LT5280

DATA SHEET

SPEC. NO.   : SZ20060802
DATE   : 2020/06/08
REV.   : A/0

Approved By: Checked By: Prepared By:

High performance Asynchronies Boost Controller for LED Driver

General Description

The LT5280 is a High performance step-up DC/DC controller specifically designed for LCD TV and LCD monitors' LED backlight application with a constant current. The LT5280 uses current mode, fixed frequency of approximately 120 kHz architecture to regulate the output constant current through an external current sense resistor. The low feedback voltage of 400 mV can minimize the system power dissipation.

The LT5280 allows a PWM signal to reduce this regulation voltage by changing the PWM duty cycle to achieve LED brightness dimming control.

The LT5280 supports the LED open loop protection, the LED cathode short to GND protection, the Diode short circuit protection and the Inductor short circuit protection.

Other features include current limit protection, thermal shutdown protection, under-voltage lockout (UVLO), and over-voltage function.

The LT5280 is available in SOP8 package.

Applications

- LCD TV Backlight
- LCD Monitor Backlight
- Laptop Computer Display Backlight

Features

- Wide Input Supply Range of 9 V ~ 35 V
- Wide Range for PWM Dimming (1 kHz~200 kHz)
- 120 kHz Switch Frequency
- 400mV Feedback Voltage
- Internal Soft-start Circuitry
- LED Open Loop Protection
- LED Cathode Short to GND Protection
- Diode Short Circuit Protection
- Inductor Short Circuit Protection
- Input Under Voltage Lockout
- Over Voltage Protection
- Current Limit Protection
- Thermal Shutdown Protection

Package

SOP8

VDD — PWM
GATE — OVP
GND — CMP
CS — FB
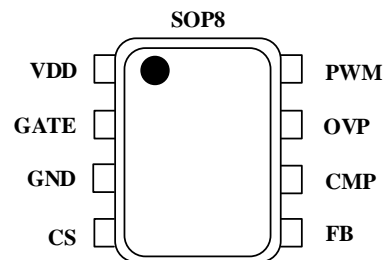
Typical Application Circuit
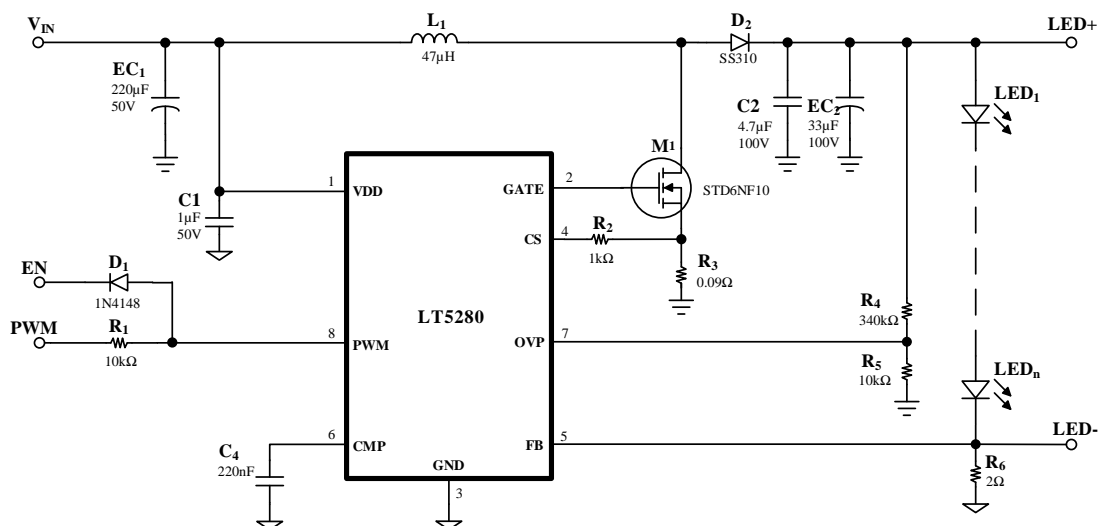
Ordering Information

Order Code	Shipping	Top Marking
LT5280SE-A1	4,000/Reel	LT5280 YWWXXXXX[1]

(1). YWW = Date code, XXXXX = Internal code

Pin Description

Pin No.	Pin Names	Pin Functions
1	VDD	Power Input Voltage Supply. Connect a decoupling capacitor between VIN and GND pins with least distance.
2	GATE	Gate Driver Output. Connect to the Gate of external MOSFET with least distance.
3	GND	Ground pin for the IC.
4	CS	Current Sense Pin. Connect to the pin of sensing resistor in circuit of the external MOSFET is recommended.
5	FB	LED Constant Current Feedback Input Pin. Connect to the pin of the sensing resistor in circuit of LED series is recommended.
6	CMP	Compensation pin. This pin is used to compensate the control loop.
7	OVP	Over Voltage Protection pin. Program the output over voltage protection threshold through a resistor divider.
8	PWM	PWM Input Pin. For the brightness dimming control.

