0.25	1.7				μA	V_{CB}=40V
					0.33	1.7	μA	V_{CB}=60V
		27	120				μA	V_{CB}=40V T_A=100°C
					25	120	μA	V_{CB}=60V T_A=100°C
C_{ob}		**6.0**	**12**		**4.8**	**10**	**pF**	**V_{CB}=10V**
C_{ib}		40	55		40	55	pF	V_{EB}=0.5V
h_{fe}	3.0	4.5		3.0	4.5			I_C=50mA V_{CE}=10V f=100MHz
t_{on}		**18**	**35**		**18**	**35**	**nsec**	**I_C≈500mA I_{B1}≈50mA I_{B2}≈50mA**
t_{off}		**45**	**60**		**45**	**60**	**nsec**	

NOTES: 1. Pulsed width ≤300 μsec; 1% duty cycle.
2. Lowest emitter-to-collector voltage.

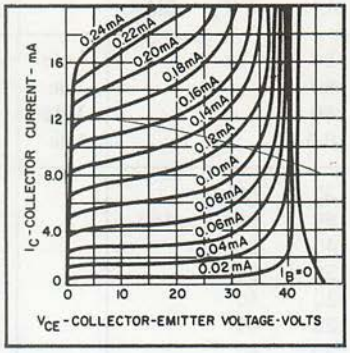
COLLECTOR CHARACTERISTICS 2N3724 2N4013

Collector Current vs. Collector Voltage, Low Base Current

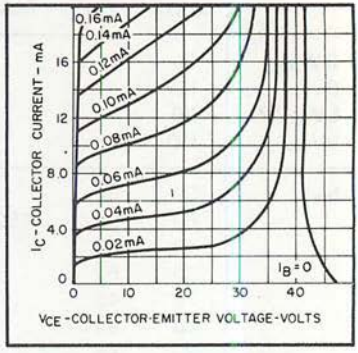
$T_A = -55°C$



$T_A = 25°C$

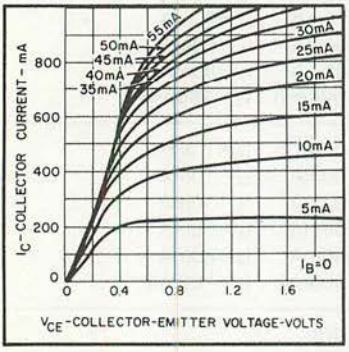


$T_A = 100°C$

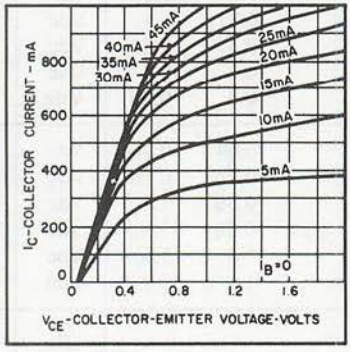


Collector Current vs. Collector Voltage, High Base Current

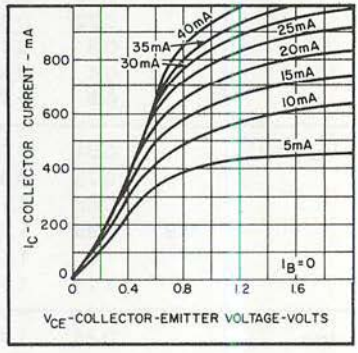
$T_A = -55°C$



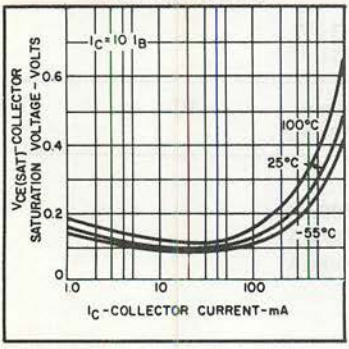
$T_A = 25°C$



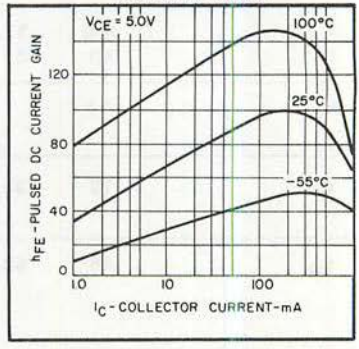
$T_A = 100°C$



COLLECTOR SATURATION VOLTAGE VS COLLECTOR CURRENT



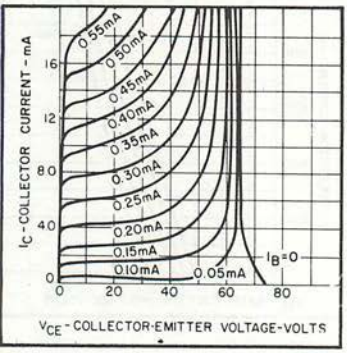
PULSED DC CURRENT GAIN VS COLLECTOR CURRENT



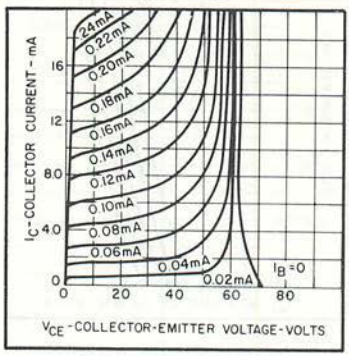
COLLECTOR CHARACTERISTICS 2N3725 2N4014

Collector Current vs. Collector Voltage, Low Base Current

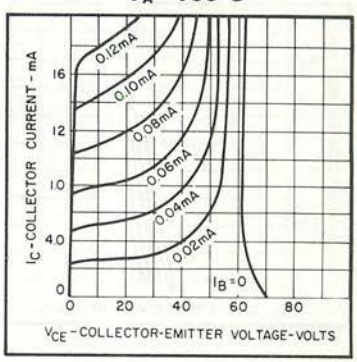
$T_A = -55°C$



$T_A = 25°C$

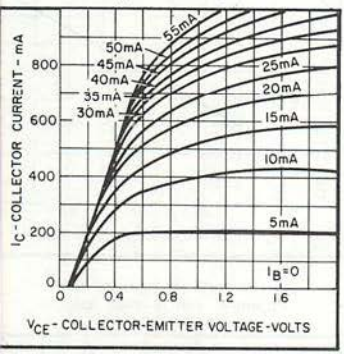


$T_A = 100°C$

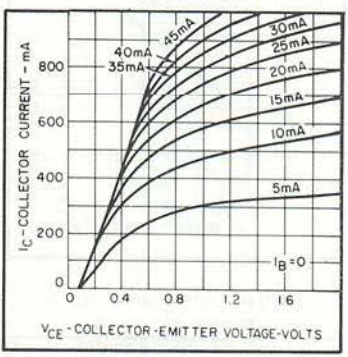


Collector Current vs. Collector Voltage, High Base Current

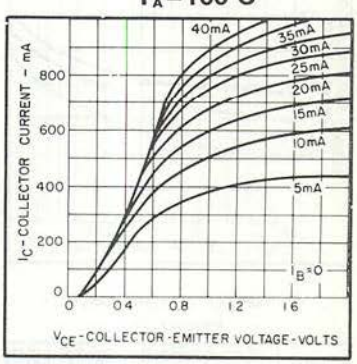
$T_A = -55°C$



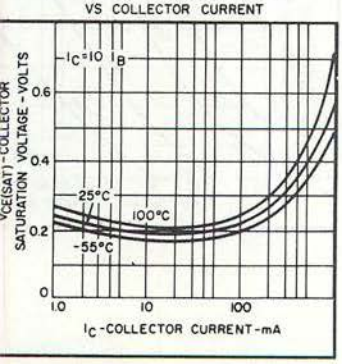
$T_A = 25°C$



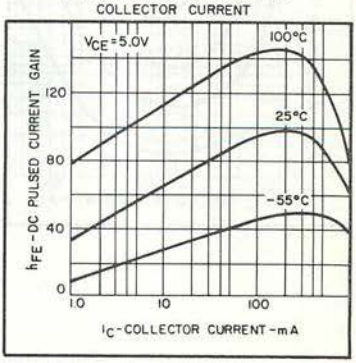
$T_A = 100°C$



COLLECTOR SATURATION VOLTAGE VS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VS COLLECTOR CURRENT



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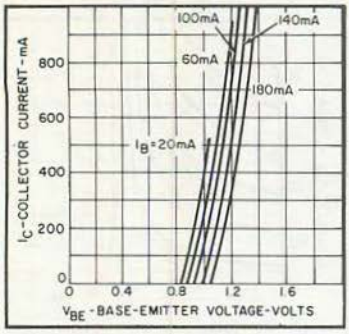
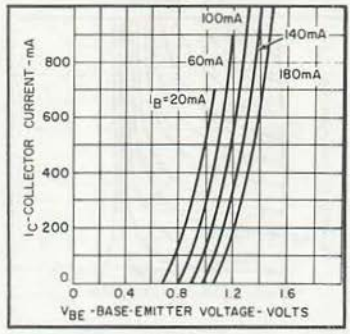
COLLECTOR CHARACTERISTICS 2N3724 2N3725 2N4013 2N4014

Collector Current vs. Base-Emitter Voltage

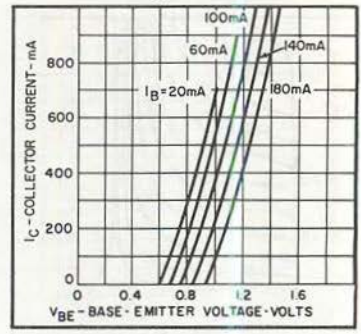
$T_A = -55°C$



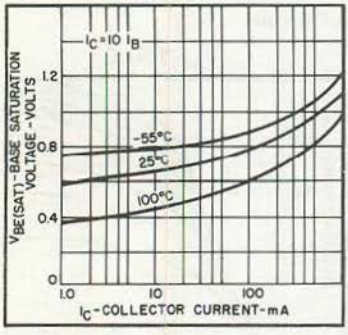
$T_A = 25°C$



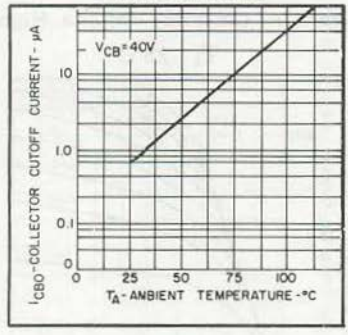
$T_A = 100°C$



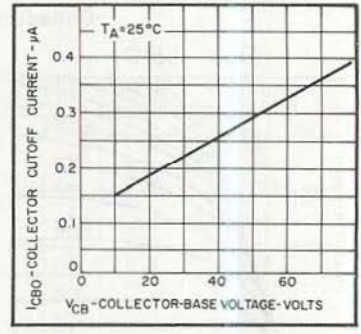
BASE SATURATION VOLTAGE VS COLLECTOR CURRENT



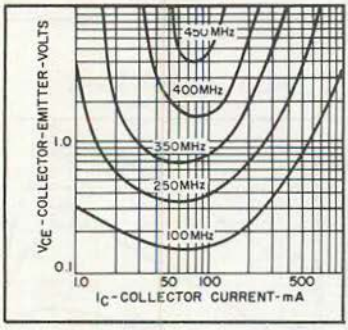
COLLECTOR CUTOFF CURRENT VS AMBIENT TEMPERATURE



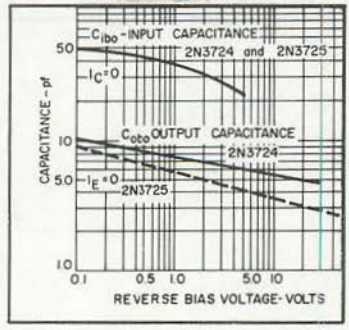
COLLECTOR CUTOFF CURRENT VS REVERSE BIAS VOLTAGE



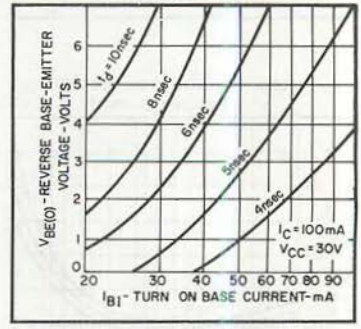
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



INPUT AND OJTPUT CAPACITANCE VS REVERSE BIAS VOLTAGE

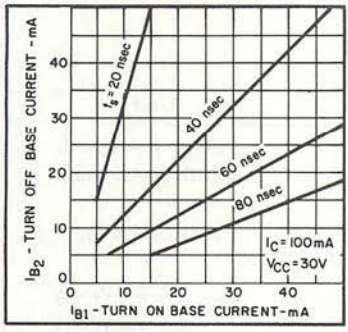


DELAY TIME VS TURN ON BASE CURRENT AND REVERSE BASE-EMITTER VOLTAGE

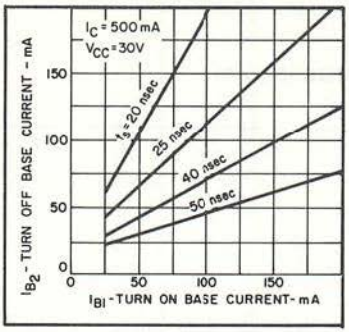


SWITCHING CHARACTERISTICS 2N3724 2N3725 2N4013 2N4014

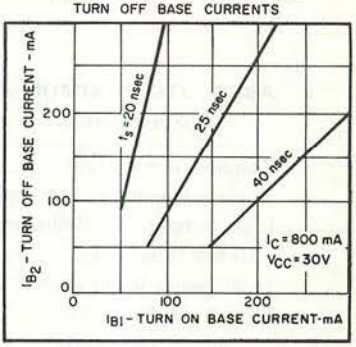
STORAGE TIME VS TURN ON AND TURN OFF BASE CURRENTS



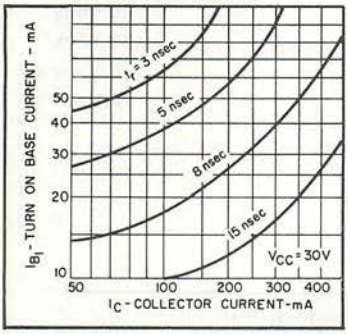
STORAGE TIME VS TURN ON AND TURN OFF BASE CURRENTS



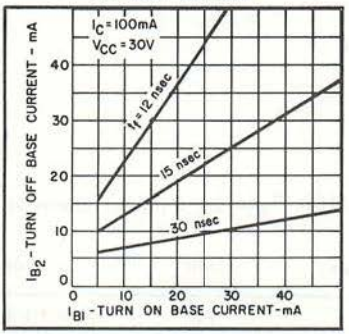
STORAGE TIME VS TURN ON AND TURN OFF BASE CURRENTS



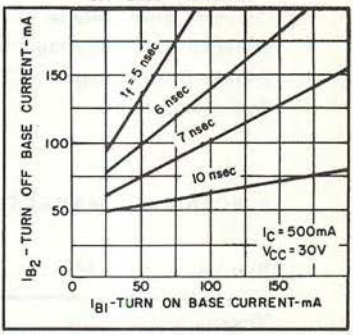
RISE TIME VS COLLECTOR AND TURN ON BASE CURRENTS



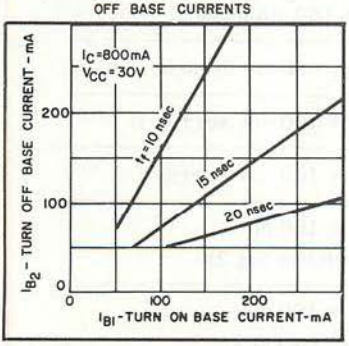
FALL TIME VS TURN ON AND TURN OFF BASE CURRENTS



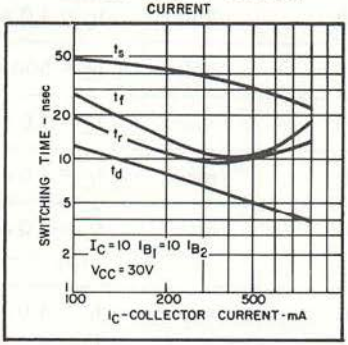
FALL TIME VS TURN ON AND TURN OFF BASE CURRENTS



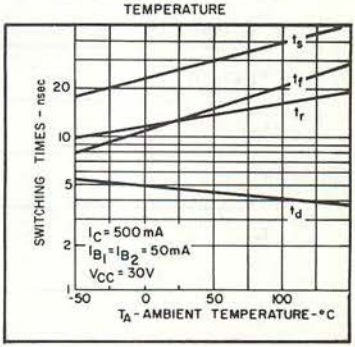
FALL TIME VS TURN ON AND TURN OFF BASE CURRENTS



SWITCHING TIMES VS COLLECTOR CURRENT



SWITCHING TIMES VS AMBIENT TEMPERATURE



2N3734, 2N3736Ⓟ
NPN SILICON HIGH VOLTAGE, HIGH CURRENT SWITCHING TRANSISTORS

Packages:
2N3734, TO-5
2N3736, TO-46

The ITT 2N3734 and 2N3736 are high voltage, high current NPN diffused silicon planar epitaxial transistors useful for memory applications requiring breakdown voltages up to 50 volts and high current capacity with Beta specified to 1.5 amperes.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 10 sec Time Limit)	+230°C Maximum
Total Device Dissipation @:	
T_C = 25°C (2N3734)	4.0 Watts
(2N3736)	2.0 Watts
T_A = 25°C (2N3734)	1.0 Watt
(2N3736)	0.5 Watt
Collector-Base Voltage	50 Volts
Collector-Emitter Voltage (Note 4)	30 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	1.5 Amps

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CEO(sust)}$	30	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
$V_{CE(sat)}$	–	0.9	Volt	I_C = 1.0 A, I_B = 100 mA (Note 5)
$V_{CE(sat)}$	–	0.5	Volt	I_C = 500 mA, I_B = 50 mA (Note 5)
t_d	–	8.0	nsec	I_C = 1.0 A, I_{B1} = 100 mA (see Fig. 1)
t_r	–	40	nsec	I_C = 1.0 A, I_{B1} = 100 mA (see Fig. 1)
t_s	–	30	nsec	I_C = 1.0 A, I_{B1} = 100 mA, I_{B2} = −100 mA (see Fig. 2)
t_f	–	30	nsec	I_C = 1.0 A, I_{B1} = 100 mA, I_{B2} = −100 mA (see Fig. 2)
h_{fe}	3.0	–	–	I_C = 50 mA, V_{CE} = 10 Volts
C_{obo}	–	9.0	pf	I_E = 0, V_{CB} = 10 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
C_{ibo}	–	80	pf	I_C = 0, V_{BE} = 0.5 Volt
h_{FE}	40	–	Volts	I_C = 150 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	35	–	Volts	I_C = 10 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	35	–	Volts	I_C = 500 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}	30	120	Volts	I_C = 1.0 A, V_{CE} = 1.5 Volts (Note 5)
h_{FE}	30	–	Volts	I_C = 1.5 A, V_{CE} = 5.0 Volts (Note 5)
$V_{CE(sat)}$	–	0.2	Volt	I_C = 10 mA, I_B = 1.0 mA (Note 5)
$V_{CE(sat)}$	–	0.3	Volt	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{BE(sat)}$	–	0.8	Volt	I_C = 10 mA, I_B = 1.0 mA (Note 5)
$V_{BE(sat)}$	–	1.0	Volt	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{BE(sat)}$	–	1.2	Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
$V_{BE(sat)}$	0.9	1.4	Volts	I_C = 1.0 A, I_B = 100 mA (Note 5)
I_{CEX}	–	0.2	μA	V_{CE} = 25 Volts, V_{EB} = 2.0 Volts
I_{CEX}(100°C)	–	20	μA	V_{CE} = 25 Volts, V_{EB} = 2.0 Volts
I_{BL}	–	0.3	μA	V_{CE} = 25 Volts, V_{EB} = 2.0 Volts
BV_{CBO}	50	–	Volts	I_C = 10μA, I_E = 0
BV_{EBO}	5.0	–	Volts	I_C = 0, I_E = 10 uA
Q_T	–	10	ncoul	I_C = 1.0 A, I_B = 100 mA V_{CC} = 30 Volts

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

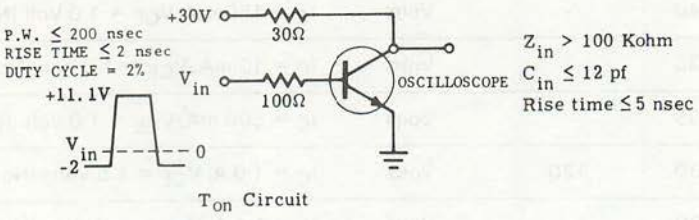
(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 43.8°C/watt (derating factor of 22.8 mW/°C) for the 2N3734; and 87.5°C/watt (derating factor of 11.4 mW/°C) for the 2N3736. junction-to-ambient thermal resistance of 175°C/watt (derating factor of 5.71 mW/°C) for the 2N3734; and 350°C/watt (derating factor of 2.86 mW/°C) for the 2N3736.

(4) Ratings refer to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300μsec; duty cycle = 1%.

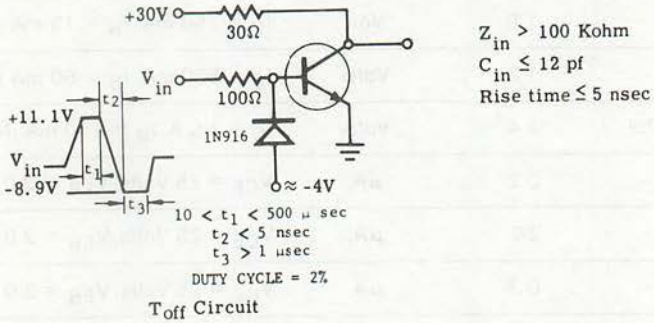
CIRCUIT DIAGRAM

FIGURE 1



T_{on} Circuit

FIGURE 2



T_{off} Circuit

Package: TO-5

2N4046, 2N4047Ⓕ
NPN SILICON HIGH-VOLTAGE, HIGH-CURRENT SWITCHING TRANSISTORS

The ITT 2N4046 and 2N4047 are high-voltage, high-current transistors useful for memory applications requiring breakdown voltages up to 50 volts and operating currents up to one ampere. Fast turn-on and turn-off times are assured because of the high minimum f_T (250 Mc) and tight control on storage time.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	
(2N4046)	50 Volts
(2N4047)	80 Volts
Collector-Emitter Voltage	
(2N4046)	50 Volts
(2N4047)	80 Volts
Collector-Emitter Voltage (Note 4)	
(2N4046)	30 Volts
(2N4047)	50 Volts
Emitter-Base Voltage	6.0 Volts
Maximum Collector Current	500 mA
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	3.5 Watts
T_A = 25°C (Notes 2 and 3)	0.8 Watt
Storage Temperature	−65°C to +200 °C
Operating Junction Temperature	+200°C Maximum
Lead Temperature	
(Soldering, 60 sec Time Limit)	+300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
$V_{CEO(sust)}$	2N4046	30	-	-	Volts	I_C = 10 mA (pulsed), I_B = 0
	2N4047	50	-	-	Volts	(Notes 4 and 5)
$V_{CE(sat)}$	2N4046	-	0 5	0 75	Volt	I_C = 1000 mA (pulsed), I_B = 100 mA
	2N4047	-	0 6	0 95	Volt	(Note 5)
$V_{CE(sat)}$	2N4046	-	0 3	0 42	Volt	I_C = 500 mA (pulsed), I_B = 50 mA
	2N4047	-	0 4	0 52	Volt	(Note 5)
t_{on}	2N4046, 2N4047	-	18	35	nsec	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA (Note 6)
t_{off}	2N4046, 2N4047	-	45	60	nsec	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA (Note 6) $I_{B2} \sim -50$ mA
h_{fe}	2N4046, 2N4047	2.5	4.5	-	-	I_C = 50 mA, V_{CE} = 10 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
C_{obo}	2N4046	-	6 0	12	pf	I_E = 0, V_{CB} = 10 Volts
	2N4047	-	4 8	10	pf	
C_{ibo}	2N4046, 2N4047	-	40	55	pf	I_C = 0, V_{EB} = 0 5 volt
h_{FE}	2N4046, 2N4047	40	90	150	-	I_C = 100 mA, V_{CE} = 1 0 Volt (Note 5)
h_{FE}	2N4046	30	50	-	-	I_C = 500 mA, V_{CE} = 1 0 Volt
	2N4047	20	45	-	-	(Note 5)
h_{FE}	2N4046	30	65	-	-	I_C = 300 mA, V_{CE} = 1 0 Volt
	2N4047	30	60	-	-	(Note 5)
h_{FE}	2N4046	25	65	-	-	I_C = 1000 mA, V_{CE} = 5 0 Volts
	2N4047	15	65	-	-	(Note 5)
h_{FE}	2N4046, 2N4047	20	60	-	-	I_C = 10 mA, V_{CE} = 1 0 Volt (Note 5)
h_{FE}	2N4046	20	45	-	-	I_C = 800 mA, V_{CE} = 2 0 Volts
	2N4047	15	40	-	-	(Note 5)
$V_{CE(sat)}$	2N4046	-	0 11	0 25	Volt	I_C = 10 mA, I_B = 1 0 mA
	2N4047	-	0 19	0 25	Volt	(Note 5)
$V_{CE(sat)}$	2N4046	-	0 13	0 2	Volt	I_C = 100 mA, I_B = 10 mA
	2N4047	-	0 21	0 26	Volt	(Note 5)
$V_{CE(sat)}$	2N4046	-	0 22	0 32	Volt	I_C = 300 mA, I_B = 30 mA
	2N4047	-	0 31	0 4	Volt	(Note 5)
$V_{CE(sat)}$	2N4046	-	0 4	0 65	Volt	I_C = 800 mA, I_B = 80 mA
	2N4047	-	0 5	0 8	Volt	(Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	-	0 64	0 76	Volt	I_C = 10 mA, I_B = 1 0 mA (Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	-	0 75	0 86	Volt	I_C = 100 mA, I_B = 10 mA (Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	-	0 89	1 1	Volts	I_C = 300 mA, I_B = 30 mA (Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	0 9	0 95	1 2	Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	-	1 0	1 5	Volts	I_C = 800 mA, I_B = 80 mA (Note 5)
$V_{BE(sat)}$	2N4046, 2N4047	-	1 1	1 7	Volts	I_C = 1000 mA, I_B = 100 mA (Note 5)
I_{CBO}	2N4046	-	0 25	1 7	μA	I_E = 0, V_{CB} = 40 Volts
I_{CBO}	2N4047	-	0 33	1 7	μA	I_E = 0, V_{CB} = 60 Volts
$I_{CBO(+85°C)}$	2N4046	-	25	120	μA	I_E = 0, V_{CB} = 40 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
I_{CBO}(+85°C)	2N4047	-	25	120	μA	I_E = 0, V_{CB} = 60 Volts
BV_{CBO}	2N4046	50	-	-	Volts	I_C = 10 μA, I_E = 0
	2N4047	80	-	-	Volts	
BV_{CES}	2N4046	50	-	-	Volts	I_C = 10 μA, V_{BE} = 0
	2N4047	80	-	-	Volts	
BV_{EBO}	2N4046, 2N4047	6 0	-	-	Volts	I_C = 0, I_E = 10 μA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired

(2) These are steady state limits The factory should be consulted on applications involving pulsed or low duty cycle operations

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 50°C watt (derating factor of 20 mW °C) Junction-to-ambient thermal resistance of 219°C watt (derating factor of 4 56 mW °C)

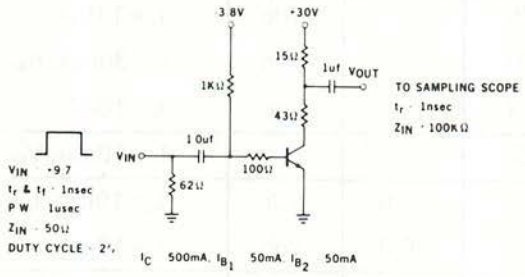
(4) Ratings refer to a high-current point where collector-to-emitter voltage is lowest

(5) Pulse Conditions length = 300 μsec. duty cycle = 1%

(6) See switching circuit for exact value of I_C, I_{B1}, and I_{B2}

SCHEMATIC

FIGURE 1 – SWITCHING TIME TEST CIRCUIT



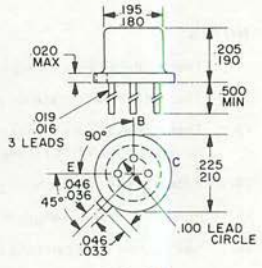
HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2368.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	25	Volts
Collector-to-Emitter Voltage	15	Volts
Emitter-to-Base Voltage	3	Volts
Operating Junction Temperature	200	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watt
P_D @ T_A = 25°C	0.3	Watt

DIMENSIONS



TO-18

ELECTRICAL CHARACTERISTICS (25C° free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	25		Vdc	I_C=1.0μA
V_{CER}	20		Vdc	I_C=30mA, R_{BE}=10Ω pulsed
BV_{EBO}	3		Vdc	I_E=10μA
h_{FE}	20			I_C=10mA, V_{CE}=1.0V
V_{CE}(sat)		0.6	Vdc	I_C=10mA, I_B=1.0mA
V_{BE}(sat)		0.9	Vdc	I_C=10mA, I_B=1.0mA
I_{CBO}		50	nA	V_{CB}=15V
I_{CBO}		30	μA	V_{CB}=15V, T_A=+150°C
C_{ob}		6.0	pF	V_{CB}=10V
h_{fe}	2			I_C=10mA, V_{CE}=15V, f=100MHz
t_{pd}	5	11	ns	I_C=4.5mA
t_s		60	ns	I_C=I_{B1}=I_{B2}=10mA, V_{CC}=10V, R_L=1KΩ

NOTE: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	25		Vdc	$I_C = 10\mu A$
LV_{CER}	20		Vdc	$I_C = 10mA$, $R_{BE} = 10\Omega$ pulsed
BV_{EBO}	5		Vdc	$I_E = 10\mu A$
h_{FE}	20			$I_C = 10mA$, $V_{CE} = 1V$
$V_{CE}(sat)$		0.6	Vdc	$I_C = 10mA$, $I_B = 1mA$
$V_{BE}(sat)$	0.7	0.9	Vdc	$I_C = 10mA$, $I_B = 1mA$
I_{CBO}		0.5	μA	$V_{CB} = 15V$
I_{CBO}		30	μA	$V_{CB} = 15V$, $T_A = 150°C$
C_{ob}		5	pF	$V_{CB} = 5V$
h_{fe}	2			$I_C = 10mA$, $V_{CE} = 10V$, $f = 100MHz$
t_s		25	ns	$I_C = I_{B1} = I_{B2} = 10mA$, $V_{CC} = 10V$, $R_L = 1K\Omega$
t_{on}		40	ns	$I_{B1} = 3mA$, $I_{B2} = 1mA$, $V_{CC} = 3V$, $R_L = 270\Omega$
t_{off}		75	ns	$I_{B1} = 3mA$, $I_{B2} = 1mA$, $V_{CC} = 3V$, $R_L = 270\Omega$

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	25		Vdc	$I_C = 10\mu A$
LV_{CER}	20		Vdc	$I_C = 10mA$, $R_{BE} = 10\Omega$ pulsed
LV_{CEO}	15		Vdc	$I_C = 10mA$ pulsed
BV_{EBO}	5		Vdc	$I_E = 10\mu A$
h_{FE}	20	60		$I_C = 10mA$, $V_{CE} = IV$
$V_{CE}(sat)$		0.4	Vdc	$I_C = 10mA$, $I_B = 1mA$
$V_{BE}(sat)$	0.7	0.9	Vdc	$I_C = 10mA$, $I_B = 1mA$
I_{CBO}		0.5	μA	$V_{CB} = 15V$
I_{CBO}		30	μA	$V_{CB} = 15V$, $T_A = 150°C$
I_{CER}		10	μA	$V_{CE} = 20V$, $R_{BE} = 100K$
C_{ob}		5	pF	$V_{CB} = 5V$
h_{fe}	2.0			$I_C = 10mA$, $V_{CE} = 10V$, $f = 100MHz$
r_b'		50	ohms	$I_C = 10mA$, $V_{CE} = 15V$, $f = 300MHz$
τ_s		25	ns	$I_C = I_{B1} = I_{B2} = 10mA$, $V_{CC} = 10V$, $R_L = 1K\Omega$
t_{on}		40	ns	$I_{B1} = 3mA$, $I_{B2} = 1mA$, $V_{CC} = 3V$, $R_L = 270\Omega$
t_{off}		75	ns	$I_{B1} = 3mA$, $I_{B2} = 1mA$, $V_{CC} = 3V$, $R_L = 270\Omega$

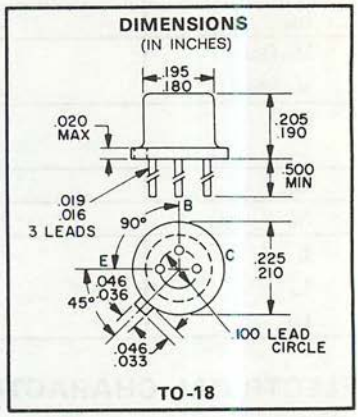
NOTE: Pulse width $\leq 300\ \mu sec$, duty cycle $\leq 2\%$.

2N708®

SILICON SWITCHING TRANSISTOR

HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2369A.



ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	40	Volts
Collector-to-Emitter Voltage	15	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature	200	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.2	Watts
P_D @ T_A = 25°C	.36	Watt

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	40		Vdc	I_C=1μA
LV_{CER}	20		Vdc	I_C=3mA pulsed, R_{BE}=10Ω
LV_{CEO}	15		Vdc	I_C=30mA pulsed
BV_{EBO}	5		Vdc	I_E=10μA
h_{FE}	30	120		I_C=10mA, V_{CE}=1V
h_{FE}	15			I_C=0.5mA, V_{CE}=1V, T_A=−55°C
h_{FE}	15			I_C=10mA, V_{CE}=1V
V_{CE}(sat)		.40	Vdc	I_C=10mA, I_B=1.0mA
V_{CE}(sat)		.40	Vdc	I_C=7mA, I_B=.7mA, T_A=+125°C
V_{BE}(sat)	.72	.80	Vdc	I_C=10mA, I_B=1.0mA
V_{BE}(sat)		.90	Vdc	I_C=10mA, I_B=1.0mA, T_A=−55°C
I_{CBO}		25	nA	V_{CB}=20V
I_{CBO}		15	μA	V_{CB}=20V, T_A=+150°C
I_{EBO}		0.1	μA	V_{EB}=4V
I_{CEX}		10	μA	V_{CE}=20V, V_{EB}=.25V, T_A=125°C
C_{ob}		6	pF	V_{CB}=10V
h_{fe}	3			I_C=10mA, V_{CE}=10V, f=100MHz
r_b'		50	ohms	I_C=10mA, V_{CE}=10V, f=300MHz
τ_s		25	ns	I_C=I_{B1}=I_{B2}=10mA
t_{on}		40	ns	I_C=10mA, I_{B1}=3mA, V_{EB}=2V
t_{off}		75	ns	I_C=10mA, I_{B1}=3mA, I_{B2}=1mA

NOTE: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

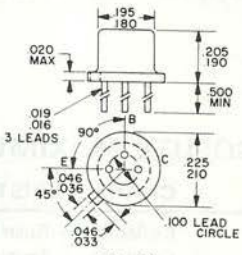
HIGH SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2369

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	20	Volts
Collector-to-Emitter Voltage	12	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature	200	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watt
P_D @ T_A = 25°C	0.3	Watt

DIMENSIONS



TO-18

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	20		Vdc	I_C=1μA
LV_{CEO}	12		Vdc	I_C=10mA pulsed
BV_{EBO}	5		Vdc	I_C=10μA
h_{FE}	20			I_C=1.0mA, V_{CE}=0.25V
h_{FE}	40	120		I_C=10mA, V_{CE}=0.35V
h_{FE}	20			I_C=100mA, V_{CE}=1.0V pulsed
h_{FE}	20			I_C=10mA, V_{CE}=0.35V, T_A= −55°C
V_{CE}(sat)	0.35		Vdc	I_C=10mA, I_B=1mA, T_A=170°C
V_{CE}(sat)	1		Vdc	I_C=100mA, I_B=10mA, T_A=170°C pulsed
V_{BE}(sat)	0.65	0.85	Vdc	I_C=10mA, I_B=1mA
V_{BE}(sat)		1.5	Vdc	I_C=100mA, I_B=10mA pulsed
V_{BE}(sat)		1.1	Vdc	I_C=10mA, I_B=1mA, T_A= −55°C
V_{BE}(sat)		1.6	Vdc	I_C=100mA, I_B=10mA, T_A= −55°C pulsed
I_{CBO}		1	μA	V_{CB}=20V
I_{CEO}		30	μA	V_{CE}=10V, V_{BE}=0.35V, T_A=100°C
I_{CES}		1	μA	V_{CE}=20V
I_{CES}		100	μA	V_{CE}=20V, T_A=170°C
C_{ob}		5	pF	V_{CB}=5V
h_{fe}	2.8			I_C=10mA, V_{CE}=10V, f=100MHz
T_s		18	ns	I_C=I_{B1}=I_{B2}=10mA
t_{on}		12	ns	I_C=100mA, I_{B1}=40mA, I_{B2}=20mA
t_{on}		16	ns	I_C=10mA, I_{B1}=3mA, I_{B2}=1.5mA
t_{off}		45	ns	I_C=100mA, I_{B1}=40mA, I_{B2}=20mA
t_{off}		24	ns	I_C=10mA, I_{B1}=3mA, I_{B2}=1.5mA

NOTE: Pulse width ≤ 300μsec, duty cycle ≤ 2%.

