

## Description

The AL3022 is a constant 140KHz, voltage mode, external compensation boost controller. The AL3022 has low feedback voltage and makes it ideal for low cost LED backlight supplies. The AL3022 can support external PWM dimming and analog dimming.

The AL3022 offers complete system protection with integrated Under Voltage Lockout, Over Voltage Protection, Over Current Protection, Output Voltage ( $V_{OUT}$ ) Short to GND Protection and Over Temperature Protection circuitry.

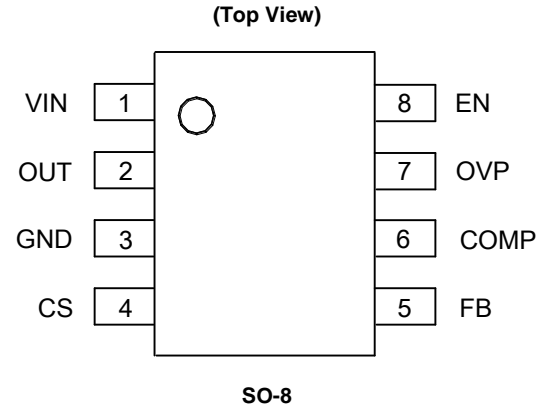
To satisfy the limited PCB mounting space requirements, this IC is available in SO-8 package to save space.

## Features

- Voltage Mode PWM Controller
- Low 0.2V Reference Voltage
- Fixed 140KHz Frequency
- External PWM Dimming and Analog Dimming
- Low Shutdown Current (0.1 $\mu$ A)
- External Compensation
- Built-in UVLO Function
- Built-in OVP
- Built-in OTP
- Built-in OCP
- Built-in  $V_{OUT}$  Short to GND Protection
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
  3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

