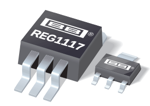
REG1117
REG1117A



SBVS001B – OCTOBER 2001

800mA and 1A Low Dropout Positive Regulator 1.8V, 2.5V, 2.85V, 3.3V, 5V, and Adjustable

FEATURES

- **FIXED AND ADJUSTABLE VERSIONS**
- **2.85V MODEL FOR SCSI-2 ACTIVE TERMINATION**
- **OUTPUT CURRENT:**
  REG1117: 800mA max
  REG1117A: 1A max
- **OUTPUT TOLERANCE: ±1% max**
- **DROPOUT VOLTAGE:**
  REG1117: 1.2V max at I_O = 800mA
  REG1117A: 1.3V max at I_O = 1A
- **INTERNAL CURRENT LIMIT**
- **THERMAL OVERLOAD PROTECTION**
- **SOT-223 AND DDPAK SURFACE-MOUNT PACKAGES**

APPLICATIONS

- **SCSI-2 ACTIVE TERMINATION**
- **HAND-HELD DATA COLLECTION DEVICES**
- **HIGH EFFICIENCY LINEAR REGULATORS**
- **BATTERY POWERED INSTRUMENTATION**
- **BATTERY MANAGEMENT CIRCUITS FOR NOTEBOOK AND PALMTOP PCs**
- **CORE VOLTAGE SUPPLY: FPGA, PLD, DSP, CPU**

DESCRIPTION

The REG1117 is a family of easy-to-use three-terminal voltage regulators. The family includes a variety of fixed- and adjustable-voltage versions, two currents (800mA and 1A) and two package types (SOT-223 and DDPAK). See the chart below for available options.

Output voltage of the adjustable versions is set with two external resistors. The REG1117's low dropout voltage allows its use with as little as 1V input-output voltage differential.

Laser trimming assures excellent output voltage accuracy without adjustment. An NPN output stage allows output stage drive to contribute to the load current for maximum efficiency.

	800mA		1A	
VOLTAGE	SOT-223	DDPAK	SOT-223	DDPAK
1.8V			✔	✔
2.5V			✔	✔
2.85V	✔			
3.3V	✔	✔		
5V	✔			✔
Adj.	✔		✔	✔

PACKAGE/ORDERING INFORMATION

PRODUCT	V_O / I_O	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
800mA Output							
REG1117-2.85	2.85/800mA	SOT223-3	DCY	0°C to +125°C	BB11172	REG1117-2.85	Rails, 80
"	"/"	"		"	"	REG1117-2.85	Tape and Reel, 2500
REG1117-3.3	3.3/800mA	SOT223-3	DCY	0°C to +125°C	BB11174	REG1117-3.3	Rails, 80
"	"/"	"		"	"	REG1117-3.3	Tape and Reel, 2500
REG1117F-3.3	3.3/800mA	DDPAK-3	KTT	0°C to +125°C	BB1117F4	REG1117F-3.3	Rails, 49
"	"/"	"		"	"	REG1117F-3.3	Tape and Reel, 500
REG1117-5	5V/800mA	SOT223-3	DCY	0°C to +125°C	BB11175	REG1117-5	Rails, 80
"	"/"	"		"	"	REG1117-5	Tape and Reel, 2500
REG1117	Adj./800mA	SOT223-3	DCY	0°C to +125°C	BB1117	REG1117	Rails, 80
"	"/"	"		"	"	REG1117	Tape and Reel, 2500
1A Output							
REG1117A-1.8	1.8V/1A	SOT223-3	DCY	0°C to +125°C	R111718	REG1117A-1.8	Rails, 80
"	"/"	"		"	"	REG1117A-1.8	Tape and Reel, 2500
REG1117FA-1.8	1.8/1A	DDPAK-3	KTT	0°C to +125°C	REG1117FA1.8	REG1117FA-1.8	Rails, 49
"	"/"	"		"	"	REG1117FA-1.8	Tape and Reel, 500
REG1117A-2.5	2.5/1A	SOT223-3	DCY	0°C to +125°C	R111725	REG1117A-2.5	Rails, 80
"	"/"	"		"	"	REG1117A-2.5	Tape and Reel, 2500
REG1117FA-2.5	2.5/1A	DDPAK-3	KTT	0°C to +125°C	REG1117FA2.5	REG1117FA-2.5	Rails, 49
"	"/"	"		"	"	REG1117FA-2.5	Tape and Reel, 500
REG1117FA-5	5/1A	DDPAK-3	KTT	0°C to +125°C	REG1117FA5.0	REG1117FA-5.0	Rails, 49
"	"/"	"		"	"	REG1117FA-5.0	Tape and Reel, 500
REG1117A	Adj./1A	SOT223-3	DCY	0°C to +125°C	BB1117A	REG1117A	Rails, 80
"	"/"	"		"	"	REG1117A	Tape and Reel, 2500
REG1117FA	Adj./1A	DDPAK-3	KTT	0°C to +125°C	REG1117FA	REG1117FA	Rails, 49
"	"/"	"		"	"	REG1117FA	Tape and Reel, 500

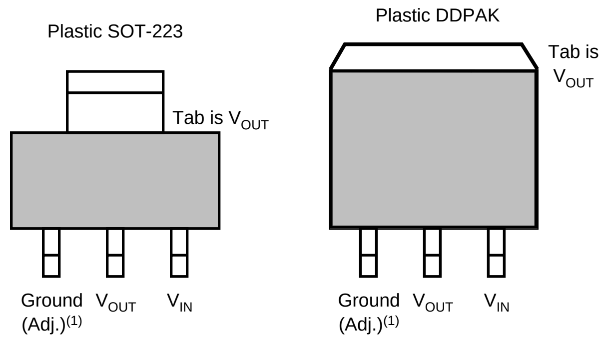
ABSOLUTE MAXIMUM RATINGS(1)

Power Dissipation	Internally Limited
Input Voltage	15V
Operating Junction Temperature Range	0°C to +125°C
Storage Temperature Range	–65°C to +150°C
Lead Temperature (soldering, 10s)(2)	+300°C

NOTE: (1) Stresses above these ratings may cause permanent damage. (2) See "Soldering Methods."

CONNECTION DIAGRAM

Front View



NOTE: (1) Adjustable-Voltage Model.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ELECTRICAL CHARACTERISTICS

At T_J = +25°C, unless otherwise noted.

