National Semiconductor

November 30, 2010

LM117QML

3-Terminal Adjustable Regulator

General Description

The LM117 series of adjustable 3-terminal positive voltage regulators is capable of supplying either 0.5A or 1.5A over a 1.2V to 37V output range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators.

In addition to higher performance than fixed regulators, the LM117 series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejection ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators, the LM117 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., avoid short-circuiting the output.

Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment pin and output, the LM117 can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

For the negative complement, see LM137 series data sheet.

Features

- Available with Radiation Guarantee
  - — High Dose Rate 100 krad(Si)
  - — ELDRS Free 100 krad(Si)
- Guaranteed max. 0.3% load regulation (LM117)
- Guaranteed 0.5A or 1.5A output current
- Adjustable output down to 1.2V
- Current limit constant with temperature
- 80 dB ripple rejection
- Output is short-circuit protected

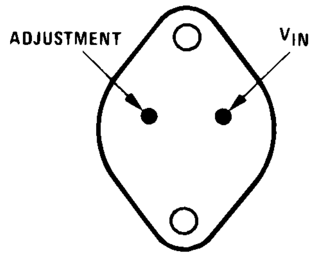
Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM117E/883		E20A	20LD LCC
LM117H/883		H03A	3LD T0–39 Metal Can
LM117HRQMLV (Note 12)	5962R9951703VXA 100 krad(Si)	H03A	3LD T0–39 Metal Can
LM117HRLQMLV (Note 13) ELDRS Free	5962R9951705VXA 100 krad(Si)	H03A	3LD T0–39 Metal Can
LM117K/883		K02C	2LD T0–3 Metal Can
LM117KRQMLV (Note 12)	5962R9951704VYA 100 krad(Si)	K02C	2LD T0–3 Metal Can
LM117WGRQMLV (Note 12)	5962R9951703VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM117WGRLQMLV (Note 13) ELDRS Free	5962R9951705VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM117H MDE (Note 13) ELDRS Free	5962R9951705V9A 100 krad(Si)	(Note 1)	Bare Die
LM117H MDR (Note 12)	5962R9951703V9A 100 krad(Si)	(Note 1)	Bare Die
LM117H MD8		(Note 1)	Bare Die
LM117KG MD8		(Note 1)	Bare Die

Note 1: FOR ADDITIONAL DIE INFORMATION, PLEASE VISIT THE HI REL WEB SITE AT: www.national.com/analog/space/level_die

Connection Diagrams

(TO-3)
Metal Can Package



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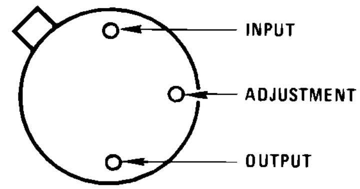
CASE IS OUTPUT

Bottom View
Steel Package
NS Package Number K02C

(TO-39)
Metal Can Package



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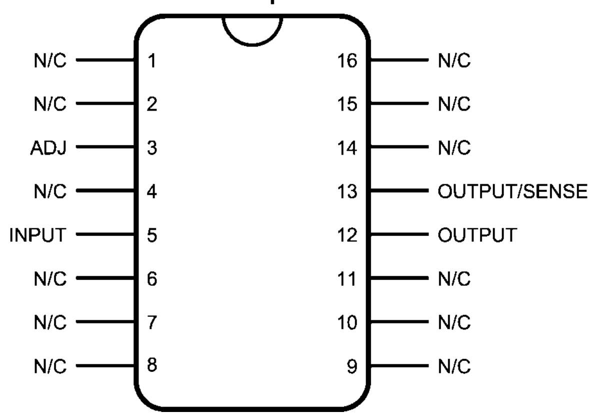
CASE IS OUTPUT

Bottom View
NS Package Number H03A

Ceramic SOIC
Chip Carrier



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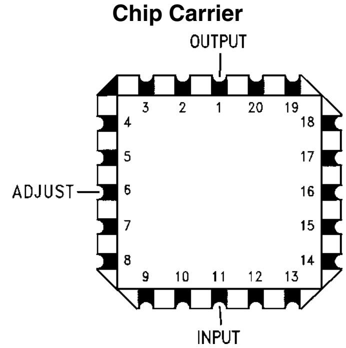
Top View
NS Package Number WG16A
(Note 5)

Ceramic Leadless
Chip Carrier



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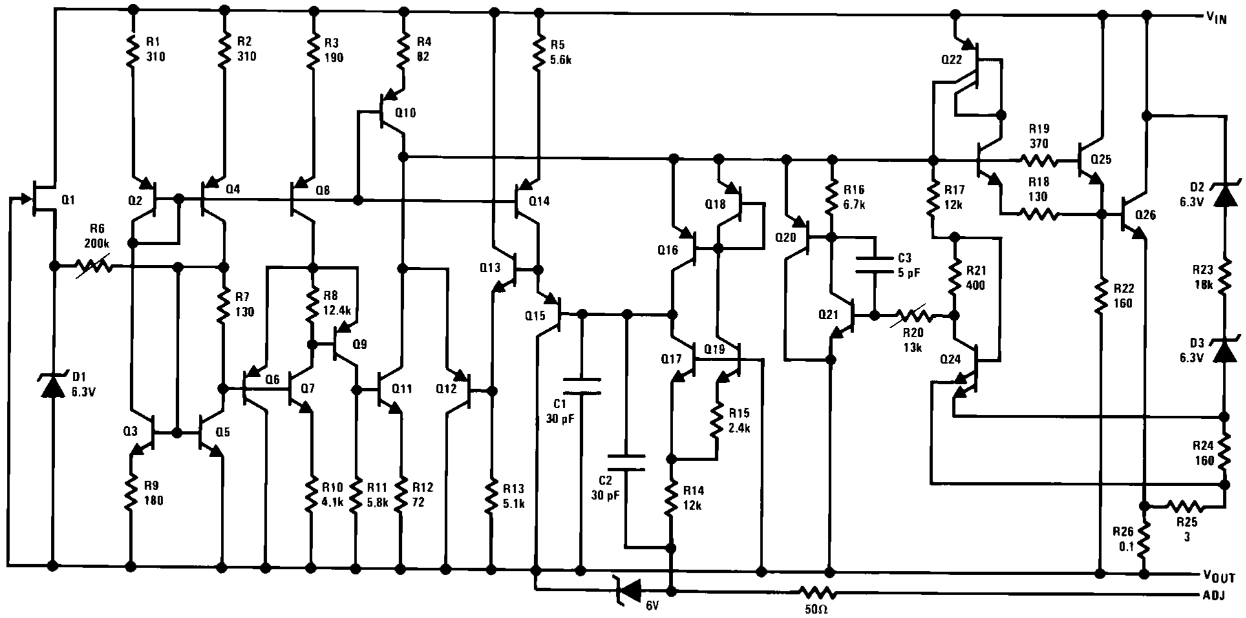
Top View
NS Package Number E20A

LM117 Series Packages

Part Number Suffix	Package	Design Load Current
K	TO-3	1.5A
H	T0–39	0.5A
WG	Ceramic SOIC	0.5A
E	LCC	0.5A

Schematic Diagram



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Absolute Maximum Ratings (Note 2)

Power Dissipation (Note 3)	Internally Limited
Input-Output Voltage Differential	+40V, −0.3V
Storage Temperature	$-65°C \leq T_A \leq +150°C$
Maximum Junction Temperature (T_{Jmax}	+150°C
Lead Temperature Metal Package	300°C
Thermal Resistance	
θ_{JA}	
T0–3 Still Air	39°C/W
T0–3 500LF/Min Air flow	14°C/W
T0–39 Still Air	186°C/W
T0–39 500LF/Min Air flow	64°C/W
Ceramic SOIC Still Air	115°C/W
Ceramic SOIC 500LF/Min Air flow	66°C/W
LCC Still Air	88°C/W
LCC 500LF/Min Air flow	62°C/W
θ_{JC}	
T0–3	1.9°C/W
T0–39 Metal Can	21°C/W
Ceramic SOIC (Note 6)	3.4°C/W
LCC	12°C/W
Package Weight	
T0–39 Metal Can	960mg
SOIC	365mg
ESD Tolerance (Note 4)	3KV

Recommended Operating Conditions

Operating Temperature Range	$-55°C \leq T_A \leq +125°C$
Input Voltage Range	4.25V to 41.25V

Quality Conformance Inspection

MIL-STD-883, Method 5005 - Group A

Subgroup	Description	Temp (°C)
1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55
12	Settling time at	+25
13	Settling time at	+125
14	Settling time at	-55

