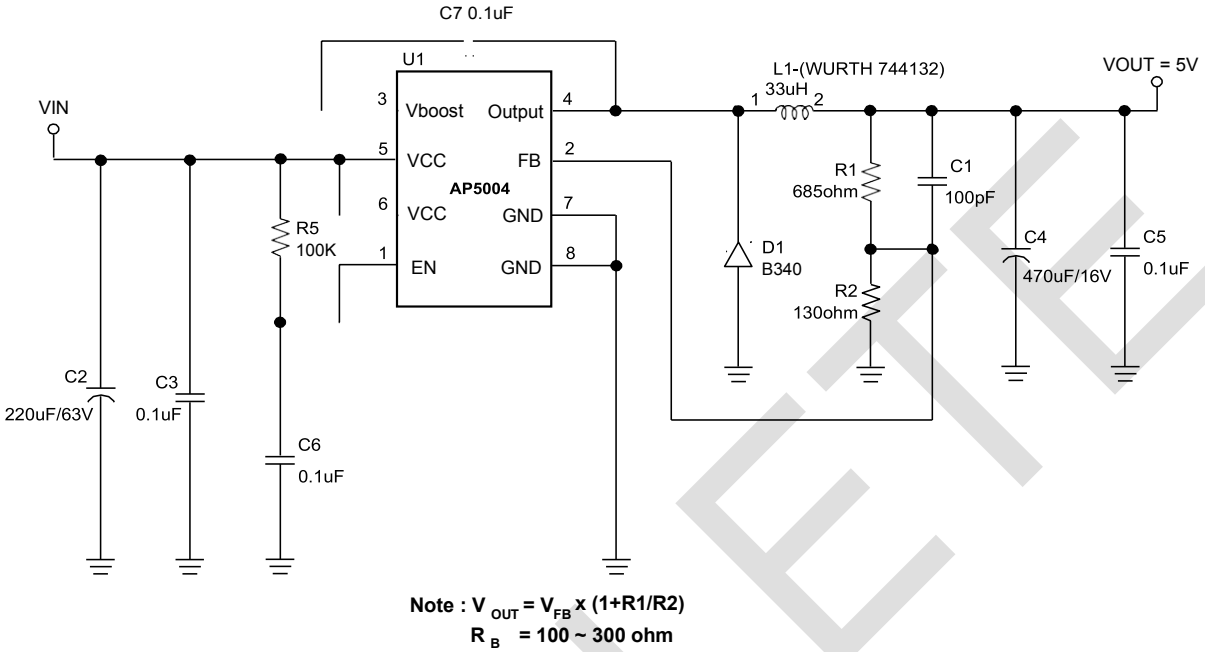
Typical Application Circuit



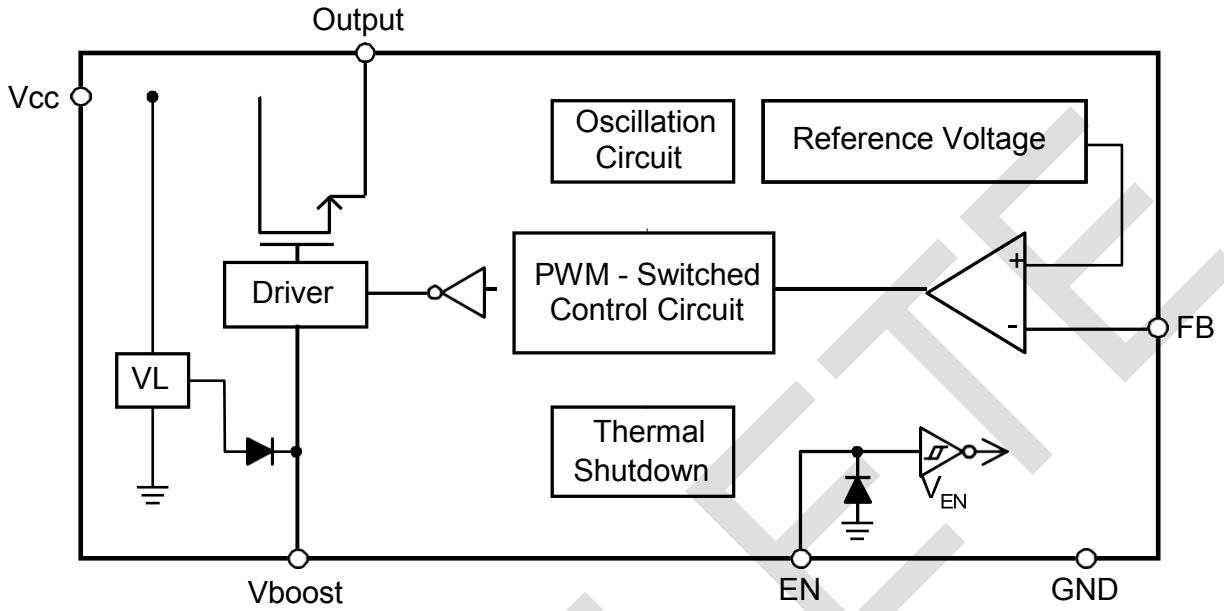
Note : $V_{OUT} = V_{FB} \times (1+R1/R2)$
R_B = 100 ~ 300 ohm

