

# IS31BL3230

## 8 CHANNELS CONSTANT CURRENT LED DRIVER WITH PWM BRIGHTNESS CONTROL

March 2015

### GENERAL DESCRIPTION

The IS31BL3230 provides eight regulated current sources, each delivers up to 90mA of load current with careful selection of external sense resistors, all outputs at the IS31BL3230 may be connected in parallel to enable the current through the LED to be as high as 720mA.

The IS31BL3230 does not include a charge pump and therefore has no noise and significantly improved the efficiency. The external resistor,  $R_{SET1}$ , determines the constant current output of ports LED1 thru LED4, while resistor  $R_{SET2}$  determines the constant current output of ports LED5 thru LED8.

Brightness can be controlled with PWM techniques. The constant current source is set with two external sense resistors.

Alternatively, a PWM signal applied to the PWM pin can vary the perceived brightness of the LED. The device is in shut down mode when the PWM Input is logic low.

### FEATURES

- Ultra low headroom voltage
- Total output current can be 720mA
- Cost effective LED driver
- Current adjustable via external resistors
- Best noise and efficiency performance
- Highly integrated design, minimal component
- 1.6 $\mu$ A (Typ.) shutdown current
- Small package QFN-16 (3mm $\times$ 3mm)

### APPLICATIONS

- Flash LED driver
- Backlight LED driver

### TYPICAL APPLICATION CIRCUIT

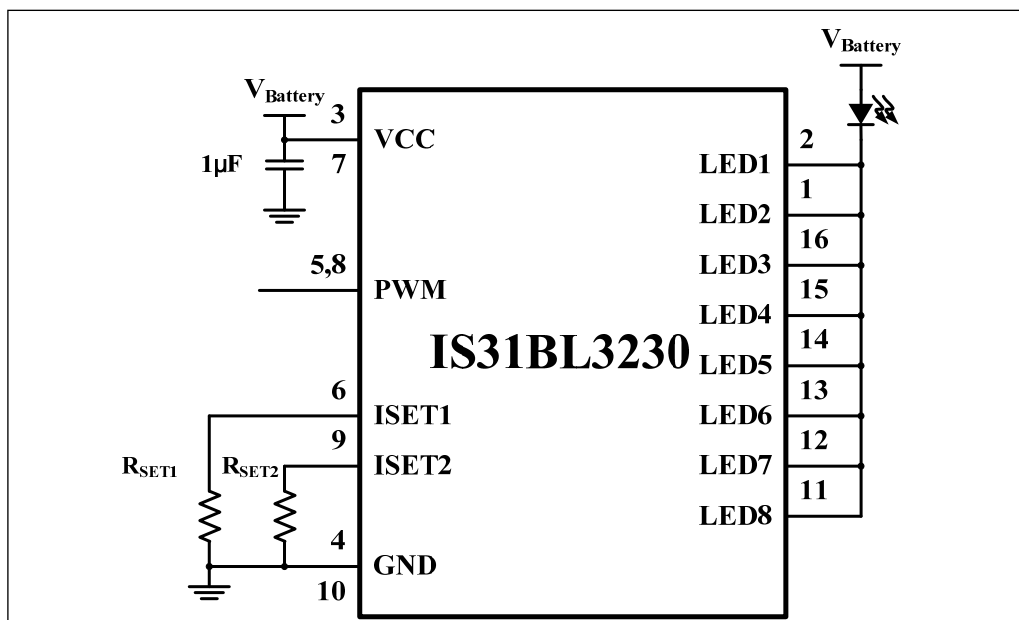


Figure 1 Typical Application Circuit for Flash LED Driving

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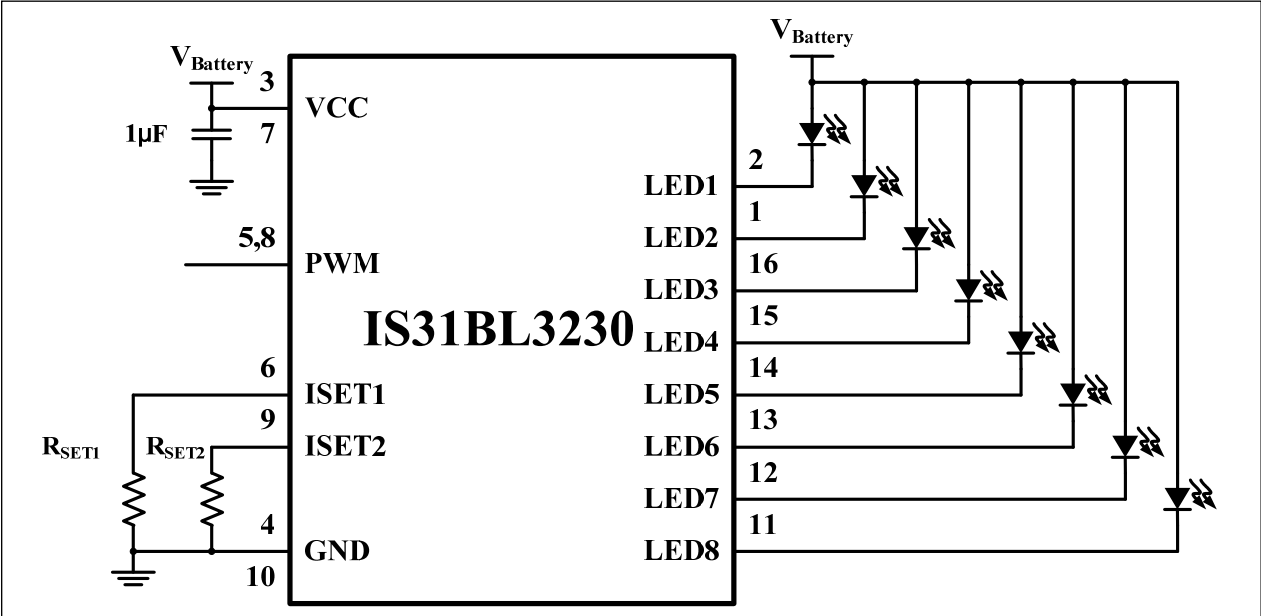
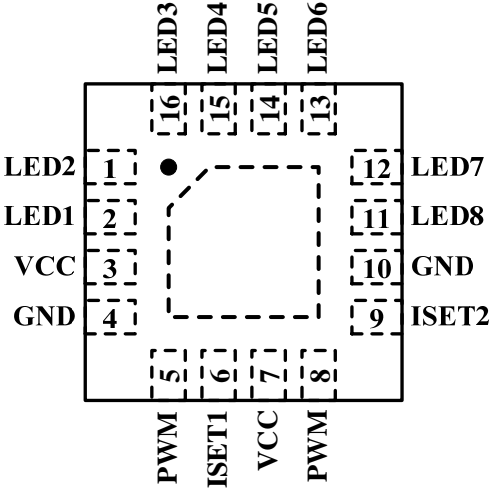


Figure 2 Typical Application Circuit for 8 LEDs Driving

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## PIN CONFIGURATION