LM117H & WG Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{Diff} = (V_I - V_O)$, I_L = 8mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjustment Pin Current	V_{Diff} = 3V			100	μA	1
		V_{Diff} = 3.3V			100	μA	2, 3
		V_{Diff} = 40V			100	μA	1, 2, 3
I_Q	Minimum Load Current	V_{Diff} = 3V, V_O = 1.7V			5.0	mA	1
		V_{Diff} = 3.3V, V_O = 1.7V			5.0	mA	2, 3
		V_{Diff} = 40V, V_O = 1.7V			5.0	mA	1, 2, 3
V_{Ref}	Reference Voltage	V_{Diff} = 3V		1.2	1.3	V	1
		V_{Diff} = 3.3V		1.2	1.3	V	2, 3
		V_{Diff} = 40V		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	3V ≤ V_{Diff} ≤ 40V, V_O = 1.2V		-8.9	8.9	mV	1
		3.3V ≤ V_{Diff} ≤ 40V, V_O = 1.2V		-22.2	22.2	mV	2, 3
V_{RLoad}	Load Regulation	V_{Diff}= 3V, I_L = 10mA to 500mA		-15	15	mV	1
		V_{Diff}= 3.3V, I_L = 10mA to 500mA		-15	15	mV	2, 3
		V_{Diff}= 40V, I_L = 10mA to 150mA		-15	15	mV	1
		V_{Diff}= 40V, I_L = 10mA to 100mA		-15	15	mV	2, 3
ΔI_{Adj} / Load	Adjustment Current Change	V_{Diff} = 3V, I_L = 10mA to 500mA		-5.0	5.0	μA	1
		V_{Diff} = 3.3V, I_L = 10mA to 500mA		-5.0	5.0	μA	2, 3
		V_{Diff} = 40V, I_L = 10mA to 150mA		-5.0	5.0	μA	1
		V_{Diff} = 40V, I_L = 10mA to 100mA		-5.0	5.0	μA	2, 3
ΔI_{Adj} / Line	Adjustment Current Change	3V ≤ V_{Diff} ≤ 40V		-5.0	5.0	μA	1
		3.3V ≤ V_{Diff} ≤ 40V		-5.0	5.0	μA	2, 3
I_{OS}	Short Circuit Current	V_{Diff} = 10V		0.45	1.6	A	1
θ_R	Thermal Regulation	T_A = 25°C, t = 20mS, V_{Diff} = 40V, I_L = 150mA		-6.0	6.0	mV	1
I_{CL}	Current Limit	V_{Diff} ≤ 15V	(Note 7)	0.5		A	1, 2, 3
		V_{Diff} = 40V	(Note 7)	0.15		A	1

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
RR	Ripple Rejection	V_I = +6.25V, V_O = V_{Ref}, f= 120Hz, e_I = 1V_{RMS}, I_L = 125mA	(Note 8)	66		dB	4, 5, 6

LM117K Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{Diff} = (V_I – V_O)$, $I_L = 10mA$

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjustment Pin Current	$V_{Diff} = 3V$			100	µA	1
		$V_{Diff} = 3.3V$			100	µA	2, 3
		$V_{Diff} = 40V$			100	µA	1, 2, 3
I_Q	Minimum Load Current	$V_{Diff} = 3V$, $V_O = 1.7V$			5.0	mA	1
		$V_{Diff} = 3.3V$, $V_O = 1.7V$			5.0	mA	2, 3
		$V_{Diff} = 40V$, $V_O = 1.7V$			5.0	mA	1, 2, 3
V_{Ref}	Reference Voltage	$V_{Diff} = 3V$		1.2	1.3	V	1
		$V_{Diff} = 3.3V$		1.2	1.3	V	2, 3
		$V_{Diff} = 40V$		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	$3V \le V_{Diff} \le 40V$, $V_O = 1.2V$		-8.9	8.9	mV	1
		$3.3V \le V_{Diff} \le 40V$, $V_O = 1.2V$		-22.2	22.2	mV	2, 3
V_{RLoad}	Load Regulation	$V_{Diff}= 3V$, $I_L = 10mA$ to $1.5A$		-15	15	mV	1
		$V_{Diff}= 3.3V$, $I_L = 10mA$ to $1.5A$		-15	15	mV	2, 3
		$V_{Diff}= 40V$, $I_L = 10mA$ to $300mA$		-15	15	mV	1
		$V_{Diff}= 40V$, $I_L = 10mA$ to $195mA$		-15	15	mV	2, 3
ΔI_{Adj} / Load	Adjustment Current Change	$V_{Diff} = 3V$, $I_L = 10mA$ to $1.5A$		-5.0	5.0	µA	1
		$V_{Diff} = 3.3V$, $I_L = 10mA$ to $1.5A$		-5.0	5.0	µA	2, 3
		$V_{Diff} = 40V$, $I_L = 10mA$ to $300mA$		-5.0	5.0	µA	1
		$V_{Diff} = 40V$, $I_L = 10mA$ to $195mA$		-5.0	5.0	µA	2, 3
ΔI_{Adj} / Line	Adjustment Current Change	$3V \le V_{Diff} \le 40V$		-5.0	5.0	µA	1
		$3.3V \le V_{Diff} \le 40V$		-5.0	5.0	µA	2, 3
I_{OS}	Short Circuit Current	$V_{Diff} = 10V$		1.6	3.4	A	1
θ_R	Thermal Regulation	$T_A = 25°C$, $t = 20mS$, $V_{Diff} = 40V$, $I_L = 300mA$		-10.5	10.5	mV	1
I_{CL}	Current Limit	$V_{Diff} \le 15V$	(Note 7)	1.5		A	1, 2, 3
		$V_{Diff} = 40V$	(Note 7)	0.3		A	1

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
RR	Ripple Rejection	$V_I = +6.25V$, $V_O = V_{Ref}$, $f = 120Hz$, $e_I = 1V_{RMS}$, $I_L = 0.5A$	(Note 8)	66		dB	4, 5, 6

LM117E Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{Diff} = (V_I - V_O)$, $I_L = 8mA$, $P_D \leq 1.5W$

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjustment Pin Current	$V_{Diff} = 3V$			100	µA	1
		$V_{Diff} = 3.3V$			100	µA	2, 3
		$V_{Diff} = 40V$			100	µA	1, 2, 3
I_Q	Minimum Load Current	$V_{Diff} = 3V$, $V_O = 1.7V$			5.0	mA	1
		$V_{Diff} = 3.3V$, $V_O = 1.7V$			5.0	mA	2, 3
		$V_{Diff} = 40V$, $V_O = 1.7V$			5.0	mA	1, 2, 3
V_{Ref}	Reference Voltage	$V_{Diff} = 3V$		1.2	1.3	V	1
		$V_{Diff} = 3.3V$		1.2	1.3	V	2, 3
		$V_{Diff} = 40V$		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	$3V \leq V_{Diff} \leq 40V$, $V_O = 1.2V$		-8.9	8.9	mV	1
		$3.3V \leq V_{Diff} \leq 40V$, $V_O = 1.2V$		-22.2	22.2	mV	2, 3
V_{RLoad}	Load Regulation	$V_{Diff} = 3V$, $I_L = 10mA$ to $100mA$		-15	15	mV	1
		$V_{Diff} = 3.3V$, $I_L = 10mA$ to $100mA$		-15	15	mV	2, 3
		$V_{Diff} = 40V$, $I_L = 10mA$ to $100mA$		-15	15	mV	1,2
				–25	25	mV	3
		$V_{Diff} = 3V$, $I_L = 10mA$ to $500mA$		-15	15	mV	1
		$V_{Diff} = 3.3V$, $I_L = 10mA$ to $500mA$		-15	15	mV	2, 3
ΔI_{Adj} / Load	Adjustment Current Change	$V_{Diff} = 3V$, $I_L = 10mA$ to $500mA$		-5.0	5.0	µA	1
		$V_{Diff} = 3.3V$, $I_L = 10mA$ to $500mA$		-5.0	5.0	µA	2, 3
		$V_{Diff} = 40V$, $I_L = 10mA$ to $100mA$		-5.0	5.0	µA	1, 2, 3
ΔI_{Adj} / Line	Adjustment Current Change	$3V \leq V_{Diff} \leq 40V$		-5.0	5.0	µA	1
		$3.3V \leq V_{Diff} \leq 40V$		-5.0	5.0	µA	2, 3
I_{OS}	Short Circuit Current	$V_{Diff} = 10V$		0.45	1.6	A	1
θ_R	Thermal Regulation	$T_A = 25°C$, $t = 20mS$, $V_{Diff} = 40V$, $I_L = 75mA$		-6.0	6.0	mV	1
I_{CL}	Current Limit	$V_{Diff} \leq 15V$	(Note 7)	0.5		A	1, 2, 3
		$V_{Diff} = 40V$	(Note 7)	0.15		A	1

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
RR	Ripple Rejection	$V_I = +6.25V$, $V_O = V_{Ref}$, $f = 120Hz$, $e_I = 1V_{RMS}$, $I_L = 100mA$, $C_{Adj} = 10µf$	(Note 8)	66		dB	4, 5, 6

