

IS31LT3515

HIGH VOLTAGE LED LIGHTING DRIVER BOOST OR BUCK-BOOST TOPOLOGY

Advanced Information
March 2015

GENERAL DESCRIPTION

The IS31LT3515 is a current mode PWM controller designed to drive an external MOSFET for high current LED applications. With a current sense amplifier threshold of 250mV, the LED current is programmable with one external current sense resistor. The IS31LT3515 is ideal for boost or buck-boost operation. With 250kHz operating frequency (typical, and this frequency can be set up by external resistor), the external inductor and capacitors can be small while maintaining high efficiency.

Dimming can be either analog or PWM digital. Input DC voltage from LD pin for analog dimming. Input PWM signal from PWM pin can get either analog dimming or PWM dimming.

The IS31LT3515 is available in SOP-16 package and TSSOP-16 package.

FEATURES

- Wide input voltage from 5V to 35V
- Boost or buck-boost operation
- Easy dimming: Analog, PWM or PWM converting to analog with an external capacitor
- Output over voltage protection (OVP)
- Internal soft start to avoid inrush current
- Current mode PWM with an 250kHz operating frequency (Typical, $R_{SET} = 150k\Omega$)
- Output short circuit protection
- VCC under voltage lock out and over temperature protection (OTP)

APPLICATIONS

- General industrial high power LED lighting
- Desk lights and room lighting, street lighting
- Display backlight

TYPICAL APPLICATION CIRCUIT

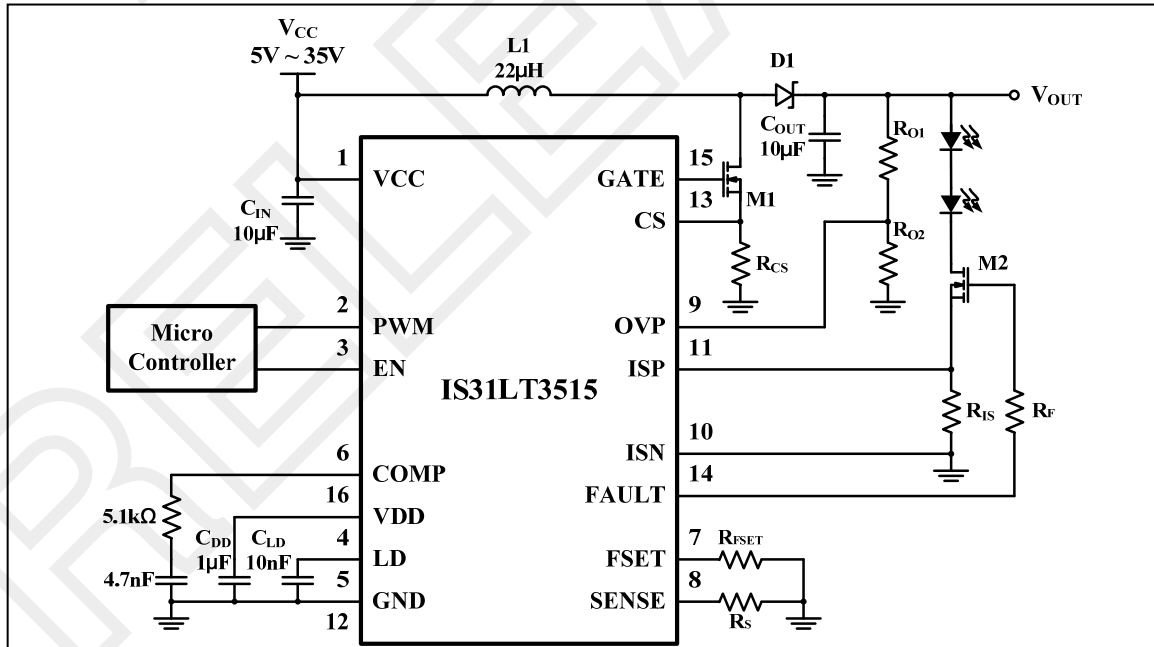


Figure 1 Typical Application Circuit (Boost Configuration)

