# Digital FET, Dual N & P **Channel**

# **FDG6320C**

## **General Description**

These dual N & P-Channel logic level enhancement mode field effect transistors are produced using ON Semiconductor's proprietary, high cell density, DMOS technology, this very high density process is especially tailored to minimize on-state resistance. This device has been designed especially for low voltage applications as a replacement for bipolar digital transistors and small signal MOSFETS. Since bias resistors are not required, this dual digital FET can replace several different digital transistors, with different bias resistor values.

#### **Features**

- N-Ch 0.22 A, 0.25 V
  - $R_{DS(ON)} = 4.0 \Omega @ V_{GS} = 4.5 V$
  - $R_{DS(ON)} = 5.0 \Omega @ V_{GS} = 2.7 V$
- P-Ch -0.14 A, -25 V
  - $R_{DS(ON)} = 10 \Omega @ V_{GS} = -4.5 V$
  - $R_{DS(ON)} = 13 \Omega @ V_{GS} = -2.7 V$
- Very Small Package Outline SC70-6
- Very Low Level Gate Drive Requirements Allowing Direct Operation in 3 V Circuits ( $V_{GS(th)} < 1.5 \text{ V}$ )
- Gate-Source Zener for ESD Ruggedness (>6 kV Human Body
- These Devices are Pb-Free and are RoHS Compliant

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

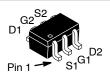
| Symbol                            | Parameter  |            | N-Channel | P-Channel | Units |
|-----------------------------------|--|------------|-----------|-----------|-------|
| V <sub>DSS</sub>                  | Drain-Source V   | /oltage    | 25        | -25       | V     |
| V <sub>GSS</sub>                  | Gate-Source V  | oltage     | 8         | -8        | V     |
| I <sub>D</sub>                    | Drain Current  | Continuous | 0.22      | -0.14     | Α     |
|                                   |  | Pulsed     | 0.65      | -0.4      |       |
| P <sub>D</sub>                    | Maximum Power Dissipation (Note 1)                             |            | 0.3       |           | W     |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage<br>Temperature Range                     |            | –55 t     | o 150     | °C    |
| ESD                               | Electrostatic Dis<br>Rating MIL-STI<br>Human Body M<br>1500 Ω) | D-883D     | •         | 5         | kV    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



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SC-88/SC70-6/SOT-363 **CASE 419B-02** 

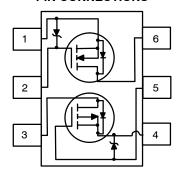
### **MARKING DIAGRAM**



20 М

- = Specific Device Code
- = Assembly Operation Month

### **PIN CONNECTIONS**



#### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

### THERMAL CHARACTERISTICS

| Symbol          | Parameter  | Ratings | Unit |
|-----------------|--|---------|------|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1) | 415     | °C/W |

R<sub>θJA</sub> is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. R<sub>θJC</sub> is guaranteed by design while R<sub>θCA</sub> is determined by the user's board design. R<sub>θJA</sub> = 415°C/W on minimum pad mounting on FR-4 board in still air.

