LED Driver with PWM Dimming Control

General Description

LP3353 is a cost-effective LED driver optimized for LCD monitor and LCD TV backlighting application. It provides a high-performance LED backlight solution with minimized the bill of material cost.

The LP3353 contains a PWM boost driver which uses current mode control and fixed frequency operation to regulate the LED current. The LED current is sensed through an external current sense resistor. The voltage across the sensing resistor is compared with reference level of 0.4V, the error amplifier to control the pulse width of the power switch thus to regulate the LED current.

Otherwise, the LP3353 offers an external frequency PWM dimming method for a wide range of dimming control.

Other features include over current protection (OCP), over voltage protection (OVP) and under-voltage lockout (UVLO). The LP3353 is available in a space saving SOP-8 (pitch 1.27mm).

Order Information

P3353□□□
- F: Green
- Package Type
  - SO: SOP-8

Features

- Wide V_{IN} Range: 7V to 26V
- Current-Mode PWM Controller
- External PWM Dimming Mode
- Under-Voltage Lockout
- Over Voltage Protection
- Over Current Protection
- Under-Voltage Protection
- Over-Temperature Protection
- Available in SOP-8
- RoHS Compliant and Halogen Free
- Pb-Free Package

Applications

- TFT LCD TV
- TFT LCD Monitor
- Flat Panel Display

Marking Information

Device	Marking	Package	Shipping
LP3353SOF	LPS LP3353 YWX	SOP-8	4K/REEL
Y: Year code. **W**: Week code. **X**: Batch number.			

Typical Application Circuit

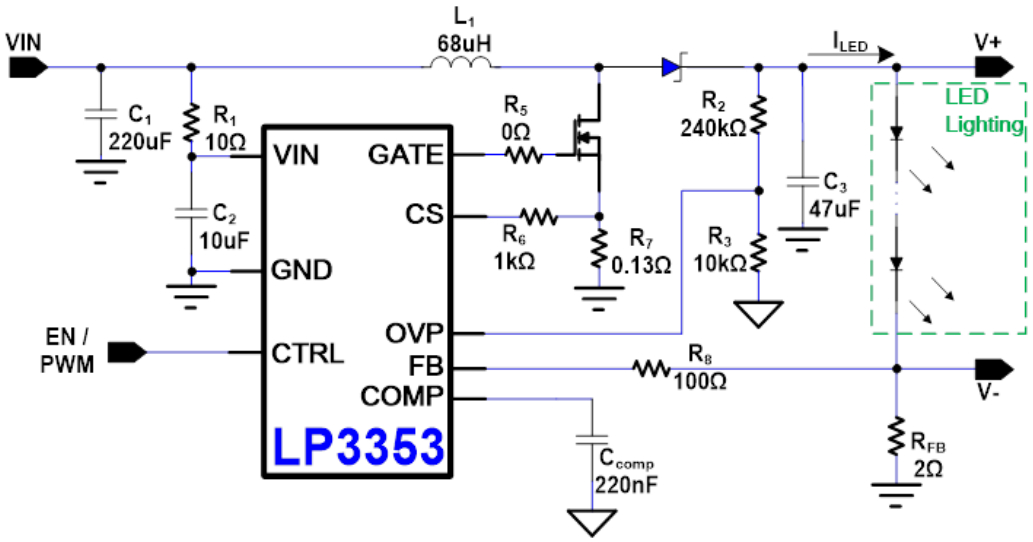


Figure 1. Typical Application Circuit of LP3353

Pin Configuration

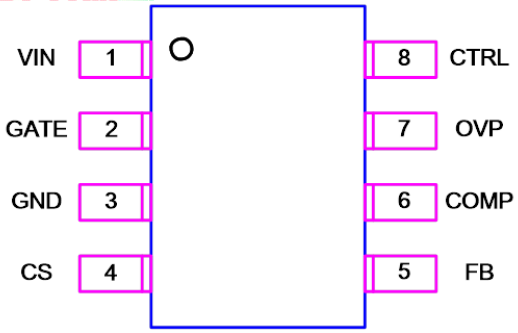


Figure 2. SOP-8 Package (Top View)