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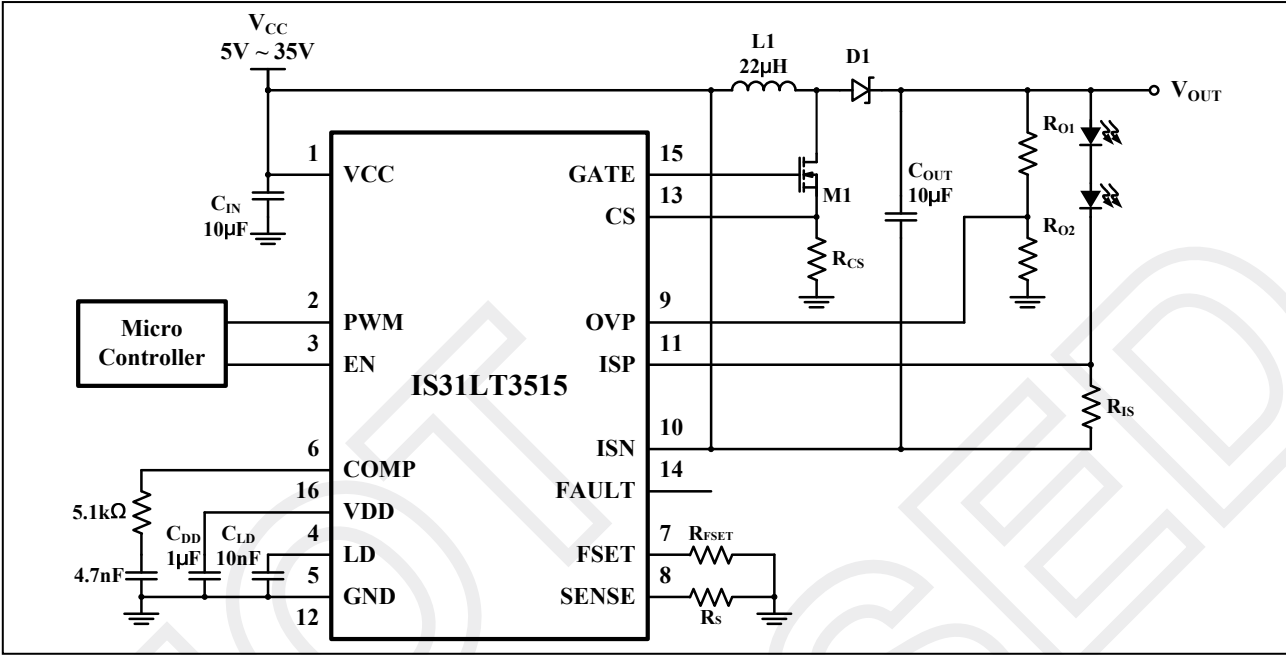
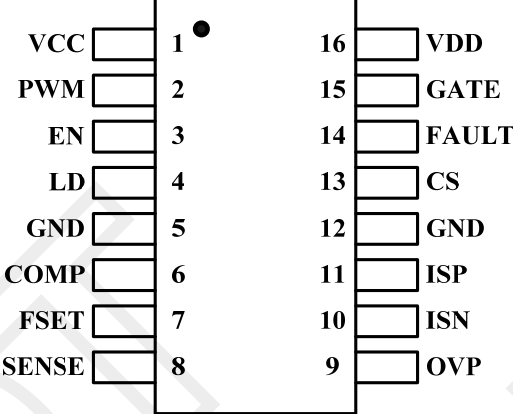


Figure 2 Typical Application Circuit (Buck-Boost Configuration)