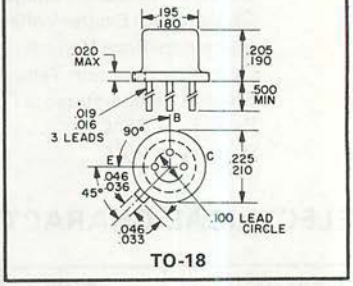
2N753℮

SILICON SWITCHING TRANSISTOR

HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2369.

DIMENSIONS



TO-18

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	25	Volts
Collector-to-Emitter Voltage	15	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watt
P_D @ T_A = 25°C	0.3	Watt

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	25		Vdc	I_C=10μA
LV_{CER}	20		Vdc	I_C=10mA, R_{BE}=10Ω pulsed
LV_{CEO}	15		Vdc	I_C=10mA pulsed
BV_{EBO}	5		Vdc	I_C=10μA
h_{FE}	40	120		I_C=10mA, V_{CE}=1.0V
V_{CE}(sat)		0.6	Vdc	I_C=10mA, I_B=1.0mA
V_{BE}(sat)	0.7	0.9	Vdc	I_C=10mA, I_B=1.0mA
I_{CBO}		0.5	μA	V_{CB}=15V
I_{CBO}		30	μA	V_{CB}=15V, T_A=150°C
I_{CER}		10	μA	V_{CE}=20V, R_{BE}=100KΩ
C_{ob}	5		pF	V_{CB}=5V
h_{fe}	2			I_C=10mA, V_{CE}=10V, f=100MHz
τ_S		35	ns	I_C=10mA, I_{B1}=I_{B2}=10mA, V_{CC}=10V
t_{on}		40	ns	V_{CC}=3V, R_L=270Ω, I_{B1}=3mA
t_{off}		75	ns	V_{CC}=3V, R_L=270Ω, I_{B1}=3mA, I_{B2}=1mA

NOTES: Pulse width ≤ 300μsec, duty cycle ≤ 2%.

2N783Ⓕ
HIGH-SPEED NPN SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	175°C Maximum
Total Device Dissipation	
@ T_C = 25°C (Notes 2 and 3)	1.0 Watt
@ T_A = 25°C (Notes 2 and 3)	0.3 Watt
Collector-Base Voltage	40 Volts
Collector-Emitter Voltage (R_{BE} = 10 Ω)	20 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	20	60	–	I_C = 10 mA, V_{CE} = 1.0 Volt
$V_{CE(sat)}$	–	0.25	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{BE(sat)}$	0.7	0.9	Volt	I_C = 10 mA, I_B = 1.0 mA
I_{CBO}	–	250	nA	I_E = 0, V_{CB} = 25 Volts
I_{CBO}(150°C)	–	30	μA	I_E = 0, V_{CB} = 25 Volts
h_{fe}	2.0	–	–	I_C = 10 mA, V_{CE} = 10 Volts
C_{ob}	–	3.5	pf	I_E = 0, V_{CB} = 10 Volts
t_s	–	10	nsec	I_C = 10 mA, V_{CC} = 10 Volts (Note 4)
t_{on}	–	16	nsec	I_{B1} = 3.0 mA, I_{B2} = 1.0 mA (Note 5)
t_{off}	–	30	nsec	I_{B1} = 3.0 mA, I_{B2} = 1.0 mA (Note 5)
BV_{CBO}	40	–	Volts	I_E = 0, I_C = 100 μA
BV_{CER}	20	–	Volts	I_C = 1.0 mA, V_{BE} = 0
BV_{EBO}	5.0	–	Volts	I_C = 0, I_E = 100 μA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.67 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C)

(4) I_{B1} = 10 mA, I_{B2} = 10 mA, R_L = 1KΩ, (see Figure 2)

(5) V_{CC} = 3.0 Volts, R_L = 270 Ω, (see Figure 1)

CIRCUIT DIAGRAM

FIGURE 1 TURN-ON AND TURN-OFF CIRCUIT

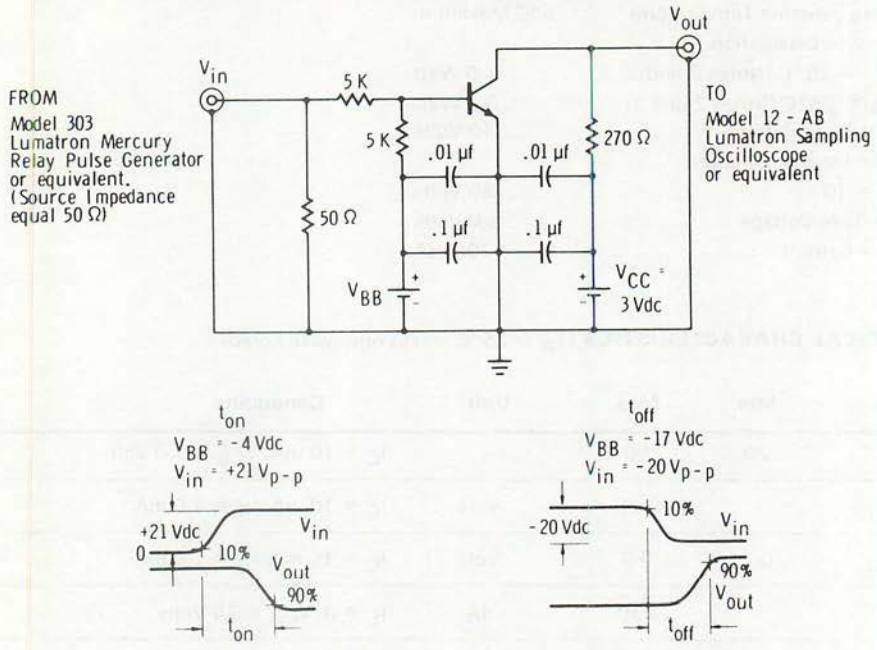
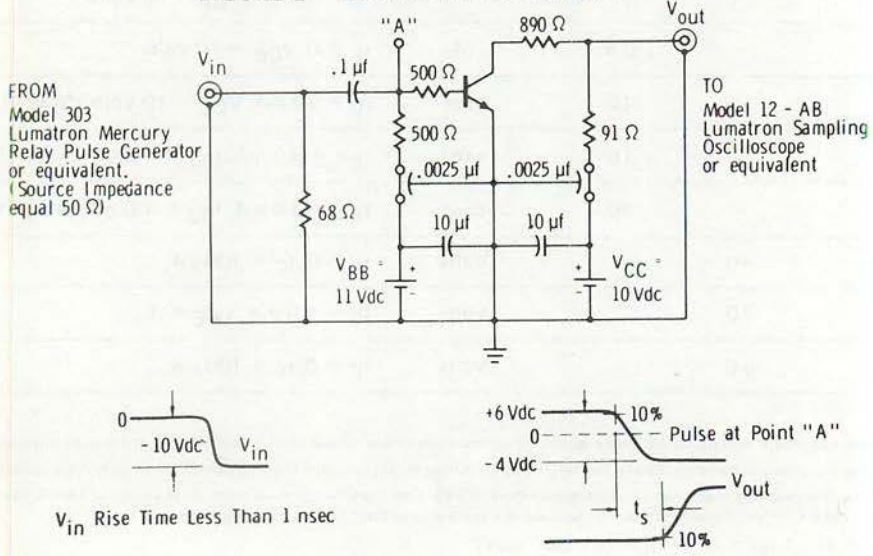
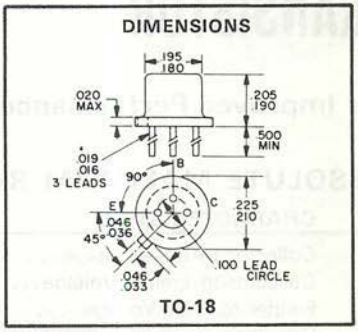


FIGURE 2 STORAGE TIME CIRCUIT



HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2368.



ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	30	Volts
Collector-to-Emitter Voltage	12	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watt
P_D @ T_A = 25°C	0.3	Watt

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

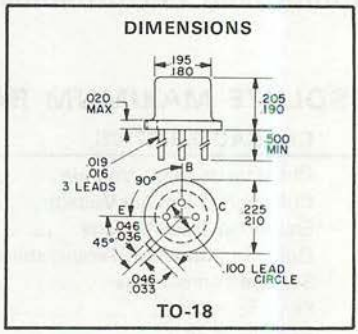
SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	30		Vdc	I_C = 100μA
BV_{CER}	15		Vdc	I_C = 10μA, R_{BE} = 10Ω
BV_{EBO}	5		Vdc	I_C = 100μA
h_{FE}	25			I_C = 10mA, V_{CE} = 10V
V_{CE}(sat)		0.19	Vdc	I_C = 10mA, I_B = 1mA
V_{BE}(sat)	0.7	0.9	Vdc	I_C = 10mA, I_B = 1mA
I_{CBO}		250	nA	V_{CB} = 25V
I_{CBO}		30	μA	V_{CB} = 25V, T_A = 150°C
C_{ob}		3.5	pF	V_{CB} = 10V
h_{fe}	2			I_C = 10mA, V_{CE} = 10V, f = 100MHz
t_s		15	ns	$I_C = I_{B1} = I_{B2}$ = 10mA, V_{CC} = 10V, R_L = 1KΩ
t_{on}		20	ns	I_{B1} = 3mA, I_{B2} = 1mA, V_{CC} = 3V, R_L = 270Ω
t_{off}		40	ns	I_{B1} = 3mA, I_{B2} = 1mA, V_{CC} = 3V, R_L = 270Ω

2N834©

SILICON SWITCHING TRANSISTOR

HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2369.



ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	40	Volts
Collector-to-Emitter Voltage	25	Volts
Emitter-to-Base Voltage	5	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watt
P_D @ T_A = 25°C	0.3	Watt

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	40		Vdc	I_C = 100μA
BV_{CES}	30		Vdc	I_C = 10μA
BV_{EBO}	5		Vdc	I_E = 100μA
h_{FE}	25			I_C = 10mA, V_{CE} = 1.0V
V_{CE}(sat)		0.25	Vdc	I_C = 10mA, I_B = 1.0mA
V_{CE}(sat)		0.4	Vdc	I_C = 50mA, I_B = 5.0mA pulsed
V_{BE}(sat)		0.9	Vdc	I_C = 10mA, I_B = 1.0mA
I_{CBO}		0.5	μA	V_{CB} = 20V
I_{CBO}		30	μA	V_{CB} = 20V, T_A = 150°C
C_{ob}		4	pF	V_{CB} = 10V
h_{fe}	3.5			I_C = 10mA, V_{CE} = 15V, f = 100MHz
τ_s		25	ns	I_C = 10mA, I_{B1} = I_{B2} = 10mA
t_{on}		35	ns	I_C = 10mA, I_{B1} = 3mA, I_{B2} = 1mA
t_{off}		75	ns	I_C = 10mA, I_{B1} = 3mA, I_{B2} = 1mA

NOTE: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

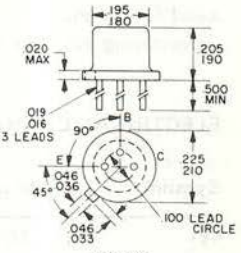
HIGH-SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTOR

For Improved Performance See ITT 2N2369.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	25	Volts
Collector-to-Emitter Voltage	15	Volts
Emitter-to-Base Voltage	3	Volts
Operating Junction Temperature	175	°C
Storage Temperature	−65 to +200	°C
P_D @ T_C = 25°C	1.0	Watts
P_D @ T_A = 25°C	0.3	Watts

DIMENSIONS



TO-18

ELECTRICAL CHARACTERISTICS (25°C free air unless otherwise noted)

SYMBOL	MIN.	MAX.	UNIT	CONDITIONS
BV_{CBO}	25		Vdc	I_C = 10μA
BV_{CES}	20		Vdc	I_C = 10μA
BV_{EBO}	3		Vdc	I_C = 10μA
h_{FE}	20			I_C = 10mA, V_{CE} = 1V
V_{CE}(sat)		0.3	Vdc	I_C = 10mA, I_B = 1mA
V_{BE}(sat)		0.9	Vdc	I_C = 10mA, I_B = 1mA
I_{CBO}		0.5	μA	V_{CB} = 20V
I_{CBO}		30	μA	V_{CB} = 20V, T_A = 150°C
C_{ob}		4	pF	V_{CB} = 10V
h_{fe}	3			I_C = 10mA, V_{CE} = 15V, f = 100MHz
τ_s		35	ns	I_C = 10mA, I_{B1} = I_{B2} = 10mA
t_{on}		20	ns	I_C = 10mA, I_{B1} = 3mA, I_{B2} = 1mA
t_{off}		35	ns	I_C = 10mA, I_{B1} = 3mA, I_{B2} = 1mA

2N914Ⓕ

Package: TO-18

NPN SILICON SATURATED SWITCH AND VHF AMPLIFIER

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	40 Volts
Collector-Emitter Voltage	
$R_{BE} \leq 10$ ohms (Note 4)	20 Volts
Collector-Emitter Voltage (Note 4)	15 Volts
Emitter-Base Voltage	5.0 Volts
Total Dissipation @ :	
$T_C = 25°C$ (Notes 2 and 3)	1.2 Watts
$T_C = 100°C$ (Notes 2 and 3)	0.68 Watt
$T_A = 25°C$ (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature	
(Soldering, No Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	30	55	120	–	$I_C = 10$ mA, $V_{CE} = 1.0$ Volt (Note 5)
$h_{FE}(-55°C)$	12	28	–	–	$I_C = 10$ mA, $V_{CE} = 1.0$ Volt (Note 5)
h_{FE}	10	17	–	–	$I_C = 500$ mA, $V_{CE} = 5.0$ Volts (Note 5)
$V_{BE(sat)}$	0.70	0.74	0.80	Volt	$I_C = 10$ mA, $I_B = 1.0$ mA
$V_{CE(sat)}$	–	0.40	0.70	Volt	$I_C = 200$ mA, $I_B = 20$ mA
$V_{CE(sat)}$	–	0.20	0.25	Volt	$I_C = 10\ I_B$ (Note 6)
h_{fe}	3.0	3.7	–	–	$I_C = 20$ mA, $V_{CE} = 10$ Volts
C_{obo}	–	4.5	6.0	pf	$I_E = 0$, $V_{CB} = 10$ Volts
C_{ibo}	–	–	9.0	pf	$I_C = 0$, $V_{EB} = 0.5$ Volt
I_{CBO}	–	4.0	25	mμA	$I_E = 0$, $V_{CB} = 20$ Volts
$I_{CBO}(150°C)$	–	3.0	15	μA	$I_E = 0$, $V_{CB} = 20$ Volts
BV_{CBO}	40	–	–	Volts	$I_C = 1.0\,\mu A$, $I_E = 0$
$V_{CER(sust)}$	20	–	–	Volts	$I_C = 30$ mA (pulsed), $R_{BE} \leq 10$ ohms (Notes 4 and 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C uniess otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
$V_{CEO(sust)}$	15	–	–	Volts	I_C = 30 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	–	Volts	I_C = 0, I_E = 10 μA
I_{EBO}	–	0.007	0.1	μA	I_C = 0, V_{EB} = 4.0 Volts
I_{CEX}(125°C)	–	3.0	10	μA	V_{CE} = 20 Volts, V_{BE} = +0.25 Volt
τ_s	–	13	20	nsec	$I_C = I_{B1} \approx$ 20 mA, $I_{B2} \approx -20$ mA (Notes 7 and 8)
t_{d+r}	–	25	40	nsec	$I_C \approx$ 200 mA, $I_{B1} \approx$ 40 mA (Note 8)
t_{s+f}	–	25	40	nsec	$I_C \approx$ 200 mA, $I_{B1} \approx$ 40 mA, $I_{B2} \approx -20$ mA (Note 8)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired

(2) These are steady state limits The factory should be consulted on applications involving pulsed or low duty cycle operations

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 145°C watt (derating factor of 6 9 mW/°C), junction-to-ambient thermal resistance of 486°C watt (derating factor of 2 1 mW/°C)

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest

(5) Pulse Conditions length = 300μsec. duty cycle = 1%

(6) I_C = 1 0 mA through 20 mA

(7) Measured on Sampling Scope PW ≥ 200 nsec

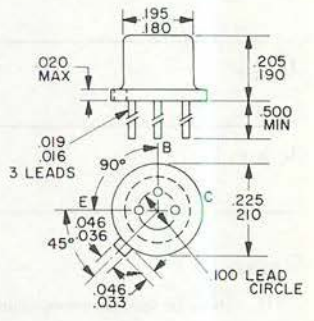
(8) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}

HIGH SPEED NPN SILICON PLANAR EPITAXIAL SATURATED SWITCHING TRANSISTORS

- High f_T: 650 mHz, typ.
- High Gain: 40 min. @ $I_C = 10mA$
- Low C_{ob} : 4pf max. @ $V_{CB} = 5V$
- Low T_{on} = 9 nsec typ.
- Low t_{off} = 13 nsec typ.

The ITT 2N2368 and 2N2369 are NPN silicon planar epitaxial saturated switching transistors for applications at current ranges from 0.1 to 100 mA. High gain and narrow base region provide excellent radiation resistance. They can operate at clock rates above 10 MHz for commercial computer applications.

DIMENSIONS

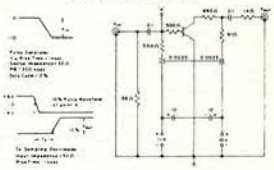
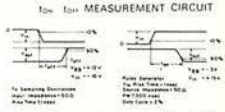
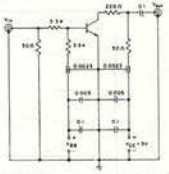


TO-18

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS		UNITS
Collector-to-Base Voltage	40	Volts
Collector-to-Emitter Voltage (shorted base)	40	Volts
Collector-to-Emitter Voltage (open base)	15	Volts
Emitter-to-Base Voltage	4.5	Volts
Collector Current (10 μsec. pulse)	500	mA
Junction Temperature (op. and stg.)	−65 to +200	°C
Total Power Dissipation @ $T_C = 25°C$	1.2	Watts
(derate 6.8 mW/°C above 25°C)		
@ $T_C = 100°C$	0.68	Watts
Total Power Dissipation @ $T_A = 25°C$	0.36	Watts
(derate 2.06 mW/°C above 25°C)		

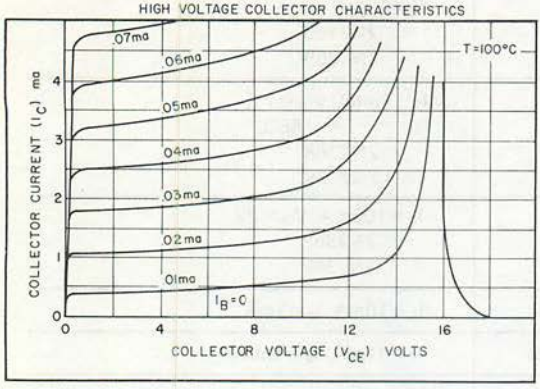
ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
h_{FE} [1])	20 40		60 120		$I_C = 10mA$, $V_{CE} = 1V$ 2N2368 2N2369
	10 20				$I_C = 10mA$, $V_{CE} = 1V$, $T = -55°C$ 2N2368 2N2369
	10 20				$I_C = 100mA$, $V_{CE} = 2V$ 2N2368 2N2369
V_{CE} (sat)		0.2	0.25	Vdc	$I_C = 10mA$, $I_B = 1mA$
V_{BE} (sat)	0.7	0.75	0.85	Vdc	$I_C = 10mA$, $I_B = 1mA$
I_{CBO}		0.1 10	0.4 30	μA μA	$V_{CB} = 20V$, $I_E = 0$ $V_{CB} = 20V$, $I_E = 0$, $T = 150°C$
f_T		650		MHz	$V_{CE} = 10V$, $I_C = 10mA$
C_{ob}		2.5	4.0	pf	$V_{CB} = 5V$, $I_E = 0$
τ_S [2] (charge storage time)		5	10	nsec	$I_C = I_{B1} \approx 10mA$, $I_{B2} \approx -10mA$ CHARGE STORAGE TIME MEASUREMENT CIRCUIT 
t_{on} (2)		9.0	12	nsec	$I_C \approx 10mA$, $I_{B1} \approx 3mA$ t_{ON} t_{OFF} MEASUREMENT CIRCUIT 
t_{off} [2]		10 13	15 18	nsec nsec	I_C 10mA, I_{B1} 3mA, $I_{B2} \approx -1.5mA$ 2N2368 2N2369 
BV_{CBO}	40			Vdc	$I_C = 10\mu A$, $I_E = 0$
BV_{CES}	40			Vdc	$I_C = 10\mu A$, $I_B = 0$
V_{CEO}(sust)	15			Vdc	$I_C = 10mA$, $I_B = 0$
BV_{EBO}	4.5			Vdc	$I_E = 10\mu A$, $I_C = 0$

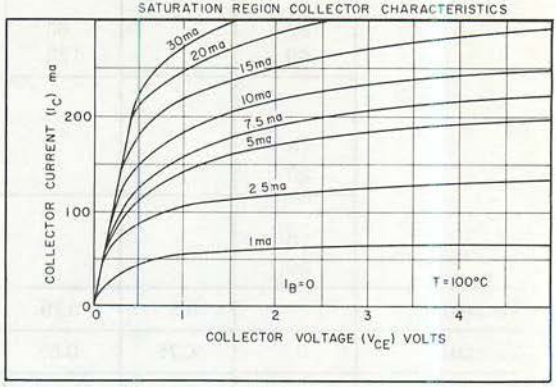
NOTES: 1. Pulse measurement: width $\leq$ 300 μsec, duty cycle $\leq$ 2%.
2. See switching circuits for exact I_C, I_{B1}, and I_{B2}.

TYPICAL CHARACTERISTICS[1]

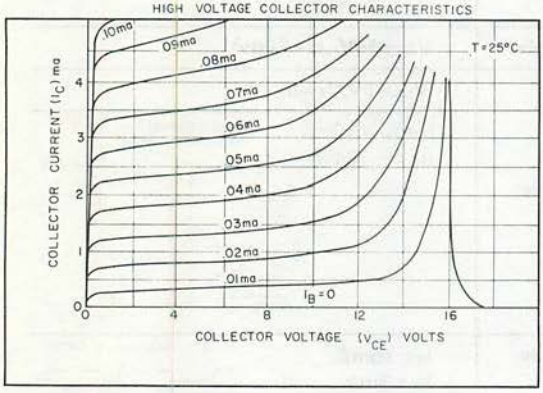
HIGH VOLTAGE COLLECTOR CHARACTERISTICS



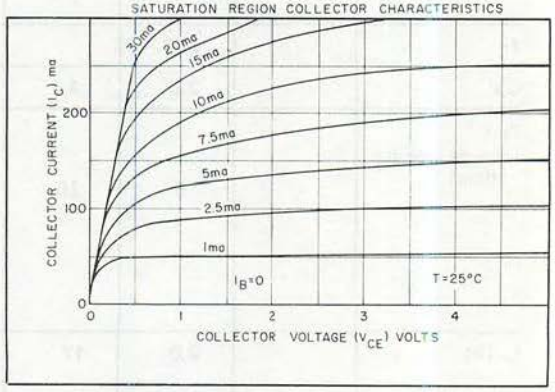
SATURATION REGION COLLECTOR CHARACTERISTICS



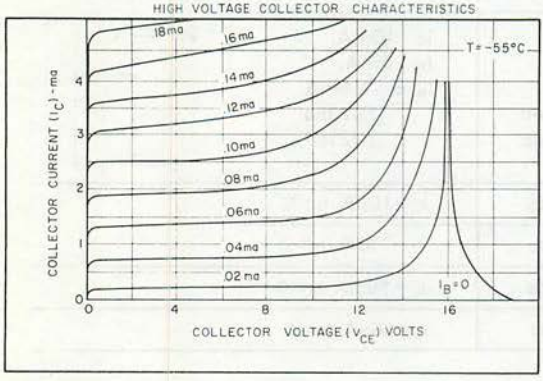
HIGH VOLTAGE COLLECTOR CHARACTERISTICS



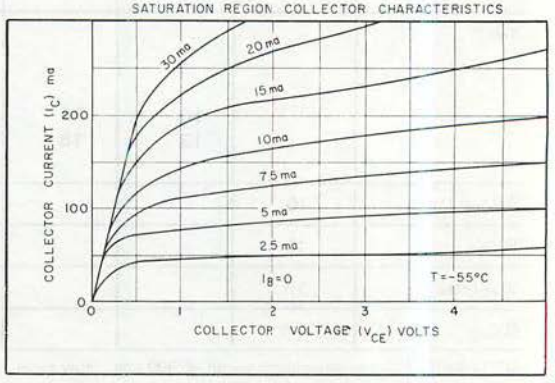
SATURATION REGION COLLECTOR CHARACTERISTICS



HIGH VOLTAGE COLLECTOR CHARACTERISTICS



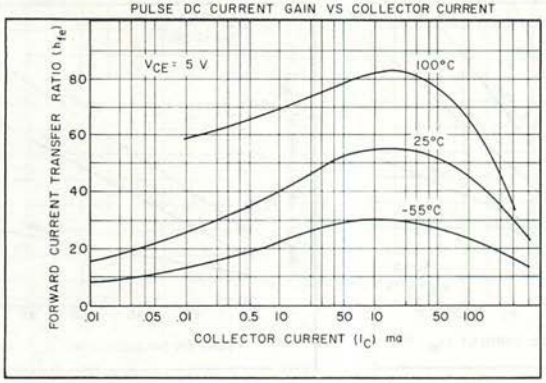
SATURATION REGION COLLECTOR CHARACTERISTICS



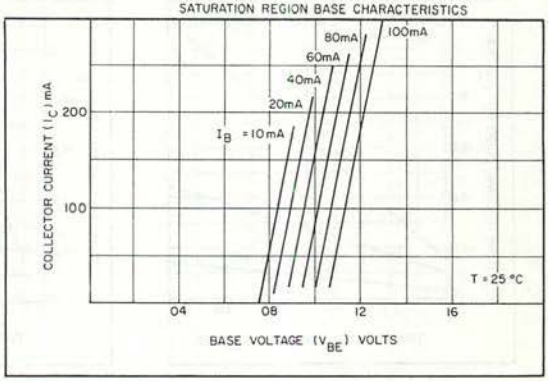
NOTE: Single family characteristics on Transistor Curve Tracer

TYPICAL CHARACTERISTICS, continued

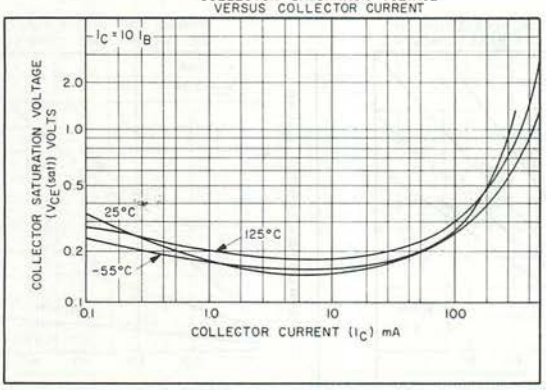
PULSE DC CURRENT GAIN VS COLLECTOR CURRENT



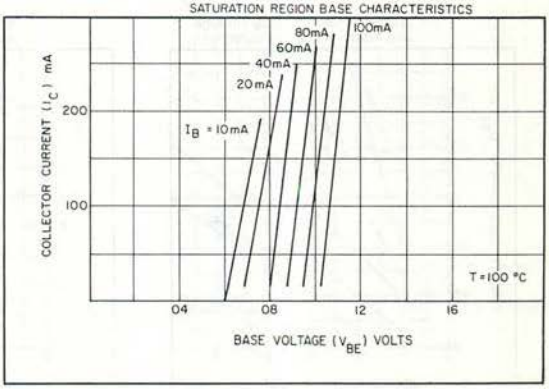
SATURATION REGION BASE CHARACTERISTICS



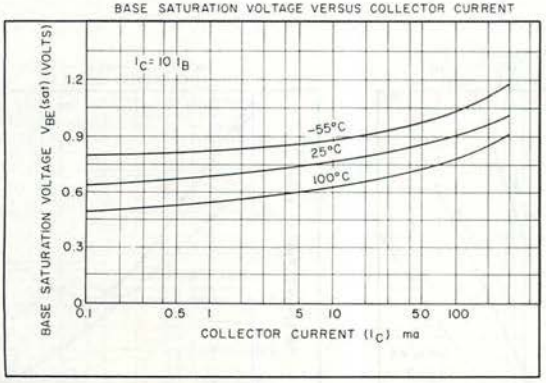
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



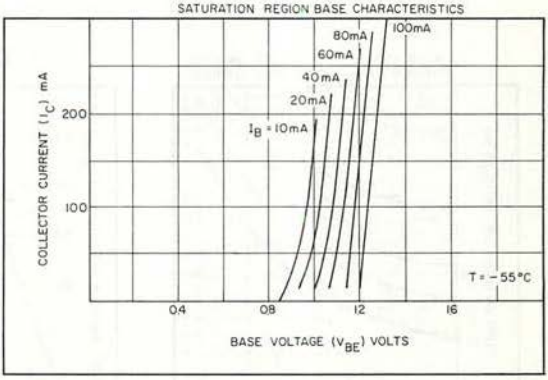
SATURATION REGION BASE CHARACTERISTICS



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

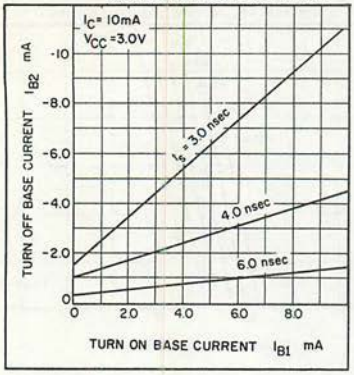


SATURATION REGION BASE CHARACTERISTICS

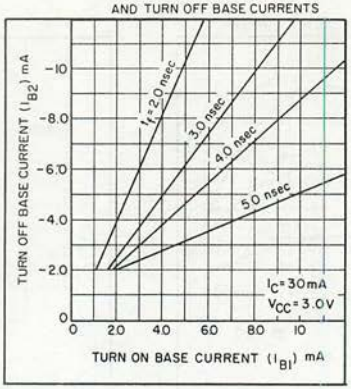


TYPICAL CHARACTERISTICS, continued

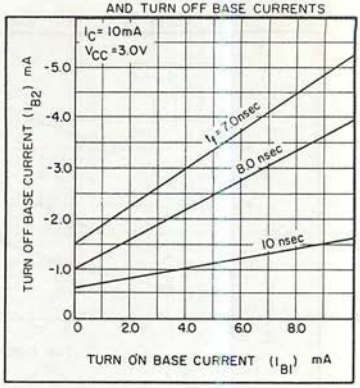
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



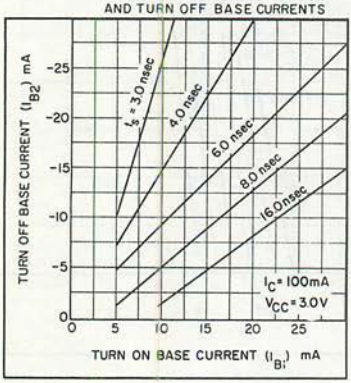
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



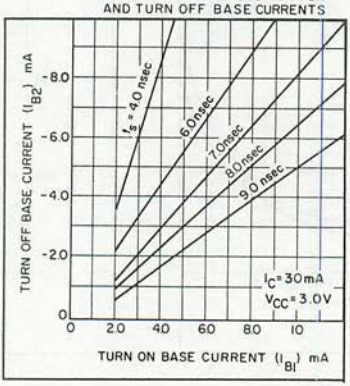
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



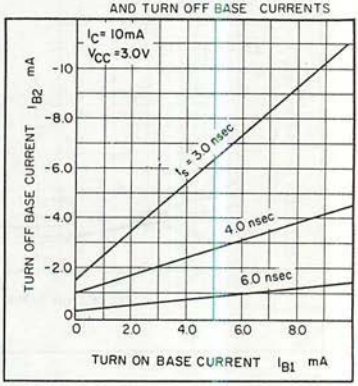
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



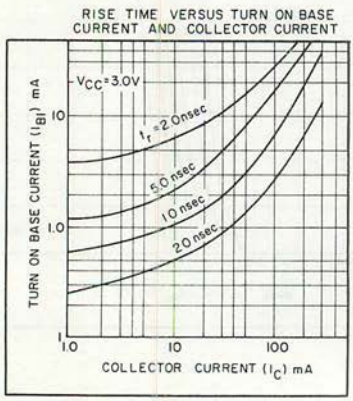
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



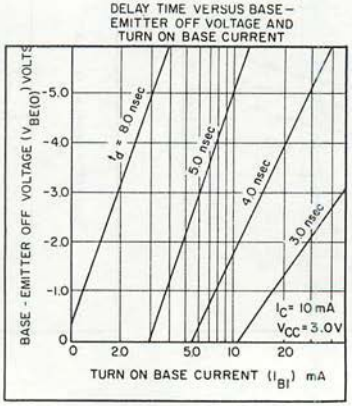
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



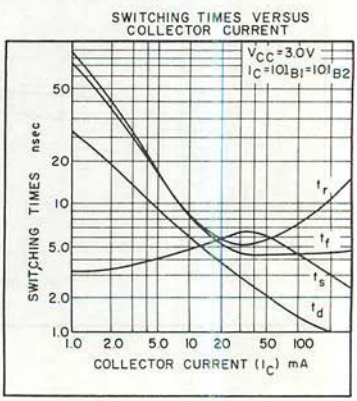
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



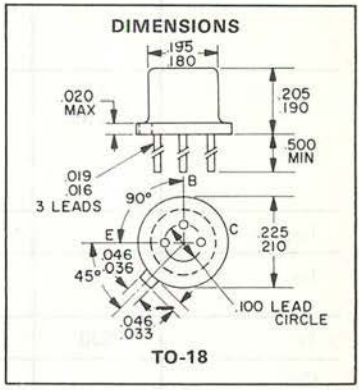
SWITCHING TIMES VERSUS COLLECTOR CURRENT



HIGH SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

- High f_T: 675 MHz, typ.
- High Gain: 40 min. @ $I_C = 10$ mA
- Low C_{ob}: 4 pf max. @ $V_{CB} = 5V$
- Low t_{on}: 9 nsec typ.;
- Low t_{off}: 13 nsec typ.

The ITT 2N2369A is a NPN silicon planar epitaxial saturated switching transistor for applications at current ranges from 0.1 to 100 mA. High gain and narrow base region provide excellent radiation resistance. The 2N2369A can operate at clock rates above 10 MHz for commercial computer applications.

