

## Complementary Silicon High-Power Transistors

... PowerBase complementary transistors designed for high power audio, stepping motor and other linear applications. These devices can also be used in power switching circuits such as relay or solenoid drivers, dc-to-dc converters, inverters, or for inductive loads requiring higher safe operating area than the 2N3055 and MJ2955.

- Current-Gain — Bandwidth-Product @  $I_C = 1.0 \text{ Adc}$   
 $f_T = 0.8 \text{ MHz (Min) — NPN}$   
 $= 2.2 \text{ MHz (Min) — PNP}$
- Safe Operating Area — Rated to 60 V and 120 V, Respectively

### \*MAXIMUM RATINGS

| Rating                                                                                 | Symbol         | 2N3055A<br>MJ2955A | MJ15015<br>MJ15016 | Unit                         |
|----------------------------------------------------------------------------------------|----------------|--------------------|--------------------|------------------------------|
| Collector-Emitter Voltage                                                              | $V_{CEO}$      | 60                 | 120                | Vdc                          |
| Collector-Base Voltage                                                                 | $V_{CBO}$      | 100                | 200                | Vdc                          |
| Collector-Emitter Voltage Base Reversed Biased                                         | $V_{CEV}$      | 100                | 200                | Vdc                          |
| Emitter-Base Voltage                                                                   | $V_{EBO}$      | 7.0                |                    | Vdc                          |
| Collector Current — Continuous                                                         | $I_C$          | 15                 |                    | Adc                          |
| Base Current                                                                           | $I_B$          | 7.0                |                    | Adc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 115<br>0.65        | 180<br>1.03        | Watts<br>W/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range                                       | $T_J, T_{stg}$ | -65 to +200        |                    | $^\circ\text{C}$             |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max  | Max  | Unit               |
|--------------------------------------|-----------------|------|------|--------------------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.52 | 0.98 | $^\circ\text{C/W}$ |

\* Indicates JEDEC Registered Data. (2N3055A)

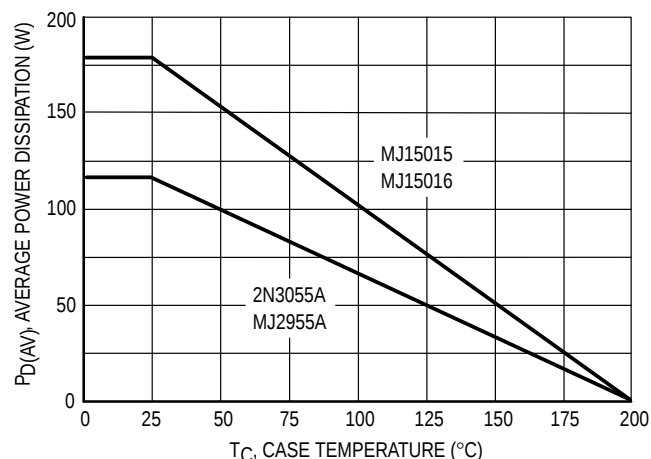


Figure 1. Power Derating

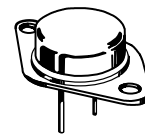
Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

**NPN**  
**2N3055A**  
  
**MJ15015\***  
  
**MJ2955A**  
**PNP**  
**MJ15016\***

\*Motorola Preferred Device

**15 AMPERE**  
**COMPLEMENTARY**  
**SILICON**  
**POWER TRANSISTORS**  
**60, 120 VOLTS**  
**115, 180 WATTS**



**CASE 1-07**  
**TO-204AA**  
**(TO-3)**

## 2N3055A MJ15015 MJ2955A MJ15016

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

| Characteristic                                                                                                                                         |                                      | Symbol         | Min       | Max        | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------|-----------|------------|------|
| <b>OFF CHARACTERISTICS (1)</b>                                                                                                                         |                                      |                |           |            |      |
| *Collector–Emitter Sustaining Voltage<br>( $I_C = 200\text{ mA}$ , $I_B = 0$ )                                                                         | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $V_{CEO(sus)}$ | 60<br>120 | —<br>—     | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $V_{BE(off)} = 0\text{ Vdc}$ )<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{BE(off)} = 0\text{ Vdc}$ ) | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $I_{CEO}$      | —<br>—    | 0.7<br>0.1 | mA   |
| *Collector Cutoff Current<br>( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ )                                                       | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $I_{CEV}$      | —<br>—    | 5.0<br>1.0 | mA   |
| Collector Cutoff Current<br>( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ ,<br>$T_C = 150^\circ\text{C}$ )                         | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $I_{CEV}$      | —<br>—    | 30<br>6.0  | mA   |
| Emitter Cutoff Current<br>( $V_{EB} = 7.0\text{ Vdc}$ , $I_C = 0$ )                                                                                    | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $I_{EBO}$      | —<br>—    | 5.0<br>0.2 | mA   |