| Package | Pin Configurations (Top View)  |
|---------|--|
| QFN-16  |  |

## PIN DESCRIPTION

| No.   | Name        | Description                 |
|-------|-------------|-----------------------------|
| 1     | LED2        | Current source outputs 2.   |
| 2     | LED1        | Current source outputs 1.   |
| 3, 7  | VCC         | Input voltage.              |
| 4, 10 | GND         | Ground.                     |
| 5, 8  | PWM         | PWM brightness control.     |
| 6     | ISET1       | Current set 1 input.        |
| 9     | ISET2       | Current set 2 input.        |
| 11~16 | LED8~LED3   | Current source outputs 8~3. |
|       | Thermal Pad | Connect to GND.             |



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## ORDERING INFORMATION

Industrial Range: -40°C to +85°C

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| Order Part No.      | Package           | QTY/Reel |
|---------------------|-------------------|----------|
| IS31BL3230-QFLS2-TR | QFN-16, Lead-free | 2500     |

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Rev. B, 02/09/2015

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## ABSOLUTE MAXIMUM RATINGS

|  |                       |
|--|-----------------------|
| Supply voltage, $V_{CC}$                 | -0.3V ~ +6.0V         |
| PWM                                      | -0.3V ~ $V_{CC}+0.3V$ |
| Maximum junction temperature, $T_{JMAX}$ | 150°C                 |
| Storage temperature range, $T_{STG}$     | -65°C ~ +150°C        |
| Operating temperature range, $T_A$       | -40°C ~ +85°C         |
| ESD (HBM)                                | 3kV                   |
| ESD (CDM)                                | 1kV                   |