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PIN CONFIGURATION

Package	Pin Configurations (Top View)
SOP-16 TSSOP-16	

PIN DESCRIPTION

No.	Pin	Description
1	VCC	The power supply pin.
2	PWM	PWM dimming input. The PWM signal will convert to analog signal with an external capacitor. High is enabled, internal has pull down resistor.
3	EN	Enable pin. Floating (pull up internal), enable; pull to low, shutdown mode.
4	LD	Analog dimming input.
5,12	GND	Ground.
6	COMP	Buck-boost/boost compensation pin, connect external RC.
7	FSET	With an external resistor to set operation frequency. (250kHz, $R_{FSET}=150k\Omega$)
8	SENSE	Current sense mirror pin, connect a resistor to CS pin (5000:1).
9	OVP	Over voltage protect, this pin voltage exceed 1.2V, GATE will pull low.
10	ISN	The LED current sense amplifier negative input.
11	ISP	The LED current sense amplifier positive input.
13	CS	MOSFET current sense.
14	FAULT	This pin is the same as PWM signal and when $V_{ISP}-V_{ISN}>0.5V$, pulled to ground (short circuit is detected).
15	GATE	Gate drive to the external MOSFET (12V).
16	VDD	LDO 12V output, need a 1 μ F external capacitor.



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ORDERING INFORMATION
INDUSTRIAL RANGE: -40°C TO +85°C

Order Part No.	Package	QTY
IS31LT3515-GRLS2-TR	SOP-16, Lead-free	2500/Reel
IS31LT3515-GRLS2		50/Tube
IS31LT3515-ZLS2-TR	TSSOP-16, Lead-free	2500/Reel
IS31LT3515-ZLS2		96/Tube

NOT RELEASABLE

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ABSOLUTE MAXIMUM RATINGS

VDD, VCC, ISP, ISN	-0.3V ~ +40V
GATE	-0.3V ~ +13V
FAULT	-0.3V ~ +13V
EN, PWM, OVP, LD	-0.3V ~ +6V
Operating temperature ($T_A = T_J$)	-40°C ~ +85°C
Junction temperature, $T_{J(MAX)}$	150°C
Storage temperature, T_{STG}	-65°C ~ +150°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.

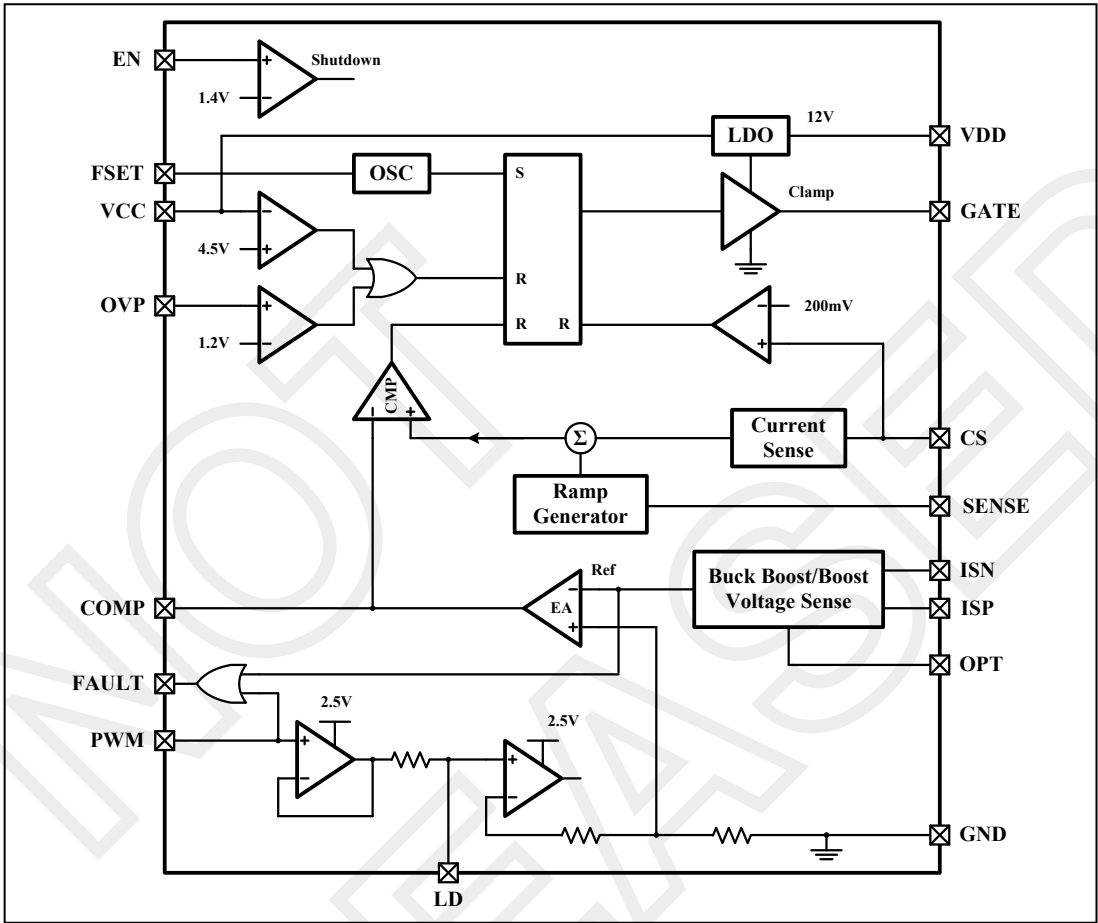
ELECTRICAL CHARACTERISTICS (TBD)

