4A Ultra-low Dropout Regulator

Features

- Maximum Dropout Voltage of 0.7V at 4A load current
- Built-In Thermal Shutdown
- Output Current Limiting
- Adjustable, or Fixed Output Voltages of 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, 5.0V
- Fast Transient Response
- Good Noise Rejection
- RoHS-compliant and Halogen-free package

Description

The APE1184-HF-3 is a 4A regulator with extremely low drop-out voltage.This product is specifically designed to provide regulated supplies for applications requiring voltages of 2.8V or less from 3.3V ATX power supplies. The high efficiency of a switcher can be achieved without the cost and complexity associated with switching regulators. One such application is for the new graphic chip sets that require anywhere from 2.4V to 2.7V supply voltage.
The APE1184-HF-3 is available in RoHS-compliant, halogen-free five-lead TO-220, TO-252 and TO-263 packages.

Typical Application

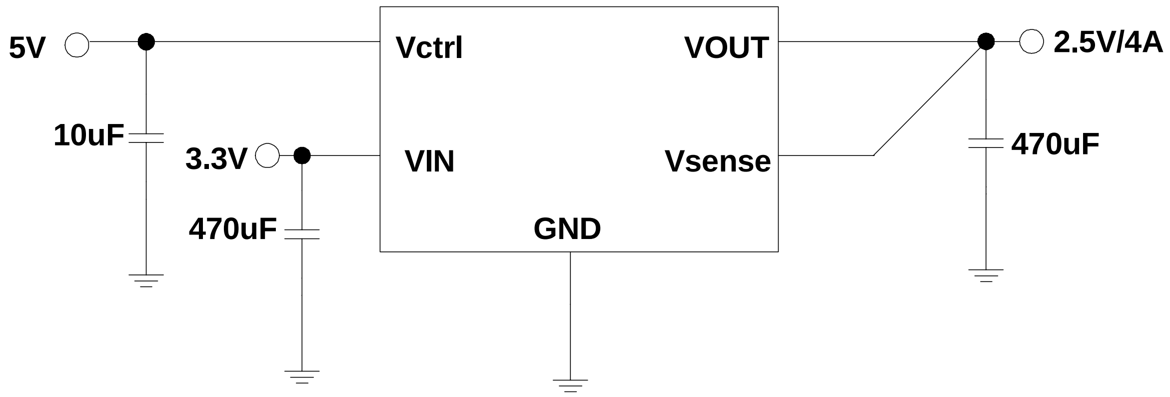
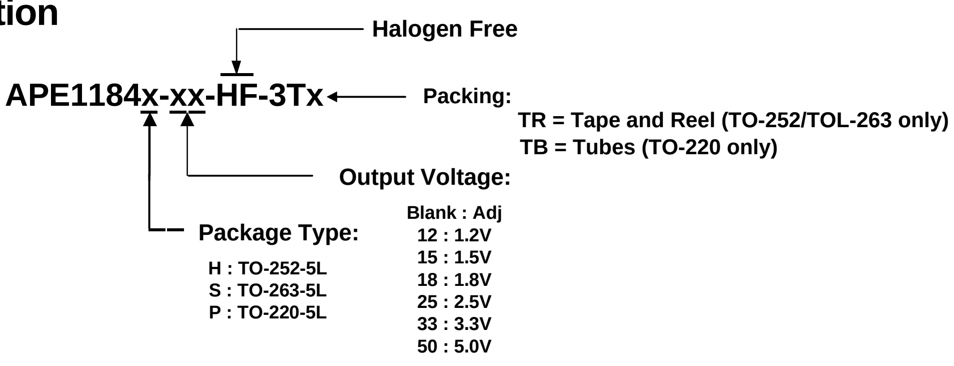


Figure 1 - Typical application of APE1184S-25-HF-3 in a 5V to 2.5V supply.