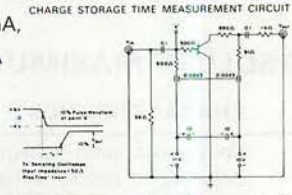
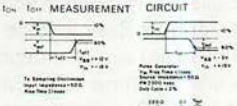
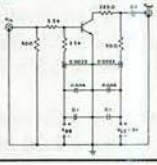


TO-18

ABSOLUTE MAXIMUM RATINGS

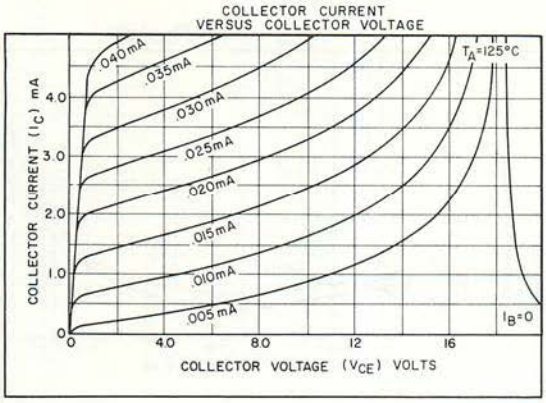
CHARACTERISTICS		UNITS
Collector-to-Base Voltage	40	Volts
Collector-to-Emitter Voltage (shorted base)	40	Volts
Collector-to-Emitter Voltage (open base)	15	Volts
Emitter-to-Base Voltage	4.5	Volts
Collector Current (continuous)	200	mA
Collector Current (10 μsec pulse)	500	mA
Junction Temperature (op. and stg.)	−65 to +200	°C
Total Power Dissipation @ $T_C = 25°C$	1.2	Watts
(derate 6.8 mW/°C above 25°C)		
@ $T_C = 100°C$	0.68	Watts
Total Power Dissipation @ $T_A = 25°C$	0.36	Watts
(derate 2.06 mW/°C above 25°C)		

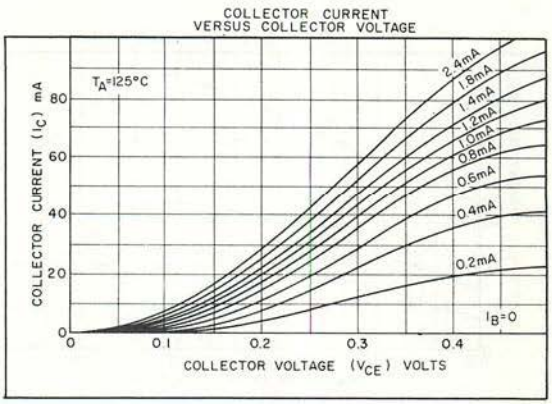
ELECTRICAL CHARACTERISTICS @ $T_A = 25°C$ unless otherwise noted

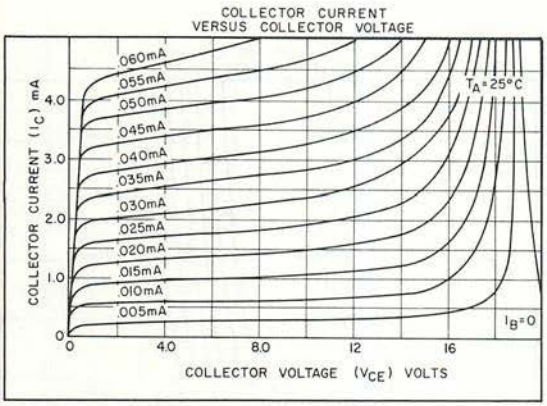
SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
h_{FE}[1]	**40**	**66**	**120**		**I_C=10mA, V_{CE}=1V**
	40	**63**	**120**		**I_C=10mA, V_{CE}=0.35V**
	20	50			I_C=10mA, V_{CE}=0.35V, T=−55°C
	30	71			I_C=30mA, V_{CE}=0.4V
	20				I_C=100mA. V_{CE}=1V
V_{CE}(sat)		0.14	0.2	Vdc	I_C=10mA, I_B=1mA
		0.19	0.3	Vdc	I_C=10mA, I_B=1mA, T=125°C
		0.17	0.25	Vdc	I_C=30mA, I_B=3mA
		0.28	0.5	Vdc	I_C=100mA, I_B=10mA
V_{BE}(sat)	0.7	0.8	0.85	Vdc	I_C=10mA, I_B=1mA
	0.59		1.02	Vdc	I_C=10mA, I_C=1mA, T=−65 to +125°C
		0.9	1.15	Vdc	I_C=30mA, I_B=3mA
		1.1	1.6	Vdc	I_C=100mA, I_B=10mA
I_{CES}		0.05	0.4	μA	V_{CE}=20V, V_{BE}=0
I_{CBO}		10	30	μA	V_{CB}=20V, I_E=0, T=150°C
f_T	**500**	**675**		**MHz**	**V_{CE}=10V, I_C=10mA**
C_{ob}		**2.3**	**4.0**	**pf**	**V_{CB}=5V, I_E=0**
τ_s (charge storage time)		6.0	13	nsec	$I_C = I_{B1} \approx 10mA$, $I_{B2} \approx -10mA$  CHARGE STORAGE TIME MEASUREMENT CIRCUIT
t_{on}		**9.0**	**12**	**nsec**	**$I_C \approx 10mA$, $I_{B1} \approx 3mA$**  t_{ON} t_{OFF} MEASUREMENT CIRCUIT
t_{off}		13	**18**	**nsec**	**$I_C \approx 10mA$, $I_{B1} \approx 3mA$, $I_{B2} \approx -1.5mA$** 
BV_{CBO}	40			Vdc	I_C=10μA, I_E=0
BV_{CES}	40			Vdc	I_C=10μA, V_{BE}=0
V_{CEO}(sust)[1,2]	15			Vdc	I_C=10mA, I_B=0
BV_{EBO}	4.5			Vdc	I_E=10μA, I_C=0

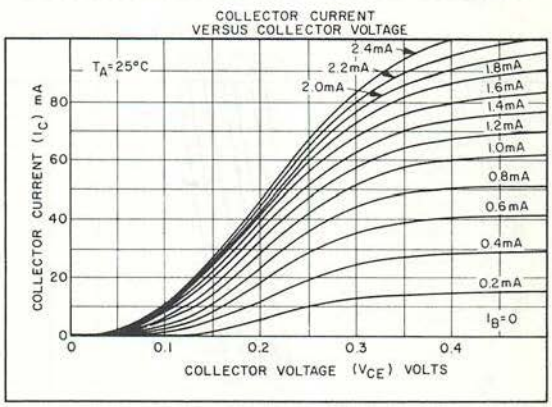
NOTES: 1. Pulse measurement: width ≤ 300 μsec, duty cycle ≤ 2%. 2. Rating refers to a high-current point where collector-to-emitter voltage is lowest.

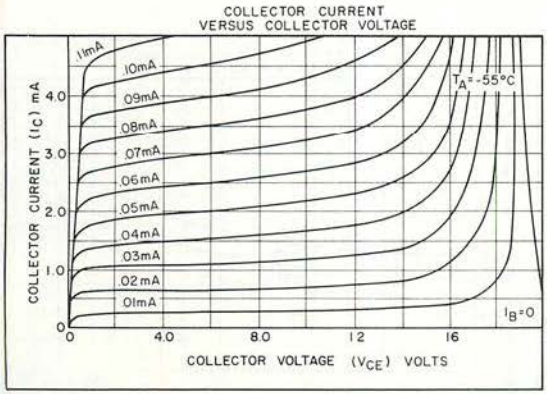
TYPICAL COLLECTOR CHARACTERISTICS[1]

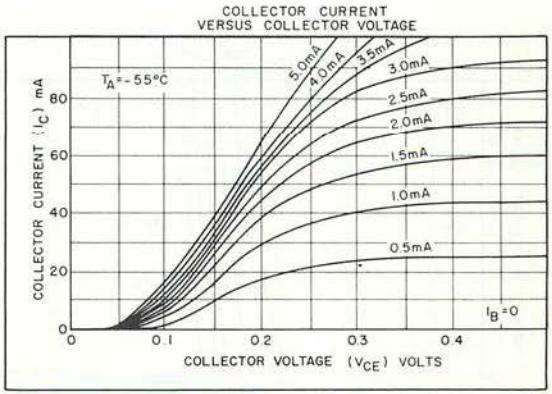








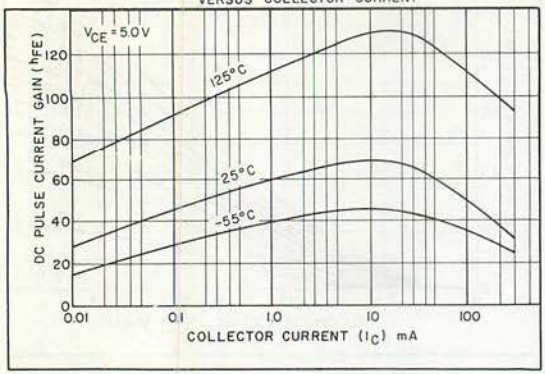




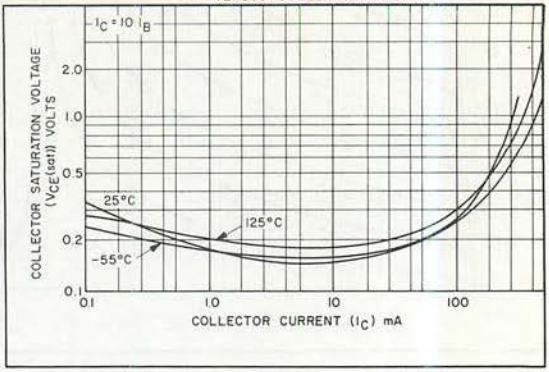
NOTE: Single family characteristics on Transistor Curve Tracer

TYPICAL COLLECTOR CHARACTERISTICS, continued

PULSED DC CURRENT GAIN
VERSUS COLLECTOR CURRENT

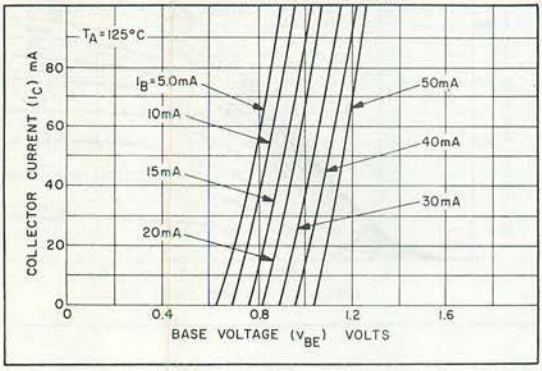


COLLECTOR SATURATION VOLTAGE
VERSUS COLLECTOR CURRENT

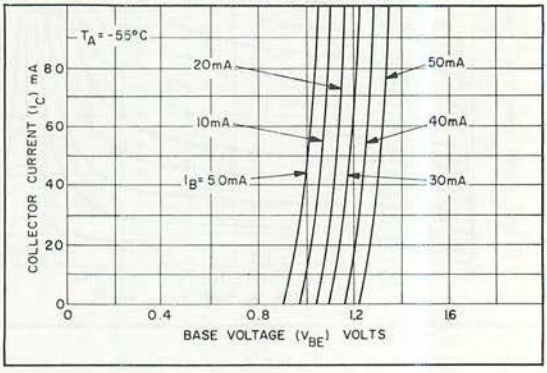


TYPICAL BASE CHARACTERISTICS[1]

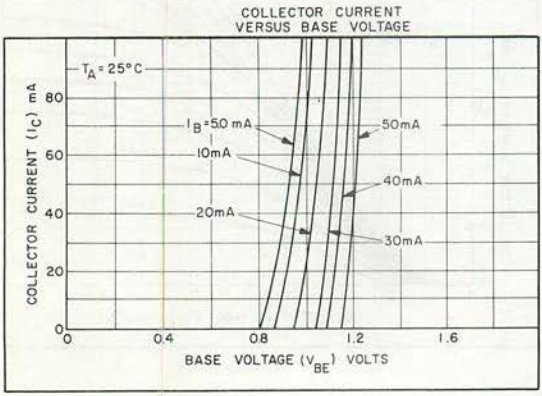
COLLECTOR CURRENT
VERSUS BASE VOLTAGE



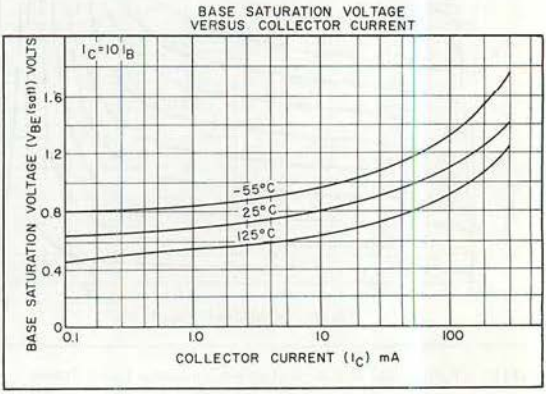
COLLECTOR CURRENT
VERSUS BASE VOLTAGE



COLLECTOR CURRENT
VERSUS BASE VOLTAGE

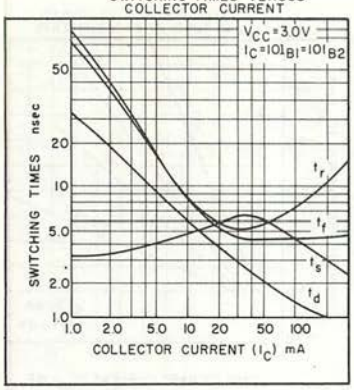


BASE SATURATION VOLTAGE
VERSUS COLLECTOR CURRENT

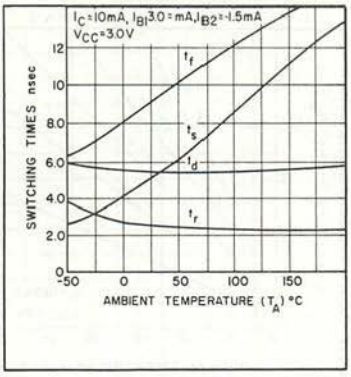


TYPICAL ELECTRICAL CHARACTERISTICS

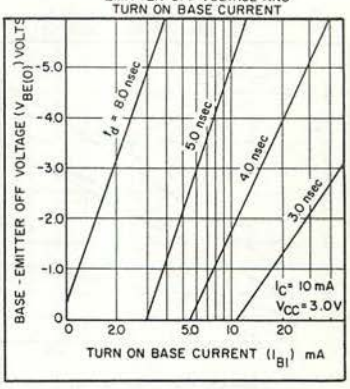
SWITCHING TIMES VERSUS COLLECTOR CURRENT



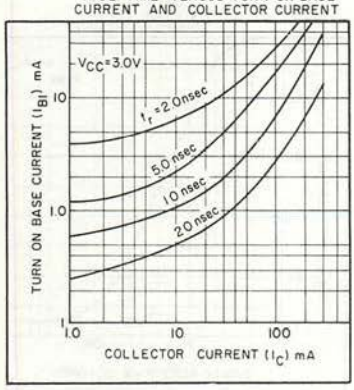
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



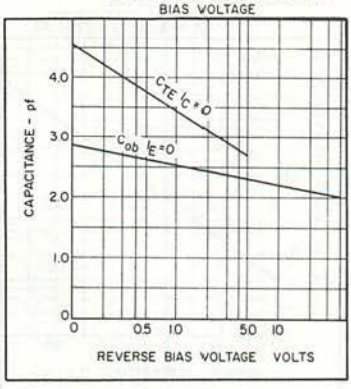
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



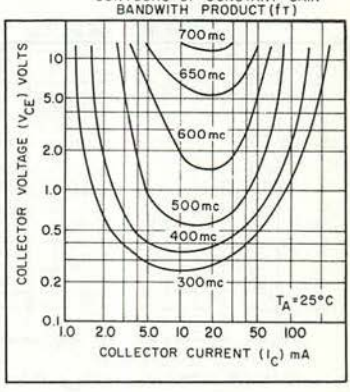
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



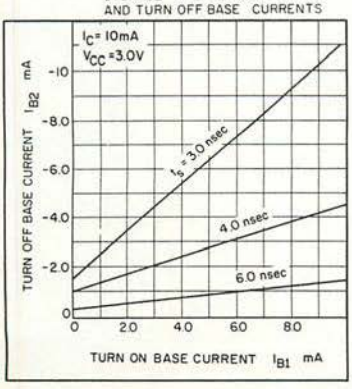
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



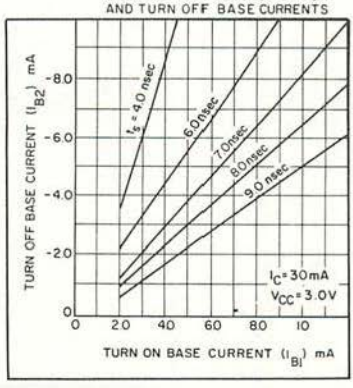
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



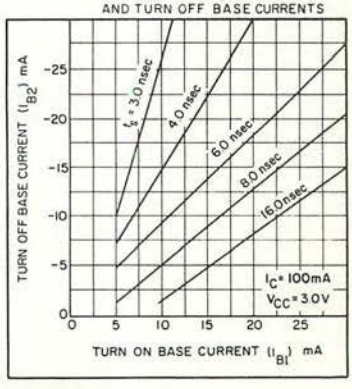
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

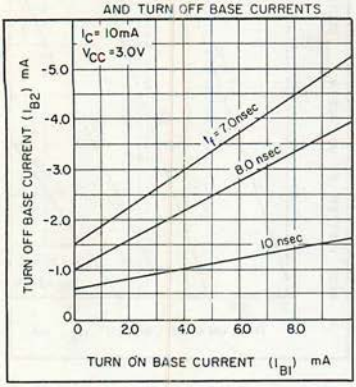


STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

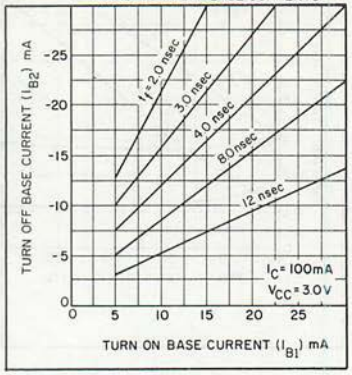


TYPICAL CHARACTERISTICS, continued

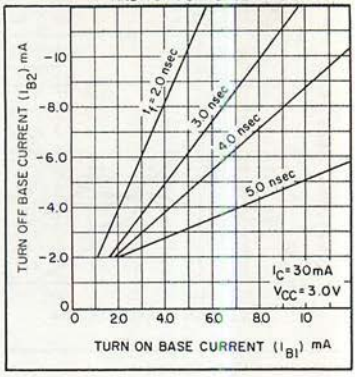
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



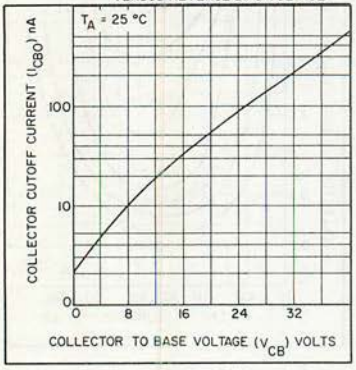
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



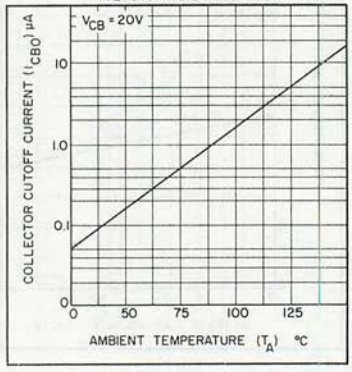
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



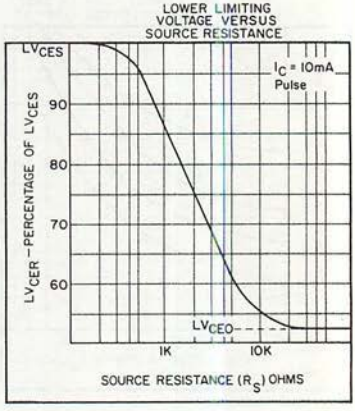
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



2N2710
HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	20 Volts
Collector-Emitter Voltage	30 Volts
Collector-Base Voltage	40 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current – Continuous	500 mA
Total Device Dissipation @ T_A = 25°C	0.36 Watt
Derate above 25°C	2.1 mW/°C
Total Device Dissipation @ T_C = 25°C	1.2 Watts
Operating Junction Temperature Range	+200 °C
Storage Temperature Range	−65 to +200 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	20	–	Volts	I_C = 10 mA, I_B = 0
BV_{CES}	30	–	Volts	I_C = 10 μA, V_{BE} = 0
BV_{CBO}	40	–	Volts	I_C = 10 μA, I_E = 0
BV_{EBO}	5.0	–	Volts	I_E = 10 μA, I_C = 0
I_{CBO}	–	30	μA	V_{CB} = 20 Volts, I_E = 0
I_{CBO}	–	30	μA	V_{CB} = 20 Volts, I_E = 0, T_A = +150°C
I_{EBO}	–	1.0	μA	V_{BE} = 3.0 Volts, I_C = 0
h_{FE}	40	–	–	I_C = 10 mA, V_{CE} = 1.0 Volt
h_{FE}	40	–	–	I_C = 50 mA, V_{CE} = 1.0 Volt
$V_{CE(sat)}$	–	0.25	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{CE(sat)}$	–	0.4	Volt	I_C = 50 mA, I_B = 5.0 mA
$V_{BE(sat)}$	–	0.9	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{BE(sat)}$	–	1.3	Volts	I_C = 50 mA, I_B = 5.0 mA
f_T	500	–	MHz	I_C = 10 mA, V_{CE} = 20 Volts, f = 100 MHz
C_{ob}	–	4.0	pF	V_{CB} = 10 Volts, I_E = 0, f = 4.0 MHz

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
t_{on}	–	20	ns	V_{CC} = 3.0 Volts, $V_{BE(off)}$ = 2.0 Volts, I_C = 10 mA, I_{B1} = 3.0 mA
t_{off}	–	35	ns	V_{CC} = 3.0 Volts, I_C = mA, I_{B1} = 3.0 mA, I_{B2} = 1.0 mA
t_s	–	15	ns	V_{CC} = 10 Volts, I_C = I_{B1} = I_{B2} = 10 mA

CIRCUIT DIAGRAM

FIGURE 1 – STORAGE TEST CIRCUIT

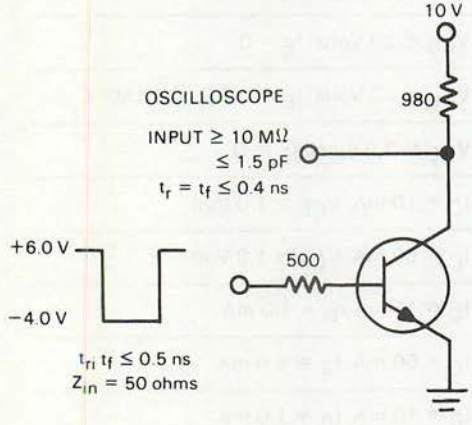
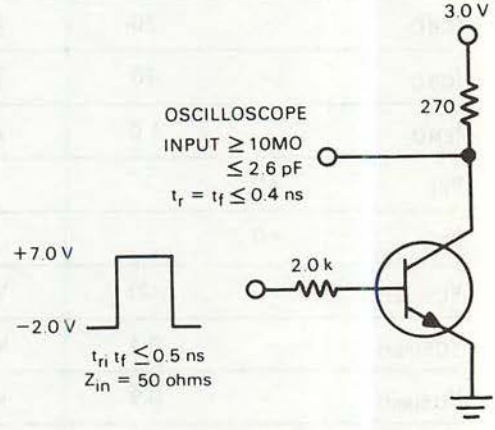


FIGURE 2 – TURN ON AND TURN OFF TIME TEST CIRCUIT



2N3011Ⓔ

Package: TO-18

HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

The ITT 2N3011 is an NPN silicon planar eptiaxial transistor designed specifically for high-speed saturated switching applications in the 50-100 mc range at current levels from 100 microamperes to 100 milliamperes. It is suitable for most small-signal, RF, and digital type circuits.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	30 Volts
Collector-Emitter Voltage	30 Volts
Collector-Emitter Voltage (Note 4)	12 Volts
Emitter-Base Voltage	5.0 Volts
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_C = 100°C (Notes 2 and 3)	0.68 Watt
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +200 °C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	300°C Maximum

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

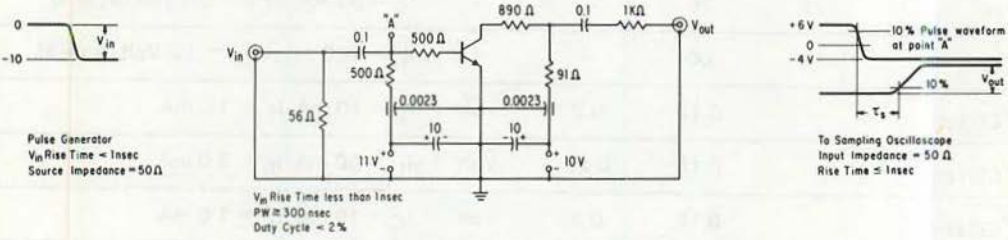
Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	30	70	120	–	I_C = 10 mA, V_{CE} = 0.35 Volt (Note 5)
h_{FE}	25	75	–	–	I_C = 30 mA, V_{CE} = 0.4 Volt (Note 5)
h_{FE}	12	50	–	–	I_C = 100 mA, V_{CE} = 1.0 Volt (Note 5)
$V_{CE(sat)}$	–	0.17	0.2	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{CE(sat)}$	–	0.18	0.25	Volt	I_C = 30 mA, I_B = 3.0 mA
$V_{CE(sat)}$	–	0.15	0.3	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{CE(sat)}$	–	0.3	0.5	Volt	I_C = 100 mA, I_B = 10 mA
$V_{BE(sat)}$	0.72	0.8	0.87	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{BE(sat)}$	–	0.9	1.15	Volts	I_C = 30 mA, I_B = 3.0 mA
$V_{BE(sat)}$	–	1.1	1.6	Volts	I_C = 100 mA, I_B = 10 mA
h_{fe}	4.0	6.5	–	–	I_C = 20 mA, V_{CE} = 10 Volts
C_{ob}	–	2.3	4.0	pf	I_E = 0, V_{CB} = 5.0 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

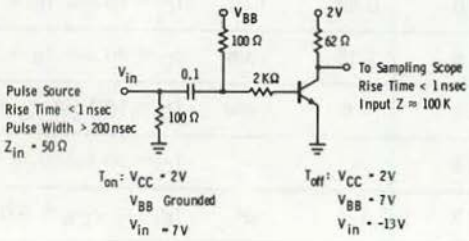
Symbol	Min	Typ	Max	Unit	Conditions
I_{CES}	–	0.05	0.4	μA	V_{CE} = 20 Volts, V_{BE} = 0
I_{CES}(85°C)	–	1.0	10	μA	V_{CE} = 20 Volts, V_{BE} = 0
BV_{CBO}	30	–	–	Volts	I_C = 10 μA, I_E = 0
BV_{CES}	30	–	–	Volts	I_C = 10 μA, V_{EB} = 0
$V_{CEO(sust)}$	12	–	–	Volts	I_C = 10 mA (pulsed), I_B = 0
BV_{EBO}	5.0	–	–	Volts	I_E = 100 μA, I_C = 0
τ_S	–	–	13	nsec	$I_C = I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA (Note 6)
t_{on}	–	–	15	nsec	$I_C \approx 30$ mA, $I_{B1} \approx 3.0$ mA (Note 6)
t_{off}	–	–	20	nsec	$I_C \approx 30$ mA, $I_{B1} \approx 3.0$ mA, $I_{B2} \approx -3.0$ mA (Note 6)

SCHEMATIC

CHARGE STORAGE TIME — CONSTANT TEST CIRCUIT



t_{on}-t_{off} MEASUREMENT CIRCUIT



2N3115, 2N3116
NPN HIGH-SPEED SILICON SWITCHING AND AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	60 Volts
Collector-Emitter Voltage	20 Volts
Emitter-Base Voltage	5 Volts
Collector-Current	600 mA
Total Device Dissipation @ T_A = 25°C	1.8 Watts
Derate above 25°C	12 mW/°C
Total Device Dissipation @ T_A = 25°C	0.4 Watt
Derate above 25°C	2.67 mW/°C
Junction Temperature Range	−65 to +175°C
Storage Temperature Range	−65 to +200°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	0.025	μA	V_{CB} = 50 Volts, I_E = 0
I_{CBO}	–	15	μA	V_{CB} = 50 Volts, I_E = 0, T_A = 150°C
I_{CEX}	–	0.050	μA	V_{CE} = 30 Volts, V_{BE} = 0.5 Volt
I_{BL}	–	0.050	μA	V_{CE} = 30 Volts, V_{BE} = 0.5 Volt
BV_{CBO}	60	–	Volts	I_C = 10 μA, I_E = 0
BV_{CEO}*	20	–	Volts	I_C = 10 mA, pulsed, I_B = 0*
BV_{EBO}	5	–	Volts	I_E = 10 μA, I_C = 0
$V_{CE(sat)}$*	–	0.5	Volt	I_C = 150 mA, I_B = 15 mA*
$V_{BE(sat)}$*	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA*
h_{FE}	40	120	–	I_C = 150 mA, 2N3115
h_{FE}	100	300	–	V_{CE} = 10 Volts, 2N3116
C_{ob}	–	8	pF	V_{CB} = 10 Volts, I_E = 0, f = 100 kHz
t_d	–	20	ns	V_{CC} = 30 Volts, I_{CS} = 150 mA, I_{B1} = 15 mA
t_r	–	75	ns	V_{CC} = 30 Volts, I_{CS} = 150 mA, I_{B1} = 15 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Conditions				Symbol	Min	Max	Unit
t_s	–	300	ns	V_{CC} = 6 Volts, I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = 15 mA			
t_f	–	200	ns	V_{CC} = 6 Volts, I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = 15 mA			
f_T	250	–	MHz	I_C = 20 mA, V_{CE} = 20 Volts, f = 100 MHz			

* Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%

Package: TO-92

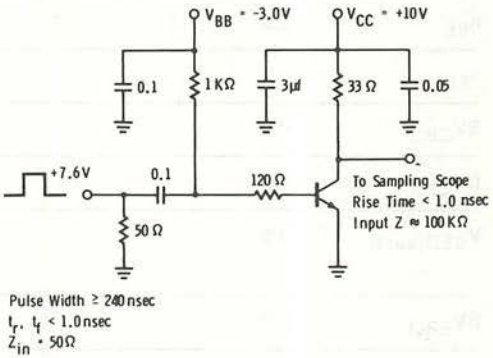
HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

The ITT 2N3646 is an NPN silicon planar epitaxial transistor designed for logic and memory applications to 500 milliamperes. It features the unique combination of 350 Mc f_T minimum with a guaranteed 300 milliampere collector saturation voltage of 0.5 volt.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	40 Volts
Collector-Emitter Voltage	40 Volts
Collector-Emitter Voltage (Note 4)	15 Volts
Emitter-Base Voltage	5.0 Volts
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	0.5 Watt
T_A = 25°C (Notes 2 and 3)	0.2 Watt
Storage Temperature	−55°C to +125°C
Operating Junction Temperature	+125°C Maximum
Lead Temperature (Soldering, 10 sec Time Limit)	+260°C Maximum

T_{ON} and T_{OFF} TEST CIRCUIT



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
$V_{CE(sat)}$	–	0.16	0.2	Volt	I_C = 30 mA, I_B = 3.0 mA (Note 5)
$V_{CE(sat)}$	–	0.18	0.28	Volt	I_C = 100 mA, I_B = 10 mA (Note 5)
$V_{CE(sat)}$	–	0.18	0.3	Volt	I_C = 30 mA, I_B = 3.0 mA (Note 5) (T_A = +65°C)
$V_{CE(sat)}$	–	0.39	0.5	Volt	I_C = 300 mA, I_B = 30 mA (Note 5)
h_{fe}	3.5	5.5	–	–	I_C = 30 mA, V_{CE} = 10 Volts
τ_s		8.0	18	nsec	$I_C = I_{B1} \approx$ 10 mA, $I_{B2} \approx -10$ mA (Note 6)
t_{on}	–	0	18	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA (Note 6)
t_{off}	–	15	28	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx -30$ mA (Note 6)
C_{obo}	–	3.3	5.0	pf	I_E = 0, V_{CB} = 5.0 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
C_{ibo}	–	6.6	8.0	pf	I_C = 0, V_{EB} = 0.5 Volt
h_{FE}	30	60	120	–	I_C = 30 mA, V_{CE} = 0.4 Volt (Note 5)
h_{FE}	25	55	–	–	I_C = 100 mA, V_{CE} = 0.5 Volt (Note 5)
h_{FE}	15	–	–	–	I_C = 300 mA, V_{CE} = 1.0 Volt (Note 5)
BV_{CBO}	40	–	–	Volts	I_C = 100 μA, I_E = 0
BV_{CES}	40	–	–	Volts	I_C = 100 μA, V_{EB} = 0
$V_{CEO(sust)}$	15	–	–	Volts	I_C = 10 mA, I_B = 0 (Notes 4 and 5)
BV_{EBO}	5.0	–	–	Volts	I_E = 100 μA, I_C = 0
$V_{BE(sat)}$	0.75	0.82	0.95	Volt	I_C = 30 mA, I_B = 3.0 mA (Note 5)
$V_{BE(sat)}$	–	0.97	1.2	Volts	I_C = 100 mA, I_B = 10 mA (Note 5)
$V_{BE(sat)}$	–	1.3	1.7	Volts	I_C = 300 mA, I_B = 30 mA (Note 5)
I_{CES}	–	0.04	0.5	μA	V_{CE} = 20 Volts, V_{EB} = 0
I_{CES}(65°C)	–	0.5	3.0	μA	V_{CE} = 20 Volts, V_{EB} = 0

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

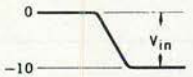
(3) These ratings give a minimum junction temperature of 125°C and junction-to-case thermal resistance of 200°C/watt (derating factor of 5.0 mW/°C); junction-to-ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

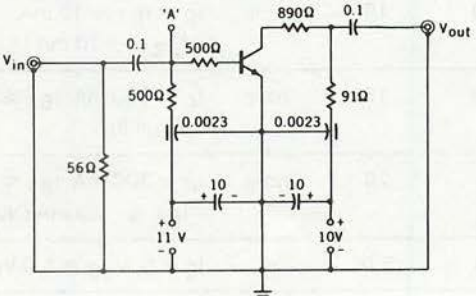
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

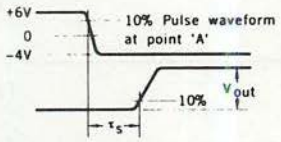
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

CHARGE STORAGE TIME MEASUREMENT CIRCUIT



Pulse Generator
V_{in} Rise Time < 1 nsec
Source Impedance = 50Ω
PW ≥ 300 nsec
Duty Cycle < 2%





To Sampling Oscilloscope
z_{IN} ≈ 100 KΩ
Rise Time ≤ 1 nsec

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	40 Volts
Collector-Base Voltage	60 Volts
Emitter-Base Voltage	6.0 Volts
Collector-Current	200 mA
Total Device Dissipation @ T_A = 25°C	310 mW
Total Device Dissipation @ T_A = 60°C	210 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	−55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	60	–	Volts	I_C = 10 μA, I_E = 0
BV_{CEO}*	40	–	Volts	I_C = 1.0 mA, I_B = 0*
BV_{EBO}	6.0	–	Volts	I_E = 10 μA, I_C = 0
I_{CEX}	–	50	nA	V_{CE} = 30 Volts, $V_{EB(off)}$ = 3.0 Volts
h_{FE}*	20	–	–	I_C = 0.1 mA, V_{CE} = 1.0 Volt (2N3903)
h_{FE}*	40	–	–	I_C = 0.1 mA, V_{CE} = 1.0 Volt* (2N3904)
h_{FE}*	35	–	–	I_C = 1.0 mA, V_{CE} = 1.0 Volt (2N3903)
h_{FE}*	70	–	–	I_C = 1.0 mA, V_{CE} = 1.0 Volt (2N3904)
h_{FE}*	50	150	–	I_C = 10 mA, V_{CE} = 1.0 Volt (2N3903)
h_{FE}*	100	300	–	I_C = 10 mA, V_{CE} = 1.0 Volt (2N3904)
h_{FE}*	30	–	–	I_C = 50 mA, V_{CE} = 1.0 Volt (2N3903)
h_{FE}*	60	–	–	I_C = 50 mA, V_{CE} = 1.0 Volt (2N3904)
h_{FE}*	15	–	–	I_C = 100 mA, V_{CE} = 1.0 Volt (2N3903)
h_{FE}*	30	–	–	I_C = 100 mA, V_{CE} = 1.0 Volt (2N3904)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CE(sat)}$*	–	0.2	Volt	I_C = 10 mA, I_B = 1.0 mA*
$V_{CE(sat)}$*	–	0.3	Volt	I_C = 50 mA, I_B = 5.0 mA
$V_{BE(sat)}$*	0.65	0.85	Volt	I_C = 10 mA, I_B = 1.0 mA*
$V_{BE(sat)}$*	–	0.95	Volt	I_C = 50 mA, I_B = 5.0 mA
f_T	250	–	MHz	I_C = 10 mA, V_{CE} = 20 Volts f = 100 MHz (2N3903)
f_T	300	–	MHz	I_C = 10 mA, V_{CE} = 20 Volts f = 100 MHz (2N3904)
C_{ob}	–	4.0	pF	V_{CB} = 5.0 Volts, I_E = 0, f = 100 kHz
C_{ib}	–	8.0	pF	V_{BE} = 0.5 Volt, I_C = 0, f = 100 kHz
h_{ie}	0.5	8.0	k ohms	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz (2N3903)
h_{ie}	1.0	10	k ohms	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz (2N3904)
h_{re}	0.1	5.0	X 10^{-4}	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz (2N3903)
h_{re}	0.5	8.0	X 10^{-4}	I_C = 1.0 mA, V_{CE} = 10 Volts f = 1.0 kHz (2N3904)
h_{fe}	50	200	–	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz (2N3903)
h_{fe}	100	400	–	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz (2N3904)
h_{oe}	1.0	40	μmhos	I_C = 1.0 mA, V_{CE} = 10 Volts, f = 1.0 kHz
t_d t_r	– –	35 35	ns ns	V_{CC} = 3.0 Volts, $V_{BE(off)}$ = 0.5 Volt, I_C = 10 mA, I_{B1} = 1.0 mA
t_s	–	175	ns	V_{CC} = 3.0 Volts, I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA (2N3903)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
t_s	–	200	ns	V_{CC} = 3.0 Volts, I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA
t_f	–	50	ns	V_{CC} = 3.0 Volts, I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.