PARAMETER	CONDITIONS	REG1117, REG1117A MIN	TYP	MAX	UNITS
OUTPUT VOLTAGE					
REG1117-2.85	I_O = 10mA, V_{IN} = 4.85V	2.820	2.85	2.880	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 4.05 to 10V	2.790	2.85	2.910	V
REG1117-3.3	I_O = 10mA, V_{IN} = 5.3V	3.270	3.30	3.330	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 4.8 to 10V	3.240	3.30	3.360	V
REG1117-5	I_O = 10mA, V_{IN} = 7V	4.950	5.00	5.050	V
See Note 1	I_O = 0 to 800mA, V_{IN} = 6.5 to 10V	4.900	5.00	5.100	V
REG1117A-1.8	I_O = 10mA, V_{IN} = 3.8V	1.782	1.8	1.818	V
See Note 1	I_O = 0 to 1A, V_{IN} = 3.8V to 10V	1.764	1.8	1.836	V
REG1117A-2.5	I_O = 10mA, V_{IN} = 4.5V	2.475	2.5	2.525	V
See Note 1	I_O = 0 to 1A, V_{IN} = 4.5V to 10V	2.450	2.5	2.550	V
REG1117A-5	I_O = 10mA, V_{IN} = 7V	4.950	5.0	5.050	V
See Note 1	I_O = 0 to 1A, V_{IN} = 7V to 10V	4.900	5.0	5.100	V
REFERENCE VOLTAGE					
REG1117 (Adjustable)	I_O = 10mA, $V_{IN} – V_O$ = 2V	1.238	1.250	1.262	V
See Note 1	I_O = 10 to 800mA, $V_{IN} – V_O$ = 1.4 to 10V	1.225	1.250	1.280	V
REG1117A (Adjustable)	I_O = 10mA, $V_{IN} – V_O$ = 2V	1.238	1.250	1.262	V
See Note 1	I_O = 10mA to 1A, $V_{IN} – V_O$ = 1.4 to 10V	1.225	1.250	1.280	V
LINE REGULATION					
REG1117-2.85(1)	I_O = 0, V_{IN} = 4.25 to 10V		1	7	mV
REG1117-3.3(1)	I_O = 0, V_{IN} = 4.8 to 10V		2	7	mV
REG1117-5(1)	I_O = 0, V_{IN} = 6.5 to 15V		3	10	mV
REG1117 (Adjustable)(1)	I_O = 10mA, $V_{IN} – V_O$ = 1.5 to 13.75V		0.1	0.4	%
REG1117A (Adjustable)(1)	I_O = 10mA, $V_{IN} – V_O$ = 1.5 to 13.75V		0.1	0.4	%
REG1117A-1.8(1)	I_O = 0, V_{IN} = 3.8V to 10V		1	7	mV
REG1117A-2.5(1)	I_O = 0, V_{IN} = 4.5V to 10V		1	7	mV
REG1117A-5.0(1)	I_O = 0, V_{IN} = 7V to 15V		3	10	mV
LOAD REGULATION					
REG1117-2.85(1)	I_O = 0 to 800mA, V_{IN} = 4.25V		2	10	mV
REG1117-3.3(1)	I_O = 0 to 800mA, V_{IN} = 4.8V		3	12	mV
REG1117-5(1)	I_O = 0 to 800mA, V_{IN} = 6.5V		3	15	mV
REG1117 (Adjustable)(1)(2)	I_O = 10 to 800mA, $V_{IN} – V_O$ = 3V		0.1	0.4	%
REG1117A (Adjustable)(1)(2)	I_O = 10mA to 1A, $V_{IN} – V_O$ = 3V		0.1	0.4	%
REG1117A-1.8	I_O = 0 to 1A, V_{IN} = 3.8V		2	10	mV
REG1117A-2.5	I_O = 0 to 1A, V_{IN} = 4.5V		2	10	mV
REG1117A-5	I_O = 0 to 1A, V_{IN} = 7.0V		3	15	mV
DROPOUT VOLTAGE(3)					
All Models(1)	I_O = 100mA		1.00	1.10	V
See Note 1	I_O = 500mA		1.05	1.15	V
REG1117 Models(1)	I_O = 800mA		1.10	1.20	V
REG1117A	I_O = 1A		1.2	1.30	V
See Note 1	I_O = 1A		1.2	1.55	V
CURRENT LIMIT					
REG1117 Models	$V_{IN} – V_O$ = 5V	800	950	1200	mA
REG1117A	$V_{IN} – V_O$ = 5V	1000	1250	1600	mA
MINIMUM LOAD CURRENT					
Adjustable Models(1)(2)	$V_{IN} – V_O$ = 13.75V		1.7	5	mA
QUIESCENT CURRENT					
Fixed-Voltage Models(1)	$V_{IN} – V_O$ = 5V		4	10	mA
Adjust Pin Current(1)(2)	I_O = 10mA, $V_{IN} – V_O$ = 1.4 to 10V		50	120	µA
vs Load Current, REG1117(1)	I_O = 10mA to 800mA, $V_{IN} – V_O$ = 1.4 to 10V		0.5	5	µA
vs Load Current, REG1117A(1)	I_O = 10mA to 1A, $V_{IN} – V_O$ = 1.4 to 10V		0.5	5	µA
THERMAL REGULATION					
All Models(4)	30ms Pulse		0.01	0.1	%/W
RIPPLE REJECTION					
All Models	f = 120Hz, $V_{IN} – V_{OUT}$ = 3V + 1Vp-p Ripple		62		dB
TEMPERATURE DRIFT					
Fixed-Voltage Models	T_J = 0°C to +125°C		0.5		%
Adjustable Models	T_J = 0°C to +125°C		2		%

