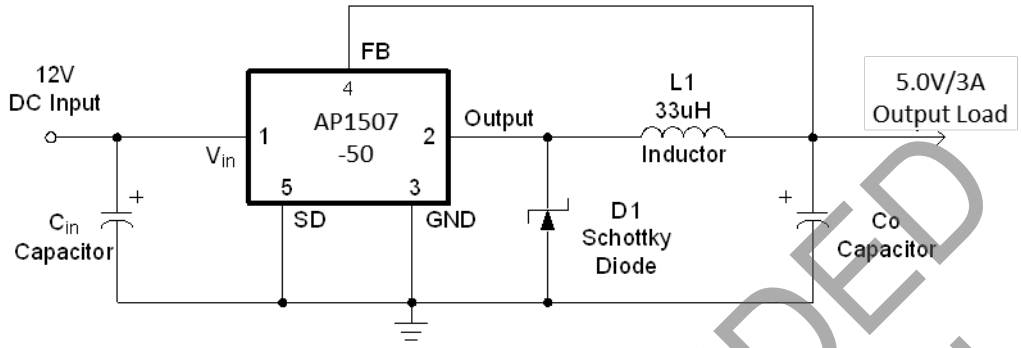
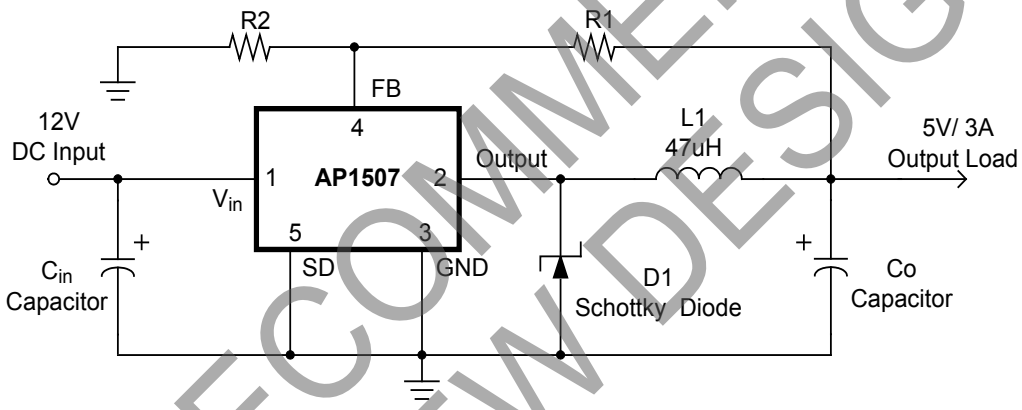
Typical Application Circuit

