

# MMDF1N05E, MVDF1N05E

## Power MOSFET

### 2 A, 50 V, N-Channel SO-8, Dual

These miniature surface mount MOSFETs feature ultra low  $R_{DS(on)}$  and true logic level performance. They are capable of withstanding high energy in the avalanche and commutation modes and the drain-to-source diode has a low reverse recovery time. These devices are designed for use in low voltage, high speed switching applications where power efficiency is important. Typical applications are dc-dc converters, and power management in portable and battery powered products such as computers, printers, cellular and cordless phones. They can also be used for low voltage motor controls in mass storage products such as disk drives and tape drives. The avalanche energy is specified to eliminate the guesswork in designs where inductive loads are switched and offer additional safety margin against unexpected voltage transients.

#### Features

- Ultra Low  $R_{DS(on)}$  Provides Higher Efficiency and Extends Battery Life
- Logic Level Gate Drive – Can Be Driven by Logic ICs
- Miniature SO-8 Surface Mount Package – Saves Board Space
- Diode Is Characterized for Use In Bridge Circuits
- Diode Exhibits High Speed
- Avalanche Energy Specified
- Mounting Information for SO-8 Package Provided
- $I_{DSS}$  Specified at Elevated Temperature
- This is a Pb-Free Device
- MVDF Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable

#### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating  | Symbol            | Value      | Unit                    |
|---|-------------------|------------|-------------------------|
| Drain-to-Source Voltage   | $V_{DS}$          | 50         | V                       |
| Gate-to-Source Voltage – Continuous   | $V_{GS}$          | $\pm 20$   | V                       |
| Drain Current – Continuous<br>– Pulsed  | $I_D$<br>$I_{DM}$ | 2.0<br>10  | A                       |
| Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$<br>( $V_{DD} = 25\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_L = 2\text{ Apk}$ ) | $E_{AS}$          | 300        | mJ                      |
| Operating and Storage Temperature Range   | $T_J$ , $T_{stg}$ | -55 to 150 | $^\circ\text{C}$        |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$  | $P_D$             | 2.0        | W                       |
| Thermal Resistance, Junction-to-Ambient (Note 1)  | $R_{\theta JA}$   | 62.5       | $^\circ\text{C/W}$      |
| Maximum Temperature for Soldering, Time in Solder Bath  | $T_L$             | 260<br>10  | $^\circ\text{C}$<br>Sec |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Mounted on 2" square FR4 board (1" sq. 2 oz. Cu 0.06" thick single sided) with one die operating, 10 sec. max.

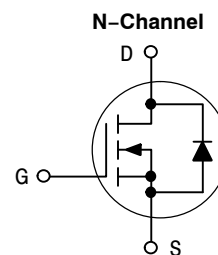


**ON Semiconductor**<sup>®</sup>

<http://onsemi.com>

**2 AMPERE, 50 VOLTS**

**$R_{DS(on)} = 300\text{ m}\Omega$**



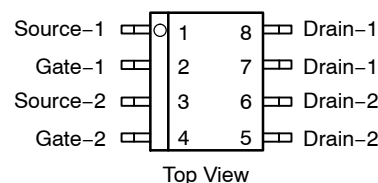
#### MARKING DIAGRAM



F1N05 = Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ■ = Pb-Free Package

(Note: Microdot may be in either location)

#### PIN ASSIGNMENT



#### ORDERING INFORMATION

| Device       | Package        | Shipping <sup>†</sup> |
|--------------|----------------|-----------------------|
| MMDF1N05ER2G | SO-8 (Pb-Free) | 2,500/Tape & Reel     |
| MVDF1N05ER2G | SO-8 (Pb-Free) | 2,500/Tape & Reel     |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# MMDF1N05E, MVDF1N05E

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|  |               |    |   |     |                    |
|--|---------------|----|---|-----|--------------------|
| Drain-to-Source Breakdown Voltage<br>( $V_{GS} = 0, I_D = 250 \mu\text{A}$ ) | $V_{(BR)DSS}$ | 50 | - | -   | Vdc                |
| Zero Gate Voltage Drain Current<br>( $V_{DS} = 50 \text{ V}, V_{GS} = 0$ )   | $I_{DSS}$     | -  | - | 2   | $\mu\text{A}_{dc}$ |
| Gate-Body Leakage Current<br>( $V_{GS} = 20 \text{ Vdc}, V_{DS} = 0$ )       | $I_{GSS}$     | -  | - | 100 | $\text{nA}_{dc}$   |