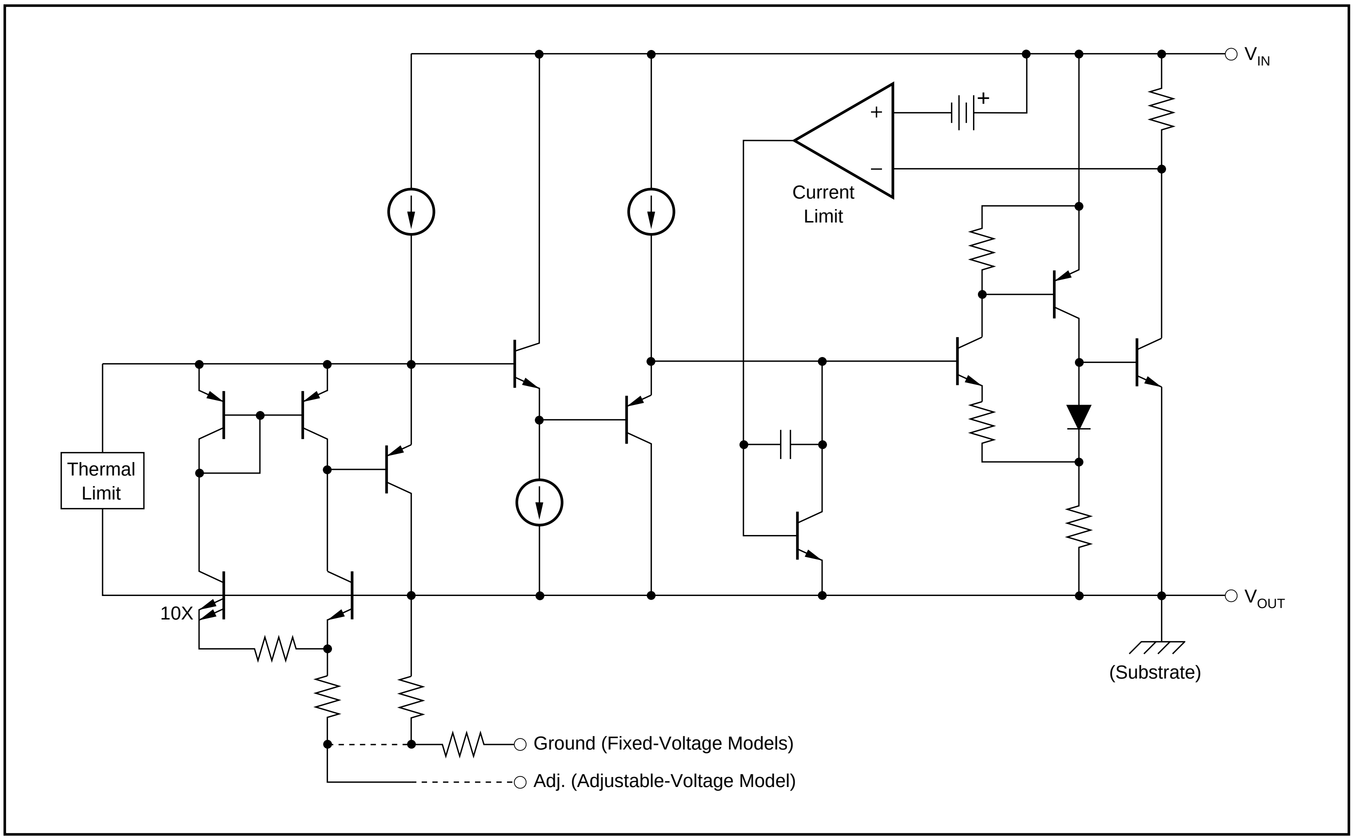
ELECTRICAL CHARACTERISTICS (Cont.)

At T_J = +25°C, unless otherwise noted.

PARAMETER	CONDITIONS	REG1117, REG1117A MIN	TYP	MAX	UNITS
LONG-TERM STABILITY					
All Models	T_A = +125°C, 1000Hr		0.3		%
OUTPUT NOISE					
rms Noise, All Models	f = 10Hz to 10kHz		0.003		%
THERMAL RESISTANCE					
Operating Junction Temperature Range		0		+125	°C
Storage Range		–65		+150	°C
Thermal Resistance, θ_{JC}	(Junction-to-Case at Tab)				
3-Lead SOT-223 Surface-Mount			15		°C/W
3-Lead DDPAK Surface-Mount	f > 50Hz		2		°C/W
	dc		3		°C/W
Thermal Resistance, θ_{JA}	(Junction-to-Case at Tab)				
3-Lead DDPAK Surface-Mount	No Heat Sink		65		°C/W

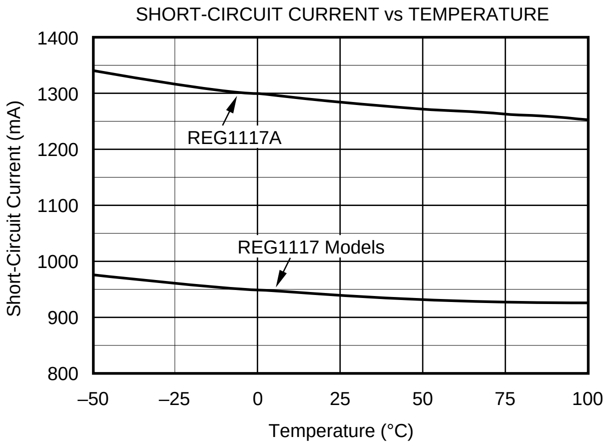
NOTES: (1) Specification applies over the full operating Junction temperature range, 0°C to +125°C. (2) REG1117 and REG1117A adjustable versions require a minimum load current for ±3% regulation. (3) Dropout voltage is the input voltage minus output voltage that produces a 1% decrease in output voltage. (4) Percentage change in unloaded output voltage before versus after a 30ms power pulse of I_O = 800mA (REG1117 models), I_O = 1A (REG1117A), $V_{IN} - V_O$ = 1.4V (Reading taken 10ms after pulse).

