AE2576

SIMPLE SWITCHER 3A Step-Down Voltage Regulator

Features

- 3.3V, 5V, 12V, 15V and adjustable output versions
- Adjustable version output voltage range, 1.23V to 30V ±4% max over line and load conditions
- Guaranteed 3A output current
- Input voltage up to 45V
- Requires only 4 external components
- 52KHz fixed frequency internal oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Thermal shutdown and current limit protection

Applications

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- Positive to negative converter (BucK-Boost)

General Description

The AE2576 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, 15V, and an adjustable output version.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation and a fixed frequency oscillator.

A standard series of inductors optimized for use with the AE2576 are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies.

Others features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency. External shutdown in included, featuring 50μA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

Typical Application

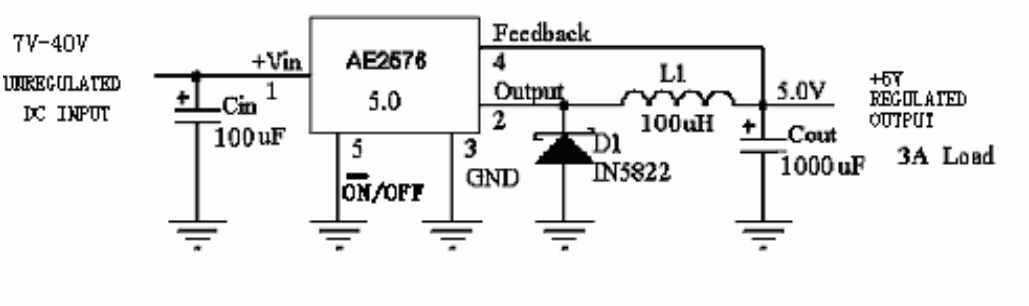
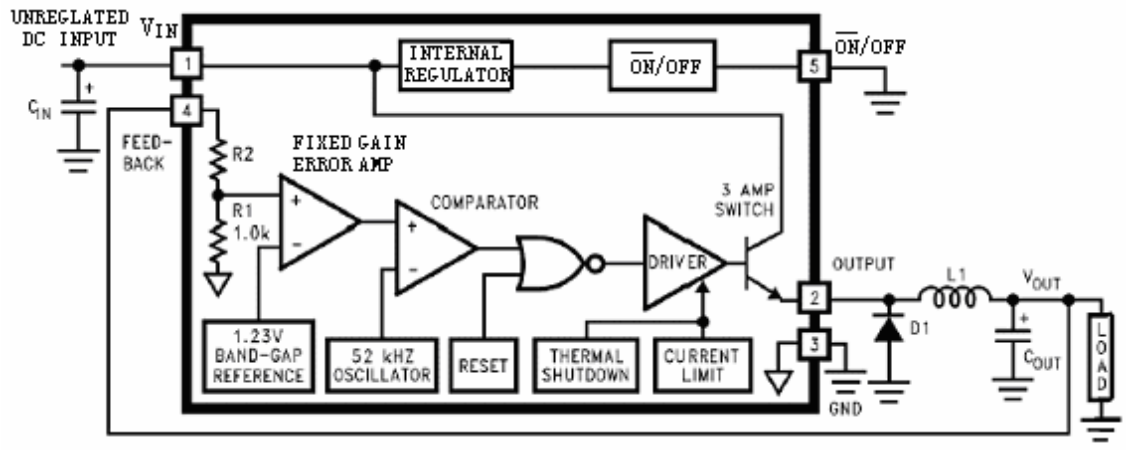


