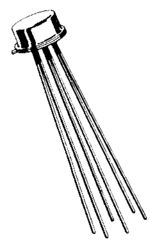
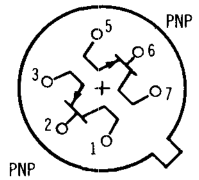
MD2904, A, F, AF
MD2905, A, F, AF

V_{CEO} = 40-60 V
I_C = 600 mA

Dual PNP silicon annular transistors designed for high-speed switching circuits, DC to VHF amplifier applications and complementary circuitry with NPN MD2218 Seires.

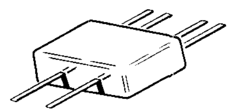


CASE 32



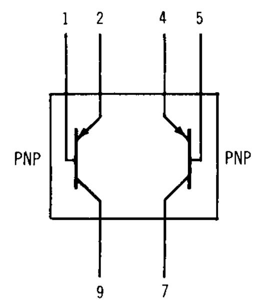
PINS 4 AND 8 OMITTED

Pin Connections, Bottom View



CASE 33
MD2904F, AF
MD2905F, AF

Pin Connections, Bottom View



Lead 1 identified by square impression or dot on underside of case.

All Leads Electrically Isolated from Case

MAXIMUM RATINGS (each side)

Rating	Symbol	Value		Unit
Collector-Emitter Voltage MD2904, MD2904F, MD2905, MD2905F MD2904A, MD2904AF, MD2905A, MD2905AF	V_{CEO}	 40 60		Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5		Vdc
Collector Current	I_C	600		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ T_A = 25°C	P_D			
Metal Can		500	600	mW
Derate above 25°C		2.9	3.4	mW/°C
TO-89 Flat Package		250	350	mW
Derate above 25°C		1.5	2.0	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
Metal Can		1.2	2.0	Watts
Derate above 25°C		6.83	11.43	mW/°C

MD2904, A, F, AF, MD2905, A, F, AF (continued)

ELECTRICAL CHARACTERISTICS (each side) (T_A = 25°C unless otherwise noted)
Characteristics apply also to corresponding flat-package type numbers.

Characteristic		Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	MD2904, MD2905		BV_{CEO}*	40	—	Vdc
	MD2904A, MD2905A			60	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)			BV_{CBO}	60	—	Vdc
Emitter-Base Breakdown Voltage (I_B = 10 μAdc, I_C = 0)			BV_{EBO}	5	—	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3 Vdc)			I_{CEX}	—	0.020	μAdc
(V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3 Vdc, T_A = 150°C)				—	30	
Base Cuttoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 3 Vdc)			I_{BL}	—	0.030	μAdc
ON CHARACTERISTICS						
DC Current Gain* (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD2904	1	h_{FE}*	20	—	—
	MD2905			35	—	
	MD2904A			40	—	
	MD2905A			75	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD2904			25	—	
	MD2905			50	—	
	MD2904A			40	—	
	MD2905A			100	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD2904			35	—	
	MD2905			75	—	
	MD2904A			40	—	
	MD2905A			100	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MD2904, MD2904A			40	120	
	MD2905, MD2905A			100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MD2904			20	—	
	MD2905			30	—	
	MD2904A			40	—	
	MD2905A			50	—	
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)		2, 3, 4	$V_{CE(sat)}$*	—	0.4	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)				—	1.6	
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)		3, 4	$V_{BE(sat)}$*	—	1.3	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)				—	2.6	
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		16	f_T	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		17	C_{ob}	—	8	pF
Input Capacitance (V_{BE} = 2 Vdc, I_C = 0, f = 100 kHz)		17	C_{ib}	—	30	pF

SWITCHING CHARACTERISTICS

Characteristic		Fig. No.	Symbol	Min	Max	Unit
Turn-On-Time	V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc	11, 15	t_{on}	—	45	ns
Delay Time		11, 15	t_d	—	12	ns
Rise Time		11, 15	t_r	—	35	ns
Turn-Off-Time	V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc	15	t_{off}	—	130	ns
Storage Time		13, 15	t_s	—	100	ns
Fall Time		14, 15	t_f	—	40	ns

*Pulse Test: Pulse Width ≤ 300 μs, duty cycle ≤ 2%

MD2904, A, F, AF, MD2905, A, F, AF (continued)