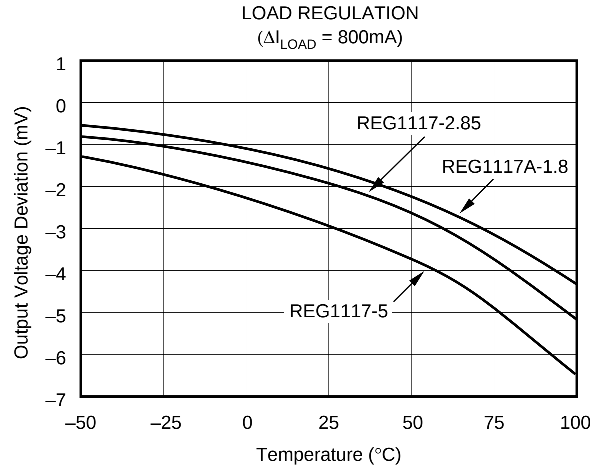
SIMPLIFIED SCHEMATIC

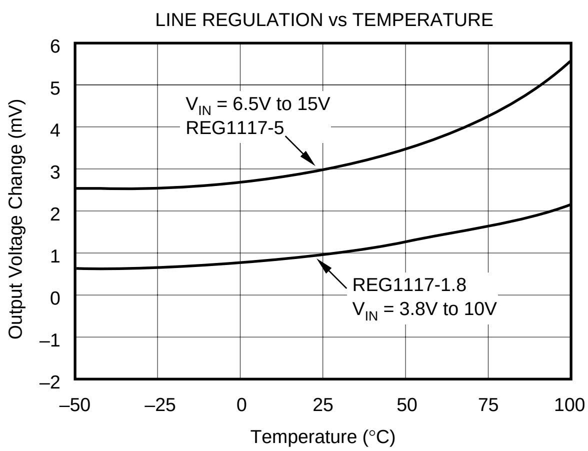


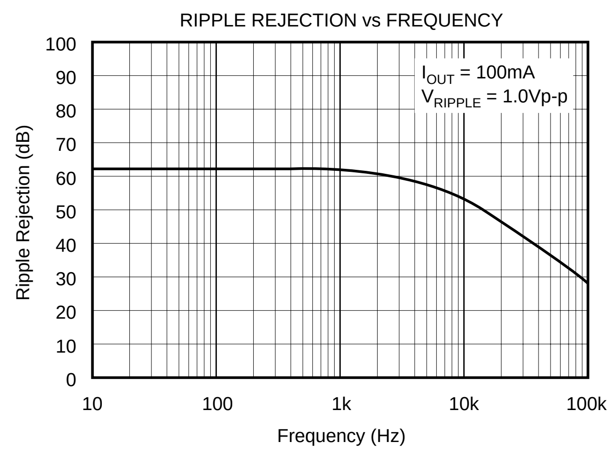
TYPICAL CHARACTERISTICS

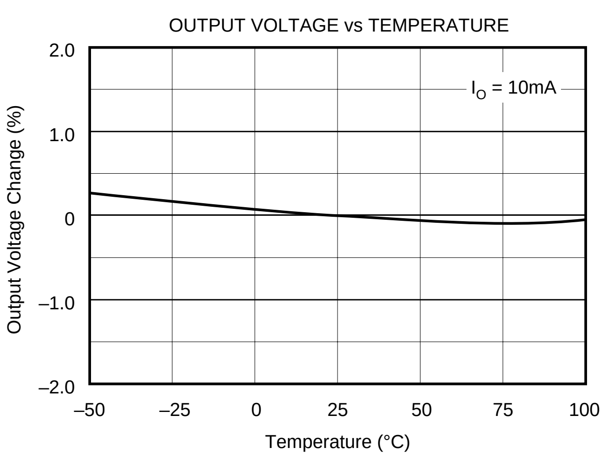
At T_J = +25°C, all models, unless otherwise specified.

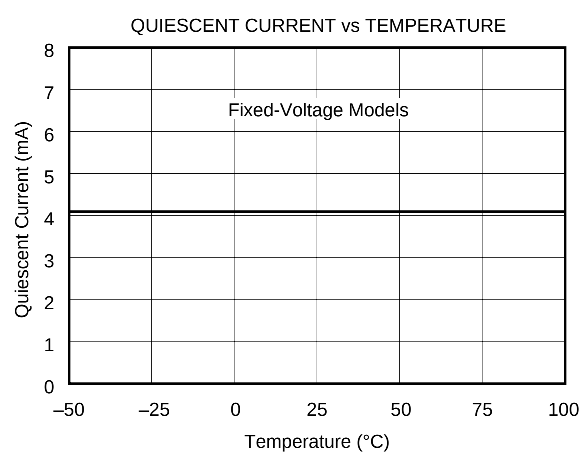




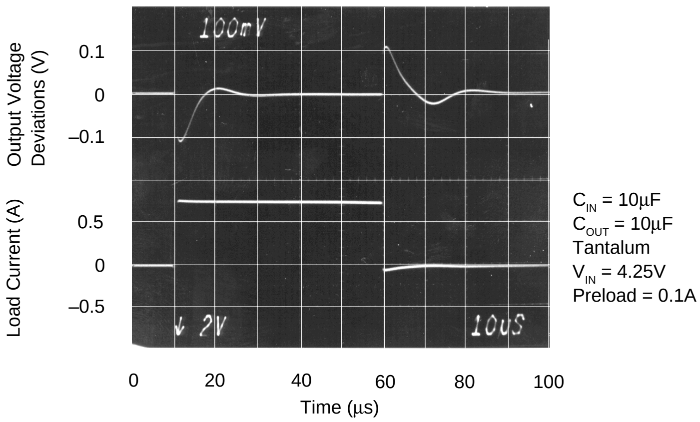




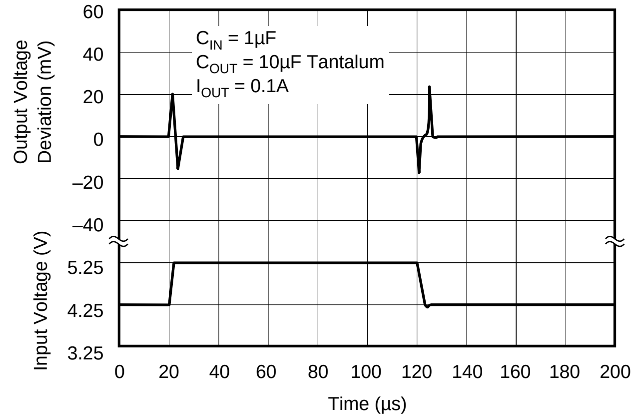




LOAD TRANSIENT RESPONSE



LINE TRANSIENT RESPONSE



APPLICATIONS INFORMATION

Figure 1 shows the basic hookup diagram for fixed-voltage models. All models require an output capacitor for proper operation and to improve high frequency load regulation. A 10µF tantalum capacitor is recommended. Aluminum electrolytic types of 50µF or greater can also be used. A high quality capacitor should be used to assure that the ESR (Effective Series Resistance) is less than 0.5Ω.

Figure 2 shows a hookup diagram for the adjustable voltage model. Resistor values are shown for some commonly used output voltages. Values for other voltages can be calculated from the equation shown in Figure 2. For best load regulation, connect R_1 close to the output pin and R_2 close to the ground side of the load as shown.

