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# MD7003, F (SILICON)
# MD7003A, AF
# MD7003B
# MQ7003

## MULTIPLE SILICON ANNULAR TRANSISTORS

. . . designed for use as high-gain, low-noise differential amplifiers, front end detectors, and temperature compensation applications.

- Low Collector-Emitter Saturation Voltage – $V_{CE(sat)}$ = 0.25 Vdc (Typ) @ $I_C$ = 10 mAdc
- DC Current Gain Specified @ 100 μAdc and 10 mAdc
- High Current-Gain–Bandwidth Product – $f_T$ = 300 MHz (Typ) @ $I_C$ = 5.0 mAdc

**PNP SILICON DUAL TRANSISTORS**

### MAXIMUM RATINGS

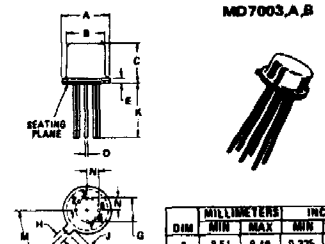
| Rating | Symbol | Value | | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | | Vdc |
| Collector-Base Voltage | $V_{CB}$ | 50 | | Vdc |
| Emitter-Base Voltage | $V_{EB}$ | 5.0 | | Vdc |
| Collector Current – Continuous | $I_C$ | 50 | | mAdc |
| | | One Die | All Die Equal Power | |
| Total Power Dissipation @ $T_A$ = 25°C | $P_D$ | | | mW |
| MD7003,A,B | | 550 | 600 | |
| MD7003F,AF | | 350 | 400 | |
| MQ7003 | | 400 | 600 | |
| Derate above 25°C | | | | mW/°C |
| MD7003,A,B | | 3.14 | 3.42 | |
| MD7003F,AF | | 2.0 | 2.28 | |
| MQ7003 | | 2.28 | 3.42 | |
| Total Power Dissipation @ $T_C$ = 25°C | $P_D$ | | | Watts |
| MD7003,A,B | | 1.4 | 2.0 | |
| MD7003F,AF | | 0.7 | 1.4 | |
| MQ7003 | | 0.7 | 2.8 | |
| Derate above 25°C | | | | mW/°C |
| MD7003,A,B | | 8.0 | 11.4 | |
| MD7003F,AF | | 4.0 | 8.0 | |
| MQ7003 | | 4.0 | 16 | |
| 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 |
| MD7003,A,B | | 319 | 292 | |
| MD7003F,AF | | 500 | 438 | |
| MQ7003 | | 438 | 292 | |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | | | °C/W |
| MD7003,A,B | | 125 | 87.5 | |
| MD7003F,AF | | 250 | 125 | |
| MQ7003 | | 250 | 62.6 | |
| | | Junction to Ambient | Junction to Case | |
| Coupling Factor | | | | % |
| MD7003,A,B | | 83 | 40 | |
| MD7003F,AF | | 75 | 0 | |
| MQ7003 (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.

**MD7003,A,B**

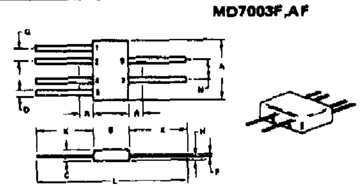



STYLE 1
PIN 1 COLLECTOR
2 BASE
3 EMITTER
4 OMITTED
5. EMITTER
6. BASE
7 COLLECTOR
8. OMITTED

| 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

**MD7003F,AF**

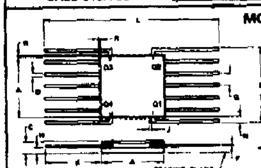



STYLE 1
PIN 1. BASE
2. EMITTER
4. EMITTER
5. BASE
7. COLLECTOR
8. COLLECTOR

| 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

**MQ7003**




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 | – |
| M | 0.25 | – | 0.010 | – |
| R | – | 0.38 | – | 0.015 |
| S | 7.62 | 8.38 | 0.300 | 0.330 |

CASE 607-04

### 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 $\Delta T_{J1}$ 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 dissipation 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. If significant power is to be dissipated in two die, die at the opposite ends of the package should be used so that lowest possible junction temperatures will result.

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Breakdown Voltage (1) ($I_C$ = 10 μAdc, $I_B$ = 0) | $BV_{CEO}$ | 40 | – | – | Vdc |
| Collector-Base Breakdown Voltage ($I_C$ = 10 μAdc, $I_E$ = 0) | $BV_{CBO}$ | 50 | – | – | Vdc |
| Emitter-Base Breakdown Voltage ($I_E$ = 10 μAdc, $I_C$ = 0) | $BV_{EBO}$ | 5.0 | – | – | Vdc |
| Collector Cutoff Current ($V_{CB}$ = 30 Vdc, $I_E$ = 0) | $I_{CBO}$ | – | – | 100 | nAdc |
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain (1) | $h_{FE}$ | | | | – |
| ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc) | | 40 | 350 | – | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc) | | 50 | 350 | – | |
| Collector-Emitter Saturation Voltage ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | $V_{CE(sat)}$ | – | 0.25 | 0.35 | Vdc |
| Base-Emitter Saturation Voltage ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | $V_{BE(sat)}$ | – | 0.6 | 1.0 | Vdc |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Current-Gain—Bandwidth Product ($I_C$ = 5.0 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | $f_T$ | 200 | 300 | – | MHz |
| Output Capacitance ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 100 kHz) | $C_{ob}$ | – | 3.0 | 6.0 | pF |
| Input Capacitance ($V_{BE}$ = 2.0 Vdc, $I_C$ = 0, f = 100 kHz) | $C_{ib}$ | – | 2.0 | 8.0 | pF |
| Noise Figure ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc, $R_S$ = 3.0 k Ohms, f = 10 Hz to 15.7 kHz) | NF | – | 2.0 | – | dB |
| **MATCHING CHARACTERISTICS** | | | | | |
| DC Current Gain Ratio (2) ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc) MD7003A,AF | $h_{FE1}/h_{FE2}$ | 0.75 | – | 1.0 | – |
| MD7003B | | 0.85 | – | 1.0 | |
| Base-Emitter Voltage Differential ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc) MD7003A,AF | $\lvert V_{BE1}-V_{BE2} \rvert$ | – | – | 25 | mV |
| MD7003B | | – | – | 15 | |

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) The lowest $h_{FE}$ reading is taken as $h_{FE1}$ for this ratio.