Ordering Information



APE1184H-xx-HF-3TR : in RoHS-compliant halogen-free 5-pin TO-252 on tape and reel (3000 pcs/reel)

APE1184S-xx-HF-3TR : in RoHS-compliant halogen-free 5-pin TO-263 on tape and reel (800 pcs/reel)

APE1184P-xx-HF-3TB : in RoHS-compliant halogen-free 5-pin TO-220 in tubes (50 pcs/tube)

Absolute Maximum Ratings

Input Voltage (V_{IN}) 16V
Control Input Voltage (V_{CTRL}) 18V
Power Dissipation .... Internally Limited
Storage Temperature Range .... -65°C to 150°C
Operating Junction Temperature Range .... 0°C to 150°C

Thermal Resistance from Junction to Caset(Rth_{JC}) TO-220-5L ---- 2.7°C/W
TO-263-5L ---- 2.7°C/W
TO-252-5L ---- 10°C/W

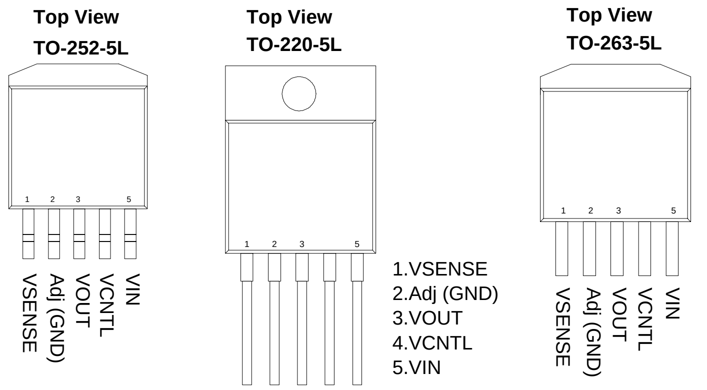
Electrical Specifications

Unless otherwise specified, these specifications apply over, C_{in}=1uF, C_{out}=10uF, and T_j=0 to 150°C.
Typical value refer to T_j=25°C. Vout=Vsense.

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Reference Voltage (Adj only)	V_{REF}	I_O=10mA, T_J=25°C, (V_{IN}-V_{OUT})=0.7V, V_{CNTL}=V_{IN}+1V	1.225	1.25	1.275	V
Line Regulation (Fixed only)		I_O=10mA, V_{OUT}+0.7V<V_{IN}<12V, T_J =25°C, V_{CNTL}=V_{IN}+1V	-	-	0.5	%
Output Voltage	APE1184-12	I_O=10mA, T_J=25°C, 2.2V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	1.176	1.2	1.224	V
	APE1184-15	I_O=10mA, T_J=25°C, 2.2V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	1.47	1.5	1.53	
	APE1184-18	I_O=10mA, T_J=25°C, 2.5V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	1.764	1.8	1.836	
	APE1184-25	I_O=10mA, T_J=25°C, 3.2V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	2.45	2.5	2.55	
	APE1184-33	I_O=10mA, T_J=25°C, 4V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	3.235	3.3	3.365	
	APE1184-50	I_O=10mA, T_J=25°C, 5.7V $\le V_{IN} \le$ 12V, V_{CNTL}=V_{IN}+1V	4.9	5	5.1	
Load Regulation	APE1184	0mA < I_O < 4A, T_J=25°C, (V_{IN}-V_{OUT})=2V, V_{CNTL}=V_{IN}+1V	-	-	1	%
	APE1184-12	V_{IN}=3V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=4V	-	10	12	mV
	APE1184-15	V_{IN}=3V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=4V	-	12	15	
	APE1184-18	V_{IN}=3.3V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=4.3V	-	15	18	
	APE1184-25	V_{IN}=4V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=5V	-	20	25	
	APE1184-33	V_{IN}=5V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=6V	-	26	33	
	APE1184-50	V_{IN}=8V, 0mA < I_O < 4A, T_J=25°C, V_{CNTL}=9V	-	40	50	
Dropout Voltage (V_{CNTL}-V_{OUT})		V_{adj}=0V for all conditions below.				
		V_{IN}=2.05V, I_O=1.5A	-	-	1.15	V
		V_{IN}=2.05V, I_O=3A	-	-	1.25	V
		V_{IN}=2.05V, I_O=4A	-	1.25	1.4	V
Dropout Voltage (V_{IN}-V_{OUT})		V_{adj}=0V for all conditions below.				
		V_{CNTL}=2.75V, I_O=1.5A	-	0.26	0.38	V
		V_{CNTL}=2.75V, I_O=3A	-	0.5	0.6	V
		V_{CNTL}=2.75V, I_O=4A	-	0.7	0.85	V
Current Limit		V_{CNTL}=2.75V, V_{IN}=2.05V, ΔV_o=100mV, V_{adj}=0V	4.2	-	-	A
Minimum Load Current		V_{CNTL}=5V, V_{IN}=3.3V, V_{Adj}=0V	-	5	10	mA
Thermal Regulation		30ms Pulse	-	0.01	0.02	%/W
Ripple Rejection		V_{CNTL}=5V, V_{IN}=5V, IO=4A, V_{adj}=0V, T_J=25, V_{ripple}=1V_{pp} at 120Hz	60	70	-	dB
Control Pin Current		V_{adj}=0V for all conditions below.				
		V_{CNTL}=2.75V, I_O=1.5A	-	6	25	mA
		V_{CNTL}=2.75V, I_O=3A	-	30	60	
		V_{CNTL}=2.75V, I_O=4A	-	33	70	
Adj Pin Current	Iadj	V_{CNTL}=2.75V, V_{IN}=2.05,V_{adj}=0	-	50	150	uA