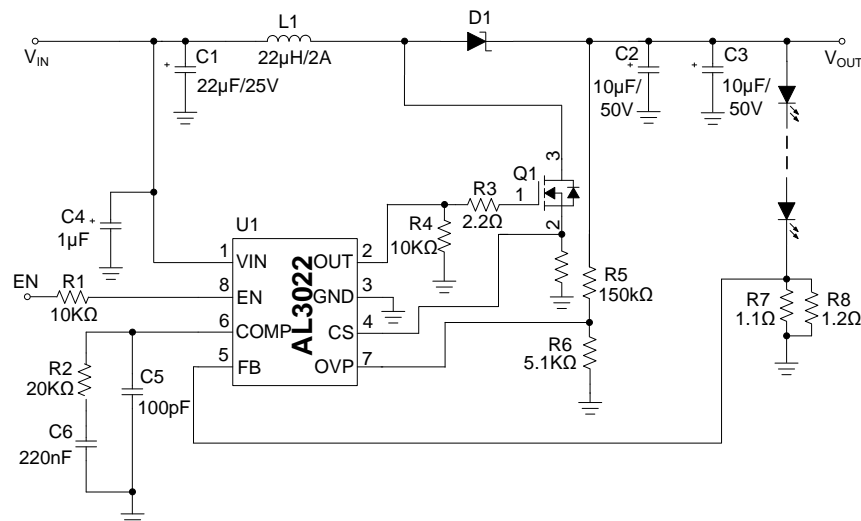
## Pin Assignments



## Applications

- LED TV
- LED Monitor
- LED Display Module

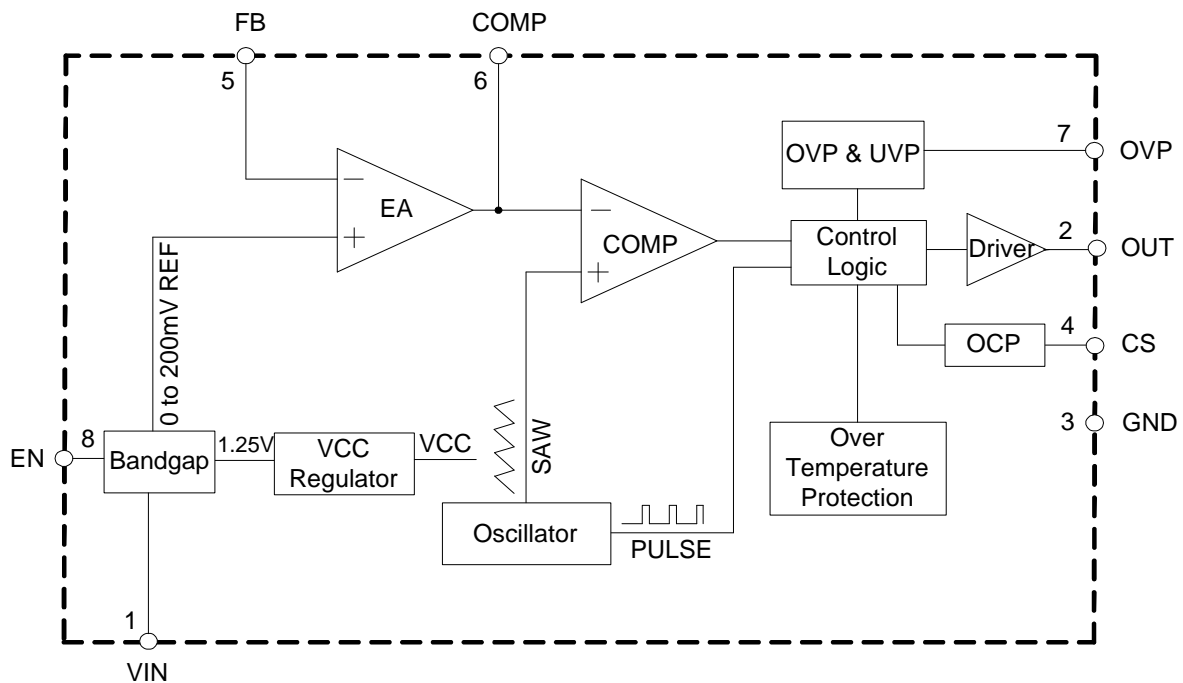
## Typical Applications Circuit



## Pin Descriptions

Pin Number	Pin Name	Function
1	VIN	Supply input pin. A capacitor should be connected between the VIN pin and GND pin to keep the DC input voltage constant.
2	OUT	Gate driver pin. This pin is connected to external MOSFET gate to turn it on/off.
3	GND	Ground pin
4	CS	Over current protection pin
5	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage.
6	COMP	Compensation pin. This pin is the output of the internal error amplifier. COMP is forced to low when $V_{IN} < 3.6V$ .
7	OVP	Overvoltage detection pin
8	EN	Enable and dimming pin. When EN input voltage is lower than 0.3V, disable the IC. When EN input voltage is higher than 2.6V, enable the IC. PWM dimming can be provided by an external control signal greater than 100Hz, duty cycle from 1% to 90%. In addition, analog dimming can be provided by a DC signal ranged from 0.8 V to 2.4V.

## Functional Block Diagram



### Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
$V_{IN}$	Input Voltage	-0.3 to 20	V
$V_{EN}$	EN Pin Voltage	-0.3 to $V_{IN} + 0.3$	V
$V_{GATE}$	OUT Pin Voltage	20	V
$V_{OVP}$	OVP Pin Voltage	7	V
$V_{FB}$	FB Pin Voltage	-0.3 to +5.5	V
$T_J$	Operating Junction Temperature	+150	°C
$T_{STG}$	Storage Temperature Range	-65 to +150	°C
$T_{LEAD}$	Lead Temperature (Soldering, 10sec)	+260	°C
$\theta_{JA}$	Thermal Resistance (Junction to Ambient)	105	°C/W
–	ESD (Machine Model)	600	V
–	ESD (Human Body Model)	4000	V

Note 4. Stresses greater than 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 under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

### Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
$V_{IN}$	Input Voltage	4	18	V
$T_A$	Operating Ambient Temperature	-40	+85	°C

