MD2904, MD2904A (SILICON)
MD2904F, MD2904AF
MD2905, MD2905A
MD2905F, MD2905AF
MQ2904, MQ2905A

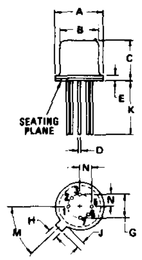
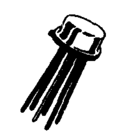
MULTIPLE SILICON ANNULAR TRANSISTORS

. . . designed for use as differential amplifiers, dual general-purpose amplifiers, front end detectors, and temperature compensation amplifiers.

- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)} = 0.4$ Vdc (Max) @ $I_C = 150$ mAdc
- Fast Switching Times – $t_{on} = 45$ ns (Max) and $t_{off} = 130$ ns (Max)
- DC Current Gain Specified – 0.1 mAdc to 500 mAdc
- High Current-Gain–Bandwidth Product – $f_T = 320$ MHz (Typ) @ $I_C = 50$ mAdc

PNP SILICON MULTIPLE TRANSISTORS

MD2904,A
MD2905,A

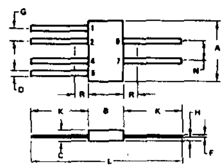



STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. OMITTED
5. EMITTER
6. BASE
7. COLLECTOR
8. OMITTED

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.40	0.335	0.370
B	7.75	8.51	0.305	0.335
C	3.81	4.70	0.150	0.185
D	0.41	0.53	0.016	0.021
G	5.08 BSC		0.200 BSC	
H	0.71	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	–	0.500	–
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	

CASE 654-07

MD2904F,AF
MD2905F,AF

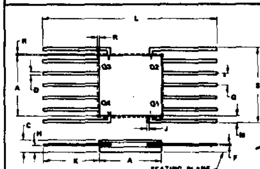
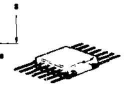



STYLE 1:
PIN 1. BASE
2. EMITTER
4. EMITTER
5. BASE
7. COLLECTOR
9. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.10	7.36	0.240	0.290
B	2.92	4.06	0.115	0.160
C	0.76	2.03	0.030	0.080
D	0.36	0.48	0.014	0.019
F	0.08	0.15	0.003	0.006
G	1.27 BSC		0.050 BSC	
H	–	0.89	–	0.035
K	3.81	–	0.150	–
N	2.54 BSC		0.100 BSC	
R	–	1.27	–	0.050

CASE 610A-03

MQ2904
MQ2905A

STYLE 1
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. NOT CONNECTED
5. EMITTER
6. BASE
7. COLLECTOR
8. COLLECTOR
9. BASE
10. EMITTER
11. NOT CONNECTED
12. EMITTER
13. BASE
14. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.10	6.99	0.240	0.275
C	0.76	2.03	0.030	0.080
D	0.25	0.48	0.010	0.019
F	0.08	0.15	0.003	0.006
G	1.27 BSC		0.050 BSC	
H	0.13	0.89	0.005	0.035
J	–	0.38	–	0.015
K	6.35	–	0.250	–
L	18.80	–	0.740	–
N	0.25	–	0.010	–
R	–	0.38	–	0.015
S	7.62	8.38	0.300	0.330

CASE 607-04

MAXIMUM RATINGS

Rating	Symbol	MD2904,F MD2905,F MQ2904	MD2904A,AF MD2905A,AF MQ2905A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous	I_C	600		mAdc
		One Die	All Die Equal Power	
Total Power Dissipation @ $T_A = 25^\circ C$	P_D			mW
MD2904,A, MD2905,A		575	625	
MD2904F,AF, MD2905F,AF		350	400	
MQ2904, MQ2905A		400	600	
Derate above 25°C				mW/°C
MD2904,A, MD2905,A		3.29	3.57	
MD2904,F,AF, MD2905F,AF		2.0	2.28	
MQ2904, MQ2905A		2.28	3.42	
Total Power Dissipation @ $T_C = 25^\circ C$	P_D			Watts
MD2904,A, MD2905,A		1.8	2.5	
MD2904F,AF, MD2905F,AF		1.0	2.0	
MQ2904, MQ2905A		0.9	3.6	
Derate above 25°C				mW/°C
MD2904,A, MD2905,A		10.3	14.3	
MD2904F,AF, MD2905F,AF		5.71	11.4	
MQ2904, MQ2905A		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD2904,A, MD2905,A		304	280	
MD2904F,AF, MD2905F,AF		500	438	
MQ2904, MQ2905A		438	292	
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD2904,A, MD2905,A		97	70	
MD2904F,AF, MD2905F,AF		175	87.5	
MQ2904, MQ2905A		195	48.8	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD2904,A, MD2905,A		84	44	
MD2904F,AF, MD2905F,AF		75	0	
MQ2904, MQ2905A (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