The specifications are at $T_A = 25^\circ\text{C}$, unless otherwise noted.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	Input voltage range		5		35	V
I_{CC}	Supply current	Gate switch off		1.2	2	mA
I_{SD}	Shutdown current	Enable low		150	200	μA
V_{UVLO}	Under-voltage lockout	V_{CC} falling		4.5	5	V
V_{UVLO_HY}	Under-voltage lockout hysteresis			200		mV
V_{FB}	ISP-ISN threshold		245	250	255	mV
V_{CS_TH}	Current limit threshold			200	230	mV
V_{SP}	Short protection threshold	Boost architecture		500	600	mV
t_{SP}	Short protection reset time	Boost architecture		2		s
V_{GATE}	GATE clamp voltage	$V_{CC} > 12\text{V}$	11	12	13	V
f_{SW}	Operation frequency	$R_{FSET} = 150\text{k}\Omega$	170	200	230	kHz
t_{RISE}	GATE rise time	$C_{GATE} = 1\text{nF}$		40		ns
t_{FALL}	GATE fall time	$C_{GATE} = 1\text{nF}$		30		ns
V_{FAULT}	Fault clamp voltage		9.5	10	10.5	V
V_{OVP}	Over voltage protection threshold		1.1	1.2	1.3	V
V_{OVP_HY}	OVP hysteresis			250		mV
V_{LD}	Analog dimming range		0.1		2.5	V
V_{LD_MAX}	Full range analog dimming		2.45	2.5	2.55	V
I_{LD}/I_{PWM}	LD/PWM pin input current				2	μA
D_{MAX}	Maximum duty cycle		85	90		%
V_{IH}	Logic high threshold on EN/PWM pin				1.4	V
V_{IL}	Logic low threshold on EN/PWM pin		0.4			V

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FUNCTIONAL BLOCK DIAGRAM





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TYPICAL PERFORMANCE CHARACTERISTICS (TBD)

NOT
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APPLICATION INFORMATION

The IS31LT3515 is a current mode PWM controller designed to drive an external MOSFET for high current LED applications. The LED current is programmable with one external current sense resistor. The IS31LT3515 is ideal for boost or buck-boost operation. With 250kHz operating frequency (typical, and this frequency can be set up by external resistor), the external inductor and capacitors can be small while maintaining high efficiency.

INPUT AND OUTPUT CAPACITOR

The output capacitor is decided by the output voltage ripple. A low ESR electronic capacitor (10 μ F or larger) will provide sufficient output capacitance for most applications. The input capacitor is used to reduce the input voltage ripple and noise. A low ESR electric capacitor (10 μ F or larger) and a 1 μ F/50V ceramic capacitor in parallel as output capacitor is recommended. Place the input and output capacitors close to the IS31LT3515 to reduce the ripple.

INDUCTOR

Inductor value involves trade-offs in performance. Larger inductors reduce inductor ripple current and larger inductors also bring in unwanted parasitic resistor that degrade the performance. Select an inductor with a rating current over input average current and the saturation current over the Internal NMOS current limit.