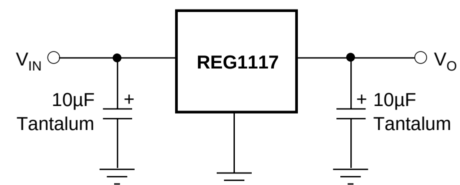
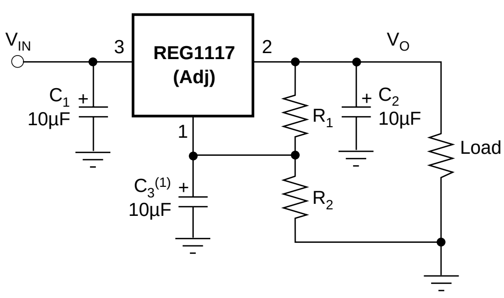


FIGURE 1. Fixed-Voltage Model—Basic Connections.



$$V_O = \frac{R_1 + R_2}{R_1} \bullet (1.25V) + \underline{(50\mu A)\ (R_2)}$$

This term is negligible with proper choice of values—see table at right.

V_{OUT} (V)	R_1 (Ω)(2)	R_2 (Ω)(2)
1.25	Open	Short
1.5	750	147
2.1	158	107
2.85	169	215
3	137	191
3.3	115	187
5	113	340
10	113	787

NOTE: (1) C_3 optional. Improves high-frequency line rejection. (2) Resistors are standard 1% values.

FIGURE 2. Adjustable-Voltage Model—Basic Connections.

THERMAL CONSIDERATIONS

The REG1117 has current limit and thermal shutdown circuits that protect it from overload. The thermal shutdown activates at approximately $T_J = 165°C$. For continuous operation, however, the junction temperature should not be allowed to exceed 125°C. Any tendency to activate the thermal shutdown in normal use is an indication of an inadequate heat sink or excessive power dissipation. The power dissipation is equal to:

$$P_D = (V_{IN} - V_{OUT})\ I_{OUT}$$

The junction temperature can be calculated by:

$$T_J = T_A + P_D\ (\theta_{JA})$$

where T_A is the ambient temperature, and
θ_{JA} is the junction-to-ambient thermal resistance

A simple experiment will determine whether the maximum recommended junction temperature is exceeded in an actual circuit board and mounting configuration: Increase the ambient temperature above that expected in normal operation until the device's thermal shutdown is activated. If this occurs at more than 40°C above the maximum expected ambient temperature, then the T_J will be less than 125°C during normal operation.

The internal protection circuitry of the REG1117 was designed to protect against overload conditions. It was not intended to replace proper heat sinking. Continuously running the REG1117 into thermal shutdown will degrade reliability.

LAYOUT CONSIDERATIONS

The DDPAK (REG1117F-3.3 and REG1117FA) is a surface-mount power package that has excellent thermal characteristics. For best thermal performance, its mounting tab should be soldered directly to a circuit board copper area, as shown in Figure 3. Increasing the copper area improves heat dissipation. Figure 4 shows typical thermal resistance from junction-to-ambient as a function of the copper area.

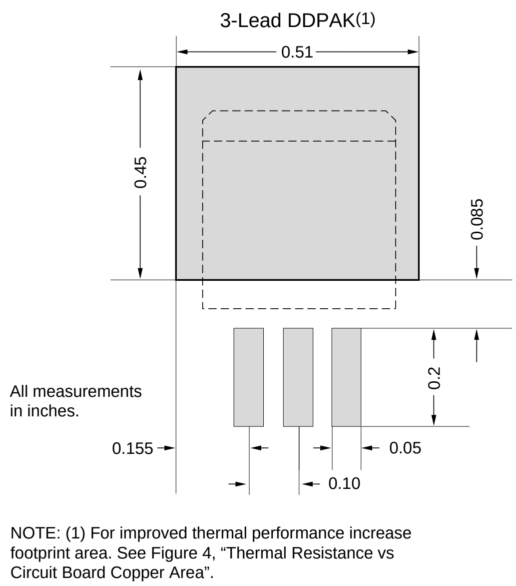
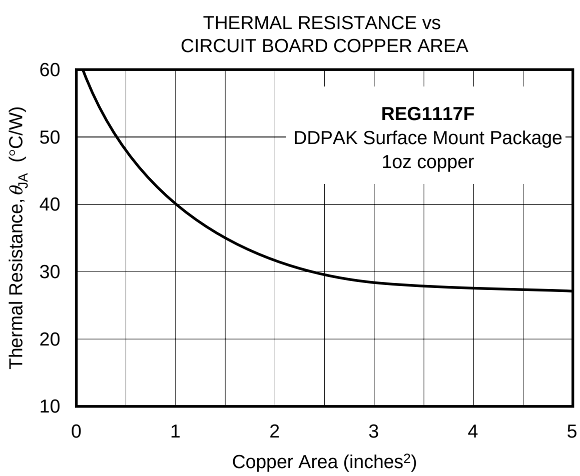


FIGURE 3. DDPAK Thermal Resistance versus Circuit Board Copper Area.



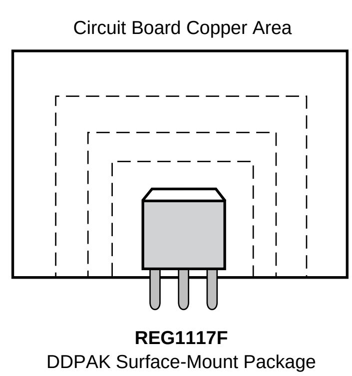


FIGURE 4. DDPAK Thermal Resistance versus Circuit Board Copper Area.

The SOT-223 package derives heat sinking from conduction through its copper leads, especially the large mounting tab. These must be soldered to a circuit board with a substantial amount of copper remaining, as shown in Figure 5. Circuit board traces connecting the tab and the leads should be made as large as practical. The mounting tab of both packages is electrically connected to V_{OUT}.

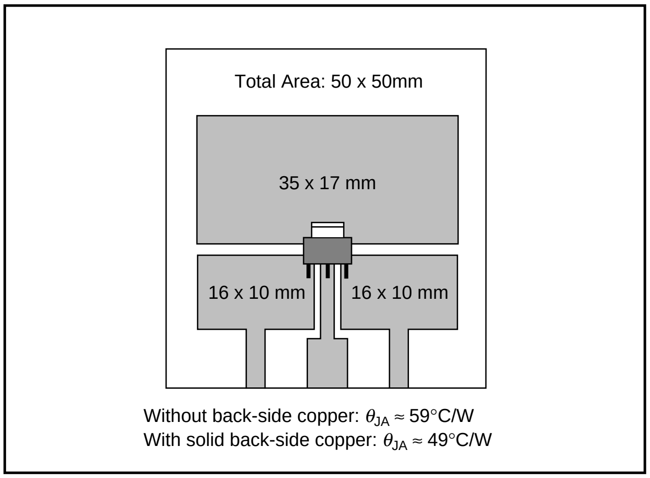


FIGURE 5. SOT-223 Circuit Board Layout Example.

