

## General Description

AP3021 is a constant 330kHz, voltage mode, external compensation boost controller. The IC has low reference voltage which makes it ideal for low cost LED backlight supplies. It can support DC dimming.

AP3021 employs complete protection to ensure system security. The device integrates Under Voltage Lockout, Over Voltage Protection, and Over Temperature Protection to protect the circuit.

To satisfy the requirements for small mounting space constraints, AP3021 is available in SOIC-8 package to save space.

## Features

- Voltage Mode PWM Controller
- Low Feedback Voltage: 0.2V
- Fixed Frequency: 330kHz
- DC Dimming
- Low Shutdown Current: 0.1 $\mu$ A
- External Compensation
- Built-in UVLO Function
- Built-in OVP
- Built-in OTP

## Applications

- LED TV
- LED Monitor
- LED Display Module



Figure 1. Package Type of AP3021

## Pin Configuration

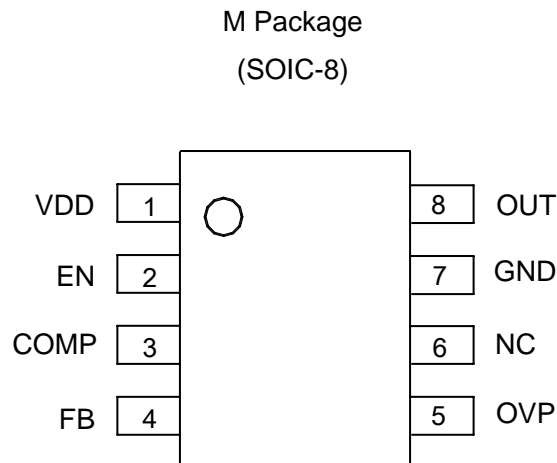


Figure 2. Pin Configuration of AP3021 (Top View)

## Pin Description

Pin Number	Pin Name	Function
1	VDD	Supply input pin. A capacitor should be connected between the VDD pin and GND pin to keep the DC input voltage constant
2	EN	Enable and dimming Pin. When EN input voltage is lower than 0.3V, disable IC. When EN input voltage works at 0.5V to 2.4V, enable DC dimming. When EN input voltage is higher than 2.6V, enable IC
3	COMP	Compensation pin. This pin is the output of the internal error amplifier. COMP is forced to low when $V_{DD} < 3.6V$
4	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage
5	OVP	Over voltage detection pin
6	NC	No connection
7	GND	Ground pin
8	OUT	Output pin, this pin is connected to external MOSFET gate to turn it on/off

**Functional Block Diagram**

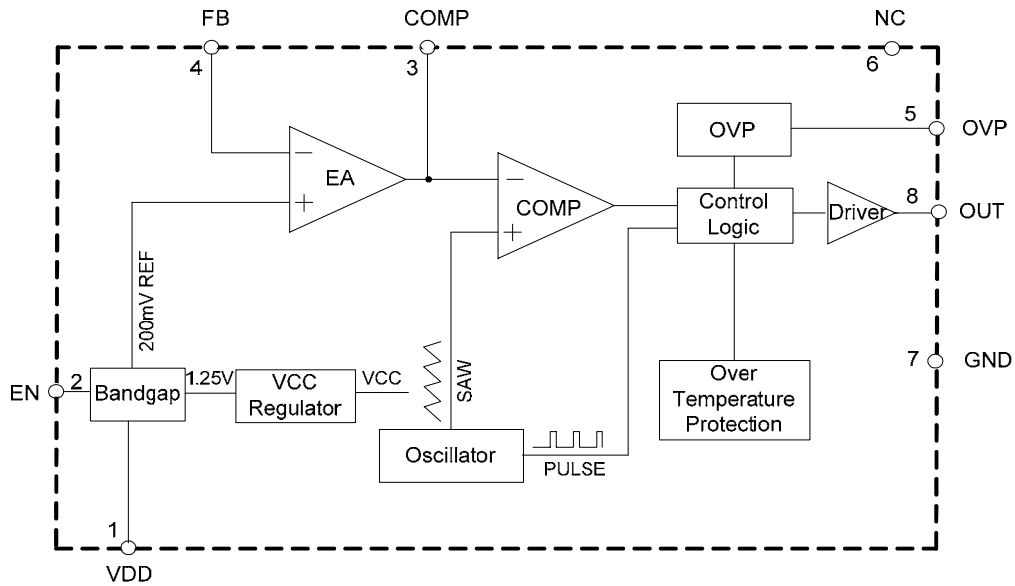
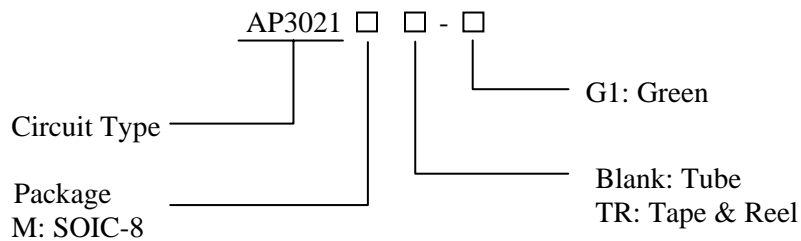


