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LM117HVQML

3-Terminal Adjustable Regulator

General Description

The LM117HV are adjustable 3-terminal positive voltage regulators capable of supplying either 0.5A or 1.5A over a 1.2V to 57V 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 LM117HV 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 rejections ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators, the LM117HV 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. do not short the output to ground.

Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM117HV 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.

Features

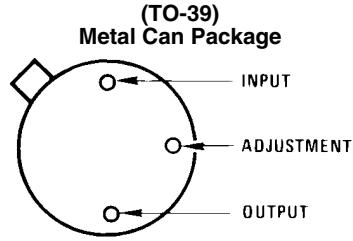
- Available with radiation guarantee
 - Total Ionizing Dose 100 krad(Si)
 - Low Dose Rate Qualified 100 krad(Si)
- Adjustable output down to 1.2V
- Guaranteed 0.5A or 1.5A output current
- Line regulation typically 0.01%/V
- Load regulation typically 0.1%
- Current limit constant with temperature
- Eliminates the need to stock many voltages
- 80 dB ripple rejection
- Output is short-circuit protected

Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM117HVH/883		H03A	3LD T0-39 Metal Can
LM117HVH-QML	5962-0722901QXA	H03A	3LD T0-39 Metal Can
LM117HVHRQMLV (Note 7)	5962R0722901VXA 100 krad(Si)	H03A	3LD T0-39 Metal Can
LM117HVHRLQMLV (Note 8) Low Dose Rate Qualified	5962R0722961VXA 100 krad(Si)	H03A	3LD T0-39 Metal Can
LM117HVK/883		K02C	2LD T0-3 Low Profile Metal Can
LM117HVK-QML	5962-0722903QYA	K02C	2LD T0-3 Low Profile Metal Can
LM117HVWG-QML	5962-0722901QZA	WG16A	16LD Ceramic SOIC
LM117HVWGRQMLV (Note 7)	5962R0722901VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM117HVWGRQMLV (Note 8) Low Dose Rate Qualified	5962R0722961VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM117HVGW-QML	5962-0722902QZA	WG16A	16LD Ceramic SOIC
LM117HVGWRQMLV (Note 7)	5962R0722902VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM117HVGWRQMLV (Note 8) Low Dose Rate Qualified	5962R0722962VZA 100 krad(Si)	WG16A	16LD Ceramic SOIC

Connection Diagrams

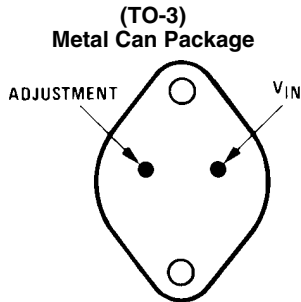
(See Physical Dimension section for further information)



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CASE IS OUTPUT

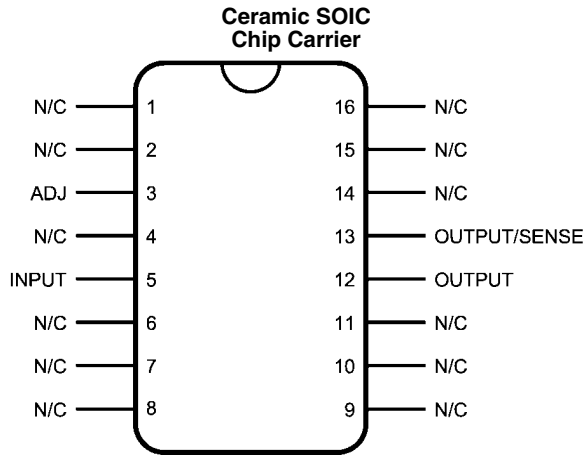
Bottom View
See NS Package Number H03A



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CASE IS OUTPUT

Bottom View
See NS Package Number K02C



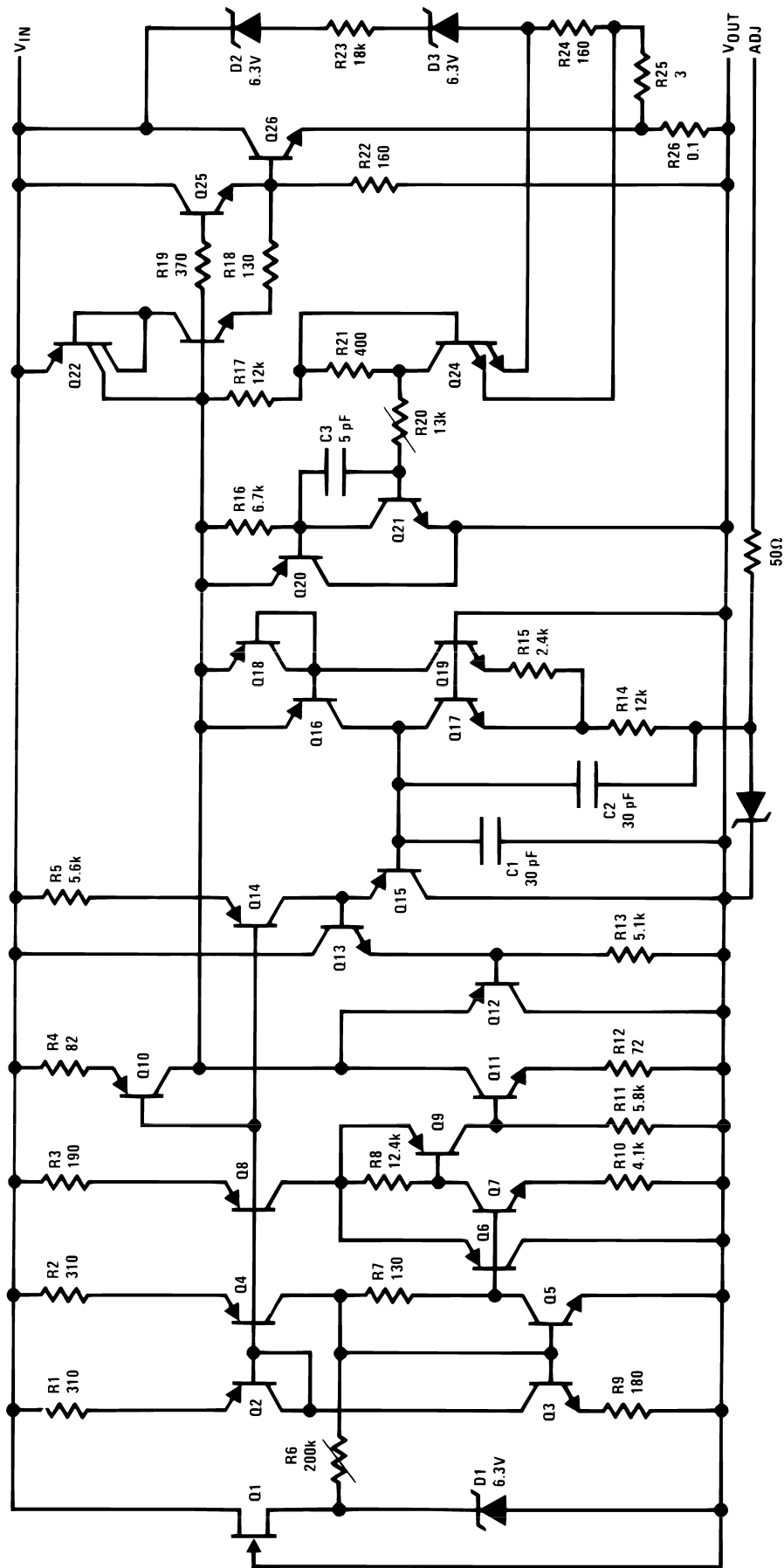
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Top View
See NS Package Number WG16A
(Note 4)