Pin Configuration

Tab is connected to Vout



Pin Descriptions

	PIN SYMBOL	PIN DESCRIPTION
	VSENSE	This pin is the positive side of the reference which allows remote load sensing to achieve excellent load regulation. A capacitor of at least 10uF must be connected from this pin to ground to ensure stability.
	Adj (Gnd)	A resistor divider from this pin to VOUT and ground sets the output voltage. Connect to GND only for fixed mode.
	VOUT	The output of the regulator. A minimum of 100µF capacitor must be connected from this pin to ground to ensure stability.
	VCTRL	This pin is the supply pin for the internal control circuitry as well as the base drive for the pass transistor. This pin must always be higher than the VOUT pin in order for the device to regulate. (See specifications) A capacitor of at least 100uF capacitor must be connected from this pin to ground to insure stability.
	VIN	The input pin of the regulator. Typically a large storage capacitor is connected from this pin to ground to ensure that the input voltage does not sag below the minimum drop out voltage during the load transient response. This pin must always be higher than VOUT in order for the device to regulate. (See specifications)

Block Diagram

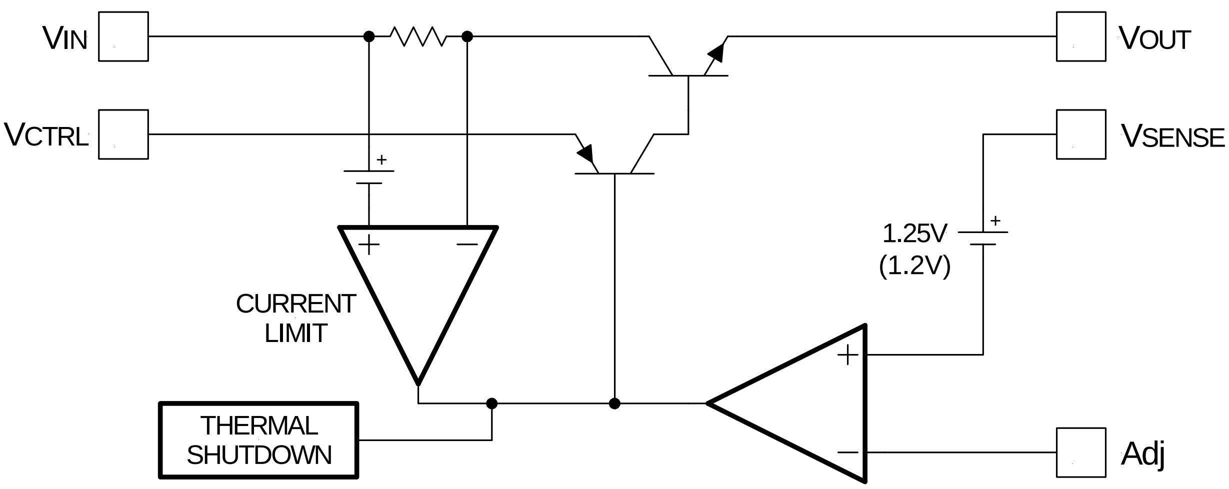


Figure 2 - Simplified block diagram of the APE1184

Function Description

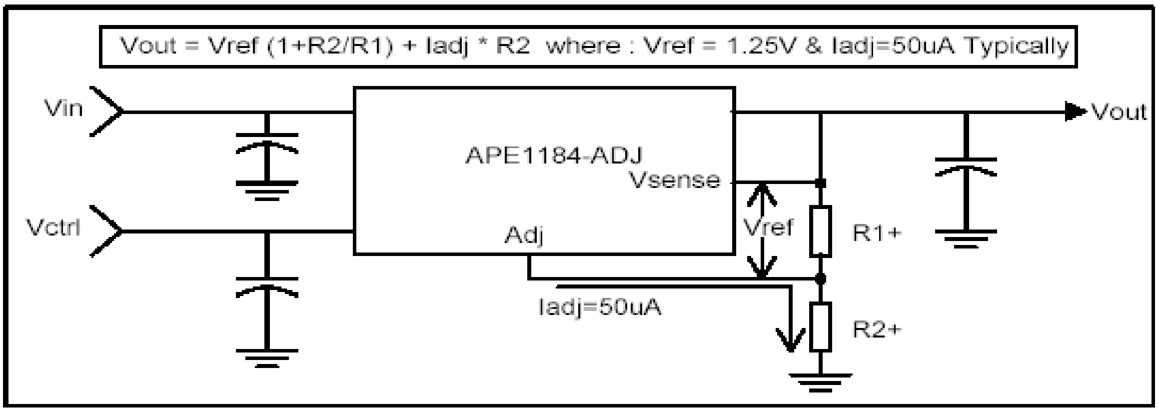
Introduction

The APE1184-HF-3 regulator is a five-terminal device designed specifically to provide extremely low dropout voltages comparable to the PNP type without the disadvantage of the extra power dissipation due to the base current associated with PNP regulators. This is done by bringing out the control pin of the regulator that provides the base current to the power NPN and connecting it to a voltage that is greater than the voltage present at the Vin pin. This flexibility makes the APE1184-HF-3 ideal for applications where dual inputs are available such as a computer motherboard with an ATX style power supply