LM211, LM311

Single Comparators

The ability to operate from a single power supply of 5.0 V to 30 V or ±15 V split supplies, as commonly used with operational amplifiers, makes the LM211/LM311 a truly versatile comparator. Moreover, the inputs of the device can be isolated from system ground while the output can drive loads referenced either to ground, the VCC or the VEE supply. This flexibility makes it possible to drive DTL, RTL, TTL, or MOS logic. The output can also switch voltages to 50 V at currents to 50 mA, therefore, the LM211/LM311 can be used to drive relays, lamps or solenoids.

Features

- These Devices are Pb–Free and are RoHS Compliant

Figure 1. Typical Comparator Design Configurations
**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM211DG</td>
<td>SOIC–8 (Pb–Free)</td>
<td>98 Units / Rail</td>
</tr>
<tr>
<td>LM211DR2G</td>
<td></td>
<td>2500 Units / Tape &amp; Reel</td>
</tr>
<tr>
<td>LM311DG</td>
<td></td>
<td>98 Units / Rail</td>
</tr>
<tr>
<td>LM311DR2G</td>
<td></td>
<td>2500 Units / Tape &amp; Reel</td>
</tr>
<tr>
<td>LM311NG</td>
<td>PDIP–8 (Pb–Free)</td>
<td>50 Units / Rail</td>
</tr>
</tbody>
</table>

†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.

**MAXIMUM RATINGS** (*T_A = +25°C, unless otherwise noted.*)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>LM211</th>
<th>LM311</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Supply Voltage</td>
<td>( V_{CC + V_{EE}} )</td>
<td>36</td>
<td>36</td>
<td>Vdc</td>
</tr>
<tr>
<td>Output to Negative Supply Voltage</td>
<td>( V_O - V_{EE} )</td>
<td>50</td>
<td>40</td>
<td>Vdc</td>
</tr>
<tr>
<td>Ground to Negative Supply Voltage</td>
<td>( V_{EE} )</td>
<td>30</td>
<td>30</td>
<td>Vdc</td>
</tr>
<tr>
<td>Input Differential Voltage</td>
<td>( V_{ID} )</td>
<td>±30</td>
<td>±30</td>
<td>Vdc</td>
</tr>
<tr>
<td>Input Voltage (Note 2)</td>
<td>( V_{in} )</td>
<td>±15</td>
<td>±15</td>
<td>Vdc</td>
</tr>
<tr>
<td>Voltage at Strobe Pin</td>
<td>–</td>
<td>( V_{CC} to V_{CC}–5 )</td>
<td>( V_{CC} to V_{CC}–5 )</td>
<td>Vdc</td>
</tr>
<tr>
<td>Power Dissipation and Thermal Characteristics</td>
<td>( P_D )</td>
<td>625</td>
<td></td>
<td>mW</td>
</tr>
<tr>
<td>Plastic DIP</td>
<td>( R_{JA} )</td>
<td>5.0</td>
<td></td>
<td>mW/°C</td>
</tr>
<tr>
<td>Derate Above ( T_A = +25°C )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Ambient Temperature Range</td>
<td>( T_A )</td>
<td>–25 to +85</td>
<td>0 to +70</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Junction Temperature</td>
<td>( T_{J(max)} )</td>
<td>+150</td>
<td>+150</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>( T_{stg} )</td>
<td>–65 to +150</td>
<td>–65 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

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.
# ELECTRICAL CHARACTERISTICS

