

### Features

- Output voltage: 3.3V, 5V, 12V and adjustable output version
- Adjustable version output voltage range, 1.23V to 37V±4%
- 50KHz ±15% fixed switching frequency
- Voltage mode non-synchronous PWM control
- Thermal-shutdown and current-limit protection
- ON/OFF shutdown control input
- Operating voltage can be up to 60V
- Output load current: 2A (for AP1512)  
3A (for AP1512A)
- Low power standby mode
- Built-in switching transistor on chip
- Lead Free Finish/ RoHS Compliant (Note 1)

### General Description

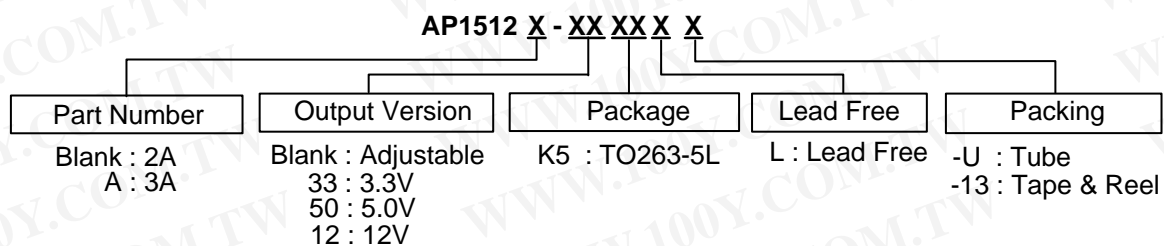
The AP1512/A is a monolithic IC designed for use as a step-down DC/DC converter with the ability of driving a 2A (3A for AP1512A) load without additional transistor components. The board space is reduced since AP1512/A requires few external components. The external shutdown function is controlled by logic level and can be put into standby mode. The internal compensation ensures feedback control has good line and load regulation without external design. Both an integrated Thermal shutdown and Current Limit function are provided to prevent damage from exceeding temperature operation and against exceeding the current operating of the output switch. The AP1512/A operates at a switching frequency of 50KHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Other features include a guaranteed ±4% tolerance on output voltage under specified input voltage and output load conditions, and ±15% tolerance on the oscillator frequency. The AP1512/A offers fixed output voltages of 3.3V, 5V, 12V, plus Adjustable. The package is available in a standard 5-lead TO263 package.

### Applications

- Simple High-efficiency step-down regulator
- On-card switching regulators
- Positive to negative converter

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### Ordering Information

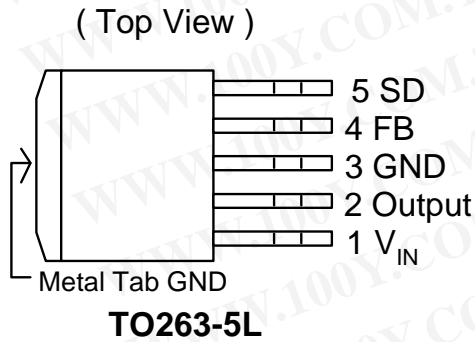


Device	Package Code	Packaging (Note 2)	Tube		13" Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP1512X-XXK5	K5	TO263-5L	50	-U	800/Tape & Reel	-13

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>.