Notes: 2. Suggested DIODES Power Schottky P/N: PDS540 or B540C.

Pin Descriptions

Pin Name	Pin #	Description
EN	1	H: Normal operation L: Step-down operation stopped
FB	2	Feedback pin
V_{boost}	3	High-side gate driver boost pin
Output	4	Switch output pin
V_{CC}	5、6	V_{CC}
GND	7、8	GND pin

Functional Block Diagram



Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
ESD HBM	Human Body Model ESD Protection	1.8	KV
ESD MM	Machine Model ESD Protection	550	V
V_{CC}	VCC Pin Voltage	V_{SS} - 0.3 to V_{SS} + 35	V
V_{FB}	V_{OUT} Pin Voltage	V_{SS} - 0.3 to V_{CC}	V
V_{EN}	EN Pin Voltage	V_{SS} - 0.3 to V_{CC} + 0.3	V
V_{boost}	V_{boost} Pin Voltage	V_{OUTPUT} + 7V	V
V_{OUTPUT}	Switch Pin Voltage	V_{SS} - 0.3 to V_{CC} + 0.3	V
T_J	Operating Junction Temperature Range	-10 to +125	°C
T_{ST}	Storage Temperature Range	-40 to +150	°C

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	10	32	V
I_{OUT}	Output Current	0	2.5	A
T_A	Operating Ambient Temperature	-10	85	°C

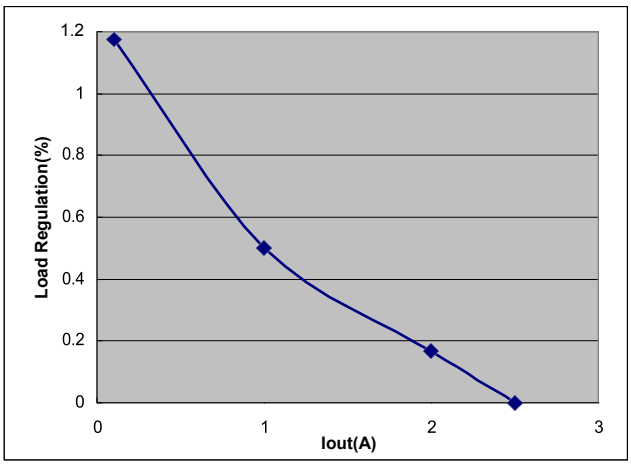
Electrical Characteristics (V_{IN} = 12V, T_A=25°C, unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ.	Max	Unit
V_{FB}	Feedback Voltage		0.780	0.8	0.820	V
V_{IN}	Input Voltage		10	-	32	V
I_{STBY}	Standby Current	V_{EN} =0V	-	2	-	μA
$\Delta V_{OUT}/V_{OUT}$	Line Regulation	V_{IN} = 10V~32V	-	±1.0	±1.5	%/V
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	I_{OUT} = 0.1 to 2.5A	-	1	1.5	%
f_{OSC}	Oscillation Frequency	Measure waveform at SW pin	240	300	360	KHz
f_{OSC1}	Frequency of Current Limit or Short Circuit Protect	Measure waveform at SW pin	-	50	-	KHz
DC	Maximum Duty Cycle	V_{FB} =0.5V	-	90	-	%
	Minimum Duty Cycle	V_{FB} =1.0V	-	0	-	%
V_{IH}	EN Pin Logic Input Threshold Voltage	Regulator ON	2.0	-	-	V
V_{IL}		Regulator OFF	-	-	0.8	
I_{SH}	EN Pin Input Leakage Current		-	20	-	μA
I_{SL}			-	-10	-	μA
$R_{DS(ON)}$	Internal MOSFET $R_{DS(ON)}$		-	80	120	mΩ
I_{LIMIT}	Current Limit		3.5	-	-	A
η	Efficiency	V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 2.5A	-	90	-	%
θ_{JA}	Thermal Resistance Junction-to-Ambient	SOP-8L (Note 3)	-	124	-	°C/W
θ_{JC}	Thermal Resistance Junction-to-Case	SOP-8L (Note 3)	-	25	-	°C/W