Figure 3. Functional Block Diagram of AP3021

**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing Type
SOIC-8	-40 to 85°C	AP3021M-G1	3021M-G1	Tube
		AP3021MTR-G1	3021M-G1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

**PWM Controller****AP3021****Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
VDD Pin Voltage	$V_{DD}$	-0.3 to 20	V
EN Pin Voltage	$V_{EN}$	-0.3 to $V_{DD}+0.3$	V
OUT Pin Voltage	$V_{OUT}$	20	V
OVP Pin Voltage	$V_{OVP}$	7	V
Feedback Pin Voltage	$V_{FB}$	-0.3 to 5.5	V
Thermal Resistance	$\theta_{JA}$	105	°C/W
Operating Junction Temperature	$T_J$	150	°C
Storage Temperature	$T_{STG}$	-65 to 150	°C
Lead Temperature (Soldering, 10sec)	$T_{LEAD}$	260	°C

Note 1: 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**

Parameter	Symbol	Min	Max	Unit
Input Voltage	$V_{DD}$	4.0	18	V
Operating Ambient Temperature	$T_A$	-40	85	°C



**PWM Controller**

**AP3021**

**Electrical Characteristics**

$V_{DD}=5V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified.

Parameters	Symbol	Conditions	Min	Typ	Max	Unit
<b>SUPPLY VOLTAGE (VDD PIN)</b>						
Input Voltage	$V_{DD}$		4.0		18	V
Quiescent Current	$I_Q$	$V_{FB}=0.3V$		5		mA
Shutdown Current	$I_{SHDN}$	$V_{EN}=0V$		0.1		$\mu A$
<b>UNDER VOLTAGE LOCKOUT</b>						
Input UVLO Threshold	$V_{UVLO}$	$V_{DD}$ Rising		3.8		V
Input UVLO Hysteresis	$V_{HYS}$		100	200	300	mV
<b>OVER VOLTAGE PROTECTION</b>						
Over Voltage Threshold			1.45	1.55	1.65	V
<b>OVER TEMPERATURE PROTECTION</b>						
Thermal Shutdown Temperature	$T_{OTSD}$			160		$^{\circ}C$
Thermal Shutdown Hysteresis				20		$^{\circ}C$
<b>ENABLE (EN PIN)</b>						
EN Pin Threshold	$V_{EN-OFF}$		0.3			V
	$V_{EN-ON}$				2.6	V
EN Pin Dimming Threshold	$V_{EN-DIM}$		0.4	0.5		V
				2.4	2.6	V
<b>VOLTAGE REFERENCE (FB PIN)</b>						
Feedback Voltage	$V_{FB}$		0.194	0.2	0.206	V
Feedback Bias Current	$I_{FB}$			35	100	nA
Line Regulation		$V_{DD}=4.5V$ to $8V$ $T_A=25^{\circ}C$		2	20	mV
		$V_{DD}=8V$ to $18V$ $T_A=25^{\circ}C$		4	40	mV
<b>OUTPUT</b>						
Oscillator Frequency	$f_{OSC}$		247	330	412	kHz
Maximum Duty Cycle	$D_{MAX}$		85	90	95	%
OUT Voltage (Note2)	$V_{OUT}$	$I_{OUT}=10mA$		$V_{DD}-1$		V
Rising Time	$t_{RISE}$	Output Pin Load=1nF		65.5		ns
Falling Time	$t_{FALL}$			88.5		ns

Note 2: Guaranteed by design.

