VERSATILE COST EFFECTIVE GREEN PWM CONTROLLER AP3103

General Description

The AP3103 is a low startup current, current mode PWM controller with green-mode power-saving operation. The PWM switching frequency at normal operation is externally programmable and is trimmed to a tigh range. The dithering of frequency will improve EMI feature. When the load decreases, the frequency will reduce and when at a very low load, the IC will enter the 'skip mode' to minimize switching loss. About 20kHZ frequency switching is aviode the audible noise as well as reduding the standby loss.

The AP3103 features a lot of functions such as the Leading-Edge Blanking (LEB) of the current sensing, internal slope compensation and several protection functions including cycle-by-cycle current limit (OCP), VCC Over Voltage Protection (VOVP), OTP, OLP protection.

This IC is available in SOT-23-6 and DIP-8 packages.

Features

- Bi-CMOS Process with Excellent Performance
- Very Low Start-up Current:(< 15μA)
- Current Mode Control
- Non-audible-noise Green-mode Control
- LEB (Leading-edge Blanking) on CS Pin
- Internal Slope Compensation
- Frequency Fold Back for High Average Efficiency
- Soft Switching for Reducing EMI
- Useful Pin Fault Protection:
  CS Pin Floating
  RI Pin Short to Ground
  RI Pin Floating
  FB/Opt-coupler Open/short
- Comprehensive System Protection Feature:
  VCC Over Voltage Protection (VOVP)
  Over Temperature Protection (OTP)
  Over Load Protection (OLP)
- Mini Size with Packages

Applications

- Switching AC-DC Adapter/Charger
- ATX/BTX Auxiliary Power
- Set-top Box(STB) Power Supply
- Open Frame Switching Power Supply

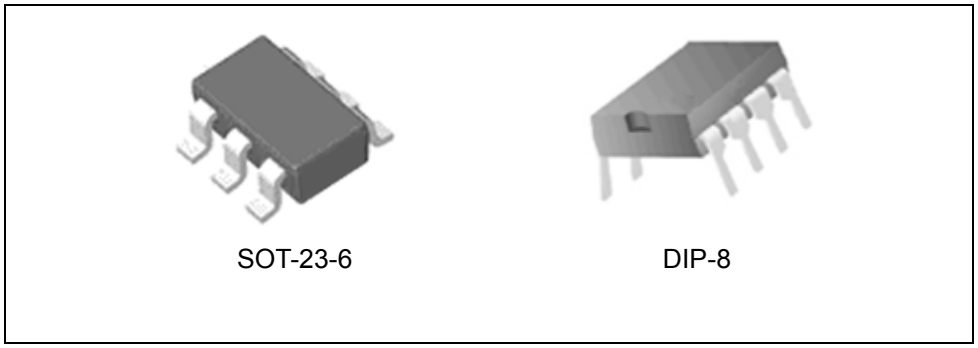


Figure 1. Package Types of AP3103

Pin Configuration

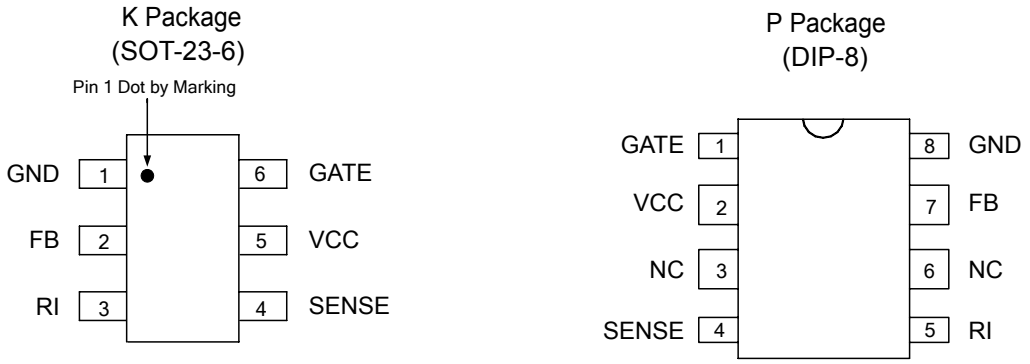


Figure 2. Pin Configuration of AP3103 (Top View)

