Features

- Input voltage: 3.6V to 20V
- Output voltage: 0.8V to V_{CC}
- Duty ratio: up to 100% PWM control
- Oscillation frequency: 500KHz typical
- Soft-start Current Limit, Enable function
- Thermal Shutdown function
- Built-in internal SW P-channel MOS
- Low ESR output capacitor (MLCC, multi-layer ceramic capacitor) support
- Efficiency 90%
- SOP-8L: Available in “Green” Molding Compound (No Br, Sb)
- Lead Free Finish / RoHS Compliant (Note 1)

General Description

AP5002 consists of step-down switching regulator with PWM control. These devices include a reference voltage source, oscillation circuit, error amplifier, internal PMOS.

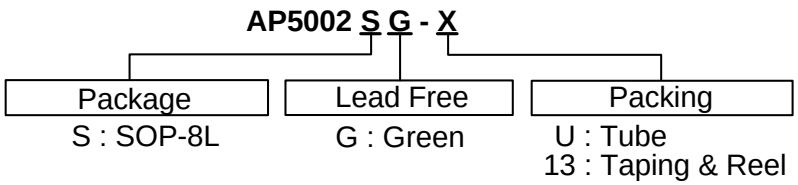
AP5002 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to vary the duty ratio linearly up to 100%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup. An enable function, an over current protect function and a short circuit protect function are built inside, and when OCP or SCP happens, the operation frequency will be reduced from 500KHz to 50KHz. Also, an internal compensation block is built in to minimum external component count.

With the addition of an internal P-channel Power MOS, a coil, capacitors, and a diode connected externally, these ICs can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP–8L mini-package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage up to 22V, it is also suitable for the operation via an AC adapter.

Applications

- PC Motherboard
- LCD Monitor
- Graphic Card
- DVD-Video Player
- Telecom Equipment
- ADSL Modem
- Printer and other Peripheral Equipment
- Microprocessor core supply
- Networking power supply

Ordering Information

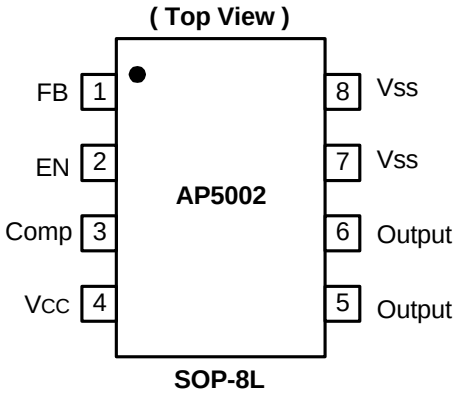


Device	Package Code	Packaging (Note 2)	Tube		13” Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP5002SG-U	S	SOP-8L	100	-U	NA	NA
AP5002SG-13	S	SOP-8L	NA	NA	2500/Tape & Reel	-13

Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied, see *EU Directive 2002/95/EC Annex Notes.*
2. 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.

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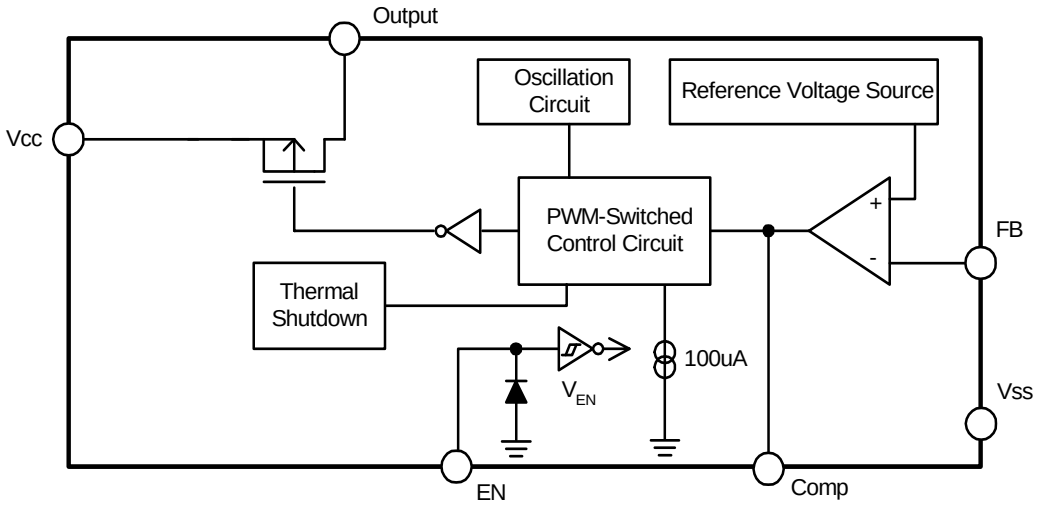
Pin Assignments