SCHEMATIC

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

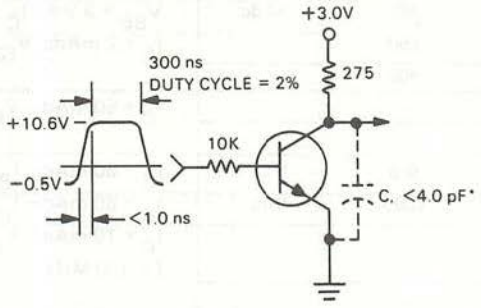
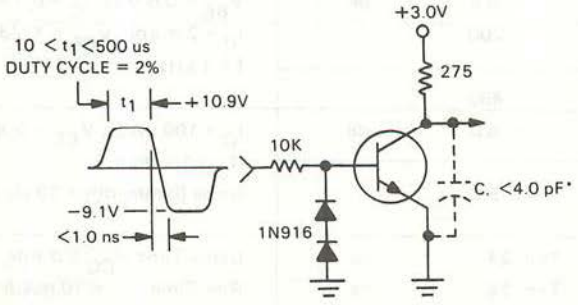


FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST TIME



*Total shunt capacitance of test jig and connectors

2N4123, 2N4124
GENERAL PURPOSE NPN SILICON SWITCHING AND AMPLIFIER TRANSISTORS

Package: To-92

ABSOLUTE MAXIMUM RATINGS

Characteristic	2N4123	2N4124	Unit
Collector-Emitter Voltage	30	25	Vdc
Collector-Base Voltage	40	30	Vdc
Emitter-Base Voltage	5.0		Vdc
Collector Current	200		mAdc
Total Device Dissipation @ T_A = 60°C	210		mW
Total Device Dissipation @ T_A = 25°C	310		mW
Derate above 25°C	2.81		mW/°C
Operating and Storage Junction Temperature Range	-55 to +135		°C
Thermal Resistance, Junction to Ambient	0.357		°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	30	–	Vdc	I_C = 1 mAdc, I_E = 0	2N4123
	25	–			2N4124
BV_{CBO}	40	–	Vdc	I_C = 10 uAdc, I_E = 0	2N4123
	30	–			2N4124
BV_{EBO}	5.0	–	Vdc	I_E = 10 uAdc, I_C = 0	
I_{CBO}	–	50	nAdc	V_{CB} = 20 Vdc, I_E = 0	
I_{EBO}	–	50	nAdc	V_{BE} = 3 Vdc, I_C = 0	
h_{FE}*	50	150	–	I_C = 2 mAdc, V_{CE} = 1 Vdc	2N4123
	120	360			2N4124
	25	–		I_C = 50 mAdc, V_{CE} = 1 Vdc	2N4123
	60	–			2N4124
$V_{CE(sat)}$*	–	0.3	Vdc	I_C = 50 mAdc, I_B = 5 mAdc	
$V_{BE(sat)}$*	–	0.95	Vdc	I_C = 50 mAdc, I_B = 5 mAdc	
$[h_{fe}]$	2.5	–	–	I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz	2N4123
	3.0	–			2N4124
f_T	250	–	MHz	I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz	2N4123
	300	–			2N4124
C_{ob}	–	4.0	pF	V_{CB} = 5 Vdc, I_E = 0, f = 100 kHz	
C_{ib}	–	8.0	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz	
h_{fe}	50	200	–	I_C = 2 mAdc, V_{CE} = 1 Vdc, f = 1 kHz	2N4123
	120	480			2N4124
NF	–	6.0	dB	I_C = 100 uAdc, V_{CE} = 5 Vdc, R_S = 1 k ohm, Noise Bandwidth = 10 Hz to 15.7 kHz	2N4123
	–	5.0			2N4124
t_d	Typ. 24		ns	Delay Time V_{CC} = 3 Vdc, $V_{EB(off)}$ = 0.5 Vdc,	
t_r	Typ. 13		ns	Rise Time I_C = 10 mAdc, I_{B1} = 1 mAdc	
t_s	Typ. 125		ns	Storage Time V_{CC} = 3 Vdc, I_C = 10 mAdc,	
t_f	Typ. 11		ns	Fall Time I_{B1} = I_{B2} = 1 mAdc	

*Pulse Test: Pulse Width = 300 us, Duty Cycle = 2%.

GENERAL PURPOSE NPN SILICON SWITCHING AND AMPLIFIER TRANSISTOR

Package: To-92

ABSOLUTE MAXIMUM RATINGS

Characteristic	2N4125	2N4126	Unit
Collector-Emitter Voltage	30	25	Vdc
Collector-Base Voltage	30	25	Vdc
Emitter-Base Voltage	4.0		Vdc
Collector Current	200		mAdc
Total Device Dissipation @ T_A = 60°C	210		mW

Total Device Dissipation @ T_A = 25°C	310	mW
Derate above 25°C	2.81	mW/°C
Operating and Storage Junction Temperature Range	-55 to +135	°C
Thermal Resistance, Junction to Ambient	0.357	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	30	–	Vdc	I_C = 1 mAdc, I_E = 0	2N4125
	25	–			2N4126
BV_{CBO}	30	–	Vdc	I_C = 10 uAdc, I_E = 0	2N4125
	25	–			2N4126
BV_{EBO}	4.0	–	Vdc	I_E = 10 uAdc, I_C = 0	
I_{CBO}	–	50	nAdc	V_{CB} = 20 Vdc, I_E = 0	
I_{EBO}	–	50	nAdc	V_{BE} = 3 Vdc, I_C = 0	
h_{FE}*	50	150	–	I_C = 2 mAdc, V_{CE} = 1 Vdc	2N4125
	120	360			2N4126
	25	–		I_C = 50 mAdc, V_{CE} = 1 Vdc	2N4125
	60	–			2N4126
$V_{CE(sat)}$*	–	0.4	Vdc	I_C = 50 mAdc, I_B = 5 mAdc	
$V_{BE(sat)}$*	–	0.95	Vdc	I_C = 50 mAdc, I_B = 5 mAdc	
h_{fe}	2.0	–	–	I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz	2N4125
	2.5	–			2N4126
f_T	200	–	MHz	I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz	2N4125
	250	–			2N4126
C_{ob}	–	4.5	pF	V_{CB} = 5 Vdc, I_E = 0, f = 100 kHz	
C_{ib}	–	10	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz	
h_{fe}	50	200	–	I_C = 2 mAdc, V_{CE} = 1 Vdc, f = 1 kHz	2N4125
	120	480			2N4126
NF	–	5.0	dB	I_C = 100 uAdc, V_{CE} = 5 Vdc, R_S = 1 ohm,	
	–				2N4125
	–	4.0		Noise Bandwidth = 10 Hz to 15.7 kHz	
					2N4126
t_d	Typ 25		ns	Delay Time V_{CC} = 3 Vdc, $V_{BE(off)}$ = 0.5 Vdc,	
t_r	Typ 18		ns	Rise Time I_C = 10 mAdc, I_{B1} = 1 mAdc	
t_s	Typ 140		ns	Storage Time V_{CC} = 3 Vdc, I_C = 10 mAdc,	
t_f	Typ 15		ns	Fall Time I_{B1} = I_{B2} = 1 mAdc	

*Pulse Test: Pulse Width = 300 usec, Duty Cycle = 2%.

2N4137Ⓕ

HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

Package: TO-18

- **HIGH FREQUENCY CURRENT GAIN** ..... f_T = 500 MHz Min.
- **HIGH VOLTAGE** ..... LV_{CEO} = 20 Volts Min.
- **LOW CAPACITY** ..... C_{obo} = 4.0 pf Max.
- **LOW CHARGE STORAGE TIME** ..... τ_s = 13 ns Max.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	40 Volts
Collector-Emitter Voltage	40 Volts
Collector-Emitter Voltage (Note 4)	20 Volts
Emitter-Base Voltage	4.5 Volts
Collector Current (10 μsec Pulse)	500 mA
DC Collector Current	200 mA
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_C = 100°C (Notes 2 and 3)	0.68 Watt
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +200°C
Operating Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	40	66	120	–	I_C = 10 mA, V_{CE} = 1.0 Volt (Note 5)
h_{FE}(−55°C)	20	50	–	–	I_C = 10 mA, V_{CE} = 0.35 Volt (Note 5)
$V_{BE(sat)}$	0.72	0.8	0.85	Volt	I_C = 10 mA, I_B = 1.0 mA (Note 5)
$V_{BE(sat)}$	0.59	–	1.02	Volts	I_C = 10 mA, I_B = 1.0 mA (Note 5)
$V_{BE(sat)}$	–	0.9	1.15	Volts	I_C = 30 mA, I_B = 3.0 mA (Note 5)
$V_{BE(sat)}$	–	1.1	1.6	Volts	I_C = 100 mA, I_B = 10 mA (Note 5)
$V_{CE(sat)}$	–	0.19	0.3	Volt	I_C = 10 mA, I_B = 1.0 mA (Note 5)
I_{CES}	–	0.05	0.4	μA	V_{BE} = 0, V_{CE} = 20 Volts
I_{CBO}(150°C)	–	10	30	μA	I_E = 0, V_{CB} = 20 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CES}	40	–	–	Volts	I_C = 10 μA, V_{BE} = 0
BV_{CBO}	40	–	–	Volts	I_C = 10 μA, I_E = 0
$V_{CEO(sust)}$	20	–	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	4.5	–	–	Volts	I_E = 10 μA, I_C = 0
h_{FE}	40	63	120	–	I_C = 10 mA, V_{CE} = 0.35 Volt (Note 5)
h_{FE}	30	71	–	–	I_C = 30 mA, V_{CE} = 0.4 Volt (Note 5)
h_{FE}	20	–	–	–	I_C = 100 mA, V_{CE} = 1.0 Volt (Note 5)
$V_{CE(sat)}$	–	0.14	0.2	Volt	I_C = 10 mA, I_B = 1.0 mA (Note 5)
$V_{CE(sat)}$	–	0.12	0.18	Volt	I_C = 10 mA, I_B = 3.3 mA (Note 5)
$V_{CE(sat)}$	–	0.17	0.25	Volt	I_C = 30 mA, I_B = 3.0 mA (Note 5)
$V_{CE(sat)}$	–	0.28	0.5	Volt	I_C = 100 mA, I_B = 10 mA (Note 5)
$V_{BE(sat)}$	0.74	0.85	1.0	Volt	I_C = 10 mA, I_B = 3.3 mA (Note 5)
h_{fe}	5.0	6.75	–	–	I_C = 10 mA, V_{CE} = 10 Volts
C_{ob}	–	2.3	4.0	pf	I_E = 0, V_{CB} = 5.0 Volts
τ_s	–	6.0	13	nsec	$I_C = I_{B1} \approx$ 10 mA, $I_{B2} \approx -10$ mA (Note 6)
t_{on}	–	9.0	12	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 3.3 mA (Note 6)
t_{off}	–	7.0	12	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 3.3 mA, $I_{B2} \approx -3.3$ mA (Note 6)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C). Junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

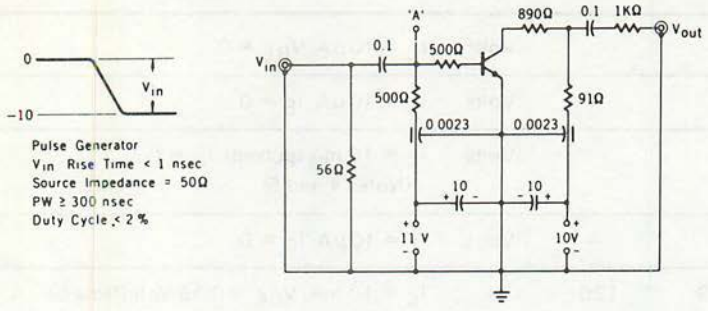
(4) Ratings refer to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

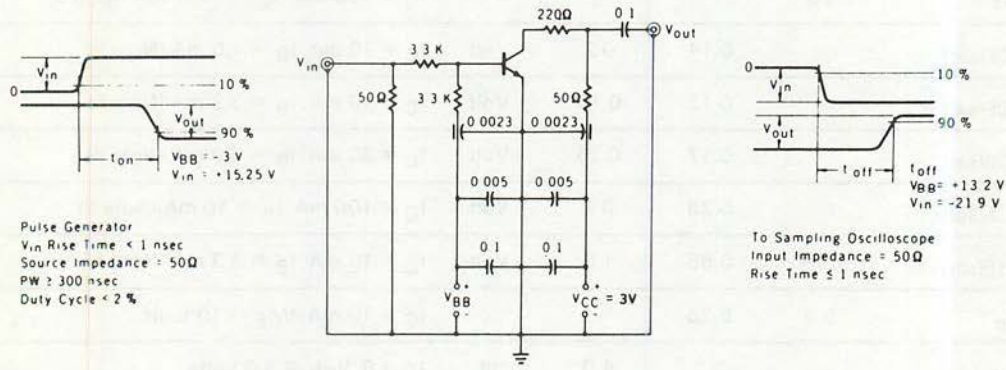
(6) See switching circuits for exact value of I_C, I_{B1}, and I_{B2}.

SCHEMATIC

CHARGE STORAGE TIME MEASUREMENT CIRCUIT



t_{ON} — t_{off} MEASUREMENT CIRCUIT



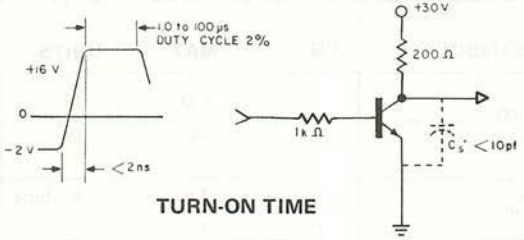
Package: To-92

ABSOLUTE MAXIMUM RATINGS

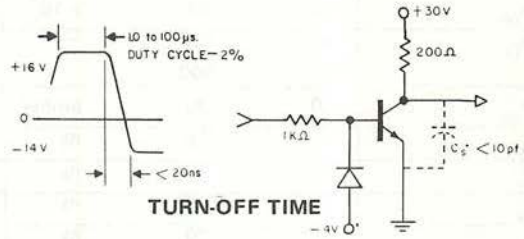
(T_A = 25°C unless otherwise noted)

Characteristic	Unit
Collector-Emitter Voltage	40 Vdc
Collector-Base Voltage	60 Vdc
Emitter-Base Voltage	6.0 Vdc
Collector Current - Continuous	600 mAdc
Total Device Dissipation	
T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating & Storage Junction	
Temperature Range	-55 to +135 °C
Thermal Resistance,	
Junction to Case	0.137 °C/mW
Thermal Resistance,	
Junction to Ambient	0.357 °C/mW

SWITCHING TIME EQUIVALENT TEST CIRCUITS



TURN-ON TIME



TURN-OFF TIME

SCOPE RISE TIME 4ns
*TOTAL SHUNT CAPACITANCE OF TEST JIG, CONNECTORS, AND OSCILLOSCOPE

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	40	–	Vdc	I_C = 1 mAdc, I_B = 0	
BV_{CBO}	60	–	Vdc	I_C = 0.1 mAdc, I_E = o	
BV_{EBO}	6.0	–	Vdc	I_E = 0.1 mAdc, I_C = 0	
I_{CEX}	–	0.1	uAdc	V_{CE} = 35 Vdc, $V_{EB(off)}$ = 0.4 Vdc	
I_{BL}	–	0.1	uAdc	V_{CE} = 35 Vdc, $V_{EB(off)}$ = o.4 Vdc	
h_{FE}	20	–	–	I_C = 0.1 mAdc, V_{CE} = 1Vdc	2N4401
	20	–		I_C = 1 mAdc, V_{CE} = 1 Vdc	2N4400
	40	–			2N4401
	40	–		I_C = 10 mAdc, V_{CE} = 1 Vdc	2N4400
	50	–			2N4401
	50	150		I_C = 150 mAdc, V_{CE} = 1 Vdc*	2N4400
	100	300			2N4401
	20	–		I_C = 500 mAdc, V_{CE} = 2 Vdc*	2N4400
	40	–			2N4401
$V_{CE(sat)}$	–	0.4	Vdc	I_C = 150 mAdc, I_B = 15 mAdc	
	–	0.75		I_C = 500 mAdc, I_B = 50 mAdc	
$V_{BE(sat)}$	0.75	0.95	Vdc	I_C = 150 mAdc, I_B = 15 mAdc	
	–	1.2		I_C = 500 mAdc, I_B = 50 mAdc	
f_T	200	–	MHz	I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz	2N4400
	250	–			2N4401

*Pulse Test: Pulse Width — 300 us, Duty Cycle — 2%.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$)

SYMBOL	MIN.	MAX.	UNITS	CONDITIONS	
C_{cb}	–	6.5	pF	V_{CB} = 5 Vdc, I_E = 0, f - 100 kHz, emitter guarded	
C_{eb}	–	30	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz, Collector guarded	
h_{ie}	0.5	7.5	k ohms	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = kHz	2N4400
	1.0	15			2N4401
h_{re}	0.1	8.0	x 10^4	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz	
h_{fe}	20	250	–	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz	2N4400
	40	500			2N4401
h_{oe}	1.0	30	*u*mhoe	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz	
t_d	–	15	ns	V_{CC} = 30 Vdc, $V_{EB(off)}$ = 2 Vdc,	
t_r	–	20	ns	I_C = 150 mAdc, I_{B1} = 15 mAdc	
t_s	–	225	ns	V_{CC} = 30 Vdc, I_C = 150 mAdc,	
t_f	–	30	ns	$I_{B1} = I_{B2}$ = 15 mAdc	

Package: To-92

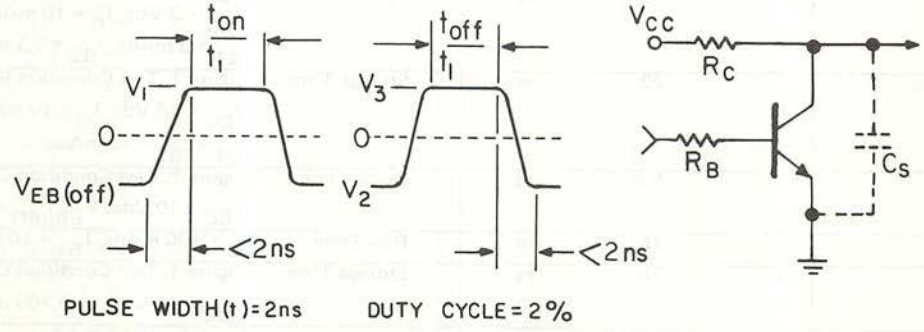
LOW-LEVEL NPN SILICON TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Characteristic	2N4418	2N4419	Unit
Collector-Emitter Voltage	15	12	Vdc
Collector-Base Voltage	30		Vdc
Emitter-Base Voltage	6.0		Vdc
Collector Current	200		mAdc
Total Device Dissipation @ T_A = 60°C	210		mW
Total Device Dissipation @ T_A = 25°C	310		mW
Derate above 25°C	2.81		mW/°C
Operating and Storage Junction Temperature Range	-55 to +135		°C
Thermal Resistance, Junction to Ambient	0.357		°C/mW

TEST CONDITION	I_C	V_{CC}	R_B	R_C	$C_{S(max)}$	$V_{EB(off)}$	V_1	V_2	V_3
	mA	V	Ω	Ω	pF	V	V	V	V
A	10	3	3300	270	4	−15	10.55	−4.15	10.70
B	10	10	560	960	4	–	–	−4.65	6.55
C	100	10	560	96	12	−2.0	6.35	−4.65	6.55

Figure 1 – Switching Time Equivalent Test Circuit



PULSE WIDTH (t) = 2ns DUTY CYCLE = 2%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}	15	–	Vdc	I_C = 1 mAdc, I_E = 0	2N4418
	12	–			2N4419
BV_{CBO}	30	–	Vdc	I_C = 10 uAdc, I_E = 0	
I_{CEX}	–	100	nAdc	V_{CE} = 12 Vdc, $V_{EB(off)}$ = 0.25 Vdc	
I_{BL}	–	0.1	uAdc	V_{CE} = 12 Vdc, $V_{EB(off)}$ = 0.25 Vdc	
	–	10		V_{CE} = 10 Vdc, $V_{EB(off)}$ = 0.25 Vdc, T_A = 100°C	
h_{FE}	25	–	–	I_C = 1 mAdc, V_{CE} = 1 Vdc	2N4418
	50	–			2N4419
	40	160		I_C = 10 mAdc, V_{CE} = 1 Vdc	2N4418
	100	400			2N4419
	20	–		I_C = 10 mAdc, V_{CE} = 1 Vdc,	2N4418
	45	–		T_A = 55°C	2N4419
	40	–		I_C = 30 mAdc, V_{CE} = 1 Vdc	2N4418
	90	–			2N4419
	30	–		I_C = 100 mAdc, V_{CE} = 1 Vdc	2N4418
	55	–			2N4419
	20	–		I_C = 200 mAdc, V_{CE} = 1 Vdc	2N4418
	35	–			2N4419
$V_{CE(sat)}$	–	0.22	Vdc	I_C = 10 mAdc, I_B = 1 mAdc	
	–	0.35		I_C = 100 mAdc, I_B = 10 mAdc	
$V_{BE(sat)}$	0.65	0.80	Vdc	I_C = 10 mAdc, I_B = 1 mAdc	
	0.75	0.95		I_C = 100 mAdc, I_B = 10 mAdc	
f_T	300	–	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz	
C_{ob}	–	4.0	pF	V_{CB} = 5 Vdc, I_E = 0, f = 100 kHz	
C_{ib}	–	8.0	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz	
t_{on}	–	25	ns	Turn-On Time	Figure 1, Test Condition A V_{CC} = 3 Vdc, $V_{EB(off)}$ = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3 mAdc
t_{off}	–	35	ns	Turn-Off Time	Figure 1, Test Condition A V_{CC} = 3 Vdc, I_C = 10 mAdc, I_{B1} = 3 mAdc, I_{B2} = 1.5 mAdc
t_s	–	20	ns	Storage Time	Figure 1, Test Condition B V_{CC} = 10 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 10 mAdc
t_d	–	8.0	ns	Delay Time	Figure 1, Test Condition C V_{CC} = 10 Vdc, $V_{EB(off)}$ = 2 Vdc,
t_r	–	15	ns	Rise Time	I_C = 100 mAdc, I_{B1} = 10 mAdc
t_s	–	20	ns	Storage Time	Figure 1, Test Condition C V_{CC} = 10 Vdc, I_C = 100 mAdc,
t_f	–	15	ns		I_{B1} = I_{B2} = 10 mAdc
Q_T	–	80	pC	Total Control Charge	V_{CC} = 3 Vdc, I_C = 10 mAdc, I_B = mAdc

2N4420, 2N4421, 2N4422

HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	40 Vdc
Collector-Emitter Voltage	40 Vdc
Collector-Emitter Voltage Applicable 0. 01-200 mA	15 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	200 mA
Collector Current (10 μs pulse)	500 mA
Total Device Dissipation @ T_A = 25°C	200 mW
Derate above 25°C	2.0 mW/°C
Total Device Dissipation @ T_C = 25°C	500 mW
Derate above 25°C	5.0 mW/°C
Operating Junction Temperature	125 °C
Storage Temperature Range	-55 to +125 °C

FIGURE 1–t_{on} and t_{off} TEST CIRCUIT

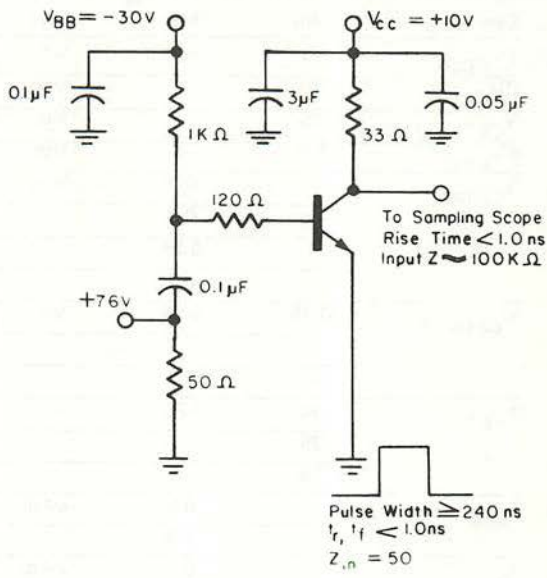
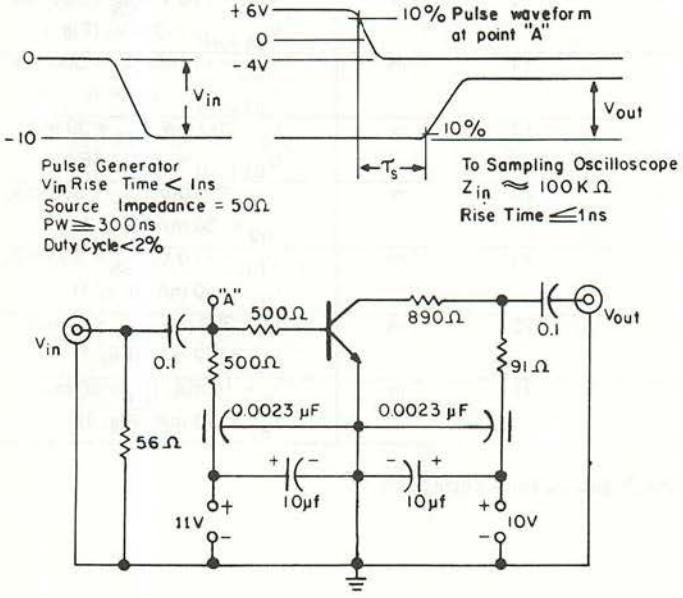


FIGURE 2–CHARGE STORAGE TIME MEASUREMENT CIRCUIT



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified.)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	40	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{CES}	40	–	Vdc	I_C = 100 uAdc, V_{BE} = 0
$V_{CEO(sus)}$*	15	–	Vdc	I_C = 10 mAdc
BV_{EBO}	5.0	–	Vdc	I_E = 100 uAdc, I_C = 0
$V_{CE(sat)}$*	–	0.2	Vdc	I_C = 30 mAdc, I_B = 3.0 mAdc
	–	0.3		I_C = 30 mAdc, I_B = 3.0 mAdc, T_A = +65 C
	–	0.28		I_C = 100 mAdc, I_B = 10 mAdc
	–	0.5		I_C = 300 mAdc, I_B = 30 mAdc
$V_{BE(sat)}$*	0.75	0.95	Vdc	I_C = 30 mAdc, I_B = 3.0 mAdc
	–	1.2		I_C = 100 mAdc, I_B = 10 mAdc
	–	1.7		I_C = 300 mAdc, I_B = 30 mAdc
h_{FE}*	30	120	–	I_C = 30 mAdc, V_{CE} = 0.4 Vdc
	25	–		I_C = 100 mAdc, V_{CE} = 0.5 Vdc
	15	–		I_C = 300 mAdc, V_{CE} = 1.0 Vdc
I_{CES}	–	0.5	uAdc	V_{CE} = 20 Vdc, V_{EB} = 0
	–	3.0		V_{CE} = 20 Vdc, V_{EB} = 0, T_A = +65 C
I_B	–	0.5	uAdc	V_{CE} = 20 Vdc, V_{EB} = 0
C_{ob}	–	5.0	pF	V_{CB} = 5.0 V, I_E = 0, f = 140 kHz
C_{ib}	–	8.0	pF	V_{BE} = 0.5 V, I_C = 0, f = 140 kHz
h_{fe}	3.5	–	–	I_C = 30 mA, V_{CE} = 10 V, f = 100 MHz
t_d	–	10	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_r	–	15	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_{on}	–	18	ns	I_C = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_s	–	20	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
t_f	–	15	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
t_{off}	–	28	ns	I_C = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
T_S	–	18	ns	I_C = 10 mA, I_{B1} = 10 mA, I_{B2} = -10 mA (Fig. 2)

*Pulse Conditions: PW $\leq$ 300 us; Duty Cycle $\leq$ 1%.

Package: To-92

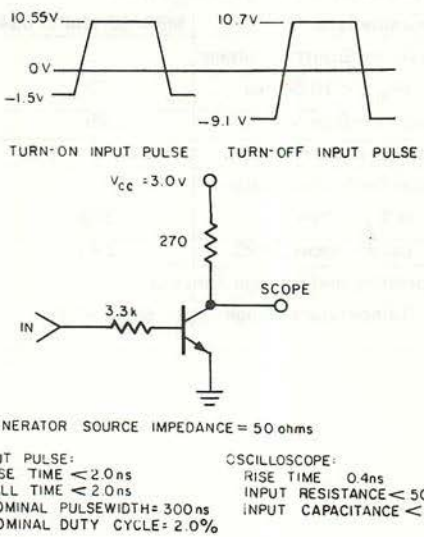
2N5224

GENERAL PURPOSE NPN SILICON LOW-LEVEL SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	12 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	5.0 Vdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

Figure 1 — Switching Time Test Circuit



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	12	—	Vdcq	I_C = 10 mAdc, I_B = 0
BV_{CBO}	25	—	Vdc	I_C = 100 *u*Adc, I_E = 0
BV_{EBO}	5.0	—	Vdc	I_E = 100 *u*Adc, I_C = 0
I_{CBO}	—	500	nAdc	V_{CB} = 15 Vdc, I_E = 0
I_{EBO}	—	100	*u*Adc	V_{BE} = 4.0 Vdc, I_C = 0
h_{FE}	40	400	—	I_C = 10 mAdc, V_{CE} = 1.0 Vdc
	15	—		I_C = 100 mAdc, V_{CE} = 1.0 Vdc
$V_{CE(sat)}$	—	0.35	Vdc	I_C = 10 mAdc, I_B = 3.0 mAdc
$V_{BE(sat)}$	—	0.9	Vdc	I_C = 10 mAdc, I_B = 3.0 mAdc
f_T	250	—	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
C_{cb}	—	4.0	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
t_d	—	25	ns	Delay Time See Figure 1
t_r	—	20	ns	Rise Time See Figure 1
t_s	—	35	ns	Storage Time See Figure 1
t_f	—	25	ns	Fall Time See Figure 1

*Pulse Test: Pulse Width = 300 us, Duty Cycle = 2.0%.

HIGH-SPEED NPN SILICON LOW-LEVEL SWITCHING TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic	MPS706	MPS706A	Unit
Collector-Emitter Voltage (R_{BE} = 10 Ohms)	20		Vdc
Collector-Base Voltage	25		Vdc
Emitter-Base Voltage	3.0	5.0	Vdc
Total Device Dissipation @ T_A = 25°C	310		mW
Derate above 25°C	2.81		mW/°C
Operating and Storage Junction Temperature Range	-55 to +135		°C

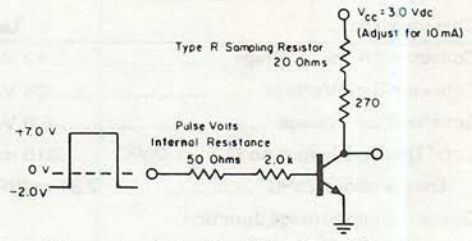


Figure 1 — Switching Time Test Circuit

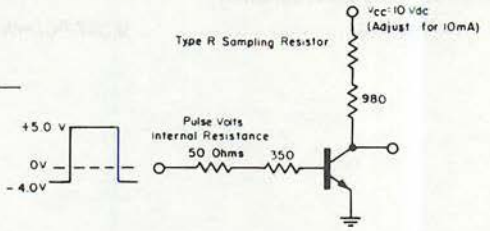


Figure 2 — Storage Time Test Circuit

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	15	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CER}	20	–	Vdcq	I_C = 10 mAdc, R_{BE} = 10 Ohms
I_{CBO}	–	0.5	uAdc	V_{CB} = 15 Vdc, I_E = 0
I_{EBO}	–	10	uAdc	V_{EB} = 3.0 Vdc, I_C = 0
h_{FE}*	20	–	–	I_C = 10 mAdc, V_{CE} = 1.0 Vdc MPS706
	20	60		MPS706A
$V_{CE(sat)}$*	–	0.6	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$*	–	0.9	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc MPS706
	0.7	0.9		MPS706A
f_T	200	–	MHz	I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 100 MHz
C_{ob}	–	6.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
r_b	–	50	Ohms	I_E = 10 mAdc, V_{CE} = 15 Vdc, f = 300 MHz
t_{on}**	–	40	ns	Turn-On Time See Figure 1
t_{off}**	–	75	ns	Turn-Off Time See Figure 1
T_S**	–	60	ns	Charge Storage Time Constant ** See Figure 2 MPS706
	–	25		MPS706A

*Pulse Test: Pulse Width ≤ 12 ns, Duty Cycle ≤ 2.0%.
**Measured with Tektronix Type R Plug-In (50-Ohm Internal Impedance) and circuits shown.