**Electrical Characteristics** (@ $V_{IN} = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise specified.)

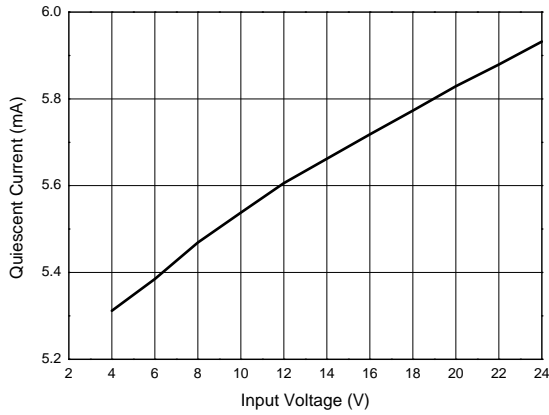
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>SUPPLY VOLTAGE (VIN PIN)</b>						
$V_{IN}$	Input Voltage	–	4.0	–	18	V
$I_Q$	Quiescent Current	Test at $V_{FB} = 0.3V$	–	5	–	mA
$I_{SHDN}$	Shutdown Supply Current	$V_{EN} = 0V$	–	0.1	–	$\mu A$
<b>UNDER VOLTAGE LOCKOUT</b>						
$V_{UVLO}$	Input UVLO Threshold	$V_{IN}$ Rising	3.6	3.8	4.0	V
$V_{HYS}$	Input UVLO Hysteresis	–	100	200	300	mV
<b>OVER VOLTAGE PROTECTION</b>						
–	Over Voltage Threshold	–	1.45	1.55	1.65	V
–	Under Voltage Threshold	–	–	0.1	–	V
<b>OVER CURRENT PROTECTION</b>						
$V_{CS}$	Over Current Threshold	Duty = 90%	–	0.33	–	V
<b>OVER TEMPERATURE PROTECTION</b>						
$T_{OTSD}$	Thermal Shutdown Temperature	–	–	+160	–	$^\circ C$
–	Thermal Shutdown Hysteresis	–	–	+20	–	$^\circ C$
<b>ERROR AMPLIFIER</b>						
$G_m$	Error Amplifier Transconductance	–	–	400	–	$\mu A/V$
<b>ENABLE (EN PIN)</b>						
$V_{EN-OFF}$	EN Pin Threshold	–	–	–	0.3	V
$V_{EN-ON}$		–	2.6	–	–	V
$V_{EN-DIM}$	EN Pin Dimming Threshold	–	–	0.8	–	V
		–	–	2.4	–	V
<b>VOLTAGE REFERENCE (FB PIN)</b>						
$V_{FB}$	Feedback Voltage	–	0.194	0.2	0.206	V
$I_{FB}$	Feedback Bias Current	–	–	35	100	nA
$\Delta V_{FB}$	Line Regulation	$V_{IN} = 4.5V$ to $18V$	–	2	20	mV
<b>GATE DRIVER (OUT PIN)</b>						
$f_{OSC}$	Oscillator Frequency	–	110	140	170	KHz
$D_{MAX}$	Max. Duty Cycle	–	90	95	99	%
$V_{GATE}$	OUT Pin Voltage (Note 5)	$I_{OUT} = 10mA$	–	$V_{IN}-1$	–	V
$t_{RISE}$	Rising Time	$V_{IN} = 5V$ , OUT Pin Load = $1nF$	–	65.5	–	ns
$t_{FALL}$	Falling Time		–	88.5	–	ns

Note 5: Guaranteed by design.

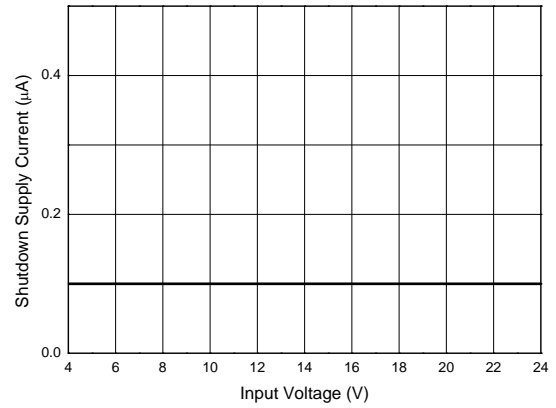
**Performance Characteristic** (@T<sub>A</sub> = +25°C, V<sub>DD</sub> = 5V, unless otherwise specified)