DIODE

To achieve high efficiency, a schottky diode must be used. Ensure that the diode's average and peak current rating exceed the output LED current and inductor peak current. The diode's reverse breakdown voltage must exceed the over voltage protection voltage (V_{OVP}).

SOFT-START

The function of soft-start is made for suppressing the inrush current to an acceptable value at startup. The IS31LT3515 provides a built-in soft-start function by clamping the input current and increasing step-by-step so that the output voltage will rise gradually in the soft-start period.

LED CURRENT CONTROL

The IS31LT3515 regulates the LED current by setting the external resistor connecting to ISP and ISN. The internal feedback reference voltage V_{FB} is 0.25V (Typ.). When the LD pin is tied to a voltage higher than 2.5V, the LED current can be set from the Equation (1) easily:

$$I_{LED} = V_{FB} / R_S \quad (1)$$

In order to have an accurate LED current, precision resistors are preferred (1% is recommended).

The LD pin also can be used to dim the output current by decreasing the internal feedback reference voltage. When the LD voltage is lower than 2.5V, the output current is:

$$I_{LED} = V_{LD} / (10 \times R_S) \quad (2)$$

When the LD voltage is lower than 0.1V, the output will be off.

DIMMING CONTROL

IS31LT3515 can modulate the brightness of LEDs by controlling the DC voltage or the PWM duty cycle.

The output LED voltage will decrease when the output current becomes lower. Therefore, it must to ensure the output voltage always higher than the input voltage during the dimming in the boost configuration.

PWM Dimming

PWM switches the LED on and off by the different duty cycle. Vary the duty cycle of PWM signal to change the output current (Figure 3).

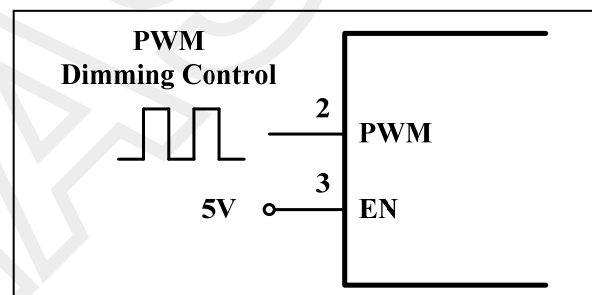


Figure 3 PWM Dimming Control

Analog Dimming

DC voltage ($0.1V < V_{LD} < 2.5V$) is linearly controlled the feedback reference voltage to change the output current. Connecting a capacitor from LD pin to GND, PWM signal fed at PWM pin can be low-pass filter to analog signal to change the output current (Figure 4).

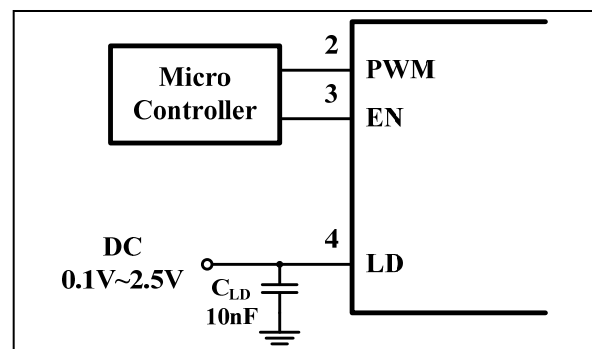


Figure 4 DC Dimming Control

SETTING THE OVER VOLTAGE PROTECTION

The open string protection is achieved through the over voltage protection (OVP). In some cases, if the output voltage reaches the programmed OVP voltage

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(V_{OVP}), the protection will be triggered. To make sure the chip functions properly, the OVP setting resistor divider must be set with a proper value. The OVP voltage should be 3V higher than normal operation output voltage. OVP pin should connect a 10nF ceramic capacitor to GND to avoid unexpected noise coupling into this pin and affecting the OVP function. The OVP threshold is calculated through the Equation (3).

$$V_{OVP} = \frac{1.2V \times (R_{O1} + R_{O2})}{R_{O2}} \quad (3)$$

SHORT CIRCUIT PROTECTION (BOOST CONFIGURATION)

When the output is short and the output current becomes higher than twice the steady state current, the GATE and FAULT outputs are pulled low for 2 seconds. The hiccup timer is started. Once the timing is complete, the converter attempts to restart. If the fault condition still persists, the converter shuts down and goes through the cycle again. If the fault condition is cleared (due to a momentary output short) the converter will start regulating the output current normally. This allows the LED driver to recover from accidental shorts without having to reset the IC.