Other nearby circuit traces, including those on the back side of the circuit board, help conduct heat away from the device, even though they may not be electrically connected. Make all nearby copper traces as wide as possible and leave only narrow gaps between traces.

Table I shows approximate values of θ_{JA} for various circuit board and copper areas for the SOT-223 package. Nearby heat dissipating components, circuit board mounting conditions, and ventilation can dramatically affect the actual θ_{JA}. Proper heat sinking significantly increases the maximum power dissipation at a given ambient temperature, as shown in Figure 6.

SOLDERING METHODS

Both REG1117 packages are suitable for infrared reflow and vapor-phase reflow soldering techniques. The high rate of temperature change that occurs with wave soldering, or hand soldering can damage the REG1117.

TOTAL PC BOARD AREA	TOPSIDE(1) COPPER AREA	BACKSIDE COPPER AREA	SOT-223 THERMAL RESISTANCE JUNCTION-TO-AMBIENT
$2500mm^2$	$2500mm^2$	$2500mm^2$	46°C/W
$2500mm^2$	$1250mm^2$	$2500mm^2$	47°C/W
$2500mm^2$	$950mm^2$	$2500mm^2$	49°C/W
$2500mm^2$	$2500mm^2$	0	51°C/W
$2500mm^2$	$1800mm^2$	0	53°C/W
$1600mm^2$	$600mm^2$	$1600mm^2$	55°C/W
$2500mm^2$	$1250mm^2$	0	58°C/W
$2500mm^2$	$915mm^2$	0	59°C/W
$1600mm^2$	$600mm^2$	0	67°C/W
$900mm^2$	$340mm^2$	$900mm^2$	72°C/W
$900mm^2$	$340mm^2$	0	85°C/W

NOTE: (1) Tab is attached to the topside copper.

TABLE I.

INSPEC Abstract Number: B91007604, C91012627
Kelly, E.G. "Thermal Characteristics of Surface 5WK9Ω Packages." The Proceedings of SMTCON. Surface Mount Technology Conference and Exposition: *Competitive Surface Mount Technology*, April 3-6, 1990, Atlantic City, NJ, USA. *Abstract Publisher*: IC Manage, 1990, Chicago, IL, USA.

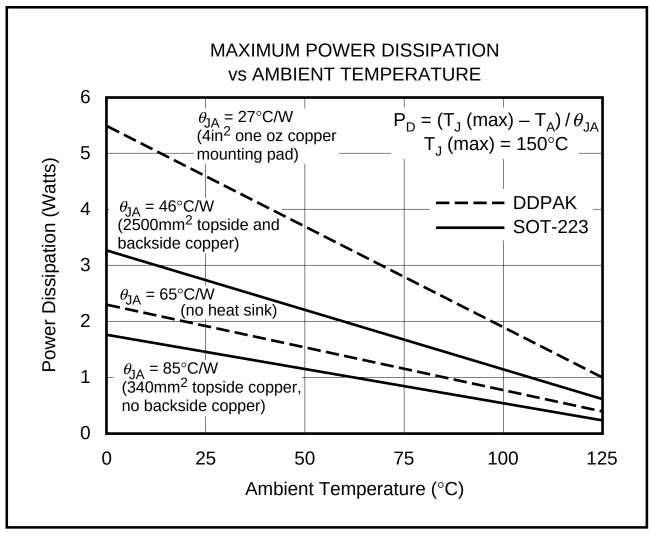


FIGURE 6. Maximum Power Dissipation versus Ambient Temperature.

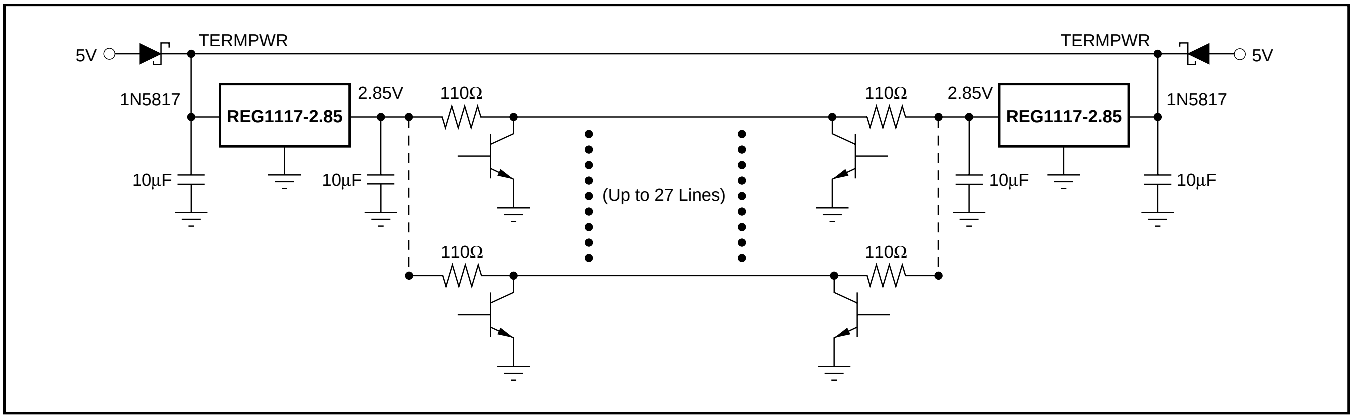


FIGURE 7. SCSI Active Termination Configuration.

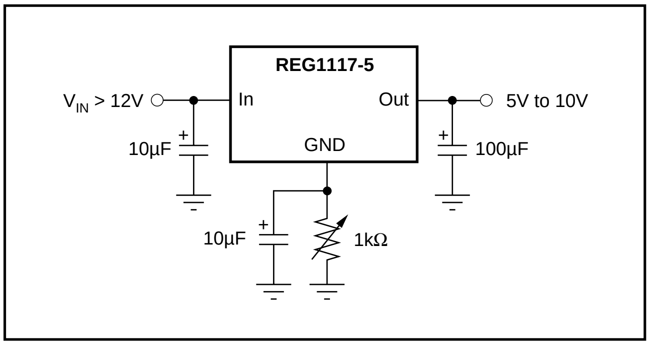


FIGURE 8. Adjusting Output of Fixed Voltage Models.