that provides 5V and 3.3V to the board. One such application is the new graphic chip sets that require anywhere from 2.4V to 2.7V supply. The APE1184 can easily be programmed with the addition of two external resistors to any voltage within the range of 1.2V to 15.5V. Another major requirement of these graphic chips is the need to switch the load current from zero to several amps in tens of nanoseconds at the processor pins, which approximately translates to a 300 to 500ns current step at the regulator. In addition, the output voltage tolerances are extremely tight and the transient response is included as part of the specification.

The APE1184 is specifically designed to meet the fast current transient needs as well as providing an accurate initial voltage, reducing the overall system cost with the need for fewer output capacitors. Another feature of the device is its true remote sensing capability allowing accurate voltage setting at the load rather than at the device.

Output Voltage Setting

The APE1184-ADJ can be programmed to any voltage in the range of 1.2V to 15.5V with the addition of R1 and R2 external resistors according to the following formula:

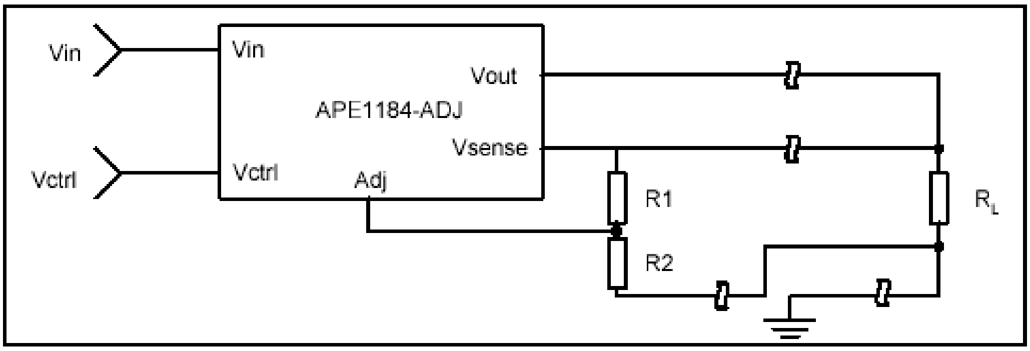


The APE1184-ADJ keeps a constant 1.25V between the Vsense pin and the Adj pin. By placing a resistor R1 across these two pins and connecting the Vsense ans Vout pin together, a constant current flows through R1, adding to the Iadj current and into the R2 resistor producing a voltage equal to the (1.25/R1)*R2 + Iadj*R2. This voltage is then added to the 1.25V to set the output voltage. This is summarized in the above equation. Since the minimum load current requirement of the APE1184-ADJ is 10mA, R1 is typically selected to be a 121Ω resistor so that it automatically satisfies this condition. Notice that since the Iadj is typically in the range of 50uA it only adds a small error to the output voltage and should only be considered when very precise output voltage setting is required.