Functional Block Diagram

LG-QR-R009-01
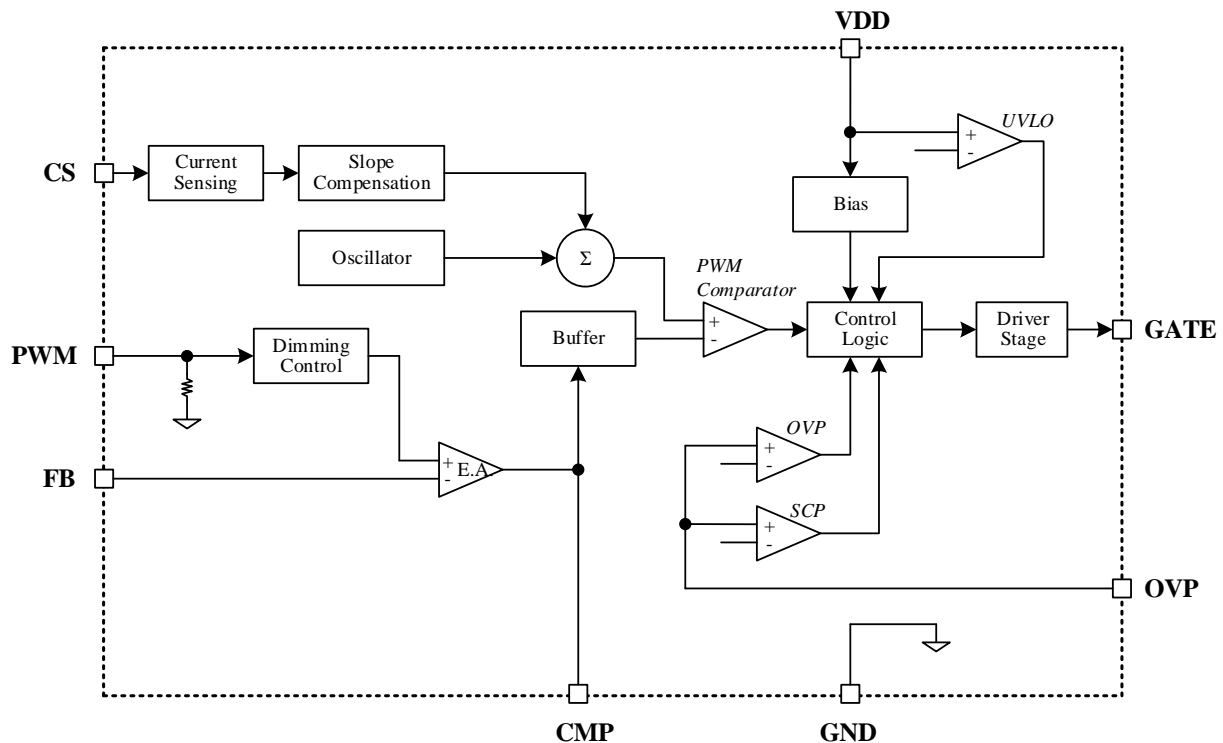
Absolute Maximum Ratings[1]

VDD, GATE, OVP...-0.3 V ~ 38 V

CS, FB, CMP, PWM...-0.3 V ~ 7 V

ESD Rating (Human Body Model)....................>±2 kV[2]

Package Thermal Resistance

Θ_{JA}[3]...40 °C/W

Min. Operating T_J...-40 °C

Max. Operating T_J....................................Internally Limited

Storage Temperature....................................-55 °C ~ 150 °C

Lead Temperature (Soldering 10 sec.).........................260 °C

(1). All voltages refer to ground unless otherwise noted; Stresses exceed those ratings may damage the device.

(2). Tested and classified as ESDA/JEDEC JDS-001-2014.

(3). Soldered to 100 mm2, 1 oz copper clad.