### \*SECOND BREAKDOWN

|                                                                                                                                     |                                      |           |             |        |     |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-----------|-------------|--------|-----|
| Second Breakdown Collector Current with Base Forward Biased<br>( $t = 0.5\text{ s}$ non-repetitive)<br>( $V_{CE} = 60\text{ Vdc}$ ) | 2N3055A, MJ2955A<br>MJ15015, MJ15016 | $I_{S/b}$ | 1.95<br>3.0 | —<br>— | Adc |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-----------|-------------|--------|-----|

### \*ON CHARACTERISTICS (1)

|                                                                                                                                                                                                        |  |               |                 |                   |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------|-----------------|-------------------|-----|
| DC Current Gain<br>( $I_C = 4.0\text{ Adc}$ , $V_{CE} = 2.0\text{ Vdc}$ )<br>( $I_C = 4.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )<br>( $I_C = 10\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )           |  | $h_{FE}$      | 10<br>20<br>5.0 | 70<br>70<br>—     | —   |
| Collector–Emitter Saturation Voltage<br>( $I_C = 4.0\text{ Adc}$ , $I_B = 400\text{ mA}$ )<br>( $I_C = 10\text{ Adc}$ , $I_B = 3.3\text{ Adc}$ )<br>( $I_C = 15\text{ Adc}$ , $I_B = 7.0\text{ Adc}$ ) |  | $V_{CE(sat)}$ | —<br>—<br>—     | 1.1<br>3.0<br>5.0 | Vdc |
| Base–Emitter On Voltage<br>( $I_C = 4.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )                                                                                                                      |  | $V_{BE(on)}$  | 0.7             | 1.8               | Vdc |

### \*DYNAMIC CHARACTERISTICS

|                                                                                                                   |                                      |          |            |           |     |
|-------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|------------|-----------|-----|
| Current–Gain — Bandwidth Product<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ , $f = 1.0\text{ MHz}$ ) | 2N3055A, MJ15015<br>MJ2955A, MJ15016 | $f_T$    | 0.8<br>2.2 | 6.0<br>18 | MHz |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )                             |                                      | $C_{ob}$ | 60         | 600       | pF  |

### \*SWITCHING CHARACTERISTICS (2N3055A only)

| RESISTIVE LOAD |                                                                                     |       |   |     |    |
|----------------|-------------------------------------------------------------------------------------|-------|---|-----|----|
| Delay Time     | (VCC = 30 Vdc, IC = 4.0 Adc,<br>IB1 = IB2 = 0.4 Adc,<br>tp = 25 μs Duty Cycle ≤ 2%) | $t_d$ | — | 0.5 | μs |
| Rise Time      |                                                                                     | $t_r$ | — | 4.0 | μs |
| Storage Time   |                                                                                     | $t_s$ | — | 3.0 | μs |
| Fall Time      |                                                                                     | $t_f$ | — | 6.0 | μs |

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

\* Indicates JEDEC Registered Data. (2N3055A)