(1) Fixed Type Circuit



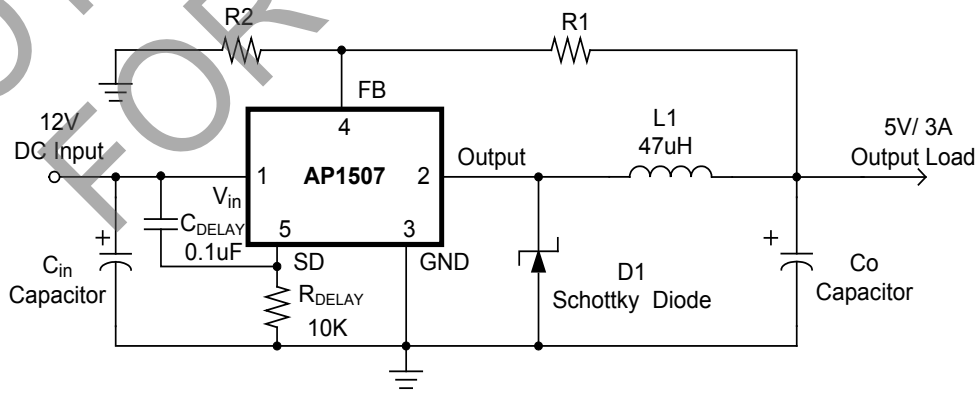
(2) Adjustable Type Circuit



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

V_{FB} = 1.23V, R2 = 1K ~ 3K

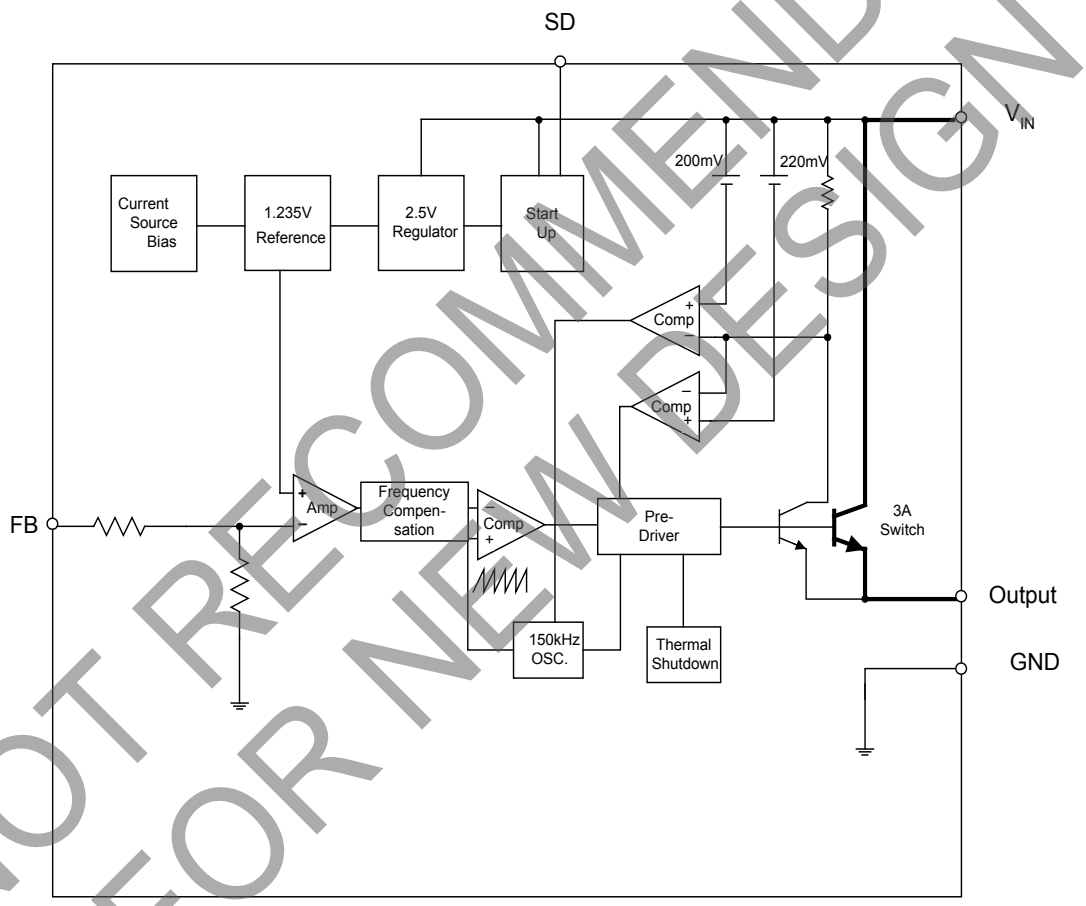
(3) Delay Start Circuit



Pin Descriptions

Pin Number	Pin Name	Description
1	V_{IN}	Operating Voltage Input
2	Output	Switching Output
3	GND	Ground
4	FB	Output Voltage Feedback Control
5	SD	$\overline{ON}$ / OFF Shutdown

Functional Block Diagram



Absolute Maximum Ratings (T_A = +25°C) (Note 4)

Symbol	Parameter	Rating	Unit
ESD HBM	Human Body Model ESD Protection	2	KV
ESD MM	Machine Model ESD Protection	200	V
V_{CC}	Supply Voltage	+24	V
V_{SD}	ON/OFF Pin Input Voltage	-0.3 to +18	V
V_{FB}	Feedback Pin Voltage	-0.3 to +18	V
V_{OUT}	Output Voltage to Ground	-1	V
P_D	Power Dissipation	Internally Limited	W
T_{ST}	Storage Temperature	-65 to +150	°C
T_J	Operating Junction Temperature	-40 to +125	°C

Note: 4. Stresses greater than the *Absolute Maximum Ratings* specified above, can cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability can be affected by exposure to absolute maximum rating conditions for extended periods of time.