**Pin Assignments**

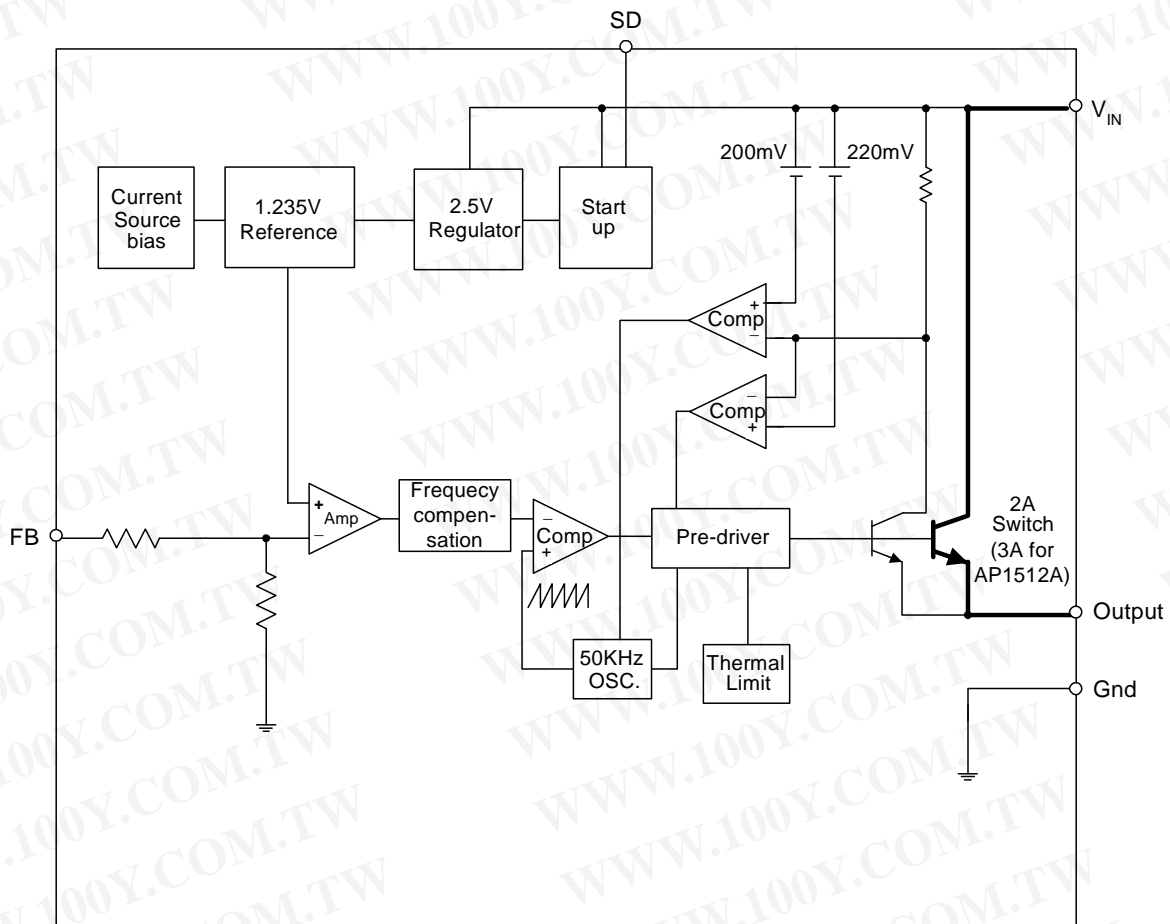
**Pin Descriptions**



Name	Description
V <sub>IN</sub>	Operating voltage input
Output	Switching output
GND	Ground
FB	Output voltage feedback control
SD	ON/OFF Shutdown

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**Block Diagram**



**Absolute Maximum Ratings**

Symbol	Parameter	Rating	Unit
ESD HBM	Human Body Model ESD Protection	4.5	KV
ESD MM	Machine Model ESD Protection	450	V
V <sub>CC</sub>	Supply Voltage	+63	V
V <sub>SD</sub>	ON/OFF Pin Input Voltage	-0.3 to +40	V
V <sub>FB</sub>	Feedback Pin Voltage	-0.3 to +40	V
V <sub>OUT</sub>	Output Voltage to Ground	-1	V
T <sub>ST</sub>	Storage Temperature	-65 to +150	°C
T <sub>J</sub>	Operating Junction Temperature	-40 to +125	°C
V <sub>OP</sub>	Operating Voltage	+4.5 to +60	V

**Recommended Operating Conditions**

Symbol	Parameter	Min	Max	Unit
V <sub>IN</sub>	Input Voltage	4.5	60	V
I <sub>OUT</sub>	Output Current	0	2	A
T <sub>A</sub>	Operating Ambient Temperature	-20	85	°C

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### Electrical Characteristics (All Output Voltage Versions)

Unless otherwise specified,  $V_{IN} = 30V$  for all version.  $I_{LOAD} = 0.5A$

Specifications with **boldface** type are for full operating temperature range, the other type are for  $T_A = 25^{\circ}C$ .