Function Block Diagram

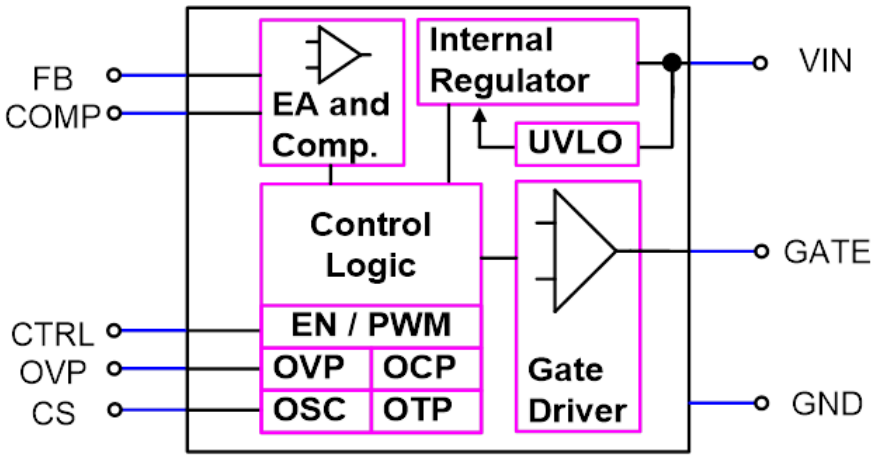


Figure 3. Function Block Diagram

Functional Pin Definition

Pin NO.	Pin Name	Description
1	VIN	Power Supply Input Pin. Decouple with 10μF ceramic capacitor close to the pin.
2	GATE	External NMOS Gate Drive Pin.
3	GND	Ground.
4	CS	Current Sense Input Pin.
5	FB	Regulator Feedback Input. Connect to an external resistor to set the output current.
6	COMP	Regulator Error Amplifier Compensation Pin.
7	OVP	Over Voltage Protection Sense Input. Connect to an external resistive voltage divider from the V+ to GND.
8	CTRL	Enable and External PWM Dimming Control.

Absolute Maximum Ratings Note 1

- ✧ VIN to GND ---------- −0.3V to +30V
- ✧ GATE to GND ---------- −0.3V to +20V
- ✧ CS, FB, COMP, OVP, CTRL to GND ---------- −0.3V to +7V
- ✧ Operating Junction Temperature Range (T_J) ---------- −40℃ to +150℃
- ✧ Operation Ambient Temperature Range (T_A) ---------- −40°C to +85°C
- ✧ Storage Temperature Range ---------- −65°C to +150°C
- ✧ Maximum Soldering Temperature (at leads, 10sec) ---------- +260°C
- ✧ Maximum Junction Temperature ---------- +160°C

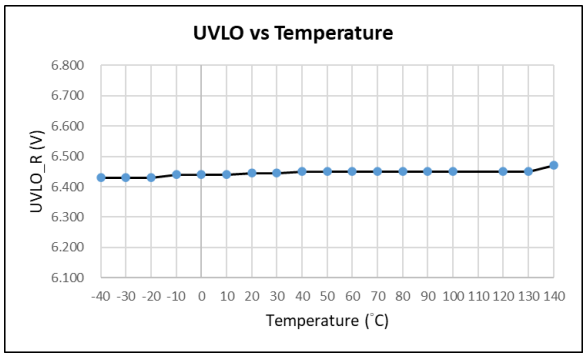
Note 1. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

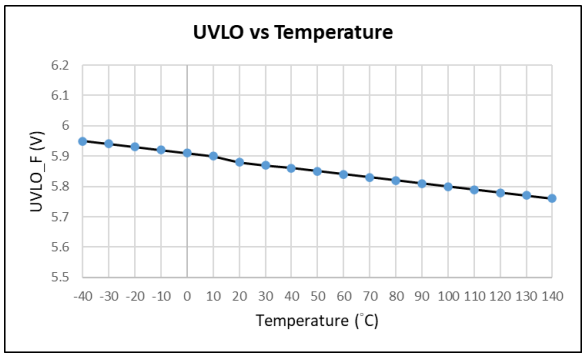
Electrical Characteristics

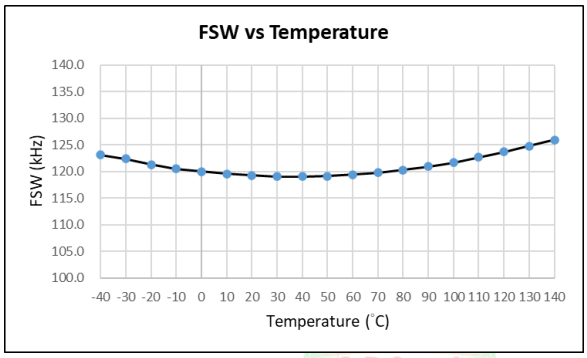
(V_{IN}=12V, V_{CTRL}=5V, T_A=25°C, unless otherwise specified)