LM117HV Series Packages

Part Number Suffix	Package	Design Load Current
H	TO-39	0.5A
K	TO-3	1.5A
WG, GW	Ceramic SOIC	0.5A

Schematic Diagram



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LM117HVQML

Absolute Maximum Ratings *(Note 1)*

Power Dissipation <i>(Note 2)</i>	Internally limited
Input - Output Voltage Differential	+60V, -0.3V
Maximum Junction Temperature	+150°C
Storage Temperature	$-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Lead Temperature (Soldering, 10 sec.)	300°C
Thermal Resistance	
θ_{JA}	
T0-3 Metal Can - Still Air	39°C/W
T0-3 Metal Can - 500LF/Min Air flow	14°C/W
T0-39 Metal Can - Still Air	186°C/W
T0-39 Metal Can - 500LF/Min Air flow	64°C/W
Ceramic SOIC - Still Air "WG"	115°C/W
Ceramic SOIC - 500LF/Min Air flow "WG"	66°C/W
Ceramic SOIC - Still Air "GW"	130°C/W
Ceramic SOIC - 500LF/Min Air flow "GW"	80°C/W
θ_{JC}	
T0-3 Metal Can	1.9°C/W
T0-39 Metal Can	21°C/W
Ceramic SOIC "WG" <i>(Note 5)</i>	3.4°C/W
Ceramic SOIC "GW"	7°C/W
ESD Tolerance <i>(Note 3)</i>	2000V

Recommended Operating Conditions

Operating Temperature Range	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
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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

LM117HVH, HVWG Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{\text{Diff}} = (V_I - V_O)$, $I_L = 8\text{mA}$, $V_{\text{OUT}} = 1.25\text{V}$ (Nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjustment Pin Current	$V_{\text{Diff}} = 3\text{V}$			100	μA	1
		$V_{\text{Diff}} = 3.3\text{V}$			100	μA	2, 3
		$V_{\text{Diff}} = 40\text{V}$			100	μA	1, 2, 3
I_{Q}	Minimum Load Current	$V_{\text{Diff}} = 3\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	1
		$V_{\text{Diff}} = 3.3\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	2, 3
		$V_I = 40\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	1, 2, 3
		$V_I = 60\text{V}$, $V_{\text{O}} = 1.7\text{V}$			8.2	mA	1
V_{Ref}	Reference Voltage	$V_{\text{Diff}} = 3\text{V}$		1.2	1.3	V	1
		$V_{\text{Diff}} = 3.3\text{V}$		1.2	1.3	V	2, 3
		$V_{\text{Diff}} = 40\text{V}$		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_{\text{O}} = V_{\text{Ref}}$		-8.64	8.64	mV	1
		$3.3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_{\text{O}} = V_{\text{Ref}}$		-18	18	mV	2, 3
		$40\text{V} \leq V_{\text{Diff}} \leq 60\text{V}$, $I_L = 60\text{mA}$		-25	25	mV	1
V_{RLoad}	Load Regulation	$V_{\text{Diff}} = 3\text{V}$, $I_L = 10\text{mA}$ to 500mA		-15	15	mV	1
		$V_{\text{Diff}} = 3.3\text{V}$, $I_L = 10\text{mA}$ to 500mA		-15	15	mV	2, 3
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 150mA		-15	15	mV	1
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 100mA		-15	15	mV	2, 3
Delta I_{Adj} / Load	Adjustment Pin Current Change	$V_{\text{Diff}} = 3\text{V}$, $I_L = 10\text{mA}$ to 500mA		-5.0	5.0	μA	1
		$V_{\text{Diff}} = 3.3\text{V}$, $I_L = 10\text{mA}$ to 500mA		-5.0	5.0	μA	2, 3
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 150mA		-5.0	5.0	μA	1
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 100mA		-5.0	5.0	μA	2, 3
Delta I_{Adj} / Line	Adjustment Pin Current Change	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$		-5.0	5.0	μA	1
		$3.3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$		-5.0	5.0	μA	2, 3
I_{OS}	Short Circuit Current	$V_{\text{Diff}} = 60\text{V}$		0.0	0.4	A	1
		$V_{\text{Diff}} = 4.25\text{V}$		0.5	1.8	A	1
θ_{R}	Thermal Regulation	$V_{\text{Diff}} = 40\text{V}$, $I_L = 150\text{mA}$, $t = 20\text{mS}$			6.0	mV	1

AC Parameters

The following conditions apply, unless otherwise specified. $V_{\text{Diff}} = (V_I - V_O)$, $I_L = 8\text{mA}$, $V_{\text{OUT}} = 1.25\text{V}$ (Nominal)

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

LM117HVH, HVWG Delta Electrical Characteristics

DC Delta 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
I_{Adj}	Adjust Pin Current	$V_{\text{Diff}} = 3\text{V}$		-10	10	μA	1
		$V_{\text{Diff}} = 40\text{V}$		-10	10	μA	1
V_{Ref}	Reference Voltage	$V_{\text{Diff}} = 3\text{V}$		-0.01	0.01	V	1
		$V_{\text{Diff}} = 40\text{V}$		-0.01	0.01	V	1
V_{RLine}	Line Regulation	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_O = V_{\text{Ref}}$		-4.0	4.0	mV	1
		$40\text{V} \leq V_{\text{Diff}} \leq 60\text{V}$, $I_L = 60\text{mA}$		-6.0	6.0	mV	1

LM117HVH, HVWG Post Radiation Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{\text{Diff}} = (V_I - V_O)$, $I_L = 8\text{mA}$, $V_{\text{OUT}} = 1.25\text{V}$ (Nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	$V_{\text{Diff}} = 3\text{V}$		1.2	1.45	V	1
		$V_{\text{Diff}} = 40\text{V}$		1.2	1.45	V	1
V_{RLine}	Line Regulation	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_O = V_{\text{Ref}}$		-40	40	mV	1
V_{RLoad}	Load Regulation	$V_{\text{Diff}} = 3\text{V}$, $I_L = 10\text{mA}$ to 500mA		-27	27	mV	1

AC Parameters

The following conditions apply, unless otherwise specified. $V_{\text{Diff}} = (V_I - V_O)$, $I_L = 8\text{mA}$, $V_{\text{OUT}} = 1.25\text{V}$ (Nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
RR	Ripple Rejection	$V_I = +6.25\text{V}$, $f = 120\text{Hz}$, $e_i = 1V_{\text{RMS}}$, $I_L = 125\text{mA}$, $V_O = V_{\text{Ref}}$		55		dB	4