### ON CHARACTERISTICS (Note 2)

|  |                              |     |     |              |          |
|--|------------------------------|-----|-----|--------------|----------|
| Gate Threshold Voltage ( $V_{DS} = V_{GS}, I_D = 250 \mu\text{A}_{dc}$ )   | $V_{GS(th)}$                 | 1.0 | -   | 3.0          | Vdc      |
| Drain-to-Source On-Resistance<br>( $V_{GS} = 10 \text{ Vdc}, I_D = 1.5 \text{ A}_{dc}$ )<br>( $V_{GS} = 4.5 \text{ Vdc}, I_D = 0.6 \text{ A}_{dc}$ ) | $R_{DS(on)}$<br>$R_{DS(on)}$ | -   | -   | 0.30<br>0.50 | $\Omega$ |
| Forward Transconductance ( $V_{DS} = 15 \text{ V}, I_D = 1.5 \text{ A}$ )  | $g_{FS}$                     | -   | 1.5 | -            | mhos     |

### DYNAMIC CHARACTERISTICS

|                              |   |           |   |     |   |             |
|------------------------------|---|-----------|---|-----|---|-------------|
| Input Capacitance            | $(V_{DS} = 25 \text{ V}, V_{GS} = 0,$<br>$f = 1.0 \text{ MHz})$ | $C_{iss}$ | - | 330 | - | $\text{pF}$ |
| Output Capacitance           |   | $C_{oss}$ | - | 160 | - |             |
| Reverse Transfer Capacitance |   | $C_{rss}$ | - | 50  | - |             |

### SWITCHING CHARACTERISTICS (Note 3)

|                     |   |              |   |      |    |    |
|---------------------|---|--------------|---|------|----|----|
| Turn-On Delay Time  | $(V_{DD} = 10 \text{ V}, I_D = 1.5 \text{ A}, R_L = 10 \Omega,$<br>$V_G = 10 \text{ V}, R_G = 50 \Omega)$ | $t_{d(on)}$  | - | -    | 20 | ns |
| Rise Time           |   | $t_r$        | - | -    | 30 |    |
| Turn-Off Delay Time |   | $t_{d(off)}$ | - | -    | 40 |    |
| Fall Time           |   | $t_f$        | - | -    | 25 |    |
| Total Gate Charge   | $(V_{DS} = 10 \text{ V}, I_D = 1.5 \text{ A},$<br>$V_{GS} = 10 \text{ V})$                                | $Q_g$        | - | 12.5 | -  | nC |
| Gate-Source Charge  |   | $Q_{gs}$     | - | 1.9  | -  |    |
| Gate-Drain Charge   |   | $Q_{gd}$     | - | 3.0  | -  |    |

### SOURCE-DRAIN DIODE CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ )

|                          |  |          |   |    |     |    |
|--------------------------|--|----------|---|----|-----|----|
| Forward Voltage (Note 2) | $(I_S = 1.5 \text{ A}, V_{GS} = 0 \text{ V})$<br>$(di_S/dt = 100 \text{ A}/\mu\text{s})$ | $V_{SD}$ | - | -  | 1.6 | V  |
| Reverse Recovery Time    |  | $t_{rr}$ | - | 45 | -   | ns |

2. Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .
3. Switching characteristics are independent of operating junction temperature.

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## TYPICAL ELECTRICAL CHARACTERISTICS