### Note:

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

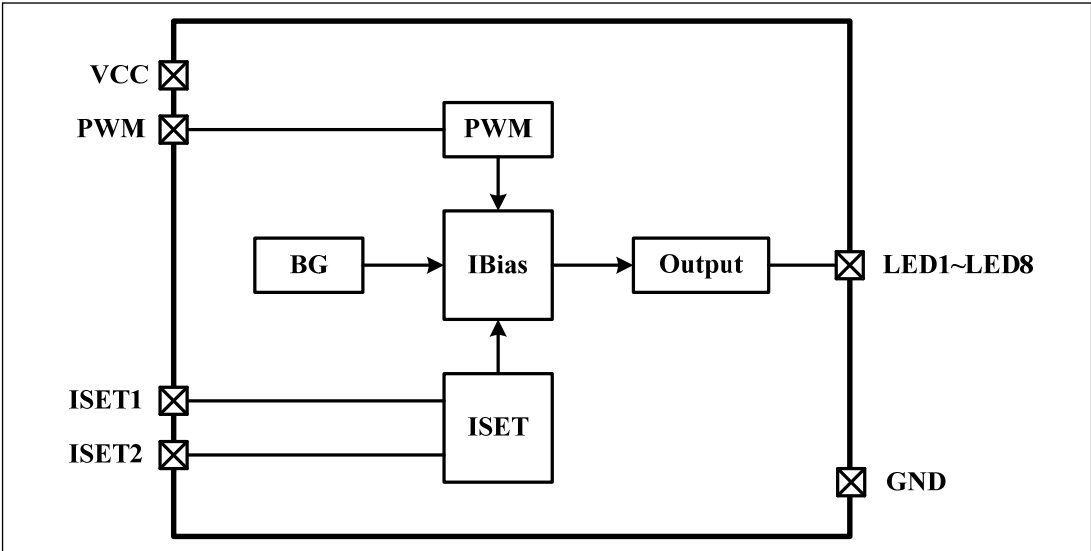
Unless otherwise specified or noted,  $V_{CC} = 3.6V$ ,  $R_{SET} = 7.5k\Omega$ ,  $V_{LEDX} = 0.5V$ . Limits apply for  $T_A = 25^\circ C$ . (Note 1)

| Symbol             | Parameter                           | Condition  | Min | Typ. | Max | Units   |
|--------------------|-------------------------------------|--|-----|------|-----|---------|
| $V_{CC}$           | Supply voltage                      |  | 2.7 |      | 5.5 | V       |
| $I_{LEDX}$         | Output current regulation           | $V_{LEDX} = 0.4V \sim 2.0V$ , $R_{SET} = 7.5k\Omega$ |     | 16   |     | mA      |
| $V_{HR}$           | Minimum headroom voltage (LEDX)     | $R_{SET} = 7.5k\Omega$ , $I_{LEDX} = 20mA$           |     | 44   |     | mV      |
| $V_{SET}$          | ISET pin voltage                    |  |     | 1.2  |     | V       |
| $I_{LEDX}/I_{SET}$ | Output current to current set ratio |  |     | 100  |     | mA/mA   |
| $I_{CC}$           | Quiescent supply current            | $I_{LEDX} = 0mA$ , $I_{SET} = \text{Float}$          |     | 244  |     | $\mu A$ |
| $I_{PWM}$          | Shutdown supply current             | $V_{PWM} = 0V$                                       |     | 1.6  |     | $\mu A$ |
| $V_{PWM\_H}$       | PWM input logic high                | $V_{CC} = 3.0V \sim 5.5V$                            | 1.4 |      |     | V       |
| $V_{PWM\_L}$       | PWM input logic low                 | $V_{CC} = 3.0V \sim 5.5V$                            |     |      | 0.4 | V       |
| $I_{PWM}$          | PWM pin current                     | $V_{PWM} = 1.5V$                                     |     | 5.6  |     | $\mu A$ |

**Note 1:** Production testing of the device is performed at 25°C. Functional operation of the device and parameters specified over other temperature range, are guaranteed by design, characterization and process control.