FIGURE1: Fixed Output Voltage Versions

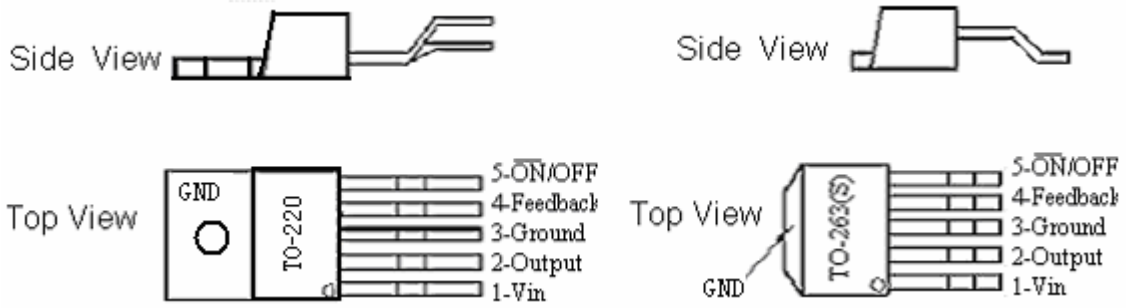
Block Diagram



3.3v R2=1.7K 5v R2=3.1K 12v R2=8.4K
15v R2=11.3K For Adjustable R2=0K R1=open

Connection Diagrams

5-Lead TO-220 **5-Lead TO-263**



Pin Functions:

+VIN —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 (+VIN VSAT) and approximately -0.5V. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be kept to a minimum**.**

FeedBack —Senses the regulated output voltage to complete the feedback loop**.**

$\overline{\text{ON}}$/OFF —Allows the switching regulator circuit to be shut down using logic level signals. Pulling this pin below a threshold voltage of approximately 1.5V turns the regulator on, and pulling this pin above 1.51V (up to a maximum of 25V) shuts the regulator down. If this shutdown feature is not needed, the $\overline{\text{ON}}$/OFF 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

Absolute Maximum Ratings (Note 1)

Parameter		Rating	Unit
Maximum Supply Voltage		45	V
$\overline{\text{ON}}$/OFF Pin Input Voltage		-0.3～+ V_{IN}	V
Output Voltage to Ground Steady State)		-1	V
Power Dissipation		Internally limited	--
Storage Temperature Range		-65～150	℃
ESD Susceptibility (Human Body Model)		2	KV
Conditions	Maximum Junction Temperature	150	℃
	Temperature Range	-40～125	℃
	Supply Voltage	4.5~40	V

Electrical Characteristics

Specifications with standard type face are for T_J = 25℃.

AE2576-3.3V

Symbol	Parameter	Conditions	Min (Note 2)	Typ	Max (Note 2)	Units
SYSTEM PARAMETERS (Note 3) Test Circuit Figure 2						
V_{OUT}	Output Voltage	6≤V_{IN}≤36V 0.5A≤I_{LOAD}≤3A	3.168	3.3	3.432	V
η	Efficiency	V_{IN}=12V，I_{LOAD}=3A	--	75	--	%

AE2576-5V

Symbol	Parameter	Conditions	Min (Note 2)	Typ	Max (Note 2)	Units
SYSTEM PARAMETERS (Note 3) Test Circuit Figure 2						
V_{OUT}	Output Voltage	$8 \leqslant V_{IN} \leqslant 36V$ $0.5A \leqslant I_{LOAD} \leqslant 3A$	4.800	5.0	5.20	V
η	Efficiency	V_{IN}=12V，I_{LOAD}=3A	--	77	--	%

AE2576-12V

Symbol	Parameter	Conditions	Min (Note 2)	Typ	Max (Note 2)	Units
SYSTEM PARAMETERS (Note 3) Test Circuit Figure 2						
V_{OUT}	Output Voltage	$15V \leqslant V_{IN} \leqslant 36V$ $0.5A \leqslant I_{LOAD} \leqslant 3A$	11.520	12	12.480	V
η	Efficiency	V_{IN}=15V, I_{LOAD}=3A	--	88	---	%

AE2576-15V

Symbol	Parameter	Conditions	Min (Note 2)	Typ	Max (Note 2)	Units
SYSTEM PARAMETERS (Note 3) Test Circuit Figure 2						
V_{OUT}	Output Voltage	$18V \leqslant V_{IN} \leqslant 36V$ $0.5A \leqslant I_{LOAD} \leqslant 3A$	14.400	15	15.600	V
η	Efficiency	V_{IN}=18V, I_{LOAD}=3A	--	88	---	%