LM117H & WG RH Electrical Characteristics

DC Parameters (Note 12, Note 13)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		1.2	1.3	V	1, 2, 3
		V_I = 4.25V, I_L = -500mA		1.2	1.3	V	1, 2, 3
		V_I = 41.25V, I_L = -5mA		1.2	1.3	V	1, 2, 3
		V_I = 41.25V, I_L = -50mA		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-9.0	9.0	mV	1
				-23	23	mV	2,3
V_{RLoad}	Load Regulation	V_I = 6.25V, -500mA ≤ I_L ≤ -5mA		-12	12	mV	1, 2, 3
		V_I = 41.25V, -50mA ≤ I_L ≤ -5mA		-12	12	mV	1, 2, 3
V_{RTh}	Thermal Regulation	V_I = 14.6V, I_L = -500mA		-12	12	mV	1
I_{Adj}	Adjust Pin Current	V_I = 4.25V, I_L = -5mA		-100	-15	µA	1, 2, 3
		V_I = 41.25V, I_L = -5mA		-100	-15	µA	1, 2, 3
ΔI_{Adj}/ Line	Adjust Pin Current Change	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-5.0	5.0	µA	1, 2, 3
ΔI_{Adj} / Load	Adjust Pin Current Change	V_I = 6.25V, -500mA ≤ I_L ≤ -5mA		-5.0	5.0	µA	1, 2, 3
I_Q	Minimum Load Current	V_I = 4.25V, Forced V_O = 1.4V		-3.0	-0.5	mA	1, 2, 3
		V_I = 14.25V, Forced V_O = 1.4V		-3.0	-0.5	mA	1, 2, 3
		V_I = 41.25V, Forced V_O = 1.4V		-5.0	-1.0	mA	1, 2, 3
I_{OS}	Output Short Circuit Current	V_I = 4.25V		-1.8	-0.5	A	1, 2, 3
		V_I = 40V		-0.5	-0.05	A	1, 2, 3
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 2.5Ω, C_L = 20µF		1.2	1.3	V	1, 2, 3
		V_I = 40V, R_L = 250Ω		1.2	1.3	V	1, 2, 3
V_O	Output Voltage	V_I = 6.25V, I_L = -5mA	(Note 9)	1.2	1.3	V	2
V_{Start}	Voltage Start-Up	V_I = 4.25V, R_L = 2.5Ω, C_L = 20µF, I_L = -500mA		1.2	1.3	V	1, 2, 3

AC Parameters (Note 12, Note 13)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub - groups
V_{NO}	Output Noise Voltage	V_I = 6.25V, I_L = -50mA			120	μV_{RMS}	7
$\Delta V_O / \Delta V_I$	Line Transient Response	V_I = 6.25V, ΔV_I = 3V, I_L = -10mA			6.0	mV/V	7
$\Delta V_O / \Delta I_L$	Load Transient Response	V_I = 6.25V, ΔI_L = -200mA, I_L = -50mA			0.6	mV/mA	7
$\Delta V_I / \Delta V_O$	Ripple Rejection	V_I = 6.25V, I_L = -125mA, E_I = 1V_{RMS} at f = 2400Hz		65		dB	4

DC Drift Parameters

The following conditions apply, unless otherwise specified.
Deltas performed on QMLV devices at Group B, Subgroup 5, only.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		-0.01	0.01	V	1
		V_I = 4.25V, I_L = -500mA		-0.01	0.01	V	1
		V_I = 41.25V, I_L = -5mA		-0.01	0.01	V	1
		V_I = 41.25V, I_L = -50mA		-0.01	0.01	V	1
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-4.0	4.0	mV	1
I_{Adj}	Adjust Pin Current	V_I = 4.25V, I_L = -5mA		-10	10	μA	1
		V_I = 41.25V, I_L = -5mA		-10	10	μA	1
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 2.5Ω, C_L = 20μf		-0.01	0.01	V	1
		V_I = 40V, R_L = 250Ω		-0.01	0.01	V	1

AC/DC Post Radiation Limits @ +25°C (Note 12, Note 13)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		1.2	1.350	V	1
		V_I = 4.25V, I_L = -500mA		1.2	1.350	V	1
		V_I = 41.25V, I_L = -5mA		1.2	1.350	V	1
		V_I = 41.25V, I_L = -50mA		1.2	1.350	V	1
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-25	25	mV	1
$\Delta V_I / \Delta V_O$	Ripple Rejection	V_I = 6.25V, I_L = -125mA E_I = 1V_{RMS} at f = 2400Hz		60		dB	4
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 2.5Ω, C_L = 20μf		1.20	1.350	V	1
		V_I = 40V, R_L = 250Ω		1.20	1.350	V	1

LM117K RH Electrical Characteristics

DC Parameters (Note 12)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		1.2	1.3	V	1, 2, 3
		V_I = 4.25V, I_L = -1.5A		1.2	1.3	V	1, 2, 3
		V_I = 41.25V, I_L = -5mA		1.2	1.3	V	1, 2, 3
		V_I = 41.25V, I_L = -200mA		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-9.0	9.0	mV	1
				-23	23	mV	2,3
V_{RLoad}	Load Regulation	V_I = 6.25V, -1.5A ≤ I_L ≤ -5mA		-3.5	3.5	mV	1
				-12	12	mV	2, 3
		V_I = 41.25V, -200mA ≤ I_L ≤ -5mA		-3.5	3.5	mV	1
				-12	12	mV	2, 3
V_{RTh}	Thermal Regulation	V_I = 14.6V, I_L = -1.5A		-12	12	mV	1
I_{Adj}	Adjust Pin Current	V_I = 4.25V, I_L = -5mA		-100	-15	µA	1, 2, 3
		V_I = 41.25V, I_L = -5mA		-100	-15	µA	1, 2, 3
ΔI_{Adj}/ Line	Adjust Pin Current Change	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-5.0	5.0	µA	1, 2, 3
ΔI_{Adj} / Load	Adjust Pin Current Change	V_I = 6.25V, -1.5A ≤ I_L ≤ -5mA		-5.0	5.0	µA	1, 2, 3
I_Q	Minimum Load Current	V_I = 4.25V, Forced V_O = 1.4V		-3.0	-0.2	mA	1, 2, 3
		V_I = 14.25V, Forced V_O = 1.4V		-3.0	-0.2	mA	1, 2, 3
		V_I = 41.25V, Forced V_O = 1.4V		-5.0	-0.2	mA	1, 2, 3
I_{OS}	Output Short Circuit Current	V_I = 4.25V		-3.5	-1.5	A	1, 2, 3
		V_I = 40V		-1.0	-0.18	A	1, 2, 3
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 0.833Ω, C_L = 20µF		1.2	1.3	V	1, 2, 3
		V_I = 40V, R_L = 250Ω		1.2	1.3	V	1, 2, 3
V_O	Output Voltage	V_I = 6.25V, I_L = -5mA	(Note 9)	1.2	1.3	V	2
V_{Start}	Voltage Start-Up	V_I = 4.25V, R_L = 0.833Ω, C_L = 20µF, I_L = -1.5A		1.2	1.3	V	1, 2, 3

AC Parameters (Note 12)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{NO}	Output Noise Voltage	V_I = 6.25V, I_L = -100mA			120	μV_{RMS}	7
$\Delta V_O / \Delta V_I$	Line Transient Response	V_I = 6.25V, ΔV_I = 3V, I_L = -10mA	(Note 10)		18	mV	7
$\Delta V_O / \Delta I_L$	Load Transient Response	V_I = 6.25V, ΔI_L = -400mA, I_L = -100mA	(Note 11)		120	mV	7
$\Delta V_I / \Delta V_O$	Ripple Rejection	V_I = 6.25V, I_L = -500mA, E_I = 1V_{RMS} at f = 2400Hz		65		dB	4

DC Drift Parameters

The following conditions apply, unless otherwise specified.
Deltas performed on QMLV devices at Group B, Subgroup 5, only.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		-0.01	0.01	V	1
		V_I = 4.25V, I_L = -1.5A		-0.01	0.01	V	1
		V_I = 41.25V, I_L = -5mA		-0.01	0.01	V	1
		V_I = 41.25V, I_L = -200mA		-0.01	0.01	V	1
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-4.0	4.0	mV	1
I_{Adj}	Adjust Pin Current	V_I = 4.25V, I_L = -5mA		-10	10	µA	1
		V_I = 41.25V, I_L = -5mA		-10	10	µA	1
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 0.833Ω, C_L = 20µS		-0.01	0.01	V	1
		V_I = 40V, R_L = 250Ω		-0.01	0.01	V	1

AC/DC Post Radiation Limits @ +25°C (*Note 12*)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	V_I = 4.25V, I_L = -5mA		1.2	1.350	V	1
		V_I = 4.25V, I_L = -1.5A		1.2	1.350	V	1
		V_I = 41.25V, I_L = -5mA		1.2	1.350	V	1
		V_I = 41.25V, I_L = -200mA		1.2	1.350	V	1
V_{RLine}	Line Regulation	4.25V ≤ V_I ≤ 41.25V, I_L = -5mA		-25	25	mV	1
V_{RLoad}	Load Regulation	V_I = 6.25V, -1.5A ≤ I_L ≤ -5mA		-7.0	7.0	mV	1
		V_I = 41.25V, -200mA ≤ I_L ≤ -5mA		-7.0	7.0	mV	1
$\Delta V_I / \Delta V_O$	Ripple Rejection	V_I = 6.25V, I_L = -500mA E_I = 1V_{RMS} at f = 2400Hz		60		dB	4
V_O (Recov)	Output Voltage Recovery	V_I = 4.25V, R_L = 0.833Ω, C_L = 20µS		1.20	1.350	V	1
		V_I = 40V, R_L = 250Ω		1.20	1.350	V	1

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 3: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower. "Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO39, LCC, and ceramic SOIC packages, and 20W for the TO3 package."

Note 4: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

Note 5: For the Ceramic SOIC device to function properly, the “Output” and “Output/Sense” pins must be connected on the users printed circuit board.