THERMAL COUPLING AND EFFECTIVE THERMAL RESISTANCE

In multiple chip devices, coupling of heat between die occurs. The junction temperature can be calculated as follows:

(1) $\Delta T_{J1} = R_{\theta 1} P_{D1} + R_{\theta 2} K_{\theta 2} P_{D2} + R_{\theta 3} K_{\theta 3} P_{D3} + R_{\theta 4} K_{\theta 4} P_{D4}$

Where ΔT_{J1} is the change in junction temperature of die 1
$R_{\theta 1}$ thru 4 is the thermal resistance of die 1 through 4
P_{D1} thru 4 is the power dissipated in die 1 through 4
$K_{\theta 2}$ thru 4 is the thermal coupling between die 1 and die 2 through 4.

An effective package thermal resistance can be defined as follows:

(2) $R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$

where: P_{DT} is the total package power dissipation.

Assuming equal thermal resistance for each die, equation (1) simplifies to

(3) $\Delta T_{J1} = R_{\theta 1} (P_{D1} + K_{\theta 2} P_{D2} + K_{\theta 3} P_{D3} + K_{\theta 4} P_{D4})$

For the conditions where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4P_D$ equation (3) can be further simplified and by substituting into equation (2) results in

(4) $R_{\theta(EFF)} = R_{\theta 1}(1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4}) /4$

Values for the coupling factors when either the case or the ambient is used as a reference are given in the table on page 1.

ELECTRICAL CHARACTERISTICS ($T_A = 25^oC$ unless otherwise noted.)
(Characteristics apply to corresponding flat package, and quad type number.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (1)		BV_{CEO}				Vdc
(I_C = 10 mAdc, I_B = 0)	MD2904, MD2905		40	–	–	
	MD2904A, MD2905A		60	–	–	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		BV_{CBO}	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		BV_{EBO}	5.0	–	–	Vdc
Collector Cutoff Current		I_{CBO}				μAdc
(V_{CB} = 50 Vdc, I_E = 0)			–	–	0.020	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)			–	–	30	
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	–	–	30	nAdc
ON CHARACTERISTICS (1)						
DC Current Gain		h_{FE}				–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD2904		20	50	–	
	MD2904A		40	70	–	
	MD2905		35	70	–	
	MD2905A		75	150	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD2904		25	75	–	
	MD2904A		40	75	–	
	MD2905		50	100	–	
	MD2905A		100	175	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD2904		35	90	–	
	MD2904A		40	90	–	
	MD2905		75	110	–	
	MD2905A		100	200	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MD2904,A,		40	90	120	
	MD2905,A		100	200	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MD2904		20	60	–	
	MD2904A		40	80	–	
	MD2905		30	130	–	
	MD2905A		50	150	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			–	0.25	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			–	0.5	1.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			–	0.88	1.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			–	1.0	2.6	

(1) Pulse Test: Pulse Width ≤300 μs, Duty Cycle ≤2.0%

ELECTRICAL CHARACTERISTICS (continued)

DYNAMIC CHARACTERISTICS

Current-Gain—Bandwidth Product(1) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	320	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	5.8	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	–	16	30	pF

SWITCHING CHARACTERISTICS

Turn-On Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 12)	t_{on}	–	–	45	ns
Delay Time		t_d	–	–	12	ns
Rise Time		t_r	–	–	35	ns
Turn-Off Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 13)	t_{off}	–	–	130	ns
Storage Time		t_s	–	–	100	ns
Fall Time		t_f	–	–	40	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – DC CURRENT GAIN