Recommended Operating Conditions (T_A = +25°C)

Symbol	Parameter	Min	Max	Unit
I_{OUT}	Output Current	0	3	A
V_{OP}	Operating Voltage	4.5	22	V
T_A	Operating Ambient Temperature	-20	+85	°C

Electrical Characteristics (All Output Voltage Versions)

Unless otherwise specified, V_{IN} = 12V for 3.3V, 5V, adjustable version and V_{IN} = 18V for the 12V version. I_{LOAD} = 0.5A
Specifications with **boldface type** are for full operating temperature range, the other type are for T_J = 25°C.

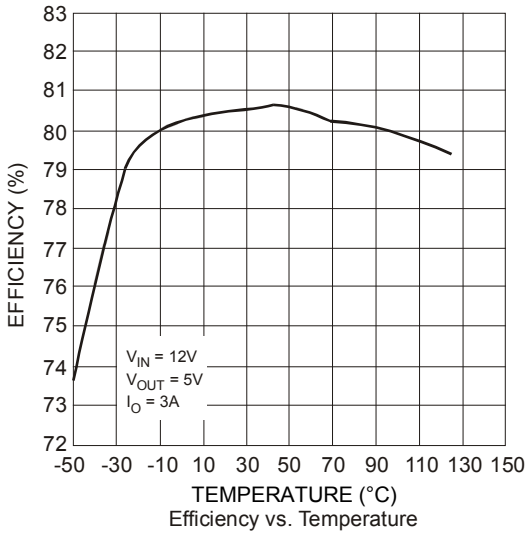
Symbol	Parameter		Conditions		Min	Typ	Max	Unit
I_{FB}	Feedback Bias Current		V_{FB} = 1.3V (Adjustable Version Only)		—	-10	-50 **-100**	nA
F_{OSC}	Oscillator Frequency		—		127 **110**	150 —	173 **173**	kHz
F_{SCP}	Oscillator Frequency of Short-Circuit Protect		When Current Limit Occurred and V_{FB} < 0.5V, T_A = 25°C		10	30	50	kHz
V_{SAT}	Saturation Voltage		I_{OUT} = 3A No Outside Circuit V_{FB} = 0V Force Driver On		—	1.4	1.6 **1.7**	V
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		Peak Current No Outside Circuit V_{FB} = 0V Force Driver On		3.6	4.5	5.5 6.5	A
I_{LEAK}	Output = 0V	Output Leakage Current	No Outside Circuit V_{FB} =12V Force Driver Off		—	—	-200	μA
	Output = -1V		V_{IN} = 22V		—	-5	—	mA
I_Q	Quiescent Current		V_{FB} = 12V Force Driver Off		—	5	10	mA
I_{STBY}	Standby Quiescent Current		ON/OFF Pin = 5V V_{IN} = 22V		—	70	150 **200**	μA
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)		—	—	-0.01	μA
I_L	ON/OFF Pin Input Current		V_{LOGIC} = 0.5V (ON)		—	-0.1	-1	
θ_{JA}	Thermal Resistance		TO252-5	Junction to Case	—	10	—	°C/W
θ_{JC}	Thermal Resistance (Copper Area of Approximately 2cm × 2cm)		TO252-5	Junction to Ambient	—	50	—	°C/W

Electrical Characteristics (continued) (All Output Voltage Versions)

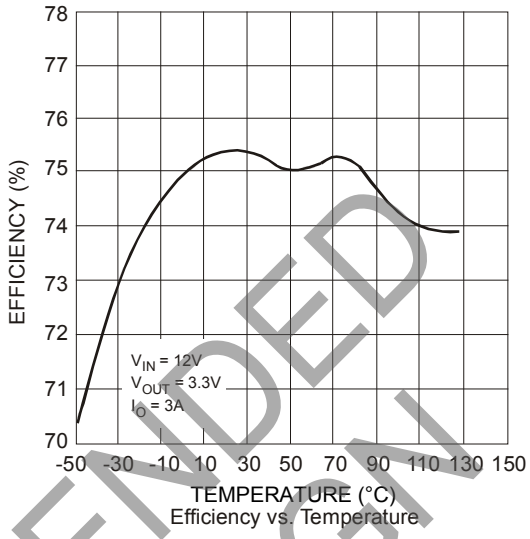
Specifications with **boldface type** are for full operating temperature range, the other type are for T_J = +25ºC.