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

| Symbol                           | Parameter   | Conditions  | Type | Min   | Тур   | Max  | Unit  |
|----------------------------------|---|---|------|-------|-------|------|-------|
| OFF CHARACT                      | ERISTICS  |   |      | •     |       |      |       |
| BV <sub>DSS</sub>                | Drain-Source Breakdown Voltage                    | $V_{GS} = 0 \text{ V}, I_D = 250 \mu\text{A}$                                     | N-Ch | 25    | _     | _    | V     |
|                                  |   | $V_{GS} = 0 \text{ V}, I_D = -250 \mu\text{A}$                                    | P-Ch | -25   | -     | -    |       |
| $\Delta BV_{DSS} / \Delta T_{J}$ | Breakdown Voltage Temperature                     | I <sub>D</sub> = 250 μA, Referenced to 25°C                                       | N-Ch | -     | 25    | -    | mV/°C |
|                                  | Coefficient                                       | $I_D = -250 \mu\text{A}$ , Referenced to $25^{\circ}\text{C}$                     | P-Ch | -     | -19   | -    |       |
| I <sub>DSS</sub>                 | Zero Gate Voltage Drain Current                   | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V                                     | N-Ch | -     | -     | 1    | μΑ    |
|                                  |   | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55°C              |      | -     | -     | 10   |       |
| I <sub>DSS</sub>                 | Zero Gate Voltage Drain Current                   | V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V                                    | P-Ch | -     | -     | -1   | μΑ    |
|                                  |   | $V_{DS} = -20 \text{ V}, V_{GS} = 0 \text{ V}, T_{J} = 55^{\circ}\text{C}$        |      | _     | _     | -10  |       |
| I <sub>GSS</sub>                 | Gate-Body Leakage Current                         | V <sub>GS</sub> = 8 V, V <sub>DS</sub> = 0 V                                      | N-Ch | -     | _     | 100  | nA    |
|                                  |   | V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 0 V                                     | P-Ch | -     | _     | -100 |       |
| ON CHARACTE                      | RISTICS (Note 2)                                  |   |      | -     |       |      | -     |
| V <sub>GS(th)</sub>              | Gate Threshold Voltage                            | $V_{DS} = V_{GS}, I_D = 250 \mu A$  | N-Ch | 0.65  | 0.85  | 1.5  | V     |
|                                  |   | $V_{DS} = V_{GS}, I_D = -250 \mu\text{A}$   | P-Ch | -0.65 | -0.82 | -1.5 |       |
|                                  | Gate Threshold Voltage<br>Temperature Coefficient | I <sub>D</sub> = 250 μA, Referenced to 25°C                                       | N-Ch | -     | -2.1  | -    | mV/°C |
|                                  |   | $I_D = -250 \mu\text{A}$ , Referenced to $25^{\circ}\text{C}$                     | P-Ch | -     | 2.1   | -    |       |
| R <sub>DS(ON)</sub>              | Static Drain–Source<br>On–Resistance              | $V_{GS} = 4.5 \text{ V}, I_D = 0.22 \text{ A}$                                    | N-Ch | _     | 2.6   | 4    | Ω     |
|                                  |   | $V_{GS} = 4.5 \text{ V}, I_D = 0.22 \text{ A},$<br>$T_J = 125^{\circ}\text{C}$    |      | -     | 5.3   | 7    |       |
|                                  |   | V <sub>GS</sub> = 2.7 V, I <sub>D</sub> = 0.19 A                                  |      | _     | 3.7   | 5    |       |
|                                  |   | V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -0.14 A                                | P-Ch | _     | 7.3   | 10   |       |
|                                  |   | $V_{GS} = -4.5 \text{ V}, I_D = -0.14 \text{ A},$<br>$T_J = 125 ^{\circ}\text{C}$ |      | -     | 11    | 17   |       |
|                                  |   | $V_{GS} = -2.7 \text{ V}, I_D = -0.05 \text{ A}$                                  |      | _     | 10.4  | 13   |       |
| I <sub>D(ON)</sub>               | On-State Drain Current                            | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 5 V                                    | N-Ch | 0.22  | -     | -    | Α     |
|                                  |   | $V_{GS} = -4.5 \text{ V}, V_{DS} = -5 \text{ V}$                                  | P-Ch | -0.14 | 1     | ı    |       |
| 9FS                              | Forward Transconductance                          | $V_{DS} = 5 \text{ V}, I_{D} = 0.22 \text{ A}$                                    | N-Ch | -     | 0.2   | -    | S     |
|                                  |   | $V_{DS} = -5 \text{ V}, I_{D} = -0.14 \text{ A}$                                  | P-Ch | -     | 0.12  | i    |       |
| DYNAMIC CHAI                     | RACTERISTICS                                      |   |      |       |       |      |       |
| C <sub>iss</sub>                 | Input Capacitance                                 | N-Channel<br>V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz           | N-Ch | -     | 9.5   | -    | pF    |
|                                  |   |   | P-Ch | -     | 12    | _    |       |
| C <sub>oss</sub>                 | Output Capacitance                                | P-Channel<br>V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V,                      | N-Ch | -     | 6     | -    |       |
|                                  |   | f = 1.0 MHz   | P-Ch | -     | 7     | -    |       |
| C <sub>rss</sub>                 | Reverse Transfer Capacitance                      |   | N-Ch | _     | 1.3   | -    | 1     |
|                                  |   |   | P-Ch | _     | 1.5   | -    |       |

