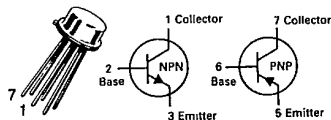


# MD986

CASE 654-07, STYLE 5

## MAXIMUM RATINGS

| Rating                                                                                    | Symbol         | Value       | Unit                          |
|-------------------------------------------------------------------------------------------|----------------|-------------|-------------------------------|
| Collector-Emitter Voltage                                                                 | $V_{CEO}$      | 15          | Vdc                           |
| Collector-Base Voltage                                                                    | $V_{CBO}$      | 40          | Vdc                           |
| Emitter-Base Voltage                                                                      | $V_{EBO}$      | 5.0         | Vdc                           |
| Collector Current — Continuous                                                            | $I_C$          | 200         | mA                            |
|                                                                                           |                | One Die     | Both Die<br>Equal Power       |
| Total Device Dissipation<br>@ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 550<br>3.14 | 600<br>3.42<br>mW<br>mW/°C    |
| Total Device Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 1.4<br>8.0  | 2.0<br>11.4<br>Watts<br>mW/°C |
| Operating and Storage Junction<br>Temperature Range                                       | $T_J, T_{stg}$ | -65 to +200 | °C                            |



**COMPLEMENTARY DUAL  
GENERAL PURPOSE TRANSISTOR**  
NPN/PNP SILICON

## THERMAL CHARACTERISTICS

| Characteristic                          | Symbol             | One Die                | Both Die<br>Equal Power | Unit |
|-----------------------------------------|--------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case    | $R_{\theta JC}$    | 125                    | 87.5                    | °C/W |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}(1)$ | 319                    | 292                     | °C/W |
|                                         |                    | Junction to<br>Ambient | Junction to<br>Case     |      |
| Coupling Factors                        |                    | 83                     | 40                      | %    |

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

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

| Characteristic                                                                                                                              | Symbol        | Min | Typ | Max      | Unit                |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----|-----|----------|---------------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                  |               |     |     |          |                     |
| Collector-Emitter Breakdown Voltage(2) ( $I_C = 10 \text{ mA}$ , $I_E = 0$ )                                                                | $V_{(BR)CEO}$ | 15  | —   | —        | Vdc                 |
| Collector-Base Breakdown Voltage ( $I_C = 10 \mu\text{A}$ , $I_E = 0$ )                                                                     | $V_{(BR)CBO}$ | 40  | —   | —        | Vdc                 |
| Emitter-Base Breakdown Voltage ( $I_E = 10 \mu\text{A}$ , $I_C = 0$ )                                                                       | $V_{(BR)EBO}$ | 5.0 | —   | —        | Vdc                 |
| Collector Cutoff Current ( $V_{CB} = 20 \text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 20 \text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ ) | $I_{CBO}$     | —   | —   | 25<br>30 | nA<br>$\mu\text{A}$ |

## ON CHARACTERISTICS

|                                                                                                                                                 |               |        |        |            |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------|--------|------------|-----|
| DC Current Gain<br>( $I_C = 10 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ )                                                                        | $h_{FE}$      | 25     | —      | —          | —   |
| Collector-Emitter Saturation Voltage<br>( $I_C = 10 \text{ mA}$ , $I_E = 1.0 \text{ mA}$ )<br>( $I_C = 50 \text{ mA}$ , $I_E = 10 \text{ mA}$ ) | $V_{CE(sat)}$ | —<br>— | —<br>— | 0.3<br>0.5 | Vdc |
| Base-Emitter Saturation Voltage<br>( $I_C = 10 \text{ mA}$ , $I_E = 1.0 \text{ mA}$ )                                                           | $V_{BE(sat)}$ | —      | —      | 0.9        | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|                                                                                                                   |           |     |     |     |     |
|-------------------------------------------------------------------------------------------------------------------|-----------|-----|-----|-----|-----|
| Current-Gain — Bandwidth Product<br>( $I_C = 20 \text{ mA}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ ) | $f_T$     | 200 | 320 | —   | MHz |
| Output Capacitance<br>( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 100 \text{ kHz}$ )                           | $C_{obo}$ | —   | —   | 4.0 | pF  |