Pin Description

Pin Number		Pin Name	Function
SOT-23-6	DIP-8		
1	8	GND	Signal ground. Current return for driver and control circuits
2	7	FB (COMP)	Feedback. Directly connected to the opto-coupler
3	5	RI	Set the bias current to determine the normal switching frequency
4	4	SENSE	Current Sense
5	2	VCC	Supply voltage of driver and control circuits
6	1	GATE	Gate driver output
	3, 6	NC	No connection. These pins are not internally connected

Functional Block Diagram

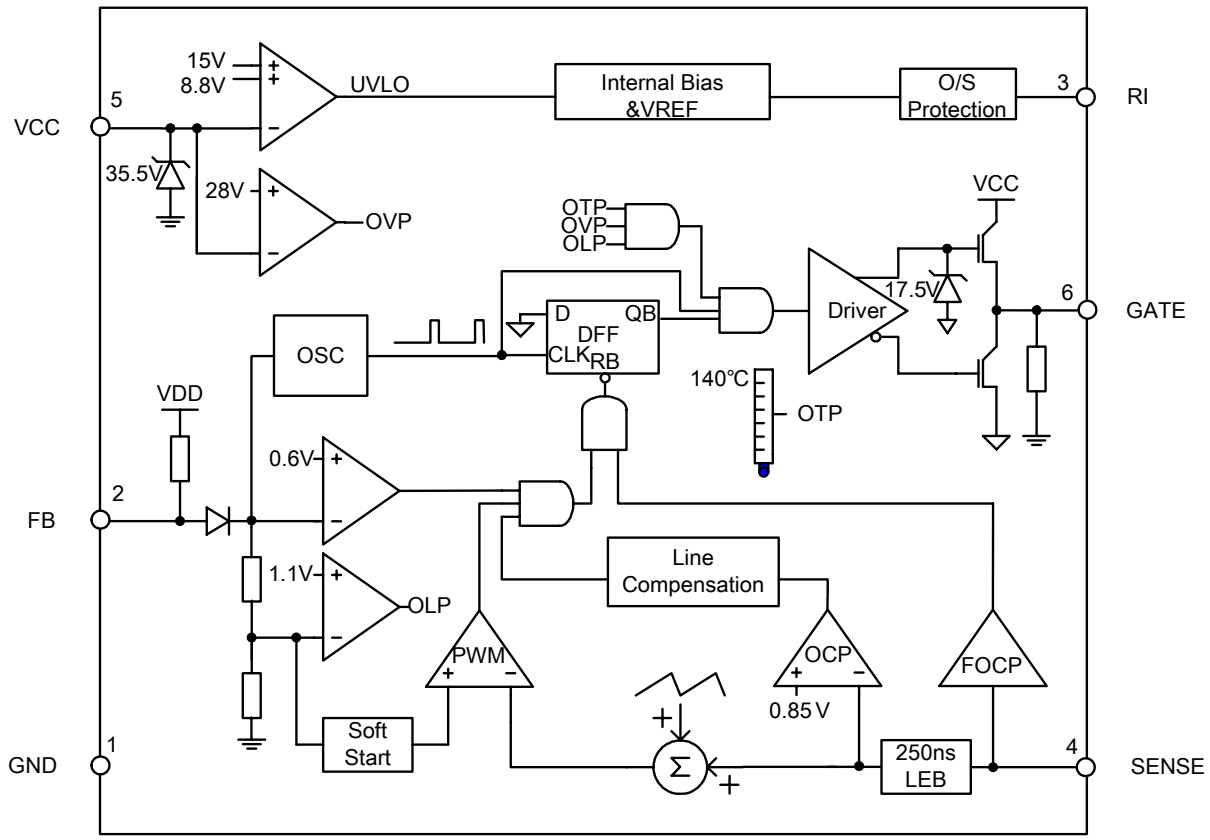
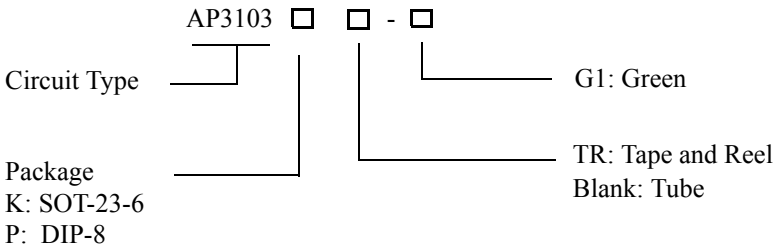


Figure 3. Functional Block Diagram of AP3103

Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing Type
SOT-23-6	-40 to 85°C	AP3103KTR-G1	GHL	Tape & Real
DIP-8	-40 to 85°C	AP3103P-G1	AP3103P-G1	Tube