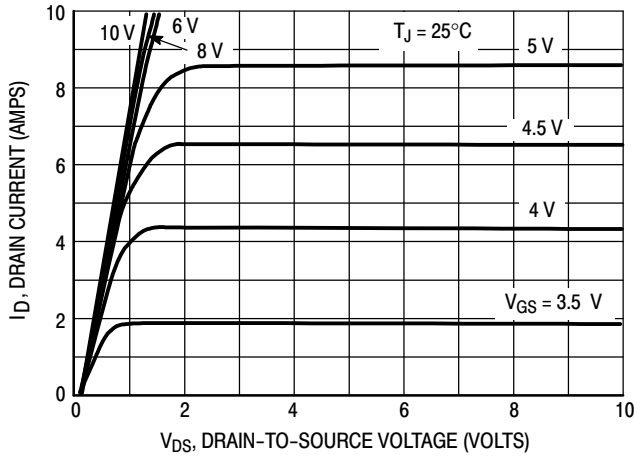


Figure 1. On-Region Characteristics

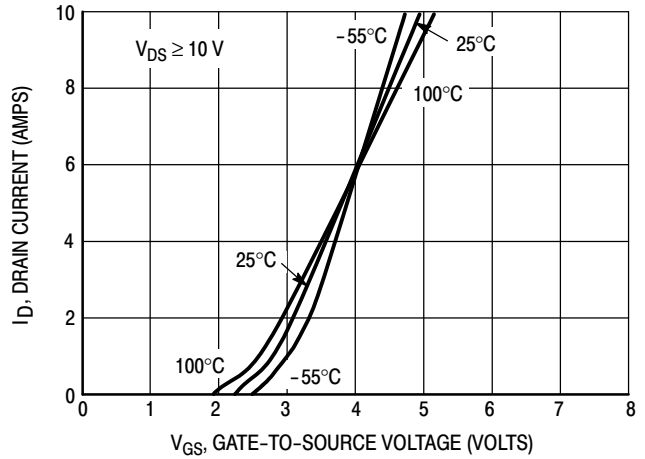


Figure 2. Transfer Characteristics

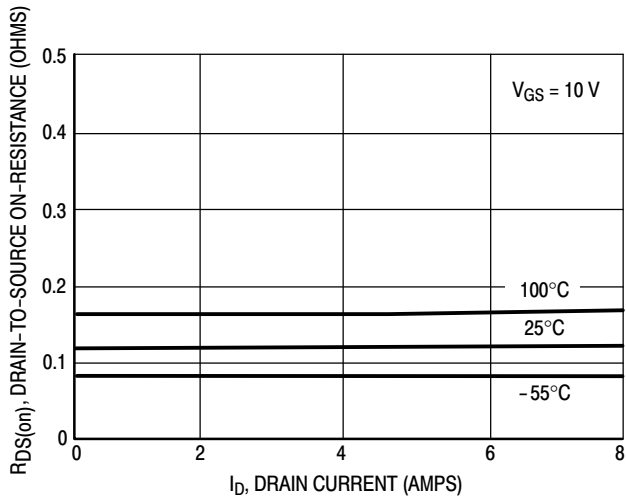


Figure 3. On-Resistance versus Drain Current

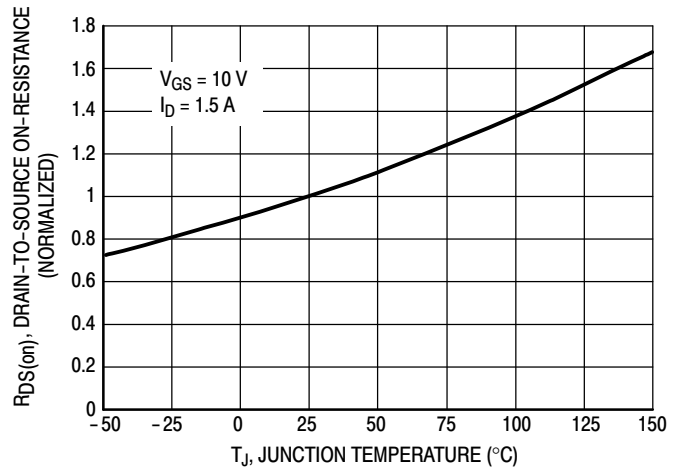


Figure 4. On-Resistance Variation with Temperature

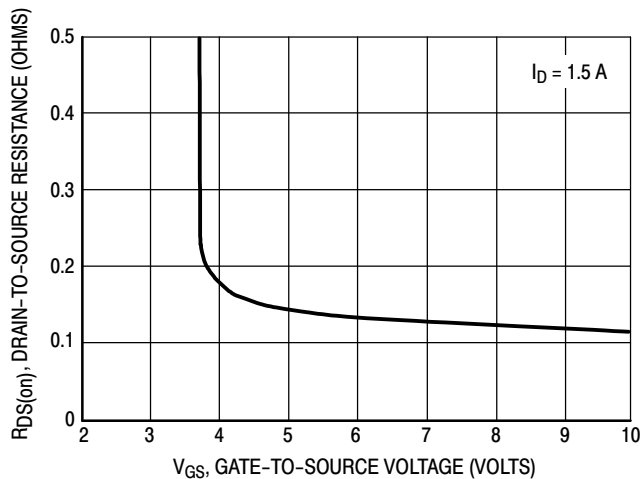


Figure 5. On Resistance versus Gate-to-Source Voltage

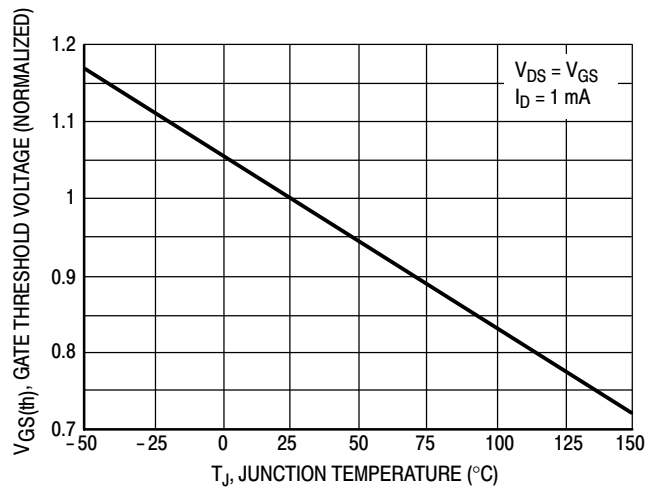


Figure 6. Gate Threshold Voltage Variation with Temperature

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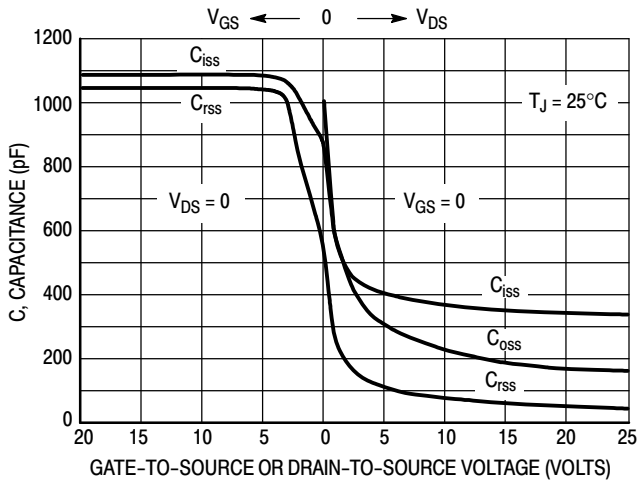


Figure 7. Capacitance Variation

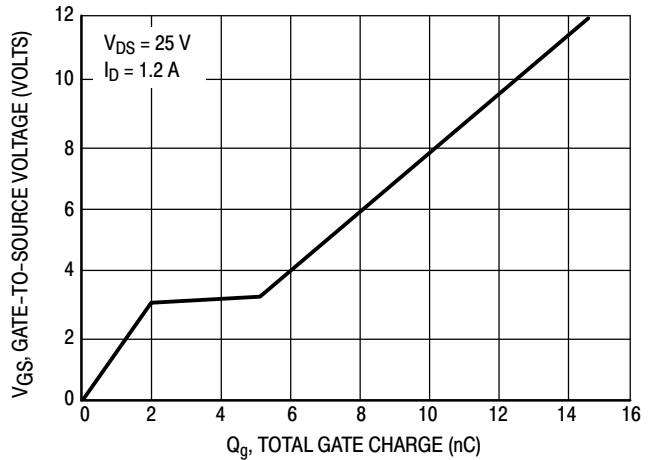


Figure 8. Gate Charge versus Gate-to-Source Voltage

## SAFE OPERATING AREA INFORMATION

### Forward Biased Safe Operating Area

The FBSOA curves define the maximum drain-to-source voltage and drain current that a device can safely handle when it is forward biased, or when it is on, or being turned on. Because these curves include the limitations of simultaneous high voltage and high current, up to the rating of the device, they are especially useful to designers of linear systems. The curves are based on a case temperature of 25°C and a maximum junction temperature of 150°C. Limitations for repetitive pulses at various case temperatures can be determined by using the thermal response curves. ON Semiconductor Application Note, AN569, "Transient Thermal Resistance – General Data and Its Use" provides detailed instructions.