AE2576-ADJ

Symbol	Parameter	Conditions	Min (Note 2)	Typ	Max (Note 2)	Units
SYSTEM PARAMETERS (Note 3) Test Circuit Figure 2						
V_{FB}	Feedback Voltage	$8V \leqslant V_{IN} \leqslant 36V$ $0.5A \leqslant I_{LOAD} \leqslant 3A$ V_{OUT}=5V	1.193	1.230	1.267	V

η	Efficiency	V_{IN}=12V， I_{LOAD}=3A V_{OUT}=5V	--	77	--	%

ALL Output Voltage Versions Electrical Characteristics

（Condition :T_J = 25℃,otherwise specified, V_{IN} =12V for the 3.3V, 5V,and Adjustable version, V_{IN} =25V for the 12V version, and V_{IN} =25V for the 12V version, and V_{IN} =30V for 15V version. I_{LOAD}=500mA）

Symbol	Parameter	Conditions	AE2576—XX			Units
			Min (Note 2)	Typ	Max (Note2)	
DEVICE PARAMETERS						
I_b	Feedback Bias Current	Adjustable Version Only, V_{OUT}=5V	--	50	100	nA
f_O	Oscillator Frequency	(Note 11)	47	52	58	KHz
V_{SAT}	V_{SAT} Saturation Voltage	I_{OUT}=3A(Note 4)	--	1.5	2.0	V
DC	Max Duty Cycle (ON)	(Note 5)	93	98	--	%
I_{CL}	Current Limit	(Notes 4,11)	5.5	6.12	6.7	A
I_L	Output Leakage Current	Output = 0V (Notes 6, 7)	--		2..0	mA
		Output =-1V (Notes 10)	--	7.5	30	mA
I_Q	Quiescent Current	(Note 6)	--	6	12	mA
I_{STBY}	Standby Quiescent Current	$\overline{ON}/OFF$ PIN = 5V (OFF)	--	200	300	μA
θ_{JA}	Thermal Resistance	T Package, Junction to Ambient (Note 8)	--	65	--	℃/W
θ_{JA}		T Package, Junction to Ambient (Note 9)	--	45	--	℃/W
θ_{JC}		T Package, Junction to Case	--	2	--	℃/W
θ_{JA}		S Package, Junction to Ambient (Note 10)	--	50	--	℃/W
$\overline{ON}/OFF$ **CONTROL**						
V_{IH}	$\overline{ON}/OFF$ Pin Logic Input Level	V_{OUT}=0V	1.38	1.50	--	V

V_{IL}		V_{OUT}=Nominal Output Voltage	--	1.36	1.43	V
I_H	$\overline{ON}/OFF$ Pin Input Current	ON/OFF Pin =5V(OFF)	--	12	30	μA
I_L		ON/OFF Pin =0V(ON)	--	0	10	μA

Note 1: Absolute Maximum Ratings indicates limits beyond which damage to the device May occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the best conditions, see the Electrical Characteristics.

Note 2: All limits guaranteed at room temperature (standard type face) and at temperature extremes (bold type face). All room temperature limits are 100% production tested. All limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods.

Note 3: External components such as the catch diode, inductor, input and output capacitors, and voltage programming resistors can affect switching regulator system performance.

Note 4: Output pin sourcing current. No diode, inductor or capacitor connected to output pin.

Note 5: Feedback pin removed from output and connected to 0V.

Note 6: Feedback pin removed from output and connected to +12V for the 3.3V, 5V, and the ADJ. version, and +25V for the 12V and 15V version, to force the output transistor switch OFF.

Note 7: V_{IN} =36V.