LM117HVK Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified. $V_{\text{Diff}} = (V_I - V_O)$, $I_L = 10\text{mA}$, $V_{\text{OUT}} = 1.25\text{V}$ (Nominal)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_{Adj}	Adjustment Pin Current	$V_{\text{Diff}} = 3\text{V}$			100	μA	1
		$V_{\text{Diff}} = 3.3\text{V}$			100	μA	2, 3
		$V_{\text{Diff}} = 40\text{V}$			100	μA	1, 2, 3
I_{Q}	Minimum Load Current	$V_{\text{Diff}} = 3\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	1
		$V_{\text{Diff}} = 3.3\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	2, 3
		$V_I = 40\text{V}$, $V_{\text{O}} = 1.7\text{V}$			5.0	mA	1, 2, 3
		$V_I = 60\text{V}$, $V_{\text{O}} = 1.7\text{V}$		0.25	8.2	mA	1
V_{Ref}	Reference Voltage	$V_{\text{Diff}} = 3\text{V}$		1.2	1.3	V	1
		$V_{\text{Diff}} = 3.3\text{V}$		1.2	1.3	V	2, 3
		$V_{\text{Diff}} = 40\text{V}$		1.2	1.3	V	1, 2, 3
V_{RLine}	Line Regulation	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_{\text{O}} = V_{\text{Ref}}$		-8.64	8.64	mV	1
		$3.3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$, $V_{\text{O}} = V_{\text{Ref}}$		-18	18	mV	2, 3
		$40\text{V} \leq V_{\text{Diff}} \leq 60\text{V}$, $I_L = 60\text{mA}$		-25	25	mV	1
V_{RLoad}	Load Regulation	$V_{\text{Diff}} = 3\text{V}$, $I_L = 10\text{mA}$ to 1.5A		-15	15	mV	1
		$V_{\text{Diff}} = 3.3\text{V}$, $I_L = 10\text{mA}$ to 1.5A		-15	15	mV	2, 3
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 300mA		-15	15	mV	1
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 195mA		-15	15	mV	2, 3
Delta I_{Adj} / Load	Adjustment Pin Current Change	$V_{\text{Diff}} = 3\text{V}$, $I_L = 10\text{mA}$ to 1.5A		-5.0	5.0	μA	1
		$V_{\text{Diff}} = 3.3\text{V}$, $I_L = 10\text{mA}$ to 1.5A		-5.0	5.0	μA	2, 3
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 300mA		-5.0	5.0	μA	1
		$V_{\text{Diff}} = 40\text{V}$, $I_L = 10\text{mA}$ to 195mA		-5.0	5.0	μA	2, 3
Delta I_{Adj} / Line	Adjustment Pin Current Change	$3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$		-5.0	5.0	μA	1
		$3.3\text{V} \leq V_{\text{Diff}} \leq 40\text{V}$		-5.0	5.0	μA	2, 3
I_{OS}	Short Circuit Current	$V_{\text{Diff}} = 60\text{V}$		0.0	0.4	A	1
		$V_{\text{Diff}} = 3\text{V}$		1.5	3.5	A	1
θ_{R}	Thermal Regulation	$V_{\text{Diff}} = 40\text{V}$, $I_L = 300\text{mA}$, $t = 20\text{mS}$			10.5	mV	1

AC Parameters

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

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

Note 1: 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 2: 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 $P_{\text{Dmax}} = (T_{\text{Jmax}} - T_{\text{A}}) / \theta_{\text{JA}}$ 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 package and 20W for the TO3 package."

Note 3: Human body model, 1.5 k Ω in series with 100 pF.

Note 4: For the Ceramic SOIC device to function properly, the "Output" and "Output/Sense" pins must be connected on the users printed circuit board.

Note 5: 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 lead frame 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.

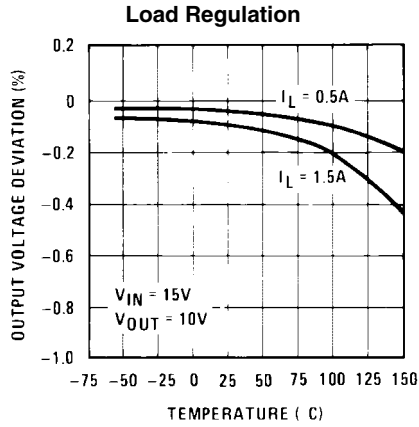
Note 6: Tested @ 25°C; guaranteed, but not tested @ 125°C & -55°C

Note 7: Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics, except as listed in the "LM117HVH, HVWG Post Radiation Electrical Characteristics" tables. 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, Condition A.

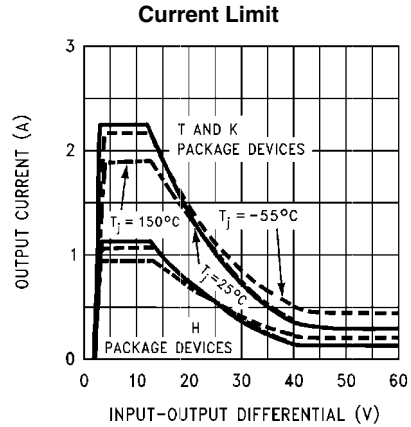
Note 8: Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics, except as listed in the "LM117HVH, HVWG Post Radiation Electrical Characteristics" tables. These parts pass all post irradiation limits under low dose rate testing at 10 mrad(Si)/s. Low dose rate qualification is performed on a wafer-by-wafer basis, per test method 1019 condition E of MIL-STD-883.

Typical Performance Characteristics

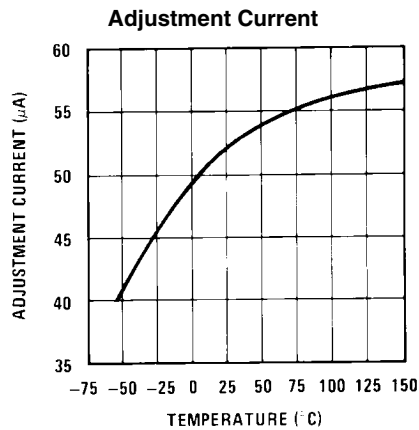
Output capacitor = 0 μ F unless otherwise noted.



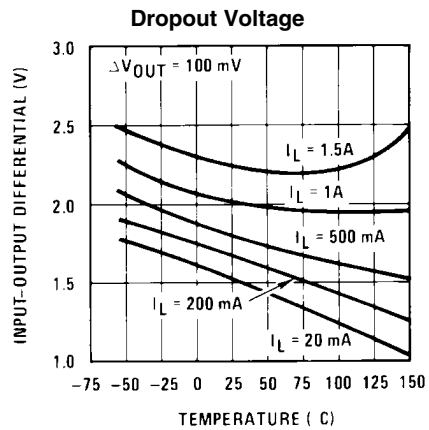
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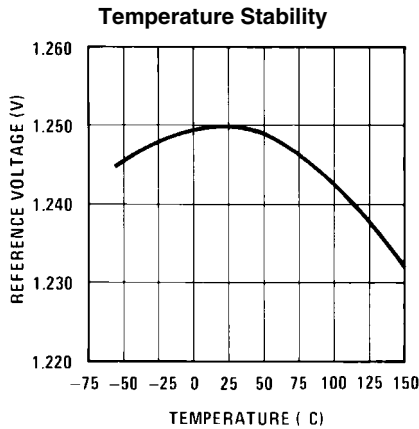
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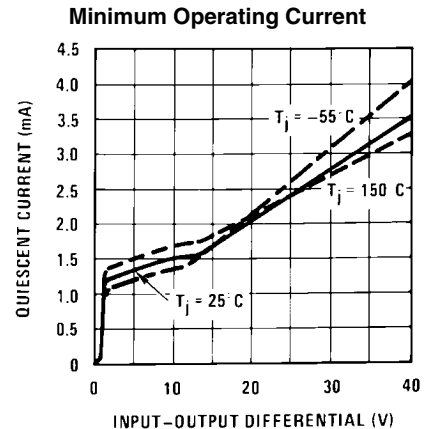
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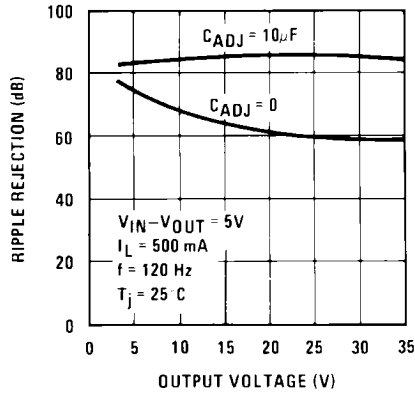