Electrical Characteristics[1]

(V_{IN} = 12 V, V_{PWM} = 5 V, T_A = 25 ℃, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Supply Voltage						
Input Voltage	V_{IN}		9		35	V
Input UVLO						
Input UVLO Threshold	V_{UVLO}	V_{IN} Rising	7.8	8.3	8.8	V
Input UVLO Hysteresis	$V_{UVLOHYS}$	V_{IN} Falling		600		mV
Input Supply Current						
Quiescent Current (Operating supply current)	I_Q	Vin=12V,PWM=5V, no loading		0.8		mA
Stand By Current	$I_{STANDBY}$	PWM low time>50ms, In sleep mode		175		µA
Error Amplifier						
Reference Voltage	V_{REF}	Reference voltage at non-inverting input	392	400	408	mV
Open Loop Gain	A_M			70		dB
Trans Conductance	G_M			100		µA/V
Output Source Current	I_{SOURCE}			30		µA
Output Sink Current	I_{SINK}			60		µA
PWM Dimming Control						
High Level Threshold	V_{PWMH}		2.5			V
Low Level Threshold	V_{PWML}				1.3	V
PWM Frequency for Analog Dimming	F_{PWM}		1		200	kHz
PWM Duty Cycle	D_{PWM}		0		100	%
OVP Protection						
OVP Threshold	V_{OVP}		1.9	2.0	2.1	V
Normal Operation OVP UVLO Threshold	$V_{OVP\_UVLO\_N}$			300		mV
System Startup OVP UVLO Threshold	$V_{OVP\_UVLO\_S}$			200		mV
Current Limit						
Voltage Threshold of Over Current Protection	V_{OCP}	Duty Cycle=90%	260	380	500	mV
CS High Protection Threshold	V_{CS_TH}	Diode or Inductor Short Circuit	1.1	1.2	1.3	V
CMP High Protection Threshold	V_{CMP_TH}	FB short to GND		3.2		V
Oscillator						
Operating Frequency	F_{SW}		110	120	130	kHz
Maximum Duty Cycle[2]	D_{MAX}		93	95	97	%

Electrical Characteristics[1] (continued)

(V_{IN} = 12 V, V_{PWM} = 5 V, T_A = 25 ℃, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Gate Driver						
Gate rise time	t_{RISE}	1nF loading		40		ns
Gate fall time	t_{FALL}	1nF loading		20		ns
Thermal Shutdown						
Thermal Shutdown Threshold[2]	T_{SDN}			150		°C

(1). Specifications over temperature range are guaranteed by design and characterization.

(2). Guaranteed by design and characterization only.

Typical Performance Characteristics

All curves taken at V_{IN} = 12 V with configuration in Typical Application Circuit shown in this datasheet. T_A = 25 °C, unless otherwise specified.
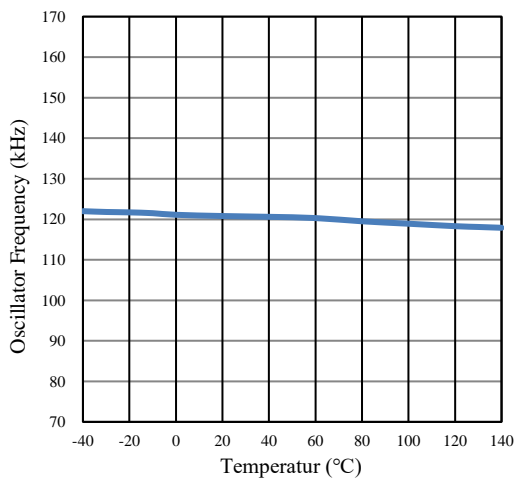

Figure 1. Oscillator Frequency vs. Temperature
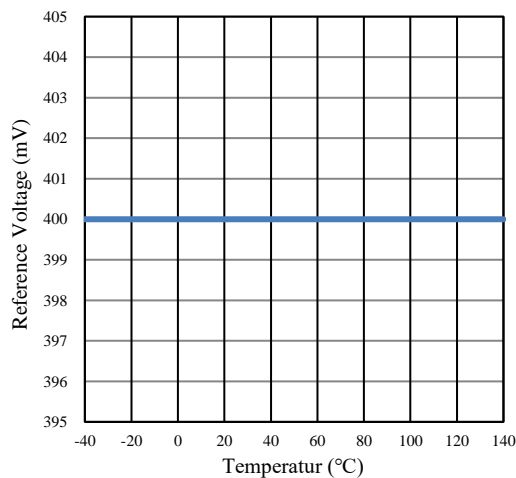