Symbol	Parameter		Conditions	Min	Typ.	Max	Unit
$I_B$	Feedback Bias Current		$V_{FB} = 1.3V$ (Adjustable version only)		5	8	$\mu A$
						<b>10</b>	
$F_{OSC}$	Oscillator Frequency				50	57.5	KHz
						<b>40</b>	
$V_{SAT}$	Saturation Voltage		$I_{OUT} = 2A$ no outside circuit $V_{FB} = 0V$ force driver on		1.3	1.4	V
						<b>1.5</b>	
DC	Max. Duty Cycle(ON)		$V_{FB} = 0V$ force driver on		100		%
	Min. Duty cycle(OFF)		$V_{FB} = 12V$ force driver off		0		
$I_{CL}$	Current Limit for AP1512		peak current no outside circuit $V_{FB} = 0V$ force driver on	2.5	3	4.5	A
						<b>5.5</b>	
$I_{CL}$	Current Limit for AP1512A		peak current no outside circuit $V_{FB} = 0V$ force driver on	3.2	4	5	A
						6	
$I_L$	Output = 0	Output leakage current	no outside circuit $V_{FB} = 12V$ force driver off			-250	$\mu A$
	Output = -1						
$I_Q$	Quiescent Current		$V_{FB} = 12V$ force driver off		5	10	mA
$I_{STBY}$	Standby Quiescent Current		ON/OFF pin = 5V $V_{IN} = 60V$		350	450	$\mu A$
						<b>500</b>	
$V_{IL}$	ON/OFF pin logic input threshold voltage		Low (regulator ON)	-	1.3	0.6	V
$V_{IH}$			High (regulator OFF)	2.0		-	
$I_H$	ON/OFF pin logic input current		$V_{LOGIC} = 2.5V$ (OFF)		0	-5	$\mu A$
$I_L$	ON/OFF pin input current		$V_{LOGIC} = 0.5V$ (ON)		-0.8	-10	
$\theta_{JC}$	Thermal Resistance		TO263-5L	Junction to case		2.5	$^{\circ}C/W$
						3.5	
$\theta_{JA}$	Thermal Resistance With copper area of approximately 3 in <sup>2</sup>		TO263-5L	Junction to ambient		28	$^{\circ}C/W$
						23	

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### Electrical Characteristics (Continued)

#### AP1512

	Symbol	Parameter	Conditions	V <sub>MIN</sub>	Typ.	V <sub>MAX</sub>	Unit
AP1512-ADJ	V <sub>FB</sub>	Output Feedback	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub> ≤ 2A V <sub>OUT</sub> programmed for 3V	1.193 <b>1.18</b>	1.23	1.267 <b>1.28</b>	V
AP1512-3.3V	V <sub>OUT</sub>	Output voltage	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub> ≤ 2A	3.168 <b>3.135</b>	3.3	3.432 <b>3.465</b>	V
AP1512-5V	V <sub>OUT</sub>	Output voltage	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub> ≤ 2A	4.8 <b>4.75</b>	5	5.2 <b>5.25</b>	V
AP1512-12V	V <sub>OUT</sub>	Output voltage	15V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub> ≤ 2A	11.52 <b>11.4</b>	12	12.48 <b>12.6</b>	V
	η	Efficiency	V <sub>IN</sub> = 30V, I <sub>LOAD</sub> = 2A		83		%

Specifications with **boldface** type are for full operating temperature range, the other type are for T<sub>A</sub> = 25°C.

#### AP1512A

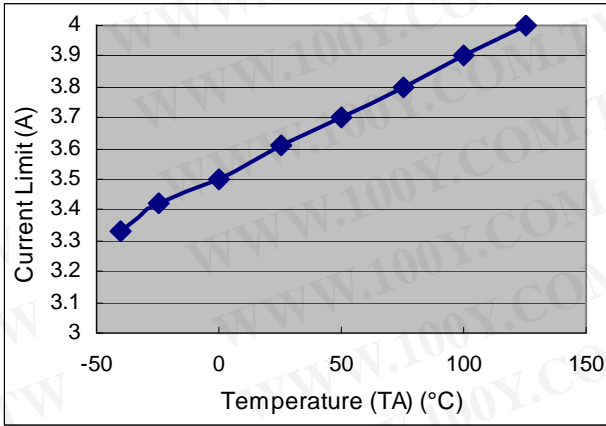
	Symbol	Parameter	Conditions	V <sub>MIN</sub>	Typ.	V <sub>MAX</sub>	Unit
AP1512A-ADJ	V <sub>FB</sub>	Output Feedback	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub> V <sub>OUT</sub> programmed for 3V	1.193 <b>1.18</b>	1.23	1.267 <b>1.28</b>	V
AP1512A-3.3V	V <sub>OUT</sub>	Output voltage	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub>	3.168 <b>3.135</b>	3.3	3.432 <b>3.465</b>	V
AP1512A-5V	V <sub>OUT</sub>	Output voltage	10V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub>	4.8 <b>4.75</b>	5	5.2 <b>5.25</b>	V
AP1512A-12V	V <sub>OUT</sub>	Output voltage	15V ≤ V <sub>IN</sub> ≤ 60V 0.2A ≤ I <sub>LOAD</sub>	11.52 <b>11.4</b>	12	12.48 <b>12.6</b>	V
	η	Efficiency	V <sub>IN</sub> = 30V, I <sub>LOAD</sub> = 3A		80		%

Specifications with **boldface** type are for full operating temperature range, the other type are for T<sub>A</sub> = 25°C.