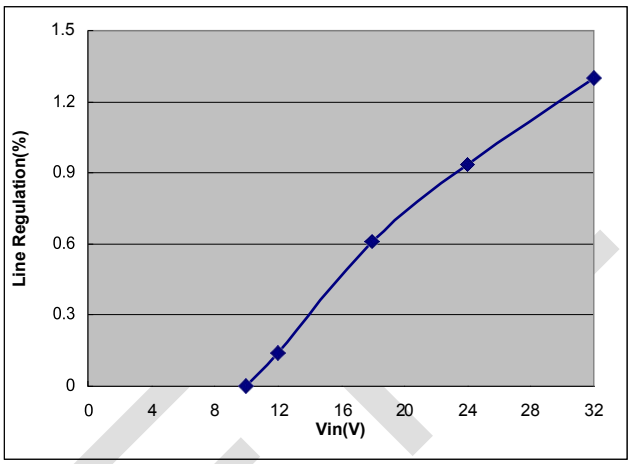
Notes: 3. Test condition for SOP-8L: Device mounted on 2oz copper, minimum recommended pad layout, FR-4 PCB.

Typical Performance Characteristics

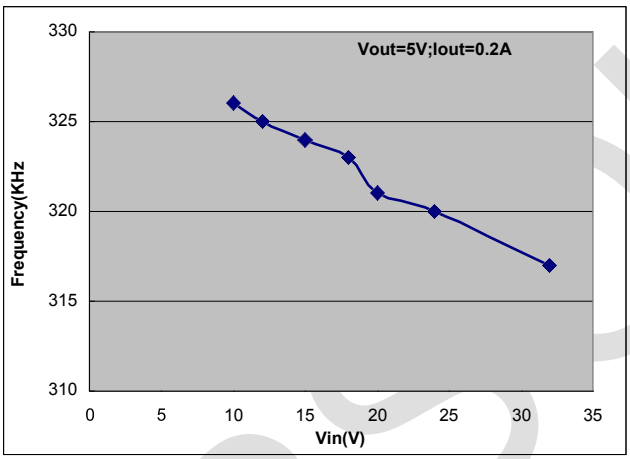
Load Regulation



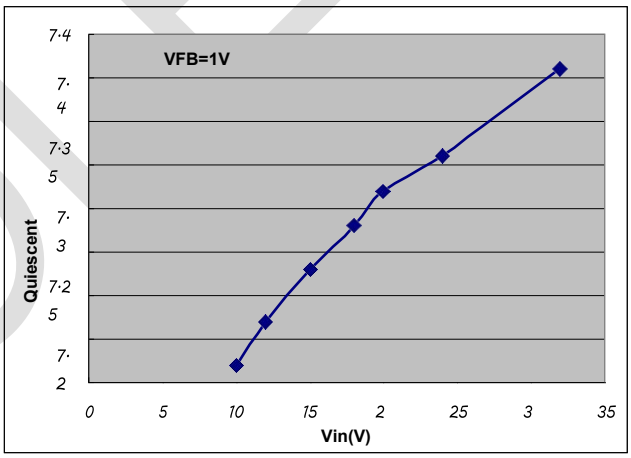
Line Regulation