Package: To-92

HIGH-SPEED NPN SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	30 Vdc
Collector-Base Voltage	40 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	200 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Total Device Dissipation @ T_C = 25°C	500 mW
Derate above 25°C	4.55 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C

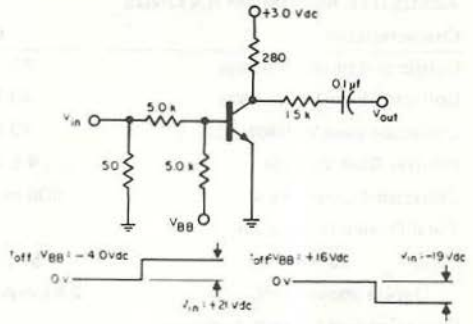


Figure 1 — Turn-On and Turn-Off Time Measurement Circuit

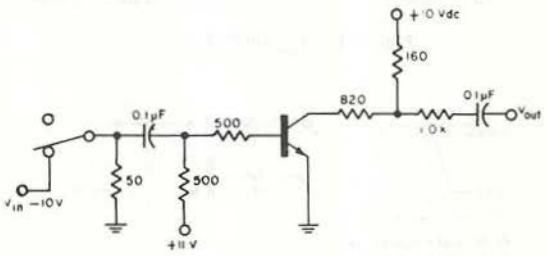


Figure 2 — Charge Storage Time Constant Measurement Circuit

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	40	—	Vdc	I_C = 10 uAdc, I_E = 0
BV_{EBO}	5.0	—	Vdc	I_E = 10 uAdc, I_C = 0
I_{CES}	—	10	uAdc	V_{CE} = 30 Vdc, V_{BE} = 0
I_{CBO}	—	0.5	uAdc	V_{CB} = 20 Vdc, I_E = 0
h_{FE}*	25	—	—	I_C = 10 mAdc, V_{CE} = 1.0 Vdc
$V_{CE(sat)}$*	—	0.25	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
	—	0.4		I_C = 50 mAdc, I_B = 5.0 mAdc
$V_{BE(sat)}$*	—	0.9	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	350	—	MHz	I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz
C_{ob}	—	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
t_{on}	—	16	ns	Turn-On Time I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.0 mAdc See Figure 1
t_{off}	—	30	ns	Turn-Off Time I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.0 mAdc See Figure 1
t_s	—	25	ns	Storage Time I_C = 10 mAdc, I_{B1} = I_{B2} = 10 mAdc See Figure 2

*Pulse Test: Pulse Width ≥ 12 ns, Duty Cycle ≥ 2.0%.

MPS2369

Package: To-92

HIGH-SPEED NPN SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	15 Vdc
Collector-Emitter Voltage	40 Vdc
Collector-Base Voltage	40 Vdc
Emitter-Base Voltage	4.5 Vdc
Collector Current-Peak	500 mAdc
Total Device Dissipation	
@ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction	
Temperature Range	-55 to +135 °C
Thermal Resistance, Junction	
to Ambient	0.355 °C/mW

Figure 1 – t_{on} Circuit

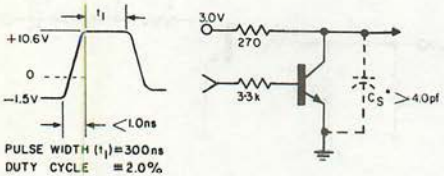


Figure 2 – t_{off} Circuit

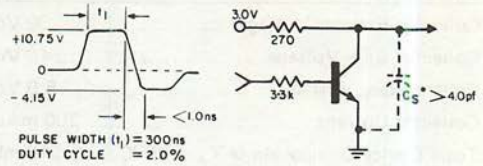
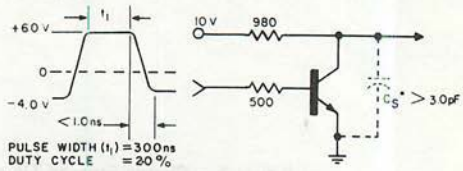


Figure 3 – Storage Test Circuit



*Total shunt capacitance of test jig and connectors

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	15	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CES}	40	–	Vdc	I_C = 10 uAdc, V_{BE} = 0
BV_{CBO}	40	–	Vdc	I_C = 10 uAdc, I_E = 0
BV_{EBO}	4.5	–	Vdc	I_E = 10 uAdc, I_C = 0
I_{CBO}	–	0.4	uAdc	V_{CB} = 20 Vdc, I_E = 0
	–	30		V_{CB} = 20 Vdc, I_E = 0, T_A = 125°C
h_{FE}*	40	120	–	I_C = 10 mAdc, V_{CE} = 1.0 Vdc
	20	–		I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = 55°C
	20	–		I_C = 100 mAdc, V_{CE} = 2.0 Vdc
$V_{CE(sat)}$	–	0.25	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$*	0.70	0.85	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
C_{ob}	–	4.0	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz
h_{fe}	5.0	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
t_{on}	–	12	ns	V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc Figure 1
t_{off}	–	18	ns	V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc Figure 2
t_s	–	13	ns	I_{B1} = I_{B2} = I_C = 10 mAdc Figure 3

*Pulse Test: Pulse Width = 300 us, Duty Cycle = 2.0%.

MPS2713, MPS2714

GENERAL PURPOSE LOW-LEVEL NPN SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Base Voltage	18 Vdc
Collector-Emitter Voltage	18 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	200 mAdc
Total Device Dissipation @ T_A = 60°C	210 mW
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Thermal Resistance, Junction to Ambient	0.357 °C/mW
Junction Operating Temperature	135 °C
Storage Temperature Range	-55 to +135 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
I_{CBO}	–	–	0.5	uAdc	V_{CB} = 18 Vdc, I_E = 0
	–	–	15		V_{CB} = 18 Vdc, I_E = 0, T_A = 100°C
I_{EBO}	–	–	0.5	uAdc	V_{EB} = 5 Vdc, I_C = 0
h_{FE}	30	60	90	–	I_C = 2 mAdc, V_{CE} = 4.5 Vdc MPS2713
	75	150	225		MPS2714
$V_{CE(sat)}$	–	0.16	0.3	Vdc	I_C = 50 mAdc, I_B = 3 mAdc
$V_{BE(sat)}$	0.6	0.75	1.3	Vdc	I_C = 50 mAdc, I_B = 3 mAdc
h_{fe}	30	–	120	–	I_C = 2 mAdc, V_{CE} = 4.5 Vdc, f = 1 kHz MPS2713
	80	–	300		MPS2714
f_T	–	250	–	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
C_{ob}	–	2.5	–	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
h_{ie}	–	3000	–	ohms	I_C = 0.5 mAdc, V_{CE} = 1 Vdc, f = 1 kHz
t_d	–	7.0	–	ns	Delay Time I_C = 10 mA, I_{B1} = 3 mA,
t_r	–	6.0	–	ns	Rise Time V_{CC} = 10 V
t_s	–	12	–	ns	Storage Time I_C = 10 mA, I_{B1} = 3 mA,
t_f	–	9.0	–	ns	Fall Time I_{B2} = 1 mA, V_{CC} = 10 V

MPS3646

Package: To-92

HIGH-SPEED NPN SILICON SATURATED SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Base Voltage	40 Vdc
Collector-Emitter Voltage	40 Vdc
Collector-Emitter Voltage Applicable 0. 01-200 mA	15 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current	200 mA
Collector Current (10 us pulse)	500 mA
Total Device Dissipation @ T_A = 25°C	200 mW
Derate above 25°C	2.0 mW/°C
Total Device Dissipation @ T_A = 25°C	500 mW
Derate above 25°C	5.0 mW/°C
Operating Junction Temperature	125 °C
Storage Temperature Range	-55 to +125 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified.)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	40	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{CES}	40	–	Vdc	I_C = 100 uAdc, V_{BE} = 0
$V_{CEO(sus)}$*	15	–	Vdc	I_C = 10 mAdc
BV_{EBO}	5.0	–	Vdc	I_E = 100 uAdc, I_C = 0
$V_{CE(sat)}$*	–	0.2	Vdc	I_C = 30 mAdc, I_B = 3.0 mAdc
	–	0.3		I_C = 30 mAdc, I_B = 3.0 mAdc, T_A = +65 C
	–	0.28		I_C = 100 mAdc, I_B = 10 mAdc
	–	0.5		I_C = 300 mAdc, I_B = 30 mAdc
$V_{BE(sat)}$*	0.75	0.95	Vdc	I_C = 30 mAdc, I_B = 3.0 mAdc
	–	1.2		I_C = 100 mAdc, I_B = 10 mAdc
	–	1.7		I_C = 300 mAdc, I_B = 30 mAdc
h_{FE}*	30	120	–	I_C = 30 mAdc, V_{CE} = 0.4 Vdc
	25	–		I_C = 100 mAdc, V_{CE} = 0.5 Vdc
	15	–		I_C = 300 mAdc, V_{CE} = 1.0 Vdc
I_{CES}	–	0.5	uAdc	V_{CE} = 20 Vdc, V_{EB} = 0
	–	3.0		V_{CE} = 20 Vdc, V_{EB} = 0, T_A = +65 C
I_B	–	0.5	uAdc	V_{CE} = 20 Vdc, V_{EB} = 0
C_{ob}	–	5.0	pF	V_{CB} = 5.0 V, I_E = 0, f = 140 kHz
C_{ib}	–	8.0	pF	V_{BE} = 0.5 V, I_C = 0, f = 140 kHz
h_{fe}	3.5	–	–	I_C = 30 mA, V_{CE} = 10 V, f = 100 MHz
t_d	–	10	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_r	–	15	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_{on}	–	18	ns	I_C = 300 mA, I_{B1} = 30 mA, $V_{BE(off)}$ = -3.0 V (Fig. 1)
t_s	–	20	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
t_f	–	15	ns	V_{CC} = +10 V, I_{CS} = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
t_{off}	–	28	ns	I_C = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA (Fig. 1)
T_S	–	18	ns	I_C = 10 mA, I_{B1} = 10 mA, I_{B2} = -10 mA (Fig. 2)

*Pulse Conditions: PW ≤ 300 us; Duty Cycle — 1%.

Figure 1 – t_{on} and t_{off} Test Circuit

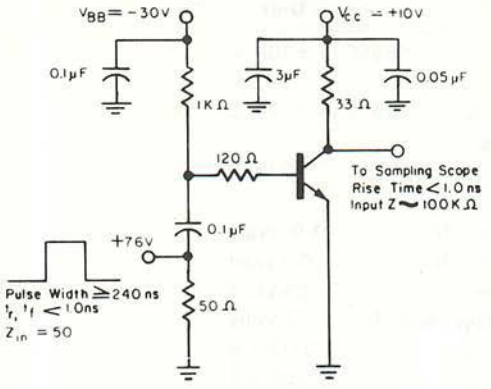
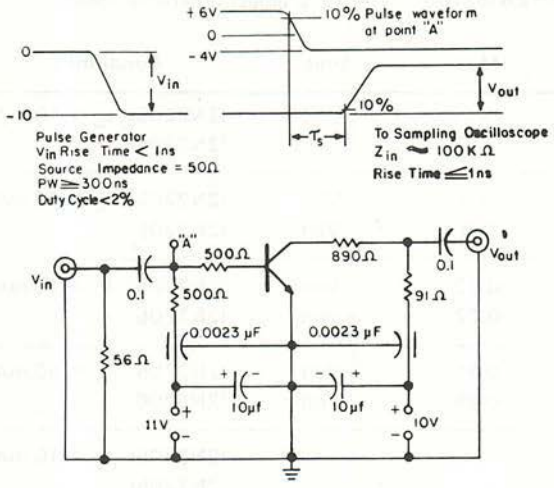


Figure 2 – Charge Storage Time Measurement Circuit



2N2205, 2N2206 Ⓕ

HIGH-SPEED NPN SILICON SWITCHING TRANSISTORS

Packages:
2N2205, TO-18
2N2206, TO-46

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +300°C
Operating Junction Temperature	−65°C to +175°C
Lead Temperature (Soldering, 10 sec time limit)	+235°C
Total Device Dissipation	
@ T_C = 25°C (Notes 2 and 3)	1.0 Watt
@ T_A = 25°C (Notes 2 and 3)	0.3 Watt
V_{CBO} Collector-Base Voltage	25 Volts
V_{CEO} Collector-Emitter Voltage (Note 4)	12 Volts
V_{EBO} Emitter-Base Voltage	3.0 Volts
I_C Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit		Conditions
h_{FE}	20	–	–	(2N2205)	I_C = 10 mA, V_{CE} = 1.0 Volt
	40	120	–	(2N2206)	
$V_{BE(sat)}$	0.7	0.9	Volt	(2N2205)	I_C = 10 mA, I_B = 1.0 mA
	0.7	0.9	Volt	(2N2206)	
$V_{CE(sat)}$	–	0.22	Volt	(2N2205)	I_C = 10 mA, I_B = 1.0 mA
	–	0.22	Volt	(2N2206)	
$V_{CE(sat)}$	–	0.35	Volt	(2N2205)	I_C = 50 mA, I_B = 5.0 mA
	–	0.35	Volt	(2N2206)	
h_{fe}	2.0	–	–	(2N2205)	I_C = 10 mA, V_{CE} = 10 Volts
	2.0	–	–	(2N2206)	
C_{obo}	–	6.0	pf	(2N2205)	I_E = 0, V_{CB} = 10 Volts
	–	6.0	pf	(2N2206)	
I_{CBO}	–	0.025	μA	(2N2205)	I_E = 0, V_{CB} = 15 Volts
	–	0.025	μA	(2N2206)	
I_{CBO}(150°C)	–	15	μA	(2N2205)	I_E = 0, V_{CB} = 15 Volts
	–	15	μA	(2N2206)	
I_{CEX}	–	15	μA	(2N2205)	V_{CE} = 10 Volts, V_{BE} = 0.25 Volt
	–	15	μA	(2N2206)	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{EBO}	–	100	μA	(2N2205) I_C = 0, V_{EB} = 3.0 Volts
	–	100	μA	(2N2206)
BV_{CBO}	25	–	Volts	(2N2205) I_E = 0, I_C = 100 μA
	25	–	Volts	(2N2206)
V_{CEO}	12	–	Volts	(2N2205) I_B = 0, I_C = 10 mA (pulsed)
	12	–	Volts	(2N2206) (Notes 4 and 5)
BV_{EBO}	3.0	–	Volts	(2N2205) I_C = 0, I_E = 100 μA
	3.0	–	Volts	(2N2206)
τ_s	–	25	nsec	(2N2205) $I_C \approx$ 10 mA, $I_{B1} \approx$ 10 mA,
	–	35	nsec	(2N2206) $I_{B2} \approx -10$ mA (Note 6)
t_{on}	–	40	nsec	(2N2205) $I_C \approx$ 10 mA, $I_{B1} \approx$ 3.0 mA,
	–	40	nsec	(2N2206) $I_{B2} \approx -1.0$ mA (Note 7)
t_{off}	–	75	nsec	(2N2205) $I_C \approx$ 10 mA, $I_{B1} \approx$ 3.0 mA,
	–	75	nsec	(2N2206) $I_{B2} \approx -1.0$ mA (Note 7)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

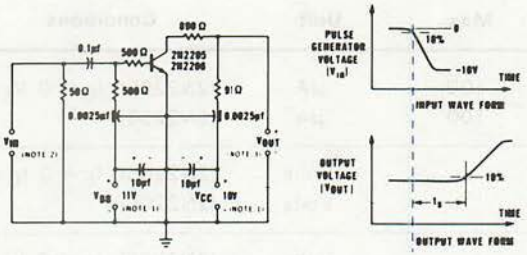
(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.7 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length <6 msec, duty cycle <30%.

(6) See Fig. 1 for exact value of I_C, I_{B1}, and I_{B2}.

(7) See Fig. 2 for exact value of I_C, I_{B1}, and I_{B2}.



NOTES:

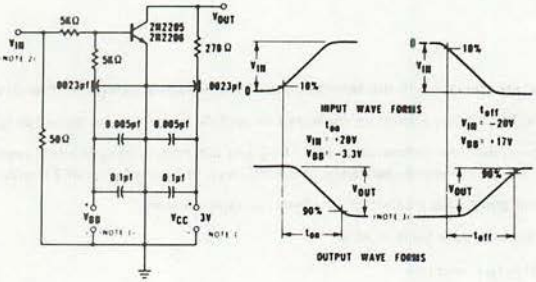
(1) With certain types of power supplies, it may be necessary to connect 25-μf decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB}.

(2) Input voltage (V_{IN}) obtained from a pulse generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec, pulse duration >300 nsec, and duty factor <2%.

(3) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance >1000 ohms.

FIGURE 1

CIRCUIT USED TO MEASURE STORAGE TIME (t_s).



NOTES:

(1) With certain types of power supplies, it may be necessary to connect 25-μf decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB}.

(2) Input voltage (V_{IN}) obtained from a pulse generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec; pulse duration >300 nsec, and duty factor <2%.

(3) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance >3000 ohms.

FIGURE 2

CIRCUIT USED TO MEASURE "TURN-ON" TIME (t_{on}) AND "TURN-OFF" TIME (t_{off}).

2N2303Ⓕ

PNP MEDIUM FREQUENCY AMPLIFIER SILICON TRANSISTOR

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	−50 Volts
Collector-Emitter Voltage ($R_{BE} \leq 10$ ohms) (Note 4)	−50 Volts
Collector-Emitter Voltage (Note 4)	−35 Volts
Emitter-Base Voltage	−5.0 Volts
Total Dissipation @ :	
T_C = 25°C (Notes 2 and 3)	2.0 Watts
T_C = 100°C (Notes 2 and 3)	1.0 Watt
T_A = 25°C	0.6 Watt
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	175°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	75	200	-	I_C = −150 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	75	-	-	I_C = −5.0 mA, V_{CE} = −10 Volts (Note 5)
$V_{BE(sat)}$	-	−1.3	Volts	I_C = −150 mA, I_B = −15 mA
$V_{CE(sat)}$	-	−1.5	Volts	I_C = −150 mA, I_B = −15 mA
h_{fe}	3.0	-	-	I_C = −50 mA, V_{CE} = −10 Volts, f = 20mHz
C_{ob}	-	45	pF	I_E = 0, V_{CB} = −10 Volts
I_{CBO}	-	1.0	μA	I_E = 0, V_{CB} = −30 Volts
$I_{CBO(150°C)}$	-	100	μA	I_E = 0, V_{CB} = −30 Volts
$V_{CER(sust)}$	−50	-	Volts	I_C = −100 mA, $R_{BE} \leq 10$ ohms
$V_{CEO(sust)}$	−35	-	Volts	I_C = −100 mA, I_B = 0

NOTES:

(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 75°C/watt (derating factor of 13.3 mW/°C).

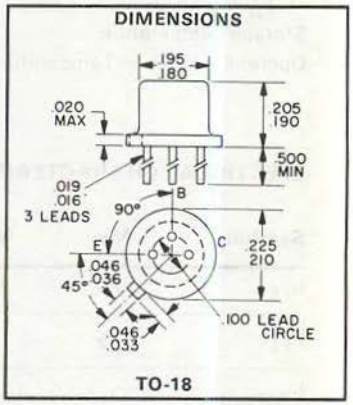
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 usec, duty cycle = 1%.

2N2894 2N3209 ®

SILICON SWITCHING TRANSISTORS

HIGH SPEED PNP SILICON PLANAR EPITAXIAL SATURATED SWITCH AND RF AMPLIFIER



TO-18

- **Fast t_{on} : 23 nsec typ. @ 30 mA**
- **Fast t_{off} : 34 nsec typ. @ 30 mA**
- **High f_T : 600 MHz typ.**
- **Low saturation : 0.25V typ. V_{CE} @ 100 mA**
- **Low C_{ob} : 3.3pF typ. @ 5V**

The ITT 2N2894 and 2N3209 are PNP diffused silicon planar epitaxial transistors designed for saturated and non-saturated switching at high currents. Both are ideal for RF and IF applications, and 100 MHz oscillator converter circuits.

ABSOLUTE MAXIMUM RATINGS

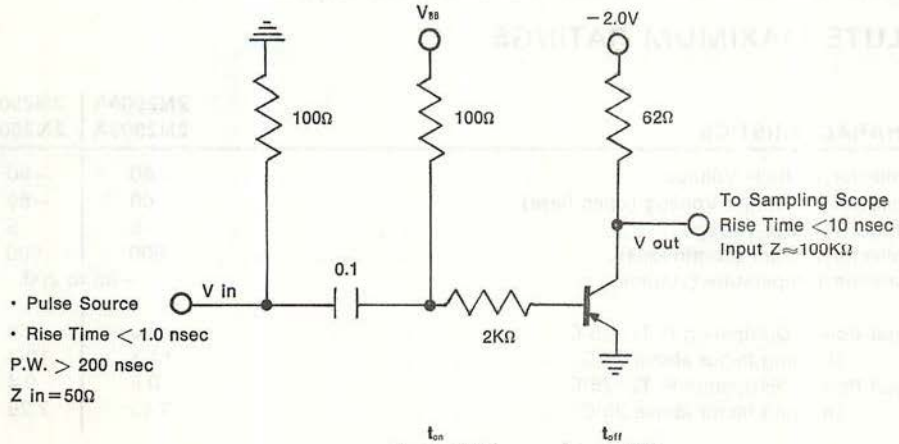
CHARACTERISTICS	2N2894	2N3209	UNITS
Collector-to-Base Voltage	−12	−20	Volts
Collector-to-Emitter Voltage (open base)	−12	−20	Volts
Emitter-to-Base Voltage	−4	−4	Volts
Collector Current (10 μsec pulse)	200	200	mA
Junction Temperature (op. and stg.)	−65 to 200		°C
Total Power Dissipation @ T_C = 25°C	1.2	1.2	Watts
(derate 6.8mW/°C above 25°C) @ T_C = 100°C	0.72	0.68	Watts
Total Power Dissipation @ T_A = 25°C (derate 2.06mW/°C above 25°C)	0.36	0.36	Watts

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

	2N2894			2N3209				
SYMBOL	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**UNIT**	**CONDITIONS**
BV_{CBO}	−12			−20			Vdc	$I_C = 10\mu A$
BV_{CES}				−20			Vdc	$I_C = 10\mu A$
LV_{CEO} (1, 2)	**−12**			**−20**			**Vdc**	**$I_C = 10mA$**
BV_{EBO}	−4.0			−4.0			Vdc	$I_E = 100\mu A$
h_{FE} (1)	40	75	150	30	75	120		$I_C = 30mA$ $V_{CE} = -0.5V$
	30	55		25	67			$I_C = 10mA$ $V_{CE} = -0.3V$
	25			15	30			$I_C = 100mA$ $V_{CE} = -1.0V$
	17	43		12	43			$I_C = 30mA$ $V_{CE} = -0.5V$ $T_A = -55°C$
V_{CE} (sat)(1)		−0.07	−0.15		−0.07	−0.15	Vdc	$I_C = 10mA$ $I_B = 1.0mA$
		−0.10	−0.20		−0.10	−0.20	Vdc	$I_C = 30mA$ $I_B = 3.0mA$
		−0.25	**−0.50**		**−0.28**	**−0.60**	**Vdc**	**$I_C = 100mA$ $I_B = 10mA$**
V_{BE} (sat)(1)	−0.78	−0.92	−0.98	−0.78	−0.92	−0.98	Vdc	$I_C = 10mA$ $I_B = 1.0mA$
	−0.85	−1.10	−1.20	−0.85	−1.10	−1.20	Vdc	$I_C = 30mA$ $I_B = 3.0mA$
		−1.40	−1.70		−1.40	−1.70	Vdc	$I_C = 100mA$ $I_B = 10mA$
I_{CES}		0.05	80		0.05	80	nA	$V_{CE} = -6V$ and $-10V$ respectively
I_{CBO}		0.025	10		0.025	10	μA	Same as above $T_A = 125°C$
C_{ob}		**3.3**	**6.0**		**3.0**	**5.0**	**pF**	**$V_{CB} = -5.0V$**
C_{ib}		3.8	6.0		3.8	6.0	pF	$V_{EB} = -0.5V$
h_{fe}	4.0	**5.5**		4.0	5.5			**$I_C = 30mA$ $V_{CE} = -10V$ $f = 100MHz$**
t_{on}		**23**	**60**		**23**	**60**	**nsec**	**$I_C \approx 30mA$ $I_{B1} \approx 1.5mA$**
t_{off}		**34**	**90**		**34**	**90**	**nsec**	**$I_C \approx 30mA$ $I_{B1} \approx 1.5mA$ $I_{B2} \approx 1.5mA$**

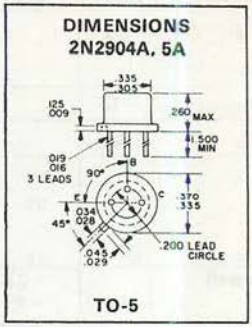
NOTES: 1. Pulsed measurement: width ≤ 300 μsec, duty cycle $\leq 2\%$.
2. Rating is where collector to emitter voltage is lowest.

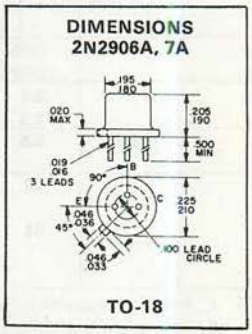
$t_{on} - t_{off}$ TEST CIRCUIT



t_{on}	t_{off}
$V_{CC} = -2.0V$	$V_{CC} = -2.0V$
$V_{BB} = 3.0V$	$V_{BB} = -4.0V$
$V_{in} = -7.0V$	$V_{in} = +6.0V$

GENERAL PURPOSE PNP SILICON PLANAR EPITAXIAL TRANSISTORS





- **High Voltage: −60V min.**
- **Low V_{CE} (sat): 0.4V @ 150 mA**
- **h_{FE} guaranteed from 100 μA to 500mA**

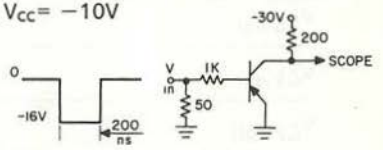
The ITT 2N2904A-7A are PNP silicon planar epitaxial general purpose transistors for applications at current ranges from 0.1 to 500 mA. Low saturation voltage and fast switching times make the 2N2904A, 5A ideal for core driving. The flat gain over a wide current range gives good linearity in amplifier circuits. High breakdown voltage allows large signal swing in switching and amplifier circuits. Designed to complement the ITT 2N2217 thru 2N2222 NPN types.

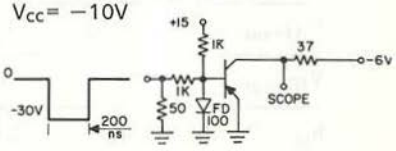
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	2N2904A 2N2905A	2N2906A 2N2907A	UNITS
Collector-to-Base Voltage	−60	−60	Volts
Collector-to-Emitter Voltage (open base)	−60	−60	Volts
Emitter-to-Base Voltage	−5	−5	Volts
Collector Current (continuous)	600	600	mA
Junction Temperature (storage)	−65 to 200		°C
Total Power Dissipation @ T_C=25°C	3.0	1.8	Watts
Derating factor above 25°C	17.3	10.3	mW/°C
Total Power Dissipation @ T_A=25°C	0.6	0.4	Watts
Derating factor above 25°C	3.43	2.28	mW/°C

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

SYMBOL	2N2904A 2N2906A MIN.	MAX.	2N2905A 2N2907A MIN.	MAX.	UNIT	CONDITIONS	
BV_{CBO}	−60		−60		Vdc	I_C= −10μA	
LV_{CEO}[1,2]	−60		−60		Vdc	I_C= −10mA	
BV_{EBO}	−5		−5		Vdc	I_E= −10μA	
h_{FE}[1]	40		75			I_C= −100μA	V_{CE}= −10V
	40		100			I_C= −1mA	V_{CE}= −10V
	40		100			I_C= −10mA	V_{CE}= −10V
	40	120	100	300		I_C= −150mA	V_{CE}= −10V
	40		50			I_C= −500mA	V_{CE}= −10V
V_{CE}(sat)[1]		−0.4		−0.4	Vdc	I_C= −150mA	I_B= −15mA
		−1.6		−1.6	Vdc	I_C= −500mA	I_B= −50mA
V_{BE}(sat)[1]		−1.3		−1.3	Vdc	I_C= −150mA	I_B= −15mA
		−2.6		−2.6	Vdc	I_C= −500mA	I_B= −50mA
I_{CBO}		10		10	nA	V_{CB}= −50V	
		10		10	μA	V_{CB}= −50V	T_A=150°C
I_{CEX}		50		50	nA	V_{CE}= −30V	V_{BE}=0.5V
I_B		50		50	nA	V_{CE}= −30V	V_{BE}=0.5V
C_{ob}		8		8	pF	V_{CB}= −10V	f=100KHz
C_{ib}		30		30	pF	V_{EB}= −2V	f=100KHz
h_{fe}	2		2			I_C= −50mA f=100MHz	V_{CE}= −20V
t_d		10		10	ns	I_C= −150mA V_{CC}= −10V	I_{B1}= −15mA
t_r		40		40	ns		
t_s				80	ns	I_C= −150mA V_{CC}= −10V	I_{B1}=I_{B2} =15mA
t_f				30	ns		





Notes: 1. Pulsed width ≤300 μsec; duty cycle ≤2%.
2. Lowest emitter to collector voltage.

2N3012Ⓕ

HIGH-SPEED PNP SILICON SWITCHING AND RF AMPLIFIER TRANSISTOR

Package: TO-18

The ITT 2N3012 is a 600 mc PNP silicon planar epitaxial transistor designed for saturated and non-saturated switching circuits requiring up to 200 milliamperes of collector current. It is suitable for 20 mc amplifiers, 10.7 mc IF amplifiers, and 100 mc oscillator converter circuits.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	−12 Volts
Collector-Emitter Voltage (Note 4)	−12 Volts
Collector-Emitter Voltage	−12 Volts
Emitter-Base Voltage	−4.0 Volts
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +200 °C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	300°C Maximum

SCHEMATIC

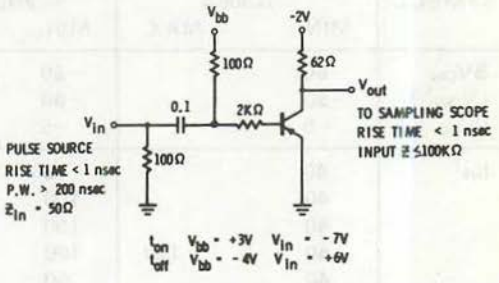


FIGURE 1 – SWITCHING TIME TEST CIRCUIT

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
h_{FE}	30	70	120	–	I_C = 30 mA, V_{CE} = −0.5 Volt (Note 5)
h_{FE}	25	50	–	–	I_C = 10 mA, V_{CE} = −0.3 Volt (Note 5)
h_{FE}	20	40	–	–	I_C = 100 mA, V_{CE} = −1.0 Volt (Note 5)
$V_{CE(sat)}$	–	−0.07	−0.15	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{CE(sat)}$	–	−0.1	−0.2	Volt	I_C = 30 mA, I_B = 3.0 mA
$V_{CE(sat)}$	–	−0.15	−0.4	Volt	I_C = 30 mA, I_B = 3.0 mA
$V_{CE(sat)}$	–	−0.25	−0.5	Volt	I_C = 100 mA, I_B = 10 mA
$V_{BE(sat)}$	−0.78	−0.90	−0.98	Volt	I_C = 10 mA, I_B = 1.0 mA
$V_{BE(sat)}$	−0.85	−1.12	−1.2	Volts	I_C = 30 mA, I_B = 3.0 mA
$V_{BE(sat)}$	–	−1.4	−1.7	Volts	I_C = 100 mA, I_B = 10 mA
h_{fe}	4.0	5.5	–	–	I_C = 30 mA, V_{CE} = −10 Volts
C_{ob}	–	3.3	6.0	pf	I_E = 0, V_{CB} = −5.0 Volts
C_{TE}	–	3.8	6.0	pf	I_C = 0, V_{EB} = −0.5 Volt

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
I_{CES}	–	0.05	80	nA	V_{CE} = −6.0 Volts, V_{BE} = 0
I_{CES}(85°C)	–	0.003	5.0	μA	V_{CE} = −6.0 Volts, V_{BE} = 0
BV_{CBO}	−12	–	–	Volts	I_C = 10 μA, I_E = 0
BV_{CES}	−12	–	–	Volts	I_C = 10 μA, I_E = 0
$V_{CEO(sust)}$	−12	–	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	−4.0	–	–	Volts	I_E = 100 μA, I_C = 0
t_{on}	–	25	60	nsec	$I_C \approx$ 30 mA, I_{B1} ≈ 1.5 mA (Note 6)
t_{off}	–	35	75	nsec	$I_C \approx$ 30 mA, $I_{B1} \approx$ 1.5 mA, $I_{B2} \approx$ −1.5 mA (Note 6)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

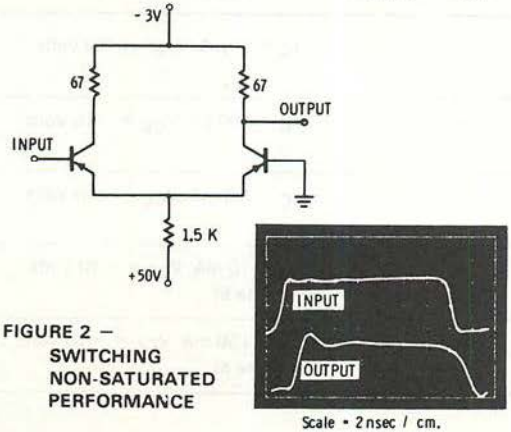


FIGURE 2 – SWITCHING NON-SATURATED PERFORMANCE

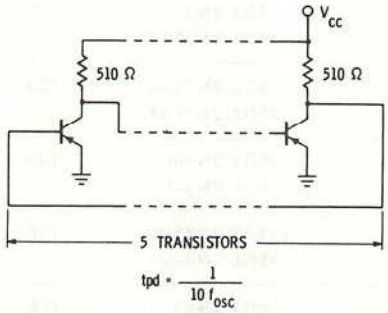


FIGURE 3 – FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY

2N3502, 2N3503, 2N3504, 2N3505 Ⓔ

PNP SILICON HIGH CURRENT SWITCHING TRANSISTORS

Packages:
2N3502/03, TO-5
2N3504/05, TO-18

These ITT PNP silicon planar epitaxial transistors are designed for digital and analog applications at current levels up to 500 milliamperes. Their high beta, high f_T at high current, high LV_{CEO}, and low noise figure make them ideal for use as line drivers, memory applications and low-noise amplifiers.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	
(2N3502, 2N3503)	3.0 Watts
(2N3504, 2N3505)	1.3 Watts
T_A = 25°C (Notes 2 and 3)	
(2N3502, 2N3503)	0.7 Watt
(2N3504, 2N3505)	0.4 Watt
Collector-Base Voltage	
(2N3503, 2N3505)	−60 Volts
(2N3502, 2N3504)	−45 Volts
Collector-Emitter Voltage (Note 4)	
(2N3503, 2N3505)	−60 Volts
(2N3502, 2N3504)	−45 Volts
Emitter-Base Voltage	
(2N3503, 2N3505)	−5.0 Volts
(2N3502, 2N3504)	−5.0 Volts
Collector Current (Note 2)	
(2N3502, 2N3503, 2N3504, 2N3505)	600 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	80	120	-	-	I_C = 10μA, V_{CE} = −10 Volts
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	120	-	-	-	I_C = 100μA, V_{CE} = −10 Volts
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	135	200	-	-	I_C = 1.0 mA, V_{CE} = −10 Volts
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	140	270	-	-	I_C = 10 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	100	150	300	-	I_C = 150 mA, V_{CE} = −10 Volts (Note 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	50	70	–	–	I_C = 500 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	2N3503, 2N3505, 2N3502, 2N3504	115	160	300	–	I_C = 50 mA, V_{CE} = −1.0 Volt
$V_{BE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	−0.9	−1.0	Volt	I_C = 50 mA, I_B = 2.5 mA (Pulsed, see Note 1)
$V_{BE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	−1.0	−1.3	Volts	I_C = 150 mA, I_B = 15 mA (Pulsed, see Note 1)
$V_{CE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	−0.08	−0.25	Volt	I_C = 50 mA, I_B = 2.5 mA (Pulsed, see Note 1)
$V_{CE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	−0.18	−0.4	Volt	I_C = 150 mA, I_B = 15 mA (Pulsed, see Note 1)
h_{fe}	2N3503, 2N3505, 2N3502, 2N3504	2.0	2.50	–	–	I_C = 50 mA, V_{CE} = −20 Volts (f = 100 mc)
$V_{CEO(sust)}$	2N3503, 2N3505, 2N3502, 2N3504	−60 −45	– –	– –	Volts Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
t_{on}	2N3503, 2N3505, 2N3502, 2N3504	–	20	40	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA (Note 6)
t_{off}	2N3503, 2N3505, 2N3502, 2N3504	–	40	100	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx$ −30 mA (Note 6)
$h_{FE}(-55°C)$	2N3503, 2N3505, 2N3502, 2N3504	50	100	–	–	I_C = 50 mA, V_{CE} = −1.0 Volt
I_{CES}	2N3503, 2N3505	–	0.07	10	nA	V_{CE} = −50 Volts, V_{BE} = 0
I_{CES}	2N3502, 2N3504	–	0.05	10	nA	V_{CE} = −30 Volts, V_{BE} = 0
BV_{CBO}	2N3503, 2N3505 2N3502, 2N3504	−60 −45	– –	– –	Volts Volts	I_C = 10 μA, I_E = 0
BV_{EBO}	2N3503, 2N3505, 2N3502, 2N3504	−5.0	–	–	Volts	I_E = 10 μA, I_C = 0
C_{ob}	2N3503, 2N3505, 2N3502, 2N3504	–	4.5	8.0	pf	I_E = 0, V_{CB} = −10 Volts
C_{TE}	2N3503, 2N3505, 2N3502, 2N3504	–	15	25	pf	I_C = 0, V_{EB} = −0.5 Volt

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
NF	2N3503, 2N3505, 2N3502, 2N3504	–	1.0	4.0	dB	I_C = 30μA, V_{CE} = −5.0 Volts (Note 7)
I_{CBO}(+150)	2N3503, 2N3505	–	–	10	μA	V_{CB} = −50 Volts, I_E = 0
I_{CBO}(+150)	2N3502, 2N3504	–	–	10	μA	V_{CB} = −30 Volts, I_E = 0
$V_{CE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	−0.5	−1.6	Volts	I_C = 500 mA, I_B = 50 mA (Pulsed, see Note 5)
$V_{BE(sat)}$	2N3503, 2N3505, 2N3502, 2N3504	–	–	−2.0	Volts	I_C = 500 mA, I_B = 50 mA (Pulsed, see Note 5)

SMALL SIGNAL CHARACTERISTICS (f = 1kc)

Symbol	Min	Typ	Max	Unit	Conditions
h_{ie}	–	1050	2300	Ohms	I_C = 10 mA, V_{CE} = −10 Volts
h_{oe}	–	110	800	umhos	I_C = 10 mA, V_{CE} = −10 Volts
h_{re}	–	240	1500	$x10^{-6}$	I_C = 10 mA, V_{CE} = −10 Volts
h_{fe}	135	200	420	–	I_C = 10 mA, V_{CE} = −10 Volts

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 58.3°C/watt (derating factor of 17.2 mW/°C) for the 2N3502 and 2N3503, and 146°C/watt (derating factor of 6.85 mW/°C) for the 2N3504 and 2N3505; junction-to-ambient thermal resistance of 250°C/watt (derating factor of 4.0 mW/°C) for the 2N3502 and 2N3503, and 438°C/watt (derating factor of 2.28 mW/°C) for the 2N3504 and 2N3505.

