Features

- Input voltage: 4V to 23V
- Output voltage: 0.8V to V_{CC}
- Output current: 1.8A up to peak 2A
- Duty ratio: 0% to 99% PWM control
- Oscillation frequency: 300KHz typ.
- Soft-start like, Current limit and Enable function
- Thermal Shutdown function
- Built-in internal SW P-channel MOS
- SOP-8L: Available in “Green” Molding Compound (No Br, Sb)
- Lead Free Finish / RoHS Compliant (Note 1)

General Description

AP1533 consists of step-down switching regulator with PWM control. These devices include a reference voltage source, oscillation circuit, error amplifier, internal PMOS.

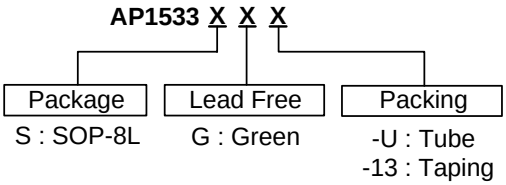
AP1533 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to vary the duty ratio linearly from 0 up to 99%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup. An 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 300KHz 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 23V, 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

Ordering Information

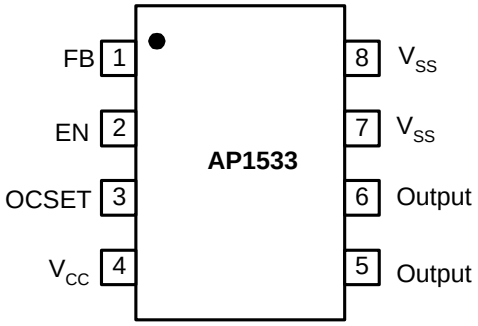


Note: 1. RoHS revision 13.2.2003. Glass and High Temperature Solder Exemptions Applied, see *EU Directive Annex Notes 5 and 7*.

Device	Package Code	Packaging (Note 2)	Tube/Bulk		13” Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP1533S	S	SOP-8L	100	-U	2500/Tape & Reel	-13

Note: 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.

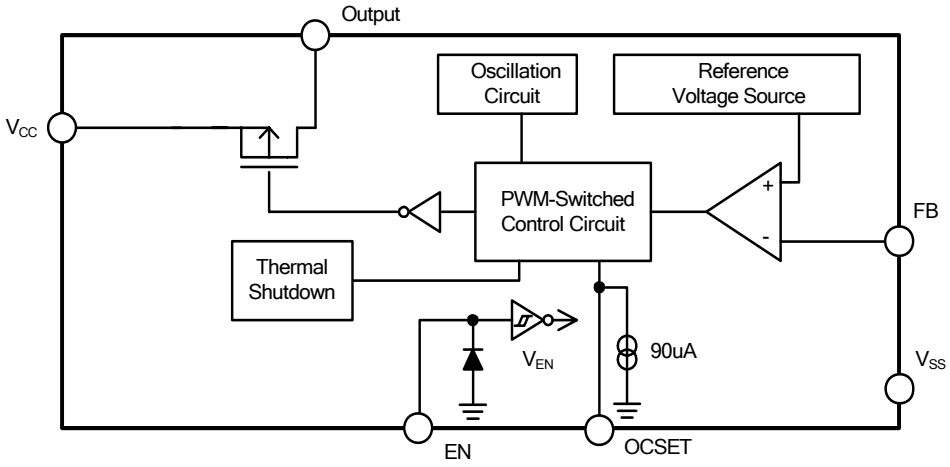
Pin Assignments



Pin Descriptions

Pin Name	Pin No.	Description
FB	1	Feedback pin
EN	2	Power-off pin H: Normal operation (Step-down operation) L: Step-down operation stopped (All circuits deactivated)
OCSET	3	Add an external resistor to set max output current
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



Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{CC}	V_{CC} Pin Voltage	V_{SS} - 0.3 to V_{SS} + 24	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} + 0.3	V
V_{OUT}	Switch Pin Voltage	V_{SS} - 0.3 to V_{IN} + 0.3	V
P_D	Power Dissipation	Internally limited	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	4	23	V
I_{OUT}	Output Current	0	1.8	A
T_A	Operating Ambient Temperature	-25	85	^oC

