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
- 1.6μA (Typ.) shutdown current
- Small package QFN-16 (3mm×3mm)

APPLICATIONS

- Flash LED driver
- Backlight LED driver
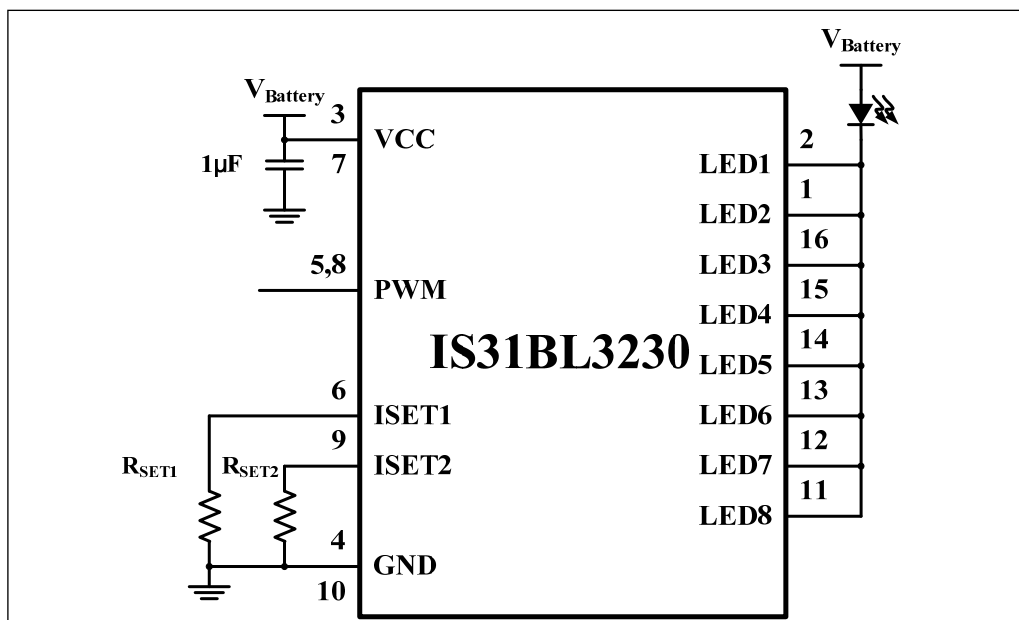
TYPICAL APPLICATION CIRCUIT

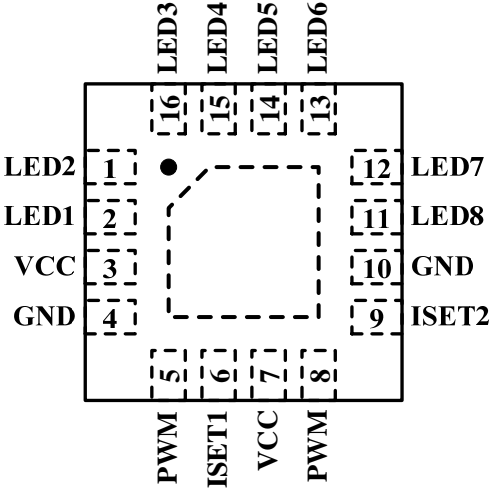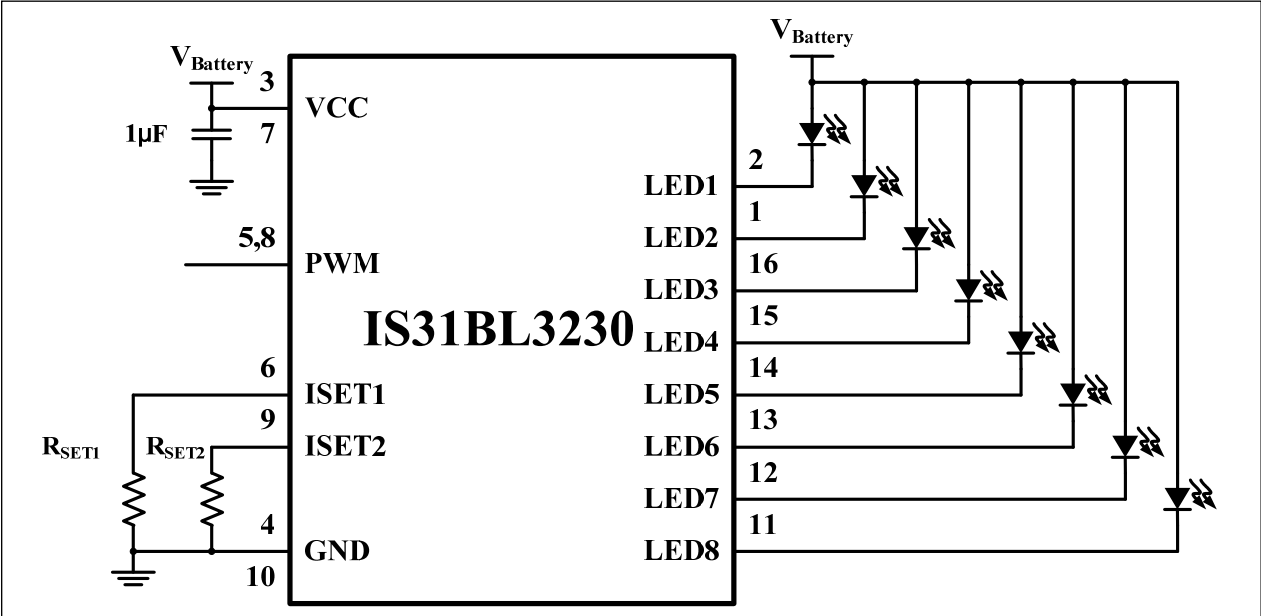**Figure 1** Typical Application Circuit for Flash LED Driving