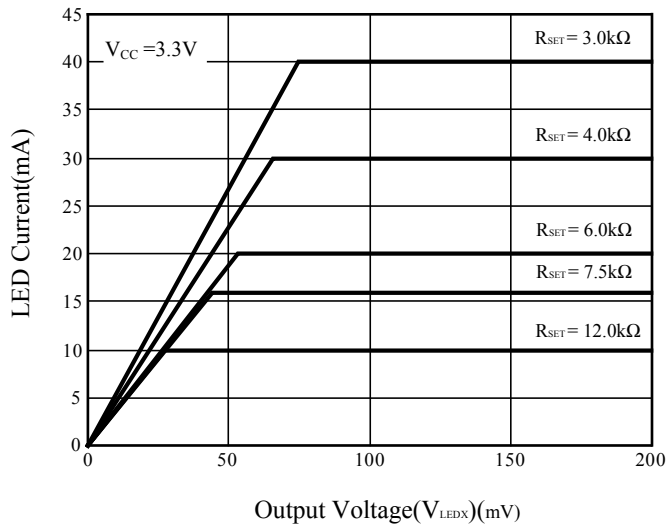
# IS31BL3230

## FUNCTIONAL BLOCK DIAGRAM

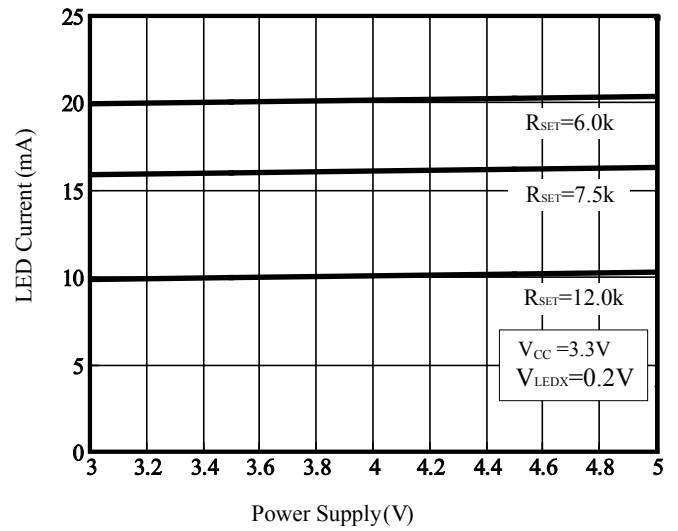


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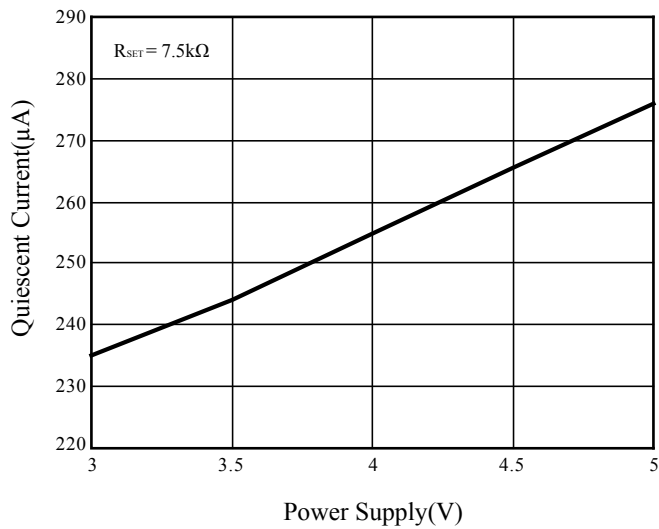
## TYPICAL PERFORMANCE CHARACTERISTICS



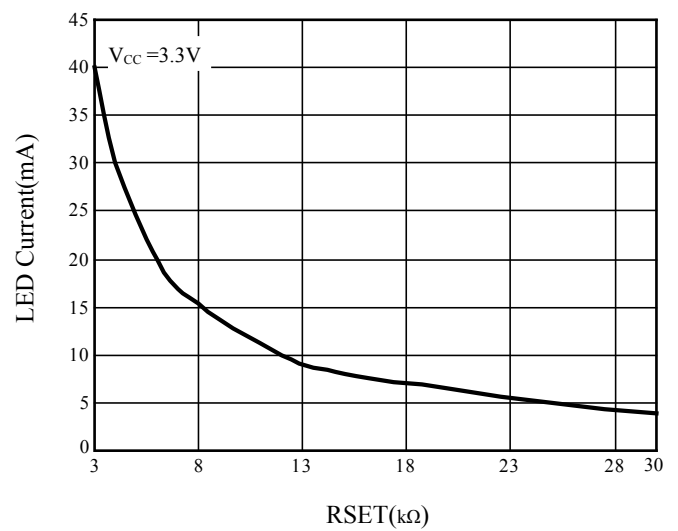
**Figure 3** Output Voltage vs. LED Current