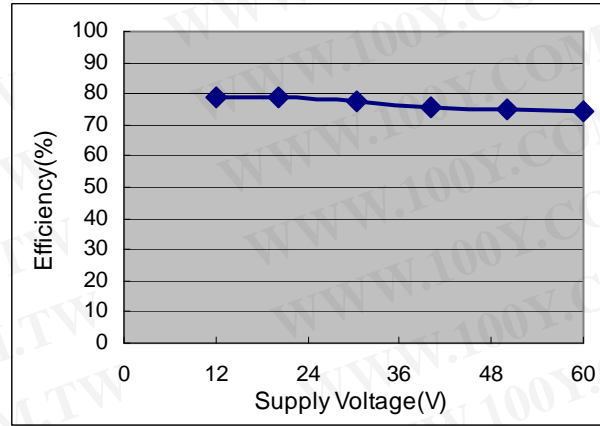
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**Typical Performance Characteristics**

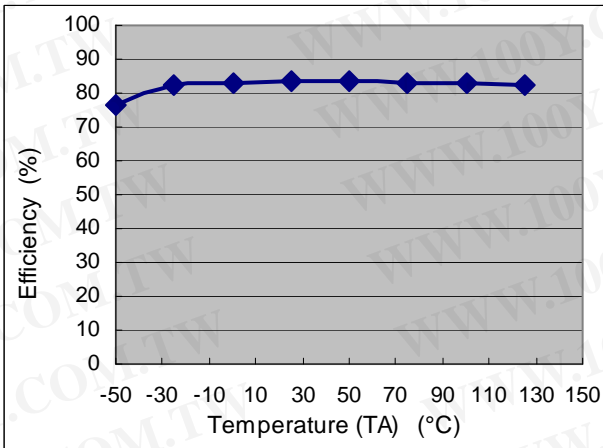
**AP1512A Current Limit vs. Temperature**  
( $V_{CC} = 60V, V_{out} = 5V$ )



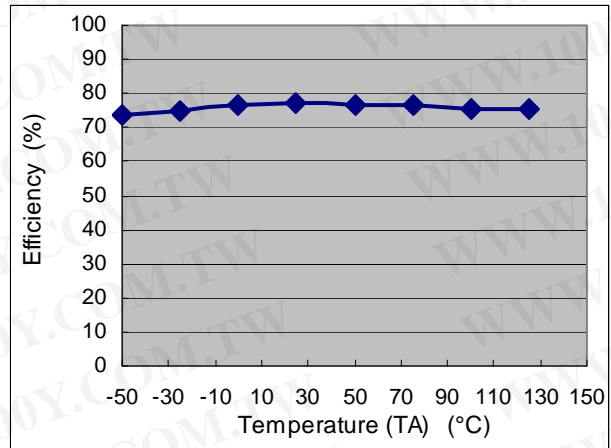
**AP1512A Efficiency vs. Supply Voltage**  
( $V_{out} = 5V, I_{out} = 3A$ )



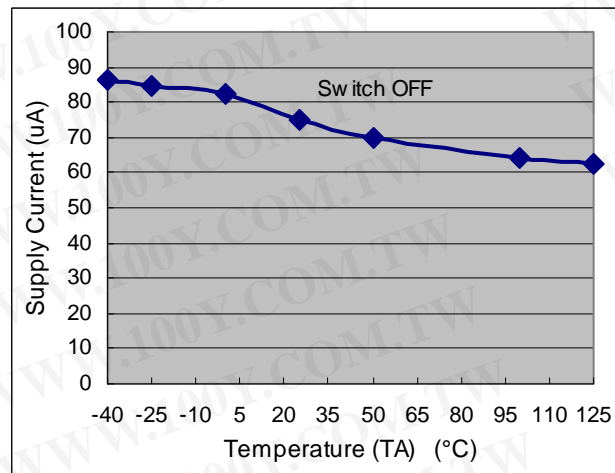
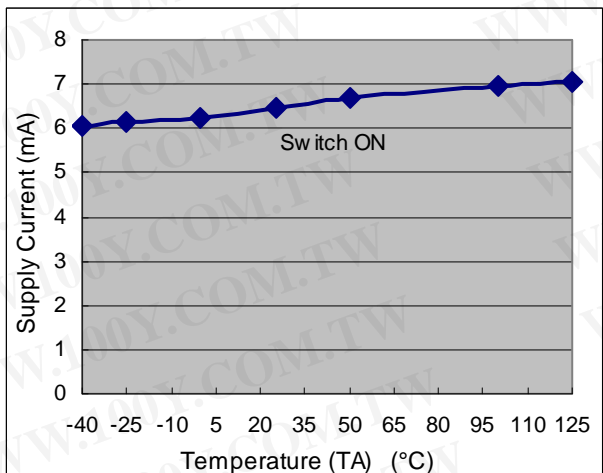
**AP1512 Efficiency vs. Temperature**  
( $V_{in} = 12V, V_{out} = 5V, I_o = 2A$ )