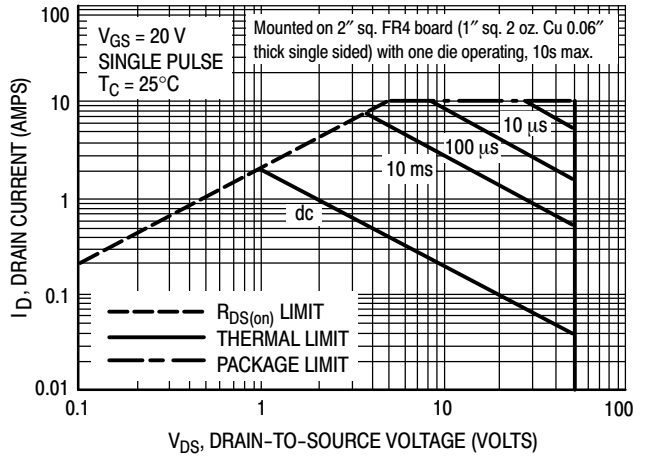


Figure 9. Maximum Rated Forward Biased Safe Operating Area

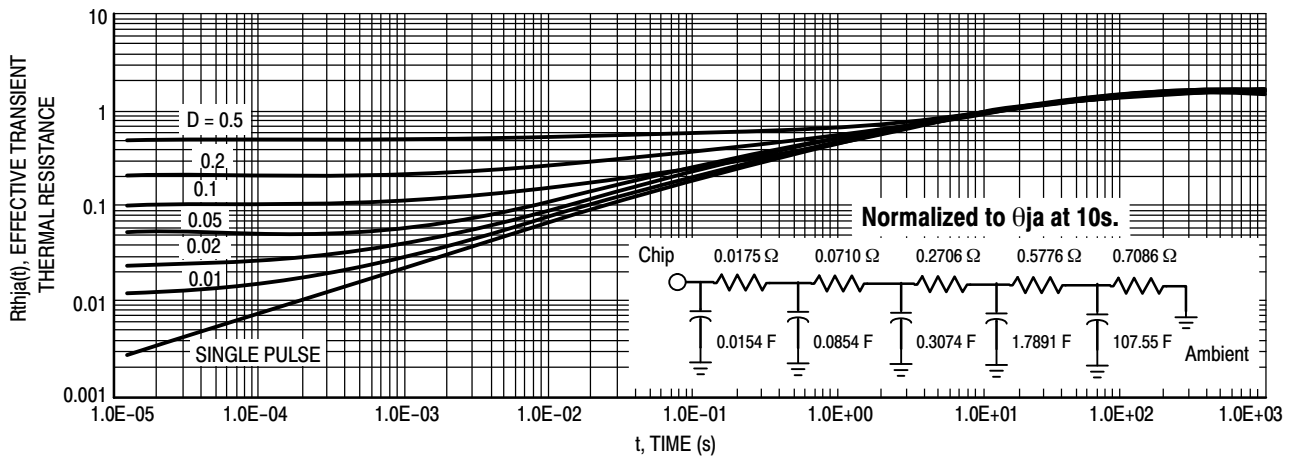


Figure 10. Thermal Response

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          | 8°   | 0°        | 8°    |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

## GENERIC MARKING DIAGRAM\*



SCALE 6:1 ( $\frac{\text{mm}}{\text{inches}}$ )



XXXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

XXXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
▪ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## STYLES ON PAGE 2

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**SOIC-8 NB**  
**CASE 751-07**  
**ISSUE AK**