(V\textsubscript{CC} = +15 V, V\textsubscript{EE} = −15 V, T\textsubscript{A} = 25°C, unless otherwise noted) Note 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>LM211</th>
<th>LM311</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Offset Voltage (Note 3)</strong></td>
<td>V\textsubscript{IO}</td>
<td>–</td>
<td>0.7</td>
</tr>
<tr>
<td>R\textsubscript{S} ≤ 50 kΩ, T\textsubscript{A} = +25°C</td>
<td>–</td>
<td>–</td>
<td>4.0</td>
</tr>
<tr>
<td>T\textsubscript{low} ≤ T\textsubscript{A} ≤ T\textsubscript{high}*</td>
<td>–</td>
<td>1.7</td>
<td>10</td>
</tr>
<tr>
<td>T\textsubscript{low} ≤ T\textsubscript{A} ≤ T\textsubscript{high}*</td>
<td>–</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td><strong>Input Offset Current (Note 3)</strong></td>
<td>I\textsubscript{IO}</td>
<td>–</td>
<td>45</td>
</tr>
<tr>
<td>TA = +25°C</td>
<td>–</td>
<td>–</td>
<td>150</td>
</tr>
<tr>
<td><strong>Input Bias Current</strong></td>
<td>I\textsubscript{IB}</td>
<td>–</td>
<td>45</td>
</tr>
<tr>
<td>TA = +25°C</td>
<td>–</td>
<td>–</td>
<td>150</td>
</tr>
<tr>
<td><strong>Voltage Gain</strong></td>
<td>A\textsubscript{V}</td>
<td>40</td>
<td>200</td>
</tr>
<tr>
<td><strong>Response Time (Note 4)</strong></td>
<td>–</td>
<td>200</td>
<td>–</td>
</tr>
<tr>
<td><strong>Saturation Voltage</strong></td>
<td>V\textsubscript{OL}</td>
<td>–</td>
<td>0.75</td>
</tr>
<tr>
<td>V\textsubscript{ID} ≤ −5.0 mV, I\textsubscript{O} = 50 mA, T\textsubscript{A} = 25°C</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>V\textsubscript{CC} ≥ 4.5 V, V\textsubscript{EE} = 0, T\textsubscript{low} ≤ T\textsubscript{A} ≤ T\textsubscript{high}*</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>V\textsubscript{ID} ≤ 8.0 mV, I\textsubscript{sink} ≤ 8.0 mA</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Strobe “On” Current (Note 5)</td>
<td>I\textsubscript{S}</td>
<td>–</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Output Leakage Current</strong></td>
<td>–</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>V\textsubscript{ID} ≥ 5.0 mV, V\textsubscript{O} = 35 V, T\textsubscript{A} = 25°C, I\textsubscript{strobe} = 3.0 mA</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>V\textsubscript{ID} ≥ 10 mV, V\textsubscript{O} = 35 V, T\textsubscript{A} = 25°C, I\textsubscript{strobe} = 3.0 mA</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>V\textsubscript{ID} ≥ 0.5 mV, V\textsubscript{O} = 35 V, T\textsubscript{low} ≤ T\textsubscript{A} ≤ T\textsubscript{high}*</td>
<td>–</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Input Voltage Range (T\textsubscript{low} ≤ T\textsubscript{A} ≤ T\textsubscript{high}*)</strong></td>
<td>V\textsubscript{ICR}</td>
<td>−14.5</td>
<td>−14.7 to 13.8</td>
</tr>
<tr>
<td><strong>Positive Supply Current</strong></td>
<td>I\textsubscript{CC}</td>
<td>–</td>
<td>+2.4</td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>I\textsubscript{EE}</td>
<td>–</td>
<td>−1.3</td>
</tr>
</tbody>
</table>

*LM211: T\textsubscript{low} = −25°C, T\textsubscript{high} = +85°C
LM311: T\textsubscript{low} = 0°C, T\textsubscript{high} = +70°C

1. Offset voltage, offset current and bias current specifications apply for a supply voltage range from a single 5.0 V supply up to ±15 V supplies.
2. This rating applies for ±15 V supplies. The positive input voltage limit is 30 V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30 V below the positive supply, whichever is less.
3. The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1.0 mA load. Thus, these parameters define an error band and take into account the “worst case” effects of voltage gain and input impedance.
4. The response time specified is for a 100 mV input step with 5.0 mV overdrive.
5. Do not short the strobe pin to ground; it should be current driven at 3.0 mA to 5.0 mA.