Figure 2 Typical Application Circuit for 8 LEDs Driving

IS31BL3230

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.

IS31BL3230

ORDERING INFORMATION
Industrial Range: -40°C to +85°C

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

IS31BL3230

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}=7.5kΩ, V_{LEDX}=0.5V. Limits apply for T_A=25°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~2.0V, R_{SET} = 7.5kΩ		16		mA
V_{HR}	Minimum headroom voltage (LEDX)	R_{SET}= 7.5kΩ, 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}= Float		244		µA
I_{PWM}	Shutdown supply current	V_{PWM}=0V		1.6		µA
V_{PWM_H}	PWM input logic high	V_{CC} = 3.0V~5.5V	1.4			V
V_{PWM_L}	PWM input logic low	V_{CC} = 3.0V~5.5V			0.4	V
I_{PWM}	PWM pin current	V_{PWM} = 1.5V		5.6		µA

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.

FUNCTIONAL BLOCK DIAGRAM
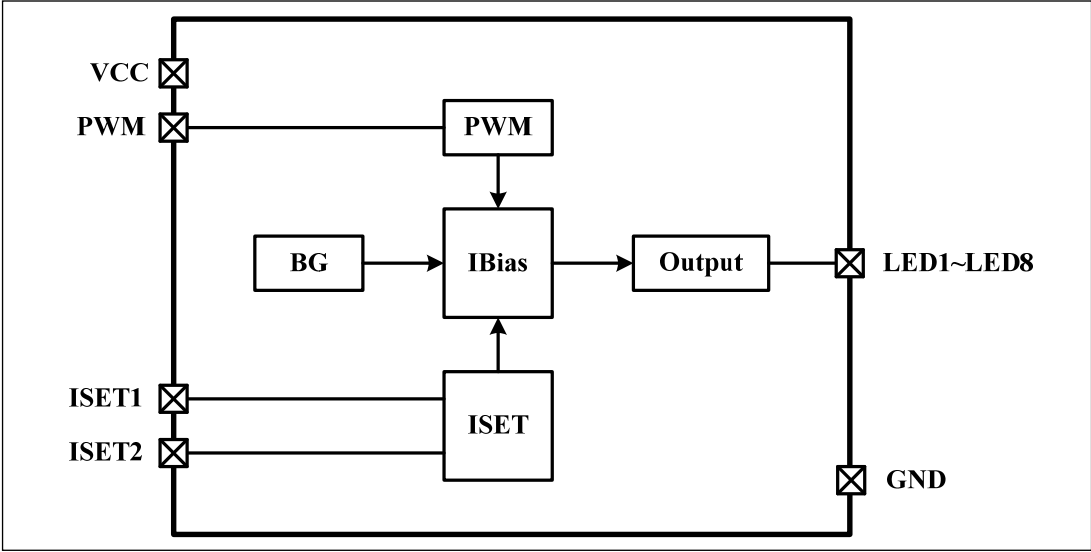
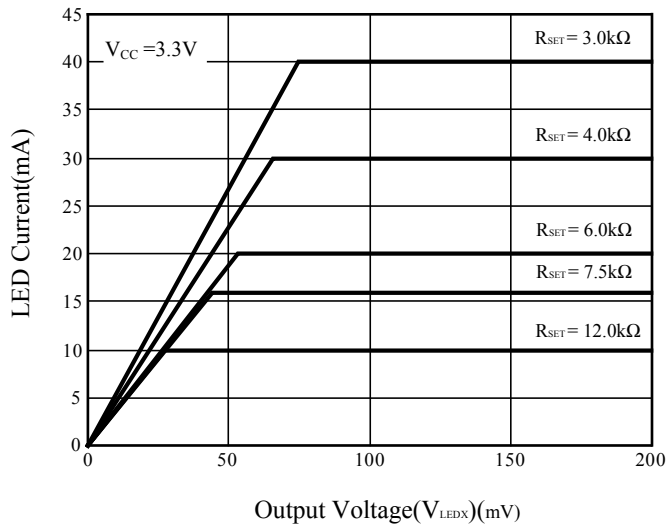## TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3   Output Voltage vs. LED Current
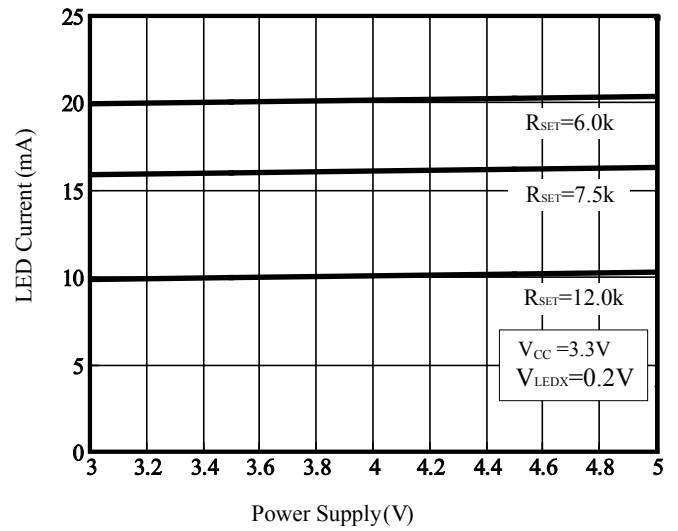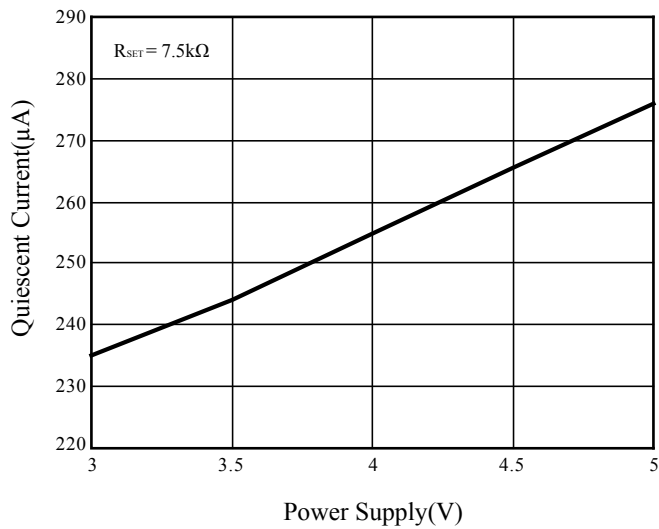