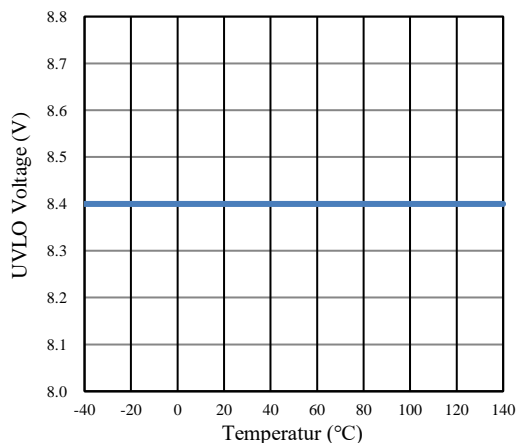Figure 2. Reference Voltage vs. Temperature
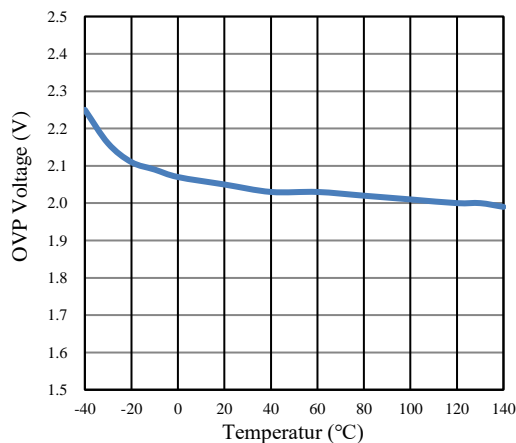

Figure 3. UVLO Voltage vs. Temperature
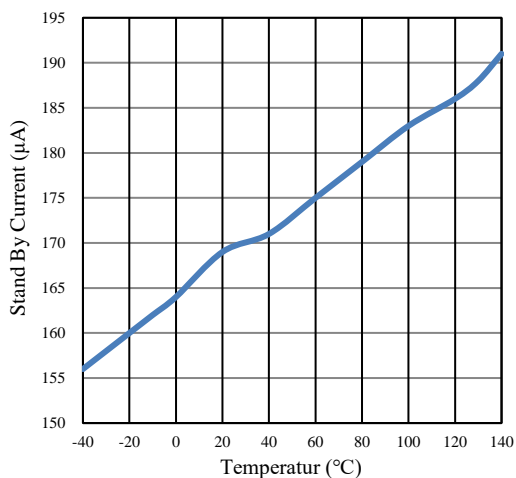

Figure 4. OVP Voltage vs. Temperature

Figure 5. Stand By Current vs. Temperature

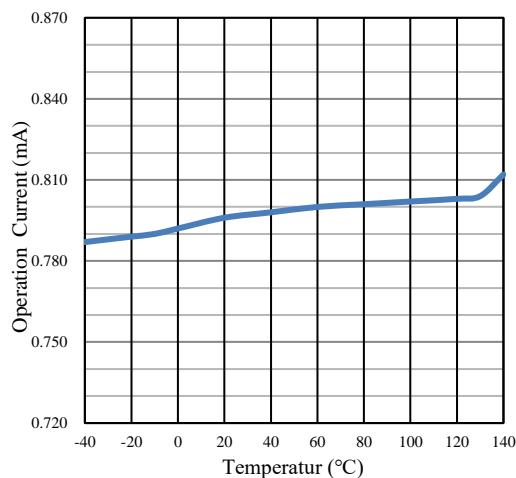Figure 6. Operation Current vs. Temperature