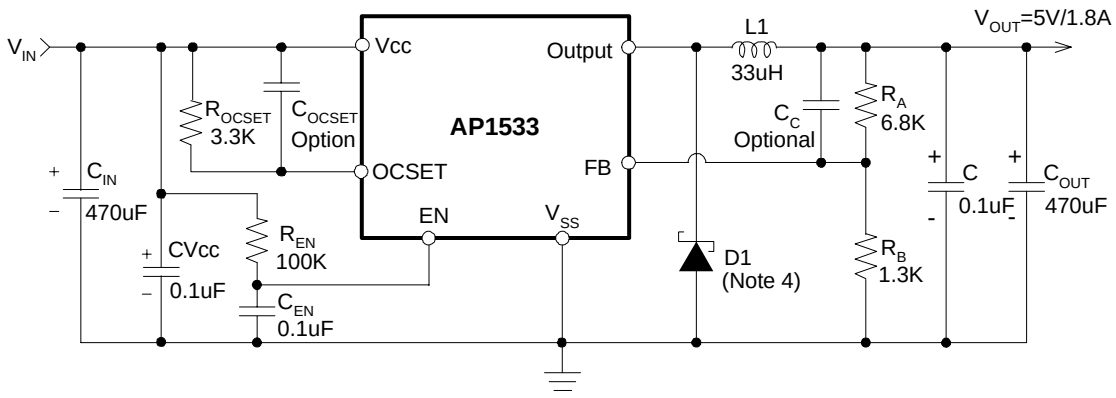
Electrical Characteristics

(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_{SHDN}	Current Consumption During Power Off	V_{EN} = 0V	-	10	-	µA
ΔV_{OUT} / V_{IN}	Line Regulation	V_{IN} = 5V~23V	-	1	2	%
ΔV_{OUT} / V_{OUT}	Load Regulation	I_{OUT} = 0.1 to 1.8A	-	0.2	0.5	%
f_{OSC}	Oscillation Frequency	Measure waveform at SW pin	240	300	400	KHz
f_{OSC1}	Frequency of Current Limit or Short Circuit Protection	Measure waveform at SW pin	-	50	-	KHz
V_{IH}	EN Pin Input Voltage	Evaluate oscillation at SW pin	2.0	-	-	V
V_{IL}		Evaluate oscillation stop at SW pin	-	-	0.8	
I_{SH}	EN Pin Input Leakage Current	EN Pin High	-	20	-	µA
I_{SL}		EN Pin Low	-	-10	-	µA
I_{OCSET}	OCSET Pin Bias Current	--	75	90	105	µA
$R_{DS(ON)}$	Internal MOSFET $R_{DS(ON)}$	V_{IN}=5V, V_{FB}=0V	-	110	150	mΩ
		V_{IN}=12V, V_{FB}=0V	-	80	110	
EFFI	Efficiency	V_{IN}=12V, V_{OUT} = 5V I_{OUT}=1.8A	-	91	-	%
T_{SHDN}	Thermal shutdown threshold		-	150	-	°C
T_{HYS}	Thermal shutdown hysteresis		-	55	-	°C
θ_{JA}	Thermal Resistance Junction-to-Ambient	SOP-8L (Note 3)	-	134	-	°C/W
θ_{JC}	Thermal Resistance Junction-to-Case	SOP-8L (Note 3)	-	22	-	°C/W

Note: 3. Test condition: Device mounted on FR-4 PCB, 2"x2", 2oz copper, minimum recommended pad layout, single side. For better thermal performance, larger copper pad for heatsink is needed.