**Figure 4** Power Supply vs. LED Current



**Figure 5** Power Supply vs. Quiescent Current



**Figure 6** R<sub>SET</sub> vs. LED Current

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## APPLICATION INFORMATION

### CIRCUIT DESCRIPTION

The IS31BL3230 is a white-LED driver with eight matched current outputs. The matched current regulators each has a 100:1 current ratio between the LED<sub>X</sub> outputs and the I<sub>SET</sub> currents. The mirror controls the current through the LEDs without the use of external ballast resistors. With a total of 720mA of total output current available, the IS31BL3230 is capable of providing 90mA to each of the eight outputs through the proper selection of the R<sub>SET1</sub> & R<sub>SET2</sub> resistor. LED brightness control can be achieved on the IS31BL3230 with PWM signal.

### SHUTDOWN

When the voltage on the active-high-logic PWM pin is low, the IS31BL3230 will be in shutdown mode. While disabled, the IS31BL3230 typically draws 1.6µA from the power supply. There is no internal pull-up or pull-down on the PWM pin of the IS31BL3230.

### OUTPUT CURRENT CAPABILITY

The IS31BL3230 can provide up to 40mA of current to each of the eight outputs given an input voltage of 2.7V to 5.5V. An external resistor can be used to set the output current, as approximated with the following equation:

$$R_{SET1,2} = 100 \times (V_{ISET1,2} / I_{LEDX})$$

R<sub>SET1</sub> determines the constant current output of ports LED1 thru LED4, R<sub>SET2</sub> determines the constant current output of ports LED5 thru LED8, V<sub>ISET</sub> is the voltage of R<sub>SET</sub> resistance, it is 1.20V typically. In order for the output currents to be regulated properly, sufficient headroom voltage (V<sub>HR</sub>) is required. The headroom voltage refers to the minimum amount of voltage that must be present across the current source in order to ensure the desired current is realizable. To ensure the desired current is obtained, using the following equations to find the minimum input voltage required:

$$V_{CC} - V_{LEDX} \geq V_{HR}$$

V<sub>LEDX</sub> is the diode forward voltage; V<sub>HR</sub> is typically as shown in table 1.

**Table 1** I<sub>LED</sub>, R<sub>SET</sub> and V<sub>HR-MIN</sub>, V<sub>CC</sub>=3.6V

| I <sub>LED</sub> | R <sub>SET</sub> | V <sub>HEADROOM</sub> |
|------------------|------------------|-----------------------|
| 10.0mA           | 12.0kΩ           | 27mV(typ.)            |
| 16.0mA           | 7.5kΩ            | 44mV(typ.)            |
| 20.0mA           | 6.0kΩ            | 53mV(typ.)            |
| 30.0mA           | 4.0kΩ            | 66mV(typ.)            |
| 40.0mA           | 3.0kΩ            | 75mV(typ.)            |
| 43.8mA           | 2.7kΩ            | 100mV(typ.)           |
| 62.5mA           | 2kΩ              | 150mV(typ.)           |
| 87.5mA           | 1.4kΩ            | 210mV(typ.)           |

### PWM BRIGHTNESS CONTROL

Brightness control can be implemented by pulsing a signal at the PWM pin.

The R<sub>SET</sub> value should be selected using the R<sub>SET</sub> equation. The LED brightness is proportional to the duty cycle (D) of the PWM signal. The PWM frequency (f) should be limited to accommodate the turn-on time (t<sub>ON</sub>=50µs) of the device.

$$D \times (1/f) > t_{ON}$$

$$f_{MAX} = D_{MIN} / t_{ON}$$

If the PWM frequency is much less than 100Hz, flicker may be seen in the LEDs. For the IS31BL3230, zero duty cycle will turn off the LEDs and a 50% duty cycle will result in an average I<sub>LED</sub> being half of the programmed LED current. For example, if R<sub>SET</sub> is set to program 16mA, a 50% duty cycle will result in an average I<sub>LED</sub> of 8mA, I<sub>LED</sub> being half the programmed LED current. R<sub>SET</sub> should be chosen not to exceed the maximum current delivery capability of the device.