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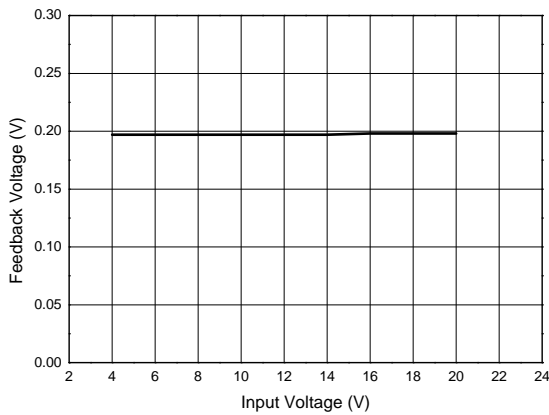
**Quiescent Current vs. Input Voltage**



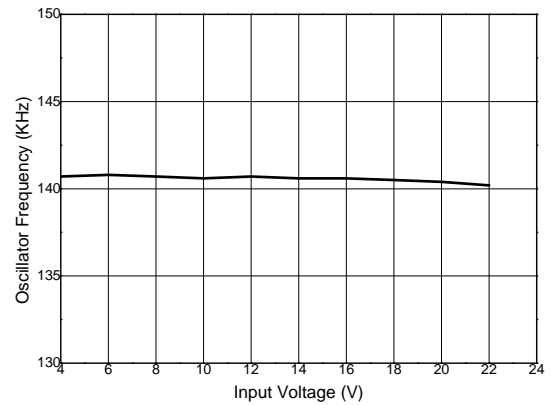
**Shutdown Supply Current vs. Input Voltage**



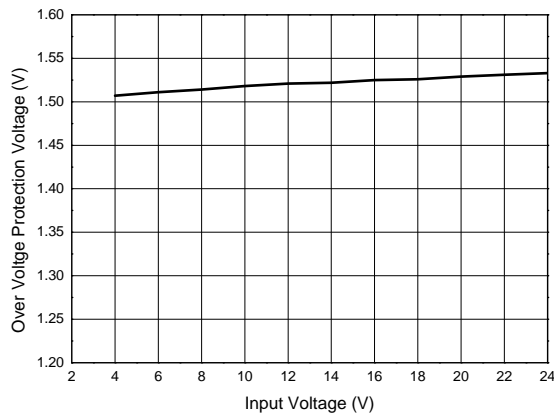
**Feedback Voltage vs. Input Voltage**



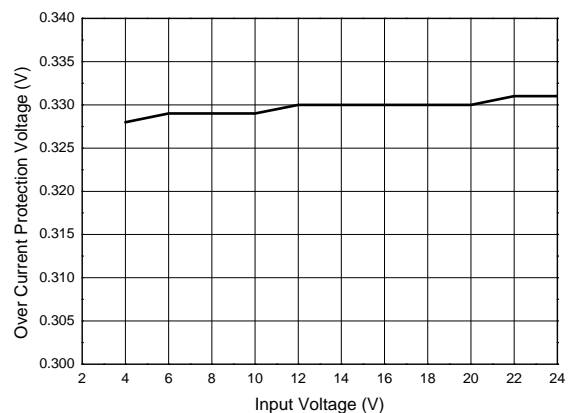
**Oscillator Frequency vs. Input Voltage**