—	Symbol	Parameter	Conditions	V_{MIN}	Typ.	V_{MAX}	Unit
AP1507-ADJ	V_{FB}	Output Feedback	5V ≤ V_{IN} ≤ 22V 0.2A ≤ I_{LOAD} ≤ 3A V_{OUT} Programmed for 3V	1.193 **1.18**	1.23	1.267 **1.28**	V
	η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3A	—	74	—	%
AP1507-3.3V	V_{OUT}	Output Voltage	5.5V ≤ V_{IN} ≤ 22V 0.2A ≤ I_{LOAD} ≤ 3A	3.168 **3.135**	3.3	3.432 **3.465**	V
	η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3A	—	75	—	%
AP1507-5V	V_{OUT}	Output Voltage	8V ≤ V_{IN} ≤ 22V 0.2A ≤ I_{LOAD} ≤ 3A	4.8 **4.75**	5	5.2 **5.25**	V
	η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3A	—	80	—	%
AP1507-12V	V_{OUT}	Output Voltage	15V ≤ V_{IN} ≤ 22V 0.2A ≤ I_{LOAD} ≤ 3A	11.52 **11.4**	12	12.48 **12.6**	V
	η	Efficiency	V_{IN} = 16V, I_{LOAD} = 3A	—	89	—	%