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

| Symbol              | Parameter                    | Conditions   | Туре | Min | Тур  | Max   | Unit |
|---------------------|------------------------------|--|------|-----|------|-------|------|
| VITCHING C          | HARACTERISTICS (Note 2)      |  | •    |     | •    | •     |      |
| t <sub>D(on)</sub>  | Turn-On Delay Time           | N-Channel  | N-Ch | -   | 5    | 12    | ns   |
|                     |                              | $V_{DD} = 5 \text{ V}, I_{D} = 0.5 \text{ A}, V_{GS} = 4.5 \text{ V}, R_{GEN} = 50 \Omega$       | P-Ch | -   | 5    | 12    |      |
| t <sub>r</sub>      | Turn-On Rise Time            | P-Channel  | N-Ch | -   | 4.5  | 10    | ns   |
|                     |                              | $V_{DD} = -5 \text{ V}, I_D = -0.5 \text{ A},$<br>$V_{GS} = -4.5 \text{ V}, R_{GEN} = 50 \Omega$ | P-Ch | -   | 8    | 16    |      |
| t <sub>D(off)</sub> | Turn-Off Delay Time          |  | N-Ch | -   | 4    | 8     | ns   |
|                     |                              |  | P-Ch | -   | 9    | 18    |      |
| t <sub>f</sub>      | Turn-Off Fall Time           | _  | N-Ch | -   | 3.2  | 7     | ns   |
|                     |                              |  | P-Ch | -   | 5    | 12    |      |
| Qg                  | Total Gate Charge            | N-Channel  | N-Ch | -   | 0.29 | 0.4   | nC   |
|                     |                              | $V_{DS} = 5 \text{ V}, I_{D} = 0.22 \text{ A}, V_{GS} = 4.5 \text{ V}$                           | P-Ch | -   | 0.22 | 0.31  |      |
| Q <sub>gs</sub>     | Gate-Source Charge           | P-Channel  | N-Ch | -   | 0.12 | _     | nC   |
|                     |                              | $V_{DS} = -5 \text{ V}, I_D = -0.14 \text{ A},$  | P-Ch | -   | 0.12 | -     |      |
| Q <sub>gd</sub>     | Gate-Drain Charge            | $V_{GS} = -4.5 \text{ V}$  | N-Ch | -   | 0.03 | -     | nC   |
|                     |                              |  | P-Ch | -   | 0.05 | -     |      |
| RAIN-SOUR           | CE DIODE CHARACTERISTICS AI  | ND MAXIMUM RATINGS   | •    |     | •    | •     | •    |
| Is                  | Maximum Continuous Source Cu | rrent  | N-Ch | -   | -    | 0.25  | Α    |
|                     |                              |  | P-Ch | -   | -    | -0.25 |      |
| V <sub>SD</sub>     | Drain-Source Diode Forward   | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 0.5 A (Note 2)   | N-Ch | -   | 0.8  | 1.2   | V    |
|                     | Voltage                      | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -0.5 A (Note 2)  | P-Ch | -   | -0.8 | -1.2  | 1    |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions. 2. Pulse Test: Pulse Width  $\leq$  300  $\mu$ s, Duty Cycle  $\leq$  2.0%