Typical Application Circuit

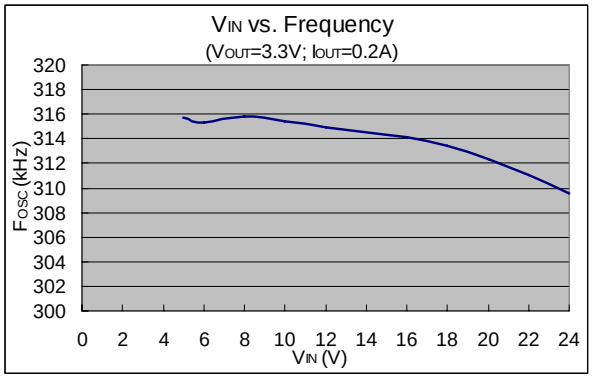


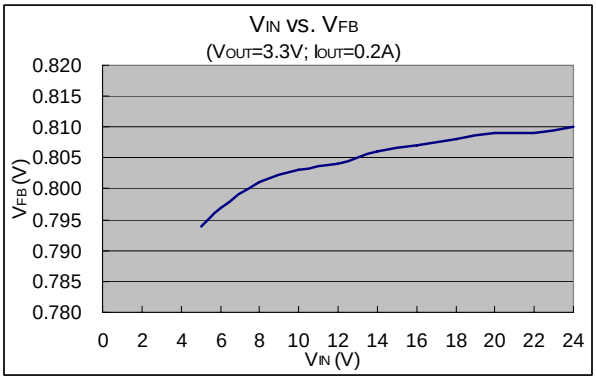
$$V_{OUT} = V_{FB} \times (1+R_A/R_B)$$

$$R_B = 0.7K\sim5K \text{ ohm}$$

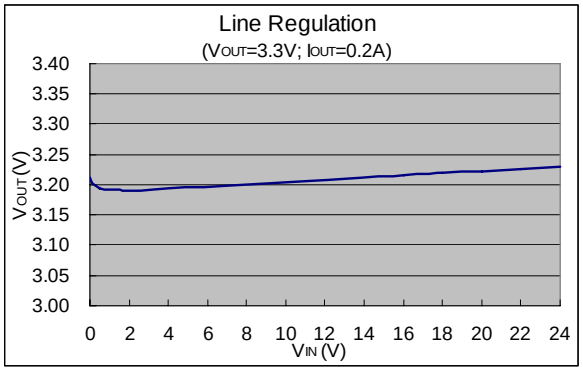
Note: 4. Suggested DIODES Power Schottky P/N: B340 series or PDS340.

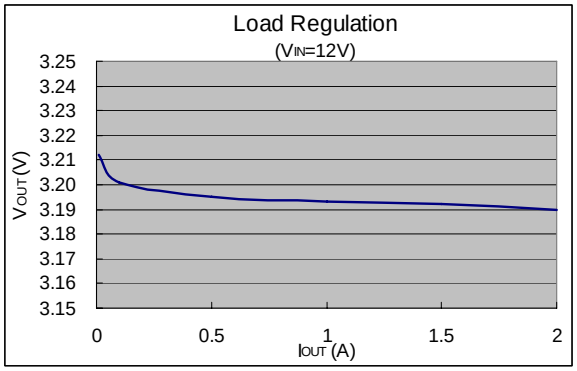
Typical Performance Characteristics

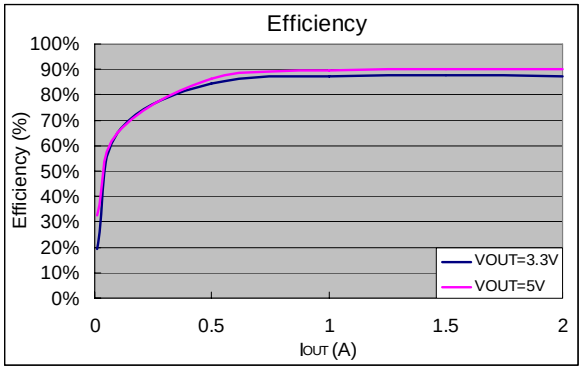




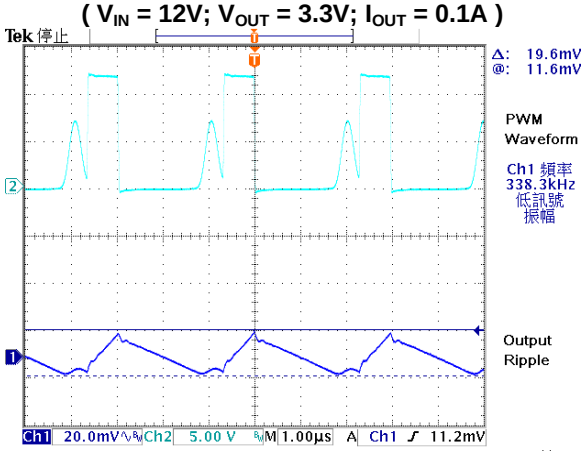
Typical Performance Characteristics (Continued)



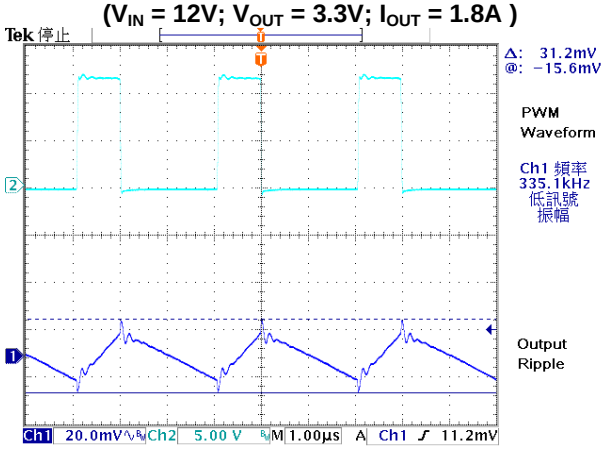




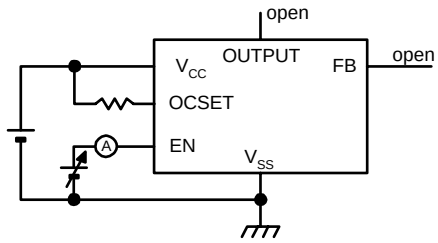
V_{OUT} Ripple
(V_{IN} = 12V; V_{OUT} = 3.3V; I_{OUT} = 0.1A)