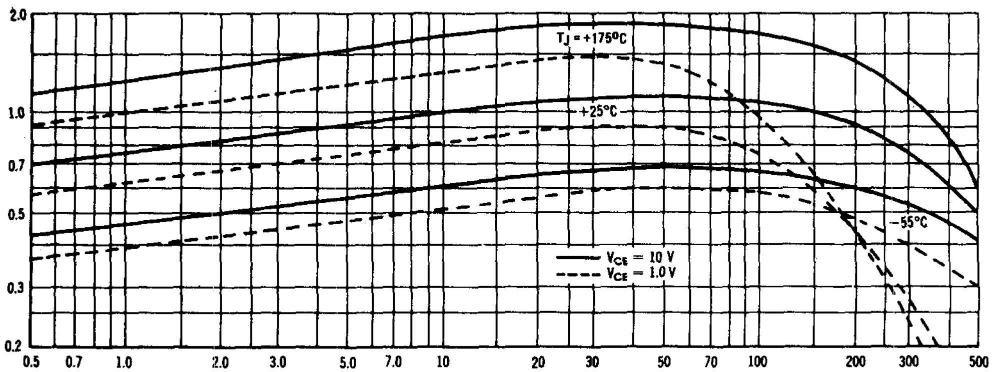


FIGURE 2 — "ON" VOLTAGES

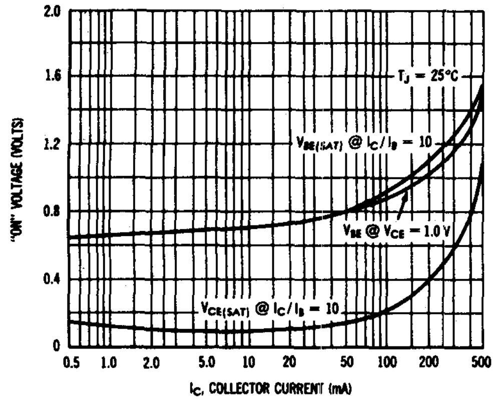
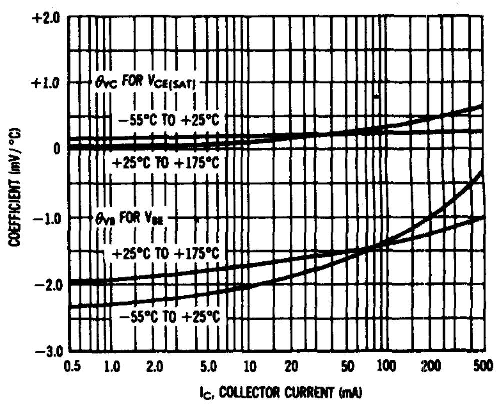