![Figure 2. Circuit Schematic](http://onsemi.com)
Figure 3. Input Bias Current versus Temperature

Figure 4. Input Offset Current versus Temperature

Figure 5. Input Bias Current versus Differential Input Voltage

Figure 6. Common Mode Limits versus Temperature

Figure 7. Response Time for Various Input Overdrives

Figure 8. Response Time for Various Input Overdrives
Figure 9. Response Time for Various Input Overdrives

Figure 10. Response Time for Various Input Overdrives

Figure 11. Output Short Circuit Current Characteristics and Power Dissipation

Figure 12. Output Saturation Voltage versus Output Current

Figure 13. Output Leakage Current versus Temperature

Figure 14. Power Supply Current versus Supply Voltage
Figure 15. Power Supply Current versus Temperature

**APPLICATIONS INFORMATION**

Figure 16. Improved Method of Adding Hysteresis Without Applying Positive Feedback to the Inputs

Figure 17. Conventional Technique for Adding Hysteresis

Figure 18. Zero-Crossing Detector Driving CMOS Logic

Figure 19. Relay Driver with Strobe Capability

*Zener Diode D1 protects the comparator from inductive kickback and voltage transients on the VCC2 supply line.
TECHNIQUES FOR AVOIDING OSCILLATIONS IN COMPARATOR APPLICATIONS

When a high speed comparator such as the LM211 is used with high speed input signals and low source impedances, the output response will normally be fast and stable, providing the power supplies have been bypassed (with 0.1 μF disc capacitors), and that the output signal is routed well away from the inputs (Pins 2 and 3) and also away from Pins 5 and 6.

However, when the input signal is a voltage ramp or a slow sine wave, or if the signal source impedance is high (1.0 kΩ to 100 kΩ), the comparator may burst into oscillation near the crossing-point. This is due to the high gain and wide bandwidth of comparators like the LM211 series. To avoid oscillation or instability in such a usage, several precautions are recommended, as shown in Figure 16.

The trim pins (Pins 5 and 6) act as unwanted auxiliary inputs. If these pins are not connected to a trim-pot, they should be shorted together. If they are connected to a trim-pot, a 0.01 μF capacitor (C1) between Pins 5 and 6 will minimize the susceptibility to AC coupling. A smaller capacitor is used if Pin 5 is used for positive feedback as in Figure 16. For the fastest response time, tie both balance pins to VCC.

Certain sources will produce a cleaner comparator output waveform if a 100 pF to 1000 pF capacitor (C2) is connected directly across the input pins. When the signal source is applied through a resistive network, R1, it is usually advantageous to choose R2 of the same value, both for DC and for dynamic (AC) considerations. Carbon, tin–oxide, and metal–film resistors have all been used with good results in comparator input circuitry, but inductive wirewound resistors should be avoided.

When comparator circuits use input resistors (e.g., summing resistors), their value and placement are particularly important. In all cases the body of the resistor should be close to the device or socket. In other words, there should be a very short lead length or printed–circuit foil run between comparator and resistor to radiate or pick up signals. The same applies to capacitors, pots, etc. For example, if R1 = 10 kΩ, as little as 5 inches of lead between the resistors and the input pins can result in oscillations that are very hard to dampen. Twisting these input leads tightly is the best alternative to placing resistors close to the comparator.

Since feedback to almost any pin of a comparator can result in oscillation, the printed–circuit layout should be engineered thoughtfully. Preferably there should be a groundplane under the LM211 circuitry (e.g., one side of a double layer printed circuit board). Ground, positive supply or negative supply foil should extend between the output and the inputs to act as a guard. The foil connections for the inputs should be as small and compact as possible, and should be essentially surrounded by ground foil on all sides to guard against capacitive coupling from any fast high-level signals (such as the output). If Pins 5 and 6 are not used, they should be shorted together. If they are connected to a trim-pot, the trim-pot should be located no more than a few inches away from the LM211, and a 0.01 μF capacitor should be installed across Pins 5 and 6. If this capacitor cannot be used, a shielding printed–circuit foil may be advisable between Pins 6 and 7. The power supply bypass capacitors should be located within a couple inches of the LM211.