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

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value		Unit
Power Supply Voltage	V_{CC}	30		V
Gate Output Current	I_O	300		mA
Input Voltage to FB, SENSE pin	V_{FB}, V_{SENSE}	-0.3 to 7		V
Thermal Resistance Junction to Ambient	θ_{JA}	SOT-23-6	250	°C/W
		DIP-8	100	
Power Dissipation and Thermal Characteristic, SENSE at T_A<25°C	P_D	SOT-23-6	500	mW
		DIP-8	1250	
Operating Junction Temperature	T_J	-40 to150		°C
Storage Temperature Range	T_{STG}	150		°C
ESD (Human Body Model)		3000		V
ESD (Machine Model)		300		V

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
Supply Voltage	V_{CC}	10	25	V
Ambient Operating Temperature Range	T_A	-40	85	°C

Electrical Characteristics

V_{CC}=16V, T_A=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage (VCC Pin)						
Start-up Current	$I_{START-UP}$	V_{CC}=14.8V		5	15	μA
Operating Supply Current	I_{CC}	V_{FB}=0V, C_L=1nF, R_{RI}=100kΩ	1	2	3	mA
		V_{FB}=3V, C_L=1nF, R_{RI}=100kΩ	0.65	1.65	2.65	
UVLO (on)			14	15	16	V
UVLO (off)			7.8	8.8	9.8	V
VCC OVP			27	28	29	V
VCC Clamp		I_{CC}=5mA	34	35.5	37	V
PWM Section/Oscillator Section						
Maximum Duty Cycle			70	75	80	%
Minimum Duty Cycle				0		
Oscillation Frequency		R_{RI}=100kΩ	60	65	70	kHz
Green Mode Frequency		R_{RI}=100kΩ	22			kHz
Frequency Temperature Stability		-40°C to 85°C			5	%
Frequency Voltage Stability		V_{CC}=12 to 30V			3	%
Frequency Dithering				±6		%
Current Sense Section (SENSE Pin)						
Maximum SENSE Voltage	V_{CS}	V_{FB}=3.3V, R_{RI}=100kΩ	0.800	0.850	0.900	V
LEB Time of SENSE			150	250	350	ns
Delay to Output			50	150	250	ns
Soft-start Time				0.5		ms
Feedback Input Section (FB Pin)						
The Ratio of Input Voltage to Current Sense Voltage			2.5	3	3.5	V/V
Input Impedance			3	4.5	6	kΩ
Source Current		V_{FB}=0V	-0.5	-1	-1.5	mA
Input Voltage for Zero Duty				1.5		V
Output Section (GATE Pin)						
Output Low Level		I_O=20mA, V_{CC}=12V			1	V
Output High Level		I_O=20mA, V_{CC}=12V	8			V
Output Clamping			16	17.5	19	V
Rising Time		C_L=1nF, V_{CC}=13V	120	220	320	ns
Falling Time		C_L=1nF, V_{CC}=13V	30	50	90	ns

Electrical Characteristics

V_{CC}=16V, T_A=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Over Temperature Protection Section						
Shutdown Temperature				140		°C
Temperature Hysteresis				20		°C
Delay Time Section						
Delay 1 of Protection		OLP		35		ms
Delay 2 of Protection		VCC OVP		25		μs