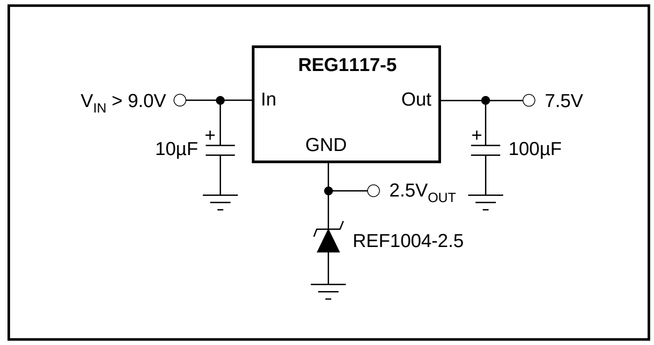


FIGURE 9. Regulator with Reference.

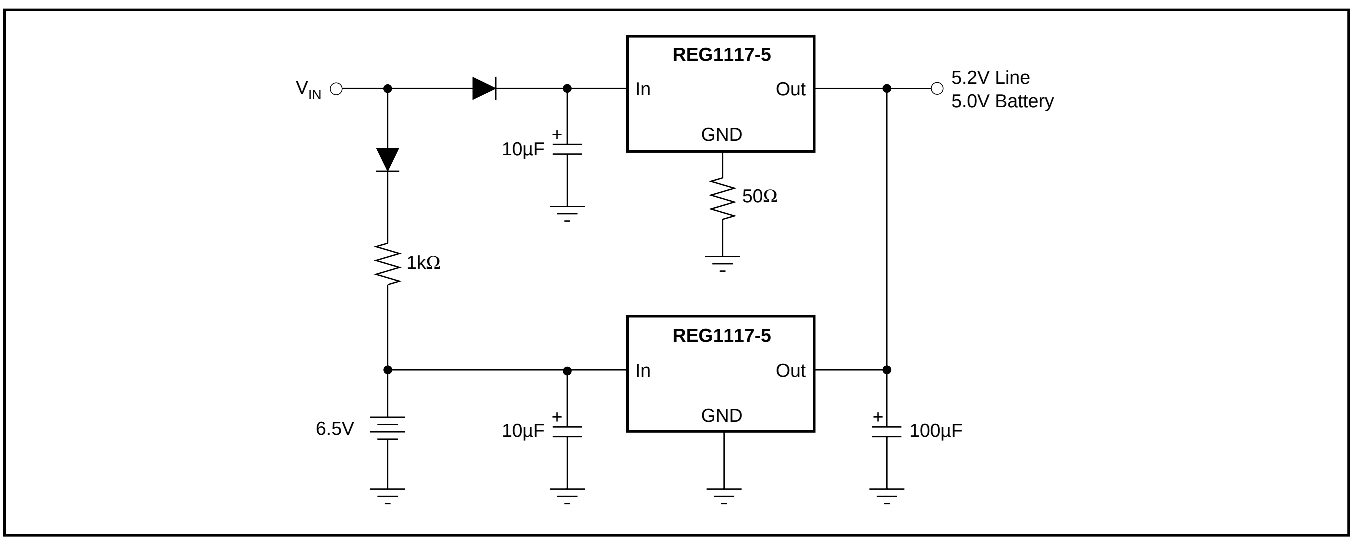


FIGURE 10. Battery Backed-Up Regulated Supply.

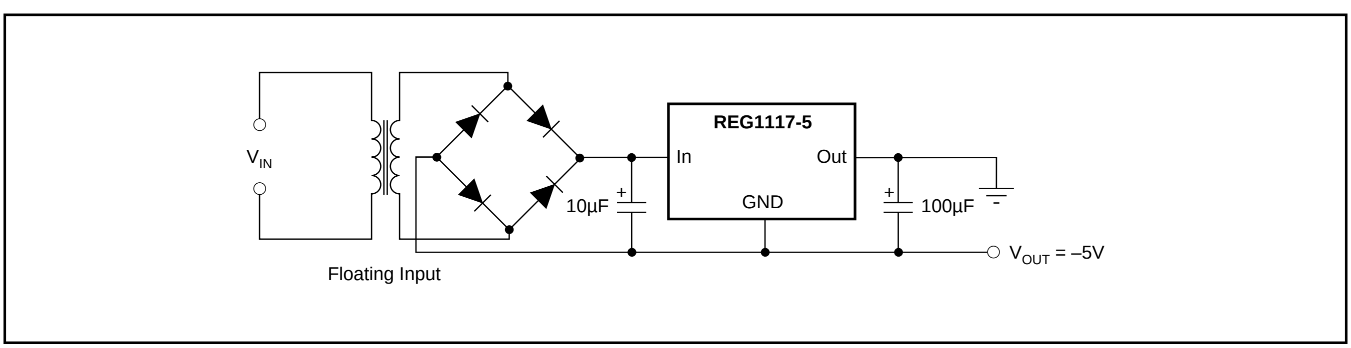
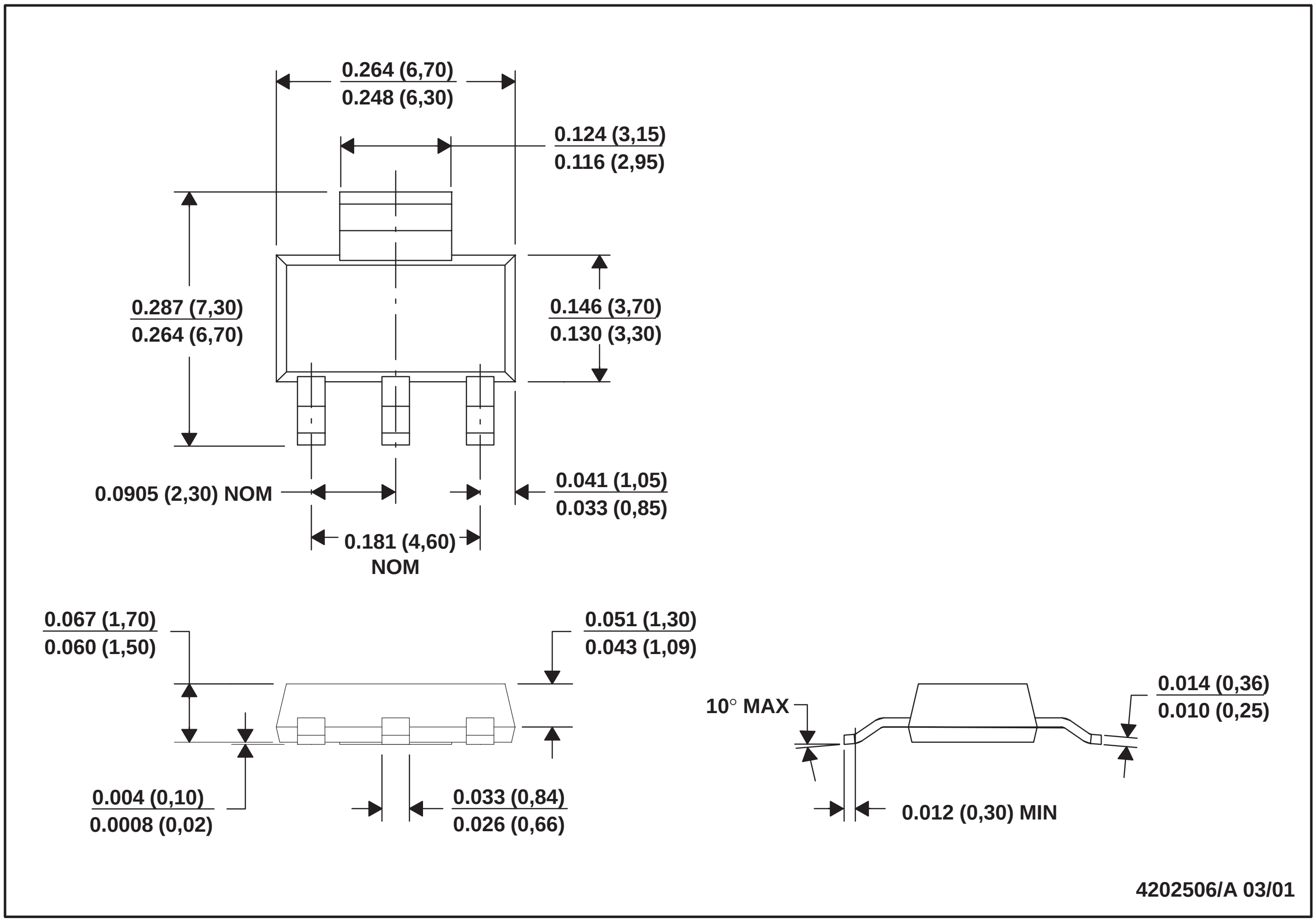