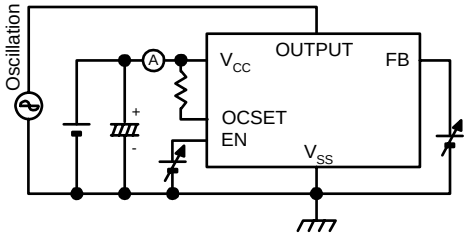
V_{OUT} Ripple
(V_{IN} = 12V; V_{OUT} = 3.3V; I_{OUT} = 1.8A)



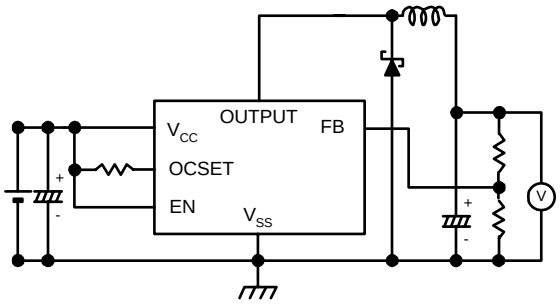
Test Circuit



Enable function test



Feedback function test



Operation function test

Function Description

PWM Control

The AP1533 is a DC/DC converter that employs pulse width modulation (PWM) scheme. Its pulse width varies in the range of 0% to 99%, based on the output current loading. The output ripple voltage caused by the PWM high frequency switching can easily be reduced through an output filter. Therefore, this converter provides a low ripple output supply over a broad range of input voltage & output current loading

Under Voltage Lockout

The under voltage lockout circuit of the AP1533 assures that the high-side MOSFET driver remains in the off state whenever the supply voltage drops below 3.3V. Normal operation resumes once V_{CC} rises above 3.5V.

Current Limit Protection

The current limit threshold is set by external resistor R_{OCSET} connected from V_{CC} supply to OCSET pin. The internal sink current I_{OCSET} (90uA typical) across this resistor sets the voltage at OCSET pin. When the PWM voltage is less than the voltage at OCSET, an over-current condition is triggered.

The current limit threshold is given by the following equation:

$$I_{PEAK} \times R_{DS(ON)} = I_{OCSET} \times R_{OCSET}$$

$$I_{PEAK} > I_{OUT\,(MAX)} + \frac{(\Delta I)}{2}$$

where,

$$\Delta I = \frac{V_{IN} - V_{OUT}}{F_S x L} x \frac{V_{OUT}}{V_{IN}}$$

I_{PEAK} is the output peak current; $R_{DS\,(ON)}$ is the MOSFET ON resistance (115mΩ typical); F_S is the PWM frequency (300KHz typical). Also, the inductor value will affect the ripple current ΔI.

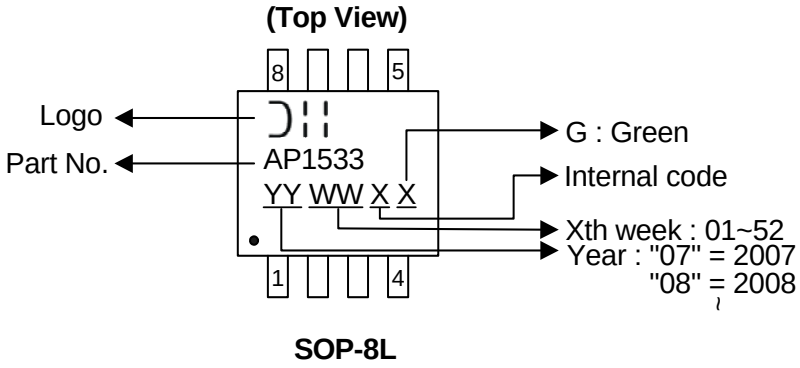
The above equation is recommended for input voltage range of 5V to 18V. For input voltage lower than 5V, higher than 18V or ambient temperature over 100°C, $R_{OCSET} \geqq 3.9K\Omega$ is recommended.

The recommended minimum R_{OCSET} value is summarized below:

V_{IN} (V)	V_{OUT} (V)	R_{OCSET} (Ω)
4	0.8	3.9K
5	3.3	3.3K
12	5	3.3K
18	12	3.3K
23	12	4.7K

The maximum R_{OCSET} value should not exceed AP1533 maximum current output.

Marking Information



SOP-8L

Package Information (unit: mm)

Package Type: SOP-8L