Note 6: The package material for these devices allows much improved heat transfer over our standard ceramic packages. In order to take full advantage of this improved heat transfer, heat sinking must be provided between the package base (directly beneath the die), and either metal traces on, or thermal vias through, the printed circuit board. Without this additional heat sinking, device power dissipation must be calculated using θ_{JA}, rather than θ_{JC}, thermal resistance. It must not be assumed that the device leads will provide substantial heat transfer out the package, since the thermal resistance of the leadframe material is very poor, relative to the material of the package base. The stated θ_{JC} thermal resistance is for the package material only, and does not account for the additional thermal resistance between the package base and the printed circuit board. The user must determine the value of the additional thermal resistance and must combine this with the stated value for the package, to calculate the total allowed power dissipation for the device.

Note 7: Guaranteed parameter, not tested.

Note 8: Tested @ 25°C; guaranteed, but not tested @ 125°C & −55°C

Note 9: Tested @ T_A = 125°C, correlated to T_A = 150°C

Note 10: SMD limit of 6mV/V is equivalent to 18mV

Note 11: SMD limit of 0.3mV/V is equivalent to 120mV

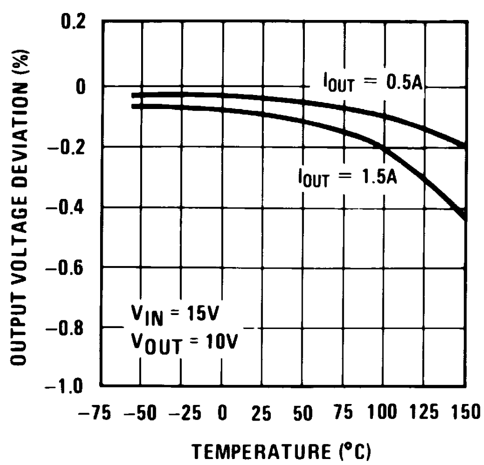
Note 12: Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics except as listed in the “Post Radiation Limits” table. These parts may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effect. Radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in Mil-Std-883, Method 1019.5, Condition A.

Note 13: Low dose rate testing has been performed on a wafer-by-wafer basis, per test method 1019 condition D of MIL-STD-883, with no enhanced low dose rate sensitivity (ELDRS) effect.

Typical Performance Characteristics

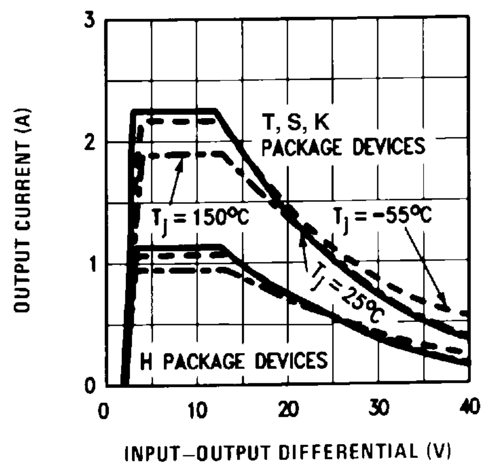
Output Capacitor = 0µF unless otherwise noted