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

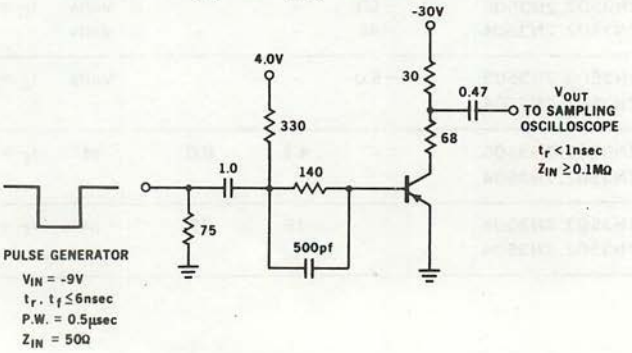
(5) Pulse Conditions: length = 300μsec; duty cycle = 1%.

(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

(7) f = 1.0 Kc; R_S = 10 KΩ.

SCHEMATIC

FIGURE 1 – T_{ON} AND T_{OFF} TEST CIRCUIT



Packages:
2N3671, TO-5
2N3672, TO-18
2N3673, TO-46

2N3671, 2N3672, 2N3673®

HIGH-SPEED PNP SILICON SWITCH AND CORE DRIVER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Total Device Dissipation (Notes 2 and 3):	
@ T_C = 25°C (2N3671)	3.0 Watts
(2N3672)	1.8 Watts
(2N3673)	3.0 Watts
@ T_A = 25°C (2N3671)	0.6 Watt
(2N3672)	0.4 Watt
(2N3673)	0.35 Watt
Collector-Base Voltage	−60 Volts
Collector-Emitter Voltage (Note 4)	−50 Volts
Emitter-Base Voltage	−5.0 Volts
Collector Current (Note 2)	600 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	75	225	–	I_C = 150 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	75	–	–	I_C = 1.0 mA, V_{CE} = −10 Volts
h_{FE}	75	–	–	I_C = 10 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	55	–	–	I_C = 0.1 mA, V_{CE} = −10 Volts
h_{FE}	40	–	–	I_C = 500 mA, V_{CE} = −10 Volts (Note 5)
h_{FE}	20	–	–	I_C = 150 mA, V_{CE} = −0.6 Volt (Note 5)
$V_{CE(sat)}$	–	−0.4	Volt	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{CE(sat)}$	–	−1.6	Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
$V_{BE(sat)}$	–	−1.3	Volts	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{BE(sat)}$	–	−2.6	Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
t_d	–	10	ns	I_{CS} = 150 mA, I_{B1} = 15 mA (See Fig. 1)
t_r	–	40	ns	I_{CS} = 150 mA, I_{B1} = 15 mA (See Fig. 1)
t_s	–	80	ns	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = −15 mA (See Fig. 2)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
t_f	–	30	ns	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = −15 mA (See Fig. 2)
t_{on}	–	45	ns	I_{CS} = 150 mA, I_{B1} = 15 mA (See Fig. 1)
t_{off}	–	100	ns	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = −15 mA (See Fig. 2)
h_{fe}	2.0	–	–	I_C = 50 mA, V_{CE} = −20 Volts
I_{CBO}	–	10	nA	I_E = 0, V_{CB} = −50 Volts
I_{CBO}(150°C)	–	10	μA	I_E = 0, V_{CB} = −50 Volts
I_{CEX}	–	50	nA	V_{CE} = −30 Volts, V_{BE} = +0.5 Volt
I_B	–	50	nA	V_{CE} = −30 Volts, V_{BE} = +0.5 Volt
C_{obo}	–	9.0	pF	I_E = 0, V_{CB} = −10 Volts
C_{ibo}	–	30	pF	I_C = 0, V_{EB} = −2.0 Volts
BV_{CBO}	−60	–	Volts	I_C = 10μA, I_E = 0
$V_{CEO(sust)}$	−50	–	Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
BV_{EBO}	−5.0	–	Volts	I_C = 0, I_E = 10μA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 58.3°C/watt (derating factor of 17.2 mW/°C); junction to ambient thermal resistance of 292°C/watt (derating factor of 3.43 mW/°C) for the 2N3671. Junction to case thermal resistance of 97.3°C/watt (derating factor of 10.3 mW/°C) junction to ambient thermal resistance of 437°C/watt (derating factor of 2.28 mW/°C for the 2N3672. Junction to case thermal resistance of 58.3°C/watt (derating factor of 17.2 mW/°C); junction to ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high-current point where collector to emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

CIRCUIT DIAGRAM

FIGURE 1

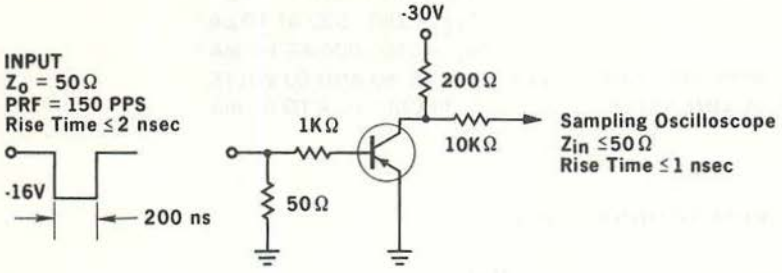
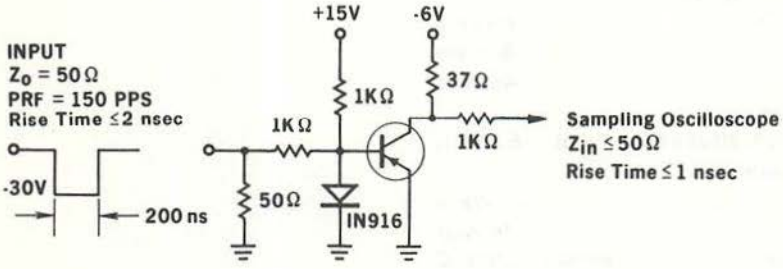


FIGURE 2



2N3962, 2N3963, 2N3964, 2N3965 Ⓕ

PNP SILICON LOW-LEVEL, LOW-NOISE TYPE TRANSISTORS

Package: TO-18

- **LOW NOISE FIGURE** ..... NF = 2.0 dB (MAX) AT 1.0 kHz
  NF = 4.0 dB (MAX) AT 100 Hz
- **HIGH CURRENT GAIN** ..... h_{FE} = 180 (MIN) AT 1.0 μA
  h_{FE} = 250 - 500 AT 10 μA
  h_{FE} = 250 - 600 AT 1.0 mA
- **HIGH BREAKDWON VOLTAGE** ..... LV_{CEO} = 45, 60 AND 80 VOLTS
- **EXCELLENT BETA LINEARITY** ..... FROM 1.0 μA TO 50 mA

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	
(2N3962, 2N3965)	−60 Volts
(2N3963)	−80 Volts
(2N3964)	−45 Volts
Collector-Emitter Voltage (Note 4)	
(2N3962, 2N3965)	−60 Volts
(2N3963)	−80 Volts
(2N3964)	−45 Volts
Emitter-Base Voltage	
(2N3962, 2N3963, 2N3964, 2N3965)	−6.0 Volts
Total Device Dissipation @:	
T_C = 25°C	1.2 Watts
T_A = 25°C	0.36 Watt
Storage Temperature	−65°C to +200 °C
Operating Junction Temperature	200°C
Lead Temperature (Soldering, 60 sec Time Limit)	300 °C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3962, 2N3963	60	175	-	-	I_C = 1.0 μA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	180	300	-	-	
h_{FE}	2N3962, 2N3963	100	210	300	-	I_C = 10 μA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	250	320	500	-	
h_{FE}	2N3962, 2N3963	100	240	-	-	I_C = 100 μA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	250	330	-	-	
h_{FE}	2N3962, 2N3963	100	260	450	-	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	250	330	600	-	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N3962, 2N3963	100	280	–	–	I_C = 10 mA, V_{CE} = −5.0 Volts (Note 5)
	2N3964, 2N3965	200	300	–	–	
h_{FE}	2N3962, 2N3963	90	260	–	–	I_C = 50 mA, V_{CE} = −5.0 Volts (Note 5)
	2N3964, 2N3965	180	315	–	–	
$h_{FE(-55°C)}$	2N3962, 2N3963	40	90	–	–	I_C = 10μA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	100	160	–	–	
$h_{FE(-55°C)}$	2N3962, 2N3963	45	150	–	–	I_C = 50 mA, V_{CE} = −5.0 Volts (Note 5)
	2N3964, 2N3965	90	190	–	–	
$h_{FE(+100°C)}$	2N3962, 2N3963	–	375	600	–	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	–	400	800	–	
BV_{CBO}	2N3962	−60	–	–	Volts	I_C = 10μA, I_E = 0
	2N3964	−45	–	–	Volts	
BV_{CBO}	2N3963	−80	–	–	Volts	I_C = 10μA, I_E = 0
	2N3965	−60	–	–	Volts	
BV_{CES}	2N3962	−60	–	–	Volts	I_C = 10μA, I_B = 0
	2N3964	−45	–	–	Volts	
BV_{CES}	2N3963	−80	–	–	Volts	I_C = 10μA, I_B = 0
	2N3965	−60	–	–	Volts	
$V_{CEO(sust)}$	2N3962	−60	–	–	Volts	I_C = 5.0 mA (pulsed), I_B = 0 (Notes 4 and 5)
	2N3964	−45	–	–	Volts	
$V_{CEO(sust)}$	2N3963	−80	–	–	Volts	I_C = 5.0 mA (pulsed), I_B = 0 (Notes 4 and 5)
	2N3965	−60	–	–	Volts	
BV_{EBO}	2N3962, 2N3963	−6.0	–	–	Volts	I_C = 0, I_E = 10μA
	2N3964, 2N3965					
NF	2N3962, 2N3963	–	1.0	3.0	dB	I_C = 20μA, V_{CE} = −5.0 Volts
	2N3964, 2N3965	–	0.7	2.0	dB	R_S = 10 k ohms, BW = 15.7 kHz
NF	2N3962, 2N3963	–	0.8	3.0	dB	I_C = 20μA, V_{CE} = −5.0 Volts,
	2N3964, 2N3965	–	0.5	2.0	dB	R_S = 10 k ohms, BW = 1.5 kHz
NF	2N3962, 2N3963	–	0.8	3.0	dB	I_C = 20μA, V_{CE} = −5.0 Volts,
	2N3964, 2N3965	–	0.5	2.0	dB	R_S = 10 k ohms, BW = 150 Hz
NF	2N3962, 2N3963	–	3.0	10	dB	I_C = 20μA, V_{CE} = −5.0 Volts,
	2N3964, 2N3965	–	1.8	4.0	dB	R_S = 10 k ohms, BW = 15 Hz
NF	2N3964, 2N3965	–	3.5	8.0	dB	I_C = 20μA, V_{CE} = −5.0 Volts, R_S = 10 k ohms, BW = 2.0 Hz
I_{CES}	2N3962	–	0.5	10	nA	V_{CE} = −50 Volts, V_{EB} = 0
	2N3965					

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
I_{CES}	2N3963	-	0.5	10	nA	V_{CE} = −70 Volts, V_{EB} = 0
I_{CES}	2N3964	-	0.5	10	nA	V_{CE} = −40 Volts, V_{EB} = 0
I_{CES}(+150°C)	2N3962	-	2.0	10	μA	V_{CE} = −50 Volts, V_{EB} = 0
	2N3965	-	0.5	10	μA	
I_{CES}(+150°C)	2N3963	-	2.0	10	μA	V_{CE} = −70 Volts, V_{EB} = 0
I_{CES}(+150°C)	2N3964	-	2.0	10	μA	V_{CE} = −40 Volts, V_{EB} = 0
I_{EBO}	2N3962, 2N3963 2N3964, 2N3965	-	-	10	nA	I_C = 0, V_{EB} = −4.0 Volts
$V_{CE(sat)}$	2N3962, 2N3963 2N3964, 2N3965	-	−0.1	−0.25	Volt	I_C = 10 mA, I_B = 0.5 mA
$V_{CE(sat)}$	2N3962, 2N3963 2N3964, 2N3965	-	−0.16	−0.4	Volt	I_C = 50 mA, I_B = 5.0 mA (Note 5)
$V_{BE(sat)}$	2N3962, 2N3963 2N3964, 2N3965	-	−0.72	−0.9	Volt	I_C = 10 mA, I_B = 0.5 mA
$V_{BE(sat)}$	2N3962, 2N3963 2N3964, 2N3965	-	−0.81	−0.95	Volt	I_C = 50 mA, I_B = 5.0 mA (Note 5)
h_{ie}	2N3962, 2N3963 2N3964, 2N3965	2.5 6.0	8.0 10	17 20	k ohms k ohms	I_C = 1.0 mA, V_{CE} = −5.0 Volts
h_{oe}	2N3962, 2N3963 2N3964, 2N3965	5.0 5.0	19 25	40 50	μmho μmho	I_C = 1.0 mA, V_{CE} = −5.0 Volts
h_{re}	2N3962, 2N3963 2N3964, 2N3965	-	-	10	X 10^{-4}	I_C = 1.0 mA, V_{CE} = −5.0 Volts
h_{fe}	2N3962, 2N3963 2N3964, 2N3965	100 250	300 360	550 700	- -	I_C = 1.0 mA, V_{CE} = −5.0 Volts
h_{fe}	2N3962, 2N3963 2N3964, 2N3965	2.0 2.5	- -	8.0 8.0	- -	I_C = 0.5 mA, V_{CE} = −5.0 Volts
C_{obo}	2N3962, 2N3963 2N3964, 2N3965	-	-	6.0	pF	I_E = 0, V_{CB} = −5.0 Volts
C_{ibo}	2N3962, 2N3963 2N3964, 2N3965	-	-	15	pF	I_C = 0, V_{EB} = −0.5 Volt

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300μs; duty cycle = 1%.

Package: To-92

GENERAL PURPOSE PNP SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	2N4059/62	2N4058	Unit
Collector-Emitter Voltage	40	25	V
Collector-Base Voltage	40	25	V
Emitter-Base Voltage	4.0		V
Collector Current	100		mA

Total Device Dissipation		
@ T_A = 60°C	210	mW
@ T_A = 25°C	310	
Junction Temperature	135	°C
Thermal Resistance, Junction to Ambient	0.357	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	40	–	–	Vdc	2N4059/62 I_C = 0.5 mAdc, I_B = 0
	25	–	–		2N4058
BV_{EBO}	4.0	–	–	Vdc	I_B = 10 uAdc, I_C = 0
I_{CBO}	–	–	0.05	uAdc	2N4059/62 V_{CB} = 30 Vdc, I_E = 0
	–	–	0.05		2N4058 V_{CB} = 20 Vdc, I_E = 0
	–	–	1.0		2N4059/62 V_{CB} = 30 Vdc, I_E = 0, T_A = 60°C
	–	–	1.0		2N4058 V_{CB} = 20 Vdc, I_E = 0, T_A = 60°C
h_{FE}	100	–	–	–	2N4058 I_C = 100 uAdc, V_{CE} = 10 Vdc
	50	–	100		2N4059/60
	90	–	180		2N4061
	150	–	300		2N4062 I_C = 2 mAdc, V_{CE} = 10 Vdc
	200	–	400		2N4058
	30	–	–		2N4059/60
	60	–	–		2N4061
	90	–	–		2N4062
$V_{CE(sat)}$	–	–	0.5	Vdc	I_C = 50 mAdc, I_B = 5 mAdc
f_T	–	200	–	MHz	2N4059/61 I_C = 2 mAdc, V_{CE} = 10 Vdc
	–	340	–		2N4062
	–	340	–		2N4058
	–	270	–		2N4059/61 I_C = 10 mAdc, V_{CE} = 10 Vdc
	–	420	–		2N4062
	–	420	–		2N4058
C_{ob}	–	–	4.0	pF	2N4059/62 V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
	–	–	4.0		2N4058
NF	–	1.8	3.0	dB	V_{CE} = 5 Vdc, I_C = 10 uAdc, R_S = 10 kohms, 2N4058 Power Bandwidth = 15.7 kHz, 3dB points @ 10 Hz and 10 kHz

*Pulse Test: Pulse Width $\leq$ 30 us, duty cycle $\leq$ 2%.

2N4248, 2N4249, 2N4250 Ⓕ

PNP SILICON LOW LEVEL, LOW NOISE AMPLIFIER TRANSISTORS

Package: TO-92

- **Low Noise Figure** ..... 2.0 dB (max) at 1.0 kHz
- **High Current Gain** ..... 250-700 at 100 μA
- **High Breakdown** ..... 40 and 60 Volts (min) LV_{CEO}
- **Excellent Beta Linearity** ..... From 1 μA to 50 mA

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperatures	−55°C to 125°C
Operating Junction Temperatures	125°C
Lead Temperature (Soldering, 10 seconds time limit)	260°C
Total Device Dissipation (Notes 2 and 3)	
@ T_C = 25°C	0.5 Watt
@ T_A = 25°C	0.2 Watt
Collector-Base Voltage	
(2N4248, 2N4250)	−40 Volts
(2N4249)	−60 Volts
Collector-Emitter Voltage	
(2N4248, 2N4250)	−40 Volts
(2N4249)	−60 Volts
Emitter-Base Voltage	
(2N4248, 2N4250)	−5.0 Volts
(2N4249)	−5.0 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
NF	2N4248	–	0.7	–	dB	I_C = 20 μA, V_{CE} = −5.0 Volts
	2N4249	–	0.7	3.0	dB	(Note 6)
	2N4250	–	0.5	2.0	dB	
NF	2N4248	–	1.0	–	dB	I_C = 20 μA, V_{CE} = −5.0 Volts
	2N4249	–	1.0	3.0	dB	(Note 7)
	2N4250	–	0.7	2.0	dB	
NF	2N4248	–	0.8	–	dB	I_C = 250 μA, V_{CE} = −5.0 Volts
	2N4249	–	0.8	3.0	dB	(Note 8)
	2N4250	–	0.7	2.0	dB	
h_{FE}	2N4248	–	90	–	–	I_C = 10 μA, V_{CE} = −5.0 Volts
	2N4249	–	190	–	–	
	2N4250	–	300	–	–	
h_{FE}	2N4248	50	100	–	–	I_C = 100 μA, V_{CE} = −5.0 Volts
	2N4249	100	240	300	–	
	2N4250	250	350	700	–	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N4248	50	110	–	–	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N4249	100	250	–	–	
	2N4250	250	350	–	–	
h_{FE}	2N4248	50	120	–	–	I_C = 10 mA, V_{CE} = −5.0 Volts
	2N4249	100	280	–	–	(Note 5)
	2N4250	250	350	–	–	
BV_{CBO}	2N4248, 2N4250	−40	–	–	Volts	I_C = 10μA, I_E = 0
	2N4249	−60	–	–	Volts	
BV_{CES}	2N4248, 2N4250	−40	–	–	Volts	I_C = 10μA
	2N4249	−60	–	–	Volts	
$V_{CEO(sust)}$	2N4248, 2N4250	−40	–	–	Volts	I_C = 5.0 mA (pulsed), I_B = 0
	2N4249	−60	–	–	Volts	(Notes 4 and 5)
BV_{EBO}	2N4248, 2N4249, 2N4250	−5.0	–	–	Volts	I_C = 0, I_E = 10μA
I_{CBO}	2N4248, 2N4249, 2N4250	–	–	10	nA	I_E = 0, V_{CB} = −40 Volts
$I_{CBO(65°C)}$	2N4248, 2N4249, 2N4250	–	–	3.0	μA	I_E = 0, V_{CB} = 40 Volts
I_{EBO}	2N4248, 2N4249, 2N4250	–	–	20	nA	I_C = 0, V_{BE} = 3.0 Volts
$V_{CE(sat)}$	2N4248, 2N4249, 2N4250	–	–	−0.25	Volt	I_C = 10 mA, I_B = 0.5 mA (Note 5)
$V_{BE(sat)}$	2N4248, 2N4249, 2N4250	–	–	−0.9	Volt	I_C = 10 mA, I_B = 0.5 mA (Note 5)
h_{fe}	2N4248	50	–	–	–	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N4249	100	250	550	–	
	2N4250	250	350	800	–	
h_{fe}	2N4248, 2N4249	2.0	–	–	–	I_C = 0.5 mA, V_{CE} = −5.0 Volts
	2N4250	2.5	–	–	–	
C_{obo}	2N4248, 2N4249, 2N4250	–	–	6.0	pF	I_E = 0, V_{CB} = −5.0 Volts
C_{ibo}	2N4248, 2N4249, 2N4250	–	–	16	pF	I_C = 0, V_{BE} = 0.5 Volt

SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

Symbol		Min	Typ	Max	Unit	Conditions
h_{ie}	2N4249	2.5	8.0	17	k ohms	I_C = 1.0 mA, V_{CE} = 5.0 Volts
	2N4250	6.0	10	20	k ohms	
h_{oe}	2N4249	5.0	19	40	μmho	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N4250	5.0	25	50	μmho	
h_{re}	2N4249, 2N4250	–	–	10	$x10^{-4}$	I_C = 1.0 mA, V_{CE} = −5.0 Volts
h_{fe}	2N4249	100	250	550	–	I_C = 1.0 mA, V_{CE} = −5.0 Volts
	2N4250	250	350	800	–	

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low-duty cycle operations.

(3) These ratings give a maximum junction temperature of 125°C and junction-to-case thermal resistance of 200°C/watt (derating factor of 5.0 mW/°C); junction-to-ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).

(4) This rating refers to a high-current point where collector to emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

(6) R_S = 10 kΩ, Power Bandwidth of 150 Hz.

(7) R_S = 10 kΩ, Power Bandwidth of 15.7 kHz with 3.0 dB points at 10 Hz and 10 kHz.

(8) R_S = 1.0 kΩ, Power Bandwidth of 150 Hz.

Package: To-92

2N5086, 2N5087

LOW-LEVEL, LOW-NOISE PNP SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	50 Vdc
Collector-Base Voltage	50 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current - Continuous	50 mAdc
Peak	100 mAdc

Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS T_A = 25°C unless otherwise noted

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	50	–	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{CBO}	50	–	–	Vdc	I_C = 100 uAdc, I_E = 0
I_{CBO}	–	–	10	nAdc	V_{CB} = 10 Vdc, I_E = 0
	–	–	50		V_{CB} = 35 Vdc, I_E = 0
I_{EBO}	–	–	50	nAdc	V_{BE} = 3.0 Vdc, I_C = 0
h_{FE}	150	–	500	–	I_C = 100 uAdc, V_{CE} = 5.0 Vdc 2N5086
	250	–	800		2N5087
	150	–	–		I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc 2N5086
	250	–	–		2N5087
	150	–	–		I_C = 10 mAdc, V_{CE} = 5.0 Vdc 2N5086
	250	–	–		2N5087
$V_{CE(sat)}$	–	–	0.3	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(on)}$	–	–	0.85	Vdc	I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc
f_T	40	120	–	MHz	I_C = 500 uAdc, V_{CE} = 5.0 Vdc, f = 20 MHz 2N5086
	40	150	–		2N5087
C_{ob}	–	–	4.0	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz
h_{fe}	150	–	600	–	I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz 2N5086
	250	–	900		2N5087
NF	–	–	3.0	dB	I_C = 20 uAdc, V_{CE} = 5.0 Vdc, R_S = 10 k ohms, f = 10 Hz to 15.7 kHz 2N5086
	–	–	2.0		2N5087
	–	1.2	3.0		I_C = 100 uAdc, V_{CE} = 5.0 Vdc, R_S = 3.0 k ohmn, f = 1.0 kHz 2N5086
	–	1.0	2.0		2N5087

2N5221

Package: To-92

LOW-POWER GENERAL PURPOSE PNP SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	15 Vdc
Collector-Base Voltage	15 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current	500 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	15	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CBO}	15	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 10 Vdc, I_E = 0
I_{EBO}	–	100	nAdc	V_{BE} = 3.0 Vdc, I_C = 0
h_{FE}	25	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
	30	600		I_C = 50 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.5	Vdc	I_C = 150 mAdc, I_B = 15 mAdc
$V_{BE(sat)}$	–	1.1	Vdc	I_C = 150 mAdc, I_B = 15 mAdc
f_T	100	–	MHz	I_C = 20 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	15	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	30	1800	–	I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

Package: To-92

MEDIUM POWER PNP SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	25 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current	500 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	25	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CBO}	25	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	300	nAdc	V_{CB} = 15 Vdc, I_E = 0
I_{EBO}	–	500	nAdc	V_{BE} = 4.0 Vdc, I_C = 0
h_{FE}	25	–	–	I_C = 10 mAdc, V_{CE} = 10 Vdc
	30	600		I_C = 50 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.8	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(sat)}$	–	1.0	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
f_T	50	–	MHz	I_C = 20 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	20	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
h_{fe}	30	1800	–	I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

2N5227

Package: To-92

GENERAL PURPOSE PNP SILICON LOW-LEVEL AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	30 Vdc
Collector-Base Voltage	30 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current	50 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	30	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{CBO}	30	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 10 Vdc, I_E = 0
I_{EBO}	–	500	nAdc	V_{BE} = 2.0 Vdc, I_C = 0
h_{FE}	30	–	–	I_C = 100 uAdc, V_{CE} = 10 Vdc
	50	700		I_C = 2.0 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.4	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
$V_{BE(sat)}$	–	1.0	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	100	–	MHz	I_C = 10 mAdc, V_{CE} = 10 Vdc
C_{cb}	–	5.0	pF	V_{CB} = 10 Vdc, I_E = 0
h_{fe}	50	1500	–	I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz

Package TO-92

GENERAL PURPOSE PNP SILICON TRANSISTORS

ABSOLUTE MAXIMUM RATINGS @ 25°C (free air)

Characteristics	Unit
Storage temperature range	-55 to +150 °C
Operating Collector Junction Temperature	+150 °C
Lead temperature 1/16" from case 10 seconds max.	+260 °C
Collector current	500 mA
Continuous device dissipation at or below 25°C free-air temperature	360 mW
Linear derating factor above 25°C	2.87 mW/°C
Emitter-base voltage	5 V
Collector-base voltage	60 V
Collector-base voltage (2N5375)	40 V
Collector-emitter voltage (Applicable from I_C = 0 mA to I_C - 10 mA	30 V

ELECTRICAL CHARACTERISTICS @ 25°C free-air temperature

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	50	nA	2N5372, 2N5373, 2N5374 V_{CB} = 40 V, I_E = 0
	–	50	nA	2N5375 V_{CE} = 30 V, I_E = 0
I_{EBO}	–	50	nA	V_{EB} = 3 V, I_C = 0
BV_{CBO}	60	–	V	2N5372, 2N5373, 2N5374 I_C = 10 uA, I_E = 0
	40	–	V	2N5375 I_C = 10 uA, I_E = 0
BV_{EBO}	5	–	V	I_E = 10 uA, I_C = 0
BV_{CEO}	30	–	V	I_C = 10 mA, I_B = 0 (Note 1)
h_{FE}	20	–	–	2N5372
	50	–	–	2N5373
	100	–	–	2N5374 V_{CE} = 10 V, I_C = 1 mA
	20	–	–	2N5375
h_{FE}	30	–	–	2N5372
	75	–	–	2N5373
	150	–	–	2N5374 V_{CE} = 10 V, I_C = 10 mA (Note 1)
	30	–	–	2N5375
h_{FE}	40	120	–	2N5372
	100	300	–	2N5373
	200	400	–	2N5374 V_{CE} = 10 V, I_C = 150 mA (Note 1)
	40	400	–	2N5375
V_{BE}	–	1.2	V	V_{CE} = 10 V, I_C = 150 mA (Note 1)
$V_{BE(sat)}$	–	1.3	V	I_C = 150 mA, I_B = 15 mA (Note 1)
$V_{CE(sat)}$	–	0.3	V	I_C = 150 mA, I_B = 15 mA (Note 1)
C_{cb}	–	10	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz (Note 2)
$[h_{fe}]$	1.5	–	–	V_{CE} = 10 V, I_C = 20 mA, f = 100 MHz
t_{on}	–	50	nsec	I_C = 150 mA, V_{CC} = 30 V, I_{B1} = 15 mA, (see fig. 1)
t_{off}	–	150	nsec	2N5372, 2N5373 I_C = 150 mA, V_{CC} = 6 V,
	–	175	usec	2N5374, 2N5375 I_{B1} = I_{B2} = 15 mA (see fig. 2)

NOTES: 1. Pulse test: PW = 300 usec, duty cycle $\leq$ 2%.
2. C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

2N5378, 2N5379

Package: To-92

GENERAL PURPOSE PNP SILICON TRANSISTORS

ABSOLUTE MAXIMUM RATINGS @ 25°C (free air)

Characteristics	Unit
Storage temperature range	-55 to +150 °C
Operating Collector Junction Temperature	+150 °C
Lead temperature 1/16" from case 10 seconds max.	+260 °C
Emitter-base voltage	5 V
Collector-base voltage	40 V
Collector-emitter voltage (Applicable from I_C = 0 mA to I_C = 10 mA)	30 V
Collector current	500 mA
Continuous device dissipation at or below 25°C free-air temperature	360 mW
Linear derating factor above 25°C	2.87 mW/°C

ELECTRICAL CHARACTERISTICS @ 25°C free-air temperature

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	10	nA	V_{CB} = 30 V, I_E = 0
BV_{CBO}	40	–	V	I_C = 10 uA, I_E = 0
BV_{EBO}	5	–	V	I_E = 100 nA, I_C = 0
BV_{CEO}	30	–	V	I_C = 10 mA, I_B = 0 (Note 1)
h_{FE}	100	500	–	2N5378 V_{CE} = 5 V, I_C = 10 uA
	40	200	–	2N5379 V_{CE} = 5 V, I_C = 10 uA
h_{FE}	120	600	–	2N5378 V_{CE} = 5 V, I_C = 1 mA
	100	500	–	2N5379 V_{CE} = 5 V, I_C = 1 mA
h_{FE}	150	–	–	2N5378 V_{CE} = 5 V, I_C = 10 mA (Note 1)
	120	–	–	2N5379
$V_{BE(sat)}$	0.65	0.80	V	I_C = 10 mA, I_B = 1 mA
$V_{CE(sat)}$	–	0.2	V	I_C = 10 mA, I_B = 1 mA
h_{ib}	20	32	Ohms	I_C = 1 mA, V_{CE} = 5 V, f = 1 kHz
h_{ob}	0.06	0.5	umhos	I_C = 1 mA, V_{CE} = 5 V, f = 1 kHz
h_{fe}	120	1000	–	2N5378 I_C = 1 mA, V_{CE} = 5 V, f = 1 kHz
	100	900	–	2N5379
C_{cb}	–	10	pF	V_{CB} = 10 V, I_E = 0, f = 1 Mhz (Note 2)
$[h_{fe}]$	20	100	–	V_{CE} = 5 V, I_C = 500 uA, f = 10 MHz
NF	–	2.0	dB	2N5378 I_C = 10 uA, V_{CE} = 5 V, Rg = 10 K Ohms,
	–	3.0	dB	2N5379 Bandwidth = 10 Hz to 15.7 kHz

NOTES:
1. Pulse: tPulse width = 300 usec, duty cycle ≤ 2%.
2. C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

Package: To-92

PNP SILICON AMPLIFIER TRANSISTORS

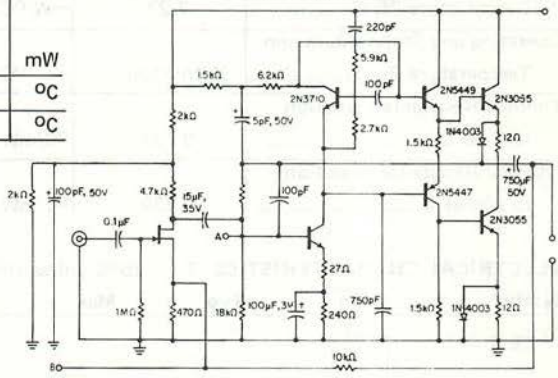
***ABSOLUTE MAXIMUM RATINGS** at 25°C free-air temperature (unless otherwise noted)

Characteristic	2N5447	2N5448	Unit
Collector-Base Voltage	−40	−50	V
Collector-Emitter Voltage (See Note 1)	−25	−30	V
Emitter-Base Voltage	−5	−5	V
Continuous Collector Current	200		mA
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 2)	360		mW
Continuous Device Dissipation at (or below) 25°C Lead Temperature (See Note 3)	500		mW
Storage Temperature Range	−65 to 150		°C
Junction Temperature-Operating	260		°C

NOTES:

1. These values apply when the base-emitter diode is open-circuited.
2. Derate linearly to 150°C free-air temperature at the rate of 2.88 mW/deg.
3. Derate linearly to 150°C lead temperature at the rate of 4 mW/deg. Lead temperature is measured on the collector lead 1/16 inch from the case.