**Over Voltage Protection Voltage vs. Input Voltage**

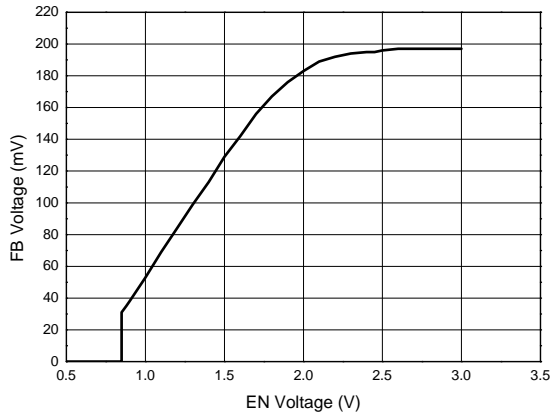


**Over Current Protection Voltage vs. Input Voltage**

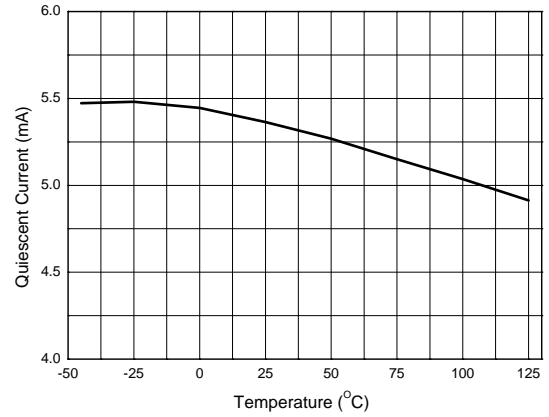


**Performance Characteristic** (Cont. @ $T_A = +25^\circ\text{C}$ ,  $V_{DD} = 5\text{V}$ , unless otherwise specified)

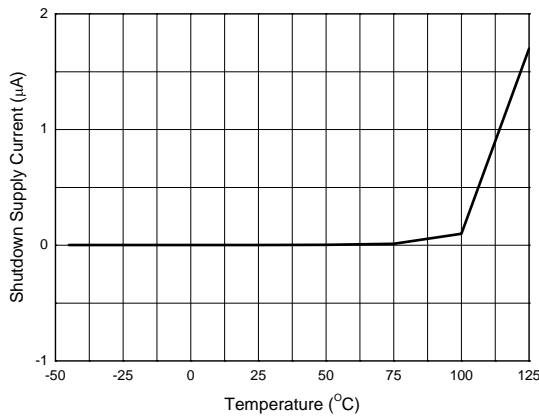
**FB Voltage vs. EN Voltage**



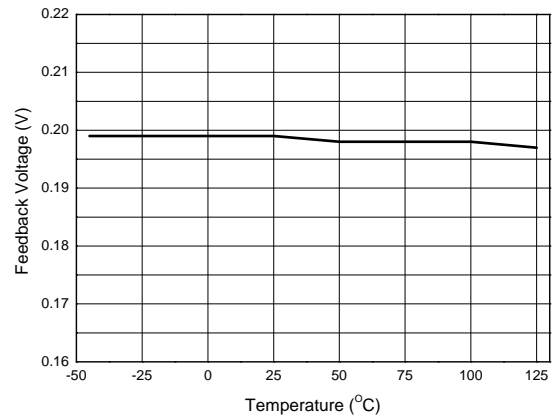
**Quiescent Current vs. Temperature**



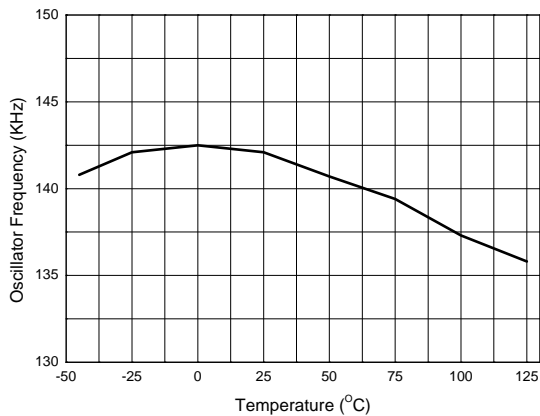
**Shutdown Supply Current vs. Temperature**



**Feedback Voltage vs. Temperature**



**Oscillator Frequency vs. Temperature**



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## Application Information

### General Operation

The AL3022 uses a constant frequency, voltage mode control scheme to provide excellent line and load regulation. To drive LED load, the AL3022 can be connected as shown in the Typical Applications Circuit on page 1. The maximum duty cycle of the PWM controller is limited to 90%. PWM dimming input can be provided by an external control signal greater than 100Hz, duty ratio of 1% to 90%. In addition, analog dimming can be provided by a DC signal ranged from 0.8V to 2.4V.