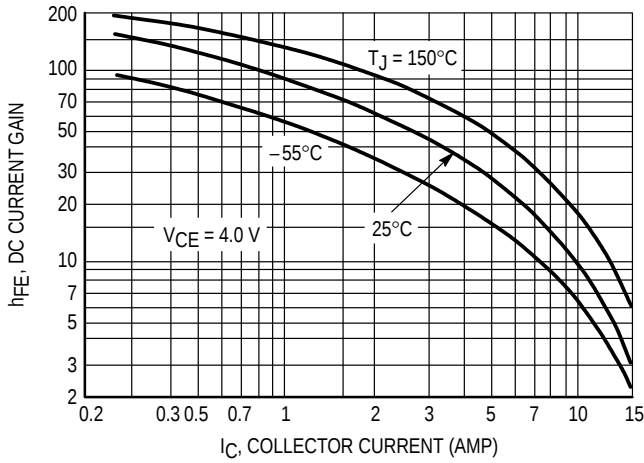


Figure 2. DC Current Gain

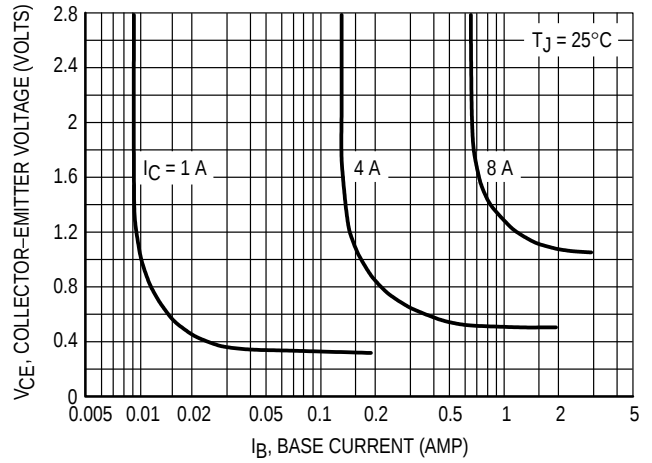


Figure 3. Collector Saturation Region

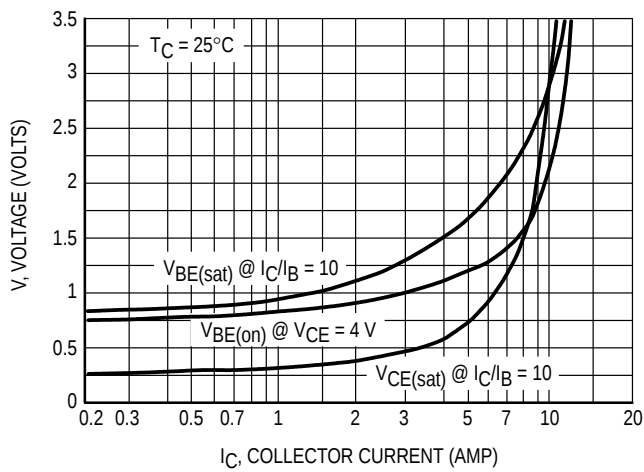


Figure 4. "On" Voltages

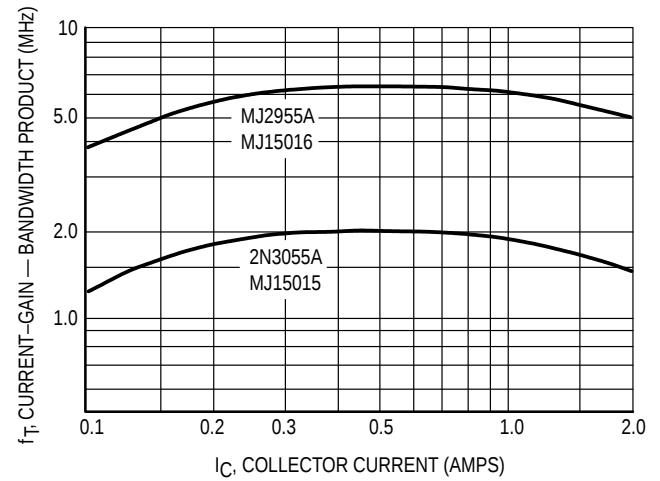


Figure 5. Current-Gain — Bandwidth Product

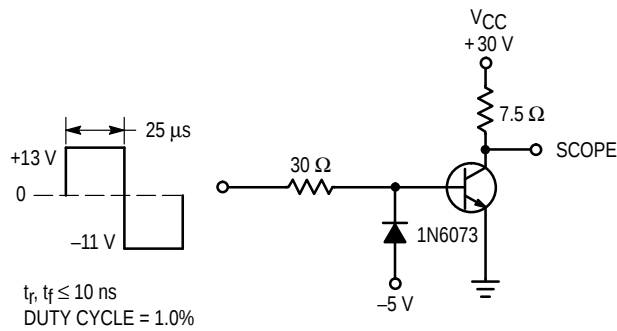


Figure 6. Switching Times Test Circuit  
(Circuit shown is for NPN)