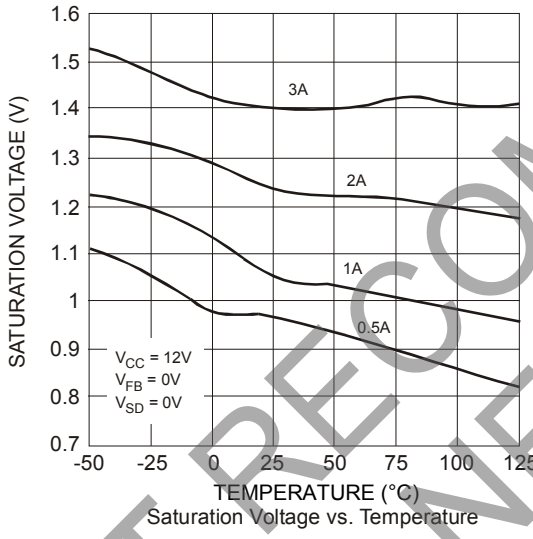
Typical Characteristics



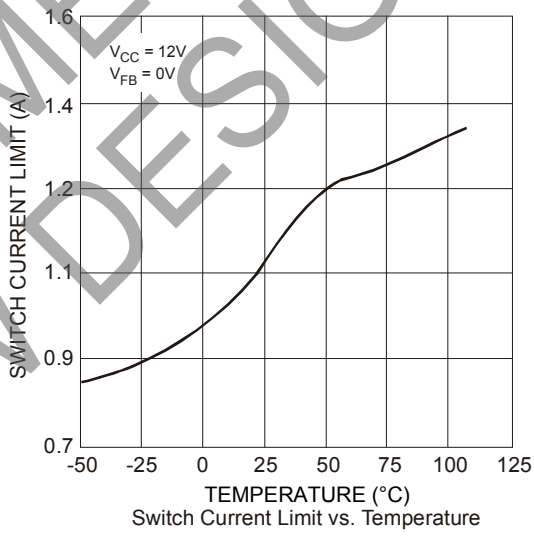
Efficiency vs. Temperature



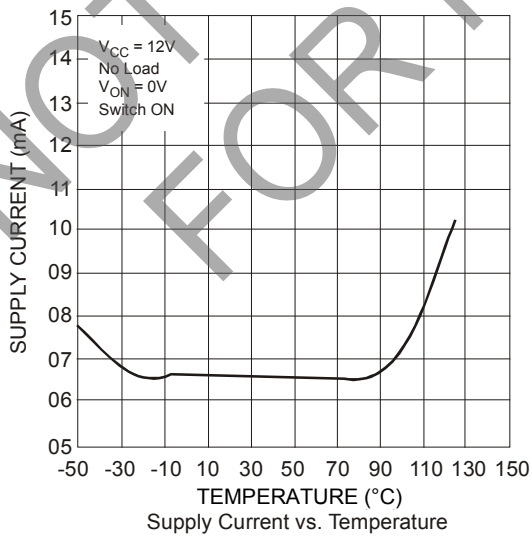
Efficiency vs. Temperature



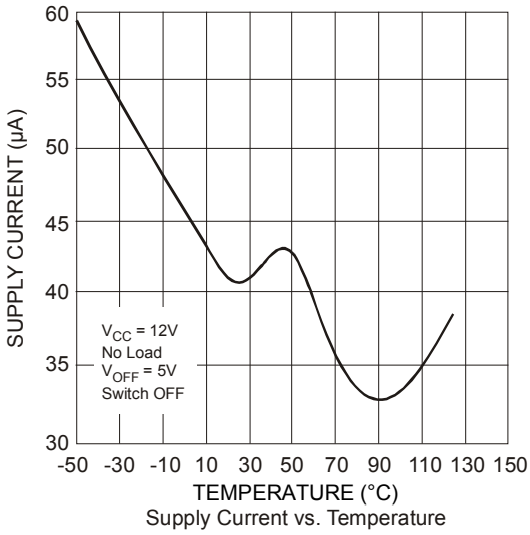
Saturation Voltage vs. Temperature



Switch Current Limit vs. Temperature

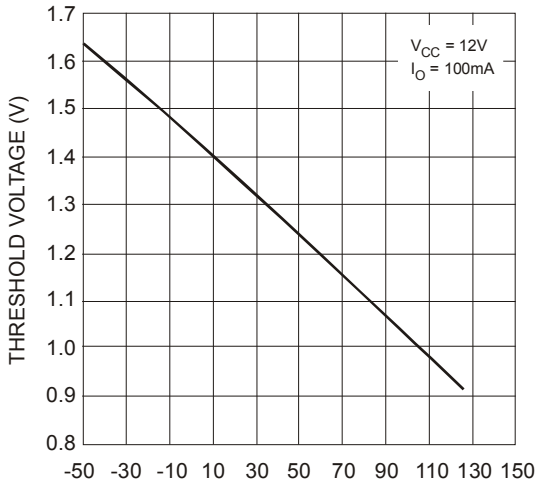


Supply Current vs. Temperature

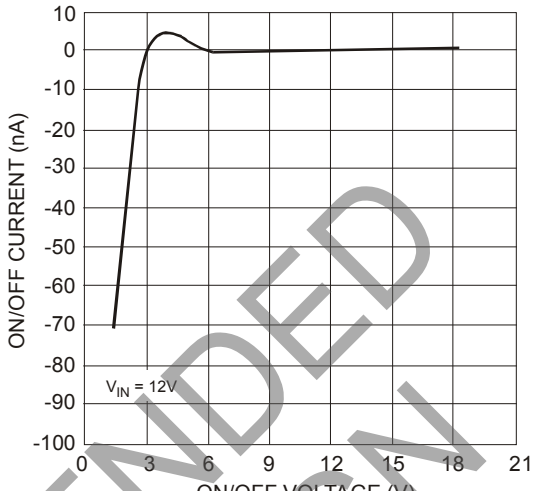


Supply Current vs. Temperature

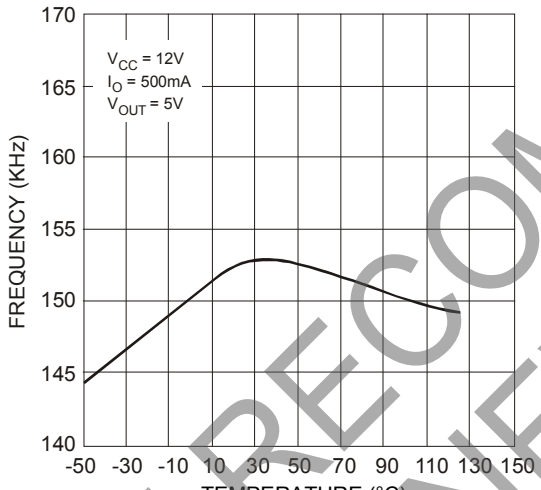
Typical Characteristics (continued)



