

2N3724, 2N3725 — 2N4013, 2N4014 (continued)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
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ON CHARACTERISTICS (continued)

Collector-Emitter Saturation Voltage* ($I_C = 10 \text{ mA dc}, I_B = 1.0 \text{ mA dc}$)	2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014	$V_{CE(sat)}$ *	-	0.25	Vdc
($I_C = 100 \text{ mA dc}, I_B = 10 \text{ mA dc}$)			-	0.20	
($I_C = 300 \text{ mA dc}, I_B = 30 \text{ mA dc}$)			-	0.26	
($I_C = 500 \text{ mA dc}, I_B = 50 \text{ mA dc}$)			-	0.32	
($I_C = 800 \text{ mA dc}, I_B = 80 \text{ mA dc}$)			-	0.40	
($I_C = 1.0 \text{ A dc}, I_B = 100 \text{ mA dc}$)			-	0.42	
($I_C = 1.0 \text{ A dc}, I_B = 100 \text{ mA dc}$)			-	0.52	
Base-Emitter Saturation Voltage* ($I_C = 10 \text{ mA dc}, I_B = 1.0 \text{ mA dc}$)	2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014 2N3724, 2N4013 2N3725, 2N4014	$V_{BE(sat)}$ *	-	0.76	Vdc
($I_C = 100 \text{ mA dc}, I_B = 10 \text{ mA dc}$)			-	0.86	
($I_C = 300 \text{ mA dc}, I_B = 30 \text{ mA dc}$)			-	1.1	
($I_C = 500 \text{ mA dc}, I_B = 50 \text{ mA dc}$)			0.9	1.2	
($I_C = 800 \text{ mA dc}, I_B = 80 \text{ mA dc}$)			-	1.5	
($I_C = 1.0 \text{ A dc}, I_B = 100 \text{ mA dc}$)			-	1.7	

SMALL-SIGNAL CHARACTERISTICS

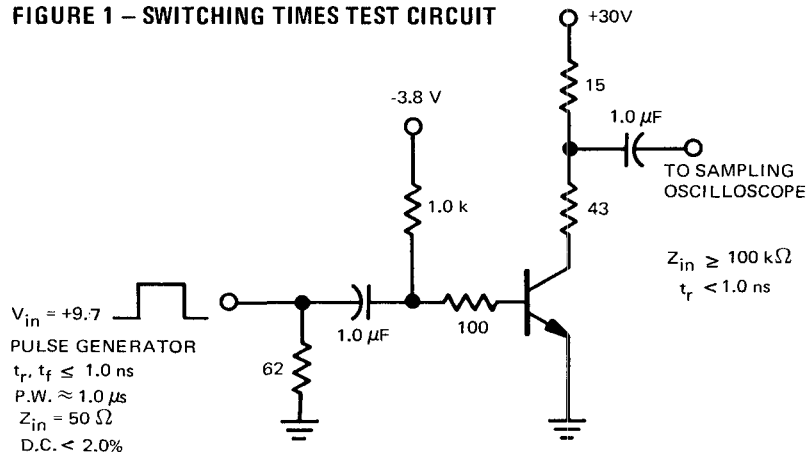
Current-Gain-Bandwidth Product ($I_C = 50 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 100 \text{ MHz}$)	f_T	300	-	MHz
Output Capacitance ($V_{CB} = 10 \text{ V dc}, I_E = 0, f = 140 \text{ kHz}$)	C_{ob}	-	12	pF
		-	10	
Input Capacitance ($V_{BE} = 0.5 \text{ V dc}, I_C = 0, f = 140 \text{ kHz}$)	C_{ib}	-	55	pF

SWITCHING CHARACTERISTICS

Turn-On Time	$(V_{CC} = 30 \text{ V dc}, V_{BE(off)} = 3.8 \text{ V dc}, I_C = 500 \text{ mA dc}, I_{B1} = 50 \text{ mA dc})$ (See Figure 1)	t_{on}	-	35	ns
Delay Time		t_d	-	10	ns
Rise Time		t_r	-	30	ns
Turn-Off Time	$(V_{CC} = 30 \text{ V dc}, I_C = 500 \text{ mA dc}, I_{B1} = I_{B2} = 50 \text{ mA dc})$ (See Figure 1)	t_{off}	-	60	ns
Storage Time		t_s	-	50	ns
Fall Time		t_f	-	25	ns

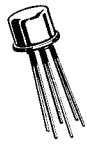
* Pulse Test: Pulse Width = 300 μs , Duty Cycle = 1.0%.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT

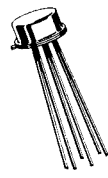


2N3800 thru **2N3817** (SILICON)
 (JAN 2N3810 AND 2N3811 Available)