SILICON 15-WATT QUASI-COMPLEMENTARY POWER AMPLIFIER



ELECTRICAL CHARACTERISTICS at 25°C free-air temperature

Symbol	2N5447 Min	2N5447 Max	2N5448 Min	2N5448 Max	Unit	Test Conditions
$V_{(BR)CBO}$	−40		−50		V	$I_C = -100\ uA, I_E = 0$
$V_{(BR)CEO}$	−25		−30		V	$I_C = -10$ mA, $I_B = 0$, See Note 4
$V_{(BR)\ EBO}$	−5		−5		V	$I_E = -100\ uA, I_C = 0$
I_{CBO}		−100		−100	nA	$V_{CB} = 20$ V, $I_E = 0$
I_{EBO}		−100		−100	nA	$V_{EB} = -3$ V, $I_C = 0$
h_{FE}	60	300	30	150		$V_{CE} = -5$ V, $I_C = -50$ mA, See Note 4
V_{BE}	−0.6	−1	−0.6	−1	V	$V_{CE} = -5$ V, $I_C = -50$ mA, See Note 4
V_{CE}		−0.25		−0.25	V	$I_B = -5$ mA, $I_C = -50$ mA, See Note 4
$[h_{fe}]$	5		5			$V_{CE} = -5$ V, $I_C = -50$ mA, f = 20 MHz
C_{cb}		12		12	pF	$V_{CB} = 10$ V, $I_E = 0$, f = 1 MHz See Note 5

NOTES: 4. These parameters must be measured using pulse techniques. t_p = 300 us, duty cycle ≤ 2%.
5. C_{cb} is measured using three-terminal measurement techniques with the emitter guarded.

MPS-A55

Package: To-92

PNP SILICON AMPLIFIER TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic		Unit
Collector-Emitter Voltage	60	Vdc
Collector-Base Voltage	60	Vdc
Emitter-Base Voltage	4.0	Vdc
Collector Current - Continuous	500	mAdc
Total Device Dissipation @ T_A = 25°C	500	mW
Derate above 25°C	4.54	mW/°C
Total Device Dissipation @ T_C = 25°C	800	mW
Derate above 25°C	7.27	mW/°C
Operating and Storage Junction Temperature Range	-55 to +135	°C
Thermal Resistance, Junction to Case	0.137	°C/mW
Thermal Resistance, Junction to Ambient	0.220	°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions
BV_{CEO}	60	–	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{EBO}	4.0	–	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	–	100	nAdc	V_{CB} = 60 Vdc, I_E = 0
h_{FE}	50	150	–	–	I_C = 10 mAdc, V_{CE} = 1.0 Vdc
	50	125	–		I_C = 100 mAdc, V_{CE} = 1.0 Vdc
	–	80	–		I_C = 350 mAdc, V_{CE} = 1.0 Vdc
$V_{CE(sat)}$	–	0.09	0.25	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(sat)}$	–	0.78	–	Vdc	I_C = 100 mAdc, I_B = 10 mAdc
$V_{BE(on)}$	–	0.73	1.2	Vdc	I_C = 100 mAdc, V_{CE} = 1.0 Vdc
f_T	50	100	–	MHz	I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz
C_{ob}	–	6.5	–	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz
C_{ib}	–	20	–	pF	V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz

Package: To-92

GENERAL PURPOSE PNP SILICON AMPLIFIER TRANSISTORS

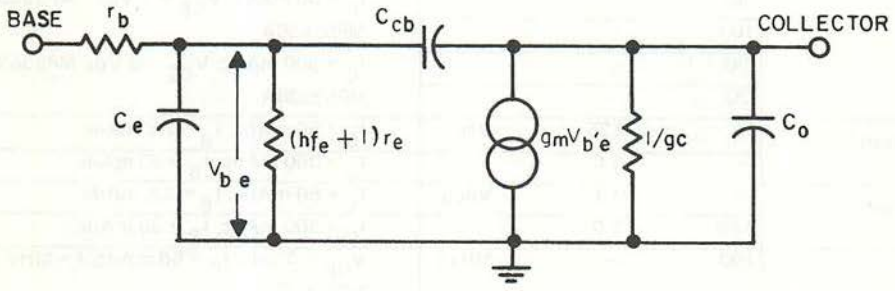
ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	40 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current - Continuous	100 mAdc
Total Device Dissipation @ T_A = 25°C	300 mW
Derate above 25°C	2.73 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.367 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	40	–	Vdc	I_C = 1.0 mAdc, I_B = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CBO}	–	100	nAdc	V_{CB} = 30 Vdc, I_E = 0
h_{FE}	40	400	–	I_C = 5.0 mAdc, V_{CE} = 10 Vdc
$V_{CE(sat)}$	–	0.25	Vdc	I_C = 10 mAdc, I_B = 1.0 mAdc
f_T	125	–	MHz	I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz
C_{ob}	–	4.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz

Figure 1—Simplified AC Equivalent Circuit (Common Emitter)



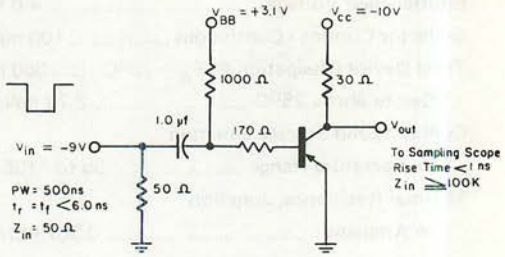
MPS3638, MPS3638A
PNP SILICON TRANSISTOR

Package: To-92

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	25 Vdc
Collector-Emitter Voltage	25 Vdc
Collector-Base Voltage	25 Vdc
Emitter-Base Voltage	4.0 Vdc
Collector Current	500 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

Figure 1



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	25	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CES}	25	–	Vdc	I_C = 100 uAdc, V_{BE} = 0
BV_{CBO}	25	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	4.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CES}	–	0.035	uAdc	V_{CE} = 15 Vdc, V_{BE} = 0
	–	2.0		V_{CE} = 15 Vdc, V_{BE} = 0, T_A = 65°C
I_B	–	0.035	uAdc	V_{CE} = 15 Vdc, V_{BE} = 0
h_{FE}*	80	–	–	I_C = 1 mAdc, V_{CE} = 10 Vdc MPS3638A
	20	–		I_C = 10 mAdc, V_{CE} = 10 Vdc MPS3638
	100	–		MPS3638A
	30	–		I_C = 50 mAdc, V_{CE} = 1 Vdc MPS3638
	100	–		MPS3638A
	20	–		I_C = 300 mAdc, V_{CE} = 2 Vdc MPS3638
	20	–		MPS3638A
$V_{CE(sat)}$*	–	0.25	Vdc	I_C = 50 mAdc, I_B = 2.5 mAdc
	–	1.0		I_C = 300 mAdc, I_B = 30 mAdc
$V_{BE(sat)}$*	–	1.1	Vdcq	I_C = 50 mAdc, I_B = 2.5 mAdc
	0.80	2.0		I_C = 300 mAdc, I_B = 30 mAdc
f_T	100	–	MHz	V_{CE} = 3 Vdc, I_C = 50 mAdc, f = MHz MPS3638
	150	–		MPS3638A
C_{ob}	–	20	pF	V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz MPS3638
	–	10		MPS3638A

ELECTRICAL CHARACTERISTICS $T_A = 25^\circ C$ unless otherwise specified

SYMBOL	MIN	MAX	UNIT	CONDITIONS
C_{ib}	–	65	pF	V_{CE} = 0.5 Vdc, I_C = 0, f = 140 kHz MPS3638
	–	25		MPS3638A
h_{fe}	25	180	–	I_C = 10 mAdc, V_{CE} = 10 Vdc, F = 1.0 kHz MPS3638
	100	–		MPS3638A
h_{oe}	–	1.2	mmhos	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz
h_{ie}	–	1500	Ohms	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz MPS3638
	–	2000		MPS3638A
h_{re}	–	26	X10-4	I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz MPS3638
	–	15		MPS3638A
t_d	–	20	ns	Delay Time V_{CC} = 10 Vdc, I_C = 300 mAdc,
t_r	–	70	ns	Rise Time I_{B1} = 30 mAdc, $V_{BE(off)}$ = 3.1 Vdc
t_s	–	140	ns	Storage Time V_{CC} = 10 Vdc, I_C = 300 mAdc,
t_f	–	70	ns	Fall Time I_{B1} = 30 mAdc, I_{B2} = 30 mAdc
t_{on}	–	75	ns	Turn-On Time I_C = 300 mAdc, I_{B1} = 30 mAdc
t_{off}	–	170	ns	Turn-Off Time I_C = 300 mAdc, I_{B1} = 30 mAdc, I_{B2} = 30 mAdc

*Pulse Test: Pulse Width = 300 us; Duty Cycle = 1%.

MPS3702, MPS3703

Package: To-92

LOW-POWER PNP SILICON TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	MPS3702	MPS3703	Unit
Collector-Emitter Voltage	25	30	Vdc
Collector-Base Voltage	40	50	Vdc
Emitter-Base Voltage	5.0		Vdc
Collector Current - Continuous	200		mAdc
Total Device Dissipation @ T_A = 25°C	310		mW
Derate above 25°C	2.81		mW/°C
Operating and Storage Junction Temperature Range	-55 to +135		°C
Thermal Resistance, Junction to Ambient	0.357		°C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	25	–	Vdc	I_C = 10 mAdc, I_B = 0	MPS3702
	30	–			MPS3702
BV_{CBO}	40	–	Vdc	I_C = 100 uAdc, I_E = 0	MPS3702
	50	–			MPS3703
BV_{EBO}	5.0	–	Vdc	I_E = 100 uAdc, I_C = 0	
I_{CBO}	–	100	nAdc	V_{CB} = 20 Vdc, I_E = 0	
I_{EBO}	–	100	nAdc	V_{BE} = 3 Vdc, I_C = 0	
h_{FE}*	60	300	–	I_C = 50 mAdc, V_{CE} = 5 Vdc	MPS3702
	30	150			MPS3703
$V_{CE(sat)}$*	–	0.25	Vdc	I_C = 50 mAdc, I_B = 5 mAdc	
$V_{BE(on)}$*	0.6	1.0	Vdc	I_C = 50 mAdc, V_{CE} = 5 Vdc	
f_T	100	–	MHz	I_C = 50 mAdc, V_{CE} = 5 Vdc, f = 20 MHz	
C_{ob}	–	12	pF	V_{CB} = 10 Vdc, f = 1 MHz	

*Pulse Test: Pulse Width = 300 us; Duty Cycle = 2%.

Package: To-92

PNP SILICON AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Characteristic			Unit
Collector-Base Voltage			
MPS6533, MPS6534		40	Vdc
MPS6535		39	
Collector-Emitter Voltage			
MPS6533, MPS6534		40	
MPS6535		30	

Emitter-Base Voltage	5.0	4.0	Vdc
Collector Current	600	600	mAdc
Total Device Dissipation			
@ T_A = 60°C	210	210	mW
@ T_A = 25°C	310	310	
Thermal Resistance, Junction to Ambient	0.357	0.357	°C/mW
Junction Temperature	135	135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Typ	Max	Unit	Conditions	
BV_{CBO}	40	–	–	Vdc	I_C = 10 uAdc, I_E = 0	MPS6533, MPS6534
	30	–	–			MPS6535
BV_{CEO}	40	–	–	Vdc	I_C = 10 mAdc, I_B = 0	MPS6533, MPS6534
	30	–	–			MPS6535
BV_{EBO}	4.0	–	–	Vdc	I_B = 10 uAdc, I_C = 0	
I_{CBO}	–	–	0.05	uAdc	V_{CB} = 30 Vdc, I_E = 0	MPS6533, MPS6534
	–	–	0.1		V_{CB} = 20 Vdc, I_E = 0	MPS6535
	–	–	2.0		V_{CB} = 30 Vdc, I_E = 0, T_A = 60°C	MPS6533, MPS6534
	–	–	5.0		V_{CB} = 20 Vdc, I_E = 0, T_A = 60°C	MPS6535
h_{FE}	30	70	–	–	I_C = 10 mAdc, V_{CE} = 1 Vdc	MPS6533
	60	110	–			MPS6534
	40	85	120		I_C = 100 mAdc, V_{CE} = 1 Vdc	MPS6533
	90	140	270			MPS6534
	30	–	–			MPS6535
	25	55	–		I_C = 500 mAdc, V_{CE} = 10 Vdc	MPS6533
	50	70	–			MPS6534
$V_{CE(sat)}$	–	0.2	0.5	Vdc	I_C = 100 mAdc, I_B = 10 mAdc	MPS6533, MPS6535
	–	0.13	0.3			MPS6534
$V_{BE(sat)}$	–	0.84	1.0	Vdc	I_C = 100 mAdc, I_B = 10 mAdc	MPS6533, MPS6534
	–	0.87	1.2			MPS6535
C_{ob}	–	4.8	6.0	pF	V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz	
f_T	–	260	–	MHz	I_C = 50 mAdc, V_{CE} = 10 Vdc	

2N2696Ⓕ

Package TO-18

PNP VHF AMPLIFIERS, HIGH CURRENT SWITCHES

The ITT 2N2696, ia a PNP silicon PLANAR epitaxial transistor designed for digital and analog applications at current levels to 500 milliamperes. The high gain-bandwidth product, f_t, at high currents, makes them excellent units for line driving and memory applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Units
Collector-Base Voltage	−25 Volts
Collector-Emitter Voltage (Note 4)	−25 Volts
Emitter-Base Voltage	−4.0 Volts
Collector Current (Note 2)	500 mA
Total Dissipation @:	
T_C = 25°C (Notes 2 and 3)	1.2 Watts
T_C = 100°C (Notes 2 and 3)	0.68 Watt
T_A = 25°C (Notes 2 and 3)	0.36 Watt
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	300°C Maximum

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	30	130	-	I_C = 50 mA, V_{CE} = −1.0 Volt (Note 5)
h_{FE}	20	-	-	I_C = 300 mA, V_{CE} = −2.0 Volts (Note 5)
$h_{FE(-55°C)}$	12	-	-	I_C = 50 mA, V_{CE} = −1.0 Volt (Note 5)
$V_{BE(sat)}$	-	−1.1	Volts	I_C = 50 mA, I_B = 2.5 mA
$V_{BE(sat)}$	-	−2.0	Volts	I_C = 300 mA, I_B = 30 mA
$V_{CE(sat)}$	-	−0.25	Volt	I_C = 50 mA, I_B = 2.5 mA
$V_{CE(sat)}$	-	−1.0	Volt	I_C = 300 mA, I_B = 30 mA
h_{fe}	1.0	-	-	I_C = 50 mA, V_{CE} = −3.0 Volts f=100MHz
C_{ob}	-	20	pF	I_E = 0, V_{CB} = −10 Volts
I_{CBO}	-	25	nA	I_E = 0, V_{CB} = −10 Volts
$I_{CBO(150°C)}$	-	5.0	μA	I_E = 0, V_{CB} = −10 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	−25	–	Volts	I_C = 100 μA, I_E = 0
$V_{CEO(sust)}$	−25	–	Volts	I_C = 30 mA (pulsed), I_B = 0
BV_{EBO}	−4.0	–	Volts	I_C = 0, I_E = 100 μA
T_{on}	–	75	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA
T_{off}	–	170	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx$ 30 mA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance for the 2N2696 of 145°C/watt (derating factor of 6.9 mW/°C). Junction-to-ambient thermal resistance of 486°C/watt (derating factor 2.1 mW/°C).

(4) Rating refers to a high-curent point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 usec; duty cycle = 1%.

2N2801, 2N2837

NPN SILICON SWITCHING TRANSISTOR

Packages:
2N2801, TO-5
2N2837, TO-18

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	50 Volts
Collector-Emitter Voltage	35 Volts
Emitter-Base Voltage	5 Volts
Collector Current	800 mA
Total Device Dissipation @ $T_A = 25°C$	
(2N2801)	0.8 Watt
Derate above 25°C	4.57 mW/°C
(2N2837)	0.5 Watt
Derate above 25°C	2.86 mW/°C
Total Device Dissipation @ $T_C = 25°C$	
(2N2801)	3 Watts
Derate above 25°C	17.3 mW/°C
(2N2837)	1.8 Watts
Derate above 25°C	10.3 mW/°C
Junction Temperature, Operating	+200 °C
Storage Temperature	−65°C to +200 °C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	50	–	Volts	$I_C = 10\mu A$, $I_E = 0$
BV_{EBO}	5	–	Volts	$I_E = 100\mu A$, $I_C = 0$
BV_{CEO}	35	–	Volts	$I_C = 100$ mA, $I_B = 0$
I_{CEX}	–	100	nA	$V_{CE} = 25$ Volts, $V_{BE} = 0.5$ Volt
I_{BL}	–	100	nA	$V_{CE} = 25$ Volts, $V_{BE} = 0.5$ Volt
h_{FE}	20	–	–	$I_C = 0.1$ mA, $V_{CE} = 10$ Volts (2N2837)
h_{FE}	30	–	–	$I_C = 0.1$ mA, $V_{CE} = 10$ Volts (2N2801)
h_{FE}	30	90	–	$I_C = 150$ mA, $V_{CE} = 10$ Volts* (2N2837)
h_{FE}	75	225	–	$I_C = 150$ mA, $V_{CE} = 10$ Volts* (2N2801)
h_{FE}	15	–	–	$I_C = 150$ mA, $V_{CE} = 1$ Volt* (2N2837)
h_{FE}	30	–	–	$I_C = 150$ mA, $V_{CE} = 1$ Volt* (2N2801)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
h_{FE}	25	–	–	I_C = 500 mA, V_{CE} = 10 Volts* (2N2837)
h_{FE}	40	–	–	I_C = 500 mA, V_{CE} = 10 Volts* (2N2801)
$V_{CE(sat)}$	–	0.4	Volt	I_C = 150 mA, I_B = 15 mA
$V_{CE(sat)}$	–	1.2	Volts	I_C = 500 mA, I_B = 50 mA
$V_{BE(sat)}$	–	1.3	Volts	I_C = 150 mA, I_B = 15 mA
$V_{BE(sat)}$	–	1.8	Volts	I_C = 500 mA, I_B = 50 mA
C_{ob}	–	25	pF	V_{CB} = 10 Volts, f = 100 kHz
f_T	120	–	MHz	I_C = 50 mA, V_{CE} = 10 Volts, f = 100 MHz

* Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%

SWITCHING CHARACTERISTICS
(At 25°C unless otherwise noted)

Characteristics	Typ	Max	Unit
Delay Time	9	25	ns
Rise Time	25	45	ns
Storage Time	100	225	ns
Fall Time	30	45	ns

SCHEMATIC

FIGURE 1 – DELAY AND RISE TIME TEST CIRCUIT

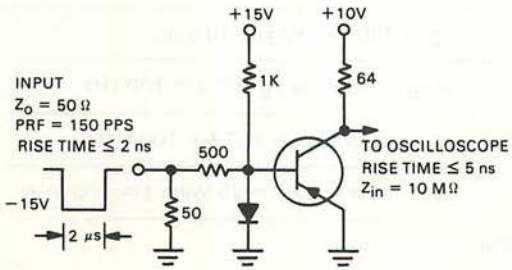
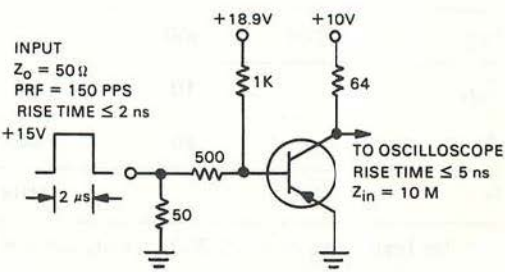


FIGURE 2 – STORAGE AND FALL TIME TEST CIRCUIT



2N3134
HIGH-SPEED NPN SILICON SWITCHING AND AMPLIFIER TRANSISTOR

Package: TO-5

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	50 Volts
Collector-Emitter Voltage	35 Volts
Emitter-Base Voltage	4 Volts
Collector Current	600 mA
Total Device Dissipation @ $T_C = 25°C$	3 Watts
Derate above 25°C	17.3 mW/°C
Total Device Dissipation @ $T_A = 25°C$	0.6 Watts
Derate above 25°C	3.43 mW/°C
Junction Temperature	−65 to +200 °C
Storage Temperature	−65 to +200 °C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	0.05	μA	V_{CB} = 30 Volts, $I_E = 0$
I_{CBO}	–	30	μA	V_{CB} = 30 Volts, $I_E = 0$, $T_A = 150°C$
I_{CEX}	–	0.1	μA	V_{CE} = 30 Volts, V_{BE} = 0.5 Volt
I_{BL}	–	0.1	μA	V_{CE} = 30 Volts, V_{BE} = 0.5 Volt
BV_{CBO}	50	–	Volts	I_C = 10 uA, $I_E = 0$
BV_{CEO}*	35	–	Volts	I_C = 10 mA, $I_B = 0$*
BV_{EBO}	4	–	Volts	I_E = 10 uA, $I_C = 0$
$V_{CE(sat)}$*	–	0.6	Volt	I_C = 150 mA, I_B = 15 mA*
$V_{BE(sat)}$*	–	1.5	Volts	I_C = 150 mA, I_B = 15 mA*
h_{FE}	50	–	–	I_C = 1.0 mA, V_{CE} = 10 Volts
h_{FE}	100	300	–	I_C = 150 mA, V_{CE} = 10 Volts*
C_{ob}	–	10	pF	V_{CB} = 10 Volts, $I_E = 0$, f = 100 kHz
C_{ib}	–	40	pF	V_{BE} = 2 Volts, $I_C = 0$, f = 100 kHz
f_T	200	–	MHz	I_C = 50 mA, V_{CE} = 20 Volts, f = 100 MHz

* Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%

Package: TO-18

HIGH-SPEED PNP SILICON SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Base Voltage	15 Volts
Collector-Emitter Voltage	12 Volts
Emitter-Base Voltage	4.5 Volts
Total Device Dissipation @ $T_A = 25°C$	0.36 Watt
Derate above 25°C	2.06 mW/°C
Total Device Dissipation @ $T_C = 25°C$	1.2 Watts
Derate above 25°C	6.9 mW/°C
Operating Junction Temperature	200 °C
Storage Temperature Range	−65 to +200 °C
Thermal Resistance, Junction to Ambient	0.49 °C/mW
Thermal Resistance, Junction to Case	0.15 °C/mW

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
I_{CBO}	–	0.010	μA	$V_{CB} = 10$ Volts
I_{CBO}	–	10	μA	$V_{CB} = 10$ Volts, $T_A = 150°C$
I_{CEX}	–	0.010	μA	$V_{CE} = 10$ Volts, $V_{BE(off)} = 3$ Volts
I_{BL}	–	0.10	μA	$V_{CE} = 10$ Volts, $V_{BE(off)} = 3$ Volts
BV_{CBO}	15	–	Volts	$I_C = 10\,\mu A$, $I_E = 0$
BV_{EBO}	4.5	–	Volts	$I_E = 10\,\mu A$, $I_C = 0$
BV_{CEO}*	12	–	Volts	$I_C = 10$ mA, $I_B = 0$*
$V_{CE(sat)}$*	–	0.15	Volt	$I_C = 10$ mA, $I_B = 1$ mA*
$V_{CE(sat)}$*	–	0.25	Volt	$I_C = 50$ mA, $I_B = 5$ mA*
$V_{CE(sat)}$*	–	0.50	Volt	$I_C = 100$ mA, $I_B = 10$ mA
$V_{BE(sat)}$*	0.7	0.9	Volt	$I_C = 10$ mA, $I_B = 1$ mA
$V_{BE(sat)}$*	0.8	1.3	Volts	$I_C = 50$ mA, $I_B = 5$ mA
$V_{BE(sat)}$*	–	1.6	Volts	$I_C = 100$ mA, $I_B = 10$ mA
h_{FE}*	20	–	–	$I_C = 1.0$ mA, $V_{CE} = 1$ Volt*
h_{FE}*	30	120	–	$I_C = 10$ mA, $V_{CE} = 1$ Volt
h_{FE}*	15	–	–	$I_C = 10$ mA, $V_{CE} = 1$ Volt, $T_A = −55°C$

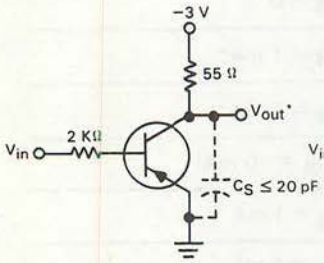
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

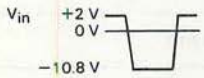
Symbol	Min	Max	Unit	Conditions
h_{FE}*	25	–	–	I_C = 50 mA, V_{CE} = 1 Volt
h_{FE}*	15	–	–	I_C = 100 mA, V_{CE} = 1 Volt
C_{ob}	–	6	pF	V_{CB} = 10 Volts, I_E = 0, f = 1 MHz
C_{ib}	–	5	pF	V_{BE} = 0.5 Volt, I_C = 0, f = 1 MHz
f_T	700	–	MHz	I_C = 10 mA, V_{CE} = 10 Volts, f = 100 MHz
Q_T	–	400	pC	I_C = 50 mA, I_B = 5 mA, V_{CC} = 3 Volts
t_d	–	10	ns	I_C = 50 mA, I_B = 5 mA,
t_r	–	15	ns	V_{BE} = 2 Volts, V_{CC} = 3 Volts
t_s	–	20	ns	I_C = 50 mA, I_{B1} = I_{B2} = 5 mA,
t_f	–	15	ns	V_{CC} = 3 Volts
t_{on}	–	40	ns	(See Figure 3,4,5)
t_{off}	–	30	ns	

* Pulse Test: PW = 300 μs, Duty Cycle ≤ 2%

CIRCUIT DIAGRAM

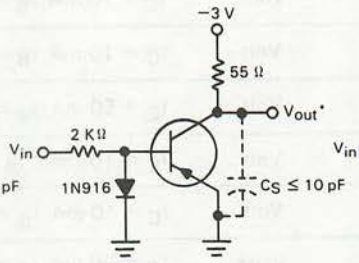
FIGURE 1
DELAY AND RISE TIME
EQUIVALENT TEST CIRCUIT

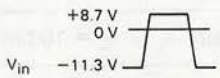




PULSE WIDTH = 200 ns
RISE TIME ≤ 2 ns
DUTY CYCLE ≤ 10%

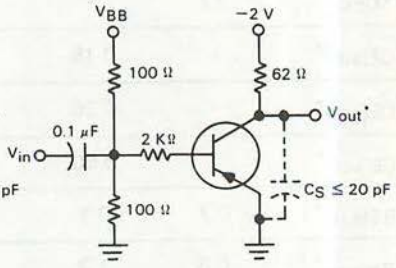
FIGURE 2
STORAGE AND FALL TIME
EQUIVALENT TEST CIRCUIT





PULSE WIDTH = 200 ns
RISE TIME ≤ 2 ns
DUTY CYCLE ≤ 10%

FIGURE 3
SWITCHING TIME TEST CIRCUIT



PULSE WIDTH > 200 ns
RISE TIME < 1 ns
Z_{in} = 50 Ω

t_{on}: V_{BB} = +3 V, V_{in} = −7 V
t_{off}: V_{BB} = −4 V, V_{in} = +6 V

*OSCILLOSCOPE RISE TIME ≤ 1 ns

Package: TO-92

PNP SILICON GENERAL PURPOSE SWITCHING AND AMPLIFIER TRANSISTORS

ABSOLUTE MAXIMUM RATINGS

Characteristics	Unit
Collector-Emitter Voltage	40 Volts
Collector-Base Voltage	40 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	200 mA
Total Device Dissipation @ T_A = 25°C	310 mW
Total Device Dissipation @ T_A = 60°C	210 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	−55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CBO}	40	–	Volts	I_C = 10μA, I_E = 0
BV_{CEO}*	40	–	Volts	I_C = 1.0 mA, I_B = 0
BV_{EBO}	5.0	–	Volts	I_E = 10μA, I_C = 0
I_{CEX}	–	50	nA	V_{CE} = 30 Volts, $V_{BE(off)}$ = 3.0 Volts
I_{BL}	–	50	nA	V_{CE} = 30 Volts, $V_{BE(off)}$ = 3.0 Volts
h_{FE}*	30	–	–	(2N3905) I_C = 0.1 mA, V_{CE} = 1.0 Volt
	60	–	–	(2N3906)
h_{FE}*	40	–	–	(2N3905) I_C = 1.0 mA, V_{CE} = 1.0 Volt
	80	–	–	(2N3906)
h_{FE}*	50	150	–	(2N3905) I_C = 10 mA, V_{CE} = 1.0 Volt
	100	300	–	(2N3906)
h_{FE}*	30	–	–	(2N3905) I_C = 50 mA, V_{CE} = 1.0 Volt
	60	–	–	(2N3906)
h_{FE}*	15	–	–	(2N3905) I_C = 100 mA, V_{CE} = 1.0 Volt
	30	–	–	(2N3906)
$V_{CE(sat)}$*	–	0.25	Volt	I_C = 10 mA, I_B = 1.0 mA
	–	0.4	Volt	I_C = 50 mA, I_B = 5.0 mA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{BE(sat)}$*	0.65	0.85	Volt	I_C = 10 mA, I_B = 1.0 mA
	–	0.95	Volt	I_C = 50 mA, I_B = 5.0 mA
f_T	200	–	MHz	(2N3905) I_C = 10 mA, V_{CE} = 20 Volts,
	250	–	MHz	(2N3906) f = 100 MHz
C_{ob}	–	4.5	pF	V_{CB} = 5.0 Volts, I_E = 0, f = 100 kHz
C_{ib}	–	10	pF	V_{BE} = 0.5 Volt, I_C = 0, f = 100 kHz
h_{ie}	0.5	8.0	k ohms	(2N3905) I_C = 1.0 mA, V_{CE} = 10 Volts,
	2.0	12	k ohms	(2N3906) f = 1.0 kHz
h_{re}	0.1	5.0	X 10^{-4}	(2N3905) I_C = 1.0 mA, V_{CE} = 10 Volts,
	1.0	10	X 10^{-4}	(2N3906) f = 1.0 kHz
h_{fe}	50	200	–	(2N3905) I_C = 1.0 mA, V_{CE} = 10 Volts,
	100	400	–	(2N3906) f = 1.0 kHz
h_{oe}	1.0	40	μmhos	(2N3905) I_C = 1.0 mA, V_{CE} = 10 Volts,
	3.0	60	μmhos	(2N3906) f = 1.0 kHz
NF	–	5.0	dB	(2N3905) I_C = 100 μA, V_{CE} = 5.0 Volts,
	–	4.0	dB	(2N3906) R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz
t_d	–	35	ns	V_{CC} = 3.0 Volts, $V_{BE(off)}$ = 0.5 Volt,
t_r	–	35	ns	I_C = 10 mA, I_{B1} = 1.0 mA
t_s	–	200	ns	(2N3905) V_{CC} = 3.0 Volts, I_C = 10 mA,
	–	225	ns	(2N3906) I_{B1} = I_{B2} = 1.0 mA
t_f	–	60	ns	(2N3905) V_{CC} = 3.0 Volts, I_C = 10 mA,
	–	75	ns	(2N3906) I_{B1} = I_{B2} = 1.0 mA

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

SCHEMATIC

FIGURE 1 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

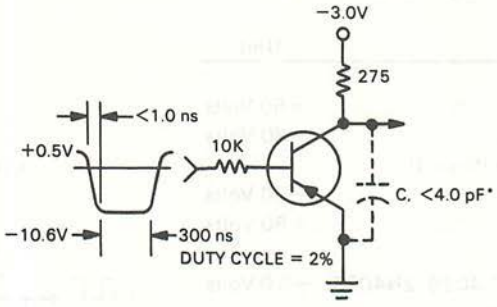
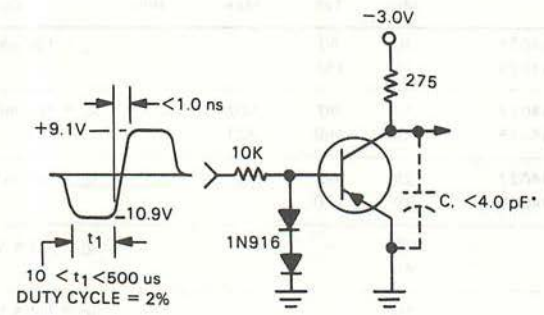


FIGURE 2 — STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

2N4026, 2N4027, 2N4028, 2N4029®

PNP SILICON HIGH-VOLTAGE GENERAL PURPOSE AMPLIFIER TRANSISTORS

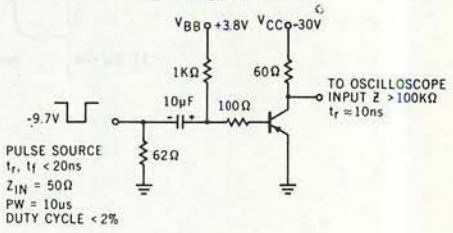
Package: TO-18

- **HIGH BETA** ..... 100 - 300 @ 100 mA
- **HIGH VOLTAGE** ..... 60 AND 80 VOLTS LV_{CEO}
- **LOW $V_{CE(sat)}$** ..... 1.0 VOLT (MAX) @ 1.0 A
- **EXCELLENT BETA LINEARITY** ..... FROM 100 μA TO 500 mA

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Collector-Base Voltage	
(2N4026, 2N4028)	−60 Volts
(2N4027, 2N4029)	−80 Volts
Collector-Emitter Voltage (Note 4)	
(2N4026, 2N4028)	−60 Volts
(2N4027, 2N4029)	−80 Volts
Emitter-Base Voltage	
(2N4026, 2N4027, 2N4028, 2N4029)	−5.0 Volts
Total Device Dissipation @:	
T_C = 25°C (Notes 2 and 3)	2.0 Watts
T_{AF} = 25°C (Notes 2 and 3)	0.5 Watt
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	+300°C Maximum

T_{on} AND T_{off} TEST CIRCUIT



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
h_{FE}	2N4026, 2N4027	30	80	-	-	I_C = 100 μA, V_{CE} = −5.0 Volts (Note 5)
	2N4028, 2N4029	75	150	-	-	
h_{FE}	2N4026, 2N4027	40	80	120	-	I_C = 100 mA, V_{CE} = −5.0 Volts (Note 5)
	2N4028, 2N4029	100	160	300	-	
h_{FE}	2N4026, 2N4027	25	60	-	-	I_C = 500 mA, V_{CE} = −5.0 Volts (Note 5)
	2N4028, 2N4029	70	110	-	-	
h_{FE}	2N4026	15	-	-	-	I_C = 1.0 A, V_{CE} = −5.0 Volts (Note 5)
	2N4028	40	-	-	-	
h_{FE}	2N4027	10	-	-	-	I_C = 1.0 A, V_{CE} = −5.0 Volts (Note 5)
	2N4029	25	-	-	-	
$h_{FE(-55°C)}$	2N4026, 2N4027	15	50	-	-	I_C = 100 mA, V_{CE} = −5.0 Volts (Note 5)
	2N4028, 2N4029	40	100	-	-	
h_{fe}	2N4026, 2N4027	1.0	1.5	4.0	-	I_C = 50 mA, V_{CE} = −10 Volts
	2N4028, 2N4029	1.5	2.0	5.0	-	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
C_{obo}	2N4026, 2N4027 2N4028, 2N4029	-	15	20	pF	I_E = 0, V_{CB} = −10 Volts
C_{ibo}	2N4026, 2N4027 2N4028, 2N4029	-	75	110	pF	I_C = 0, V_{EB} = −0.5 Volt
t_{on}	2N4026, 2N4027 2N4028, 2N4029	-	30 23	100 100	ns ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA (Note 6)
t_s	2N4026, 2N4027 2N4028, 2N4029	-	150 175	350 350	ns ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA, $I_{B2} \approx$ −50 mA (Note 6)
t_f	2N4026, 2N4027 2N4028, 2N4029	-	25 22	50 50	ns ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA, $I_{B2} \approx$ −50 mA (Note 6)
$V_{CE(sat)}$	2N4026, 2N4028 2N4027, 2N4029	-	−0.1	−0.15	Volts	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{CE(sat)}$	2N4026, 2N4028 2N4027, 2N4029	-	−0.25	−0.5	Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
$V_{CE(sat)}$	2N4026, 2N4028	-	−0.5	−1.0	Volt	I_C = 1000 mA, I_B = 100 mA (Note 5)
$V_{BE(sat)}$	2N4026, 2N4028 2N4027, 2N4029	-	−0.8	−0.9	Volt	I_C = 150 mA, I_B = 15 mA (Note 5)
$V_{BE(sat)}$	2N4026, 2N4028 2N4027, 2N4029	- -	- −0.95	−1.1 −1.1	Volts Volts	I_C = 500 mA, I_B = 50 mA (Note 5)
$V_{BE(sat)}$	2N4026, 2N4028	-	−1.05	−1.2	Volts	I_C = 1000 mA, I_B = 100 mA (Note 5)
BV_{CBO}	2N4026, 2N4028 2N4027, 2N4029	−60 −80	-	-	Volts Volts	I_E = 0, I_C = 10 μA
BV_{EBO}	2N4026, 2N4028 2N4026, 2N4028	−5.0	-	-	Volts	I_C = 0, I_E = 10 μA
$V_{CEO(sust)}$	2N4026, 2N4028 2N4027, 2N4029	−60 −80	-	-	Volts Volts	I_C = 10 mA (pulsed), I_B = 0 (Notes 4 and 5)
I_{CBO}	2N4026, 2N4028	-	0.2	50	nA	I_E = 0, V_{CB} = −50 Volts
I_{CBO}	2N4027, 2N4029	-	0.2	50	nA	I_E = 0, V_{CB} = −60 Volts
$I_{CBO(150°C)}$	2N4026, 2N4028	-	0.2	50	μA	I_E = 0, V_{CB} = −50 Volts
$I_{CBO(150°C)}$	2N4027, 2N4029	-	0.25	50	μA	I_E = 0, V_{CB} = −60 Volts

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 87.5°C/watt (derating factor of 11.4 mW/°C); junction-to-ambient thermal resistance of 350°C/watt (derating factor of 2.85 mW/°C).