THERMAL ROLL BACK OF OUTPUT CURRENT

To protect the IC from damage due to high power dissipation, the temperature of the die is monitored. When the temperature of the die is below the thermal rollback start threshold of (120°C), the output current maximum is the value set by the selection of R_S . When the die temperature is between the thermal rollback start threshold and the over temperature shutdown threshold, the output current decreases linearly from the peak value to a target value of 40% of the maximum current occurring at the thermal shutdown temperature.

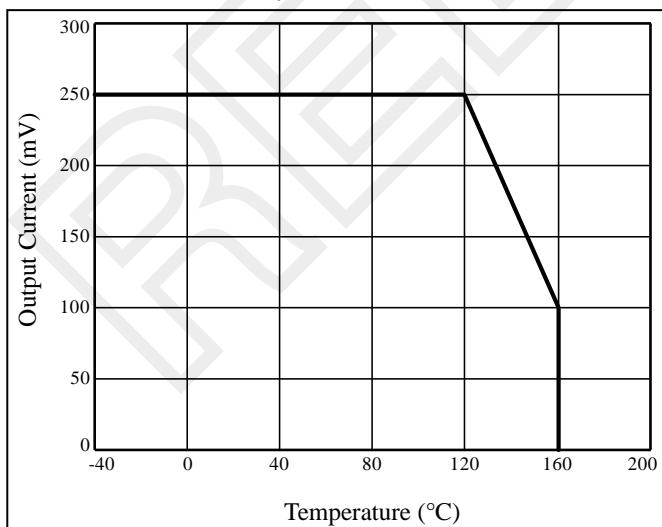


Figure 5 Thermal Roll Back

PCB LAYOUT CONSIDERATION

As for all switching power supplies, especially those providing high current and using high switching frequencies, layout is an important design step. If layout is not carefully done, the regulator could show instability as well as EMI problems.

- Wide traces should be used for connection of the high current loop.
- When layout signal ground (pin 5), it is recommended to use the traces separate from power ground (pin12) traces and connect them together at the input capacitor negative terminal or the large ground plane that will avoid the signal ground shift. Both of signal and power ground should be as wide as possible. Other components ground must be connected to signal ground. Especially the R_{FSET} ground to signal ground (pin 5) connection should be as short as possible to have an accurate LED current.
- The capacitor C_{IN} and C_{DD} should be placed as close as possible to VCC and VDD pin for good filtering.
- The thermal pad on the back of package must be soldered to the large ground plane for ideal power dissipation.

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CLASSIFICATION REFLOW PROFILES

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (T _{smin}) Temperature max (T _{smax}) Time (T _{smin} to T _{smax}) (t _s)	150°C 200°C 60-120 seconds
Average ramp-up rate (T _{smax} to T _p)	3°C/second max.
Liquidous temperature (T _L) Time at liquidous (t _L)	217°C 60-150 seconds
Peak package body temperature (T _p)*	Max 260°C
Time (t _p)** within 5°C of the specified classification temperature (T _c)	Max 30 seconds
Average ramp-down rate (T _p to T _{smax})	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