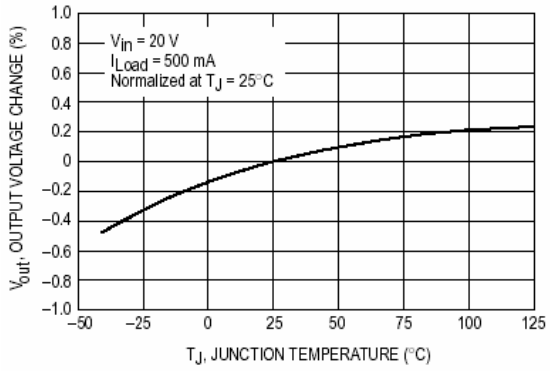
Note 8: Junction to ambient thermal resistance (no external heat sink) for the 5 lead TO-220 package mounted vertically, with 1/2 inch leads in a socket, or on a PC board with minimum copper area.

Note 9: Junction to ambient thermal resistance (no external heat sink) for the 5 lead TO-220 package mounted vertically, with 1/4 inch leads soldered to a PC board containing approximately 4spuare inches of copper area surrounding the leads.

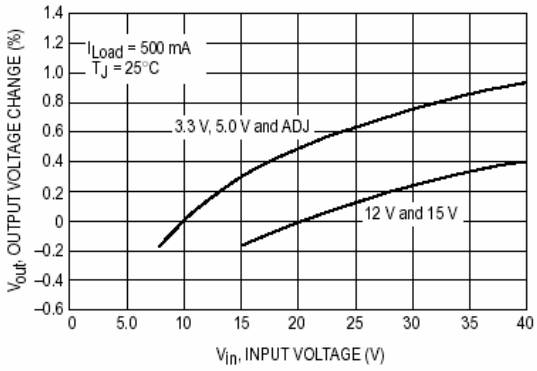
Note 10: If the TO-263 package is used, the thermal resistance can be reduced by increasing the PC board copper area thermally to the package.Using 0.5spuare inches of copper area θ_{JA} ＝50℃/W, with 1square inch of copper area, θ_{JA} ＝37℃/W, and with 1.6 or more square inches of copper area θ_{JA} ＝32℃/W.