DATE 16 FEB 2011

- |  |   |   |   |
|--|---|---|---|
| <p><b>STYLE 1:</b><br/> PIN 1. EMITTER<br/> 2. COLLECTOR<br/> 3. COLLECTOR<br/> 4. EMITTER<br/> 5. EMITTER<br/> 6. BASE<br/> 7. BASE<br/> 8. EMITTER</p>   | <p><b>STYLE 2:</b><br/> PIN 1. COLLECTOR, DIE, #1<br/> 2. COLLECTOR, #1<br/> 3. COLLECTOR, #2<br/> 4. COLLECTOR, #2<br/> 5. BASE, #2<br/> 6. EMITTER, #2<br/> 7. BASE, #1<br/> 8. EMITTER, #1</p>               | <p><b>STYLE 3:</b><br/> PIN 1. DRAIN, DIE #1<br/> 2. DRAIN, #1<br/> 3. DRAIN, #2<br/> 4. DRAIN, #2<br/> 5. GATE, #2<br/> 6. SOURCE, #2<br/> 7. GATE, #1<br/> 8. SOURCE, #1</p>                            | <p><b>STYLE 4:</b><br/> PIN 1. ANODE<br/> 2. ANODE<br/> 3. ANODE<br/> 4. ANODE<br/> 5. ANODE<br/> 6. ANODE<br/> 7. ANODE<br/> 8. COMMON CATHODE</p>   |
| <p><b>STYLE 5:</b><br/> PIN 1. DRAIN<br/> 2. DRAIN<br/> 3. DRAIN<br/> 4. DRAIN<br/> 5. GATE<br/> 6. GATE<br/> 7. SOURCE<br/> 8. SOURCE</p>   | <p><b>STYLE 6:</b><br/> PIN 1. SOURCE<br/> 2. DRAIN<br/> 3. DRAIN<br/> 4. SOURCE<br/> 5. SOURCE<br/> 6. GATE<br/> 7. GATE<br/> 8. SOURCE</p>  | <p><b>STYLE 7:</b><br/> PIN 1. INPUT<br/> 2. EXTERNAL BYPASS<br/> 3. THIRD STAGE SOURCE<br/> 4. GROUND<br/> 5. DRAIN<br/> 6. GATE 3<br/> 7. SECOND STAGE Vd<br/> 8. FIRST STAGE Vd</p>                    | <p><b>STYLE 8:</b><br/> PIN 1. COLLECTOR, DIE #1<br/> 2. BASE, #1<br/> 3. BASE, #2<br/> 4. COLLECTOR, #2<br/> 5. COLLECTOR, #2<br/> 6. EMITTER, #2<br/> 7. EMITTER, #1<br/> 8. COLLECTOR, #1</p>                              |
| <p><b>STYLE 9:</b><br/> PIN 1. EMITTER, COMMON<br/> 2. COLLECTOR, DIE #1<br/> 3. COLLECTOR, DIE #2<br/> 4. EMITTER, COMMON<br/> 5. EMITTER, COMMON<br/> 6. BASE, DIE #2<br/> 7. BASE, DIE #1<br/> 8. EMITTER, COMMON</p> | <p><b>STYLE 10:</b><br/> PIN 1. GROUND<br/> 2. BIAS 1<br/> 3. OUTPUT<br/> 4. GROUND<br/> 5. GROUND<br/> 6. BIAS 2<br/> 7. INPUT<br/> 8. GROUND</p>  | <p><b>STYLE 11:</b><br/> PIN 1. SOURCE 1<br/> 2. GATE 1<br/> 3. SOURCE 2<br/> 4. GATE 2<br/> 5. DRAIN 2<br/> 6. DRAIN 2<br/> 7. DRAIN 1<br/> 8. DRAIN 1</p>   | <p><b>STYLE 12:</b><br/> PIN 1. SOURCE<br/> 2. SOURCE<br/> 3. SOURCE<br/> 4. GATE<br/> 5. DRAIN<br/> 6. DRAIN<br/> 7. DRAIN<br/> 8. DRAIN</p>   |
| <p><b>STYLE 13:</b><br/> PIN 1. N.C.<br/> 2. SOURCE<br/> 3. SOURCE<br/> 4. GATE<br/> 5. DRAIN<br/> 6. DRAIN<br/> 7. DRAIN<br/> 8. DRAIN</p>  | <p><b>STYLE 14:</b><br/> PIN 1. N-SOURCE<br/> 2. N-GATE<br/> 3. P-SOURCE<br/> 4. P-GATE<br/> 5. P-DRAIN<br/> 6. P-DRAIN<br/> 7. N-DRAIN<br/> 8. N-DRAIN</p>   | <p><b>STYLE 15:</b><br/> PIN 1. ANODE 1<br/> 2. ANODE 1<br/> 3. ANODE 1<br/> 4. ANODE 1<br/> 5. CATHODE, COMMON<br/> 6. CATHODE, COMMON<br/> 7. CATHODE, COMMON<br/> 8. CATHODE, COMMON</p>               | <p><b>STYLE 16:</b><br/> PIN 1. EMITTER, DIE #1<br/> 2. BASE, DIE #1<br/> 3. EMITTER, DIE #2<br/> 4. BASE, DIE #2<br/> 5. COLLECTOR, DIE #2<br/> 6. COLLECTOR, DIE #2<br/> 7. COLLECTOR, DIE #1<br/> 8. COLLECTOR, DIE #1</p> |