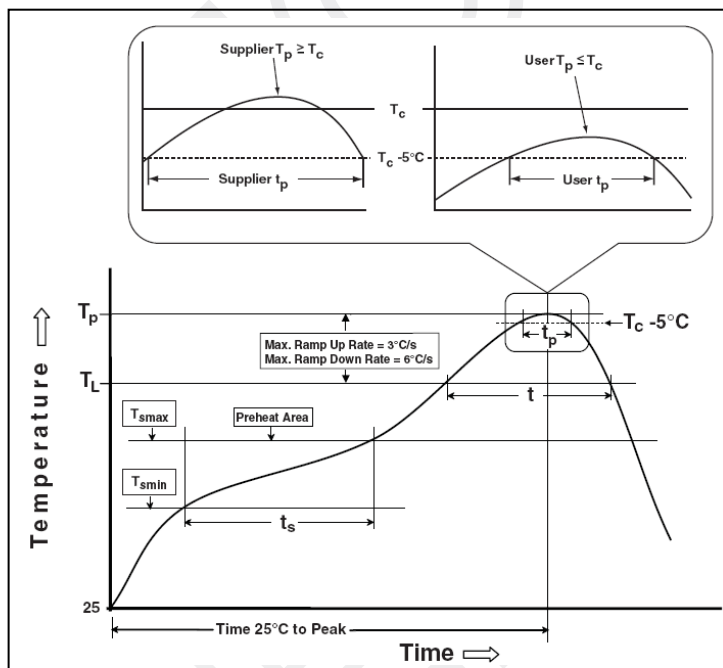
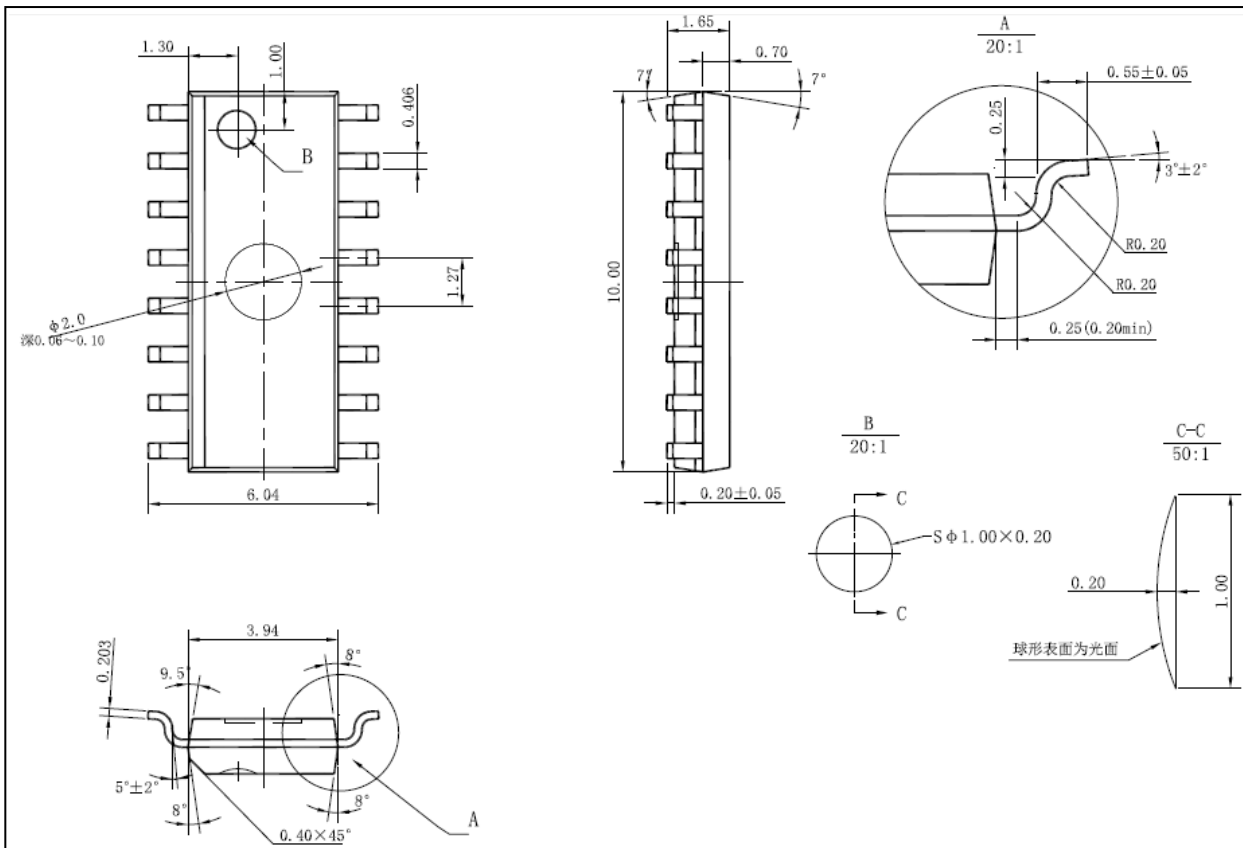