Figure 4   Power Supply vs. LED Current

Figure 5   Power Supply vs. Quiescent Current
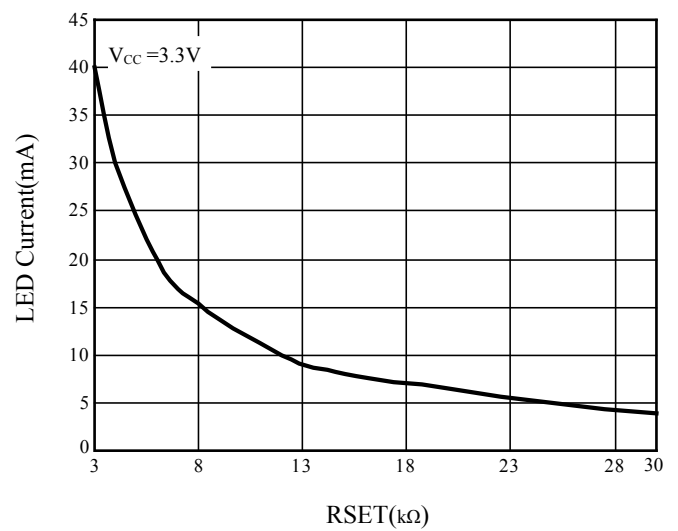

Figure 6   R$_{SET}$ vs. LED Current

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_X outputs and the I_{SET} 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_{SET1} & R_{SET2} 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 form 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 the equation:

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

R_{SET1} determines the constant current output of ports LED1 thru LED4, R_{SET2} determines the constant current output of ports LED5 thru LED8, V_{ISET} is the voltage of R_{SET} resistance, it is 1.20V typically. In order for the output currents to be regulated properly, sufficient headroom voltage (V_{HR}) 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_{LEDX} is the diode forward voltage; V_{HR} is typically as shown in table1.

Table 1 I_{LED}, R_{SET} and V_{HR-MIN}, V_{CC}=3.6V

I_{LED}	R_{SET}	$V_{HEADROOM}$