Typical Performance Characteristics

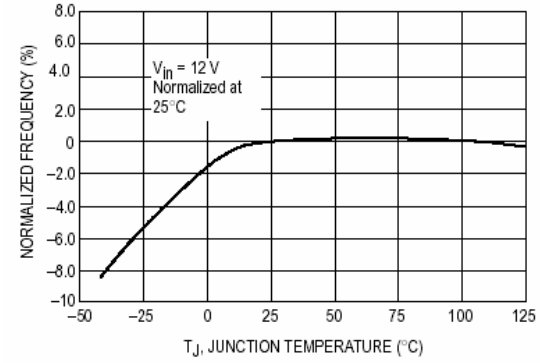
Normalized Output Voltage



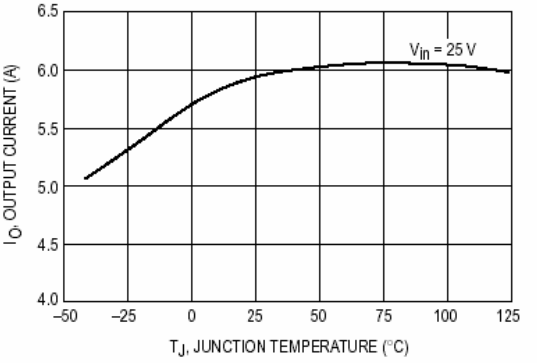
Line Regulation



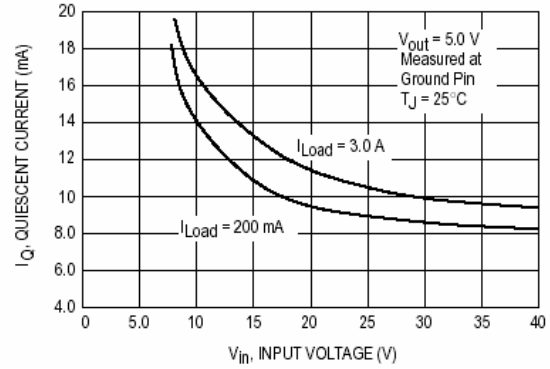
Oscillator Frequency



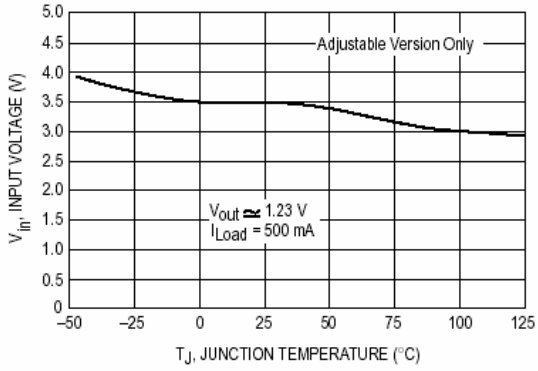
Current Limit



Quiescent Current

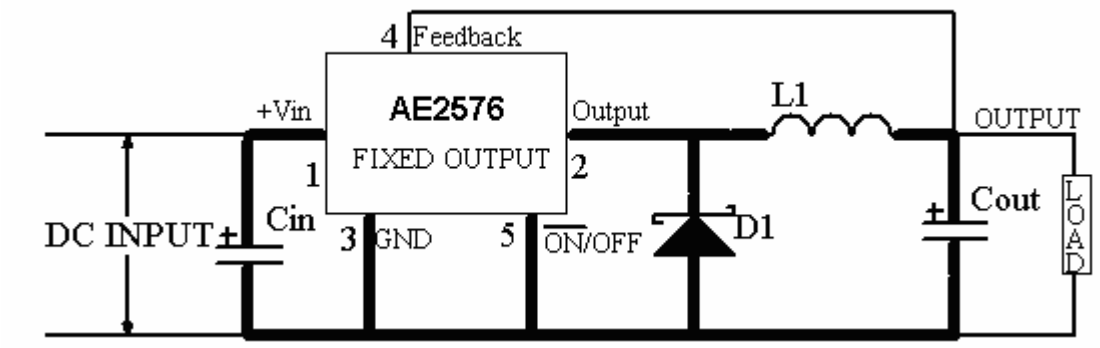


Minimum Operating Voltage



Testing Circuit

Fixed Output Voltage Versions



Adjustable Output Voltage Versions

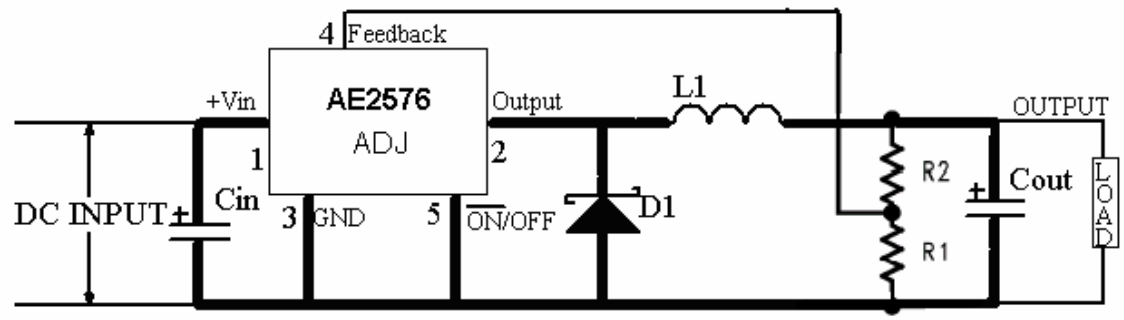
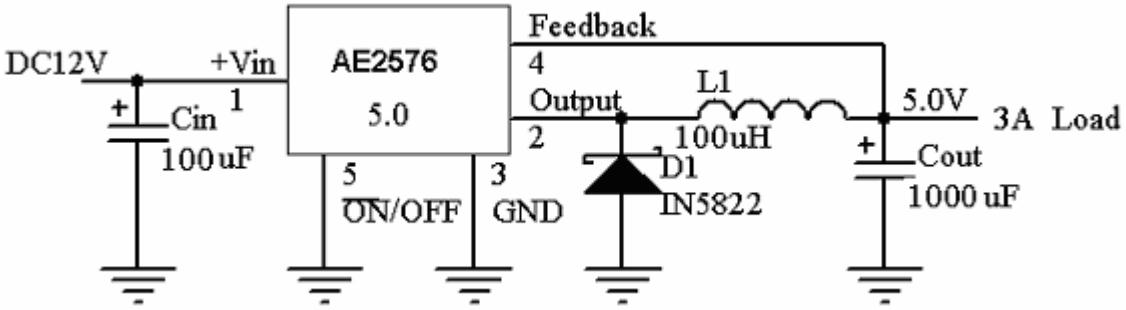