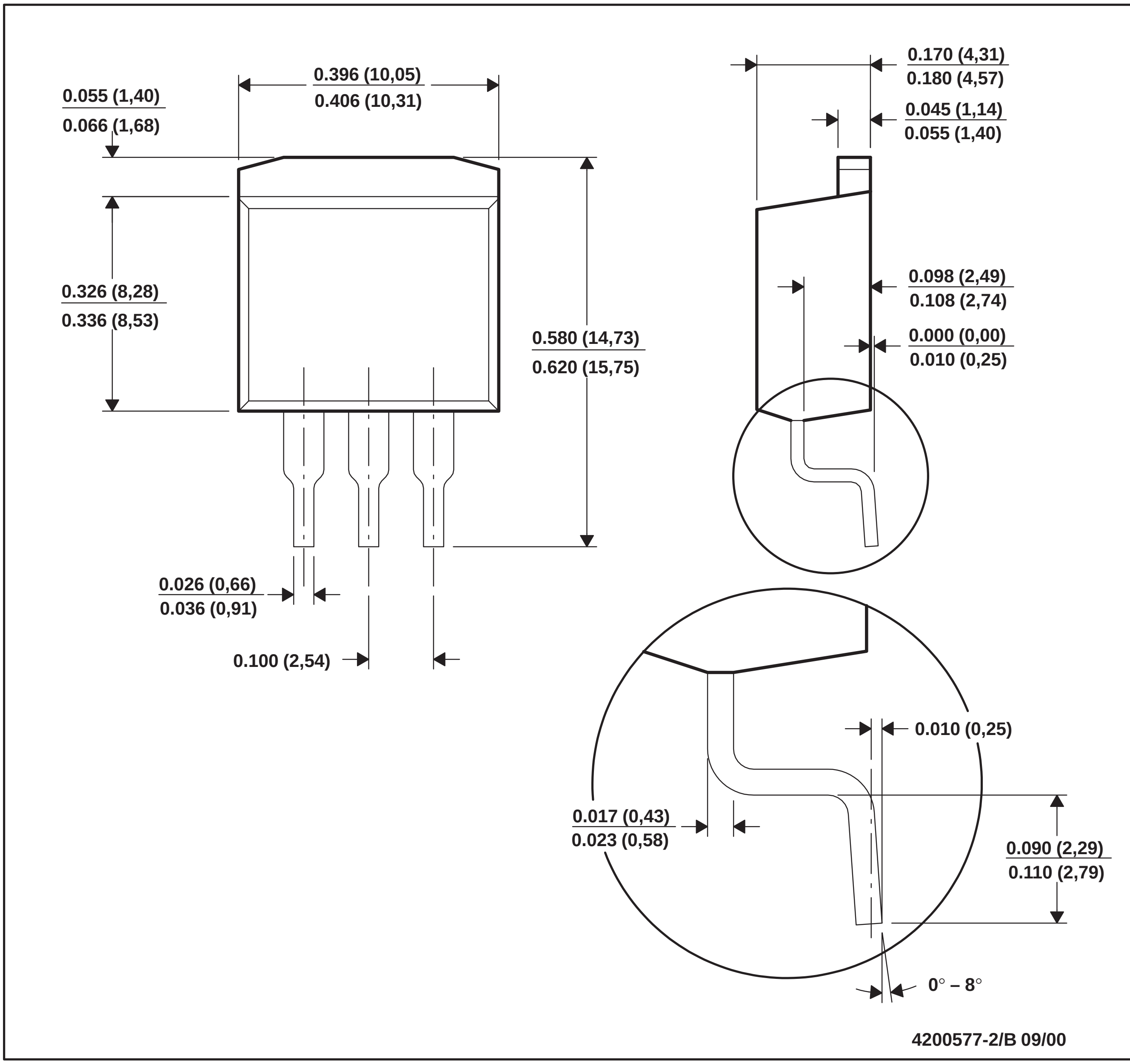
FIGURE 11. Low Dropout Negative Supply.

DCY (R-PDSO-G4) **PLASTIC SMALL-OUTLINE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.

KTT (R-PSFM-G3) **PLASTIC FLANGE-MOUNT**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).

IMPORTANT NOTICE

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