Pin Descriptions

Name	Pin	Description
FB	1	Feedback pin
EN	2	Power-off pin H: Normal operation (Step-down operation) L: Step-down operation stopped (All circuits deactivated)
Comp	3	Compensation pin
V_{CC}	4	IC power supply pin
Output	5、6	Switch Pin. Connect external inductor/diode here. Minimize trace area at this pin to reduce EMI.
V_{SS}	7、8	GND Pin

Block Diagram



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Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
ESD HBM	Human Body Model ESD Protection	5	KV
ESD MM	Machine Model ESD Protection	200	V
V_{CC}	Vcc Pin Voltage	V_{SS} - 0.3 to V_{SS} + 22	V
V_{FB}	Feedback Pin Voltage	V_{SS} - 0.3 to V_{CC}	V
V_{EN}	EN Pin Voltage	V_{SS} - 0.3 to V_{IN}	V
V_{OUTPUT}	Switch Pin Voltage	V_{SS} - 0.3 to V_{IN}	V
P_D	Power Dissipation	1000	mW
T_J	Operating Junction Temperature Range	-20 to +125	^oC
T_{ST}	Storage Temperature Range	-65 to +150	^oC

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	3.6	20	V
I_{OUT}	Output Current	0	2	A
T_A	Operating Ambient Temperature	-20	85	^oC

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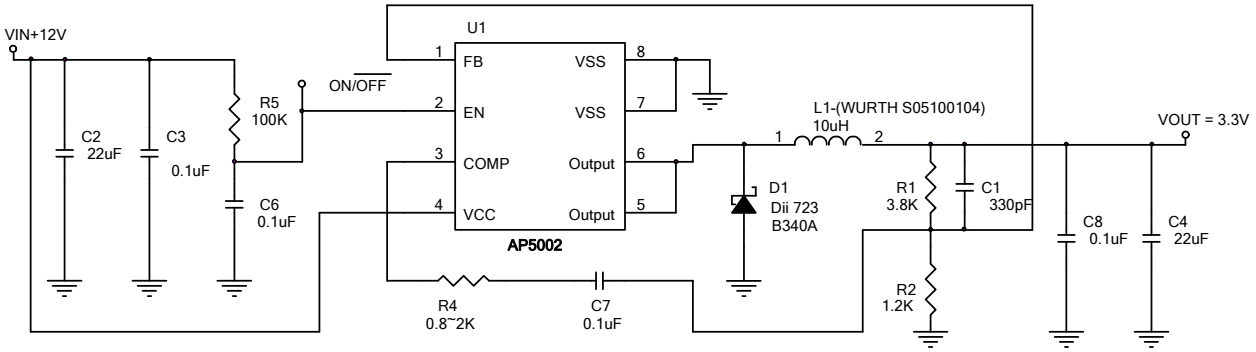
Electrical Characteristics (V_{IN} = 12V, T_A = 25°C, unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ.	Max	Unit
V_{FB}	Feedback Voltage	I_{OUT} = 0.1A	0.784	0.8	0.816	V
I_{FB}	Feedback Bias Current	I_{OUT} = 0.1A	-	0.1	0.5	μA
I_{CCQ}	Quiescent Current	V_{FB} = 1.2 force drive off	-	3	5	mA
I_{SW}	Switch Current	--	3.5	-	-	A
I_{SD}	Shutdown Supply Current	V_{EN} = 0V	-	10	-	μA
ΔV_{OUT} /V_{OUT}	Line Regulation	V_{IN} = 4V~20V, I_{OUT} = 0.2A	-	1	2	%
ΔV_{OUT} /V_{OUT}	Load Regulation	I_{OUT} = 0.1 to 2A	-	0.5	1	%
f_{OSC}	Oscillation Frequency	Measure waveform at SW pin	400	500	600	KHz
V_{SH}	EN Pin Input Voltage	Evaluate oscillation at SW pin	2.0	-	-	V
V_{SL}		Evaluate oscillation stop at SW pin	-	-	0.8	
I_{SH}	EN Pin Input Leakage Current	Ven = 2V	-10	-	10	μA
I_{SL}		Ven = 0.8V	-10	-	10	μA
T_{SS}	Soft-Start Time	--	-	3	-	ms
R_{DSON}	Internal MOSFET Rdson	V_{IN} = 5V, V_{FB} = 0V	-	110	150	mΩ
		V_{IN} = 12V, V_{FB} = 0V	-	70	100	
	Thermal shutdown			140		°C
	Minimum Duty Cycle			6.5		%
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