FIGURE2：Fixed and Adjustable Output Voltage

C_{IN} —100 µF, 50V, Aluminum Electrolytic Nichicon “PL Series”
C_{OUT} —1000 µF, 50V Aluminum Electrolytic, Nichicon “PL Series”
D1 —5A, 40V Schottky Rectifier, 1N5822
L1 —100µH
Note: Keep Feedback wiring away from inductor flux and heavy line must be kept short and use ground plane construction or best results.

Application Note



INPUT CAPACITOR C_{IN} —A low ESR aluminum or tantalum bypass capacitor is needed between the input pin and ground pin**.** It must be located near the regulator using short leads. This capacitor prevents large voltage transients from appearing at the input, and provides the instantaneous current needed each time the switch turns on. Selecting an input capacitor requires consulting the manufacturers data sheet for maximum allowable RMS ripple current. For a maximum ambient temperature of 40℃, a general guideline would be to select a capacitor with a ripple current rating of approximately 50% of the DC load current. For ambient temperatures up to 70℃, a current rating of 75% of the DC load current would be a good choice for a conservative design. The capacitor voltage rating must be at least 1.25 times greater than the maximum input voltage, and often a much higher voltage capacitor is needed to satisfy the RMS current requirements.

OUTPUT CAPACITOR C_{OUT} —-An output capacitor is required to filter the output and provide regulator loop stability. Low impedance or low ESR Electrolytic or solid tantalum capacitors designed for switching regulator applications must be used. When selecting an output capacitor, the important capacitor parameters are; the 100 kHz 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 capacitor requires an ESR value that has an upper and lower limit. For low output ripple voltage, a low ESR value is needed. This value is determined by the maximum allow able output ripple voltage, typically 1% to 2% of the output voltage. But if the selected capacitor's ESR is extremely low, there is a possibility of an unstable feedback loop, resulting in an oscillation at the output.