## Operation Description

### 1. PWM Operation

The AP3021 uses a constant frequency, voltage mode control scheme to provide excellent line and load regulation. To drive LED load, AP3021 can be connected as current regulator (Figure 5) or voltage regulator (Figure 6), both topologies can realize LED lighting and dimming. Load regulation is less than 3% even if AP3021 is connected as voltage regulator. The maximum duty cycle of the PWM controller is limited to 93%. For more information please refer to the functional block diagram (Figure 3).

### 2. Enable Control

The EN pin is used to turn on and off the controller. When EN input voltage is lower than 0.3V, the controller turns off and the shutdown current can be limited under 0.1 $\mu$ A. When EN input voltage goes higher than 2.6V, the controller turns on and the feedback voltage is set to 0.2V. When EN voltage works at 0.5V to 2.4V, the IC will operate in dimming mode, more details please refer to section 4.

The AP3021 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.

### 3. Soft Start Control

The AP3021 external compensation circuit can clamp the output waveform to soft start smoothly.

### 4. DC Dimming Control

The DC Dimming is to inject a constant DC voltage to EN pin. The feedback voltage is indirectly adjusted when the EN pin voltage is between 0.5V to 2.4V, which can be used as dimming control. Application in Figure 4 is designed so that a voltage signal of 0.5V to 2.4V varies the LED current from minimum output current to maximum output current. Comparing with all kinds of dimming control, this method features a best output voltage and LEDs current.

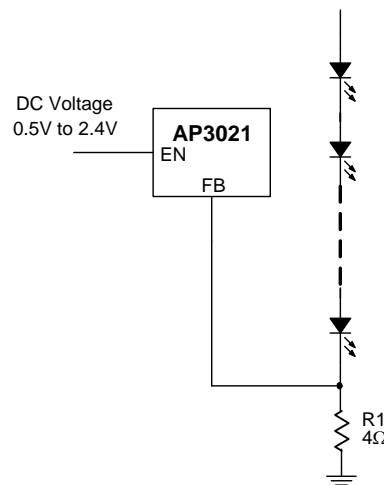


Figure 4. Dimming Control Using A DC Voltage Signal in EN Pin

## 5. Operation Protection

### 5.1 Over Voltage 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 open. The AP3021 will latch off the output if the OVP pin senses a voltage that is higher 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.

### 5.2 UVLO

The AP3021 provides an under voltage lockout circuit to prevent it from undefined status when startup. The UVLO circuit turns the driver off when supply voltage drops below 3.6V. The UVLO circuit has 200mV hysteresis, which means the device starts up again when  $V_{DD}$  rises to 3.8V.

### 5.3 OTP

The AP3021 monitors the temperature of itself. If the temperature exceeds the threshold value (typically 160°C), the AP3021 shuts itself off. This is a no-latched protection. The device recovers once the temperature has decreased approximately 20°C.