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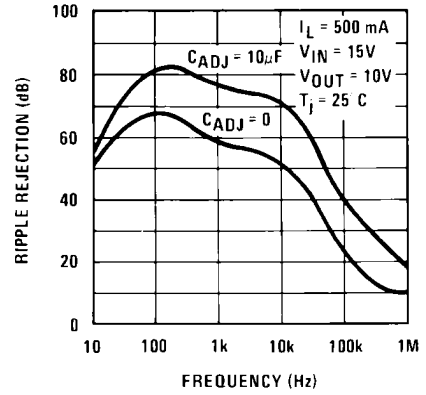
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Ripple Rejection



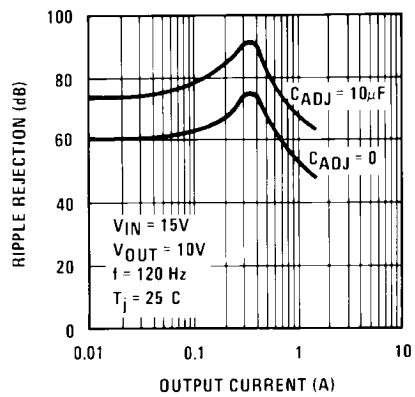
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Ripple Rejection



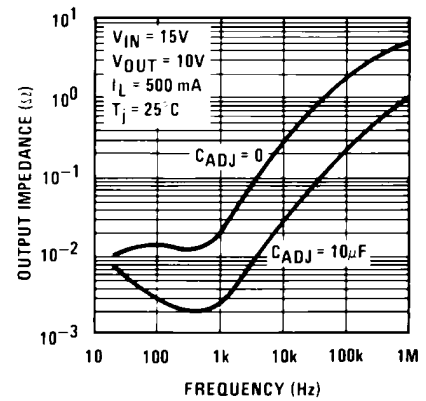
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Ripple Rejection



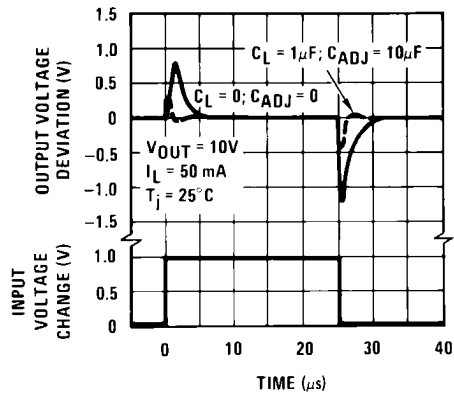
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Output Impedance



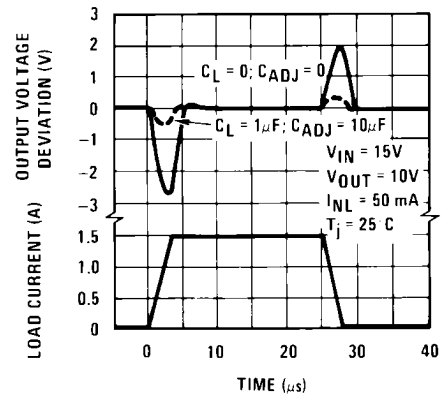
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Line Transient Response



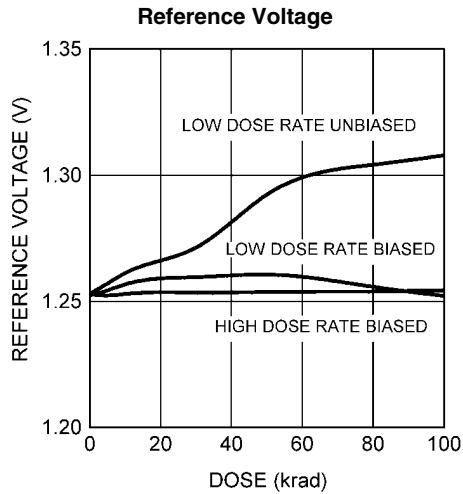
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Load Transient Response

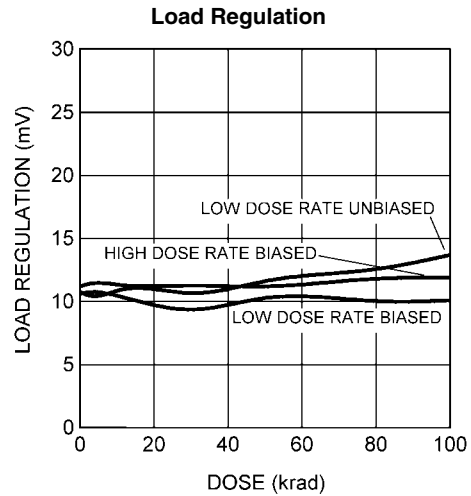


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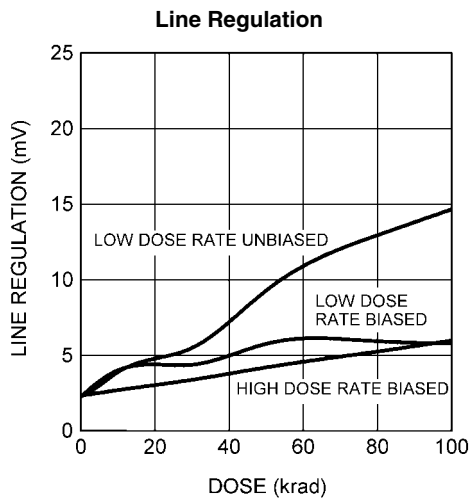
Typical Radiation Characteristics (Note 9)



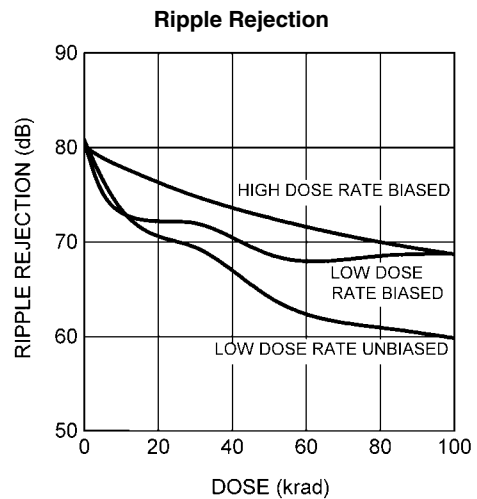
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Note 9: Irradiation conditions: $V_i = 60V$; low dose rate = 10 mrad(Si)/s

Application Hints

In operation, the LM117HV 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

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

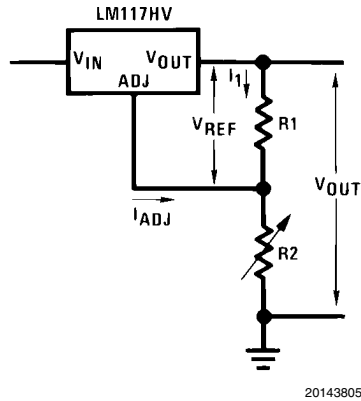


FIGURE 1.