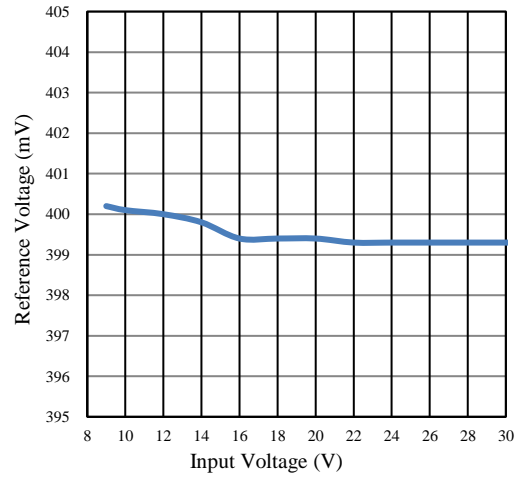| Part No. | LT5280 | Page | 6 of 11 |

Typical Performance Characteristics (continued)
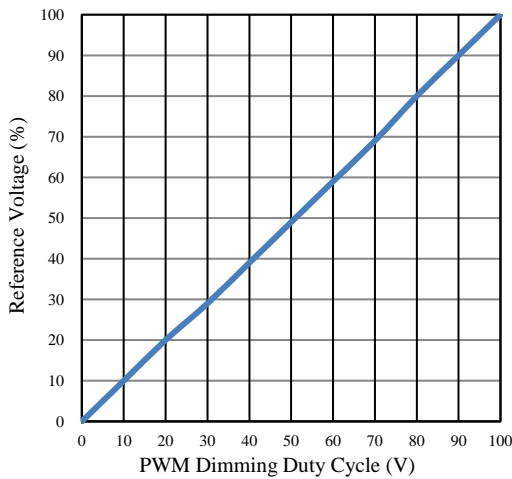
All curves taken at VIN = 12 V with configuration in Typical Application Circuit shown in this datasheet. TA = 25 °C, unless otherwise specified.
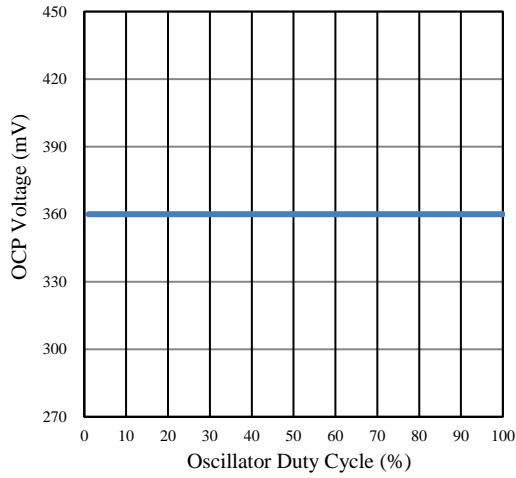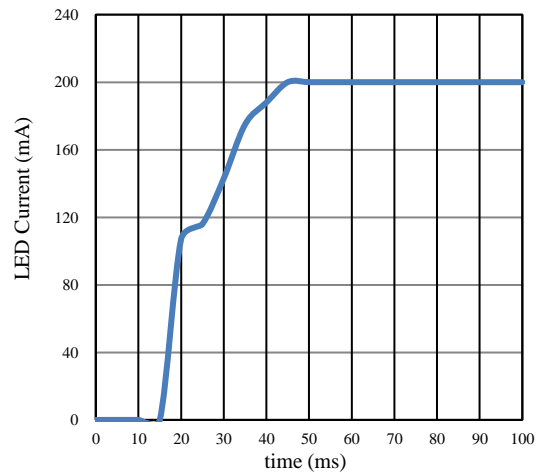

Figure 7. OCP Voltage vs. Oscillator Duty Cycle

Figure 8. Reference Voltage vs. Input Voltage

Figure 9. Reference Voltage vs. PWM Dimming Duty Cycle

Figure 10. Power On Waveform

Functional Description

1. Operation

The LT5280 is a high performance asynchronous boost controller with accurately constant current output in a wide input range from 9 V to 35 V. This constant current can be programed through the FB pin connecting a sensing resistor or set by the external PWM diming duty cycle.

With the slope compensated current mode PWM control, the LT5280 provides stable switching and cycle-by-cycle current limit for protection of the external MOSFET.

2. Additional External Slope Compensation

To improve control loop stability when the operation switch duty cycles greater than 50%, LT5280 has a build-in slope compensation circuit. **Figure 11** shows the basic slope compensation principle.
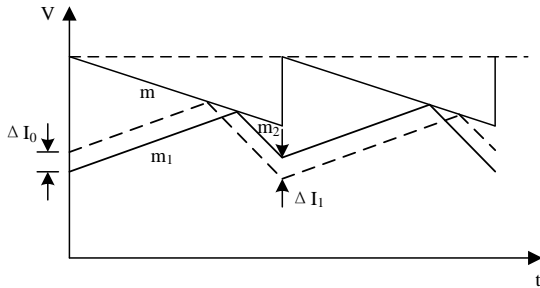
Figure 11 the Slope Compensation Principle

There is an **Equation 1** for slope compensation as below:

$$k = \frac{\Delta I_1}{\Delta I_0} = \frac{m_2 - m}{m_1 + m} \tag{1}$$

Where

- k is the factor of the Slope Compensation.
- ΔI_0 is the difference of inductor current between the original inductor current and the perturbed current.
- ΔI_1 is the difference of inductor current between the two currents after slope compensation one operational period.
- m is the slope of the compensation ramp.
- m_1 is the slope of the inductor rising current.
- m_2 is the slope of the inductor falling current.

The condition of a good compensation is that ensure the factor **k** is less than 1. Can calculate the **Equation 1** with the following equations:

$$m = 0.05 \times f_{sw} \tag{2}$$

$$m_1 = \frac{R_s \times (V_{OUT} - V_{IN})}{L} \tag{3}$$

$$m_2 = \frac{R_s \times V_{IN}}{L} \tag{4}$$

Where

- f_{SW} is the Operating Frequency.
- R_S is the sensing resistor of the external MOSFET.
- V_{OUT} is the output voltage.
- V_{IN} is the input voltage.
- L is the value of the inductor.