FIGURE 3 — TEMPERATURE COEFFICIENTS



NOISE FIGURE

$V_{CE} = 10$ V, $T_A = 25°C$

FIGURE 4 — FREQUENCY EFFECTS

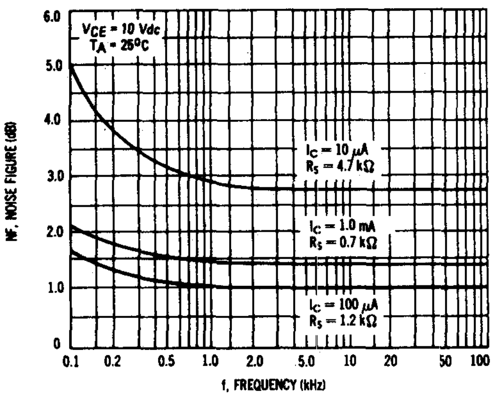


FIGURE 5 — SOURCE RESISTANCE EFFECTS

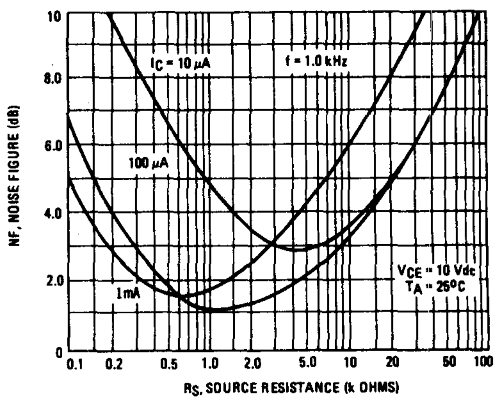


FIGURE 6 — CURRENT-GAIN BANDWIDTH PRODUCT

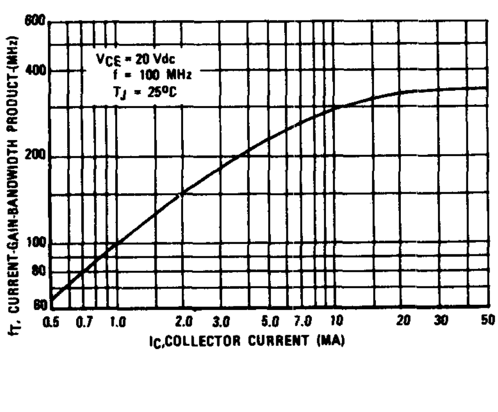


FIGURE 7 — CAPACITANCE

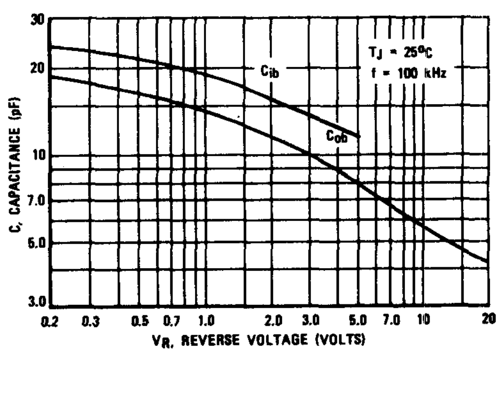


FIGURE 8 — TURN ON TIME

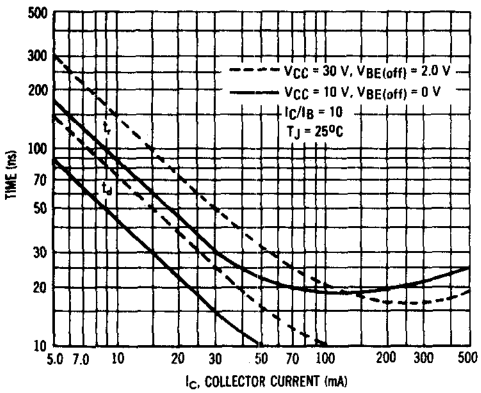


FIGURE 9 — CHARGE DATA

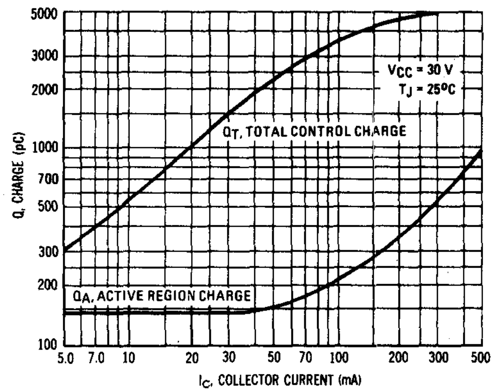


FIGURE 10 — STORAGE TIME

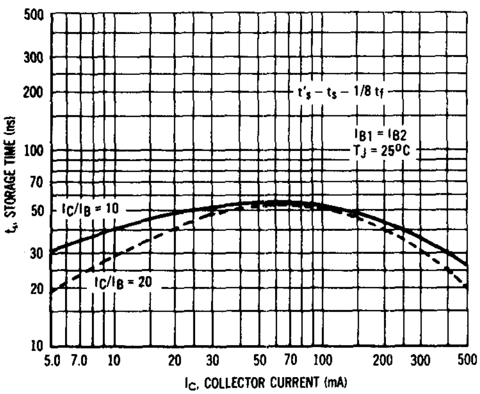


FIGURE 11 — FALL TIME

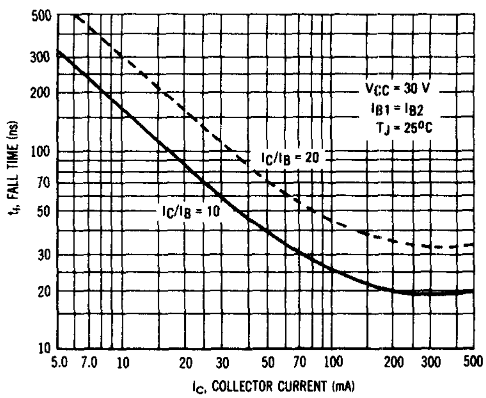


FIGURE 12 — DELAY AND RISE TIME TEST CIRCUIT

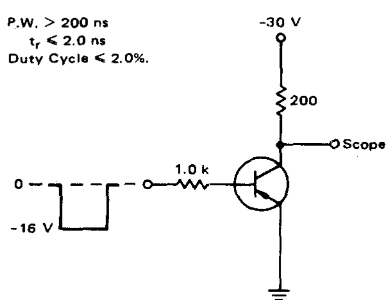


FIGURE 13 — STORAGE AND FALL TIME TEST CIRCUIT