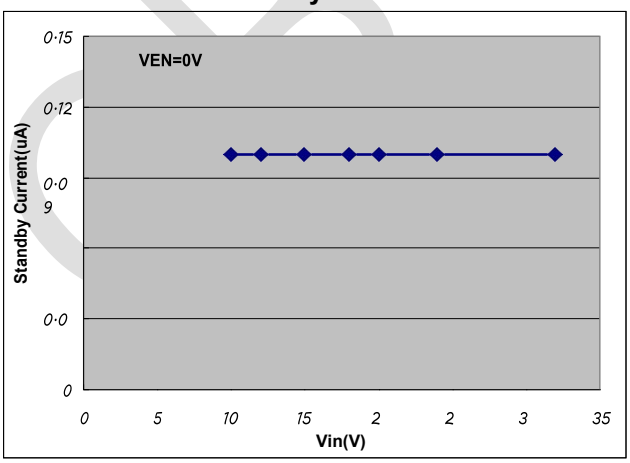
Frequency vs. Vin



Iccq vs. Vin

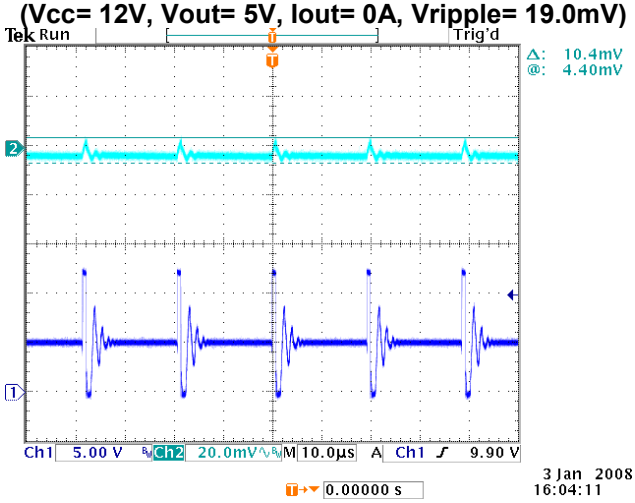


Istandby vs. Vin

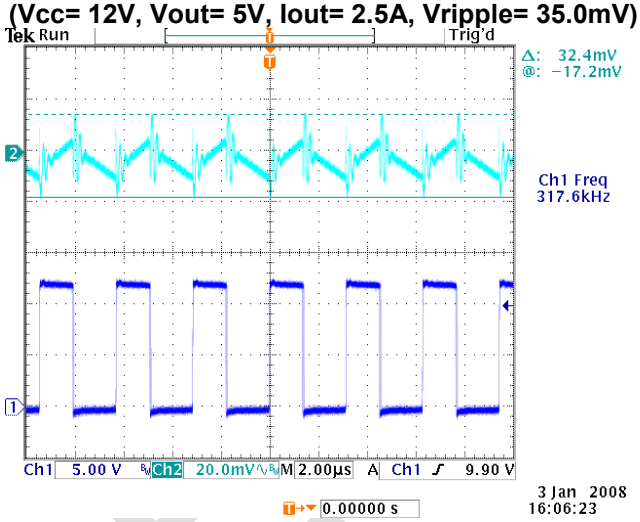


Typical Performance Characteristics (Continued)

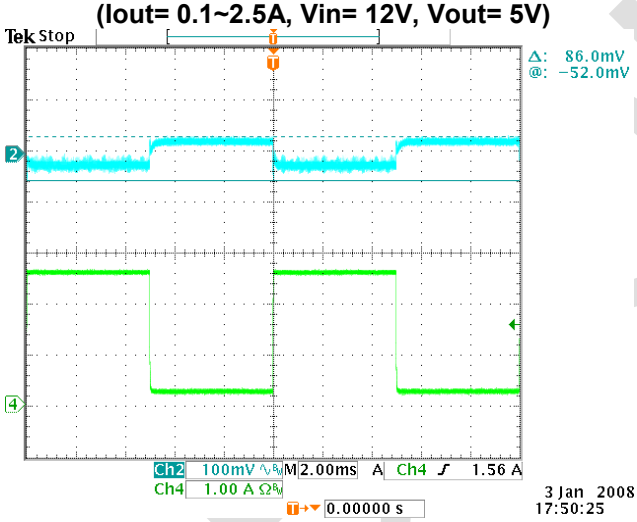
Vout Ripple
(Vcc= 12V, Vout= 5V, Iout= 0A, Vripple= 19.0mV)