The built-in slope compensation may be inadequate to stable the control loop under some conditions, the LT5280 supports an additional external Slope Compensation as **Figure 12**:
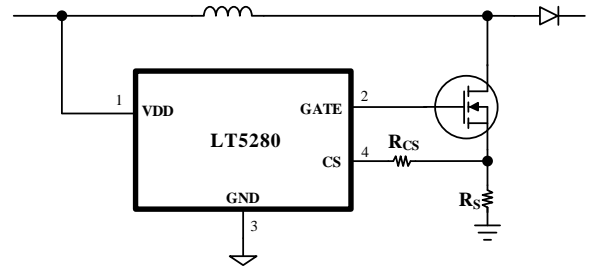
Figure 12 the Additional External Slope Compensation

The slope of the compensation ramp **m** is changed to **Equation 5** by the additional external Slope Compensation as below:

$$m = (0.05 + 0.0005 \times R_{CS}) \times f_{sw} \tag{5}$$

Where

- R_{CS} is the resistor between CS pin and external MOSFET.

3. Input Under-voltage Lockout (UVLO)

An input UVLO circuit prevents the converter from starting the operation until the input voltage rises above the typical UVLO threshold of 8.3 V. And when input decrease to a hysteresis voltage of 600 mV, The LT5280 will be lockout until to input reaching 8.3 V again.

4. Soft-start

The LT5280 implements the soft-start function to reduce the inrush current during startup. The soft-start begins once the input voltage raises above typical UVLO threshold, the soft-start Slope is typically 22 mV/ms.

5. LED Current Setting

The loop of Boost structure will keep the FB pin voltage equal to the reference voltage V_{REF}. Therefore, when R_{FB} connects FB pin and GND, and consider the PWM pin apply a continuous high level voltage, the current flows from V_{OUT} through LED and R_{FB} to GND will be decided by the current on R_{FB}, which is equal to following equation:

$$I_{LED} = \frac{V_{REF}}{R_{FB}} \tag{6}$$

6. Dimming Control

For the brightness dimming control of the LT5280 , the IC provides typically 400mV feedback voltage when the PWM pin is pulled constantly high. However, PWM pin allows a PWM signal to reduce this regulation voltage by changing the PWM duty cycle to achieve LED brightness dimming control. The relationship between the duty cycle and FB voltage can be calculated as following equation.

$$V_{REF} = D \times 400mV \tag{7}$$

Where

- D is the PWM dimming frequency.

This frequency of PWM dimming frequency varies in the range from 1kHz to 100kHz . An internal low pass filter is used to filter the pulse signal, and then the reference voltage can be made by connecting the output of the filter to the error amplifier for the FB pin voltage regulation. and the VA

approach a DC signal, so the LED current is a DC current which provides the smooth display performance and eliminates the audio noise.

The following **Figure 13** shows the LT5280 has an extreme dimming linearity.
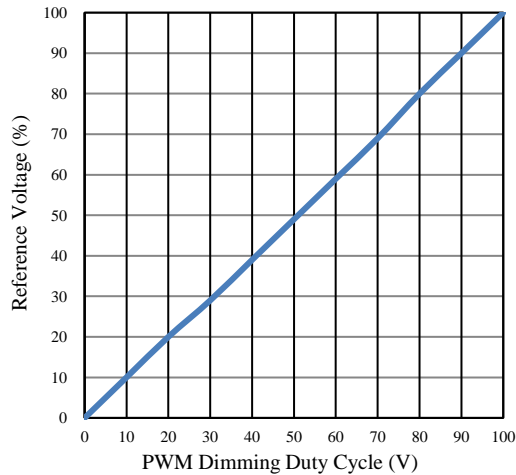
Figure 13 the Extreme Dimming Linearity

7. Cycle by Cycle Peak Current Limit Protection

The peak current limit prevents the LT5280 from high inductor current and drawing excessive current from the input voltage rail. It also can protect the external MOSFT from over current situation.

8. OVP Protection

The Over Voltage Protection is detected by the OVP pin, connected to the resistors divider between V_{OUT} to GND. Once LED open or other abnormal operation, V_{OUT} goes over the setting voltage and the voltage of OVP pin is rising above OVP threshold, the LT5280 will stop switching and the MOSFET will be turned off. Then, the V_{OUT} will be clamped to be near the setting voltage. This function will latch the IC until the V_{IN} or PWM restarts.