(2) Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

# **MAXIMUM RATINGS**

| Rating                                                                                                            | Symbol                            | Value                | Unit                          |
|-------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------|-------------------------------|
| Collector-Emitter Voltage                                                                                         | V <sub>CEO</sub>                  | 30                   | V <sub>dc</sub>               |
| Collector-Base Voltage                                                                                            | V <sub>CBO</sub>                  | 60                   | V <sub>dc</sub>               |
| Emitter-Base Voltage                                                                                              | V <sub>EBO</sub>                  | 5.0                  | V <sub>dc</sub>               |
| Collector Current — Continuous                                                                                    | I <sub>C</sub>                    | 500                  | mAdc                          |
|                                                                                                                   |                                   | One Die              | All Die Equal Power           |
| Total Device Dissipation @ T <sub>A</sub> = 25°C<br>MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120         | P <sub>D</sub>                    | 575<br>350<br>400    | 625<br>400<br>600<br>mW       |
| Derate above 25°C<br>MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120                                        |                                   | 3.29<br>2.0<br>2.28  | 3.57<br>2.28<br>3.42<br>mW/°C |
| Total Device Dissipation @ T <sub>C</sub> = 25°C<br>MD1120, MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120 | P <sub>D</sub>                    | 1.8<br>1.0<br>0.9    | 2.5<br>2.0<br>3.6<br>Watts    |
| Derate above 25°C<br>MD1120, MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120                                |                                   | 10.3<br>5.71<br>5.13 | 14.3<br>11.4<br>20.5<br>mW/°C |
| Operating and Storage Junction Temperature Range                                                                  | T <sub>J</sub> , T <sub>stg</sub> | -65 to +200          | °C                            |

## **THERMAL CHARACTERISTICS**

| Characteristic                                                                                        | Symbol               | One Die              | All Die Equal Power | Unit |
|-------------------------------------------------------------------------------------------------------|----------------------|----------------------|---------------------|------|
| Thermal Resistance, Junction to Case<br>MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120         | R <sub>θJC</sub>     | 97<br>175<br>195     | 70<br>87.5<br>48.8  | °C/W |
| Thermal Resistance, Junction to Ambient<br>MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120      | R <sub>θJA</sub> (1) | 304<br>500<br>438    | 280<br>438<br>292   | °C/W |
|                                                                                                       |                      | Junction to Ambient  | Junction to Case    | Unit |
| Coupling Factors<br>MD1121, MD1122<br>MD1120F, MD1121F, MD1122F<br>MQ1120 (Q1-Q2)<br>(Q1-Q3 or Q1-Q4) |                      | 84<br>75<br>57<br>55 | 44<br>0<br>0<br>0   | %    |

(1) R<sub>θJA</sub> is measured with the device soldered into a typical printed circuit board.

## **ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted.)**

| Characteristic                                                                                                                                       | Symbol               | Min | Typ | Max      | Unit            |
|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----|-----|----------|-----------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                           |                      |     |     |          |                 |
| Collector-Emitter Breakdown Voltage(2)<br>(I <sub>C</sub> = 10 mAdc, I <sub>B</sub> = 0)                                                             | V <sub>(BR)CEO</sub> | 30  | —   | —        | V <sub>dc</sub> |
| Collector-Base Breakdown Voltage<br>(I <sub>C</sub> = 10 μAdc, I <sub>E</sub> = 0)                                                                   | V <sub>(BR)CBO</sub> | 60  | —   | —        | V <sub>dc</sub> |
| Emitter-Base Breakdown Voltage<br>(I <sub>E</sub> = 10 μAdc, I <sub>C</sub> = 0)                                                                     | V <sub>(BR)EBO</sub> | 5.0 | —   | —        | V <sub>dc</sub> |
| Collector Cutoff Current<br>(V <sub>CB</sub> = 50 Vdc, I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 50 Vdc, I <sub>E</sub> = 0, T <sub>A</sub> = 150°C) | I <sub>CBO</sub>     | —   | —   | 10<br>10 | nAdc<br>μAdc    |
| Emitter Cutoff Current<br>(V <sub>EB</sub> = 3.0 Vdc, I <sub>C</sub> = 0)                                                                            | I <sub>EBO</sub>     | —   | —   | 10       | nAdc            |

**MD1120F  
MD1121,F  
MD1122,F  
MQ1120**

**MD1121, MD1122  
CASE 654-07, STYLE 1**



**MD1120F  
CASE 610A-04, STYLE 1**



**MQ1120  
CASE 607-04, STYLE 1**



**DUAL  
AMPLIFIER TRANSISTOR  
NPN SILICON**

Refer to MD2218,A for graphs.

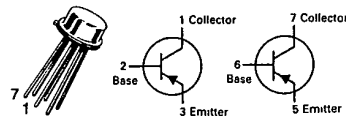
**ELECTRICAL CHARACTERISTICS** (continued) ( $T_A = 25^\circ\text{C}$  unless otherwise noted.)