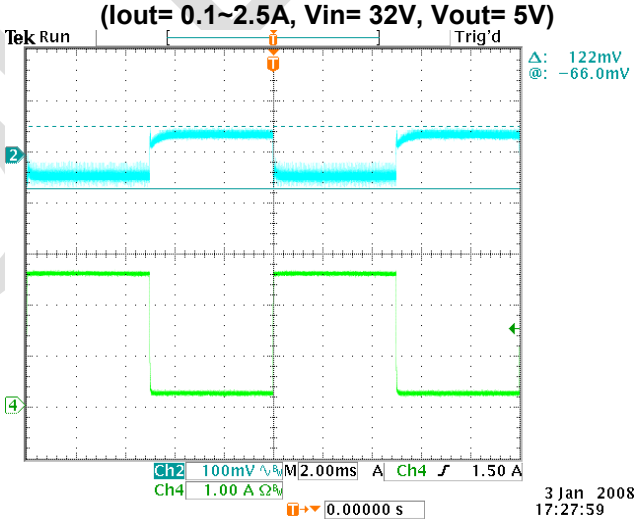
Vout Ripple
(Vcc= 12V, Vout= 5V, Iout= 2.5A, Vripple= 35.0mV)



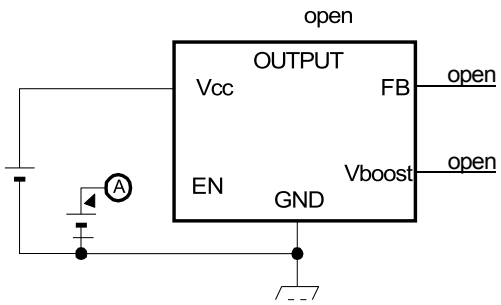
Load Transient Response
(Iout= 0.1~2.5A, Vin= 12V, Vout= 5V)



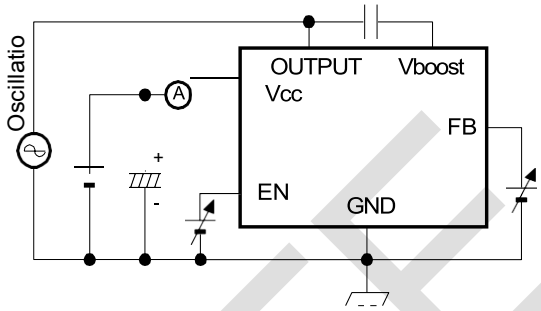
Load Transient Response
(Iout= 0.1~2.5A, Vin= 32V, Vout= 5V)



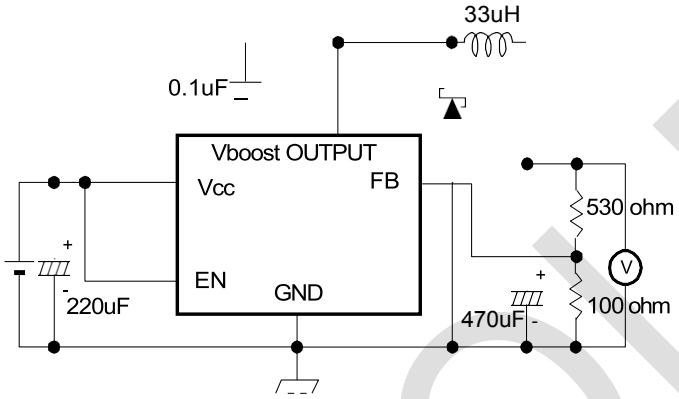
Test Circuit



Enable function test



Feedback function test



Operation function test

Functional Description

PWM Control

The AP5004 consists of DC/DC converters that employ a pulse-width modulation (PWM) system. The PWM controller is internally clocked by a fixed 300KHz oscillator.