A standard procedure is to add hysteresis to a comparator to prevent oscillation, and to avoid excessive noise on the output. In the circuit of Figure 17, the feedback resistor of 510 kΩ from the output to the positive input will cause about 3.0 mV of hysteresis. However, if R2 is larger than 100 Ω, such as 50 kΩ, it would not be practical to simply increase the value of the positive feedback resistor proportionally above 510 kΩ to maintain the same amount of hysteresis.

When both inputs of the LM211 are connected to active signals, or if a high-impedance signal is driving the positive input of the LM211 so that positive feedback would be disruptive, the circuit of Figure 16 is ideal. The positive feedback is applied to Pin 5 (one of the offset adjustment pins). This will be sufficient to cause 1.0 mV to 2.0 mV hysteresis and sharp transitions with input triangle waves from a few Hz to hundreds of kHz. The positive-feedback signal across the 82 Ω resistor swings 240 mV below the positive supply. This signal is centered around the nominal voltage at Pin 5, so this feedback does not add to the offset voltage of the comparator. As much as 8.0 mV of offset voltage can be trimmed out, using the 5.0 kΩ pot and 3.0 kΩ resistor as shown.
**MECHANICAL CASE OUTLINE**

**PACKAGE DIMENSIONS**

### PDIP-8

**CASE 626–05**

**ISSUE P**

**DATE 22 APR 2015**

**NOTES:**
2. CONTROLLING DIMENSION: INCHES.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION b2 IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

<table>
<thead>
<tr>
<th>INCHES</th>
<th>MILLIMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.210</td>
</tr>
<tr>
<td>A1</td>
<td>0.016</td>
</tr>
<tr>
<td>A2</td>
<td>0.115</td>
</tr>
<tr>
<td>b</td>
<td>0.014</td>
</tr>
<tr>
<td>b2</td>
<td>0.006 TYP</td>
</tr>
<tr>
<td>C</td>
<td>0.008</td>
</tr>
<tr>
<td>D</td>
<td>0.005</td>
</tr>
<tr>
<td>D1</td>
<td>0.300</td>
</tr>
<tr>
<td>e</td>
<td>0.100 BSC</td>
</tr>
<tr>
<td>eB</td>
<td>0.240</td>
</tr>
<tr>
<td>L</td>
<td>0.115</td>
</tr>
<tr>
<td>M</td>
<td>0.500</td>
</tr>
</tbody>
</table>

*This information is generic. Please refer to device data sheet for actual part marking. Pb–Free indicator, "G" or microdot "C0071", may or may not be present.*

**STYLE 1:**

1. PIN 1, AC IN
2. DC + IN
3. DC – IN
4. AC IN
5. GROUND
6. OUTPUT
7. AUXILIARY
8. Vcc

**DOCUMENT NUMBER:** 98ASB42420B

**DESCRIPTION:** PDIP-8

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MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

SOIC–8 NB
CASE 751–07
ISSUE AK

DATE 16 FEB 2011

NOTES:
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.

SOLDERING FOOTPRINT*

IC

IC (Pb–Free)

Discrete

Discrete (Pb–Free)

*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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### STYLE 1:
- **PIN 1. Emitter**
- **PIN 2. Collector**
- **PIN 3. Collector**
- **PIN 4. Emitter**
- **PIN 5. Emitter**
- **PIN 6. Base**
- **PIN 7. Base**
- **PIN 8. Emitter**

### STYLE 2:
- **PIN 1. Collector, Die, #1**
- **PIN 2. Collector, #2**
- **PIN 3. Collector, #2**
- **PIN 4. Emitter, #2**
- **PIN 5. Emitter, #2**
- **PIN 6. Emitter, #1**
- **PIN 7. Base, #1**
- **PIN 8. Emitter, #1**