## TYPICAL PERFORMANCE CHARACTERISTICS: N-CHANNEL

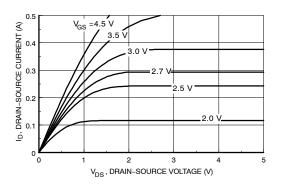


Figure 1. On-Region Characteristics

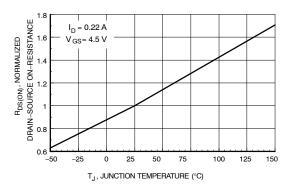


Figure 3. On–Resistance Variation with Temperature

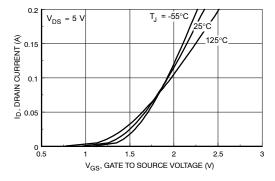


Figure 5. Transfer Characteristics

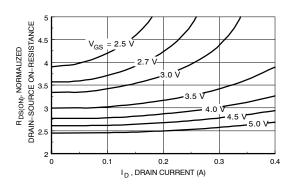


Figure 2. On–Resistance Variation with Drain Current and Gate Voltage

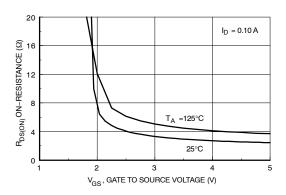


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

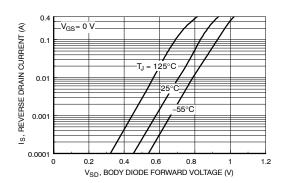


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

# TYPICAL PERFORMANCE CHARACTERISTICS: N-CHANNEL (continued)

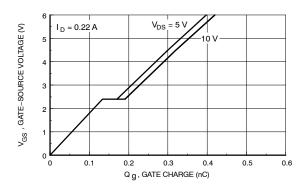


Figure 7. Gate Charge Characteristics

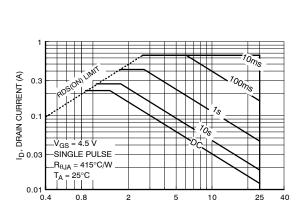


Figure 9. Maximum Safe Operating Area

 $V_{\mbox{\footnotesize DS}}$  , DRAIN-SOURCE VOLTAGE (V)

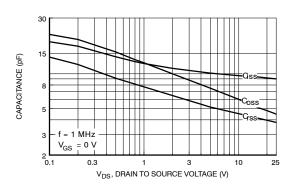


Figure 8. Capacitance Characteristics

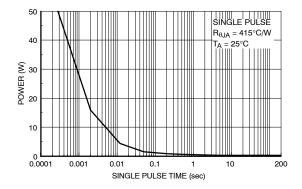


Figure 10. Single Pulse Maximum Power Dissipation

## TYPICAL PERFORMANCE CHARACTERISTICS: P-CHANNEL

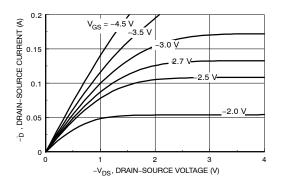


Figure 11. On-Region Characteristics

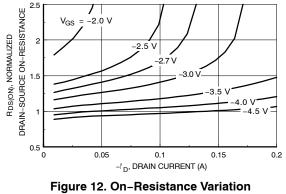


Figure 12. On–Resistance Variation with Drain Current and Gate Voltage

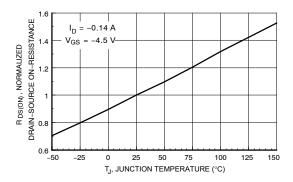


Figure 13. On–Resistance Variation with Temperature

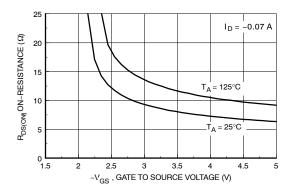


Figure 14. On-Resistance Variation with Gate-to-Source Voltage

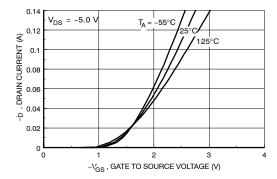


Figure 15. Transfer Characteristics

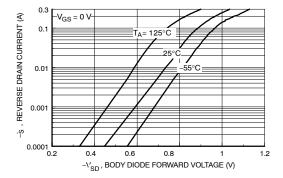


Figure 16. Body Diode Forward Voltage Variation with Source Current and Temperature

# TYPICAL PERFORMANCE CHARACTERISTICS: P-CHANNEL (continued)

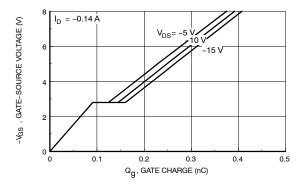


Figure 17. Gate Charge Characteristics

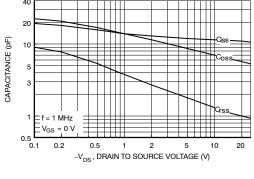


Figure 18. Capacitance Characteristics

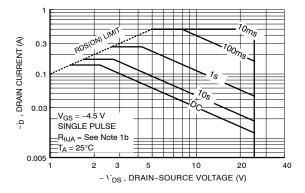


Figure 19. Maximum Safe Operating Area

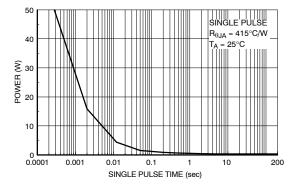
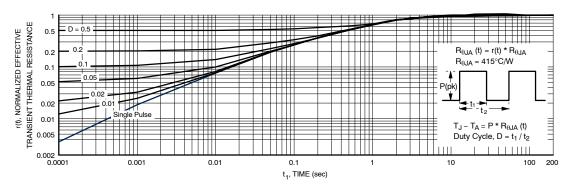


Figure 20. Single Pulse Maximum Power Dissipation

## TYPICAL PERFORMANCE CHARACTERISTICS: N & P-CHANNEL



Thermal characterization performed using the conditions described in Note 1. Transient thermal response will change depending on the circuit board design.