When used as a converter, the AP5004's pulse width varies in a range from 0% to 90%, according to the load current. The ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, these converters provide a low-ripple power over broad ranges of input voltage and load current.

Enable Control

The Enable Control allows the output of the AP5004 to be turned ON or OFF. Connecting the Enable pin to GND or any voltage source lower than 0.8V will turn the output OFF. In the OFF state, the current drawn through the V_{CC} input is approximately 2μA. Please note that the slew rate from ON to OFF must be >0.013v/μs to ensure proper operation.

BOOST Capacitor

This capacitor boosts the gate drive to the internal MOSFET above V_{IN} to fully turn it ON thus minimizing conduction losses in the power switch to maintain high efficiency. The recommended value of the capacitor is 0.1μF. The capacitor must be connected from pin 3 to the switch output, pin 4.

Feedback

This is the input to a two-stage high gain amplifier, which drives the PWM controller. Two external resistors are required to set the DC output voltage. For stable operation of the power supply, it is important to prevent coupling of any inductor flux to the feedback input.

Current Limit

The current limit threshold is set by the internal circuit such that the minimum switching current is 3.5A. If the switching current exceeds the threshold, the output voltage will drop and the switching frequency will be reduced to 50KHz.

Inductor Selection

Most designs operate with inductors of 15μH to 33μH. The inductor value can be derived from the following equation:

$$L = \frac{(V_{IN} - V_{OUT})V_{OUT}}{\otimes I_L \times f_{osc} \times V_{IN}}$$

Large value inductors will result in a lower ripple current where as small value inductors will result in high ripple currents. The inductor ripple current should be set to approximately 15% of the maximum load current 2.5A, ΔIL=0.375A. The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation (2A+0.19A).

Input Capacitor Selection

The input current to the step-down converter is discontinuous, and therefore an input capacitor C2 is required to supply the AC current to the step-down converter while maintaining the DC input voltage. A low ESR capacitor is required to keep the noise at the IC to a minimum. Its RMS current rating should be greater than approximately half of the DC load current.

Functional Description (Continued)

Output Capacitor Selection

An output capacitor is required to maintain the DC output voltage. Low ESR capacitors are preferred to keep the output voltage ripple low. The characteristics of the output capacitor also affect the stability of the regulation control system. The ESR dominates the impedance at the switching frequency.The output ripple is calculated as:

$$V_{RIPPLE} \cong \otimes I \times R_{ESR}$$

Output Rectifier Diode

The output rectifier diode supplies the current to the inductor when the high-side switch is OFF. To reduce losses due to the diode forward voltage and recovery times, use a Schottky rectifier.

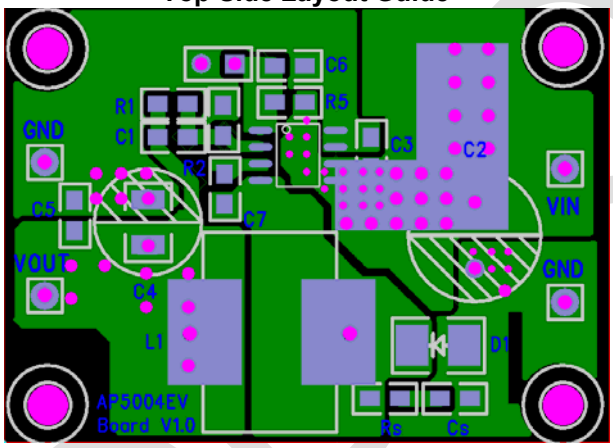
PCB Layout Guide

The dual Output pin (4) and VSS pins (7 & 8) on the SOP-8L package are internally connected to die pad. If low T_C & T_J or a large PD (Power Dissipation) is needed, the PCB layout should allow for maximum possible copper area exposure at the SW pins. Please also follow the steps below to reduce switching noise.