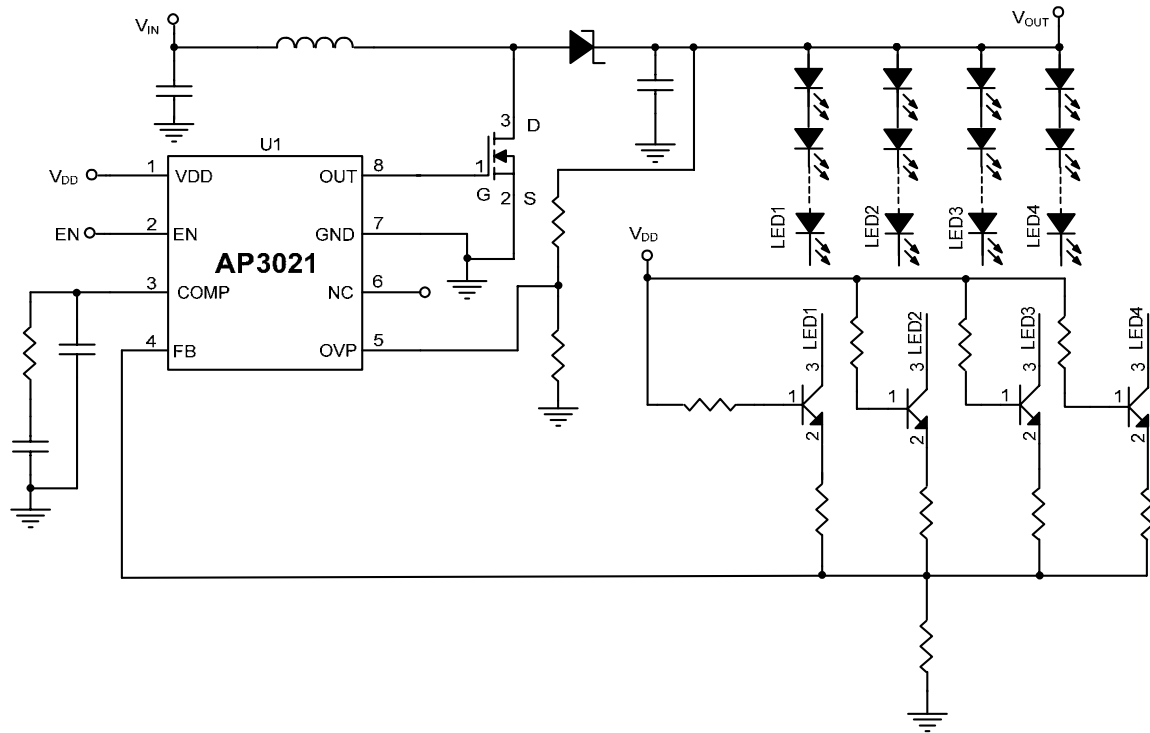
**Typical Application**


Figure 5. Current Regulator to Drive LEDs

**Typical Application (Continued)**

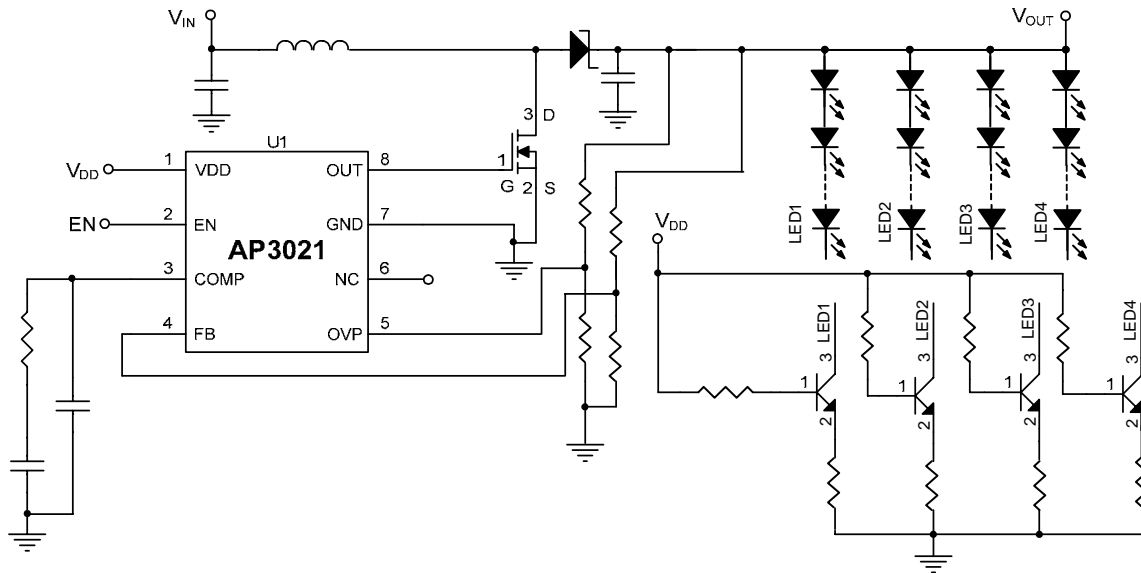


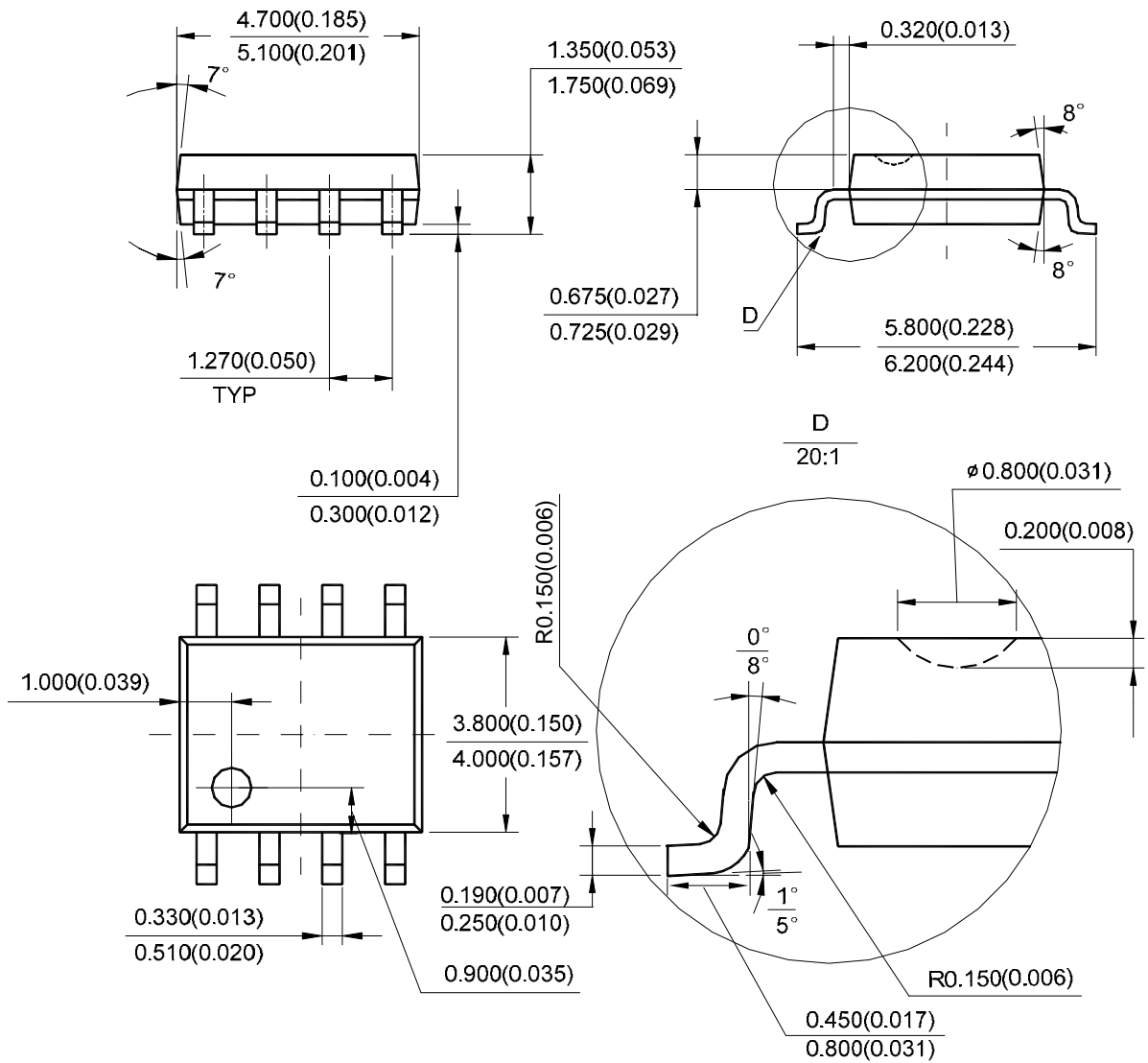
Figure 6. Voltage Regulator to Drive LEDs



**Mechanical Dimensions**

**SOIC-8**

**Unit: mm(inch)**



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



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