Load Regulation



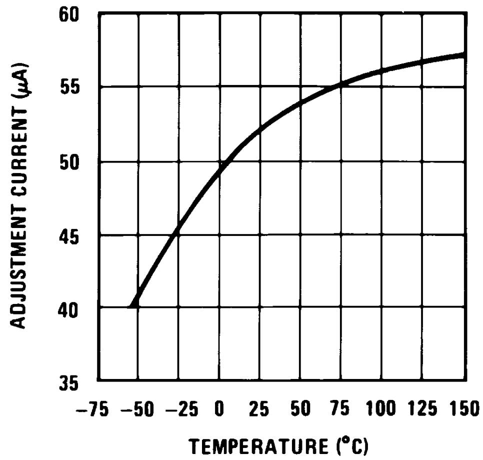
20143637

Current Limit



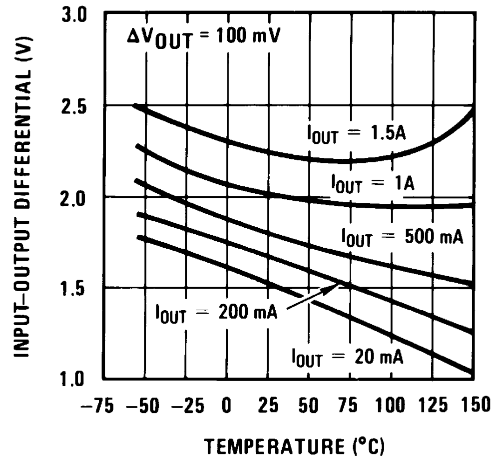
20143638

Adjustment Current



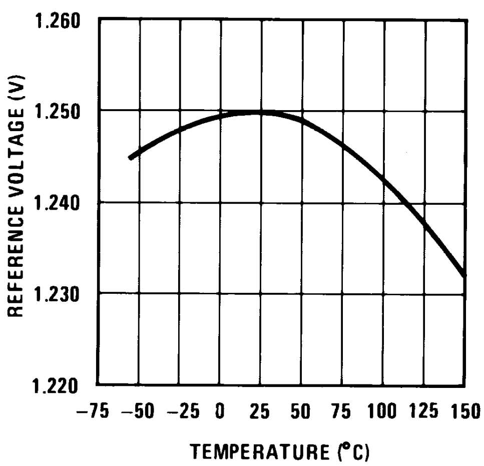
20143639

Dropout Voltage



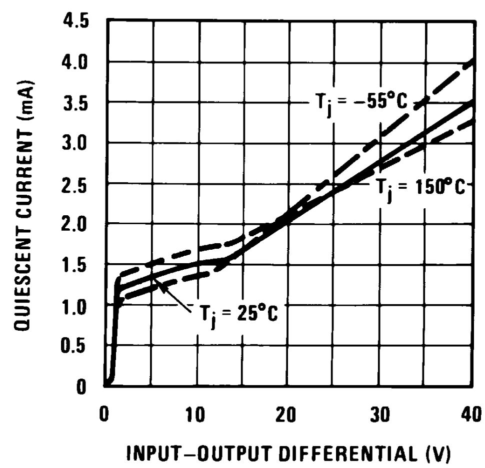
20143640

Temperature Stability



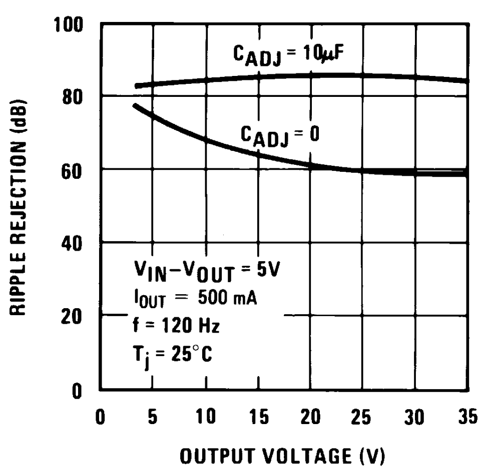
20143641

Minimum Operating Current



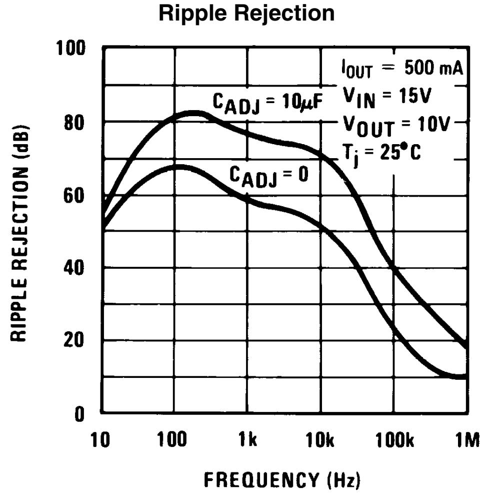
20143642

Ripple Rejection



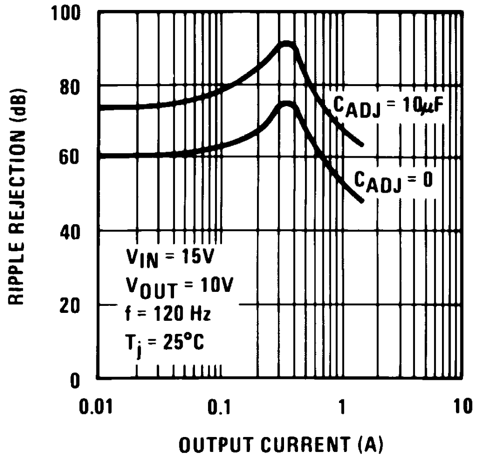
20143643

Ripple Rejection



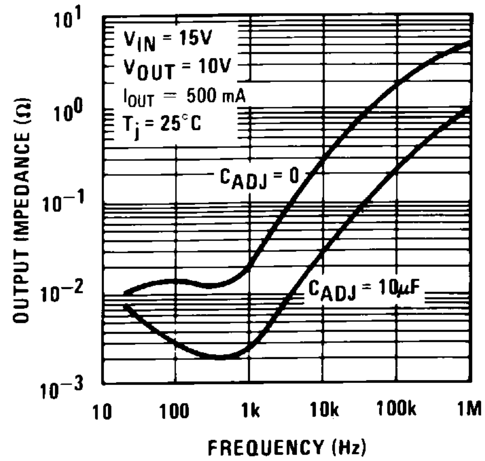
20143644

Ripple Rejection



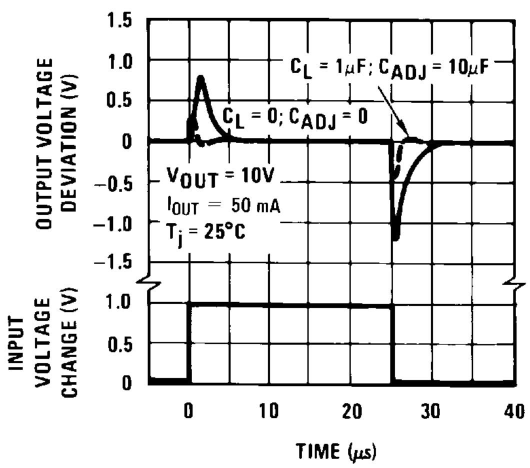
20143645

Output Impedance



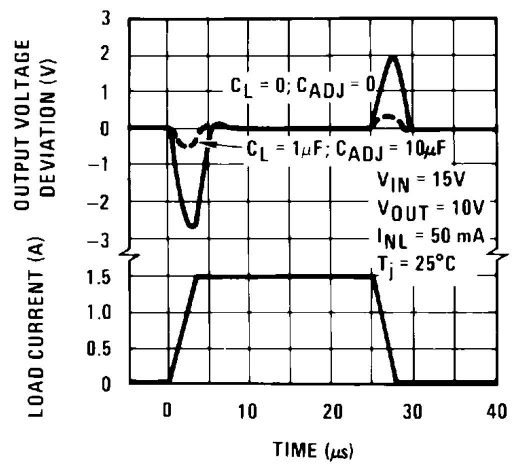
20143646

Line Transient Response



20143647

Load Transient Response



20143648

Application Hints

In operation, the LM117 develops a nominal 1.25V reference voltage, V_{REF}, between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

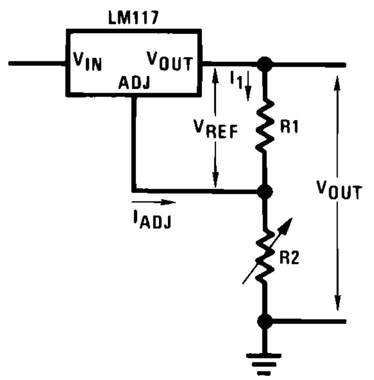


FIGURE 1.

Since the 100μA current from the adjustment terminal represents an error term, the LM117 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

EXTERNAL CAPACITORS

An input bypass capacitor is recommended. A 0.1μF disc or 1μF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the LM117 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10μF bypass capacitor 80dB ripple rejection is obtainable at any output level. Increases over 10μF do not appreciably improve the ripple rejection at frequencies above 120Hz. If the bypass capacitor is used, it is sometimes necessary to include protection diodes to prevent the capacitor from discharging through internal low current paths and damaging the device.

In general, the best type of capacitors to use is solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25μF in aluminum electrolytic to equal 1μF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large decrease in capacitance at frequencies around 0.5MHz. For this reason, 0.01μF disc may seem to work better than a 0.1μF disc as a bypass.

Although the LM117 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1μF solid tantalum (or 25μF aluminum electrolytic) on the output swamps this effect and insures stability. Any increase of the load capacitance larger than 10μF will merely improve the loop stability and output impedance.

LOAD REGULATION

The LM117 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240Ω) should be tied directly to the output (case) of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 15V regulator with 0.05Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω × I_L. If the set resistor is connected near the load the effective line resistance will be 0.05Ω (1 + R2/R1) or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 240Ω set resistor.

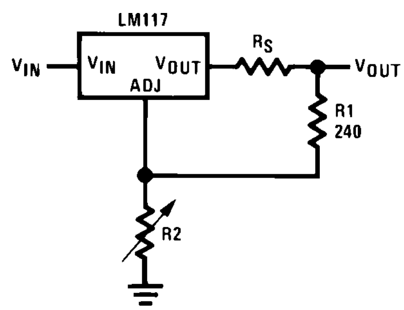


FIGURE 2. Regulator with Line Resistance in Output Lead

With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor, by using two separate leads to the case. However, with the TO-39 package, care should be taken to minimize the wire length of the output lead. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

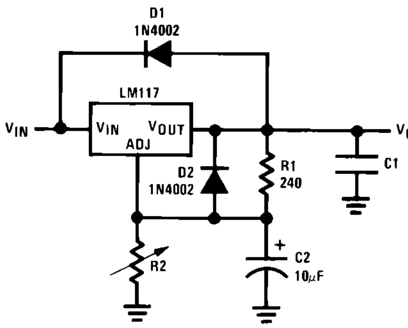
PROTECTION DIODES

When external capacitors are used with *any* IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10μF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the LM117, this discharge path is through a large junction that is able to sustain 15A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25μF or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the LM117 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and

10µF capacitance. *Figure 3* shows an LM117 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



$$V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

D1 protects against C1

D2 protects against C2

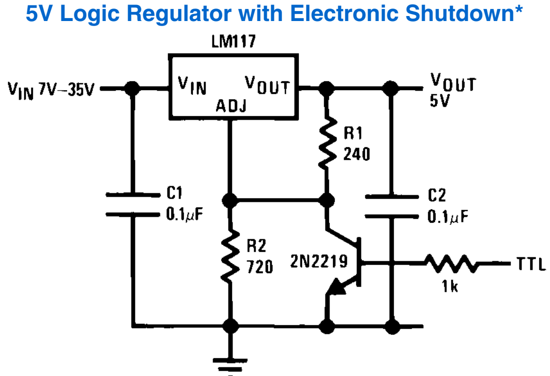
FIGURE 3. Regulator with Protection Diodes

When a value for $\theta_{(H-A)}$ is found using the equation shown, *a heatsink must be selected that has a value that is less than or equal to this number.*

$\theta_{(H-A)}$ is specified numerically by the heatsink manufacturer in the catalog, or shown in a curve that plots temperature rise vs power dissipation for the heatsink.

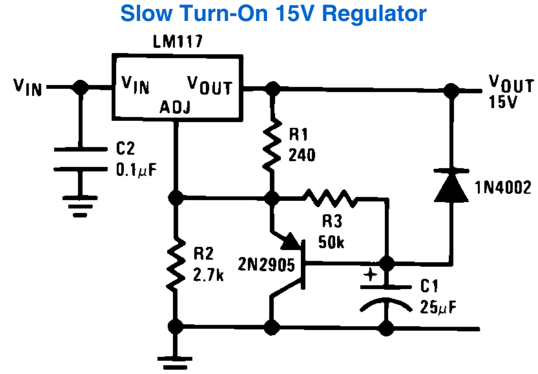
Typical Applications

5V Logic Regulator with Electronic Shutdown*

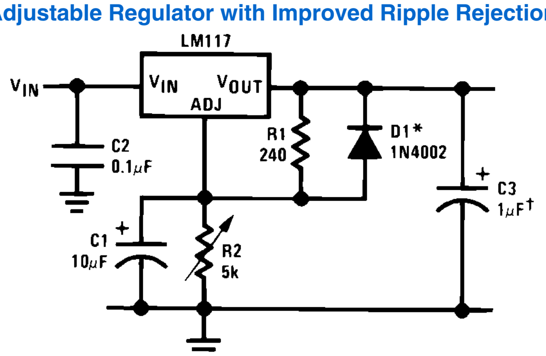


*Min. output ≅ 1.2V

Slow Turn-On 15V Regulator



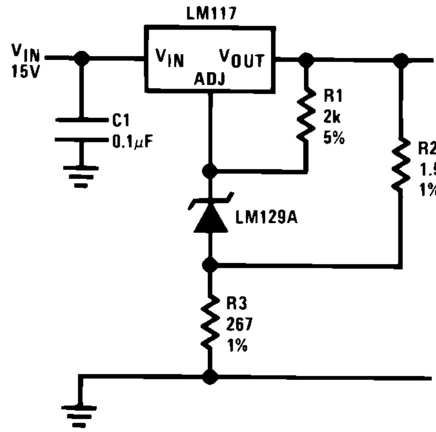
Adjustable Regulator with Improved Ripple Rejection



†Solid tantalum

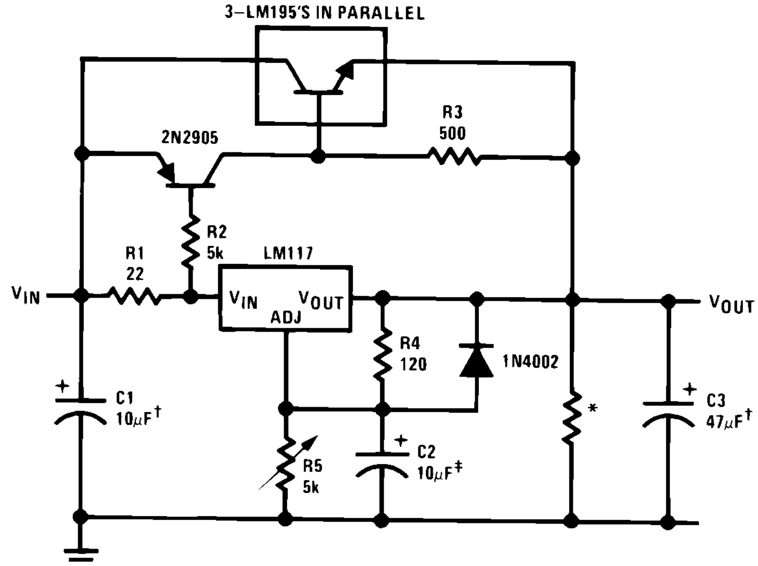
*Discharges C1 if output is shorted to ground