Function Description (cont.)

Load Regulation

Since the APE1184 has separate pins for the output (Vout) and the sense (Vsense), it is ideal for providing true remote sensing of the output voltage at the load. This means that the voltage drops due to parasitic resistance such as PCB traces between the regulator and the load are compensated for using remote sensing. Figure following shows a typical application of the APE1184-ADJ with remote sensing.

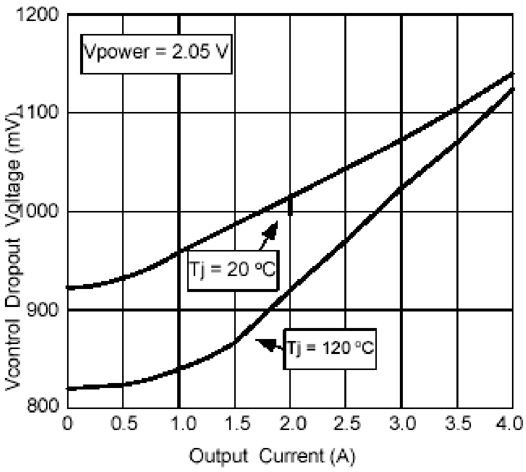


Stability

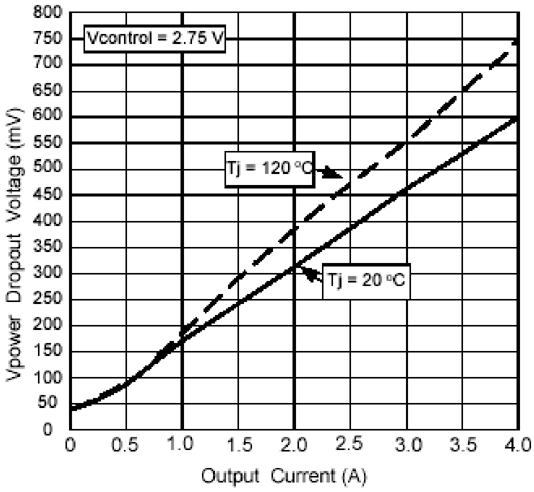
The APE1184-XX requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. Typical designs for the microprocessor applications use standard electrolytic capacitors with typical ESR in the range of 50 to 100mΩ and an output capacitance of 100uF to 1000uF. Fortunately as the capacitance increases, the ESR decreases resulting in a fixed RC time constant. The APE1184-XX takes advantage of this phenomena in making the overall regulator loop stable. For most applications a minimum of 100uF aluminum electrolytic capacitor ensures both stability and good transient response.

Typical Performance Characteristics

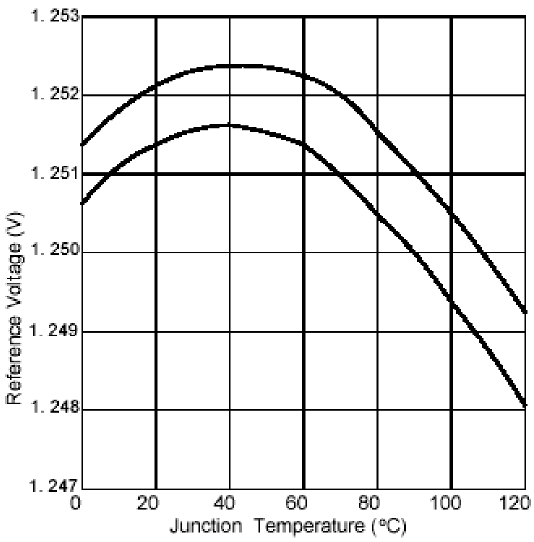
Vcontrol Dropout Voltage vs Output Current