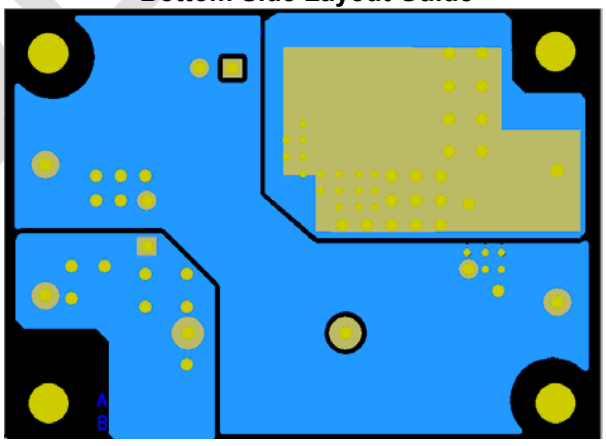
1. Connect C3 to VCC and VSS pin as closely as possible to get good power filter effect.
2. Connect ground side of the C2 & D1 as closely as possible.

Typical PC Board Layout:

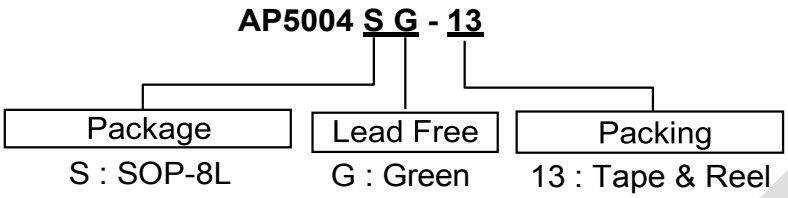
Top Side Layout Guide



Bottom Side Layout Guide



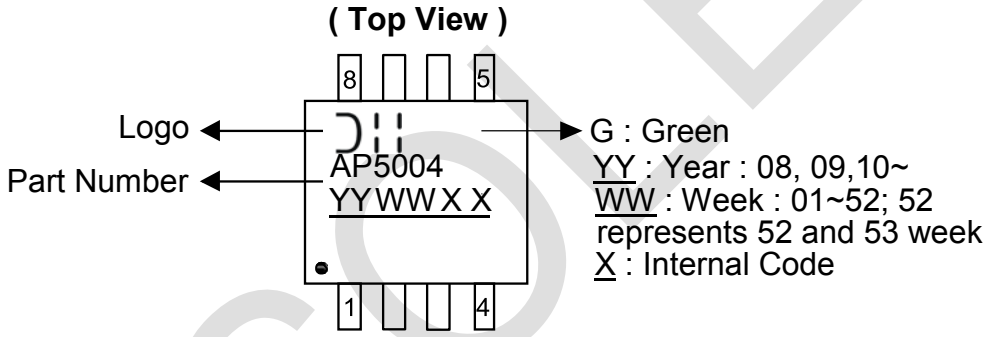
Ordering Information



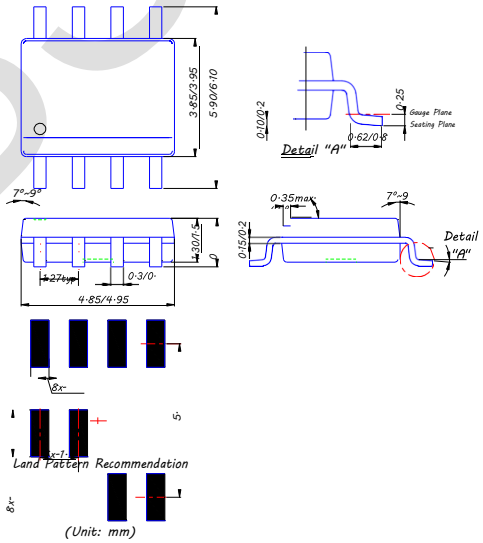
Device	Package Code	Packaging (Note 4)	13" Tape and Reel	
			Quantity	Part Number Suffix
AP5004SG-13	S	SOP-8L	2500/Tape & Reel	-13

Notes: 4. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

Marking Information



Package Outline Dimensions (All Dimensions in mm)



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