### LED SELECTION

The IS31BL3230 has ultra low headroom voltage and it is designed to drive white-LEDs with a typical forward voltage up to 3.5V.

As the voltage drop below the recommend V<sub>HR</sub>, the drive current will automatically scale down to reduce the LED current consumption.

### POWER DISSIPATION

The maximum allowable power dissipation that this package can handle is determined by the following:

$$P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$$

Where T<sub>JMAX</sub> is the maximum junction temperature, T<sub>A</sub> is the ambient temperature and θ<sub>JA</sub> is the junction-to-ambient thermal resistance of the specified package. The IS31BL3230 come in the QFN-16 3mm×3mm package, and it has a junction-to-ambient thermal resistance (θ<sub>JA</sub>) equal to 34.5°C/W. This value of θ<sub>JA</sub> is highly dependant upon the layout of the PC board. The actual power dissipated by the IS31BL3230 follows the equation:

$$P_{DISS} = (V_{CC} \times I_{CC}) - N(V_{LEDX} \times I_{LEDX})$$

Where N equals the number of active outputs, V<sub>LEDX</sub> is the LED forward voltage, and I<sub>LEDX</sub> is the current supplied to the LED.

### INPUT CAPACITOR SELECTION

The IS31BL3230 is designed to run off of a fixed input voltage. Depending on the stability and condition of this voltage rail, it may be necessary to add some small input capacitors to help filter out any noise that may be present on the line. In the event that filtering is



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needed, surface-mount multi-layer ceramic capacitors are recommended. These capacitors are small and inexpensive. Two capacitances, a 0.1 $\mu$ F and a 1 $\mu$ F are typically sufficient.

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## CLASSIFICATION REFLOW PROFILES

| Profile Feature   | Pb-Free Assembly                 |
|---|----------------------------------|
| <b>Preheat &amp; Soak</b><br>Temperature min (T <sub>smin</sub> )<br>Temperature max (T <sub>smax</sub> )<br>Time (T <sub>smin</sub> to T <sub>smax</sub> ) (t <sub>s</sub> ) | 150°C<br>200°C<br>60-120 seconds |
| Average ramp-up rate (T <sub>smax</sub> to T <sub>p</sub> )   | 3°C/second max.                  |
| Liquidous temperature (T <sub>L</sub> )<br>Time at liquidous (t <sub>L</sub> )  | 217°C<br>60-150 seconds          |
| Peak package body temperature (T <sub>p</sub> )*  | Max 260°C                        |
| Time (t <sub>p</sub> )** within 5°C of the specified classification temperature (T <sub>c</sub> )   | Max 30 seconds                   |
| Average ramp-down rate (T <sub>p</sub> to T <sub>smax</sub> )   | 6°C/second max.                  |
| Time 25°C to peak temperature   | 8 minutes max.                   |