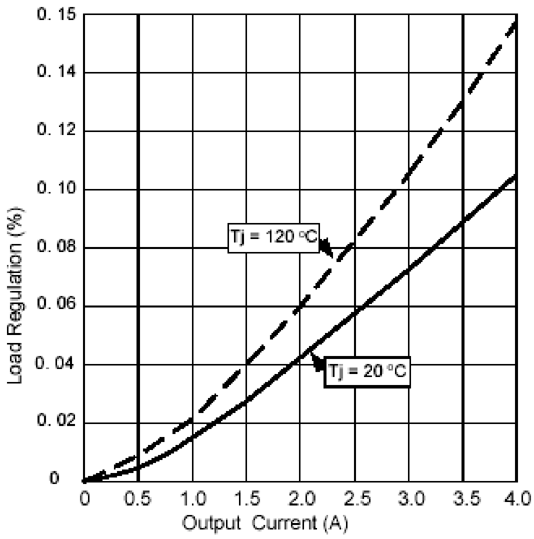
Vpower Dropout Voltage vs Output Current



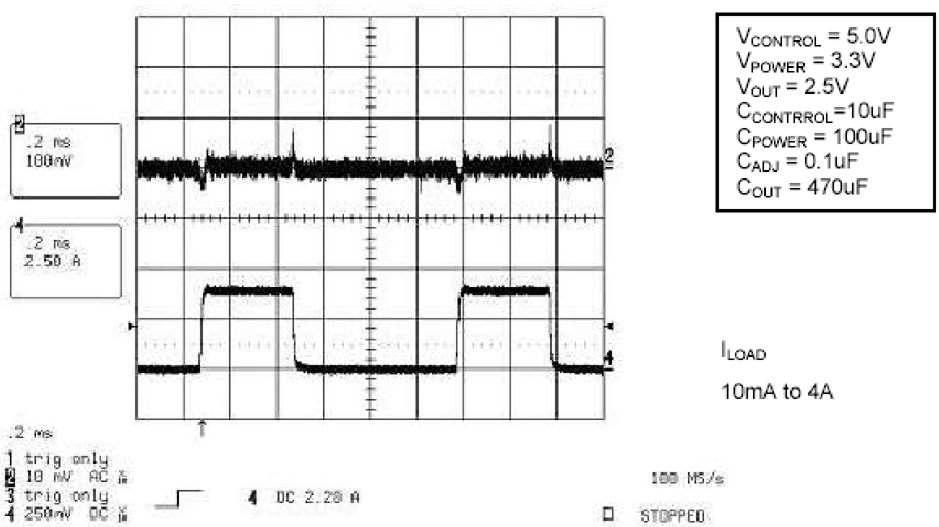
Reference Voltage vs Junction Temperature