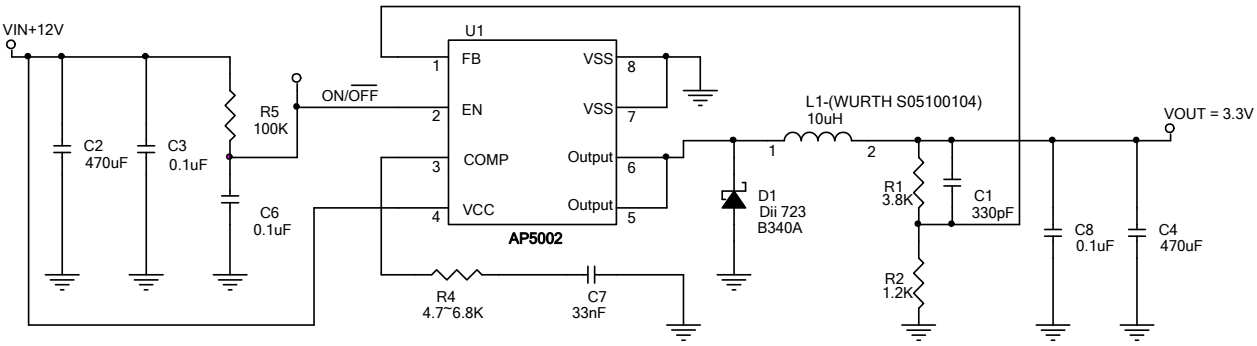
Notes: 3. Test condition: Device mounted on 2oz copper, minimum recommended pad layout, FR-4 PCB.

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Typical Application Circuit



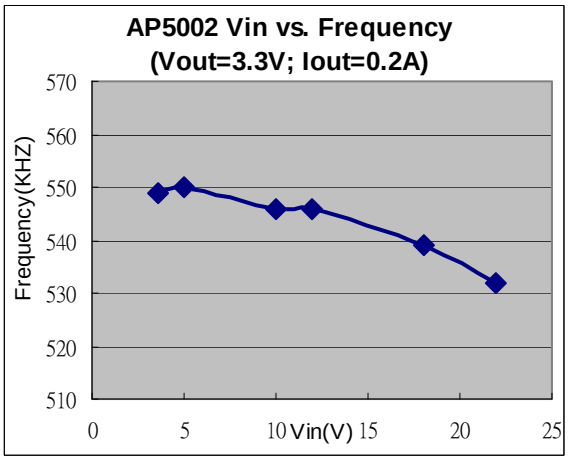
Compensation Capacitor Selection(MLCC)				
VIN	VOUT	R4	C7	C1
12V	5/ 3.3/ 2.5/ 1.8/ 1.5V	0.8~2K	0.1μF	330pF
5V	3.3/ 2.5/ 1.8/ 1.5V	0.8~2K	27nF	330pF