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_{SET} value should be selected using the R_{SET} 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_{ON}=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_{LED} being half of the programmed LED current. For example, if R_{SET} is set to program 16mA, a 50% duty cycle will result in an average I_{LED} of 8mA, I_{LED} being half the programmed LED current. R_{SET} 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_{HR}, 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_{JMAX} is the maximum junction temperature, T_A is the ambient temperature and θ_{JA} 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_{JA}) equal to 34.5°C/W. This value of θ_{JA} 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_{LEDX} is the LED forward voltage, and I_{LEDX} 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

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

CLASSIFICATION REFLOW PROFILES

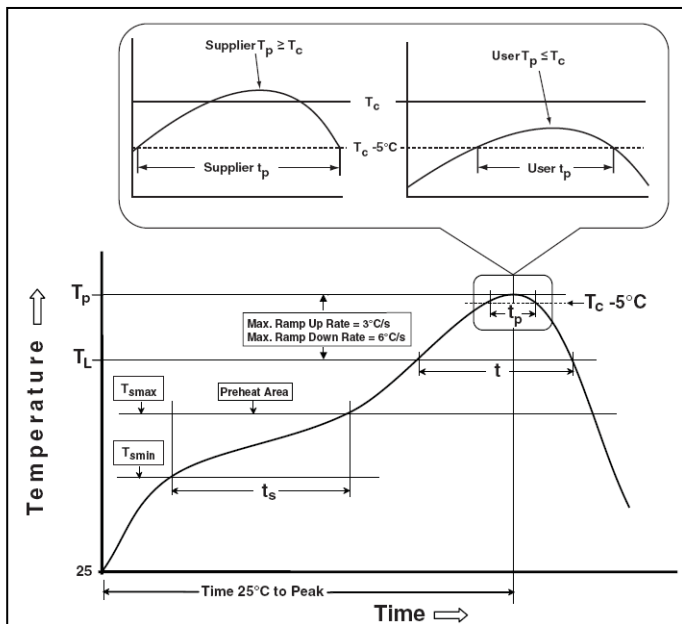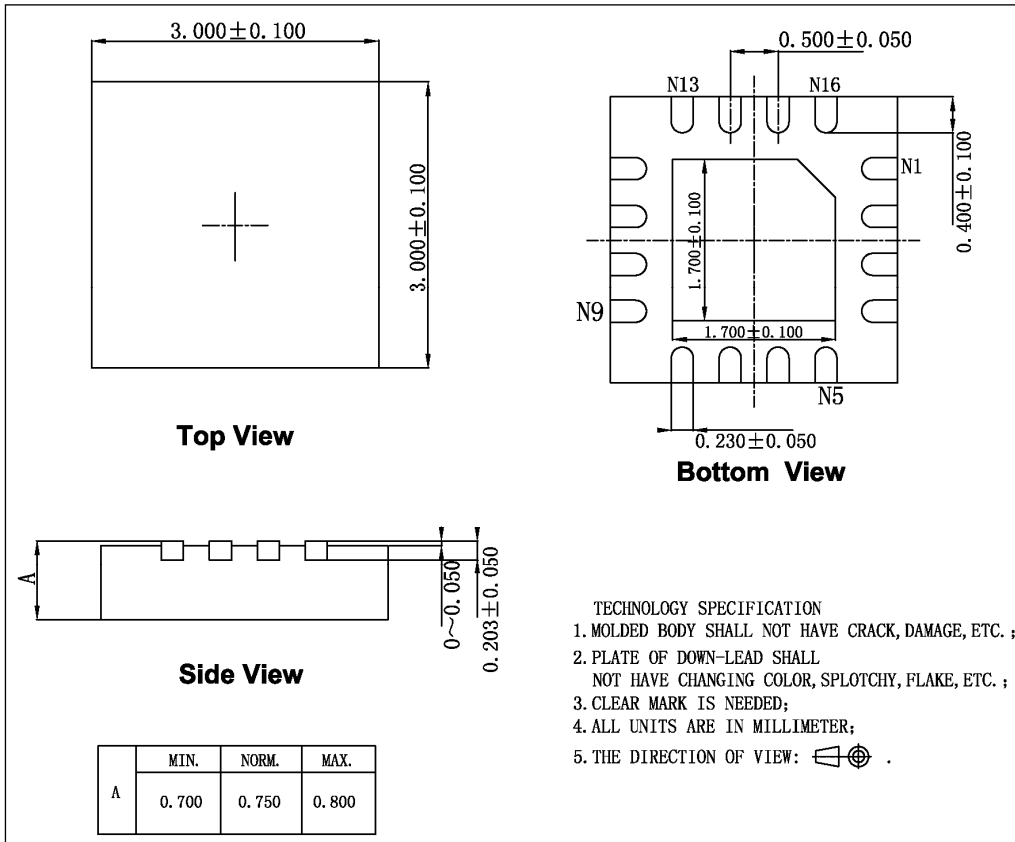| Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