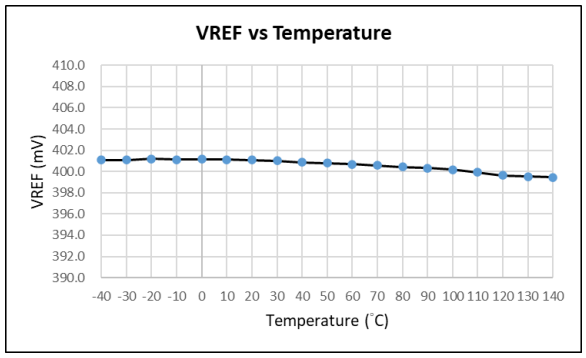
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
General						
Input Supply Voltage	V_{IN}		7		26	V
V_{IN} Supply Quiescent Current	I_Q	Sleep mode		130	180	uA
		Operation Standby mode		2	3	mA
Input UVLO Threshold	$V_{UVLO(VTH)}$	V_{IN} Rising	6.1	6.3	6.5	V
UVLO Threshold Hysteresis	$V_{UVLO(HYS)}$	Falling Hysteresis		500		mV
Soft Start Slope	T_{SS_Slop}			22		mV/ms
Thermal Shutdown Threshold	T_{SD}	Temperature Rising		160		°C
PWM Control						
CTRL Threshold Voltage	V_{IH}	Logic High.	1.5			V
	V_{IL}	Logic Low			0.7	
Switching Frequency	F_{SW}		110	120	130	kHz
Maximum Duty Cycle	D_{MAX}		93	95	97	%
Error Amplifier						
Reference Voltage	V_{REF}	Reference voltage at non-inverting input.	0.392	0.4	0.408	V
Open Loop Voltage Gain	A_m			70		dB
Transconductance of EA	Gm			100		uA/V
GATE Source Current	I_{Source}			30		uA
GATE Sink Current	I_{Sink}			60		uA
Gate rise time	T_{rise}	1nF load		40		ns
Gate fall time	T_{fall}	1nF load		20		ns
Protection Threshold						
Over Voltage Protection	V_{OVP}	Threshold of OVP	1.9	2	2.1	V
Over Current Protection	V_{OCP}	Threshold of OCP	260	380	500	mV
Fault Trigger Duration	T_{Fault}			35		ms
CMP high protection threshold	V_{TH_CMP}		2.9	3.2	3.5	V
SCP Threshold	V_{OVP_UV}	Normal Operation		250		mV

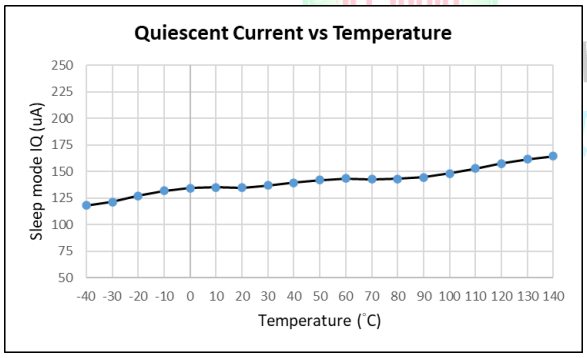
Characterization Plots

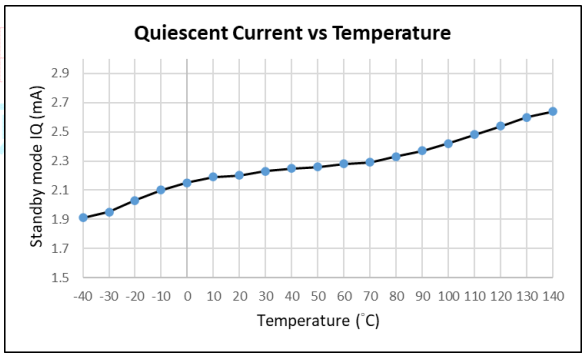












Application Information

The LP3353 is designed in a current mode, constant frequency PWM boost converter. It can use dimming input that can by external control signal with a duty ratio of 1% - 100% in 100Hz to 50kHz. LP3353 also offers the protection features to protect the system such as output over voltage protection, boost diode disconnection protection, output short circuit protection and over temperature protection.

Under Voltage Lockout (UVLO)

The LP3353 had an UVLO internal circuit that enables the device once the voltage on the VIN voltage exceeds the UVLO threshold voltage.