| Characteristic                                                                                                                                                                                                                                                                         | Symbol                      | Min                  | Typ                  | Max                      | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------------------|----------------------|--------------------------|------|
| <b>ON CHARACTERISTICS</b>                                                                                                                                                                                                                                                              |                             |                      |                      |                          |      |
| DC Current Gain(2)<br>( $I_C = 10\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ )<br>( $I_C = 100\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ )<br>( $I_C = 1.0\ \text{mAdc}$ , $V_{CE} = 10\ \text{Vdc}$ )<br>( $I_C = 10\ \text{mAdc}$ , $V_{CE} = 10\ \text{Vdc}$ )                   | $h_{FE}$                    | 20<br>30<br>40<br>50 | 40<br>50<br>60<br>65 | 100<br>120<br>160<br>200 | —    |
| Collector-Emitter Saturation Voltage<br>( $I_C = 10\ \text{mAdc}$ , $I_B = 1.0\ \text{mAdc}$ )                                                                                                                                                                                         | $V_{CE(sat)}$               | —                    | 80                   | 100                      | mVdc |
| Base-Emitter Saturation Voltage<br>( $I_C = 10\ \text{mAdc}$ , $I_B = 1.0\ \text{mAdc}$ )                                                                                                                                                                                              | $V_{BE(sat)}$               | —                    | 700                  | 850                      | mVdc |
| <b>SMALL-SIGNAL CHARACTERISTICS</b>                                                                                                                                                                                                                                                    |                             |                      |                      |                          |      |
| Current-Gain — Bandwidth Product(2)<br>( $I_C = 20\ \text{mAdc}$ , $V_{CE} = 20\ \text{Vdc}$ , $f = 100\ \text{MHz}$ )                                                                                                                                                                 | $f_T$                       | 200                  | 250                  | —                        | MHz  |
| Output Capacitance<br>( $V_{CB} = 10\ \text{Vdc}$ , $I_E = 0$ , $f = 100\ \text{kHz}$ )                                                                                                                                                                                                | $C_{obo}$                   | —                    | 3.5                  | 8.0                      | pF   |
| <b>MATCHING CHARACTERISTICS</b>                                                                                                                                                                                                                                                        |                             |                      |                      |                          |      |
| DC Current Gain Ratio(3)<br>( $I_C = 100\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ ) All Devices<br>( $I_C = 1.0\ \text{mAdc}$ , $V_{CE} = 10\ \text{Vdc}$ ) MD1122, MD1122F                                                                                                         | $h_{FE1}/h_{FE2}$           | 0.8<br>0.9           | —<br>—               | 1.0<br>1.0               | —    |
| Base-Emitter Voltage Differential<br>( $I_C = 100\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ ) All Devices<br>( $I_C = 1.0\ \text{mAdc}$ , $V_{CE} = 10\ \text{Vdc}$ ) MD1122, MD1122F                                                                                                | $ V_{BE1} - V_{BE2} $       | —<br>—               | —<br>—               | 10<br>5.0                | mVdc |
| Base-Emitter Voltage Differential Change<br>Due to Temperature — MD1121, MD1122<br>( $I_C = 100\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ , $T_A = -55$ to $+25^\circ\text{C}$ )<br>( $I_C = 100\ \mu\text{Adc}$ , $V_{CE} = 10\ \text{Vdc}$ , $T_A = +25$ to $+125^\circ\text{C}$ ) | $\Delta(V_{BE1} - V_{BE2})$ | —<br>—               | —<br>—               | 0.8<br>1.0               | mVdc |

(2) Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .(3) The lowest  $h_{FE}$  reading is taken as  $h_{FE1}$  for this ratio.

# MD1123 MD1130

CASE 654-07, STYLE 1



## DUAL AMPLIFIER TRANSISTOR

PNP SILICON

### MAXIMUM RATINGS

| Rating                                                                                    | Symbol         | Value         |             | Unit                          |
|-------------------------------------------------------------------------------------------|----------------|---------------|-------------|-------------------------------|
| Collector-Emitter Voltage                                                                 | $V_{CEO}$      | 40            |             | Vdc                           |
| Collector-Base Voltage                                                                    | $V_{CBO}$      | 60            |             | Vdc                           |
| Emitter-Base Voltage                                                                      | $V_{EBO}$      | 5.0           |             | Vdc                           |
| Collector Current — Continuous                                                            | $I_C$          | 200           |             | mAdc                          |
|                                                                                           |                | One Die       | All Die     |                               |
| Total Device Dissipation<br>@ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 575<br>3.29   | 625<br>3.57 | mW<br>mW/ $^\circ\text{C}$    |
| Total Device Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 1.8<br>10.3   | 2.5<br>14.3 | Watts<br>mW/ $^\circ\text{C}$ |
| Operating and Storage Junction<br>Temperature Range                                       | $T_J, T_{stg}$ | - 65 to + 200 |             | $^\circ\text{C}$              |

### THERMAL CHARACTERISTICS

| Characteristic                          | Symbol             | One Die                | All Die<br>Equal Power | Unit               |
|-----------------------------------------|--------------------|------------------------|------------------------|--------------------|
| Thermal Resistance, Junction to Case    | $R_{\theta JC}$    | 97                     | 70                     | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}(1)$ | 304                    | 280                    | $^\circ\text{C/W}$ |
|                                         |                    | Junction to<br>Ambient | Junction to<br>Case    |                    |
| Coupling Factors                        |                    | 84                     | 44                     | %                  |