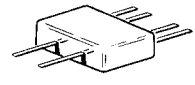
$V_{CEO} = 60\text{ V}$
 $I_C = 50\text{ mA}$
 P_D to 500 mW one side
 600 mW both sides



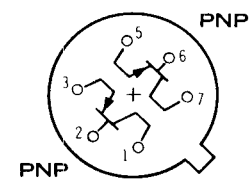
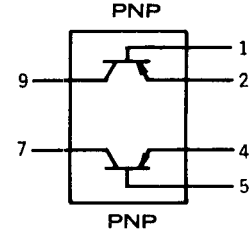
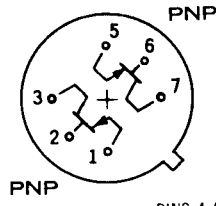
CASE 35
 (TO-71)
 2N3800
 thru
 2N3805



CASE 32 C
 2N3806
 thru
 2N3811



CASE 33
 (TO-89)
 2N3812
 thru
 2N3817



PINS 4 AND 8 OMITTED

Pin Connections, Bottom View
 All Leads Electrically Isolated from Case

MAXIMUM RATINGS (each side)

Rating	Symbol	Value		Unit
		One Side	Both Sides	
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current	I_C	50		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Metal Can (2N3800 thru 2N3805) Derate above 25°C Metal Can (2N3806 thru 2N3811) Derate above 25°C Flat Package (2N3812 thru 2N3817) Derate above 25°C	P_D	250	360	mW
		1.5	2.06	mW/°C
		500	600	mW
		2.9	3.4	mW/°C
		250	350	mW
		1.5	2.0	mW/°C

2N3800 thru 2N3817 (continued)

ELECTRICAL CHARACTERISTICS (each side) ($T_A = 25^\circ\text{C}$ unless otherwise noted)
 Characteristics apply also to corresponding flat package type numbers

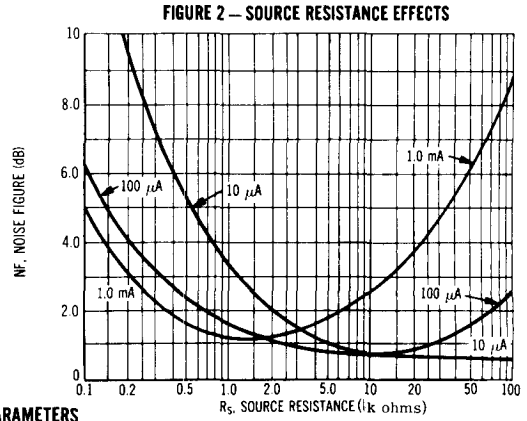
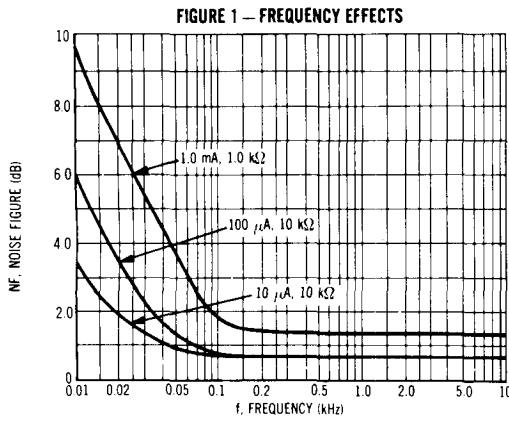
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage* ($I_C = 10\text{ mAdc}$, $I_B = 0$)	BV_{CEO}^*	60	90	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{Adc}$, $I_E = 0$)	BV_{CBO}	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ }\mu\text{Adc}$, $I_C = 0$)	BV_{EBO}	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $T_A = 150^\circ\text{C}$)	I_{CBO}	—	—	0.01 10	μAdc
Emitter Cutoff Current ($V_{BE(off)} = 4.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain* ($I_C = 1.0\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}^*	75	—	—	—
($I_C = 10\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)		100 225	—	—	
($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)		150 300	—	450 900	
($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$, $T_A = -55^\circ\text{C}$)		75 150	—	—	
($I_C = 500\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)		150 300	—	450 900	
($I_C = 1.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)		150 300	—	450 900	
($I_C = 10\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)		125 250	—	—	
Collector-Emitter Saturation Voltage* ($I_C = 100\text{ }\mu\text{Adc}$, $I_B = 10\text{ }\mu\text{Adc}$) ($I_C = 1.0\text{ mAdc}$, $I_B = 100\text{ }\mu\text{Adc}$)	$V_{CE(sat)}^*$	—	—	0.2 0.25	Vdc
Base-Emitter Saturation Voltage* ($I_C = 100\text{ }\mu\text{Adc}$, $I_B = 10\text{ }\mu\text{Adc}$) ($I_C = 1.0\text{ mAdc}$, $I_B = 100\text{ }\mu\text{Adc}$)	$V_{BE(sat)}^*$	—	—	0.7 0.8	Vdc
Base-Emitter On Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	$V_{BE(on)}$	—	—	0.7	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 500\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 30\text{ MHz}$) ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	30 100	—	— 500	MHz
Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{ob}	—	—	4.0	pF
Input Capacitance ($V_{BE(off)} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 100\text{ kHz}$)	C_{ib}	—	—	8.0	pF
Input Impedance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{ie}	2N3800, 2, 4, 6, 8, 10, 12, 14, 16 2N3801, 3, 5, 7, 9, 11, 13, 15, 17	3.0 10	— 40	15 40 k ohms
Voltage Feedback Ratio ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{re}	—	—	25	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	2N3800, 2, 4, 6, 8, 10, 12, 14, 16 2N3801, 3, 5, 7, 9, 11, 13, 15, 17	150 300	— —	600 900
Output Admittance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{oe}	—	—	60	μmos
Noise Figure ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 10\text{ Vdc}$, $R_S = 3.0\text{ k ohms}$, $f = 100\text{ Hz}$) $f = 1.0\text{ kHz}$ $f = 10\text{ kHz}$ Noise Bandwidth = 10 Hz to 15.7 kHz)	NF	2N3800, 2, 4, 6, 8, 10, 12, 14, 16 2N3801, 3, 5, 7, 9, 11, 13, 15, 17	— — —	4.0 2.5 1.5 0.8 1.0 0.8	7.0 4.0 3.0 1.5 2.5 1.5 3.5 2.5
MATCHING CHARACTERISTICS					
DC Current Gain Ratio** ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE1}/h_{FE2}^{**}	2N3802, 3, 8, 9, 14, 15 2N3804, 5, 10, 11, 16, 17	0.8 0.9	— —	1.0 1.0
Base Voltage Differential ($I_C = 10\text{ }\mu\text{Adc}$, to 10 mAdc, $V_{CE} = 5.0\text{ Vdc}$) ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	$ V_{BE1} - V_{BE2} $	2N3802, 3, 8, 9, 14, 15 2N3804, 5, 10, 11, 16, 17	— —	— —	8.0 5.0 5.0 3.0
Base Voltage Differential Gradient ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$, $T_A = -55\text{ to }+25^\circ\text{C}$) ($I_C = 100\text{ }\mu\text{Adc}$, $V_{CE} = 5.0\text{ Vdc}$, $T_A = +25\text{ to }+125^\circ\text{C}$)	$\frac{\Delta(V_{BE1} - V_{BE2})}{\Delta T_A}$	2N3802, 3, 8, 9, 14, 15 2N3804, 5, 10, 11, 16, 17	— —	— —	1.6 0.8 2.0 1.0