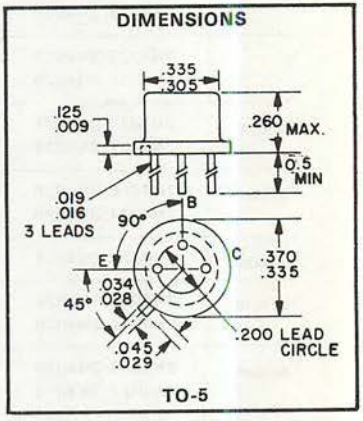
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

GENERAL PURPOSE HIGH-VOLTAGE PNP SILICON PLANAR EPITAXIAL TRANSISTORS

- **High Voltage: −80V (2N4031, 3)**
- **High Gain: 100 min. @ 100mA (2N4032, 3)**
- **Low V_{CE} (sat): −0.15V @ 150mA**



The ITT 2N4030, 2N4031, 2N4032, 2N4033 are high voltage PNP silicon planar epitaxial transistors useful in a variety of applications. Excellent linearity of current gain, high breakdown voltage and low saturation voltage combine in this 150MHz f_t device to increase the possible uses for this device. Primary applications are high voltage output stages and complementary drivers.

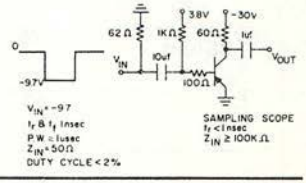
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	2N4030 2N4032	2N4031 2N4033	UNITS
Collector-to-Base Voltage	−60	−80	Volts
Collector-to-Emitter Voltage (open base)	−60	−80	Volts
Emitter-to-Base Voltage	−5	−5	Volts
Collector Current	1.0	1.0	Amps
Junction Temperature (op. and stg.)	−65 to +200		°C
Total Dissipation @ T_C=25°C	4.0		Watts
(derate above 25°C)	22.8		mW/°C
Total Dissipation @ T_A=25°C	0.8		Watts
(derate above 25°C)	4.56		mW/°C

ELECTRICAL CHARACTERISTICS @ 25°C unless otherwise noted.

SYMBOL	2N4030 MIN.	2N4030 MAX.	2N4031 MIN.	2N4031 MAX.	2N4032 MIN.	2N4032 MAX.	2N4033 MIN.	2N4033 MAX.	UNIT	CONDITIONS
BV_{CBO}	−60		−80		−60		−80		Vdc	I_C= −10μA
LV_{CEO}[1,2]	−60		−80		−60		−80		Vdc	I_C= −10mA
BV_{EBO}	−5.0		−5.0		−5.0		−5.0		Vdc	I_C= −10μA
h_{FE}[1]	40	120	40	120	100	300	100	300		I_C= −100mA V_{CE}= −5V
	30		30		75		75			I_C= −100μA V_{CE}= −5V
	25		25		70		70			I_C= −500mA V_{CE}= −5V
	15		15		40		40			I_C= −100mA V_{CE}= −5V T_A= −55°C
	15		10		40		25			I_C= −1A V_{CE}= −5V
$V_{CE}(sat)$[1]		−0.15		−0.15		−0.15		−0.15	Vdc	I_C= −150mA I_B= −15mA
		−0.50		−0.50		−0.50		−0.50	Vdc	I_C= −500mA I_B= −50mA
		−1.0				−1.0			Vdc	I_C= −1A I_B= −100mA
$V_{BE}(sat)$[1]		−0.9		−0.9		−0.9		−0.9	Vdc	I_C= −150mA I_B= −15mA
$V_{BE}(on)$		−1.1		−1.1		−1.1		−1.1	Vdc	I_C= −500mA V_{CE}= −0.5V
		−1.2				−1.2			Vdc	I_C= −1A V_{CE}= −1V
I_{CBO}		−50				−50			nAdc	V_{CB}= −50V
				−50				−50	nAdc	V_{CB}= −60V
		−50				−50			μAdc	V_{CB}= −50V T_A=150°C
				−50				−50	μAdc	V_{CB}= −60V T_A=150°C
I_{EBO}		−10		−10		−10		−10	μAdc	V_{EB}= −5V
C_{ob}		20		20		20		20	pF	V_{CB}= −10V f=1MHz
C_{ib}		110		110		110		110	pF	V_{EB}= −0.5V f=1MHz
$\|h_{fe}\|$	1.0	4.0	1.0	4.0	1.5	5.0	1.5	5.0		V_{CE}= −10V I_C= −50mA f=100MHz
t_{on}		100		100		100		100	ns	**I_C≈500mA** **I_{B1}≈50mA** **I_{B2}≈50mA**
t_s		350		350		350		350	ns	
t_f		50		50		50		50	ns	

SWITCHING TIME TEST CIRCUIT



2N4402, 2N4403

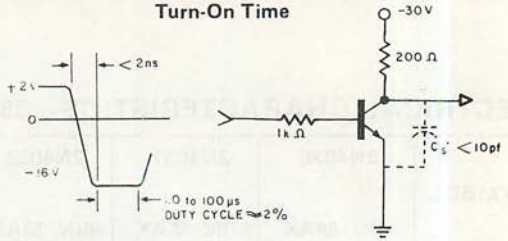
Package: To-92

GENERAL PURPOSE PNP SILICON SWITCHING AND AMPLIFYING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

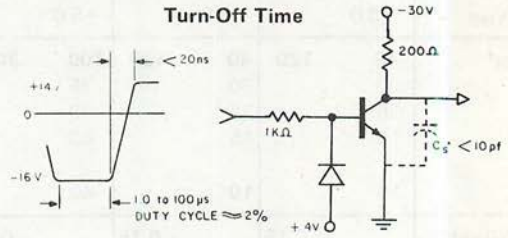
Characteristic	Unit
Collector-Emitter Voltage	40 Vdc
Collector-Base Voltage	40 Vdc
Emitter-Base Voltage	5.0 Vdc
Collector Current - Continuous	600 mAdc
Total Device Dissipation T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating & Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction To Case	0.137 °C/mW
Thermal Resistance, Junction To Ambient	0.357 °C/mW

Turn-On Time



SCOPE RISE TIME 4ns
TOTAL SHUNT CAPACITANCE OF TEST JIG, CONNECTORS, AND OSCILLOSCOPE

Turn-Off Time



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions	
BV_{CEO}*	40	–	Vdc	I_C = 1 mAdc, I_B = 0	
BV_{CBO}	40	–	Vdc	I_C = 0.1 mAdc, I_E = 0	
BV_{EBO}	5.0	–	Vdc	I_E = 0.1 mAdc, I_C = 0	
I_{CEX}	–	0.1	uAdc	V_{CE} = 35 Vdc, $V_{BE(off)}$ = 0.4 Vdc	
I_{BL}	–	0.1	uAdc	V_{CE} = 35 Vdc, $V_{BE(off)}$ = 0.4 Vdc	
h_{FE}	30	–		I_C = 0.1 mAdc, V_{CE} = 1 Vdc	2N4403
	30	–		I_C = 1 mAdc, V_{CE} = 1 Vdc	2N4402
	60	–			2N4403
	50	–		I_C = 10 mAdc, V_{CE} = 1 Vdc	2N4402
	100	–			2N4403
	50	150		I_C = 150 mAdc, V_{CE} = 2 Vdc*	2N4402
	100	300			2N4403
	20	–		I_C = 500 mAdc, V_{CE} = 2 Vdc*	
$V_{CE(sat)}$	–	0.4	Vdc	I_C = 150 mAdc, I_B = 15 mAdc	
	–	0.75		I_C = 500 mAdc, I_B = 50 mAdc	
$V_{BE(sat)}$	0.75	0.95	Vdc	I_C = 150 mAdc, I_B = 15 mAdc	
	–	1.3		I_C = 500 mAdc, I_B = 50 mAdc	
f_T	150	–	MHz	2N4402 I_C = 20 mAdc, V_{CE} = 10 Vdc,	
	200	–		2N4403 f = 100 MHz	

*Pulse Test: Pulse Width = 300 us, Duty Cycle = 2%.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$)

SYMBOL	MIN.	MAX.	UNITS	CONDITIONS
C_{cb}	–	8.5	pF	V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz, emitter guarded
C_{eb}	–	30	pF	V_{BE} = 0.5 Vdc, I_C = 0, f - 140 kHz, collector guarded
h_{ie}	750 1.5k	7.5k 15k	ohms	I_C - 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz 2N4402 2N4403
h_{re}	0.1	8.0	X 10^{-4}	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz
h_{fe}	30 60	250 500	–	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz 2N4402 2N4403
h_{oe}	1.0	100	*u*mhoe	I_C = 1 mAdc, V_{CE} = 10 Vdc, f = 1 kHz
t_d	–	15	ns	V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2 Vdc,
t_r	–	20	ns	I_C = 150 mAdc, I_{B1} = 15 mAdc
t_s	–	225	ns	V_{CC} = 30 Vdc, I_C = 150 mAdc,
t_f	–	30	ns	$I_{B1} = I_{B2}$ = 15 mAdc

2N5056, 2N5057®

Package: TO-18

HIGH SPEED PNP SILICON SATURATED SWITCHING TRANSISTORS

- **Fast Switching** ..... t_{on} = 20 ns (max) at 30 mA
  t_{off} = 35 ns (max) at 30 mA
  τ_s = 30 ns (max) at 10 mA
- **High Frequency** ..... f_T = 800 MHz (min) at 30 mA
- **Low Capacitance** ..... C_{cb} = 4.5 pF (max) at 5 Volts
- **Low Saturation Voltage** ..... $V_{CE(sat)}$ = 0.19 Volts (max) at I_C = 30 mA

ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Unit
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, 60 second time limit)	+300°C
Total Device Dissipation:	
@ T_C = 25°C (Notes 2 and 3)	1.2 Watts
@ T_C = 100°C (Notes 2 and 3)	0.72 Watt
@ T_A = 25°C (Notes 2 and 3)	0.36 Watt
Collector-Base Voltage	−15 Volts
Collector-Emitter Voltage (Note 4)	−15 Volts
Emitter-Base Voltage	−4.5 Volts

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
t_{on}	2N5056	–	10	20	ns	$I_C \approx 30$ mA, $I_{B1} \approx 3.0$ mA
	2N5057	–	10	20	ns	(Note 6, Figure 1)
t_{off}	2N5056	–	15	35	ns	$I_C \approx 30$ mA, $I_B = I_{B2} \approx 3.0$ mA
	2N5057	–	15	35	ns	(Note 6, Figure 1)
τ_s	2N5056	–	15	30	ns	$I_C \approx 10$ mA, $I_{B1} \approx 10$ mA,
	2N5057	–	15	30	ns	$I_{B2} \approx -10$ mA (Note 6, Figure 1)
$V_{CE(sat)}$	2N5056	–	−0.08	−0.13	Volt	I_C = 10 mA, I_B = 1.0 mA
	2N5057	–	−0.08	−0.13	Volt	(Note 5)
$V_{CE(sat)}$	2N5056	–	−0.12	−0.19	Volt	I_C = 30 mA, I_B = 3.0 mA
	2N5057	–	−0.12	−0.19	Volt	(Note 5)
$V_{CE(sat)}$	2N5056	–	−0.28	−0.45	Volt	I_C = 100 mA, I_B = 10 mA
	2N5057	–	−0.28	−0.45	Volt	(Note 5)
$V_{BE(sat)}$	2N5056	−0.72	−0.82	−0.92	Volt	I_C = 10 mA, I_B = 1.0 mA
	2N5057	−0.72	−0.82	−0.92	Volt	(Note 5)
$V_{BE(sat)}$	2N5056	−0.80	−0.93	−1.15	Volts	I_C = 30 mA, I_B = 3.0 mA
	2N5057	−0.80	−0.93	−1.15	Volts	(Note 5)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol		Min	Typ	Max	Unit	Conditions
$V_{BE(sat)}$	2N5056	−0.95	−1.14	−1.5	Volts	I_C = 100 mA, I_B = 10 mA
	2N5057	−0.95	−1.14	−1.5	Volts	
h_{fe}	2N5056	6.0	9.0	–	–	I_C = 30 mA, V_{CE} = −10 Volts
	2N5057	8.0	12	–	–	
C_{cb}	2N5056	–	3.3	4.5	pF	I_E = 0, V_{CB} = −5.0 Volts
	2N5057	–	3.3	4.5	pF	
C_{eb}	2N5056	–	4.7	6.0	pF	I_C = 0, V_{EB} = −0.5 Volt
	2N5057	–	4.7	6.0	pF	
I_{CES}	2N5056	–	0.3	50	nA	V_{CE} = −10 Volts, V_{BE} = 0
	2N5057	–	0.3	50	nA	
I_{CES}(+125°C)	2N5056	–	0.05	10	μA	V_{CE} = −10 Volts, V_{BE} = 0
	2N5057	–	0.05	10	μA	
$V_{CEO(sust)}$	2N5056	−15	–	–	Volts	I_C = 10 mA, I_E = 0
	2N5057	−15	–	–	Volts	(Notes 4 and 5)
BV_{CBO}	2N5056	−15	–	–	Volts	I_C = 10 μA, I_E = 0
	2N5057	−15	–	–	Volts	
BV_{CES}	2N5056	−15	–	–	Volts	I_C = 10 μA, V_{BE} = 0
	2N5057	−15	–	–	Volts	
BV_{EBO}	2N5056	−4.5	–	–	Volts	I_C = 0, I_E = 100 μA
	2N5057	−4.5	–	–	Volts	
h_{FE}	2N5056	12	25	–	–	I_C = 1.0 mA, V_{CE} = −0.5 Volt
	2N5057	20	44	–	–	(Note 5)
h_{FE}	2N5056	20	33	–	–	I_C = 10 mA, V_{CE} = −0.3 Volt
	2N5057	30	53	–	–	(Note 5)
h_{FE}	2N5056	30	48	100	–	I_C = 30 mA, V_{CE} = − 0.5 Volt
	2N5057	40	63	100	–	(Note 5)
h_{FE}	2N5056	20	45	–	–	I_C = 100 mA, V_{CE} = −1.0 Volt
	2N5057	30	55	–	–	(Note 5)
h_{FE}(−55°C)	2N5056	12	25	–	–	I_C = 30 mA, V_{CE} = −0.5 Volt
	2N5057	20	38	–	–	(Note 5)

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).

(4) This rating refers to a high-current point where collector to emitter voltage is lowest.

(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

SCHEMATIC

FIGURE 1
SWITCHING TIME TEST CIRCUIT

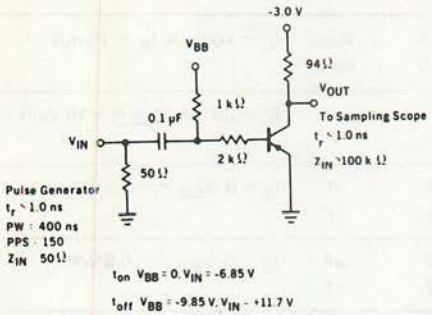


FIGURE 2
SWITCHING TIME TEST CIRCUIT

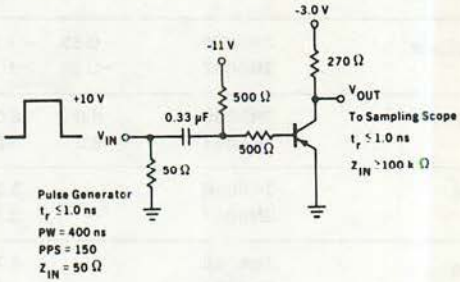


FIGURE 3
FIVE STAGE RING OSCILLATOR FOR
MEASUREMENT OF PROPAGATION DELAY

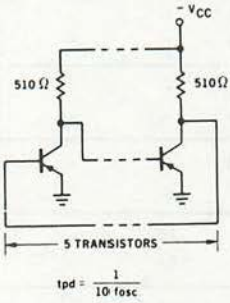
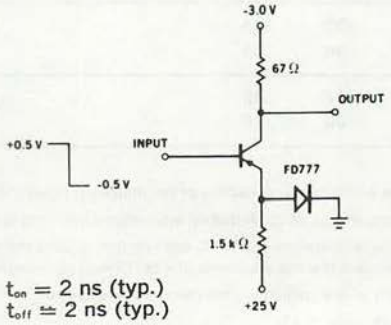


FIGURE 4
NON-SATURATED SWITCHING PERFORMANCE



Package: To-92

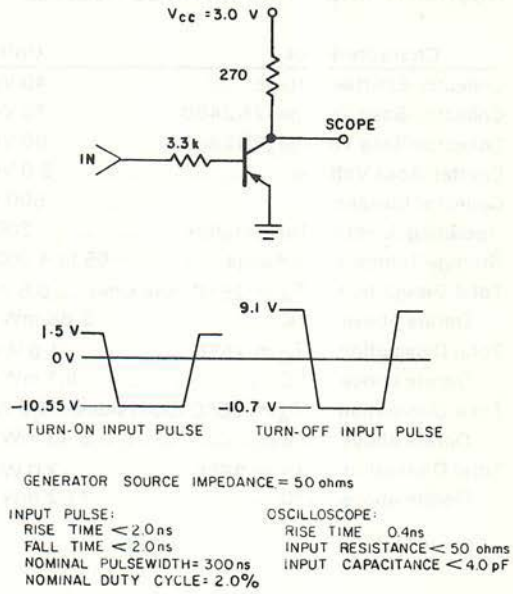
2N5228

GENERAL PURPOSE PNP SILICON LOW-LEVEL SWITCHING TRANSISTOR

ABSOLUTE MAXIMUM RATINGS

Characteristic	Unit
Collector-Emitter Voltage	5.0 Vdc
Collector-Emitter Voltage	6.0 Vdc
Collector-Base Voltage	5.0 Vdc
Emitter-Base Voltage	3.0 Vdc
Collector Current	50 mAdc
Total Device Dissipation @ T_A = 25°C	310 mW
Derate above 25°C	2.81 mW/°C
Operating and Storage Junction Temperature Range	-55 to +135 °C
Thermal Resistance, Junction to Ambient	0.357 °C/mW

Figure 1 – Switching Time Test Circuit



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}	5.0	–	Vdc	I_C = 10 mAdc, I_B = 0
BV_{CES}	6.0	–	Vdc	I_C = 100 uAdc, V_{BE} = 0
BV_{CBO}	5.0	–	Vdc	I_C = 100 uAdc, I_E = 0
BV_{EBO}	3.0	–	Vdc	I_E = 100 uAdc, I_C = 0
I_{CES}	–	100	nAdc	V_{CE} = 4.0 Vdc, V_{BE} = 0
I_{EBO}	–	100	uAdc	V_{BE} = 2.5 Vdc, I_C = 0
h_{FE}	30	–	–	I_C = 10 mAdc, V_{CE} = 0.3 Vdc
	15	–		I_C = 50 mAdc, V_{CE} = 1.0 Vdc
$V_{CE(sat)}$	–	0.4	Vdc	I_C = 10 mAdc, I_B = 3.0 mAdc
$V_{BE(sat)}$	0.65	1.25	Vdc	I_C = 10 mAdc, I_B = 3.0 mAdc
f_T	300	–	MHz	I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz
C_{cb}	–	5.0	pF	V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz
t_d	–	25	ns	Delay Time See Figure 1
t_r	–	50	ns	Rise Time See Figure 1
t_s	–	90	ns	Storage Time See Figure 1
t_f	–	50	ns	Fall Time See Figure 1

2N2480, 2N2480A

Package: TO-92

NPN SILICON DUAL TRANSISTORS

ABSOLUTE MAXIMUM RATINGS (each side)

Characteristics	Unit
Collector-Emitter Voltage	40 Volts
Collector-Base Voltage (2N2480)	75 Volts
Collector-Base Voltage (2N2480A)	80 Volts
Emitter-Base Voltage	5.0 Volts
Collector Current	500 mA
Operating Junction Temperature	200°C
Storage Temperature Range	−65 to +200°C
Total Dissipation @ T_A = 25°C (one side)	0.5 Watt
Derate above 25°C	2.86 mW/°C
Total Dissipation @ T_C = 25°C	1.6 Watts
Derate above 25°C	9.1 mW/°C
Total Dissipation @ T_A = 25°C (both sides)	0.6 Watt
Derate above 25°C	3.43 mW/°C
Total Dissipation @ T_C = 25°C	3.0 Watts
Derate above 25°C	17.2 mW/°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
BV_{CEO}*	40	–	Volts	I_C = 20 mA, I_B = 0*
BV_{CBO}	75	–	Volts	(2N2480) I_C = 100 μA, I_E = 0
	80	–	Volts	(2N2480A)
BV_{EBO}	5.0	–	Volts	I_E = 100 μA, I_C = 0
I_{CBO}	–	15	μA	V_{CB} = 30 Volts, I_E = 0, T_A = 150°C
	–	0.050	μA	(2N2480) V_{CB} = 60 Volts, I_E = 0
	–	0.020	μA	(2N2480A)
I_{EBO}	–	50	nA	(2N2480) V_{BE} = 5.0 Volts, I_C = 0
	–	20	nA	(2N2480A)
h_{FE}	20	–	–	(2N2480) I_C = 100 μA, V_{CE} = 5.0 Volts
	35	–	–	(2N2480A)
h_{FE}	30	350	–	(2N2480) I_C = 1.0 mA, V_{CE} = 5.0 Volts
	50	200	–	(2N2480A)

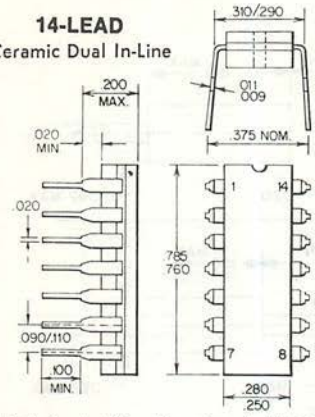
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Symbol	Min	Max	Unit	Conditions
$V_{CE(sat)}$	–	1.2	Volts	(2N2480) I_C = 50 mA, I_B = 5.0 mA
	–	1.3	Volts	(2N2480A)
$V_{BE(sat)}$	–	0.9	Volt	(2N2480) I_C = 50 mA, I_B = 5.0 mA
	–	1.0	Volt	(2N2480A)
f_T	50	–	MHz	I_C = 50 mA, V_{CE} = 10 Volts, f = 20 MHz
C_{ob}	–	20	pF	(2N2480) V_{CB} = 10 Volts, I_E = 0
	–	18	pF	(2N2480A) f = 1.0 MHz
C_{ib}	–	85	pF	(2N2480A) V_{BE} = 0.5 Volt, I_C = 0, f = 1.0 MHz
h_{ie}	1000	5000	ohms	(2N2480A) I_C = 1.0 mA, V_{CE} = 5.0 Volts, f = 1.0 kHz
h_{ib}	20	35	ohms	(2N2480A) I_C = 1.0 mA, V_{CB} = 5.0 Volts, f = 1.0 kHz
h_{fe}	50	300	–	(2N2480A) I_C = 1.0 mA, V_{CE} = 5.0 Volts, f = 1.0 kHz
h_{oe}	4.0	16	umhos	(2N2480A) I_C = 1.0 mA, V_{CE} = 5.0 Volts, f = 1.0 kHz
NF	–	8.0	dB	I_C = 0.3 mA, V_{CE} = 10 Volts, R_S = 510 ohms, f = 1.0 kHz, BW = 1.0 Hz

* Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

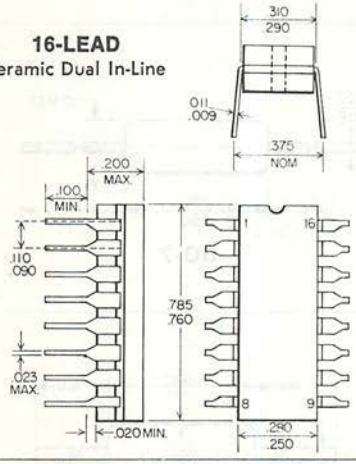
DIMENSIONS

14-LEAD
Ceramic Dual In-Line



NOTE: 1. Board drilling dimensions should equal your practice for a conventional .020 inch diameter lead.

16-LEAD
Ceramic Dual In-Line



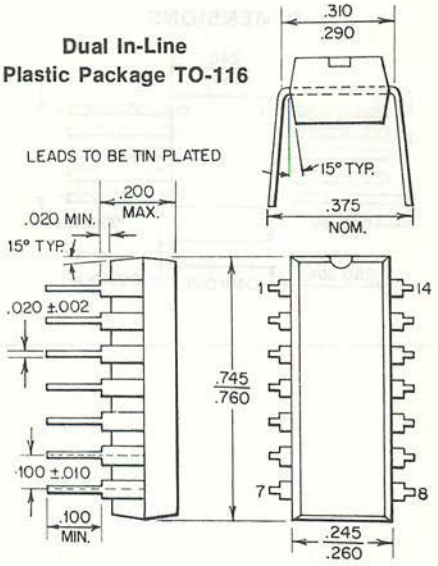
ORDERING CODE FOR 930 DTL, 9000 TTL, 9300 TTL, 950 CTL AND LINEAR CIRCUITS

Operating Temperature Range (add)
−1 for −55 to +125°C
−5 for 0 to +70°C
+75°C for digital

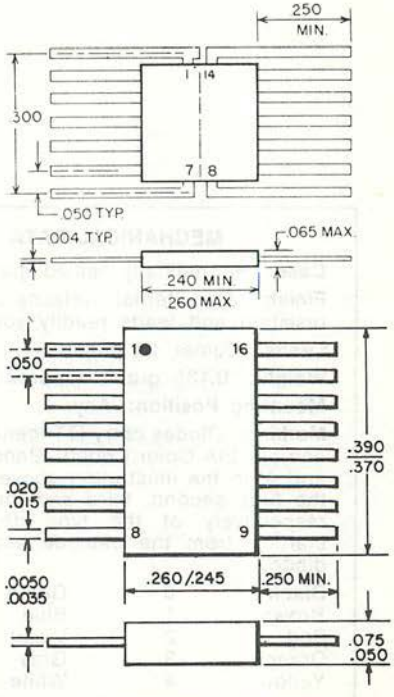
Package (add)
B for Flat Pack
C for TO-5 Style
D for Ceramic Dual In-Line
P for Plastic Dual In-Line

Example:
MIC 709A-1D
is −55 to +125°C
Range in Dual In-Line Package

Dual In-Line Plastic Package TO-116



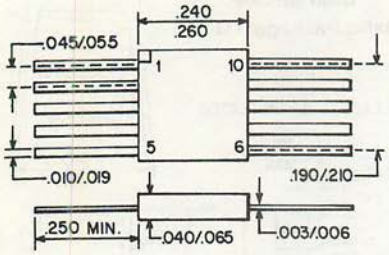
DIMENSIONS — FLAT PACK



16 LEAD—check factory for availability

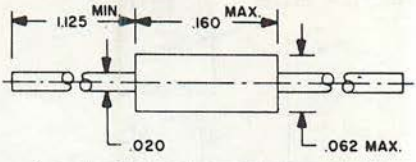
PACKAGE DIMENSIONS

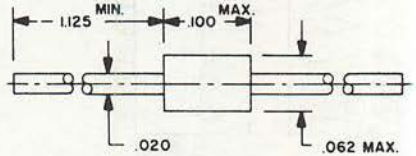
DIMENSIONS



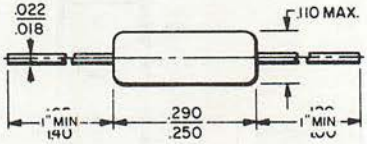
DOUBLE PLUG DIODE

STANDARD

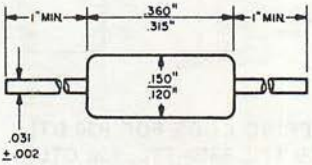




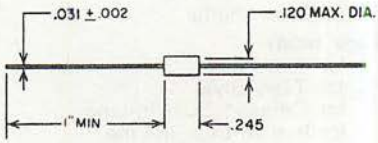
AVAILABLE



DO-7



DO-29



EPOXY PACKAGE

Lead-Material Silver Plated Copper

MECHANICAL DATA

Case: Hermetically sealed glass

Finish: All external surfaces corrosion resistant and leads readily solderable

Leads: Dumet, tin plated

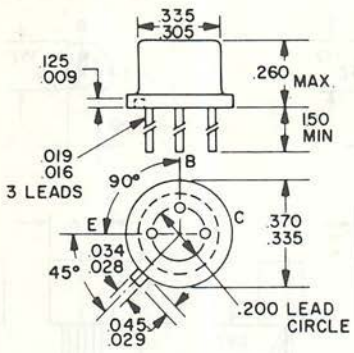
Weight: 0.135 grams (approx.)

Mounting Position: Any

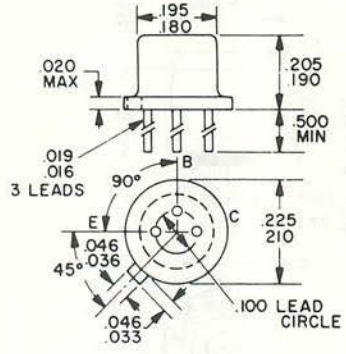
Marking: Diodes carry ITT identification, and are EIA Color Coded. Bands 1, 2, 3 and 4 on the illustration above indicate the first, second, third and fourth digit respectively of the type designation starting from the cathode end of the diode.

Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Gray	8
Yellow	4	White	9

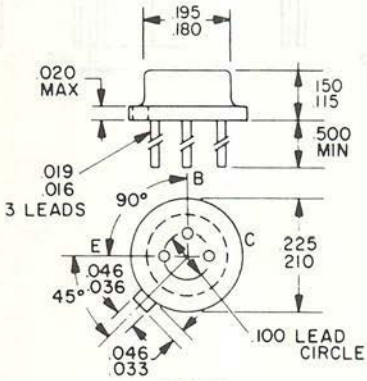
PHYSICAL DIMENSIONS



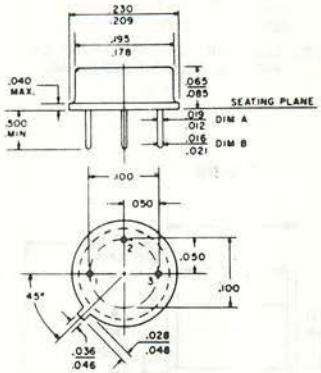
TO-5



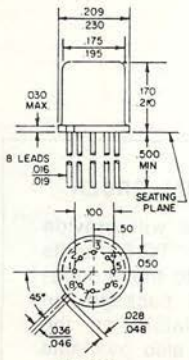
TO-18



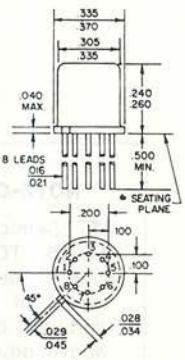
TO-52



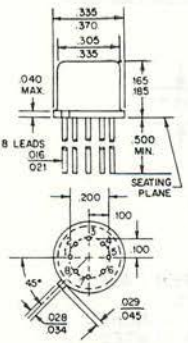
TO-46



TO-71



TO-77



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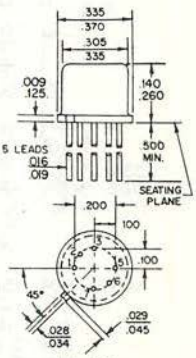


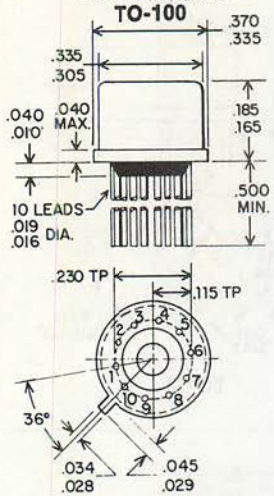
R-131c

NOTE : DIMENSIONS AS PER LATEST JS-10 COMMITTEE.

ALL DIMENSIONS IN INCHES.
LEADS ARE GOLD-PLATED KOVAR.

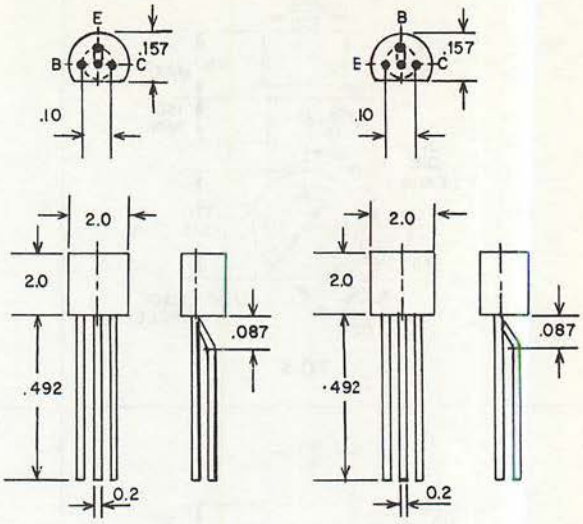
PACKAGE DIMENSIONS

DIMENSIONS TO-100

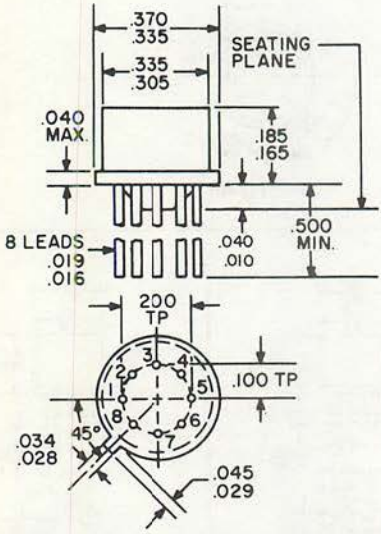


NOTES: LEADS ARE GOLD-PLATED KOVAR
PACKAGE WEIGHT IS 1.32 GRAMS

TO-92 PACKAGE



TO-99



NOTE: DIMENSIONS AS PER LATEST JS-10 COMMITTEE.
ALL DIMENSIONS IN INCHES.
LEADS ARE GOLD-PLATED KOVAR.
PACKAGE WEIGHT IS 1.12 GRAMS.

NOTE-ON SPECIAL ORDER

ITT Semiconductors will provide TO-18, TO-46 and TO-52 units with formed leads to the requirements of the TO-5 package. In addition disc insulators on the above devices are also available by special order.

TTL INTEGRATED CIRCUITS

SECTION 1

NEW PRODUCTS

HIGH LEVEL LOGIC

SECTION 2

LINEAR INTEGRATED CIRCUITS

SECTION 3

Cross-Reference by Section, Page and Device Number.

DEVICES FOR SPECIAL APPLICATIONS

SECTION 4

DTL INTEGRATED CIRCUITS

SECTION 5

MOS ARRAYS

SECTION 6

EPOXY AND GLASS RECTIFIERS

SECTION 7

THYRISTOR DIODES

SECTION 8

TUNER AND ZENER DIODES

SECTION 9

SILICON DIODES

SECTION 10

GERMANIUM DIODES

SECTION 11

SILICON TRANSISTORS

SECTION 12

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