**AP1512 Efficiency vs. Temperature**  
( $V_{in} = 12V, V_{out} = 3.3V, I_o = 2A$ )

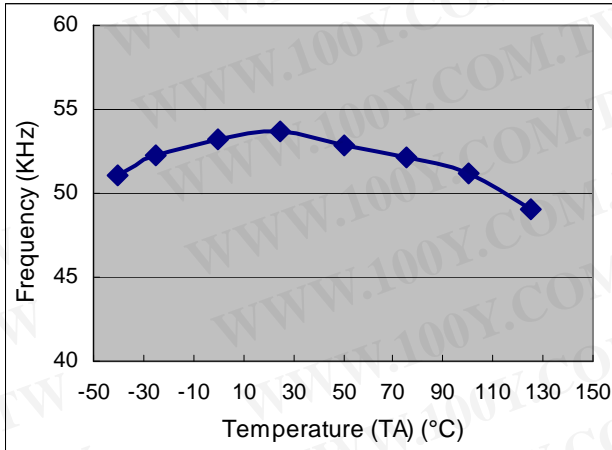


**AP1512 Supply Current vs. Temperature**  
( $V_{CC} = 12V, \text{No Load}, V_{on/off} = 0V \text{ (Switch ON)}, V_{on/off} = 5V \text{ (Switch OFF)}$ )

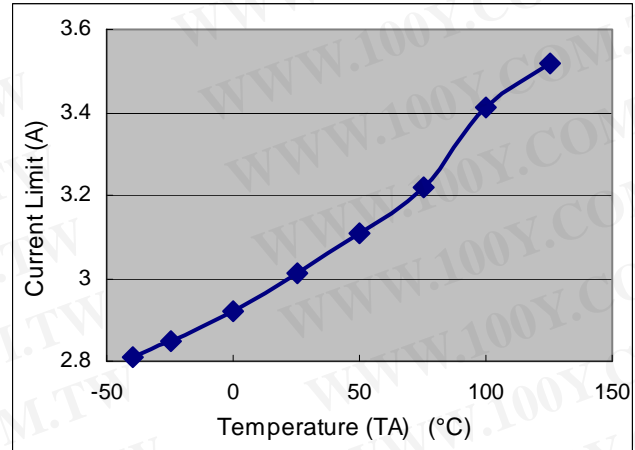


**Typical Performance Characteristics (Continued)**

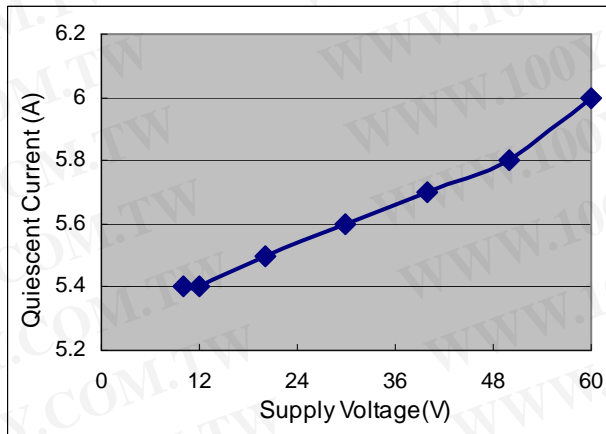
**AP1512 Frequency vs. Temperature**  
( $V_{cc} = 12V$ ,  $I_o = 1A$ ,  $V_{out} = 5V$ )