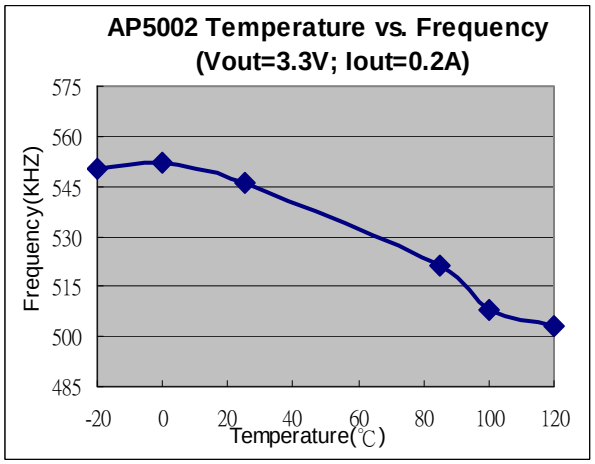


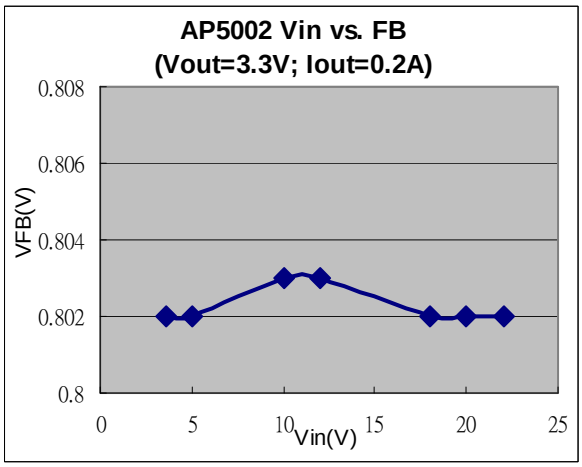
Notes: 4. $V_{OUT} = V_{FB} \times (1 + \frac{R1}{R2})$

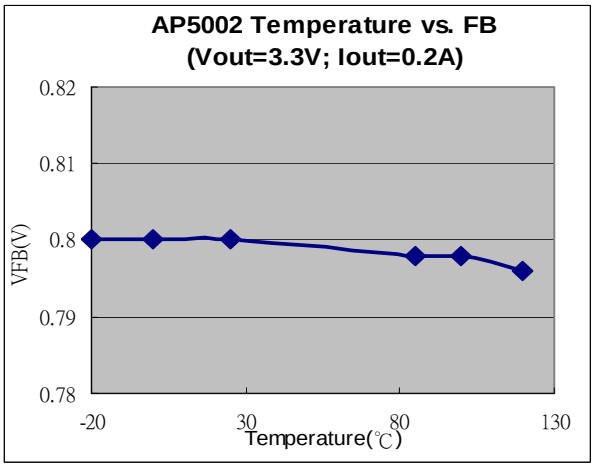
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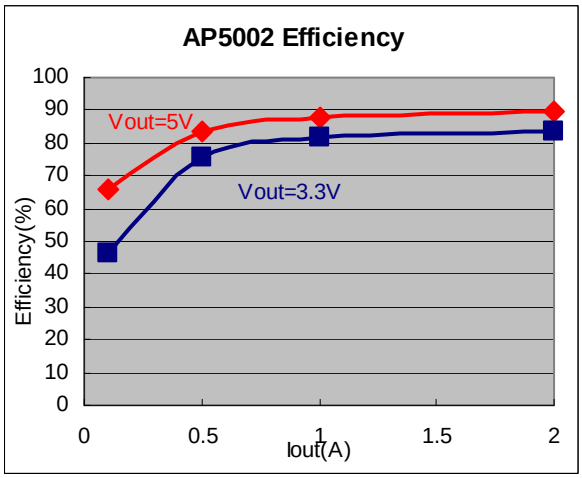
Typical Performance Characteristics