*Pulse Test: Pulse width $\leq 300\text{ }\mu\text{s}$, duty cycle $\leq 2\%$ **The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

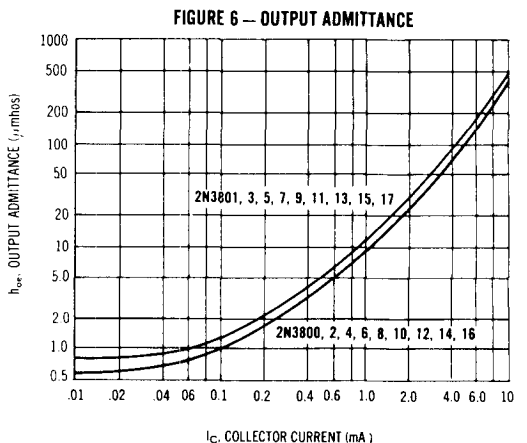
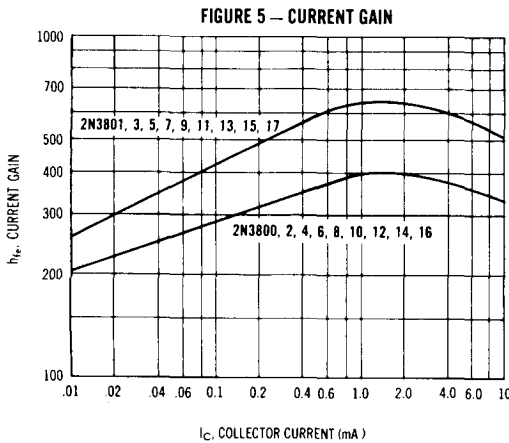
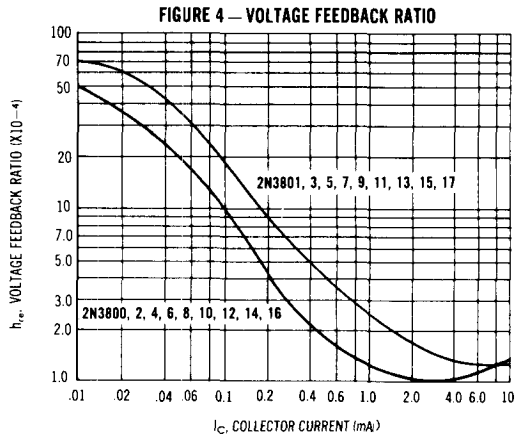
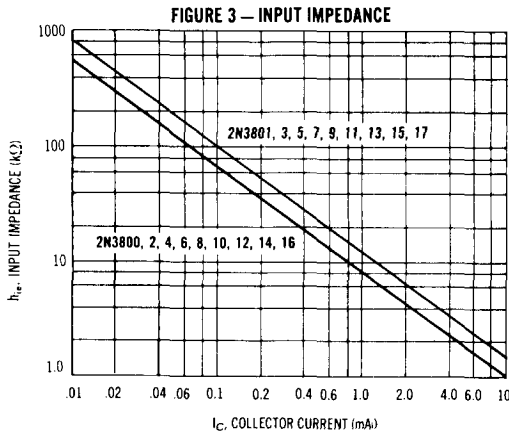
2N3800 thru 2N3817 (continued)

SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE



h PARAMETERS
 $V_{CE} = 10 \text{ Vdc}$, $f = 1 \text{ kHz}$, $T_A = 25^\circ\text{C}$



2N3800 thru 2N3817 (continued)

FIGURE 7 — TYPICAL CURRENT-GAIN CHARACTERISTICS

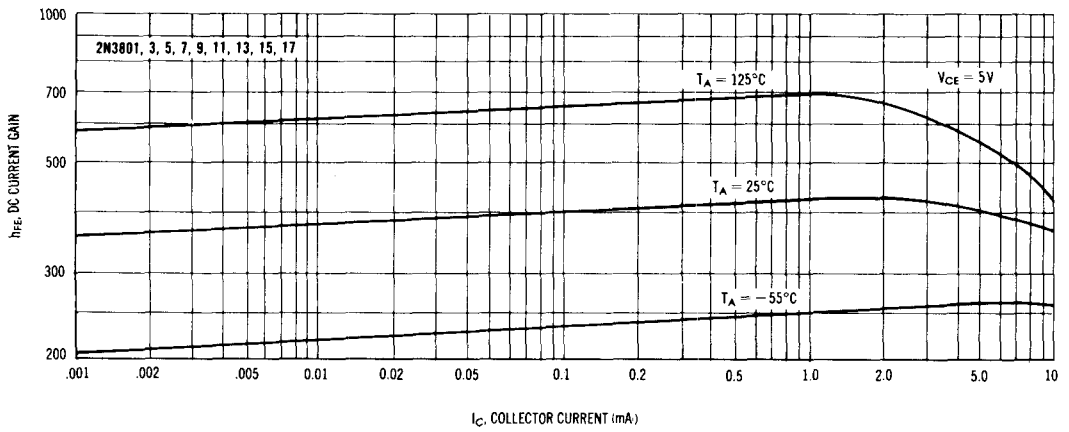
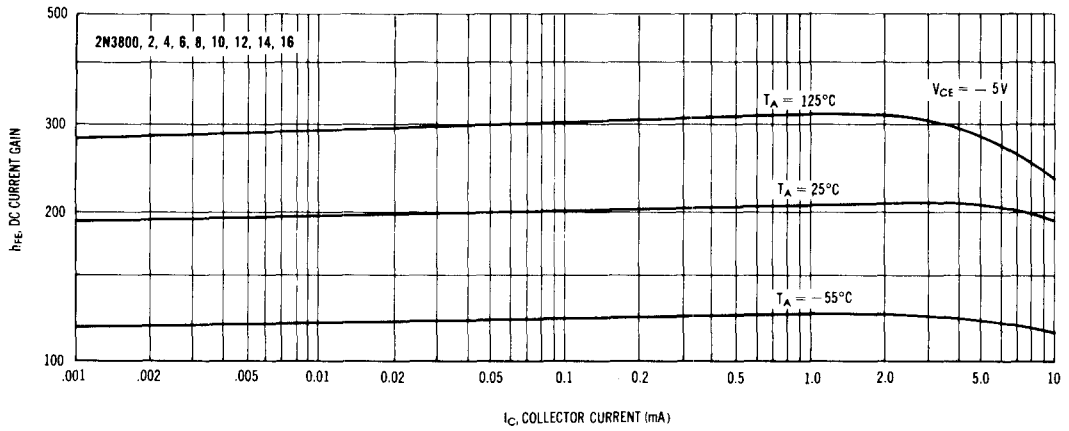


FIGURE 8 — BASE-EMITTER "ON" VOLTAGE versus TEMPERATURE