**AP1512 Current Limit vs. Temperature**  
( $V_{cc} = 60V$ ,  $V_{out} = 5V$ )



**AP1512 Quiescent Current vs. Supply Voltage**  
(force driver off)

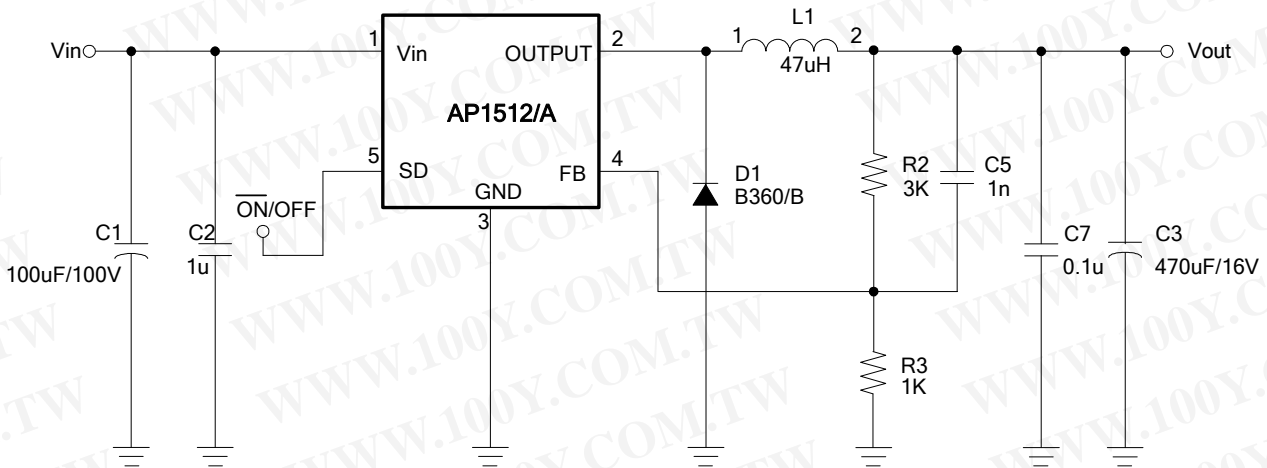


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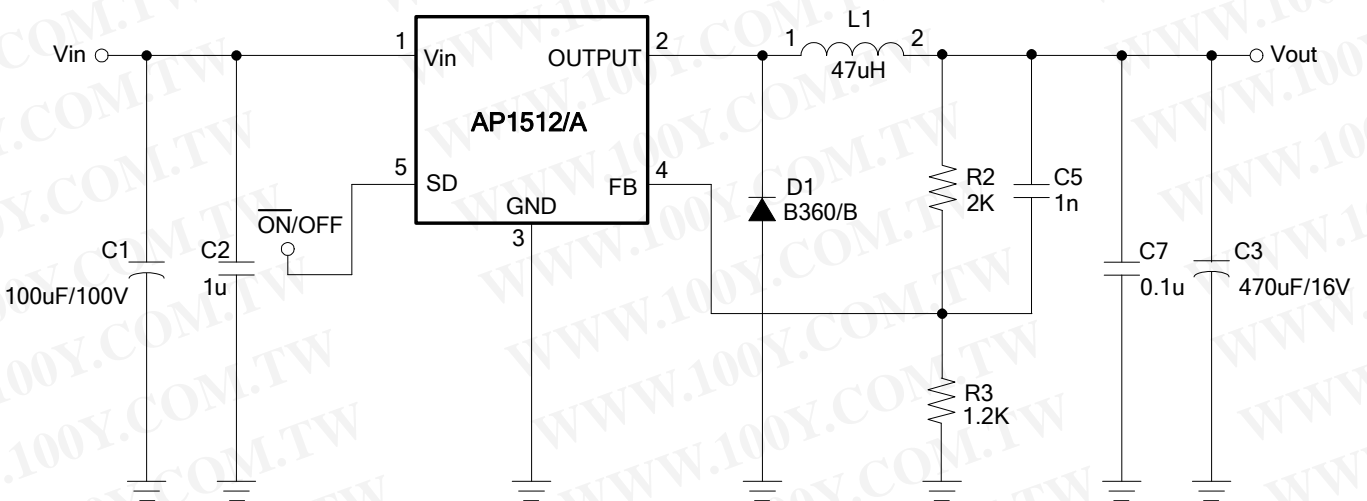
**Typical Application Circuit**