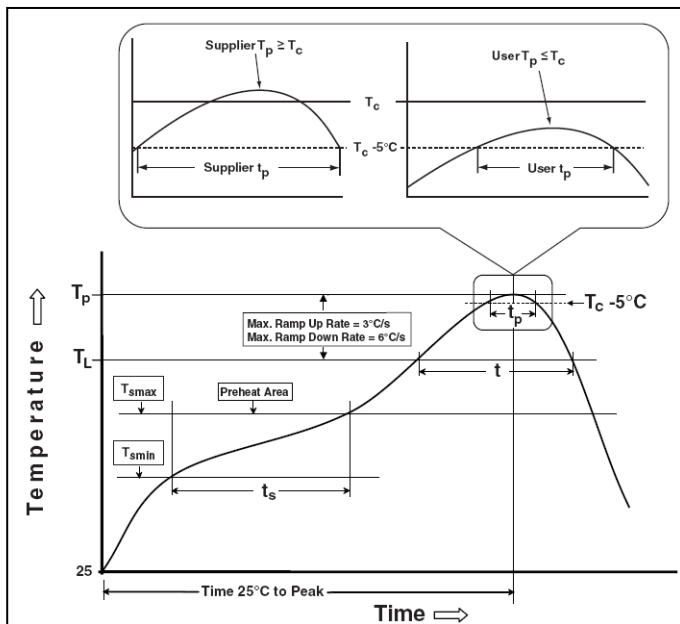
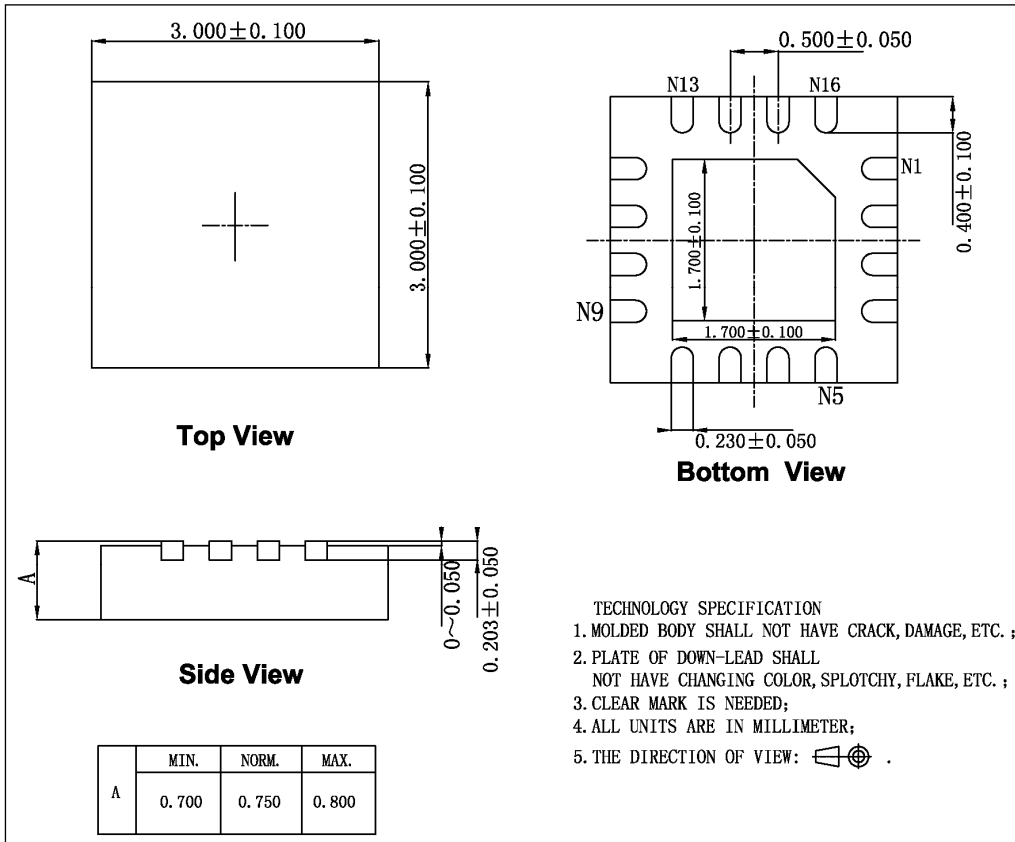


Figure 7 Classification Profile

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## PACKAGE INFORMATION

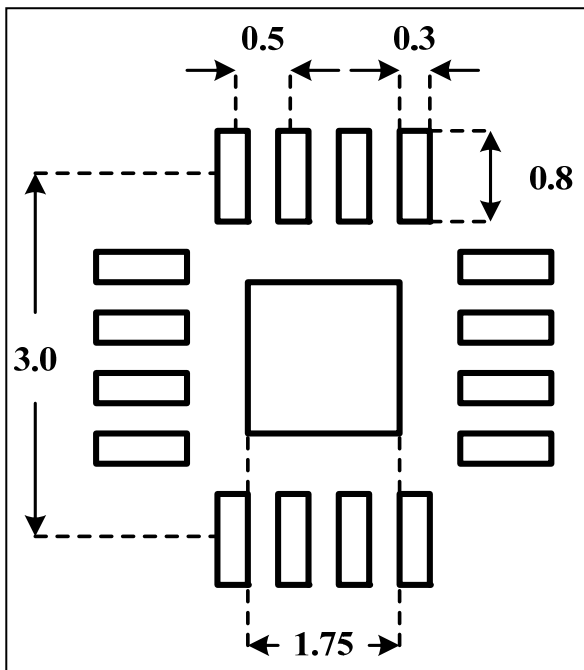
### QFN-16



**Note:** All dimensions in millimeters unless otherwise stated.

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## LAND PATTERN



**Note:**

1. Land pattern complies to IPC-7351.
2. All dimensions in MM.

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