Load Regulation vs Output Current

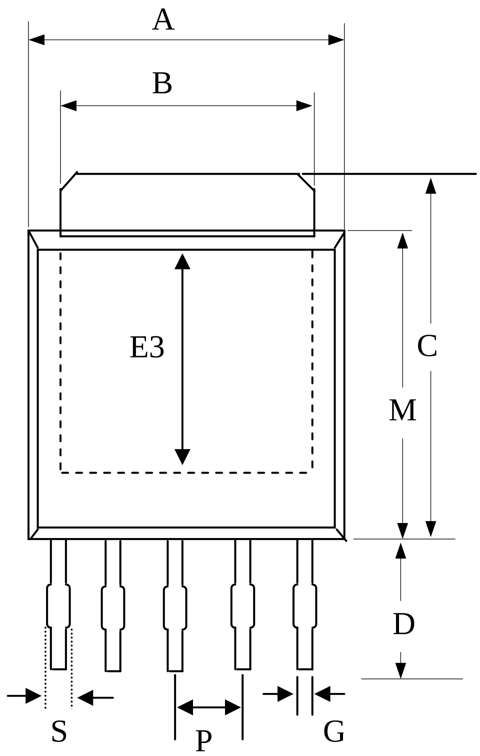


Transient Response

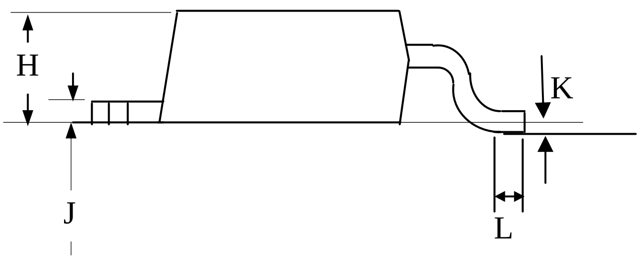


L

Package Dimensions: TO-252-5L

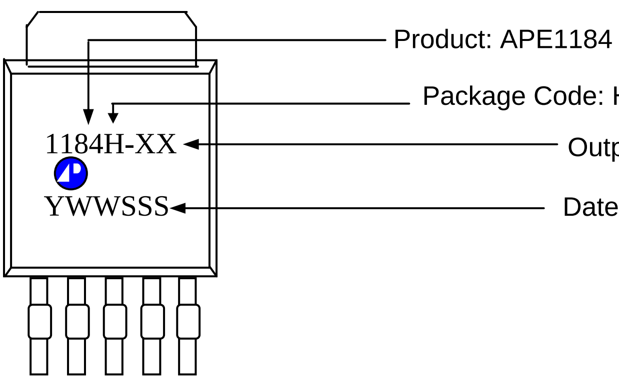


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	6.40	6.6	6.80
B	5.2	5.35	5.50
C	6.80	7.00	7.20
D	2.20	2.50	2.80
P	1.27 REF.		
S	0.50	0.65	0.80
E3	3.50	4.00	4.50
G	0.40	0.50	0.60
H	2.20	2.30	2.40
J	0.45	0.50	0.55
K	0.00	0.075	0.15
L	0.90	1.20	1.50
M	5.40	5.60	5.80



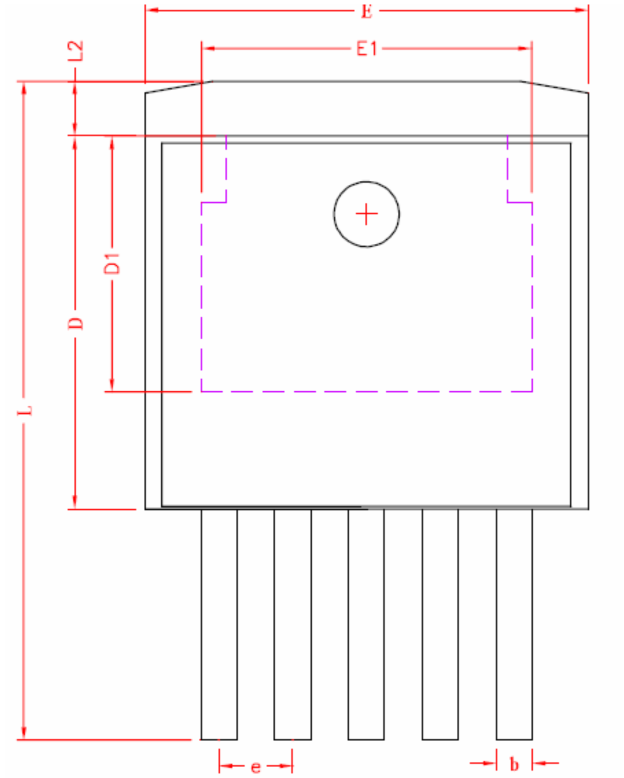
1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information: TO-252-5L