Typical Performance Characteristics

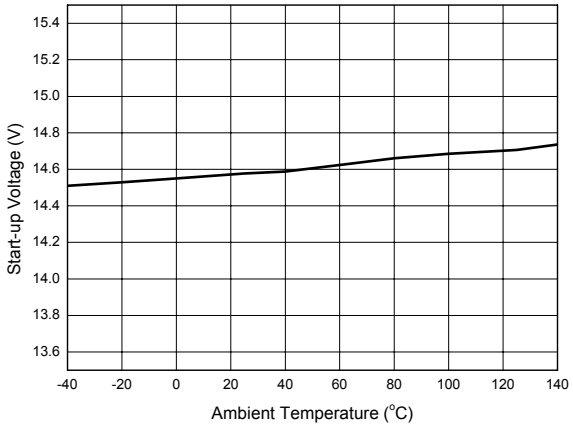


Figure 4. Start-up Voltage vs. Ambient Temperature

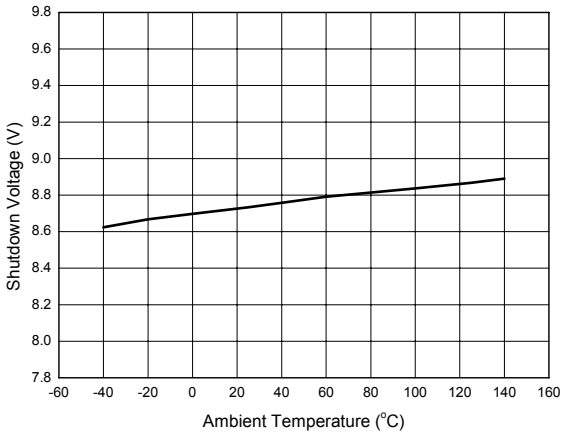


Figure 5. Shutdown Voltage vs. Ambient Temperature

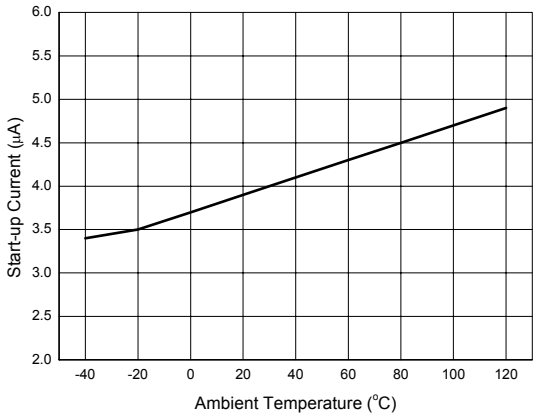


Figure 6. Start-up Current vs. Ambient Temperature

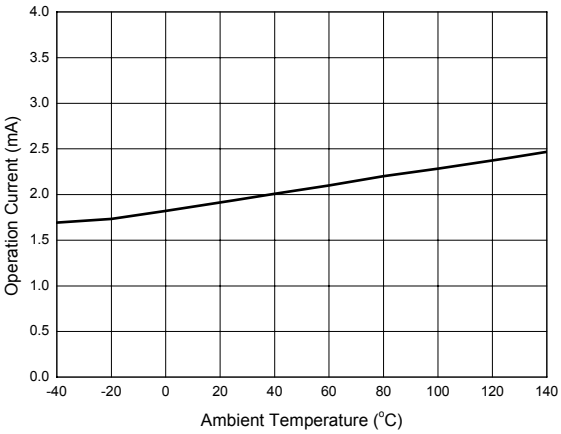


Figure 7. Operation Current vs. Ambient Temperature

Typical Performance Characteristics (Continued)

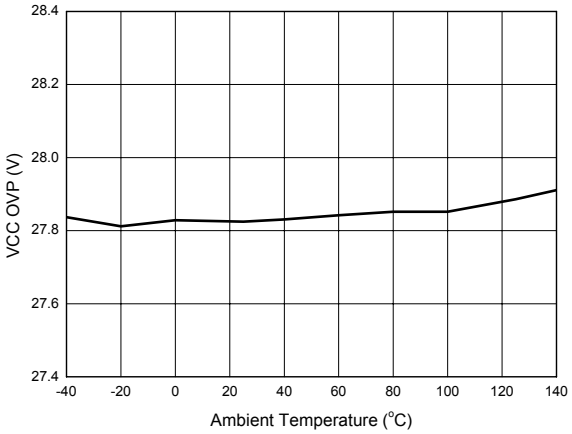


Figure 8. VCC OVP vs. Ambient Temperature

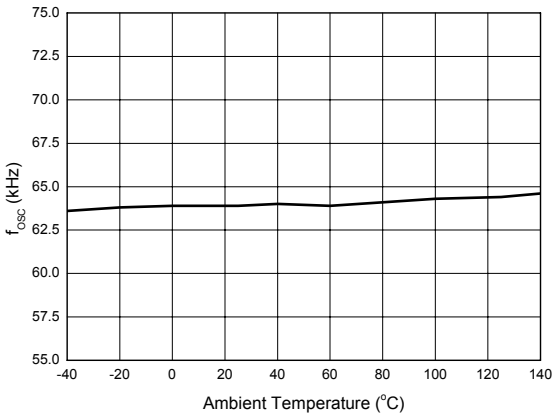


Figure 9. f_{OSC} vs. Ambient Temperature

Operation Description

The AP3103 is specifically designed for off-line AC-DC power supply used in LCD monitor, notebook adapter and battery charger applications. It offers a cost effective solution with a versatile protection function.