Figure 21. Transient Thermal Response Curve

### **ORDERING INFORMATION**

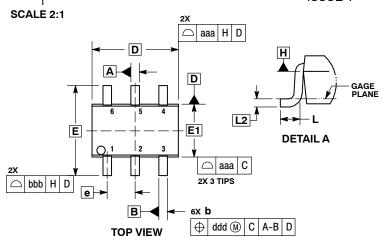
| Device Order Number | Device Marking | Package Type                      | Shipping <sup>†</sup> |
|---------------------|----------------|-----------------------------------|-----------------------|
| FDG6320C            | 20             | SC-88/SC70-6/SOT-363<br>(Pb-Free) | 3000 / Tape & Reel    |

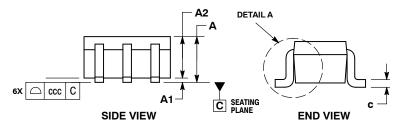
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



## SC-88/SC70-6/SOT-363 CASE 419B-02 **ISSUE Y**

**DATE 11 DEC 2012** 





#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M. 1994.
- CONTROLLING DIMENSION: MILLIMETERS.
  DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH,
- DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H. DIMENSIONS b AND B ARE DETERMINED AT DATUM H. DIMENSIONS b AND C APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.

- DIMENSION 6 DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN
- EXCESS OF DIMENSION 6 AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

|     | MIL      | LIMETE  | ERS  |       | INCHES   | 3     |
|-----|----------|---------|------|-------|----------|-------|
| DIM | MIN      | NOM     | MAX  | MIN   | NOM      | MAX   |
| Α   |          |         | 1.10 |       |          | 0.043 |
| A1  | 0.00     |         | 0.10 | 0.000 |          | 0.004 |
| A2  | 0.70     | 0.90    | 1.00 | 0.027 | 0.035    | 0.039 |
| b   | 0.15     | 0.20    | 0.25 | 0.006 | 0.008    | 0.010 |
| С   | 0.08     | 0.15    | 0.22 | 0.003 | 0.006    | 0.009 |
| D   | 1.80     | 2.00    | 2.20 | 0.070 | 0.078    | 0.086 |
| E   | 2.00     | 2.10    | 2.20 | 0.078 | 0.082    | 0.086 |
| E1  | 1.15     | 1.25    | 1.35 | 0.045 | 0.049    | 0.053 |
| е   | 0.65 BSC |         |      | 0     | .026 BS  | С     |
| L   | 0.26     | 0.36    | 0.46 | 0.010 | 0.014    | 0.018 |
| L2  |          | 0.15 BS | C    | -     | 0.006 BS | SC    |
| aaa | 0.15     |         |      |       | 0.006    |       |
| bbb | 0.30     |         |      |       | 0.012    |       |
| ccc |          | 0.10    |      |       | 0.004    |       |
| ddd |          | 0.10    |      |       | 0.004    |       |

## **GENERIC MARKING DIAGRAM\***



XXX = Specific Device Code

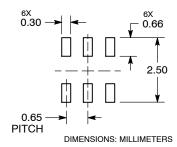
= Date Code\*

= Pb-Free Package

(Note: Microdot may be in either location)

- \*Date Code orientation and/or position may vary depending upon manufacturing location.
- \*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.

#### **RECOMMENDED** SOLDERING FOOTPRINT\*



\*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**

| DOCUMENT NUMBER: | 98ASB42985B          | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |             |  |
|------------------|----------------------|---|-------------|--|
| DESCRIPTION:     | SC-88/SC70-6/SOT-363 |   | PAGE 1 OF 2 |  |

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## SC-88/SC70-6/SOT-363 CASE 419B-02 ISSUE Y