Since the 100 μ A current from the adjustment terminal represents an error term, the LM117HV 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 0.1 μ F disc or 1 μ F 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 LM117HV to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10 μ F bypass capacitor 80 dB ripple rejection is obtainable at any output level. Increases over 10 μ F do not appreciably improve the ripple rejection at frequencies above 120 Hz. 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 are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 μ F in aluminum electrolytic to equal 1 μ F 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 0.5 MHz. For this reason, 0.01 μ F disc may seem to work better than a 0.1 μ F disc as a bypass.

Although the LM117HV is stable with no output capacitors, like any feedback circuit, certain values of external capaci-

tance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1 μ F solid tantalum (or 25 μ F aluminum electrolytic) on the output swamps this effect and insures stability. Any increase of load capacitance larger than 10 μ F will merely improve the loop stability and output impedance.

LOAD REGULATION

The LM117HV 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 240 Ω) should be tied directly to the output 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 0.05 Ω resistance between the regulator and load will have a load regulation due to line resistance of $0.05\Omega \times I_L$. If the set resistor is connected near the load the effective line resistance will be $0.05\Omega (1 + R2/R1)$ or in this case, 11.5 times worse.

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

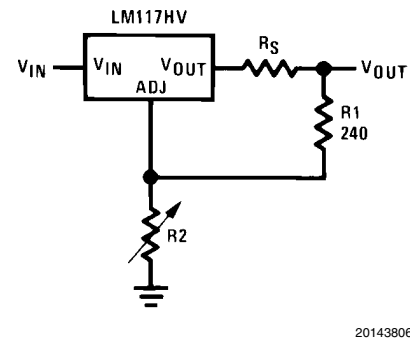


FIGURE 2. Regulator with Line Resistance in Output Lead

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-5 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 10 μ F 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 LM117HV, 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 25 μ F 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

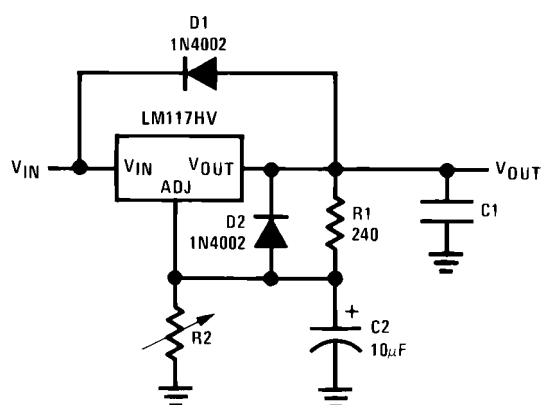
either the input or output is shorted. Internal to the LM117HV is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10 μF capacitance. *Figure 3* shows an LM117HV with protection diodes included for use with outputs greater than 25V and high values of output capacitance.

$$V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1} \right) + I_{ADJ}R_2$$

Note: D1 protects against C1
D2 protects against C2

CURRENT LIMIT

Internal current limit will be activated whenever the output current exceeds the limit indicated in the Typical Performance Characteristics. However, if during a short circuit condition the regulator's differential voltage exceeds the Absolute Maximum Rating of 60V (e.g. $V_{IN} \geq 60V$, $V_{OUT} = 0V$), internal junctions in the regulator may break down and the device may be damaged or fail. Failure modes range from an apparent open or short from input to output of the regulator, to a destroyed package (most common with the TO-220 package). To protect the regulator, the user is advised to be aware of voltages that may be applied to the regulator during fault conditions, and to avoid violating the Absolute Maximum Ratings.

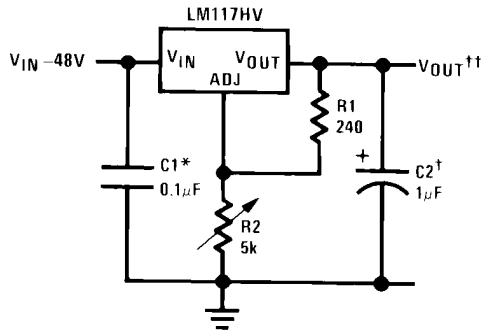


20143807

FIGURE 3. Regulator with Protection Diodes

Typical Applications

1.2V-45V Adjustable Regulator



20143801

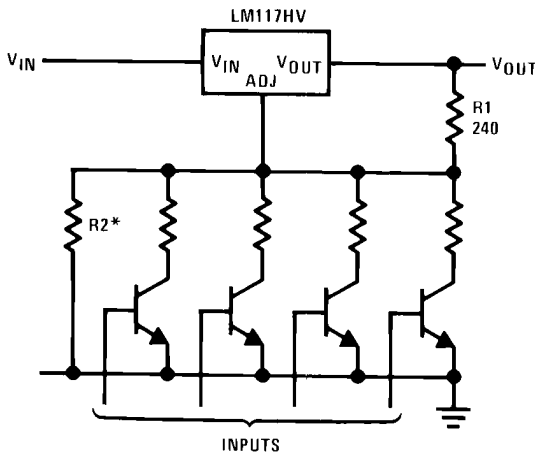
Full output current not available at high input-output voltages

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

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

$$\dagger\dagger V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1} \right) + I_{ADJ} R_2$$

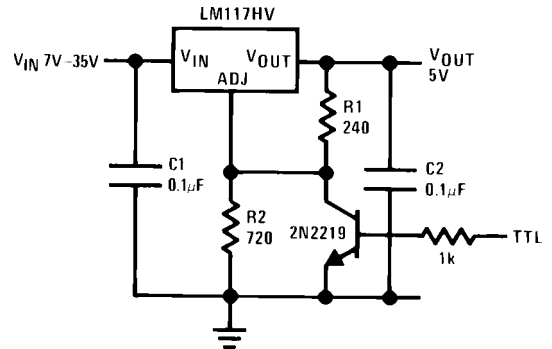
Digitally Selected Outputs



20143802

*Sets maximum V_{OUT}

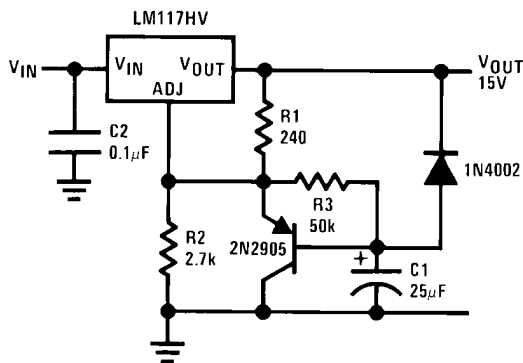
5V Logic Regulator with Electronic Shutdown*