Start-up Current and UVLO

The start-up current of AP3103 is optimized to realize ultra low current (5μA typical) so that VCC capacitor can be charged more quickly. The direct benefit of low start-up current is the availability of using large start-up resistor, which minimizes the resistor power loss for high voltage AC input.

An UVLO comparator is included in AP3103 to detect the voltage on the VCC pin. It ensures that AP3103 can draw adequate energy from hold-up capacitor during power on. The turn-on threshold is 15V and the turn-off threshold is 8.8V.

Oscillator

The oscillation frequency is programmed by the value of resistor R1, connected from pin RI to ground. The resistor will make a constant current source to determine the oscillation frequency by charging and discharging an internal capacitor. Normally, RI pin should not be placed where exists too much noise, as the disturbance may make the IC work abnormally.

The oscillation frequency can be expressed as:

$$f \approx \frac{6500}{R1(k\Omega)}(kHz)$$

The recommended oscillation frequency is 50 to 100 kHz from the EMI consideration.

Current Sense Comparator and PWM Latch

The AP3103 operates as a current mode controller; the output switch conduction is initiated by every oscillator cycle and is terminated when the peak inductor current reaches the threshold level established by the FB pin. The inductor current signal is converted to a voltage signal by inserting a reference sense resistor R_S. The inductor current under normal operating conditions is controlled by the voltage at FB pin, the relation between peak inductor current (I_{PK}) and V_{FB} is:

$$I_{PK} = (V_{FB} - 0.8) / 3R_S$$

Leading−edge Blanking

A narrow spike on the leading edge of the current waveform can usually be observed when the power MOSFET is turned on. A 250ns leading-edge blank is built-in to prevent the false-triggering caused by the turn-on spike. During this period, the current limit comparator is disabled and the gate driver can not be switched off.

FB Pin and Short Circuit Protection

This pin is normally connected to the opt-coupler and always paralleled with a capacitor for loop compensation. When the voltage at this pin is great than 4.2V (such as output short to ground or the opt-coupler is broken) and lasts for about 25ms, the IC will enter the protection mode. For AP3103, the system will enter hiccup mode to wait the VCC decreasing to low UVLO level, then the IC will try to restart until the failure removed. And when this voltage is less than 1.5V, the IC will stop the drive pulse immediately. Therefore, this feature can be used for short circuit protection, which makes the systemimmune from catastrophic failure. Normally, output short makes the VFB value to the maximum because the opt-coupler is cut off.

System Protection and Pin Fault Protection

The AP3103 provides versatile system and pin fault protections. The OCP comparator realizes the cycle-by-cycle current limiting (OCP).In universal input line voltage, the IC realizes the constant over load protection (OLP). VCC over voltage protection can be applied as the primary OVP or opt-coupler broken protection. The AP3103 also has pin fault connection protection including floating and short connection. The floating pin protection include the RI, SENSE, FB, etc; The short pin protection includes the RI pin short protection. When these pins are floated or RI pin is shorted to ground, PWM switching will be disabled, thus protecting the power system.