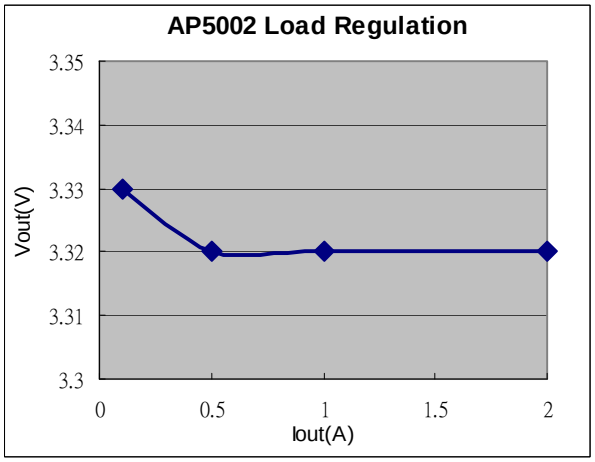


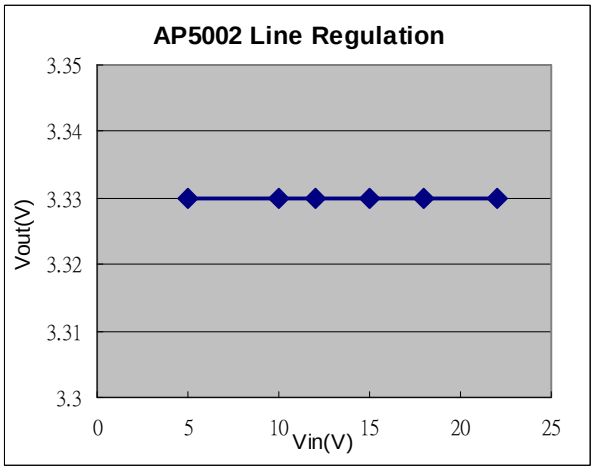


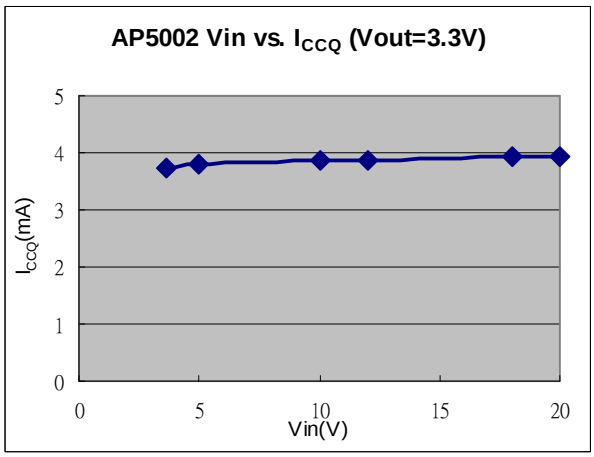


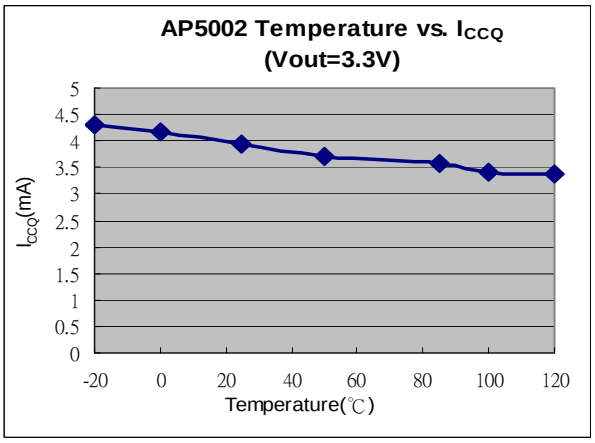
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Typical Performance Characteristics (Continued)





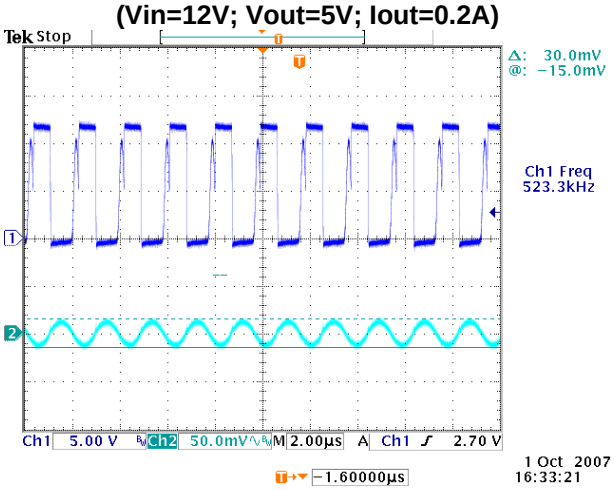




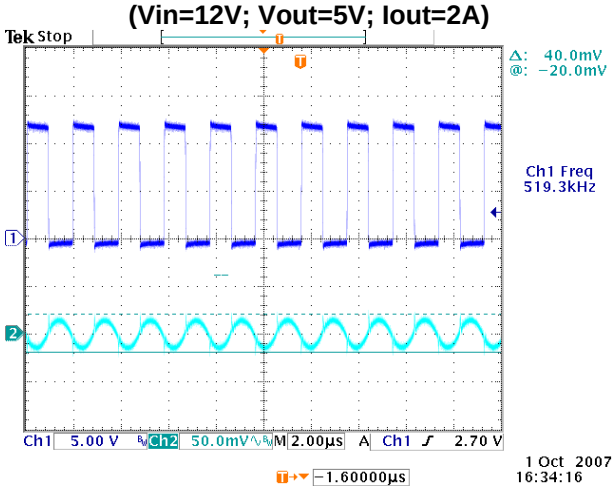
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Typical Performance Characteristics (Continued)