Boost Controller

The LP3353 uses 120kHz fixed-frequency, current mode architecture to fixed the output current. The output voltage automatically adjusts its voltage to the LED forward voltage to improve performance.

Boost Loop Compensation

The feedback loop can be compensated with an external compensation network consisted of Rcomp, Ccomp (As Figure 1). Choosing Rcomp to set high frequency integrator gain for fast transient response and Ccomp to set the integrator zero to maintain loop stability.

Over Voltage Protection

The LP3353 converter has an over voltage protection by OVP pin. When the LEDs fail open circuit or LEDs are disconnected from the circuit, the over voltage function will monitor the output voltage through OVP pin to protect the converter. When LP3353 occur OVP, it will latch off until VIN is re-startup or CTRL input is recycled.

LED Current Setting

The LED current is specified by current sense resistor between the FB pin to ground. In order to have accurate LED current, precision resistors are preferred. The LED current can be programmed by:

$$I_{LED}= V_{REF} /R_{FB}$$

Dimming Control

The LED brightness is controlled by the PWM signal at CTRL pin which has different duty cycle. LP3353 can accept an external PWM signal to CTRL pin in the range of 100Hz to 50kHz.

Over Temperature Protection

The LP3353 device enters over temperature protection (OTP) if its junction temperature exceeds 160°C (Typ.). During over temperature protection none of the device's functions are available. To resume normal operation, the junction temperature need cool down and the outputs will restart.

Current Sense and Over Current Protection (OCP)

The over current protection level can be set by R7 (As Figure 1) and senses inductor current to compare with current limit value. When the inductor current exceeds the current limit, the switching will be turned off immediately. It prevents large current damaging the external component. The OCP level is calculated as:

$$I_{OCP}= V_{OCP} /R_7$$

The LP3353 uses a current mode control structure. The CS pin not only has current sense function but also build-in a slope compensation to avoid sub-harmonic oscillation. The additional slope compensation lessened the influence of the sensed current in the control loop.

Layout Guideline

The proper PCB layout and component placement are critical for all circuit. The careful attention should be paid to prevent electromagnetic interference (EMI) problems. Here are some suggestions to the layout of LP3353 design.

1. Connected all ground together with one uninterrupted ground plane with multiple vias.

2. The input capacitor should be located as closed as possible to the VIN and ground plane.

3. Minimize all the wiring length connected to the LX node and wide route width to obtain optimum efficiency.

4. All output capacitor must be closed to ground plane. The ground terminal of COUT must be located as closed as possible to ground plane.

5. Radiated noise can be decreased by choosing a shielded inductor.

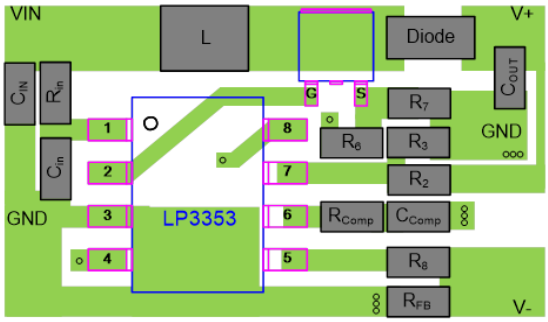
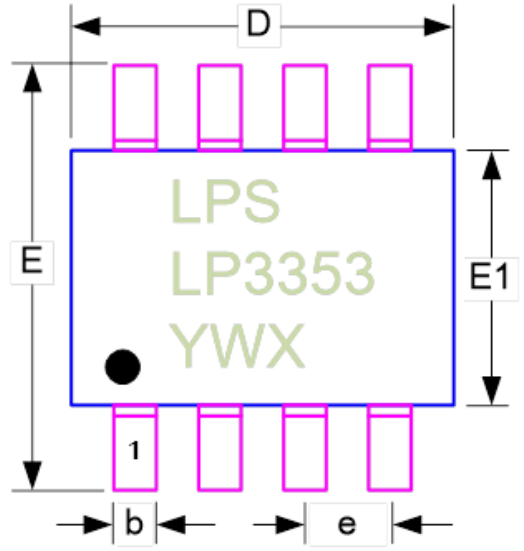