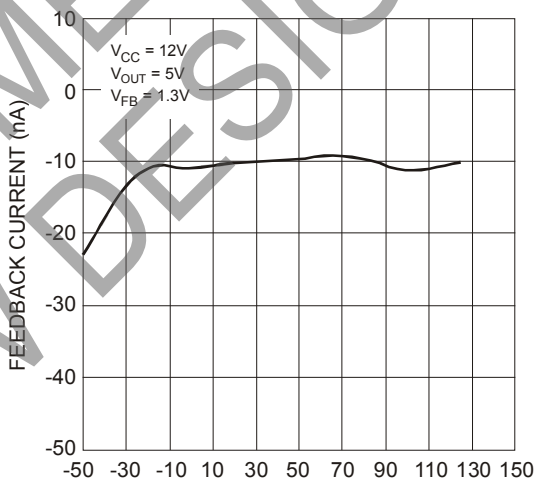
Threshold Voltage vs. Temperature



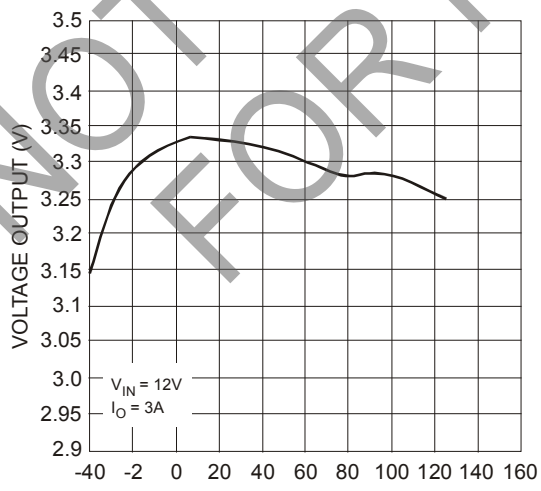
ON/OFF Current vs. ON/OFF Voltage



Frequency vs. Temperature



Feedback Current vs. Temperature



Output Voltage vs. Temperature

Application Information

Pin Functions

$+V_{IN}$

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 ($+V_{IN} – V_{SAT}$) and approximately -0.5V with a duty cycle of approximately V_{OUT}/V_{IN}. To minimize coupling to sensitive circuitry, the PCB copper area connected to this pin must be kept at a minimum.

Feedback (FB)

Senses the regulated output voltage to complete the feedback loop.

ON/OFF (SD)

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply current to approximately 150µA. 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 18V) shuts the regulator down. If this shutdown feature is not required, the ON/OFF pin can be wired to the ground pin.

Thermal Considerations

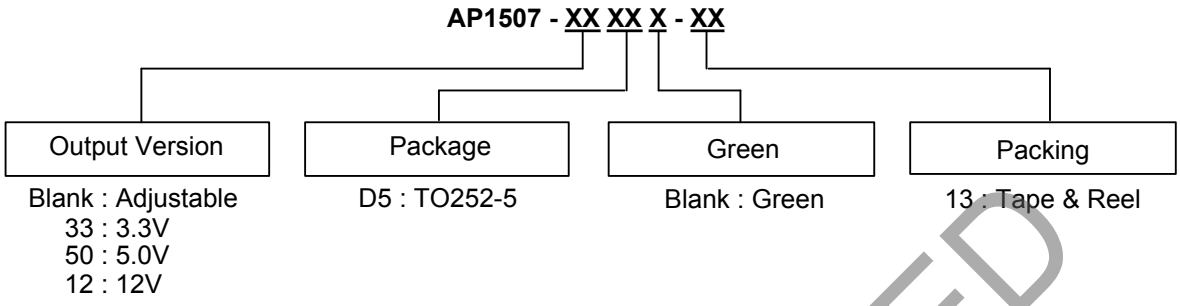
The TO252-5 surface mount package tab is designed to be soldered to the copper on a PCB. The copper and the board are the heat sink for this package and the other heat producing components, such as the catch diode and inductor. The PCB copper area that the package is soldered to should be at least 0.8 in^2 and ideally should have two or more square inches of 2oz additional copper area, which improves the thermal characteristics. With copper areas greater than approximately 6in^2, only small improvements in heat dissipation are realized. If further thermal improvements are required, double sided, multi-layer PCBs with large copper areas and/or airflow are recommended.

The AP1507 (TO252-5 package) junction temperature rises above ambient temperature with a 3A 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 PCB 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 there are many factors that can affect the junction temperature. When load currents higher than 3A are used, double-sided or multi-layer PCBs with large copper areas and/or airflow might be required, especially for high ambient temperatures and high output voltages.