**DATE 11 DEC 2012** 

| STYLE 1: PIN 1. EMITTER 2 2. BASE 2 3. COLLECTOR 1 4. EMITTER 1 5. BASE 1 6. COLLECTOR 2         | STYLE 2:<br>CANCELLED  | STYLE 3:<br>CANCELLED   | STYLE 4: PIN 1. CATHODE 2. CATHODE 3. COLLECTOR 4. EMITTER 5. BASE 6. ANODE                       | STYLE 5: PIN 1. ANODE 2. ANODE 3. COLLECTOR 4. EMITTER 5. BASE 6. CATHODE                                 | STYLE 6:<br>PIN 1. ANODE 2<br>2. N/C<br>3. CATHODE 1<br>4. ANODE 1<br>5. N/C<br>6. CATHODE 2       |
|--|--|---|---|---|--|
| STYLE 7:<br>PIN 1. SOURCE 2<br>2. DRAIN 2<br>3. GATE 1<br>4. SOURCE 1<br>5. DRAIN 1<br>6. GATE 2 | STYLE 8:<br>CANCELLED  | STYLE 9: PIN 1. EMITTER 2 2. EMITTER 1 3. COLLECTOR 1 4. BASE 1 5. BASE 2 6. COLLECTOR 2  | STYLE 10:<br>PIN 1. SOURCE 2<br>2. SOURCE 1<br>3. GATE 1<br>4. DRAIN 1<br>5. DRAIN 2<br>6. GATE 2 | STYLE 11:<br>PIN 1. CATHODE 2<br>2. CATHODE 2<br>3. ANODE 1<br>4. CATHODE 1<br>5. CATHODE 1<br>6. ANODE 2 | STYLE 12: PIN 1. ANODE 2 2. ANODE 2 3. CATHODE 1 4. ANODE 1 5. ANODE 1 6. CATHODE 2                |
| STYLE 13: PIN 1. ANODE 2. N/C 3. COLLECTOR 4. EMITTER 5. BASE 6. CATHODE                         | STYLE 14:<br>PIN 1. VREF<br>2. GND<br>3. GND<br>4. IOUT<br>5. VEN<br>6. VCC          | STYLE 15: PIN 1. ANODE 1 2. ANODE 2 3. ANODE 3 4. CATHODE 3 5. CATHODE 2 6. CATHODE 1     | STYLE 16: PIN 1. BASE 1 2. EMITTER 2 3. COLLECTOR 2 4. BASE 2 5. EMITTER 1 6. COLLECTOR 1         | STYLE 17: PIN 1. BASE 1 2. EMITTER 1 3. COLLECTOR 2 4. BASE 2 5. EMITTER 2 6. COLLECTOR 1                 | STYLE 18:<br>PIN 1. VIN1<br>2. VCC<br>3. VOUT2<br>4. VIN2<br>5. GND<br>6. VOUT1                    |
| STYLE 19:<br>PIN 1. I OUT<br>2. GND<br>3. GND<br>4. V CC<br>5. V EN<br>6. V REF                  | STYLE 20: PIN 1. COLLECTOR 2. COLLECTOR 3. BASE 4. EMITTER 5. COLLECTOR 6. COLLECTOR | STYLE 21: PIN 1. ANODE 1 2. N/C 3. ANODE 2 4. CATHODE 2 5. N/C 6. CATHODE 1               | STYLE 22:<br>PIN 1. D1 (i)<br>2. GND<br>3. D2 (i)<br>4. D2 (c)<br>5. VBUS<br>6. D1 (c)            | STYLE 23:<br>PIN 1. Vn<br>2. CH1<br>3. Vp<br>4. N/C<br>5. CH2<br>6. N/C                                   | STYLE 24: PIN 1. CATHODE 2. ANODE 3. CATHODE 4. CATHODE 5. CATHODE 6. CATHODE                      |
| STYLE 25: PIN 1. BASE 1 2. CATHODE 3. COLLECTOR 2 4. BASE 2 5. EMITTER 6. COLLECTOR 1            | STYLE 26: PIN 1. SOURCE 1 2. GATE 1 3. DRAIN 2 4. SOURCE 2 5. GATE 2 6. DRAIN 1      | STYLE 27: PIN 1. BASE 2 2. BASE 1 3. COLLECTOR 1 4. EMITTER 1 5. EMITTER 2 6. COLLECTOR 2 | STYLE 28: PIN 1. DRAIN 2. DRAIN 3. GATE 4. SOURCE 5. DRAIN 6. DRAIN                               | STYLE 29: PIN 1. ANODE 2. ANODE 3. COLLECTOR 4. EMITTER 5. BASE/ANODE 6. CATHODE                          | STYLE 30:<br>PIN 1. SOURCE 1<br>2. DRAIN 2<br>3. DRAIN 2<br>4. SOURCE 2<br>5. GATE 1<br>6. DRAIN 1 |

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

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| DESCRIPTION:     | SC-88/SC70-6/SOT-363 |  | PAGE 2 OF 2 |  |  |

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