20143803

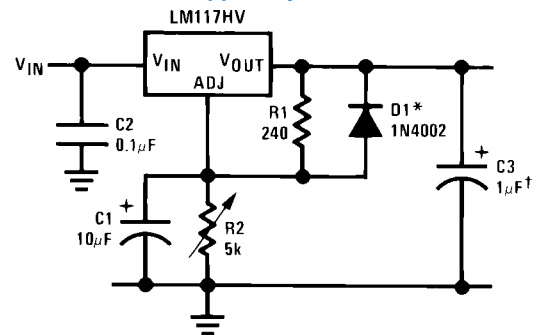
*Min. output \approx 1.2V

Slow Turn-On 15V Regulator



20143809

Adjustable Regulator with Improved Ripple Rejection

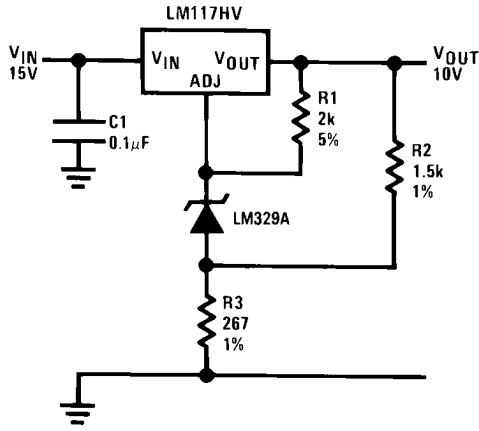


20143810

†Solid tantalum

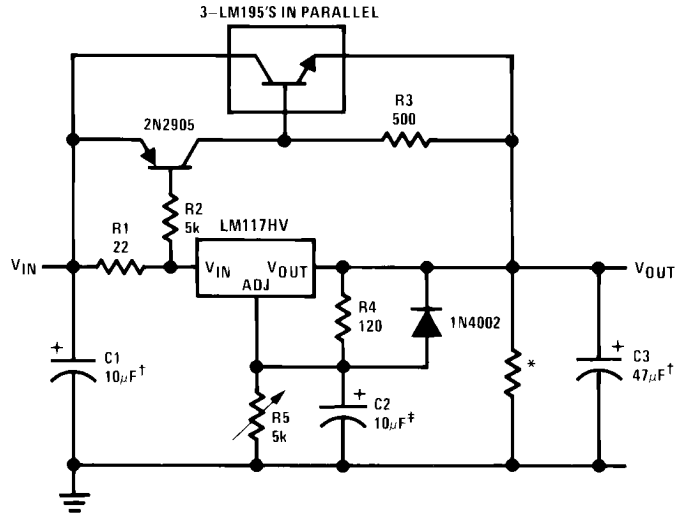
*Discharges C1 if output is shorted to ground

High Stability 10V Regulator



20143811

High Current Adjustable Regulator



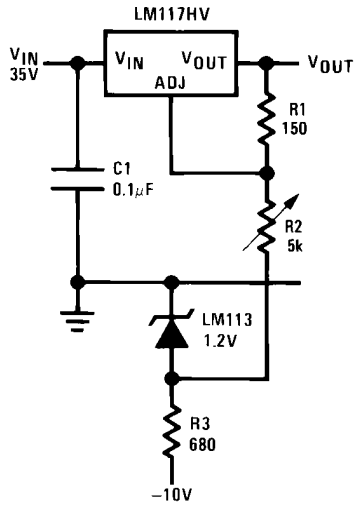
20143812

†Solid tantalum

*Minimum load current = 30 mA

‡Optional—improves ripple rejection

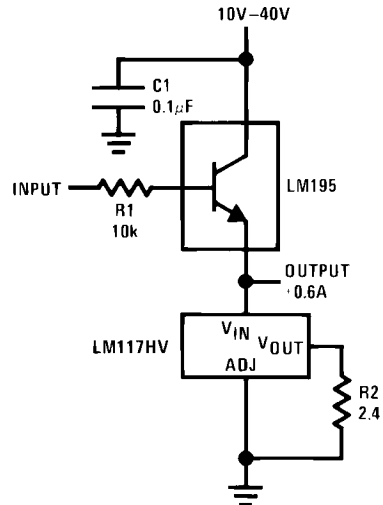
0 to 30V Regulator



20143813

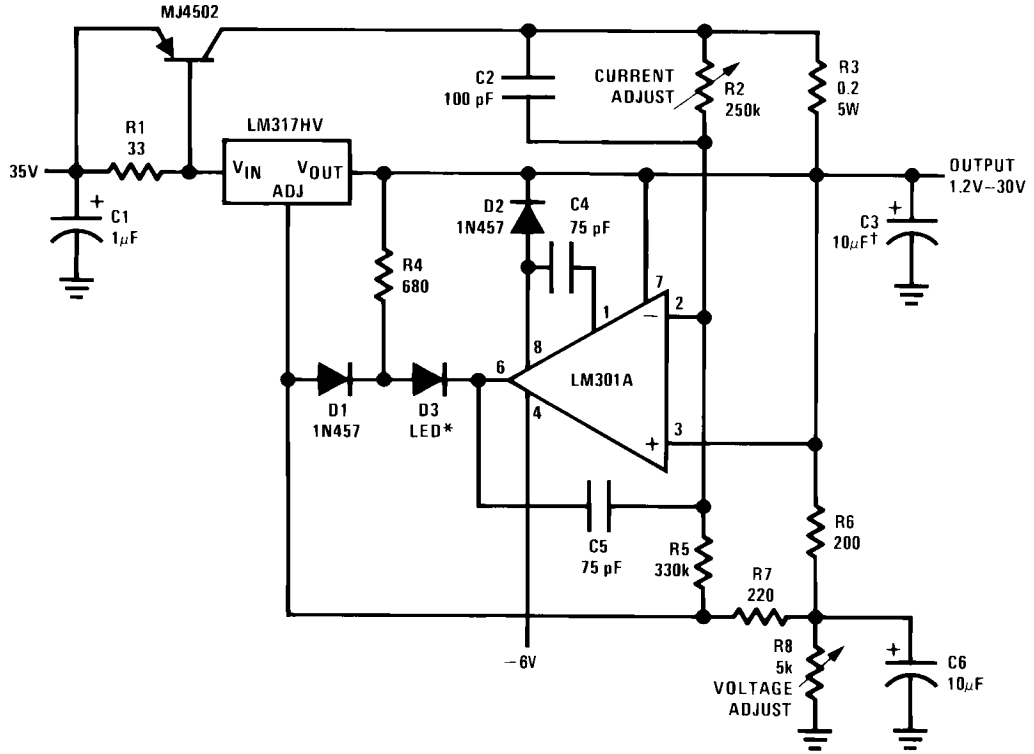
Full output current not available at high input-output voltages

Power Follower



20143814

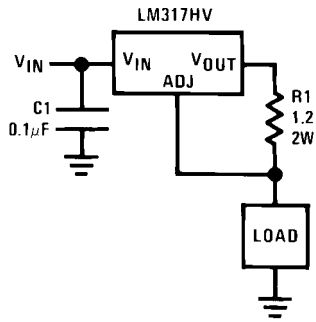
5A Constant Voltage/Constant Current Regulator



20143815

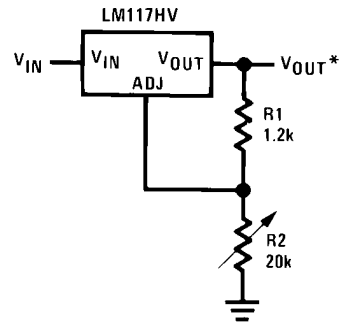
†Solid tantalum
*Lights in constant current mode