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

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

| Characteristic                                                                                                                        | Symbol        | Min | Typ | Max      | Unit                    |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------|-----|-----|----------|-------------------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                            |               |     |     |          |                         |
| Collector-Emitter Breakdown Voltage(2)<br>( $I_C = 10 \text{ mAdc}, I_E = 0$ )                                                        | $V_{(BR)CEO}$ | 40  | —   | —        | Vdc                     |
| Collector-Base Breakdown Voltage<br>( $I_C = 10 \mu\text{Adc}, I_E = 0$ )                                                             | $V_{(BR)CBO}$ | 60  | —   | —        | Vdc                     |
| Emitter-Base Breakdown Voltage<br>( $I_E = 10 \mu\text{Adc}, I_C = 0$ )                                                               | $V_{(BR)EBO}$ | 5.0 | —   | —        | Vdc                     |
| Collector Cutoff Current<br>( $V_{CB} = 60 \text{ Vdc}, I_E = 0$ )<br>( $V_{CB} = 60 \text{ Vdc}, I_E = 0, T_A = 150^\circ\text{C}$ ) | $I_{CBO}$     | —   | —   | 10<br>10 | nAdc<br>$\mu\text{Adc}$ |
| Emitter Cutoff Current<br>( $V_{BE} = 3.0 \text{ Vdc}, I_C = 0$ )                                                                     | $I_{EBO}$     | —   | —   | 10       | nAdc                    |

### ON CHARACTERISTICS

| DC Current Gain(2)<br>( $I_C = 10 \mu\text{Adc}, V_{CE} = 10 \text{ Vdc}$ ) | MD1130           | $h_{FE}$ |  | Min | Typ | Max | Unit |
|-----------------------------------------------------------------------------|------------------|----------|--|-----|-----|-----|------|
| ( $I_C = 100 \mu\text{Adc}, V_{CE} = 10 \text{ Vdc}$ )                      | MD1123           |          |  | 60  | 100 | —   | —    |
| ( $I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$ )                       | MD1130           |          |  | 30  | 80  | 120 | —    |
| ( $I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$ )                        | MD1123<br>MD1130 |          |  | 100 | 180 | —   | —    |
|                                                                             |                  |          |  | 50  | 75  | 200 | —    |
|                                                                             |                  |          |  | 100 | 150 | —   | —    |

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

| Characteristic                                                                           | Symbol        | Min | Typ  | Max  | Unit |
|------------------------------------------------------------------------------------------|---------------|-----|------|------|------|
| Collector-Emitter Saturation Voltage<br>( $I_C = 10\text{ mA}$ , $I_B = 1.0\text{ mA}$ ) | $V_{CE(sat)}$ | —   | 0.18 | 0.25 | Vdc  |
| Base-Emitter Saturation Voltage<br>( $I_C = 10\text{ mA}$ , $I_B = 1.0\text{ mA}$ )      | $V_{BE(sat)}$ | —   | 0.8  | 0.9  | Vdc  |

**SMALL-SIGNAL CHARACTERISTICS**

|                                                                                                                |                  |           |            |            |        |     |
|----------------------------------------------------------------------------------------------------------------|------------------|-----------|------------|------------|--------|-----|
| Current-Gain — Bandwidth Product<br>( $I_C = 20\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ ) | MD1123<br>MD1130 | $f_T$     | 250<br>200 | 600<br>550 | —<br>— | MHz |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 100\text{ kHz}$ )                          |                  | $C_{obo}$ | —          | 3.5        | 4.0    | pF  |

**MATCHING CHARACTERISTICS**

|                                                                                                                                                                                             |                  |                           |            |        |            |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------|------------|--------|------------|------|
| DC Current Gain Ratio(3)<br>( $I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 10\text{ Vdc}$ )                                                                                                   | MD1123<br>MD1130 | $h_{FE1}/h_{FE2}$         | 0.8<br>0.9 | —<br>— | 1.0<br>1.0 | —    |
| Base-Emitter Voltage Differential<br>( $I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )                                  | MD1123<br>MD1130 | $ V_{BE1} - V_{BE2} $     | —<br>—     | —<br>— | 10<br>5.0  | mVdc |
| Base-Emitter Voltage Differential Change<br>Due to Temperature — MD1121, MD1122<br>( $I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 10\text{ Vdc}$ , $T_A = +25\text{ to }+125^\circ\text{C}$ ) | MD1130           | $\Delta V_{BE1}/V_{BE2} $ | —          | —      | 10         | mVdc |

(2) Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .(3) The lowest  $h_{FE}$  reading is taken as  $h_{FE1}$  for this ratio.