**(1) Adjustable Type Circuit**

**A.  $V_{in} = 10V\sim 60V$ ,  $V_{out} = 5V$ ;  $I_{out} = 0.3A\sim 2A$ ,  $I_{out}$  below 0.3A DCM**



**B.  $V_{in} = 10V\sim 60V$ ,  $V_{out} = 3.3V$ ,  $I_{out} = 0.3A\sim 2A$ ,  $I_{out}$  below 0.3A DCM**

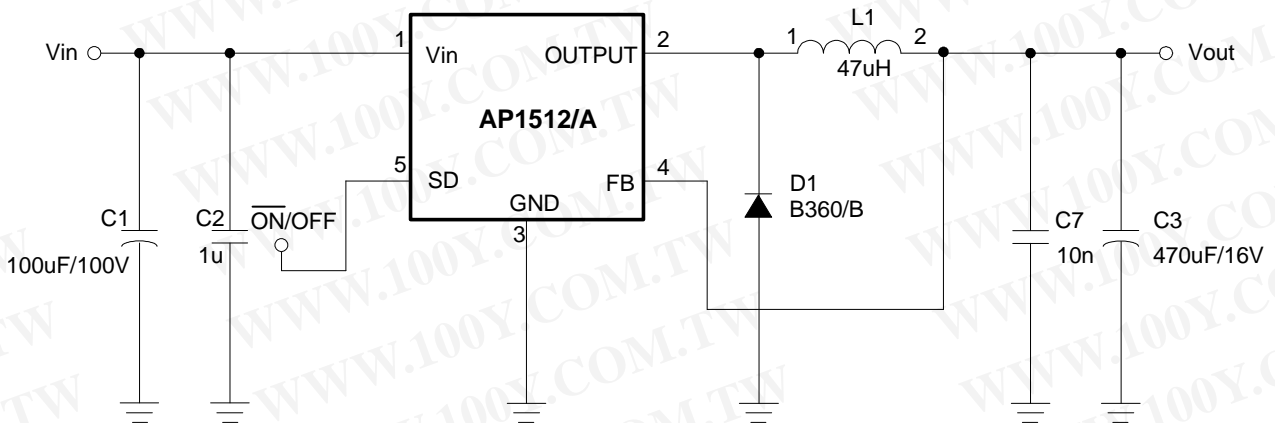


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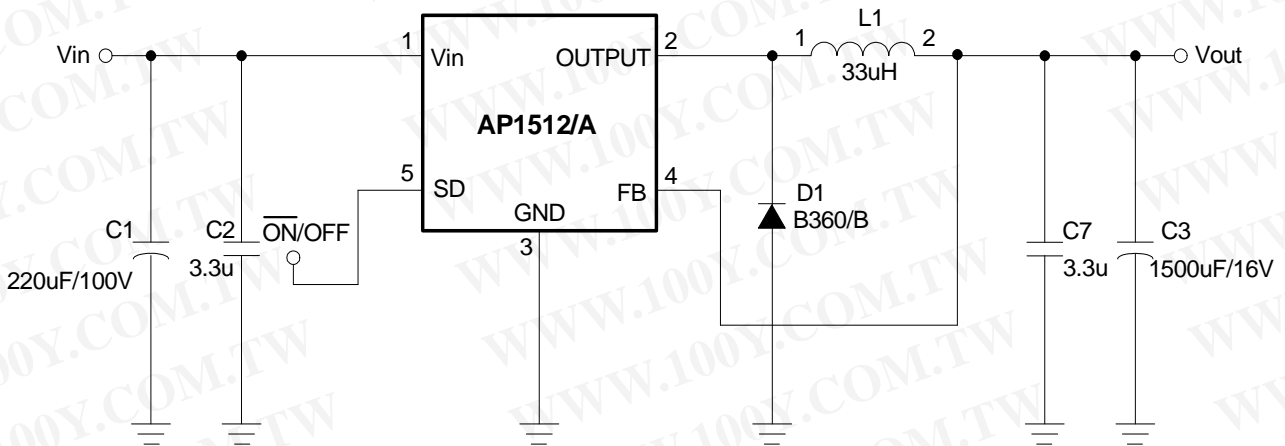
**Typical Application Circuit (Continued)**

**(2) Fixed Type Circuit**

**A.  $V_{in} = 10V\sim 60V$ ,  $V_{out} = 5V$ ,  $I_{out} = 0.7A\sim 2A$ ,  $I_{out}$  below 0.7A DCM**



**B.  $V_{in} = 10V\sim 60V$ ,  $V_{out} = 3.3V$ ,  $I_{out} = 0.7A\sim 2A$ ,  $I_{out}$  below 0.7A DCM**



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## Functional Description

### +V<sub>IN</sub>

This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be present at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

### Ground

Circuit ground.

### Output

Internal switch. The voltage at this pin switches between (+V<sub>IN</sub> - V<sub>SAT</sub>) and approximately -0.5V, with a duty cycle of approximately V<sub>OUT</sub>/V<sub>IN</sub>. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be kept a minimum.

### Feedback

Senses the regulated output voltage to complete the feedback loop.

### ON/OFF

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply current to approximately 150uA. Pulling this pin below a threshold voltage of approximately 1.3V turns the regulator on, and pulling this pin above 1.3V (up to a maximum of 40V) shuts the regulator down. If this shutdown feature is not needed, the SD pin can be wired to the ground pin or it can be left open, in either case the regulator will be in the ON condition.

### Thermal Considerations

The AP1512/A is available in a 5-pin surface mount TO-263 package.