Typical Application

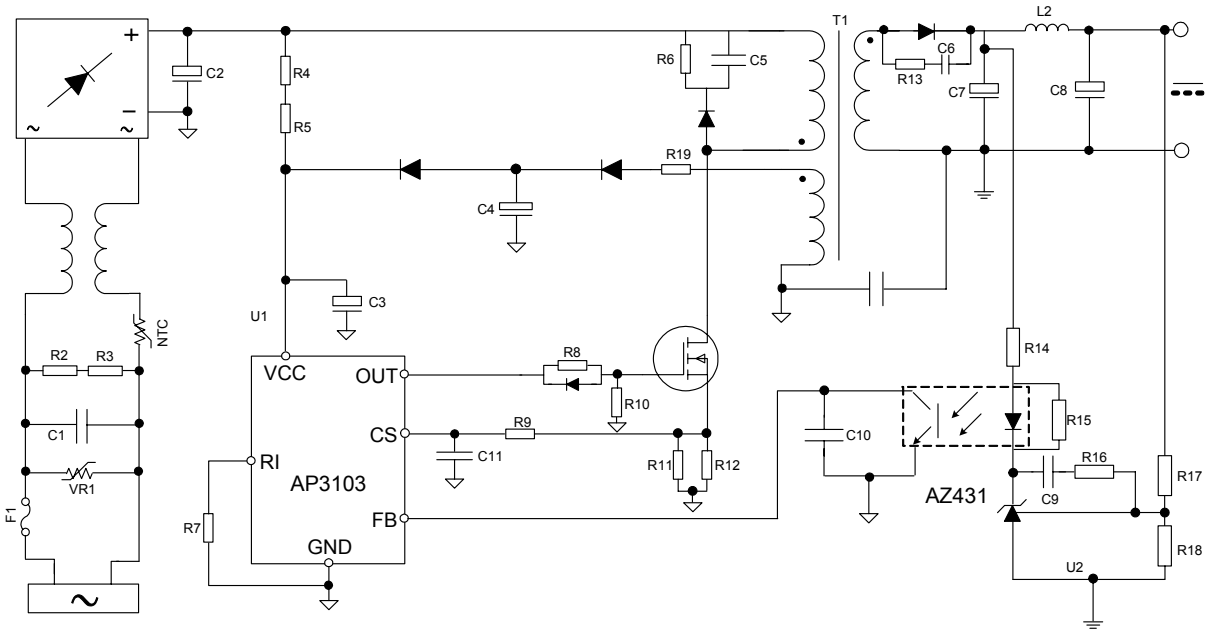
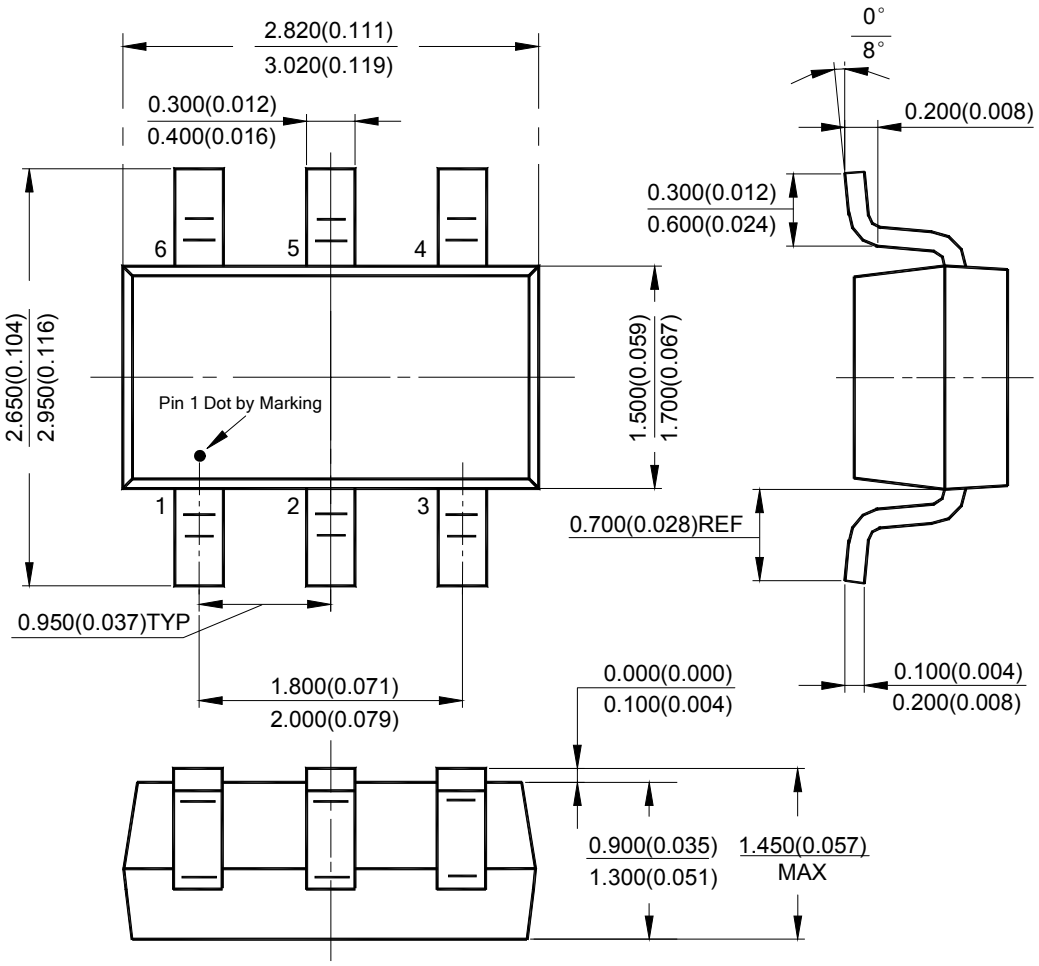