| <p><b>STYLE 17:</b><br/> PIN 1. VCC<br/> 2. V2OUT<br/> 3. V1OUT<br/> 4. TXE<br/> 5. RXE<br/> 6. VEE<br/> 7. GND<br/> 8. ACC</p>  | <p><b>STYLE 18:</b><br/> PIN 1. ANODE<br/> 2. ANODE<br/> 3. SOURCE<br/> 4. GATE<br/> 5. DRAIN<br/> 6. DRAIN<br/> 7. CATHODE<br/> 8. CATHODE</p>   | <p><b>STYLE 19:</b><br/> PIN 1. SOURCE 1<br/> 2. GATE 1<br/> 3. SOURCE 2<br/> 4. GATE 2<br/> 5. DRAIN 2<br/> 6. MIRROR 2<br/> 7. DRAIN 1<br/> 8. MIRROR 1</p>   | <p><b>STYLE 20:</b><br/> PIN 1. SOURCE (N)<br/> 2. GATE (N)<br/> 3. SOURCE (P)<br/> 4. GATE (P)<br/> 5. DRAIN<br/> 6. DRAIN<br/> 7. DRAIN<br/> 8. DRAIN</p>   |
| <p><b>STYLE 21:</b><br/> PIN 1. CATHODE 1<br/> 2. CATHODE 2<br/> 3. CATHODE 3<br/> 4. CATHODE 4<br/> 5. CATHODE 5<br/> 6. COMMON ANODE<br/> 7. COMMON ANODE<br/> 8. CATHODE 6</p>  | <p><b>STYLE 22:</b><br/> PIN 1. I/O LINE 1<br/> 2. COMMON CATHODE/VCC<br/> 3. COMMON CATHODE/VCC<br/> 4. I/O LINE 3<br/> 5. COMMON ANODE/GND<br/> 6. I/O LINE 4<br/> 7. I/O LINE 5<br/> 8. COMMON ANODE/GND</p> | <p><b>STYLE 23:</b><br/> PIN 1. LINE 1 IN<br/> 2. COMMON ANODE/GND<br/> 3. COMMON ANODE/GND<br/> 4. LINE 2 IN<br/> 5. LINE 2 OUT<br/> 6. COMMON ANODE/GND<br/> 7. COMMON ANODE/GND<br/> 8. LINE 1 OUT</p> | <p><b>STYLE 24:</b><br/> PIN 1. BASE<br/> 2. EMITTER<br/> 3. COLLECTOR/ANODE<br/> 4. COLLECTOR/ANODE<br/> 5. CATHODE<br/> 6. CATHODE<br/> 7. COLLECTOR/ANODE<br/> 8. COLLECTOR/ANODE</p>                                      |
| <p><b>STYLE 25:</b><br/> PIN 1. VIN<br/> 2. N/C<br/> 3. REXT<br/> 4. GND<br/> 5. IOUT<br/> 6. IOUT<br/> 7. IOUT<br/> 8. IOUT</p>   | <p><b>STYLE 26:</b><br/> PIN 1. GND<br/> 2. dv/dt<br/> 3. ENABLE<br/> 4. ILIMIT<br/> 5. SOURCE<br/> 6. SOURCE<br/> 7. SOURCE<br/> 8. VCC</p>  | <p><b>STYLE 27:</b><br/> PIN 1. ILIMIT<br/> 2. OVLO<br/> 3. UVLO<br/> 4. INPUT+<br/> 5. SOURCE<br/> 6. SOURCE<br/> 7. SOURCE<br/> 8. DRAIN</p>  | <p><b>STYLE 28:</b><br/> PIN 1. SW_TO_GND<br/> 2. DASIC_OFF<br/> 3. DASIC_SW_DET<br/> 4. GND<br/> 5. V_MON<br/> 6. VBULK<br/> 7. VBULK<br/> 8. VIN</p>  |
| <p><b>STYLE 29:</b><br/> PIN 1. BASE, DIE #1<br/> 2. EMITTER, #1<br/> 3. BASE, #2<br/> 4. EMITTER, #2<br/> 5. COLLECTOR, #2<br/> 6. COLLECTOR, #2<br/> 7. COLLECTOR, #1<br/> 8. COLLECTOR, #1</p>                        | <p><b>STYLE 30:</b><br/> PIN 1. DRAIN 1<br/> 2. DRAIN 1<br/> 3. GATE 2<br/> 4. SOURCE 2<br/> 5. SOURCE 1/DRAIN 2<br/> 6. SOURCE 1/DRAIN 2<br/> 7. SOURCE 1/DRAIN 2<br/> 8. GATE 1</p>                           |   |   |

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