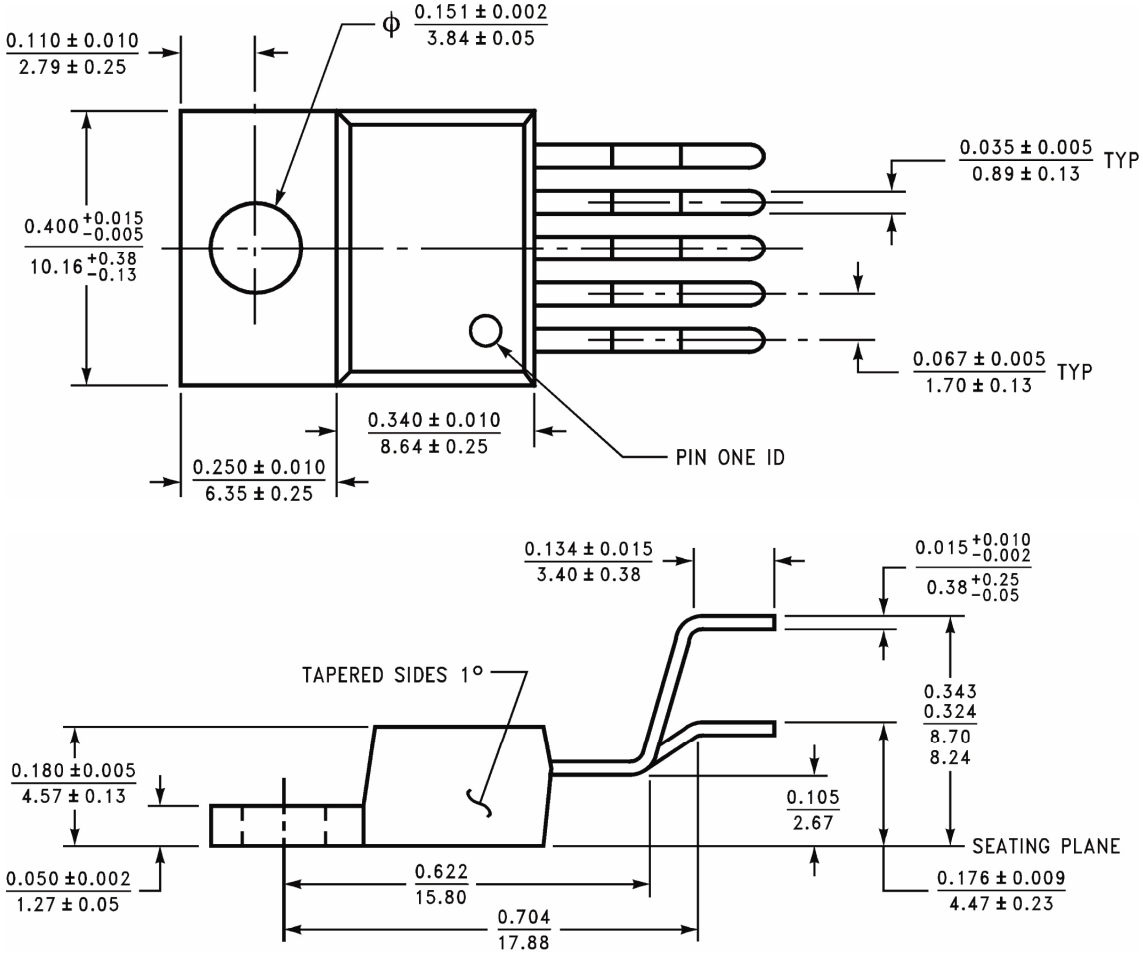
CATCH DIODE D —-Buck regulators require a diode to provide a return path for the inductor current when the switch turns off. This must be a fast diode and must be located close to the AE2576 using short leads and short printed circuit traces. Because of their very fast switching speed and low forward voltage drop, Schottky diodes provide the best performance, especially in low output voltage applications (5V and lower). Ultra fast recovery, or High-Efficiency rectifiers are also a good choice, but some types with an abrupt turnoff characteristic may cause instability or EMI problems.

INDUCTOR SELECTION L —-All switching regulators have two basic modes of operation; continuous and discontinuous. The difference between the two types relates to the inductor current, whether it is flowing continuously, or if it drops to zero for a period of time in the normal switching cycle. Each mode has distinctively different operating characteristics, which can affect the regulators performance and requirements. Most switcher designs will operate in the discontinuous mode when the load current is low. The AE2576 (or any of the Simple Switcher family) can be used for both continuous and discontinuous modes of operation. There is a formula for general applications:

$$L=(5\sim10)\ \frac{V_o}{100I_o}\ (1-\frac{V_O}{V_{IN}})\text{mH}$$

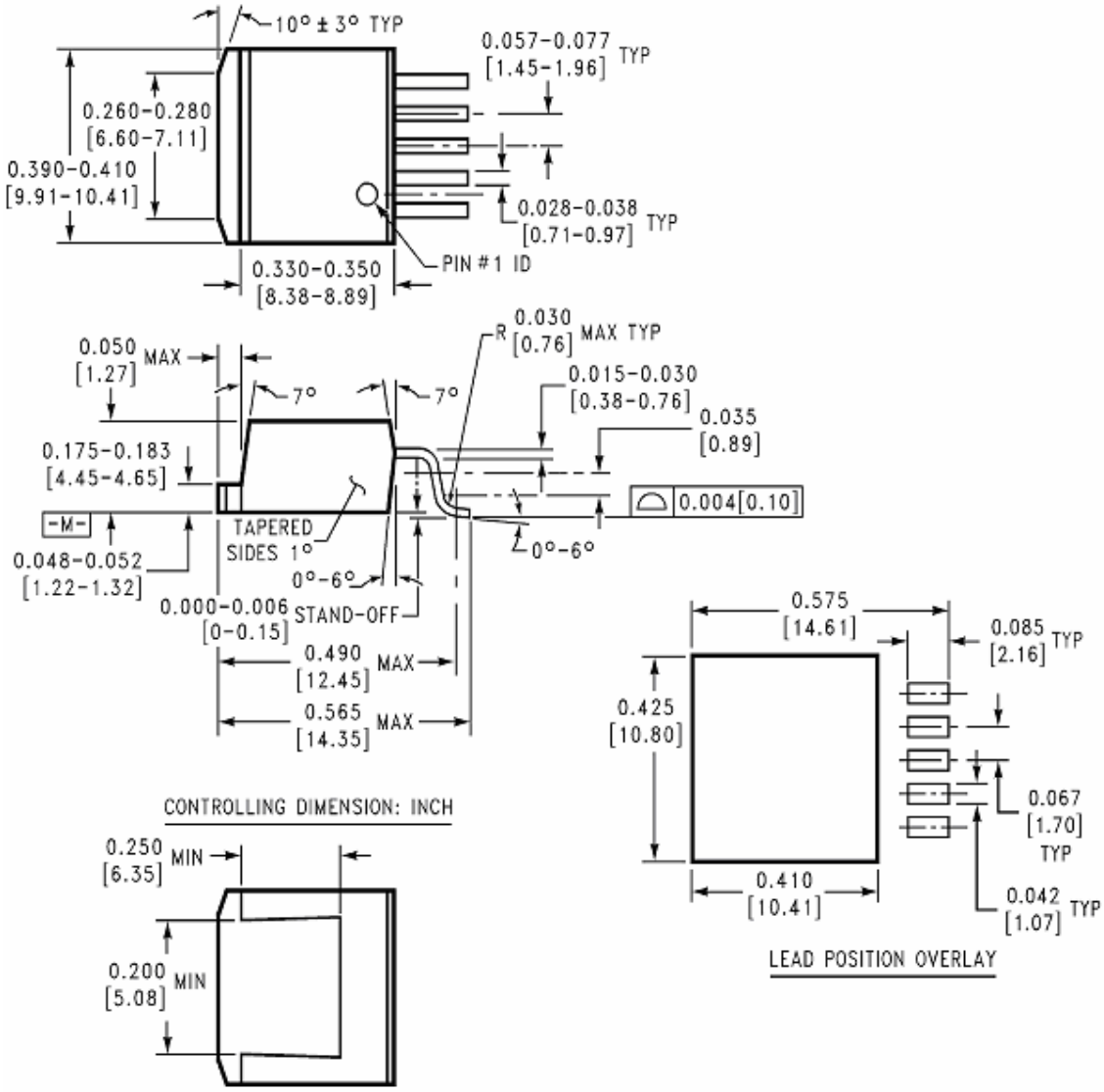
Note ： The unit of voltage is V， the unit of current is A)

Physical Dimensions inches (millimeters)



5-Lead TO-220

Physical Dimensions (Continued)



5-Lead To-263 Surface Mount Package