High Stability 10V Regulator



20143611

High Current Adjustable Regulator



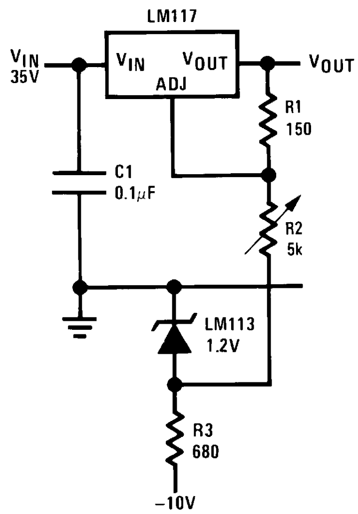
20143612

‡Optional—improves ripple rejection

†Solid tantalum

*Minimum load current = 30 mA

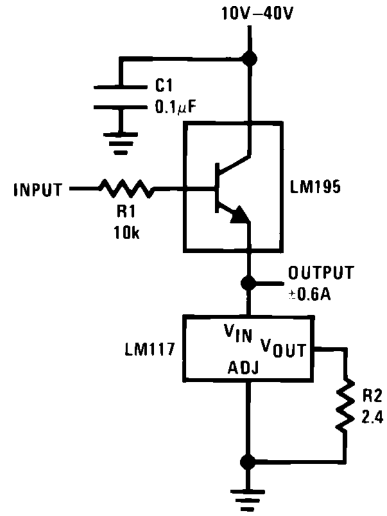
0 to 30V Regulator



20143613

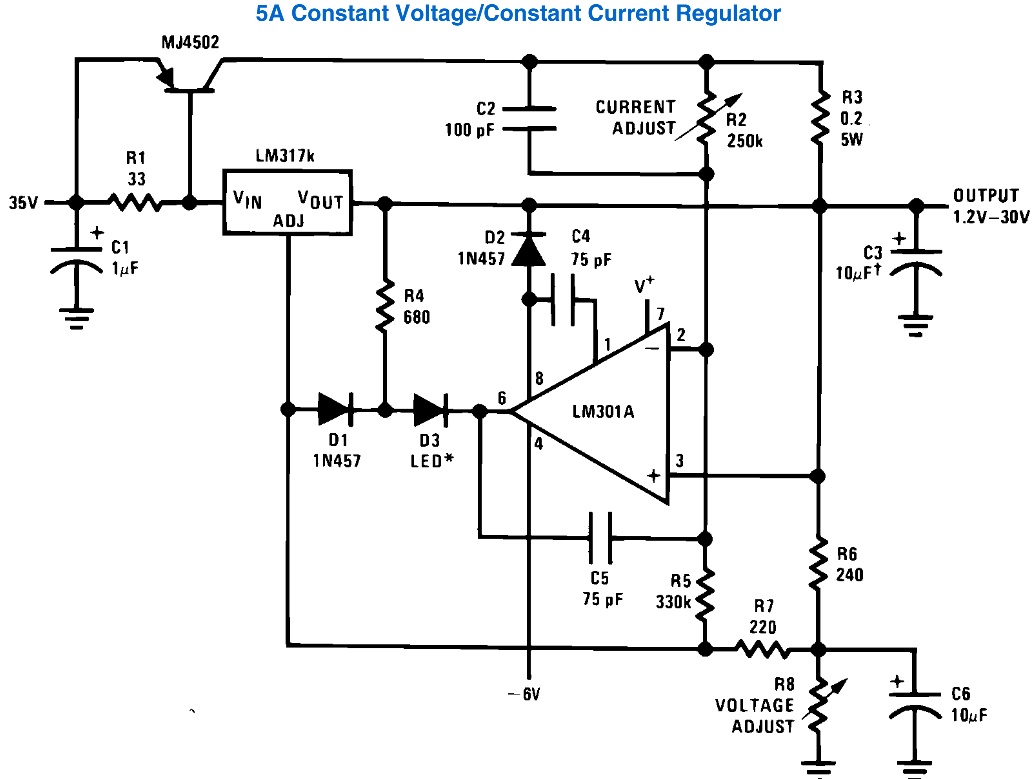
Full output current not available at high input-output voltages

Power Follower



20143614

5A Constant Voltage/Constant Current Regulator

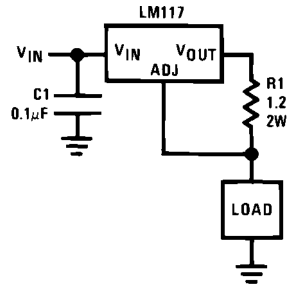


20143615

†Solid tantalum

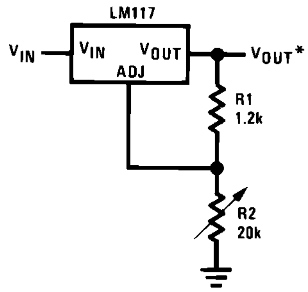
*Lights in constant current mode

1A Current Regulator



20143616

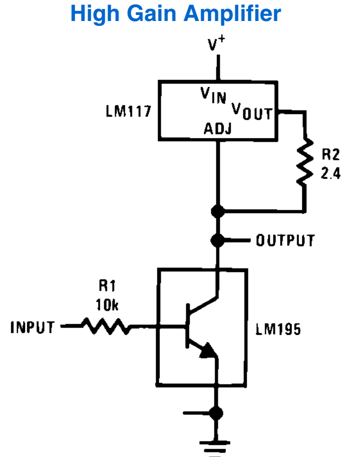
1.2V–20V Regulator with Minimum Program Current