The TO-263 surface mount package tab is designed to be soldered to the copper on a printed circuit board. The copper and the board are the heat sink for this package and the other heat producing components, such as the catch diode and inductor. The PC board copper area that the package is soldered to should be at least 0.4 in<sup>2</sup>, and ideally should have 2 or more square inches of 2 oz. Additional copper area improves the thermal characteristics, but with copper areas greater than approximately 6 in<sup>2</sup>, only small improvements in heat dissipation are realized. If further thermal improvements are needed, double sided, multilayer PC boards with large copper areas and/or airflow are recommended.

The AP1512/A (TO-263 package) junction temperature rises above ambient temperature with a 2A load for various input and output voltages. This data was taken with the circuit operating as a buck switching regulator with all components mounted on a PC board to simulate the junction temperature under actual operating conditions. This curve can be used for a quick check for the approximate junction temperature for various conditions, but be aware that there are many factors that can affect the junction temperature. When load currents higher than 2A are used, double sided or multilayer PC boards with large copper areas and/or airflow might be needed, especially for high ambient temperatures and high output voltages.

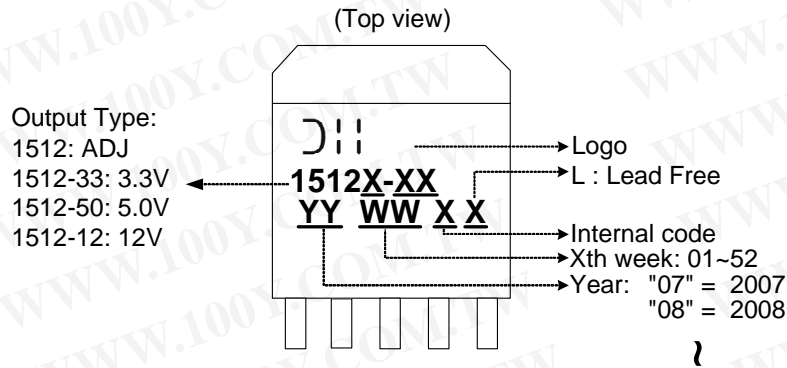
For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (Once exception to this is the output (switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding air, and moving air lowers the thermal resistance even further.

Package thermal resistance and junction temperature rise numbers are all approximate, and there are many factors that will affect these numbers. Some of these factors include board size, shape, thickness, position, location, and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, multilayer board and the amount of solder on the board. The effectiveness of the PC board to dissipate heat also depends on the size, quantity and spacing of other components on the board, as well as whether the surrounding air is still or moving. Furthermore, some of these components such as the catch diode will add heat to the PC board and the heat can vary as the input voltage changes. For the inductor, depending on the physical size, type of core material and the DC resistance, it could either act as a heat sink taking heat away from the board, or it could add heat to the board.

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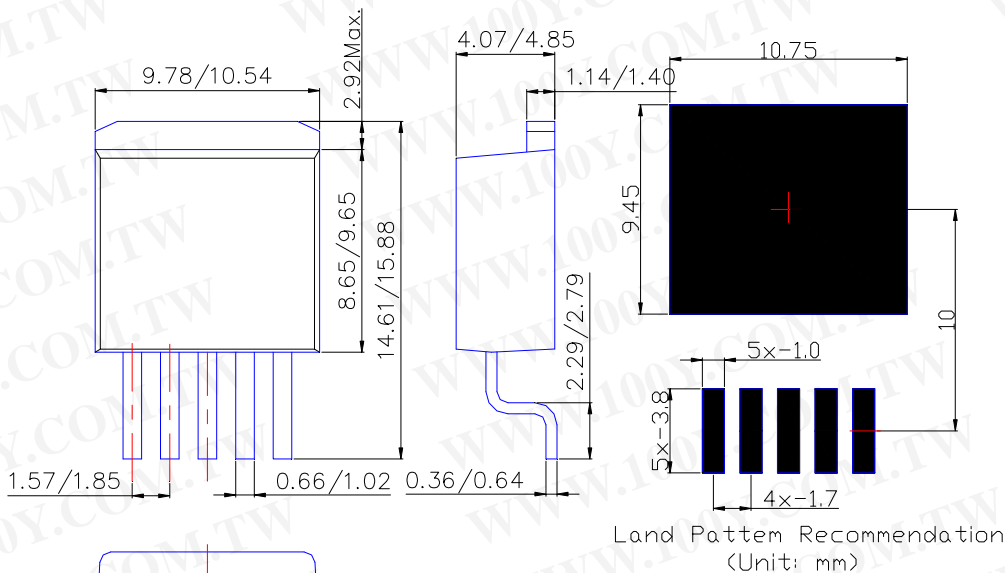
**Marking Information**

(1) TO263-5L



**Package Information (All Dimensions in mm)**

(1) Package Type: TO263-5L



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