Figure 6 Classification Profile

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PACKAGE INFORMATION

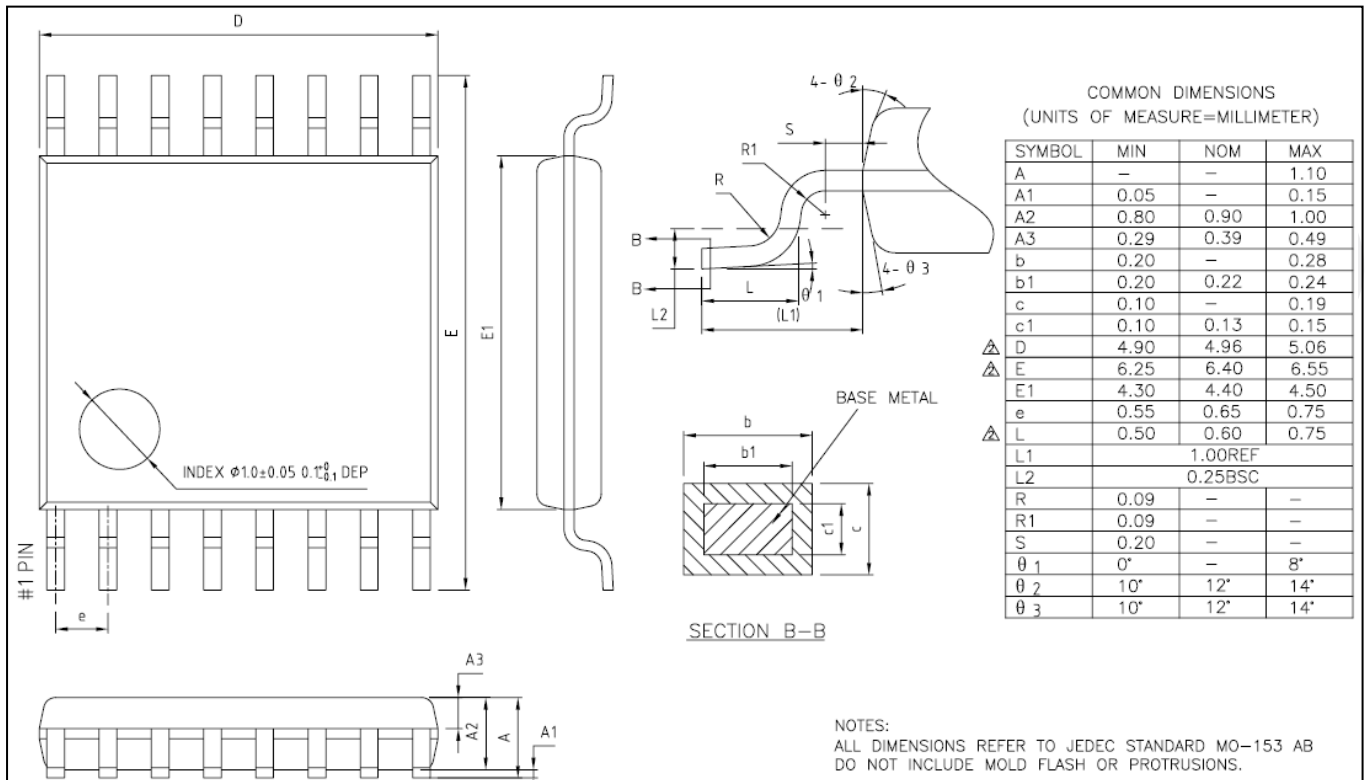
SOP-16



Note: All dimensions in millimeters unless otherwise stated.

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TSSOP-16



Note: All dimensions in millimeters unless otherwise stated.