### STYLE 3:
- **PIN 1. Drain, Die #1**
- **PIN 2. Drain, #2**
- **PIN 3. Drain, #2**
- **PIN 4. Source, #2**
- **PIN 5. Source, #2**
- **PIN 6. Source, #1**
- **PIN 7. Drain, #1**
- **PIN 8. Source, #1**

### STYLE 4:
- **PIN 1. Anode**
- **PIN 2. Base, #1**
- **PIN 3. Base, #1**
- **PIN 4. Anode**
- **PIN 5. Anode**
- **PIN 6. Anode**
- **PIN 7. Anode**
- **PIN 8. COMMON CATHODE**

### STYLE 5:
- **PIN 1. Drain**
- **PIN 2. Drain**
- **PIN 3. Drain**
- **PIN 4. Source**
- **PIN 5. Source**
- **PIN 6. Source**
- **PIN 7. Source**
- **PIN 8. Ground**

### STYLE 6:
- **PIN 1. Source**
- **PIN 2. Source**
- **PIN 3. Source**
- **PIN 4. Source**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 7:
- **PIN 1. Input**
- **PIN 2. External Bypass**
- **PIN 3. Third Stage Source**
- **PIN 4. Ground**
- **PIN 5. Collector, #2**
- **PIN 6. Collector, #2**
- **PIN 7. Emitter, #2**
- **PIN 8. Collector, #1**

### STYLE 8:
- **PIN 1. Collector, Die #1**
- **PIN 2. Base, #1**
- **PIN 3. Base, #1**
- **PIN 4. Collector, Die #2**
- **PIN 5. Collector, Die #2**
- **PIN 6. Collector, Die #2**
- **PIN 7. Collector, Die #2**
- **PIN 8. Collector, Die #1**

### STYLE 9:
- **PIN 1. Emitter, Common**
- **PIN 2. Collector, Die #1**
- **PIN 3. Collector, Die #2**
- **PIN 4. Collector, Common**
- **PIN 5. Emitter, Common**
- **PIN 6. Base, Die #2**
- **PIN 7. Base, Die #2**
- **PIN 8. Emitter, Common**

### STYLE 10:
- **PIN 1. Ground**
- **PIN 2. Bias 1**
- **PIN 3. Output**
- **PIN 4. Ground**
- **PIN 5. Ground**
- **PIN 6. Bias 2**
- **PIN 7. Input**
- **PIN 8. Ground**

### STYLE 11:
- **PIN 1. Source 1**
- **PIN 2. Source 1**
- **PIN 3. Source 1**
- **PIN 4. Source 1**
- **PIN 5. Drain 2**
- **PIN 6. Drain 2**
- **PIN 7. Drain 1**
- **PIN 8. Drain 1**

### STYLE 12:
- **PIN 1. Source**
- **PIN 2. Source**
- **PIN 3. Source**
- **PIN 4. Source**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 13:
- **PIN 1. N.C.**
- **PIN 2. Source**
- **PIN 3. Source**
- **PIN 4. Gate**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 14:
- **PIN 1. N-Source**
- **PIN 2. Source**
- **PIN 3. Source**
- **PIN 4. Gate**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 15:
- **PIN 1. Anode 1**
- **PIN 2. Anode 1**
- **PIN 3. Anode 1**
- **PIN 4. Anode 1**
- **PIN 5. Collector, Common**
- **PIN 6. Collector, Common**
- **PIN 7. Collector, Common**
- **PIN 8. Collector, Common**

### STYLE 16:
- **PIN 1. Emitter, Die #1**
- **PIN 2. Base, #1**
- **PIN 3. Emitter, Die #2**
- **PIN 4. Base, #2**
- **PIN 5. Collector, Die #2**
- **PIN 6. Collector, Die #2**
- **PIN 7. Collector, Die #2**
- **PIN 8. Collector, Die #1**