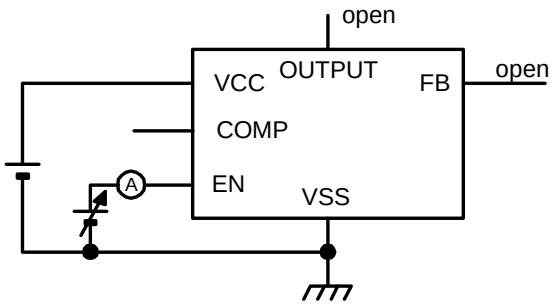
AP5002 Vout Ripple
(Vin=12V; Vout=5V; Iout=0.2A)



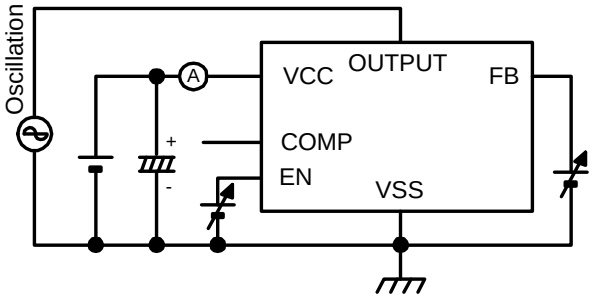
AP5002 Vout Ripple
(Vin=12V; Vout=5V; Iout=2A)



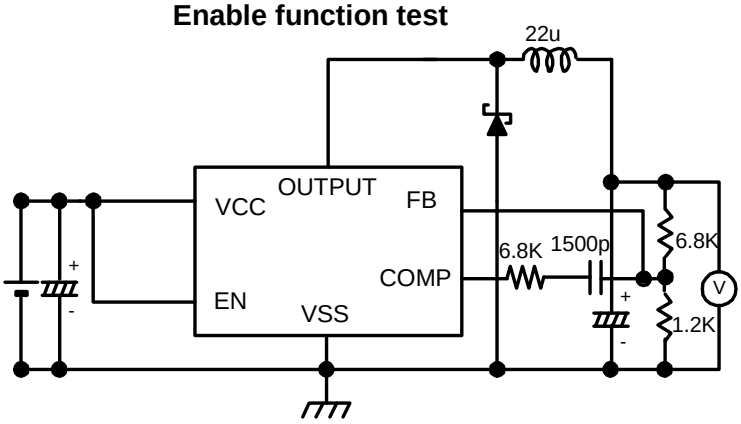
Test Circuit



Enable function test



Feedback function test



Operation function test

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Functional Description

PWM Control
The AP5002 consists of DC/DC converters that employ a pulse-width modulation (PWM) system.
In converters of the AP5002, the pulse width varies in a range up to 100%, 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.

$R_{DS(ON)}$ Current Limiting
The current limit threshold is set by the internal circuit.

Setting the Output Voltage
Application circuit item shows the basic application circuit with adjustable output version. The external resistor sets the output voltage according to the following equation:

V_{OUT} (V)	R1 (KΩ)	R2 (KΩ)
5	6.4	1.2
3.3	3.8	1.2
2.5	2.6	1.2
1.8	3.3	2.6
1.5	3.3	3.7
1.2	3.3	6.5
1	3.3	13

Inductor Selection
For most designs, the operates with inductors of 10µH to 22µH. The inductor value can be derived from the following equation:

$$L = \frac{(V_{IN} - V_{OUT})T_{ON}}{2 \times \Delta I_L \times f_{osc}}$$

Where is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 15% of the maximum load current 2A, ΔIL=0.3A. 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+0.15A).

Input Capacitor Selection
EL CAP
This capacitor should be located close to the IC using short leads and the voltage rating should be approximately 1.5 times the maximum input voltage. The RMS current rating requirement for the input capacitor of a buck regulator is approximately 1⁄2 the DC load current. A low ESR input capacitor sized for maximum RMS current must be used. A 470µF low ESR capacitor for most applications is sufficient.

MLCC CAP
A 22µF MLCC capacitor for most applications is sufficient.