For the best thermal performance, wide copper traces and generous amounts of PCB copper should be used in the board layout. One 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 PC copper area, copper thickness, single- or double-sided, multi-layer board, and the amount of solder on the board. The effectiveness of the PCB 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, add heat to the PCB, and the heat can vary as the input voltage changes. Depending on the physical size, type of core material, and the DC resistance, the inductor can either act as a heat sink taking heat away from the board, or it could add heat to the board.

Ordering Information

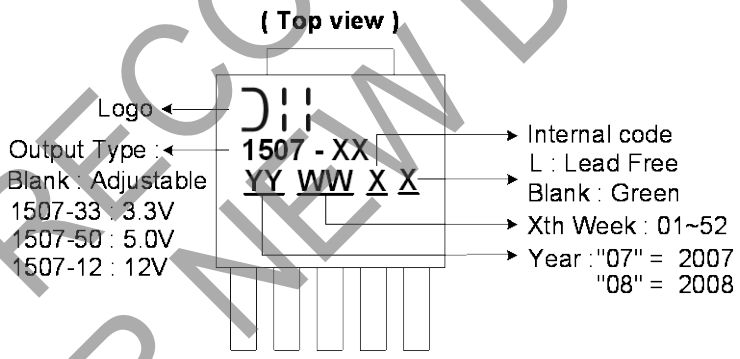


Device	Voltage (V)	Package Code	Package (Note 5)	Lead Free/Green	Quantity	Part Number Suffix		Status
						Tube	13" Tape and Reel	
AP1507-12D5-13	12	K5	TO252-5	Green	800	NA	-13	End of Life
AP1507-33D5-13	3.3	K5	TO252-5	Green	800	NA	-13	End of Life
AP1507-50D5-13	5.0	K5	TO252-5	Green	800	NA	-13	End of Life
AP1507-D5-13	ADJ	K5	TO252-5	Green	800	NA	-13	NRND

Notes: 5. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

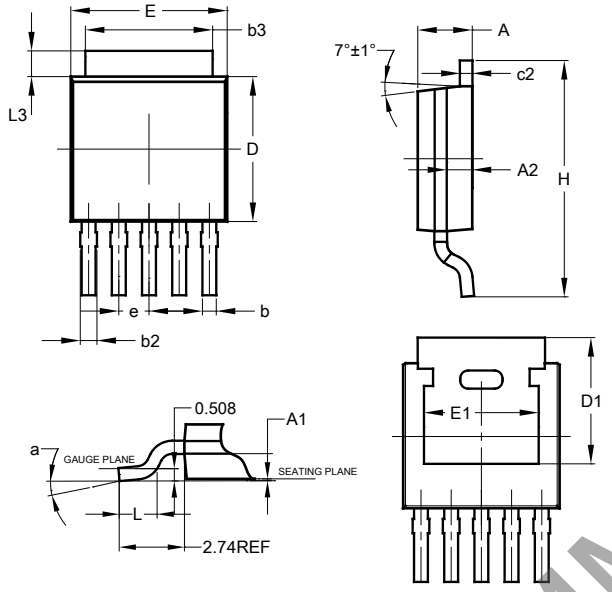
(1) TO252-5



Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

TO252-5

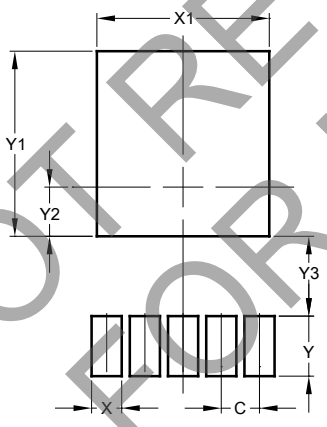


TO252-5			
Dim	**Min**	**Max**	**Typ**
A	2.19	2.39	2.29
A1	0.00	0.13	0.08
A2	0.97	1.17	1.07
b	0.51	0.71	0.583
b2	0.61	0.79	0.70
b3	5.21	5.46	5.33
c2	0.45	0.58	0.531
D	6.00	6.20	6.10
D1	5.21	—	—
e	—	—	1.27
E	6.45	6.70	6.58
E1	4.32	—	—
H	9.40	10.41	9.91
L	1.40	1.78	1.59
L3	0.88	1.27	1.08
a	0°	10°	—
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

TO252-5



Dimensions	Value (in mm)
C	1.27
X	1.00
X1	5.73
Y	2.00
Y1	6.17
Y2	1.64
Y3	2.66

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