FIGURE 1 — DC CURRENT GAIN

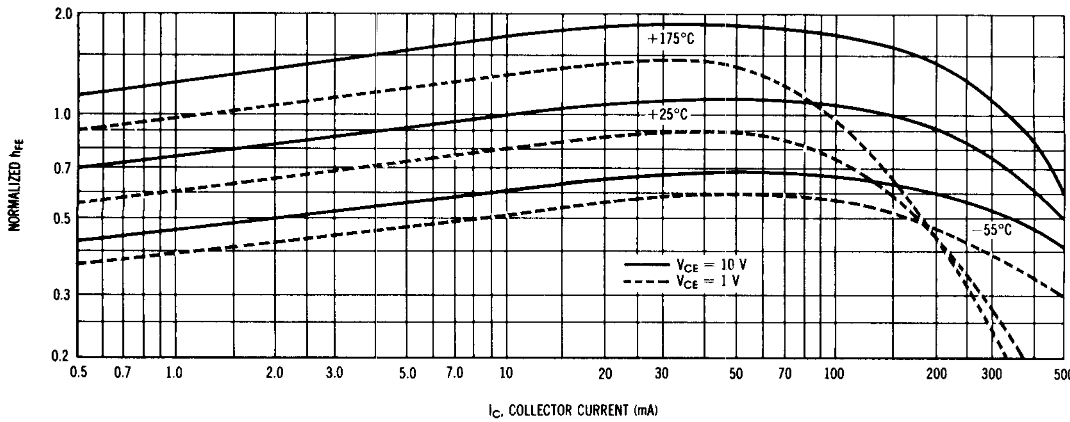
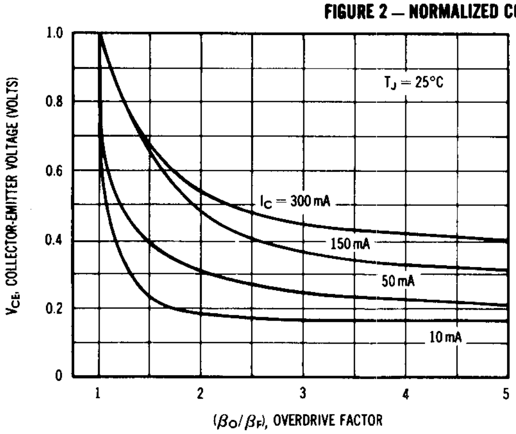


FIGURE 2 — NORMALIZED COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current. β_O (current gain at edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit.

EXAMPLE: For type MD2905, estimate a base current (I_{BF}) to insure saturation at a temperature of 25°C and a collector current of 150 mA.

Observe that at $I_C = 150$ mA an overdrive factor of at least 3 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h_{FE} @ 1 volt is approximately 0.60 of h_{FE} @ 10 volts. Using the guaranteed minimum of 100 @ 150 mA and 10 V, $\beta_O = 60$ and substituting values in the overdrive equation, we find:

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE} \text{ @ } 1\text{ V}}{I_C/I_{BF}} \qquad 3 = \frac{60}{150/I_{BF}} \qquad I_{BF} \approx 7.5 \text{ mA}$$

FIGURE 3 — "ON" VOLTAGES

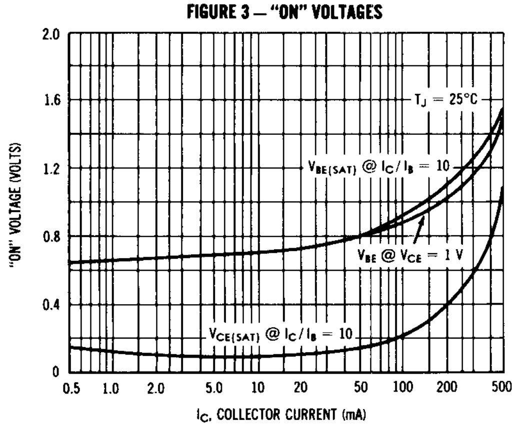
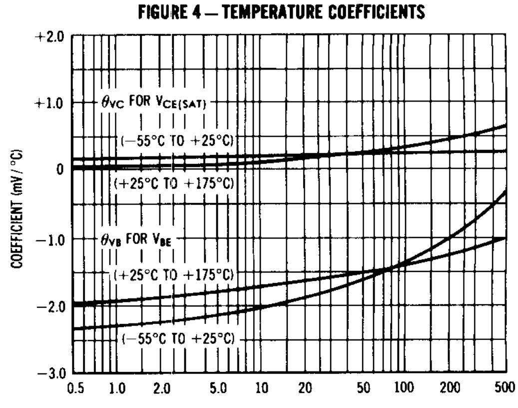


FIGURE 4 — TEMPERATURE COEFFICIENTS



MD2904, A, F, AF, MD2905, A, F, AF (continued)

SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE

$V_{CE} = 10\ V, T_A = 25°C$

FIGURE 5 — FREQUENCY EFFECTS

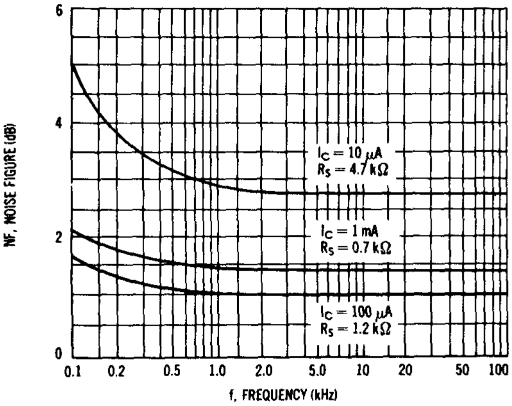
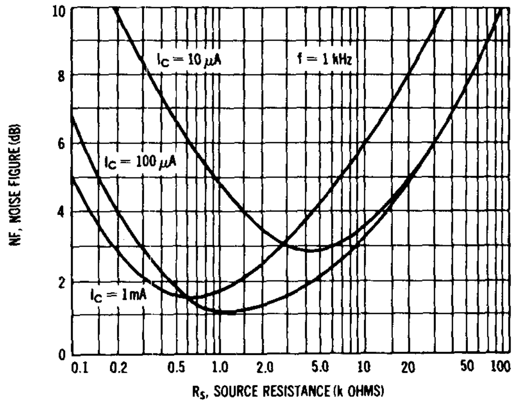


FIGURE 6 — SOURCE RESISTANCE EFFECTS



h PARAMETERS

$V_{CE} = 10\ V, f = 1\ kHz, T_A = 25°C$

FIGURE 7 — INPUT IMPEDANCE

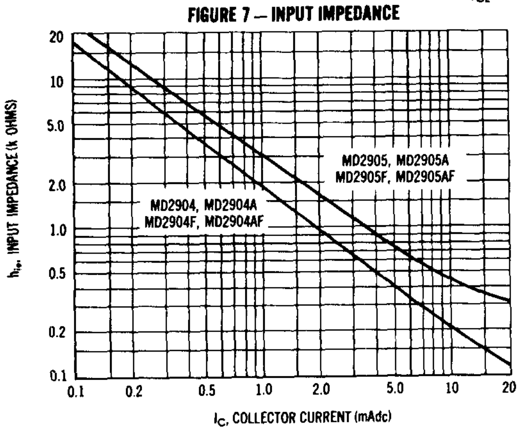


FIGURE 8 — VOLTAGE FEEDBACK RATIO

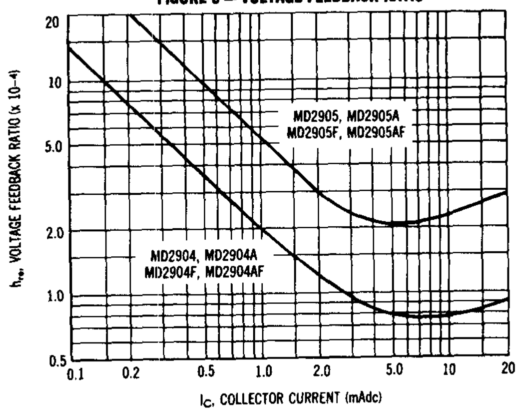


FIGURE 9 — CURRENT GAIN

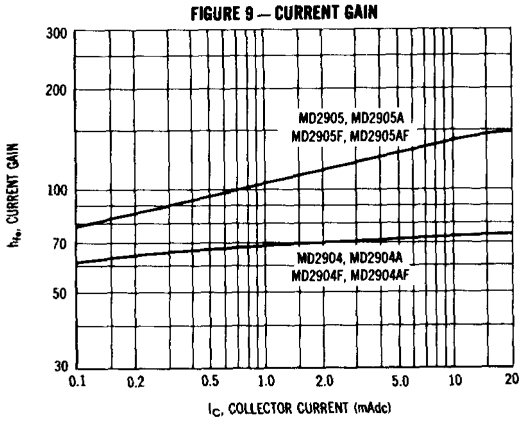
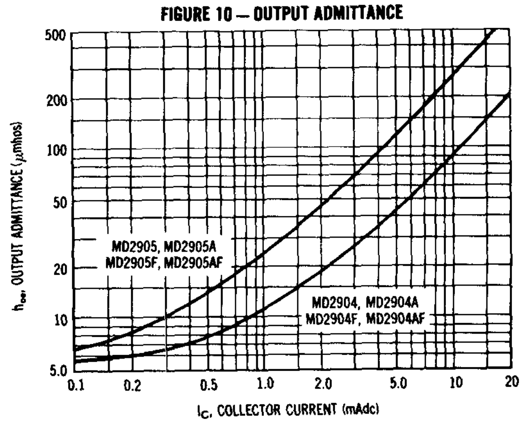