9. Short Circuit Protection

There are 4 types of short circuit protection: LED cathode short to GND Protection, the diode short circuit protection, the inductor short circuit protection and V_{OUT} short circuit protection.

When LED cathode is shorted to GND, the LT5280 output voltage will be increasing above the OVP threshold, and trigger the OVP protection. But under other conditions, if the output is limited by OCP protection before the output reach the OVP voltage, the MOSFET will never be turned off, and the large current goes through both Schottky diode and MOSFET. The LT5280 keep monitoring the voltage of COMP pin, if this voltage is continuously above 3.2 V (typical) for 20ms (typical), the MOSFET will be latched.

When the Schottky diode or the inductor shorts, the LT5280 is monitoring the voltage of CS pin voltage cycle by cycle, if this voltage is above 1.2V (typical) for continuous 17 cycles, the MOSFET will be latched.

When the V_{OUT} shorts, the voltage of OVP pin will drop below 0.3V (typical), the MOSFET is turned off until the V_{IN} or PWM restarts.

10. Thermal Shutdown

A thermal shutdown is implemented to prevent the damage due to excessive heat and power dissipation. Typically, the thermal shutdown happens at the junction temperature of 150 °C. When the thermal shutdown is triggered, the device stops switching until the junction temperature drops the hysteresis temperature lower than thermal shutdown threshold, then the device starts switching again.

Layout Guidance

For best performance of the LT5280, the following guidelines must be strictly followed.

1. Input and Output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.

2. The GND should be connected to a strong ground plane for heat sinking and noise protection.

3. Separate the high frequency switching and heavy current tracks (gate driver, MOSFET, inductor, Schottky diode and FB return ends) from the sensitive control signals, and keep the main current traces as possible as short and wide.

4. Place the feedback components as close as possible to the IC and keep away from the noisy devices.

Package Information

Package Outline and Dimensions
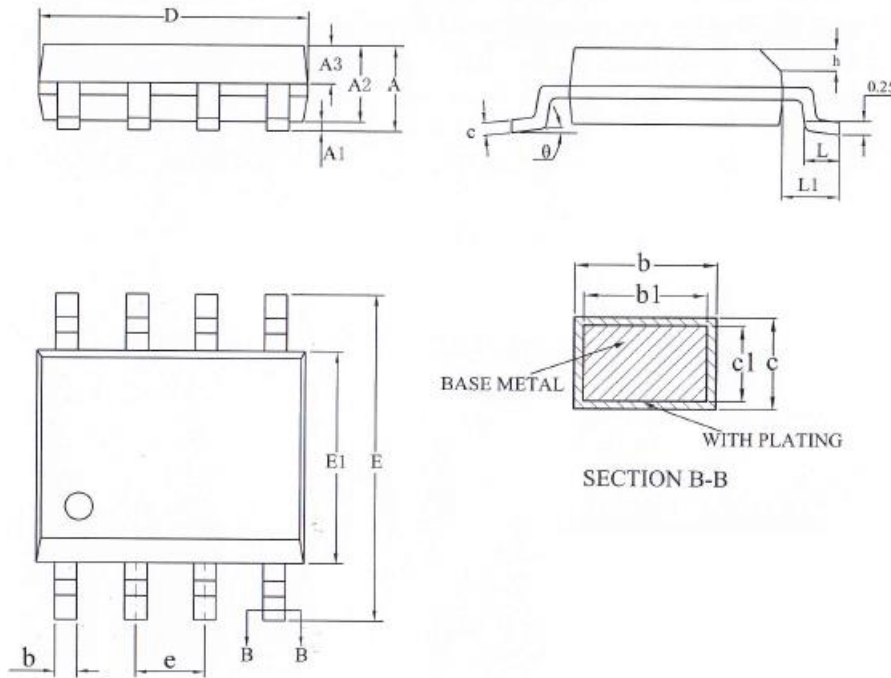
Symbol	Millimeters		
	Min.	**NOM.**	**Max.**
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.270 BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05 REF		
θ	0º	—	8º

Notes:

1. This drawing is subjected to change without notice.

2. Body dimensions do not include mold flash or protrusion.

3. This package conforms to JEDEC MS-012, variation AA.

Tape and Reel Information

Note 4

Detail A

T

H

T1

A

P1   P2   P0   ØD0

W

F   E1

B0

A0

ØD1   K0

Top View

d

UL | UR   UL | UR
LL | LR   LL | LR

Direction of Feed

ØC
ØD

Detail A

Pocket Quadrants

A (mm)	T (mm)	T1 (mm)	H (mm)	ØC (mm)	ØD (mm)	d (mm)	A0 (mm)	B0 (mm)	K0 (mm)
328	1.8	13	80	13.5	21.6	2.5	6.7	5.4	2.1