The AL3022 offers comprehensive protection features such as UVLO, OCP, OVP, OTP, LED open and  $V_{OUT}$  Short to GND.

### Enable/Dimming Control

The AL3022 uses EN pin to turn on and off the controller and also perform Digital (PWM) Dimming.

When EN input voltage is lower than 0.3V, the controller turns off and the shutdown current can be limited below 0.1 $\mu$ A. When EN input voltage is higher than 2.6V, the controller turns on and the reference voltage is set to 0.2V.

The AL3022 has an internal  $80\pm 15\%$ k $\Omega$  pull low resistor on the EN pin, thus the device is normally in the off state or shutdown mode operation.

When a PWM signal was presented into the EN pin of the AL3022 shown in Figure 1 below.

- 1). When the EN pin is higher than 2.6V, the device will turn on and the output current is at the programmed maximum level.
- 2). When the EN pin is lower than 0.3V, the device will turn off and the output current goes to 0mA.

If the frequency of the PWM signal is greater than 100Hz, the human eye cannot detect the on and off state of the LEDs. The human eye can only see a dimmed diode rather than a pulsed brightness. This dimming method provides a controlled inrush current at turn-on. The PWM duty cycle from 0% to 100% controls the output current from 0mA to the maximum programmed level.

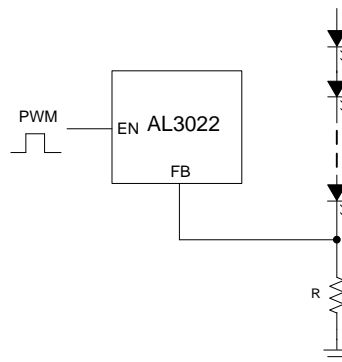


Figure 1. Digital Dimming Control Using a PWM Signal in EN Pin

### Analog Dimming Control

The Analog Dimming is to inject a constant DC voltage to EN pin shown in Figure 2 below. The feedback voltage is indirectly adjusted when the EN pin voltage is from 0.8V to 2.4V, which can be used as dimming control. The output LED current can be adjusted from minimum to maximum level by applying the DC voltage level from 0.8V to 2.4V.

Comparing with all kinds of dimming control, this method features a best output voltage and LEDs current.

**Application Information** (cont.)

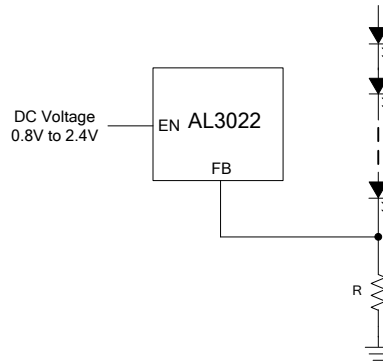


Figure 2. Analog Dimming Control Using a DC Voltage Signal in EN Pin

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**Soft Start Control**

The AL3022 external compensation circuit can clamp the output waveform to soft start smoothly.

**Operation Protection**

**1. Under Voltage Lockout**

The AL3022 provides an under voltage lockout circuit to prevent it from undefined status when startup. The Under Voltage Lockout circuit turns the driver off when supplying voltage drops below 3.6V. The UVLO circuit has 200mV hysteresis, which means the device starts up again when  $V_{IN}$  rises to 3.8V.

**2. Over Voltage Protection / LED Open Protection**

The controller has an internal OVP circuit. The controller output voltage will boost too high when LEDs are disconnected from the circuit or fail to open. The AL3022 will latch off the output if the OVP pin senses a voltage that is larger than 1.55V, and the power switching will be turned off. The latched off status can be reset by reducing the supply voltage to lower than 3.6V or EN lower than 0.3V.