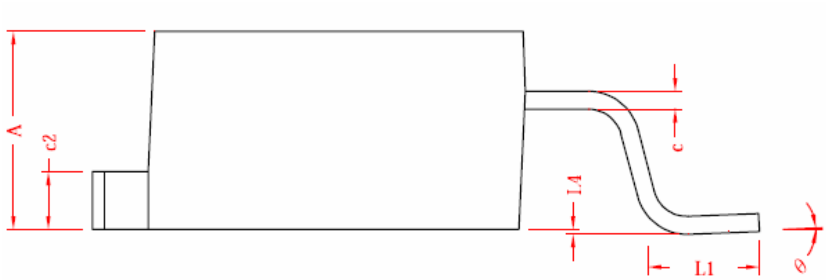


Y: Last digit of the year
WW: Work week
SSS: Lot code sequence

Package Outline: TO-263-5L

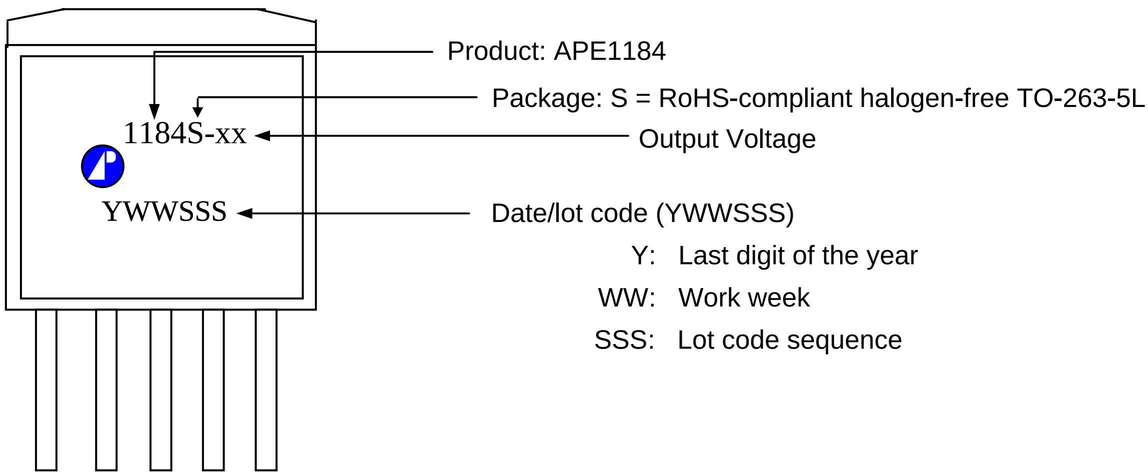


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.40	4.60	4.80
b	0.66	0.79	0.91
L4	0.00	0.15	0.30
c	0.36	0.43	0.50
L1	2.29	2.54	2.79
E	9.80	10.10	10.40
E1		7.60	
c2	1.25	1.35	1.45
L2		1.27	
D	8.60	8.80	9.00
D1		5.90	
e		1.70	
L	14.60	15.20	15.80
θ	0°	4°	8°

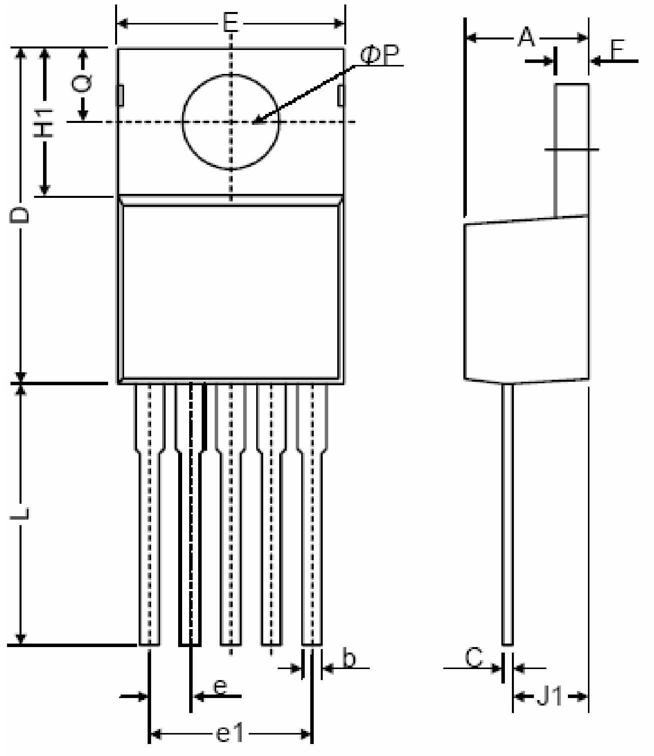


1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information: TO-263-5L



Package Dimensions: TO-220-5L



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.07	4.45	4.82
b	0.76	0.89	1.02
C	0.36	0.50	0.64
D	14.22	14.86	15.50
E	9.78	10.16	10.54
e	1.57	1.71	1.85
e1	6.68	6.81	6.93
F	1.14	1.27	1.40
H1	5.46	6.16	6.86
J1	2.29	2.74	3.18
L	13.21	13.97	14.73
ϕP	3.68	3.81	3.94
Q	2.54	2.73	2.92

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information: TO-220-5L