FIGURE 10 — OUTPUT ADMITTANCE



MD2904, A, F, AF, MD2905, A, F, AF (continued)

FIGURE 11 — TURN ON TIME

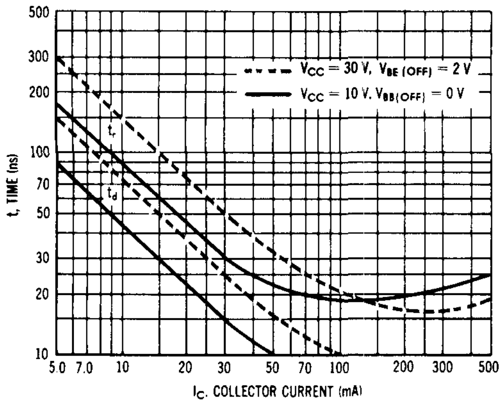


FIGURE 12 — CHARGE DATA

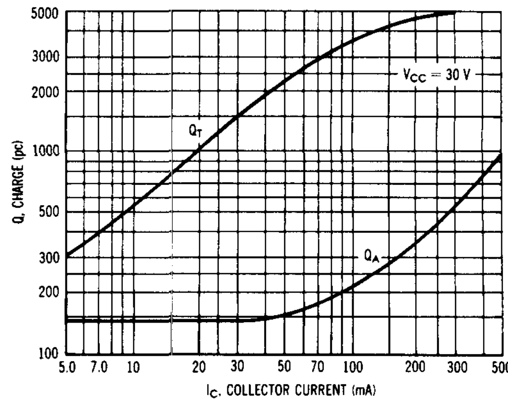


FIGURE 13 — STORAGE TIME

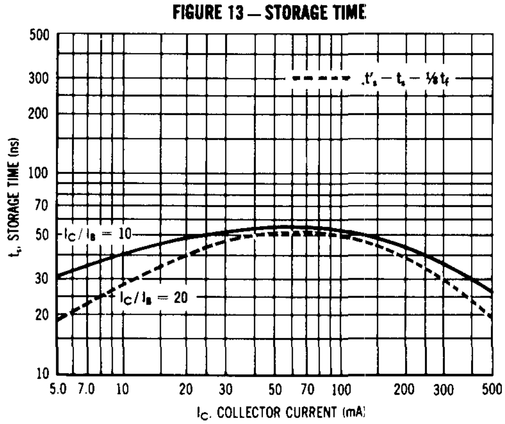


FIGURE 14 — FALL TIME

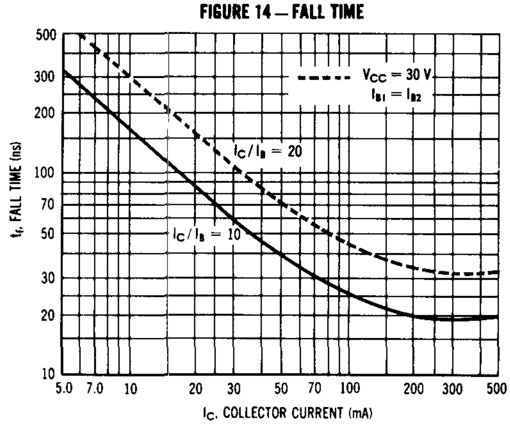
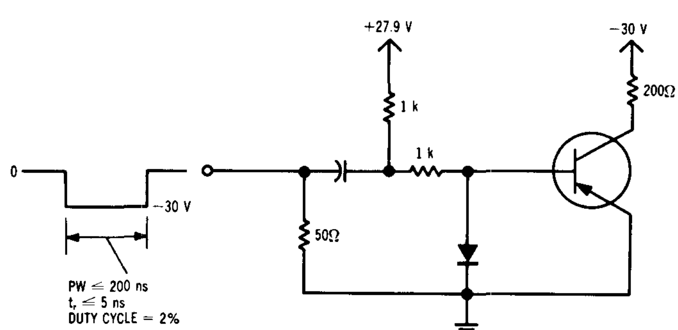


FIGURE 15 - SATURATED SWITCHING TIME TEST CIRCUIT



MD2904, A, F, AF, MD2905, A, F, AF (continued)