1A Current Regulator



20143816

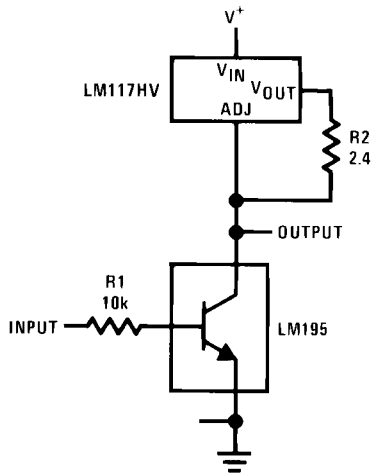
1.2V-20V Regulator with Minimum Program Current



20143817

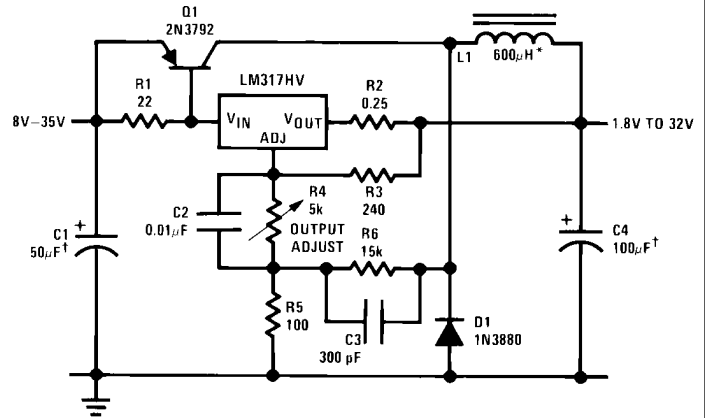
*Minimum load current ≈ 4 mA

High Gain Amplifier



20143818

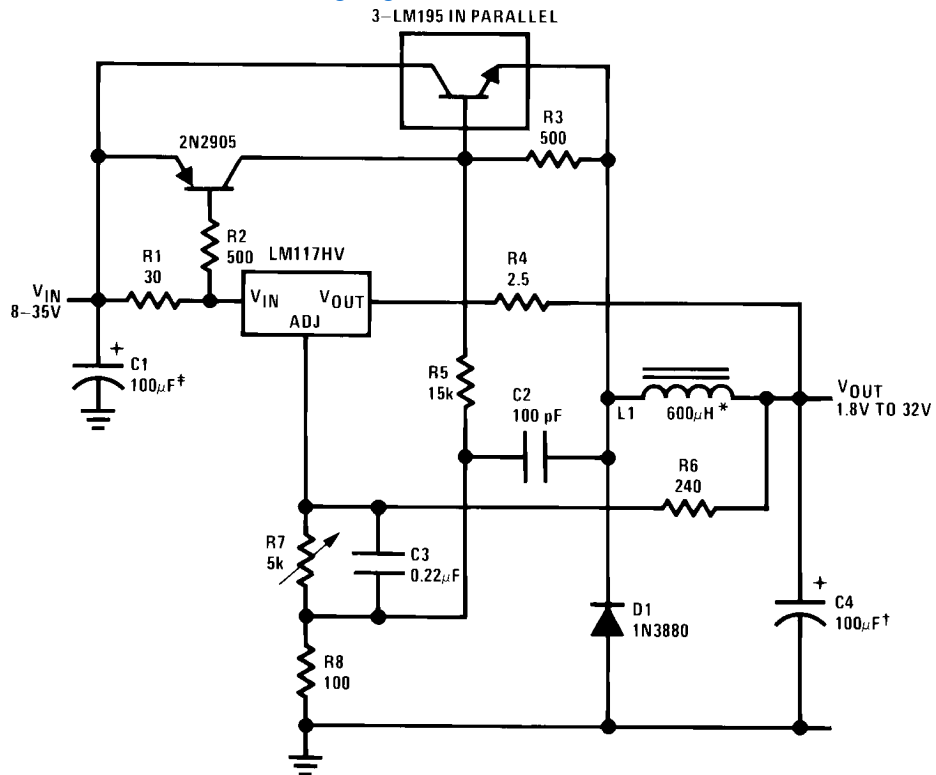
Low Cost 3A Switching Regulator



†Solid tantalum
*Core—Arnold A-254168-2 60 turns

20143819

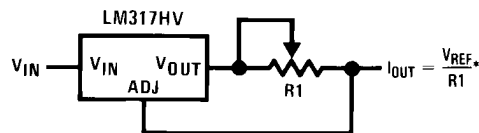
4A Switching Regulator with Overload Protection