### STYLE 17:
- **PIN 1. Vcc**
- **PIN 2. V2out**
- **PIN 3. Vout**
- **PIN 4. Txe**
- **PIN 5. Rxe**
- **PIN 6. Vee**
- **PIN 7. Gnd**
- **PIN 8. Acc**

### STYLE 18:
- **PIN 1. Anode**
- **PIN 2. Anode**
- **PIN 3. Anode**
- **PIN 4. Anode**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 19:
- **PIN 1. Line 1 In**
- **PIN 2. Common Cathode/Vcc**
- **PIN 3. Common Cathode/Vcc**
- **PIN 4. Line 1 In**
- **PIN 5. Common Anode/Gnd**
- **PIN 6. Common Anode/Gnd**
- **PIN 7. Common Anode/Gnd**
- **PIN 8. Common Anode/Gnd**

### STYLE 20:
- **PIN 1. Source (N)**
- **PIN 2. Gate 1**
- **PIN 3. Source 2**
- **PIN 4. Gate 2**
- **PIN 5. Drain 2**
- **PIN 6. Mirror 2**
- **PIN 7. Drain 1**
- **PIN 8. Mirror 1**

### STYLE 21:
- **PIN 1. Cathode 1**
- **PIN 2. Cathode 2**
- **PIN 3. Cathode 3**
- **PIN 4. Cathode 4**
- **PIN 5. Cathode 5**
- **PIN 6. Common Anode**
- **PIN 7. Common Anode**
- **PIN 8. Common Cathode**

### STYLE 22:
- **PIN 1. I/O Line 1**
- **PIN 2. Common Cathode/Vcc**
- **PIN 3. Common Cathode/Vcc**
- **PIN 4. I/O Line 3**
- **PIN 5. Common Anode/Gnd**
- **PIN 6. I/O Line 4**
- **PIN 7. Common Anode/Gnd**
- **PIN 8. Common Anode/Gnd**

### STYLE 23:
- **PIN 1. Line 1 In**
- **PIN 2. Common Anode/Gnd**
- **PIN 3. Common Anode/Gnd**
- **PIN 4. Line 1 In**
- **PIN 5. Line 2 Out**
- **PIN 6. Common Anode/Gnd**
- **PIN 7. Common Anode/Gnd**
- **PIN 8. Line 1 Out**

### STYLE 24:
- **PIN 1. Base**
- **PIN 2. Emitter**
- **PIN 3. Collector/Anode**
- **PIN 4. Collector/Anode**
- **PIN 5. Cathode**
- **PIN 6. Cathode**
- **PIN 7. Collector/Anode**
- **PIN 8. Collector/Anode**

### STYLE 25:
- **PIN 1. Vin**
- **PIN 2. N/C**
- **PIN 3. Rext**
- **PIN 4. Gnd**
- **PIN 5. Iout**
- **PIN 6. Iout**
- **PIN 7. Iout**
- **PIN 8. Iout**

### STYLE 26:
- **PIN 1. Ground**
- **PIN 2. Anode**
- **PIN 3. Emitter**
- **PIN 4. Source**
- **PIN 5. Drain**
- **PIN 6. Drain**
- **PIN 7. Drain**
- **PIN 8. Drain**

### STYLE 27:
- **PIN 1. I/O Limit**
- **PIN 2. Input+**
- **PIN 3. Source**
- **PIN 4. Source**
- **PIN 5. Source**
- **PIN 6. Source**
- **PIN 7. Source**
- **PIN 8. Source**

### STYLE 28:
- **PIN 1. SW_TO_GND**
- **PIN 2. Dasic Off**
- **PIN 3. Dasic SW Det**
- **PIN 4. Gnd**
- **PIN 5. V_mon**
- **PIN 6. Vbulk**
- **PIN 7. Vbulk**
- **PIN 8. Vin**