Figure 7 Classification Profile

PACKAGE INFORMATION

QFN-16

Top View — 3.000±0.100, 3.000±0.100

Bottom View — 0.500±0.050, 0.400±0.100, 1.700±0.100, 1.700±0.100, 0.230±0.050, N13, N16, N1, N9, N5

Side View — A, 0~0.050, 0.203±0.050

	MIN.	NORM.	MAX.
A	0.700	0.750	0.800

TECHNOLOGY SPECIFICATION
1. MOLDED BODY SHALL NOT HAVE CRACK, DAMAGE, ETC. ;
2. PLATE OF DOWN-LEAD SHALL
   NOT HAVE CHANGING COLOR, SPLOTCHY, FLAKE, ETC. ;
3. CLEAR MARK IS NEEDED;
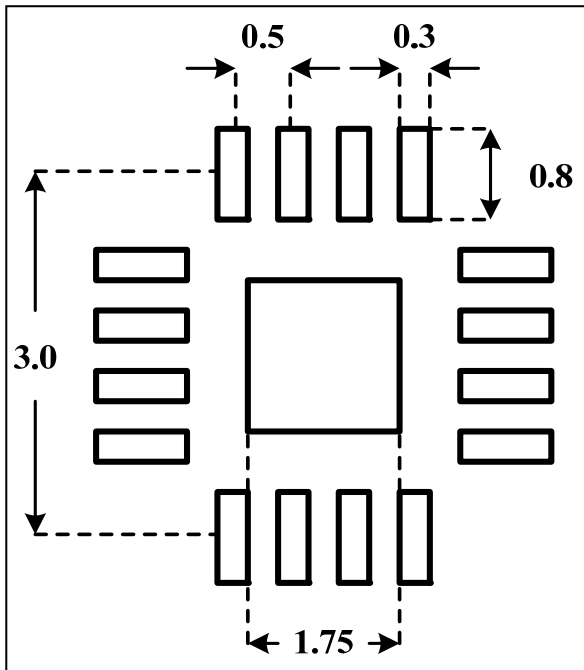4. ALL UNITS ARE IN MILLIMETER;
5. THE DIRECTION OF VIEW: ⊏⊐⊕ .

Note: All dimensions in millimeters unless otherwise stated.

LAND PATTERN

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