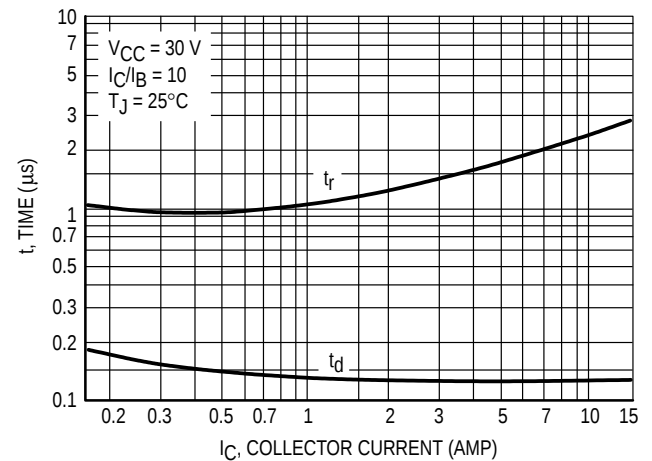


Figure 7. Turn-On Time

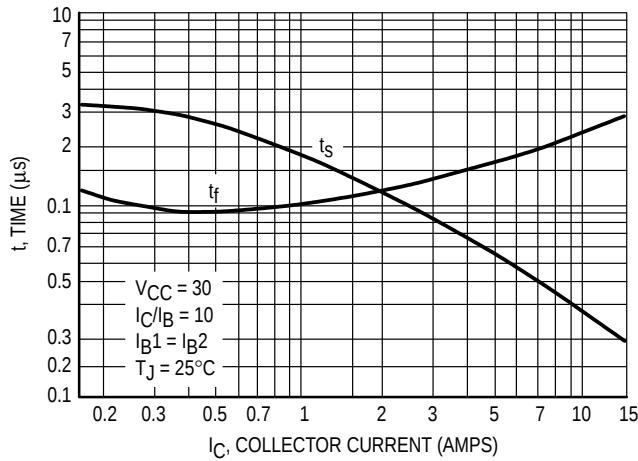


Figure 8. Turn-Off Times

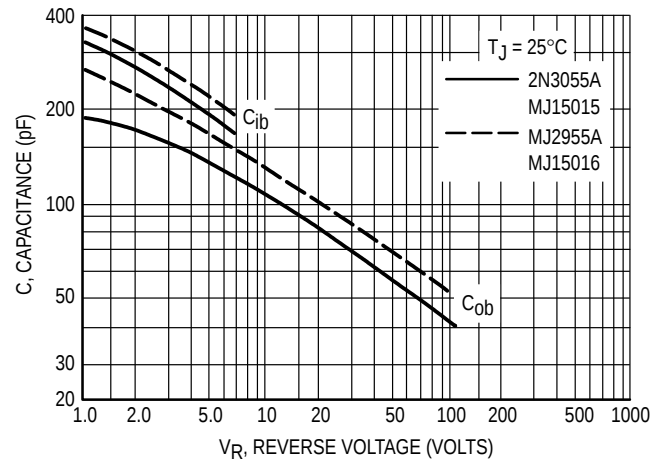


Figure 9. Capacitances

### COLLECTOR CUT-OFF REGION

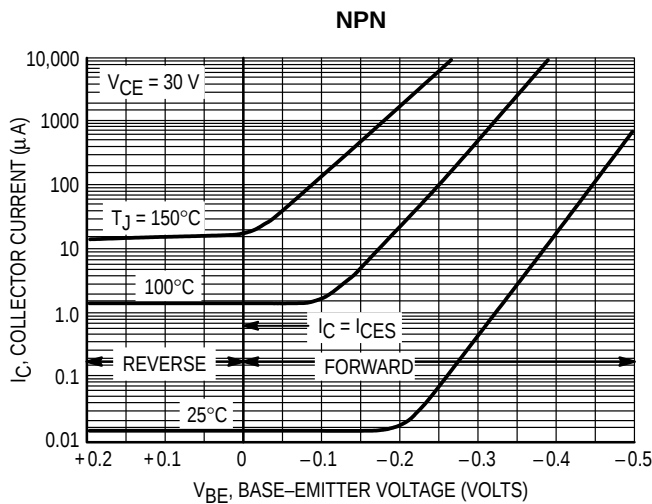


Figure 10. 2N3055A, MJ15015

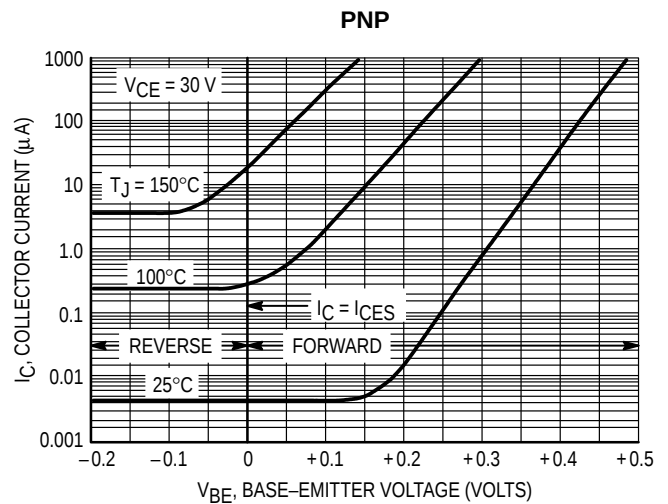


Figure 11. MJ2955A, MJ15016

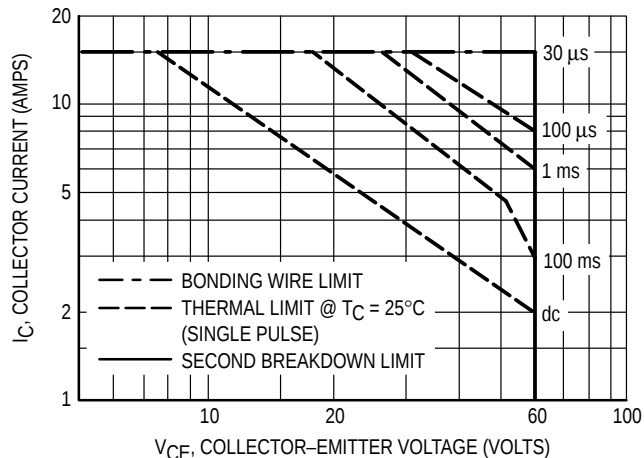


Figure 12. Forward Bias Safe Operating Area  
2N3055A, MJ2955A

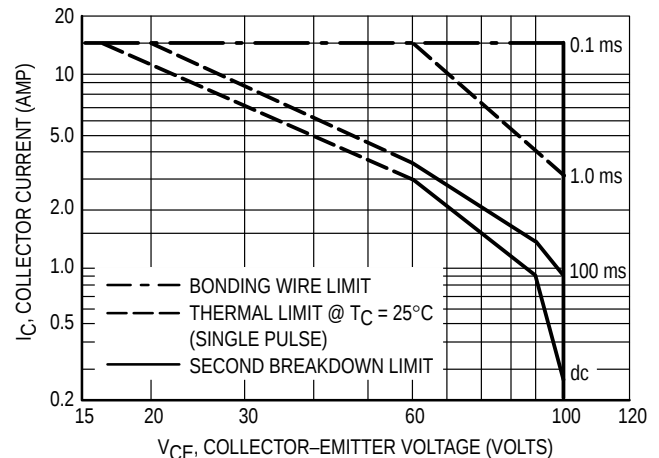


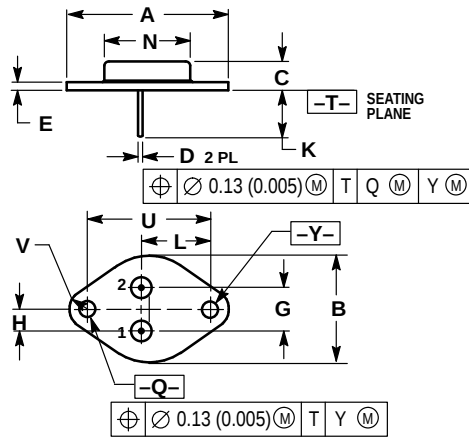
Figure 13. Forward Bias Safe Operating Area  
MJ15015, MJ15016

There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe Operating area curves indicate  $I_C - V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipa-

tion than the curves indicate.

The data of Figures 12 and 13 is based on  $T_C = 25^\circ\text{C}$ ;  $T_J(\text{pk})$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated for temperature according to Figure 1.

PACKAGE DIMENSIONS



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ALL RULES AND NOTES ASSOCIATED WITH REFERENCED TO-204AA OUTLINE SHALL APPLY.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 1.550 REF |       | 39.37 REF   |       |
| B   | —         | 1.050 | —           | 26.67 |
| C   | 0.250     | 0.335 | 6.35        | 8.51  |
| D   | 0.038     | 0.043 | 0.97        | 1.09  |
| E   | 0.055     | 0.070 | 1.40        | 1.77  |
| G   | 0.430 BSC |       | 10.92 BSC   |       |
| H   | 0.215 BSC |       | 5.46 BSC    |       |
| K   | 0.440     | 0.480 | 11.18       | 12.19 |
| L   | 0.665 BSC |       | 16.89 BSC   |       |
| N   | —         | 0.830 | —           | 21.08 |
| Q   | 0.151     | 0.165 | 3.84        | 4.19  |
| U   | 1.187 BSC |       | 30.15 BSC   |       |
| V   | 0.131     | 0.188 | 3.33        | 4.77  |

STYLE 1:

- PIN 1: BASE
- EMITTER
- COLLECTOR

CASE 1-07  
TO-204AA (TO-3)  
ISSUE Z

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**How to reach us:**

**USA / EUROPE:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE (602) 244-6609  
**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,  
6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

**HONG KONG:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