20143617

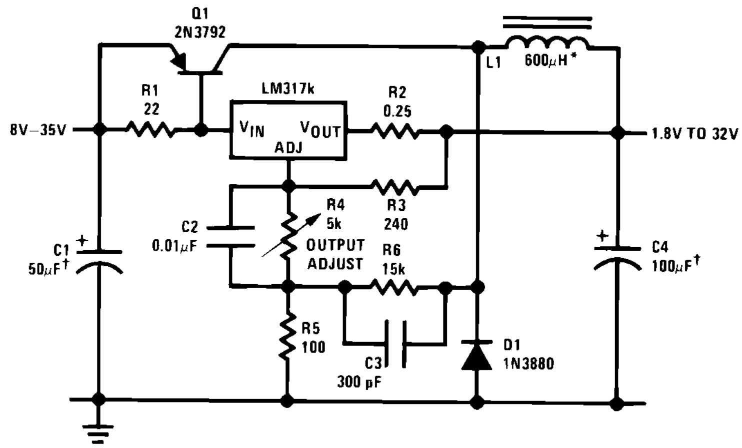
*Minimum load current ≅ 4 mA

High Gain Amplifier



20143618

Low Cost 3A Switching Regulator

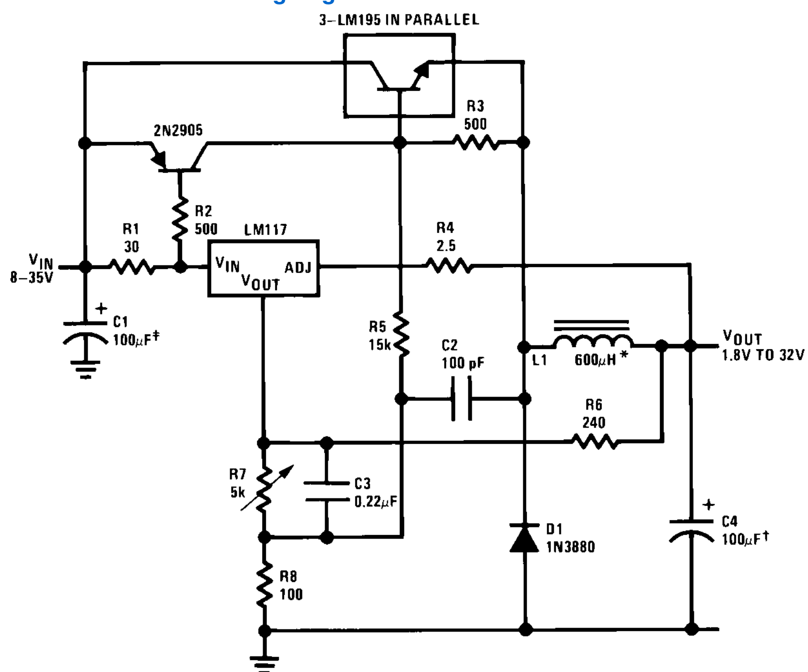


20143619

†Solid tantalum

*Core—Arnold A-254168-2 60 turns

4A Switching Regulator with Overload Protection

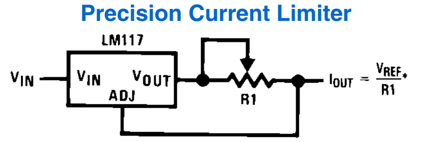


20143620

†Solid tantalum

*Core—Arnold A-254168-2 60 turns

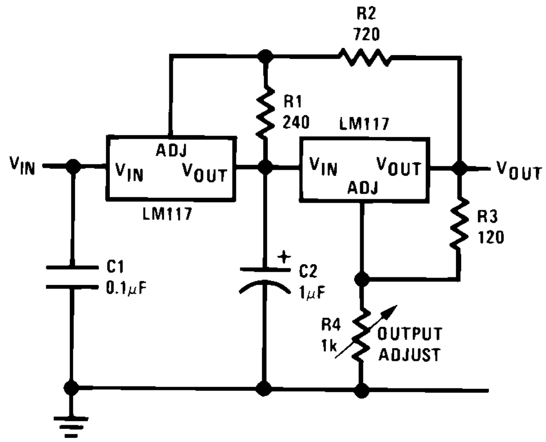
Precision Current Limiter



$*0.8\Omega \le R1 \le 120\Omega$

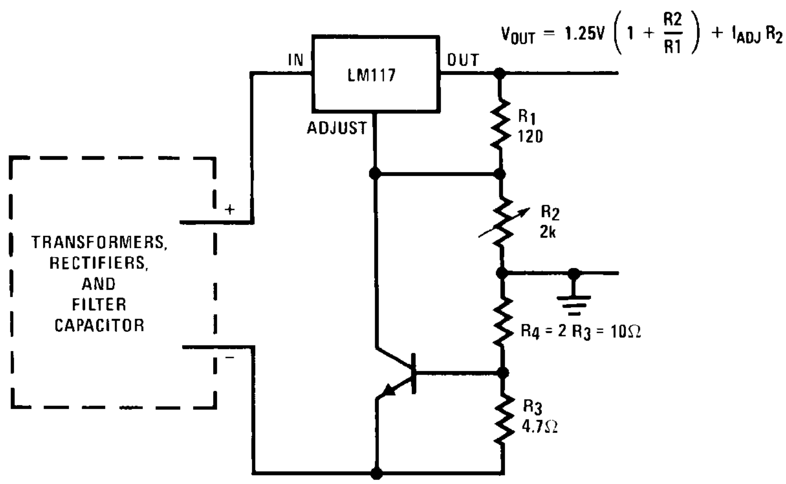
20143621

Tracking Preregulator



20143622

Current Limited Voltage Regulator



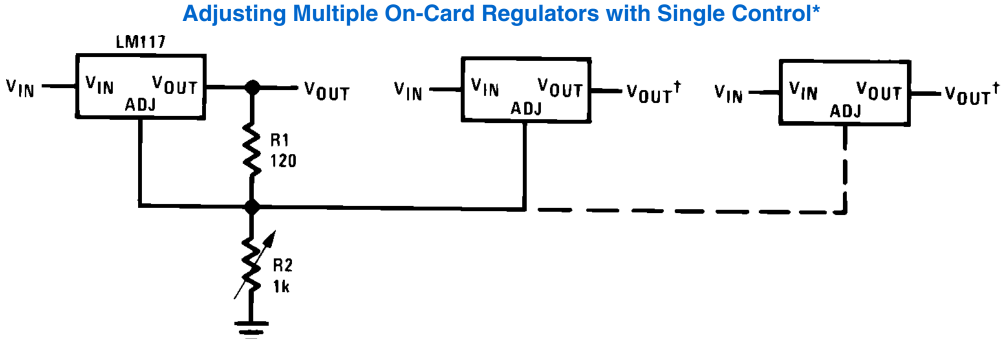
20143623

– Short circuit current is approximately $\frac{600\ \text{mV}}{R3}$, or 120 mA

(Compared to LM117's higher current limit)

—At 50 mA output only ¾ volt of drop occurs in R_3 and R_4

Adjusting Multiple On-Card Regulators with Single Control*

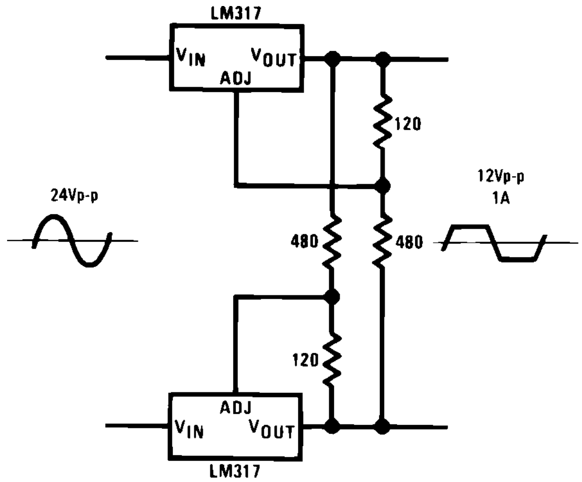


20143624

*All outputs within ±100 mV

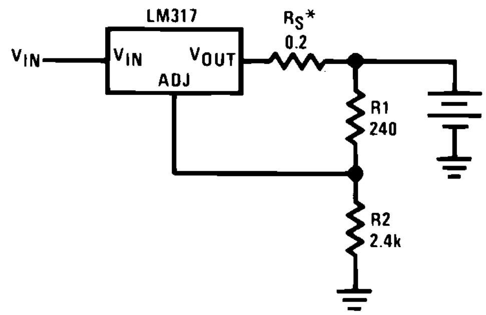
†Minimum load—10 mA

AC Voltage Regulator



20143625

12V Battery Charger

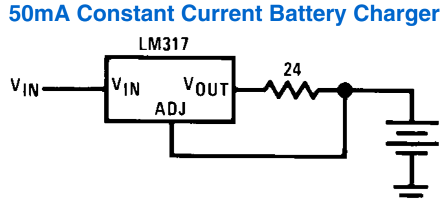


20143626

*R_S—sets output impedance of charger: $Z_{OUT} = R_S \left(1 + \frac{R2}{R1}\right)$

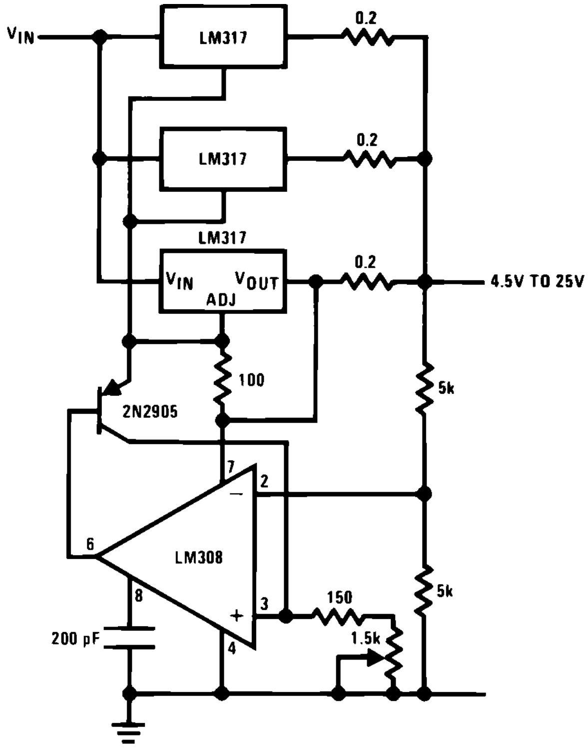
Use of R_S allows low charging rates with fully charged battery.

50mA Constant Current Battery Charger



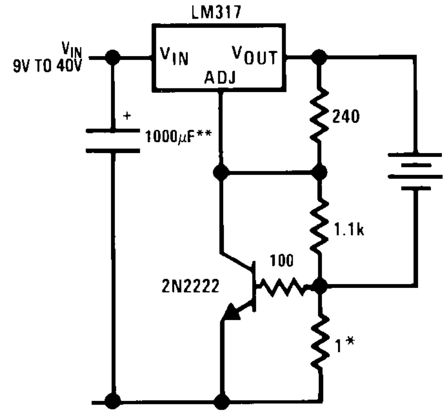
20143627

Adjustable 4A Regulator



20143628

Current Limited 6V Charger

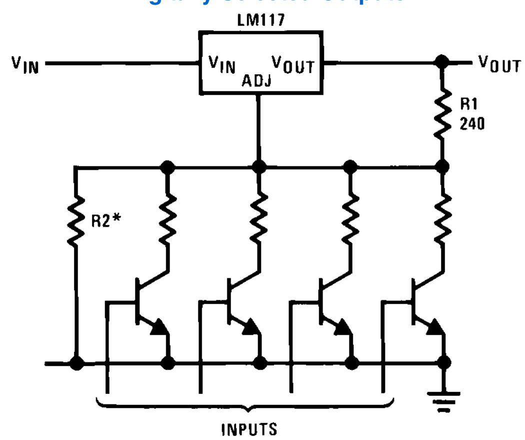


20143629

*Sets peak current (0.6A for 1Ω)

**The 1000µF is recommended to filter out input transients

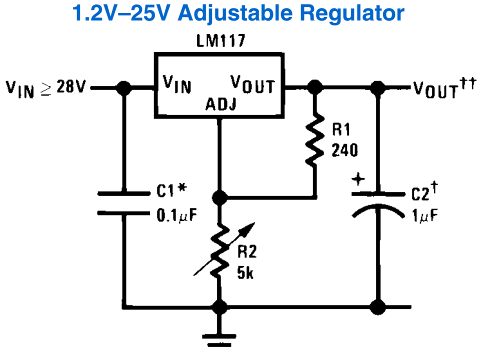
Digitally Selected Outputs



20143602

*Sets maximum V_{OUT}

1.2V–25V Adjustable Regulator



20143601

Full output current not available at high input-output voltages

*Needed if device is more than 6 inches from filter capacitors.