FIGURE 16 — CURRENT-GAIN — BANDWIDTH PRODUCT

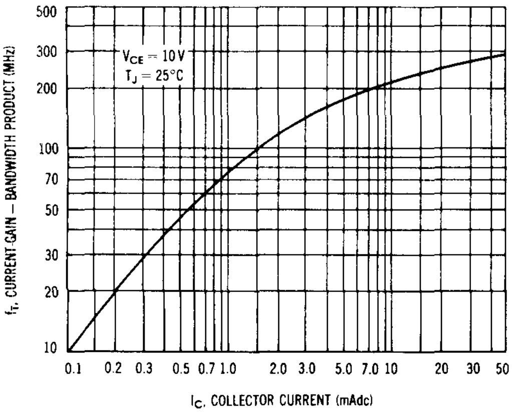


FIGURE 17 — CAPACITANCE

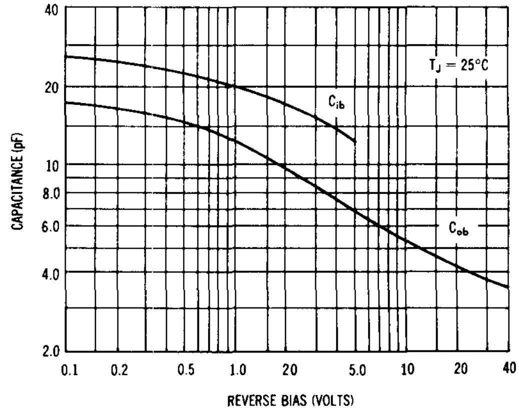


FIGURE 18 — ACTIVE REGION SAFE OPERATING AREAS

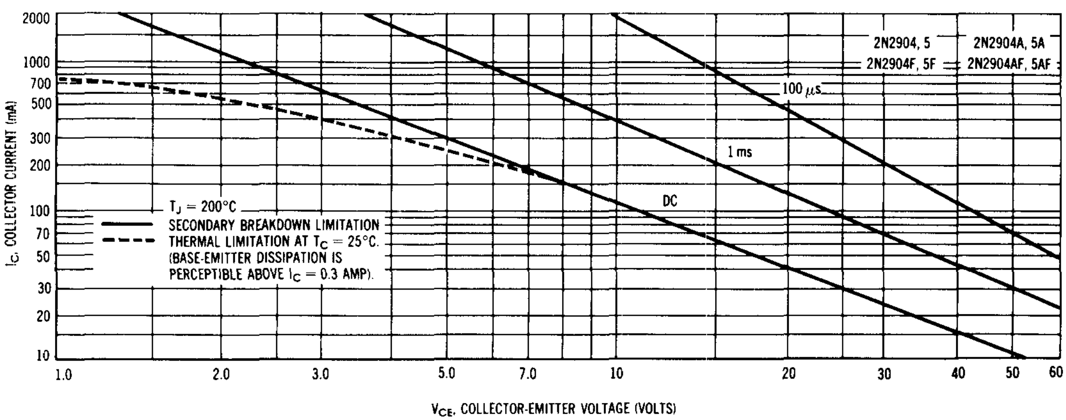
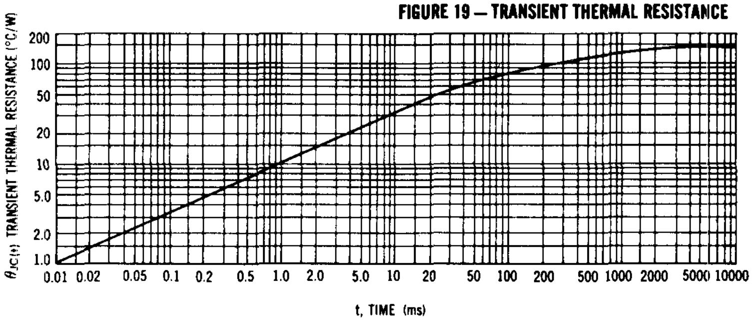


FIGURE 19 — TRANSIENT THERMAL RESISTANCE



The above graph shows the maximum I_C-V_{CE} limits of the device both from the standpoint of thermal dissipation (at 25°C case temperature), and secondary breakdown. For case temperatures other than 25°C, the thermal dissipation curve must be modified in accordance with the derating factor in the Maximum Ratings table.

To avoid possible device failure, the collector load line must fall below the limits indicated by the applicable curve. Thus, for certain operating conditions the device is thermally limited, and for others it is limited by secondary breakdown.

For pulse applications, the maximum I_C-V_{CE} product indicated by the dc thermal limits can be exceeded. Pulse thermal limits may be calculated by using the transient thermal resistance curve of Figure 19.