Output Capacitor Selection
EL CAP
The output capacitor is required to filter the output voltage and provides regulator loop stability. The important capacitor parameters are the 100KHz Equivalent Series Resistance (ESR), the RMS ripples current rating, voltage rating and capacitance value. For the output capacitor, the ESR value is the most important parameter. The output ripple can be calculated from the following formula.

$$V_{RIPPLE} = \Delta I_L \times ESR$$

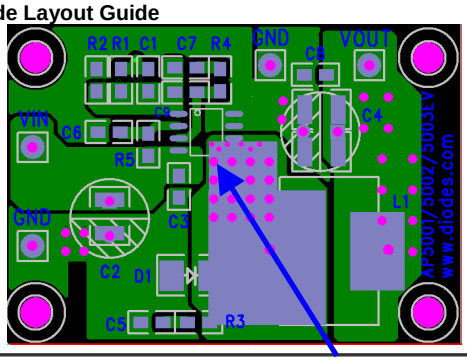
The bulk capacitor's ESR will determine the output ripple voltage and the initial voltage drop after a high slew-rate transient.

An aluminum electrolytic capacitor's ESR value is related to the capacitance and its voltage rating. In most case, higher voltage electrolytic capacitors have lower ESR values. Most of the time, capacitors with much higher voltage ratings may be needed to provide the low ESR values required for low output ripple voltage.

MLCC CAP
A 22µF MLCC capacitor for most applications is sufficient.

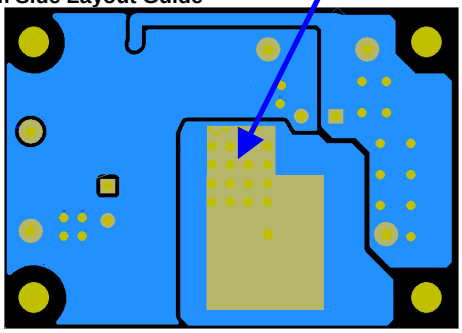
PCB Layout Guide
If you need low T_C & T_J or large PD(Power Dissipation), The dual SW pins(5& 6) and VSS pins(7& 8)on the SOP-8L package are internally connected to die pad, The PCB layout should allow for maximum possible copper area at the SW pins.
1. Connect C3 to VCC and VSS pin as closely as possible to get good power filter effect.
2. Connect R4 to VCC and OCSET pin as closely as possible.
3. Connect ground side of the C2 & D1 as closely as possible. Typical PC Board Layout

Top Side Layout Guide



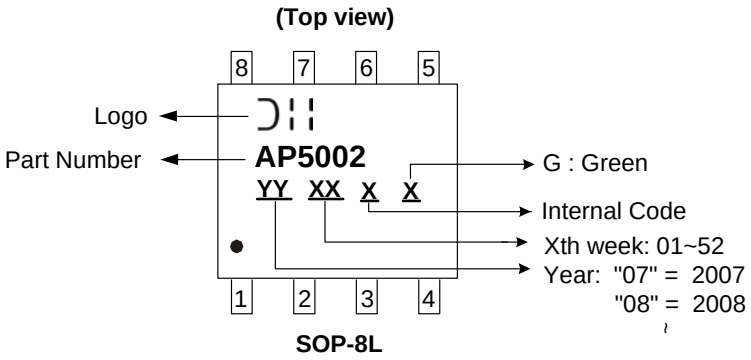
Use vias to conduct the heat into the backside of PCB layer. The PCB heat sink copper area should be solder-painted without masked. This approaches a

Bottom Side Layout Guide

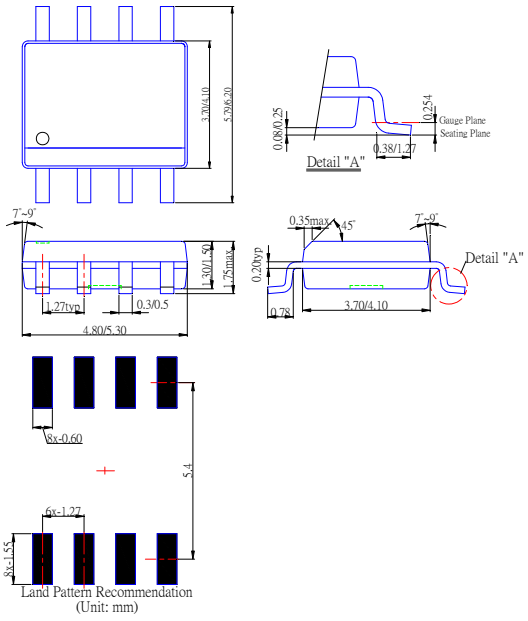


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Marking Information



Package Information (All Dimensions in mm)



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