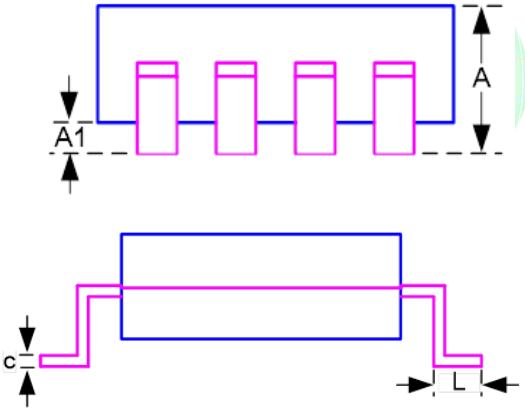
Figure 4. Recommended PCB Layout Diagram

Package Information

SOP-8 Package (Unit: mm)

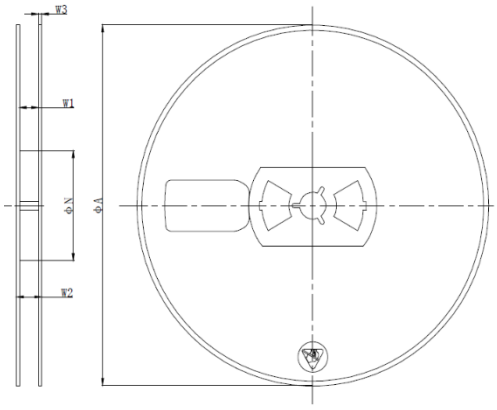


SYMBOLS	DIMENSION IN MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.750
A1	0.100	--	0.230
b	0.350	--	0.480
c	0.190	--	0.250
D	4.700	4.900	5.000
E	5.800	6.000	6.200
E1	3.700	3.900	4.100
e	1.27BSC		
L	0.500	--	0.800



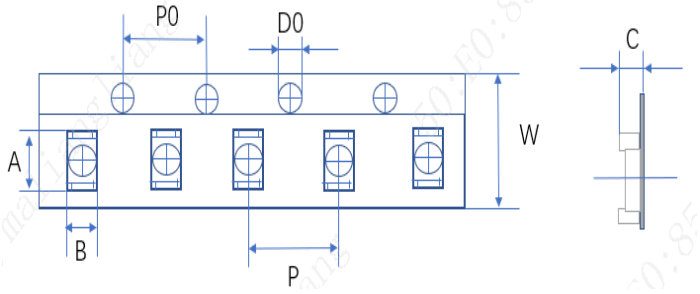
Carrier Information

REEL DIMENSIONS (Unit: mm)



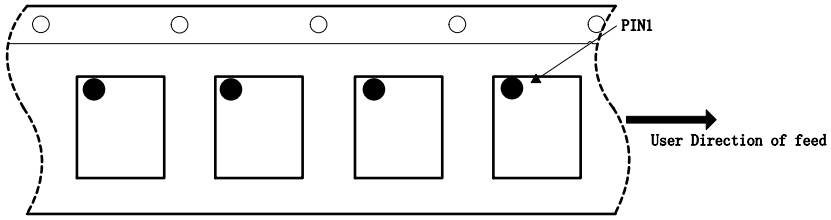
ΦA	W2
329±4	17±2

TAPE DIMENSIONS (Unit: mm)



A	B	P0	P	D0	W	C
6.60±0.40	5.50±0.40	4.00±0.20	8.00±0.20	1.50±0.20	12.00±0.30	2.10±0.20

PIN1 AND TAPE FEEDING DIRECTION



Classification of IR Reflow Profile

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat/Soak Temperature Min (T_{SMIN}) Temperature Max (T_{SMAX}) Time (T_S) from (T_{SMIN} to T_{SMAX})	 100℃ 150℃ 60~120 seconds	 150℃ 200℃ 60~120 seconds
Ramp-up rate (T_L to T_P)	3℃/second max	3℃/second max
Liquidous temperature (T_L) Time (t_L) maintained above T_L	183℃ 60~150 seconds	217℃ 60~150 seconds
Peak package body temperature (T_P)	For users T_P must not exceed the Classification temp in Table 1. For suppliers T_P must equal or exceed the Classification temp in Table 1.	For users T_P must not exceed the Classification temp in Table 2. For suppliers T_P must equal or exceed the Classification temp in Table 2.
Time (t_P)* within 5℃ of the specified classification temperature (T_C), see Figure 5	20* seconds	30* seconds
Ramp-down rate (T_P to T_L)	6℃/second max	6℃/second max
Time 25℃ to peak temperature	6 minutes max	8 minutes max
* Tolerance for peak profile temperature (T_P) is defined as a supplier minimum and a user maximum.		