**3. Under Voltage Protection /  $V_{OUT}$  Short to GND Protection**

The AL3022 monitors the OVP pin, if the OVP pin voltage is less than 0.1V, MOSFET drive output will turn off. When OVP is higher than 0.1V, system can auto recover. This protects the converter if  $V_{OUT}$  is shorted to ground.

**4. Over Current Protection**

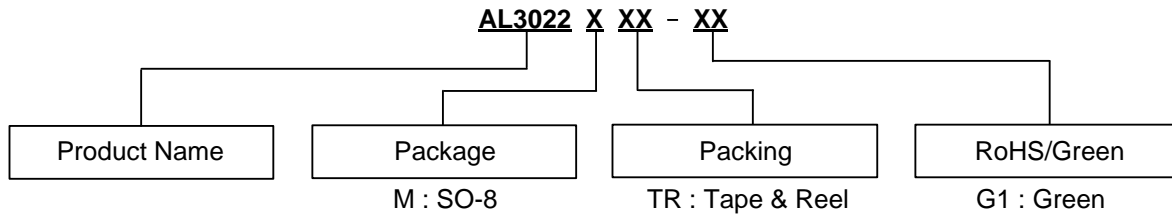
The AL3022 integrates an OCP circuit. The CS pin is connected to the voltage-sensor (RCS) that placed between the Drain of MOS and GND. If the voltage on CS pin exceeds 0.33V, it is turned off immediately and will not turn on until the next cycle begins.

**5. Over Temperature Protection**

The AL3022 monitors the temperature of itself. The AL3022 shuts itself off if the temperature exceeds the threshold value (typically +160°C). This is a no-latched protection. The device recovers once the temperature has decreased approximately +20°C.



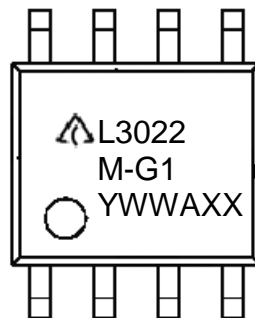
**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing
SO-8	-40°C to +85°C	AL3022MTR-G1	L3022M-G1	3000/13" Tape & Reel

**Marking Information**

(Top View)