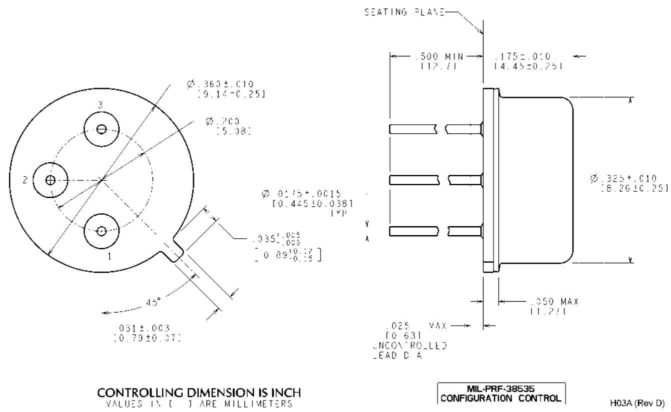
†Optional—improves transient response. Output capacitors in the range of 1µF to 1000µF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

$$††V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R_2)$$

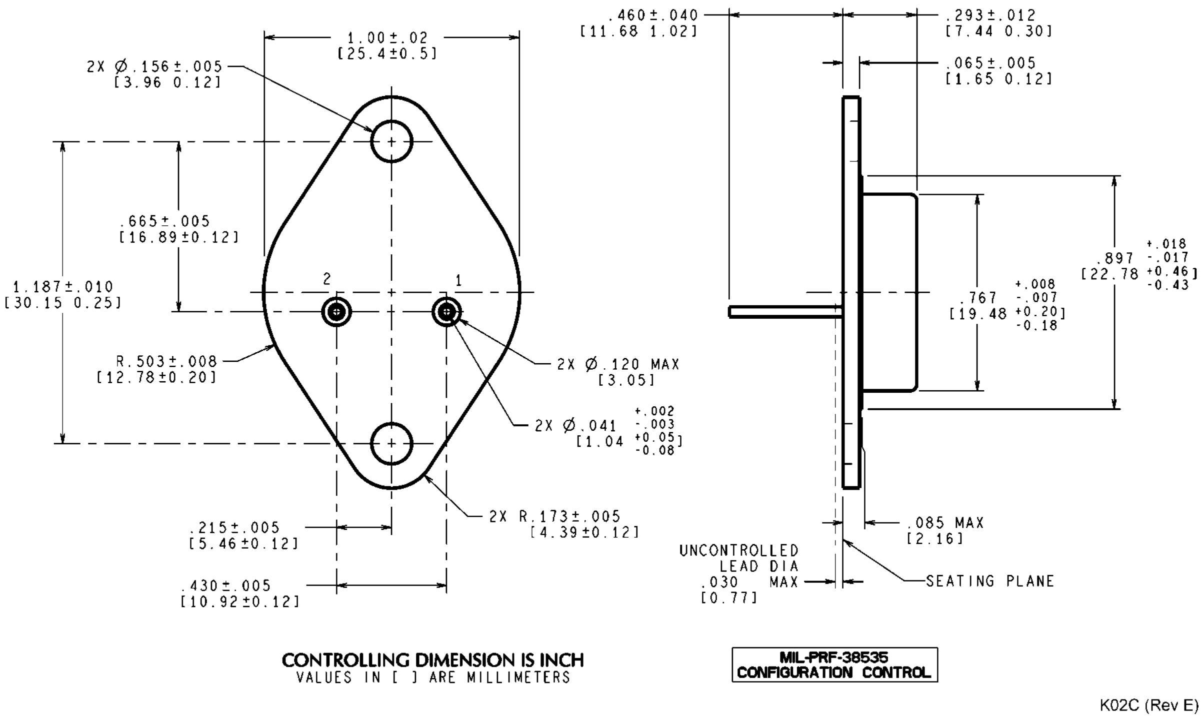
Revision History

Date Released	Revision	Section	Changes
03/17/06	A	New Release to corporate format	5 MDS data sheets were consolidated into one corporate data sheet format. Clarified ΔI_{Adj}/ Line versus ΔI_{Adj}/ Load by separating the parameters in all of the tables. MNLM117–K Rev 1C1, MNLM117–X Rev 0A0, MNLM117–E Rev 0B1, MRLM117–X-RH Rev 2A0, MRLM117–K-RH Rev 3A0 will be archived.
06/29/06	B	Features, Ordering Information Table, Rad Hard Electrical Section for H and WG packages and Notes	Deleted NSID LM117WGRQML, no longer available. Added Available with Radiation Guarantee, Low Dose NSID's to table 5962R9951705VXA LM117HRLQMLV, 5962R9951705VZA LM117WGRLQMLV, and reference to Note 11 and 12. Note 12 to Rad Hard Electrical Heading for H and WG packages. Note 12 to Notes. Archive Revision A.
11/30/2010	C	Features, Ordering Table, Absolute Ratings, LM117H, WG and K RH Drift Electrical Table	Added radiation info., Update with current device information and format, T0–39 Pkg weight, Vo (Recov). Revision B will be Archived.

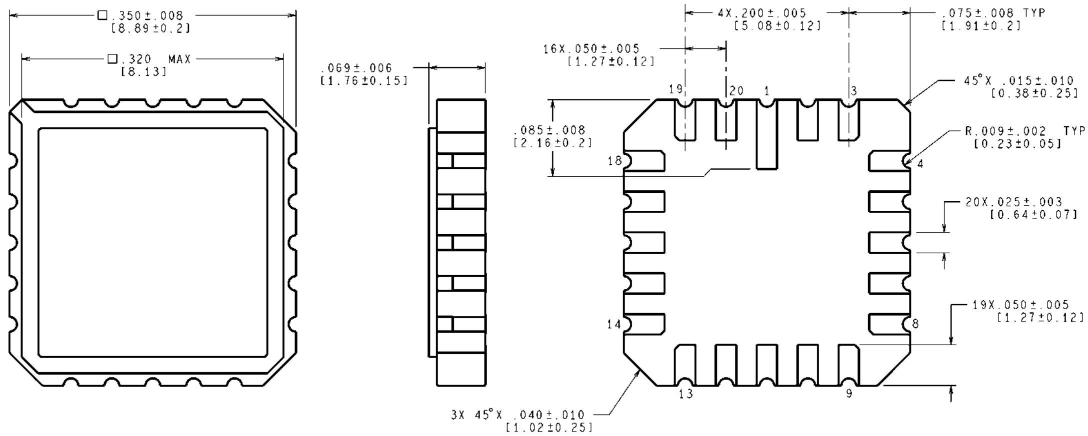
Physical Dimensions inches (millimeters) unless otherwise noted



(TO-39) Metal Can Package
NS Package Number H03A



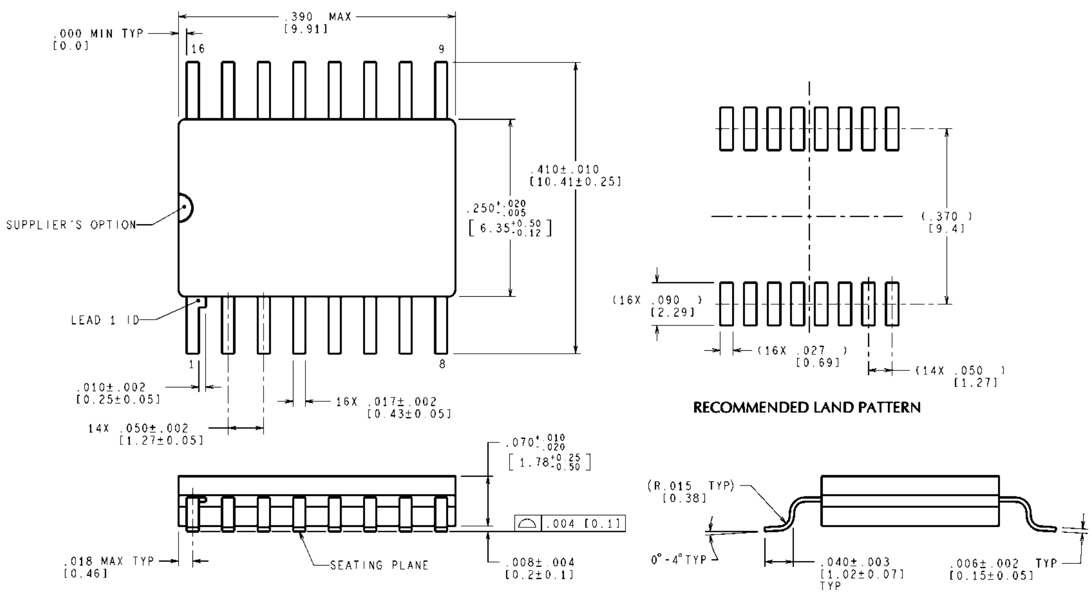
TO-3 Metal Can Package (K)
NS Package Number K02C



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

E20A (Rev F)

Ceramic Leadless Chip Carrier
NS Package Number E20A



MIL-PRF-38535
CONFIGURATION CONTROL

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
DIMENSIONS IN ( ) FOR REFERENCE ONLY

WG16A (Rev E)

Ceramic SOIC
NS Package Number WG16A

Notes

Notes

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