W (mm)	F (mm)	E1 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	ØD0 (mm)	ØD1 (mm)	Pin 1 Quadrant	
12	5.5	1.75	4	8	2	1.5	1.5	UL	
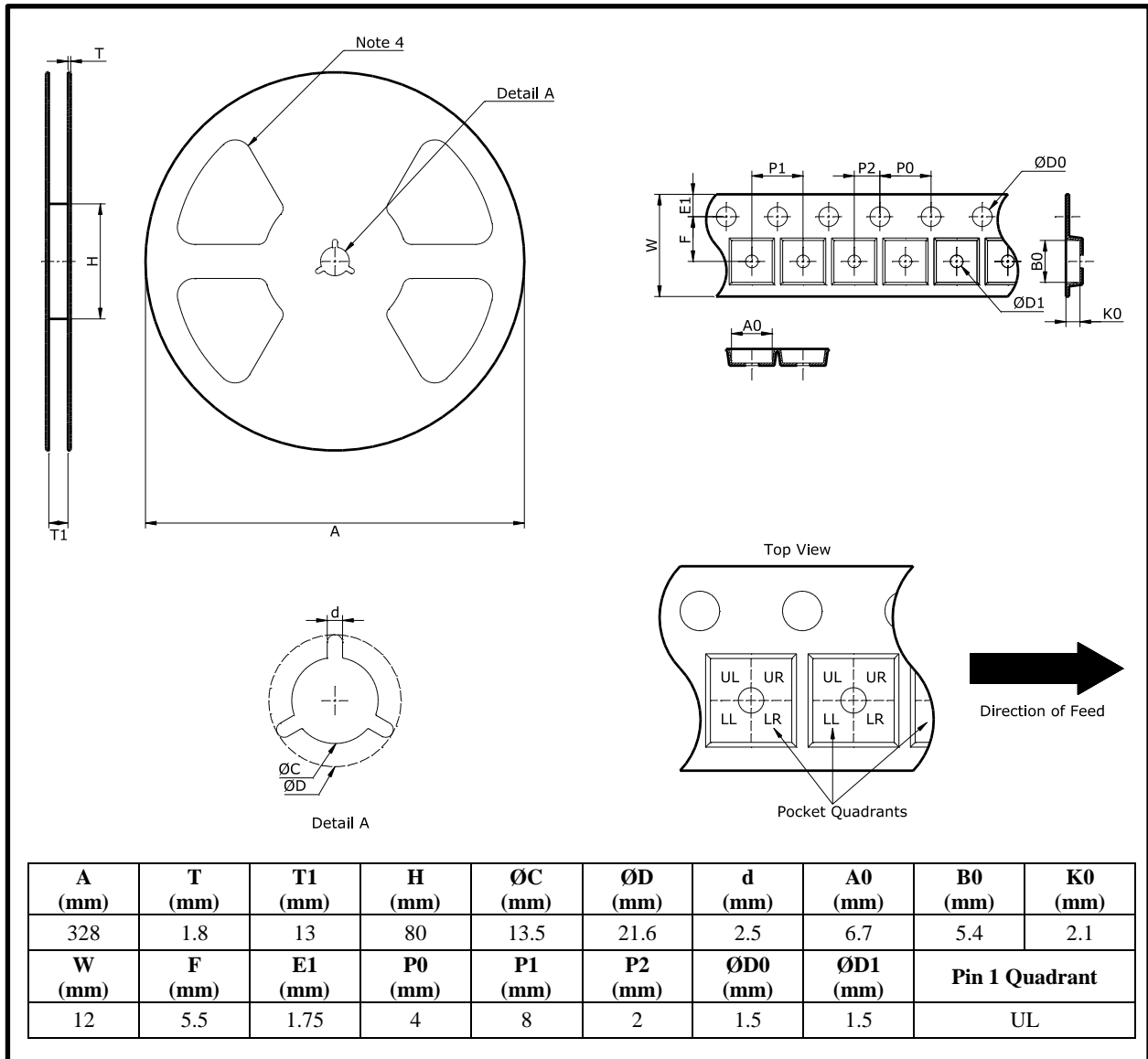
Notes:
1. This drawing is subjected to change without notice.
2. All dimensions are nominal and in mm.
3. This drawing is not in scale and for reference only.   .
4. The number of flange openings depends on the reel size and assembly site. This drawing shows an example only.

Part No.	LT5280			Page	11 of 11