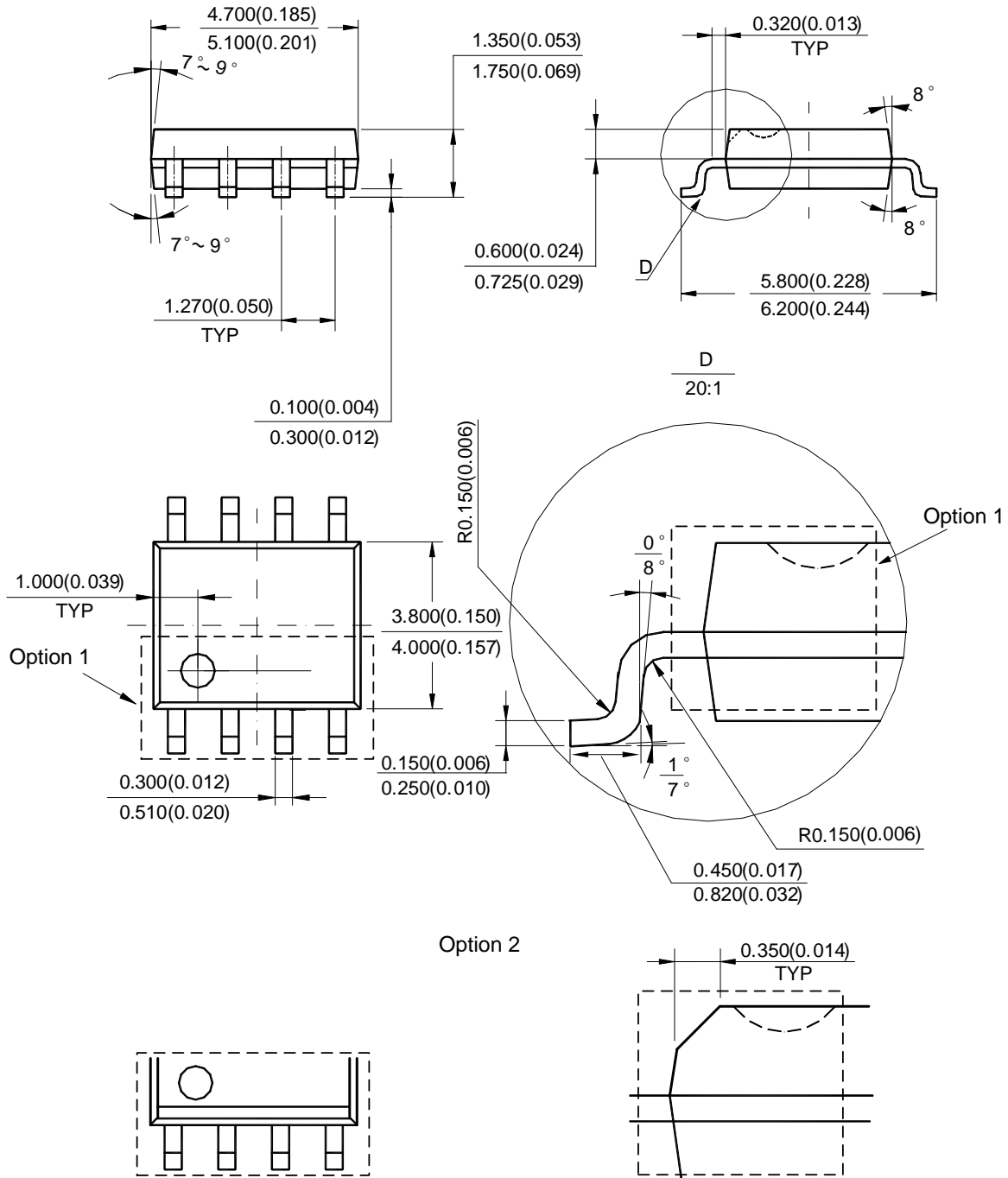


First and Second Lines: Logo and Marking ID  
 Third Line: Date Code  
 Y: Year  
 WW: Work Week of Molding  
 A: Assembly House Code  
 XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch No.

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**Package Outline Dimensions** (All dimensions in mm(inch).)

(1) Package Type: SO-8

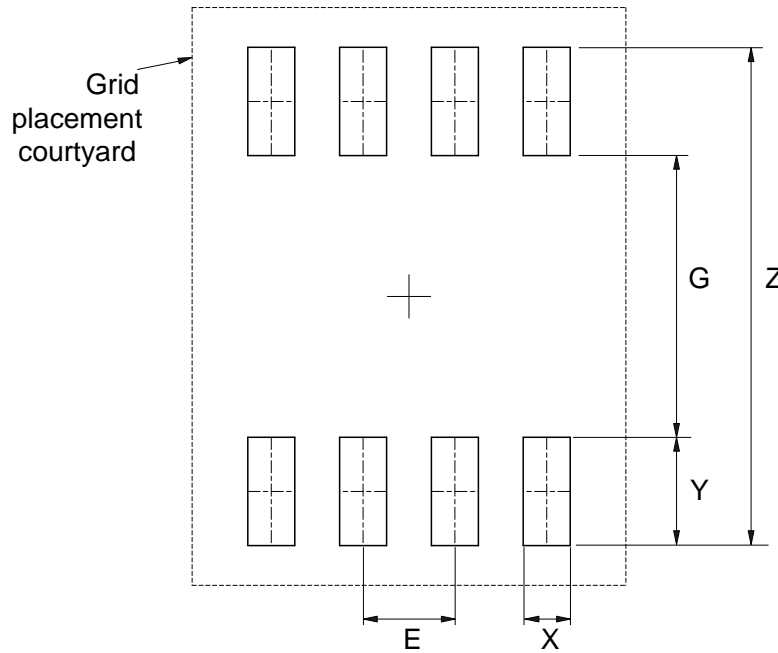


Note: Eject hole, oriented hole and mold mark is optional.

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**Suggested Pad Layout**

(1) Package Type: SO-8



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	1.270/0.050

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