20143820

†Solid tantalum
*Core—Arnold A-254168-2 60 turns

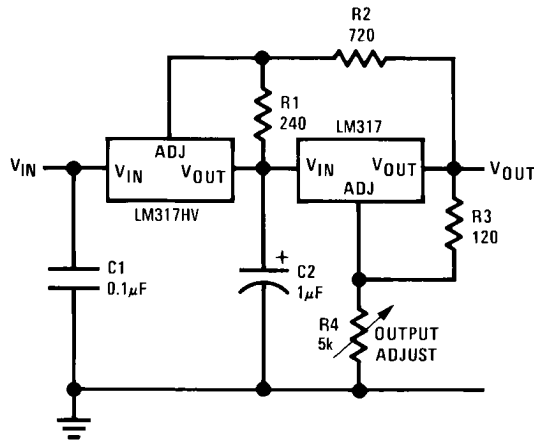
Precision Current Limiter



20143821

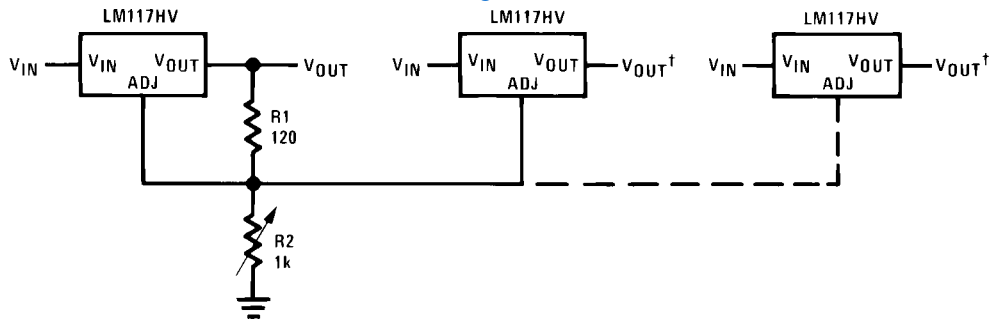
* $0.8\Omega \leq R1 \leq 120\Omega$

Tracking Preregulator



20143822

Adjustable Multiple On-Card Regulators with Single Control*

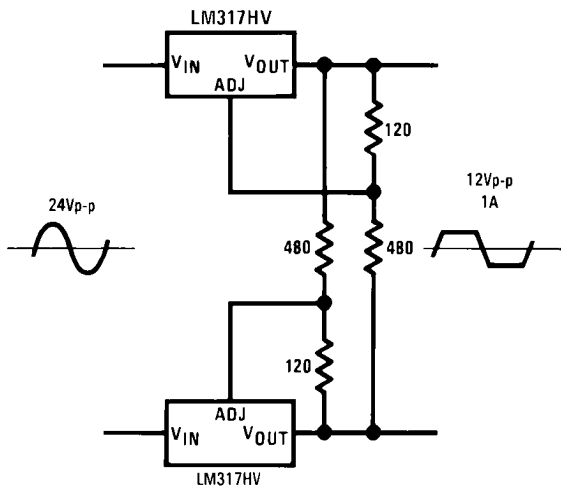


20143823

*All outputs within ±100 mV

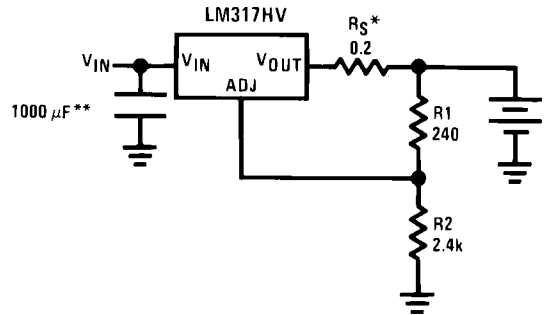
†Minimum load—10 mA

AC Voltage Regulator



20143824

12V Battery Charger



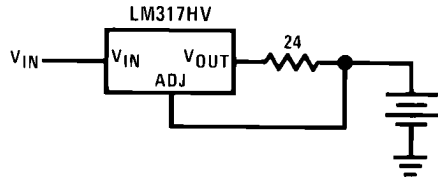
20143825

$$*R_S \text{—sets output impedance of charger } Z_{OUT} = R_S \left(1 + \frac{R_2}{R_1} \right)$$

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

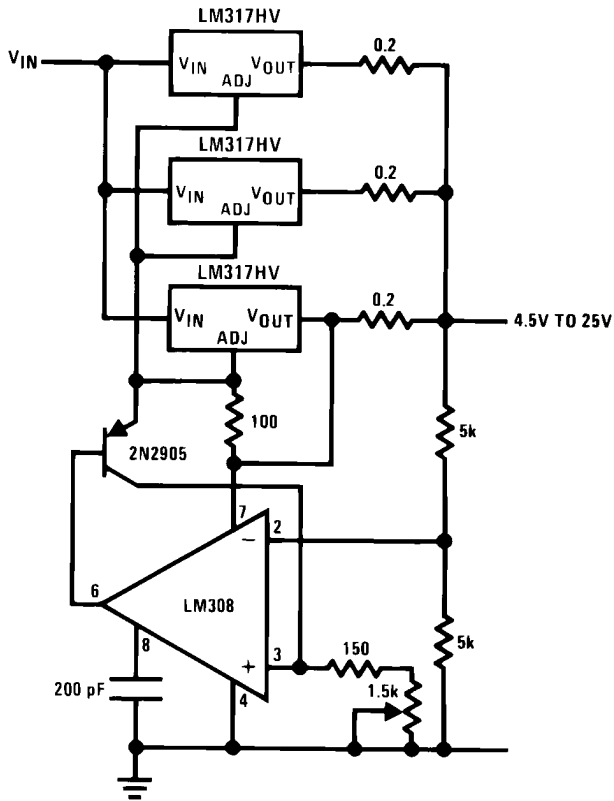
**The 1000 μF is recommended to filter out input transients

50 mA Constant Current Battery Charger



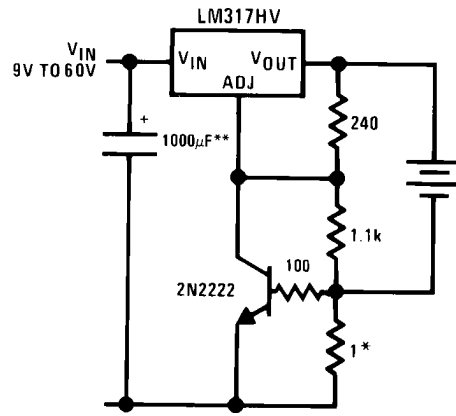
20143826

Adjustable 4A Regulator



20143827

Current Limited 6V Charger



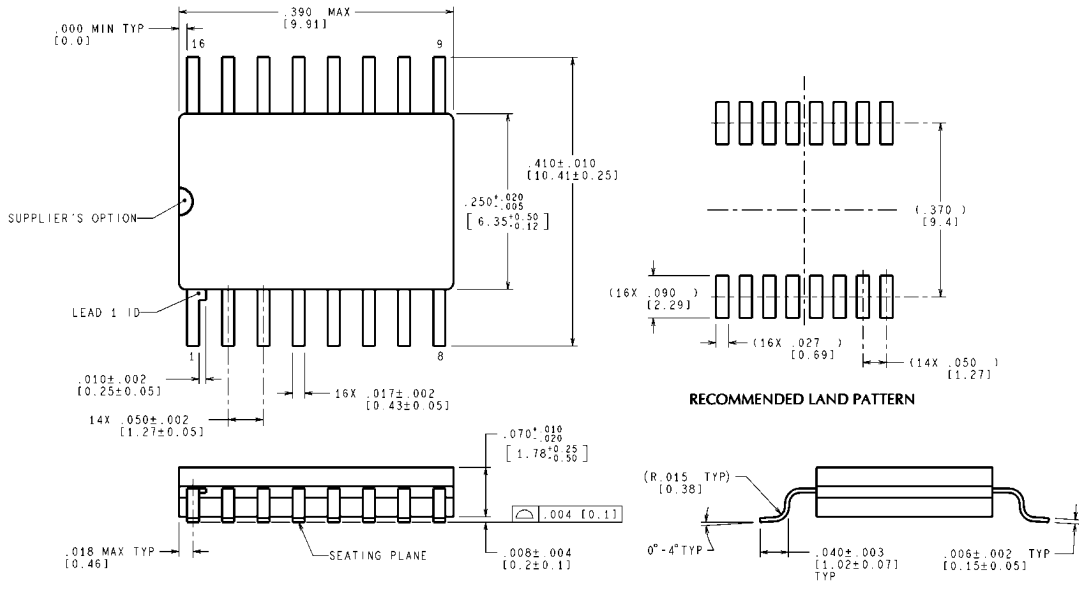
20143828

*Sets peak current (0.6A for 1Ω)

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

Revision History

Date Released	Revision	Section	Originator	Changes
03/14/06	A	New Release, Corporate format	L. Lytle	2 MDS datasheets converted into one Corporate datasheet format. Corrected I_L from 60mA to 8mA for R_{Line} . Separated Delta I_{Adj} / Line from Delta I_{Adj} / Load for both the H & K devices. Removed drift from MNLM117HV-H electrical characteristics since not performed on 883 product. MNLM117HV-K Rev 0C1 & MNLM117HV-H Rev 2A1 will be archived.
07/06/07	B	Features, Ordering Information, Connection Diagram, Absolute Maximum Ratings, Electrical's, Notes and Physical Dimensions	Larry McGee	Added Radiation information and WG information to data sheet. Revision A to be Archived.
02/13/08	C	Features, Ordering Information, Electrical's, Notes and Typical Radiation Characteristics, Physical Dimensions Drawing	Larry McGee	Added ELDRS NSID information, HVH & HVWG Delta and Post Radiation Table, Typical Radiation Characteristics Plots, Note 8, 9 and WG Market Drawing. Revision B to be Archived.
09/02/11	D	Ordering Information, Absolute Maximum Ratings	Larry McGee	Added 'GW' NSIDS & SMD numbers. Added Theta JA and Theta JC for 'GW' devices. Revision C to be Archived.



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