Figure 10. Typical Application of AP3103

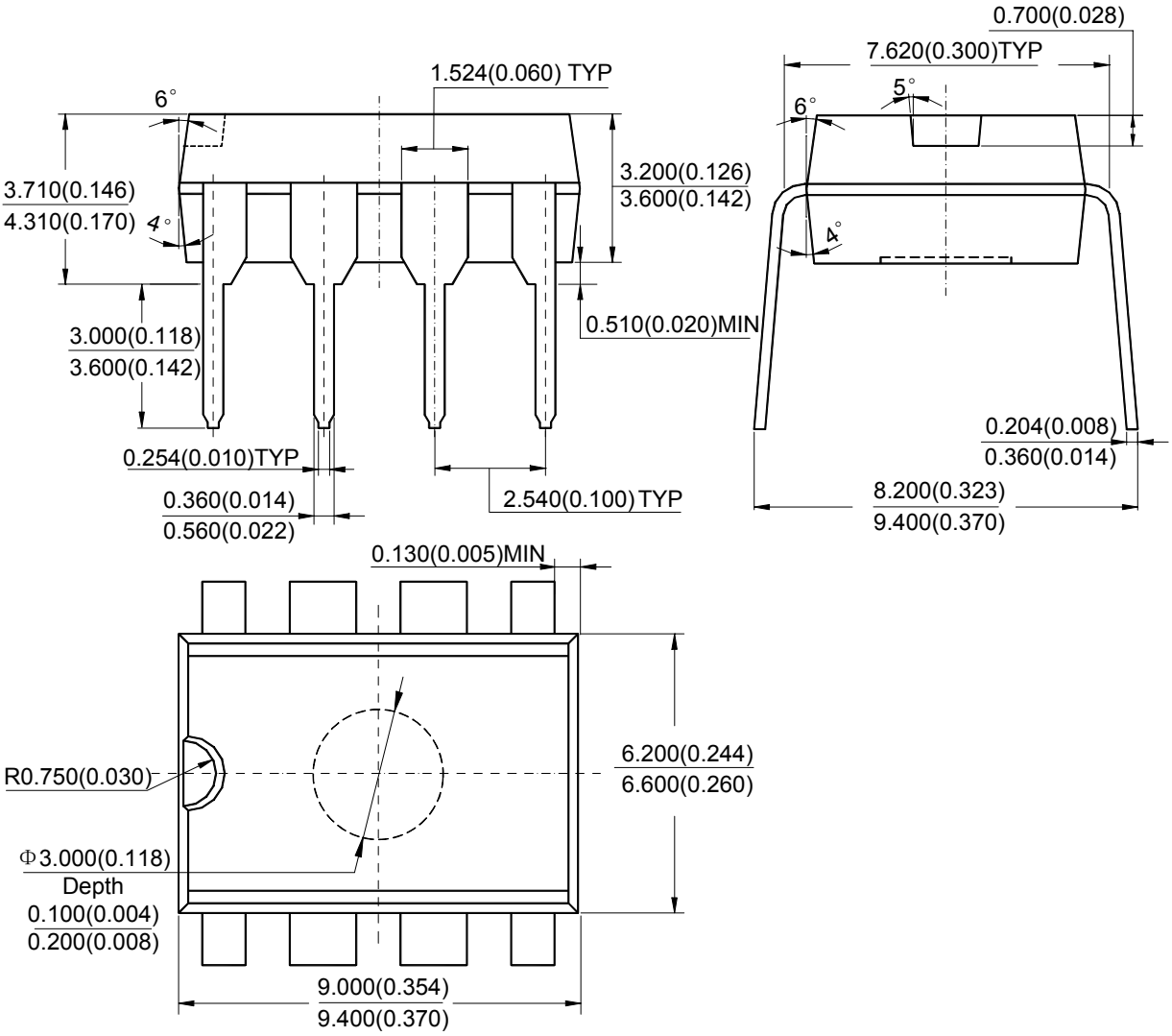
Mechanical Dimensions

SOT-23-6 **Unit: mm(inch)**



Mechanical Dimensions (Continued)

DIP-8 **Unit: mm(inch)**



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

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