Table 1 Sn-Pb Eutectic Process - Classification Temperatures (T_C)

Package Thickness	Volume mm3 <350	Volume mm3 ≥350
<2.5mm	235℃	220℃
≥2.5mm	220℃	220℃

Table 2 Pb-Free Process - Classification Temperatures (T_C)

Package Thickness	Volume mm3 <350	Volume mm3 350~2000	Volume mm3 ≥350
<1.6mm	260℃	260℃	260℃
1.6mm~2.5mm	260℃	250℃	245℃
>2.5mm	250℃	245℃	245℃

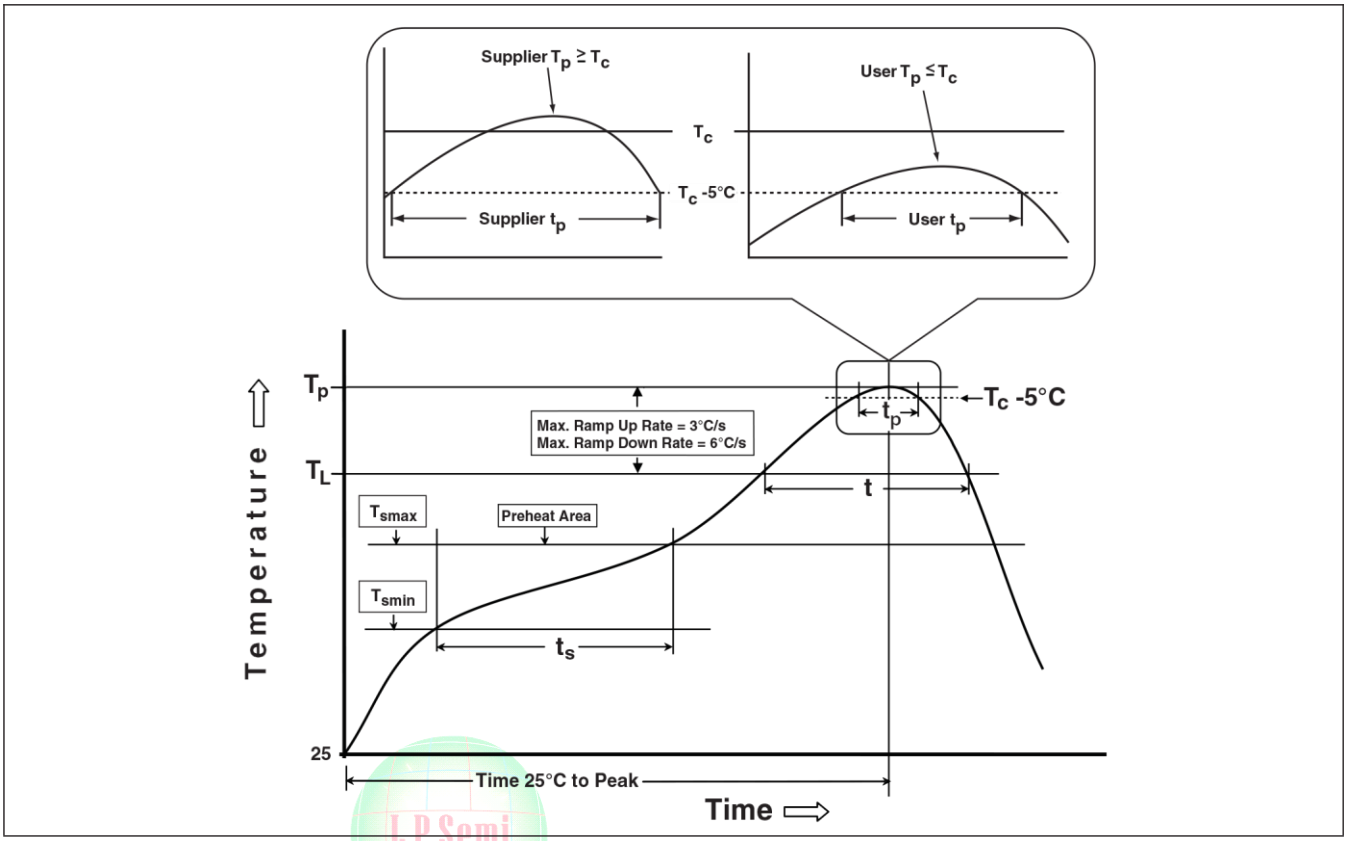


Figure 5 Classification Profile (Not to scale)

Products conform to “JEDEC J-STD-020C” standards.

Products shipped conform to “RoHS” standards.

Moisture Sensitivity Level：MSL3（CONDITION：≦30 °C/60%RH、Time control:168 hours）