LM117HVQML 3-Terminal Adjustable Regulator

Check for Samples: **LM117HVQML**, **LM117HVQML-SP**

FEATURES

- **Available with Radiation Ensured**
  - **Total Ionizing Dose 100 krad(Si)**
  - **Low Dose Rate Qualified 100 krad(Si)**
- **Adjustable Output down to 1.2V**
- **Specified 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**

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.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

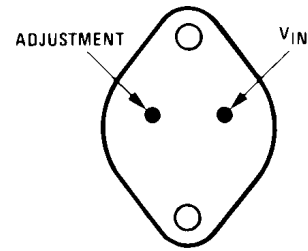All trademarks are the property of their respective owners.

CONNECTION DIAGRAMS

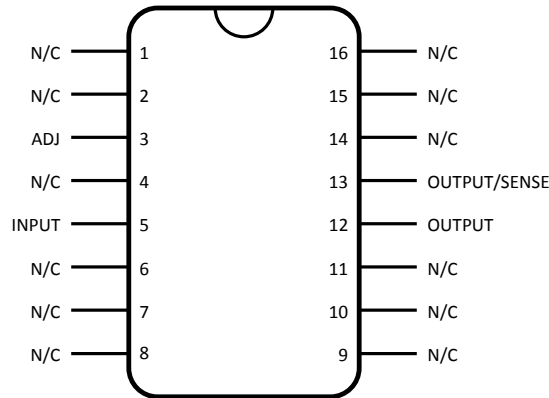(See Physical Dimension section for further information)
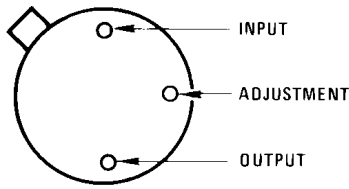
CASE IS OUTPUT

**Figure 1. 3-Pin TO Metal Can Package
Bottom View
See NDT003A Package**

CASE IS OUTPUT

**Figure 2. 2-Pin TO Metal Can Package
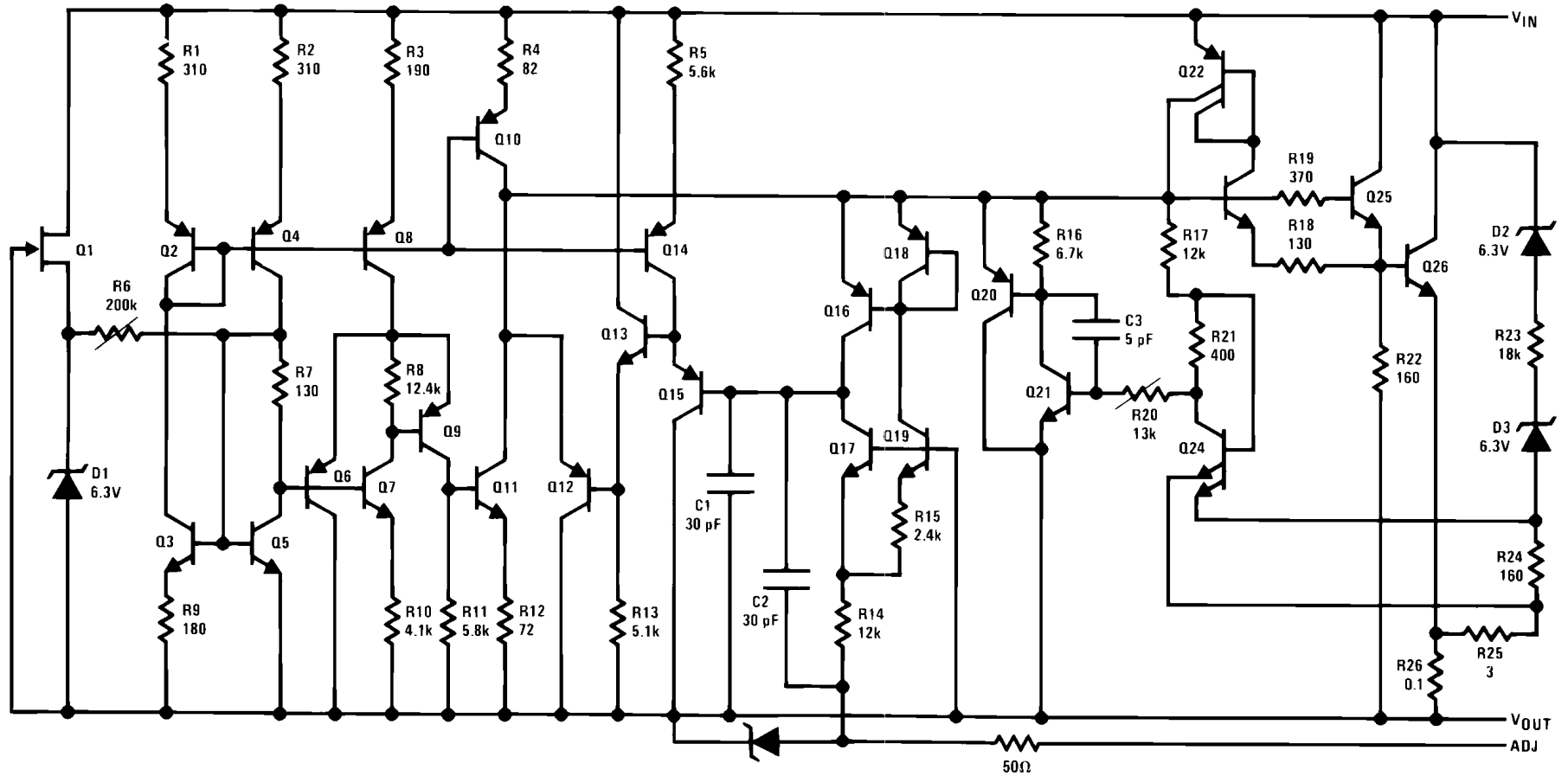Bottom View
See K0002C Package**

For the CFP device to function properly, the "Output" and "Output/Sense" pins must be connected on the users printed circuit board.

**Figure 3. 16-Pin CFP
Top View**

Table 1. LM117HV Series Packages

Part Number Suffix	Package	Design Load Current
H	TO	0.5A
K	TO	1.5A
WG, GW	CFP	0.5A

Schematic Diagram

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings[1]

Power Dissipation[2]			Internally limited
Input - Output Voltage Differential			+60V, −0.3V
Maximum Junction Temperature			+150°C
Storage Temperature			−65°C ≤ T_A ≤ +150°C
Lead Temperature (Soldering, 10 sec.)			300°C
Thermal Resistance	θ_{JA}	TO Metal Can - Still Air	39°C/W
		TO Metal Can - 500LF/Min Air flow	14°C/W
		TO Metal Can - Still Air	186°C/W
		TO Metal Can - 500LF/Min Air flow	64°C/W
		CFP "WG" (device 01, 61) - Still Air	115°C/W
		CFP "WG" (device 01, 61) - 500LF/Min Air flow	66°C/W
		CFP "GW" (device 02, 62) - Still Air	130°C/W
		CFP "GW" (device 02, 62) - 500LF/Min Air flow	80°C/W
	θ_{JC}	TO Metal Can	1.9°C/W
		TO Metal Can	21°C/W
		CFP "WG" (device 01, 61)[3]	3.4°C/W
		CFP "GW" (device 02, 62)	7°C/W
ESD Tolerance[4]			2000V

(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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(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 $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$ 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 PFM package and 20W for the TO package."

(3) 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.

(4) Human body model, 1.5 kΩ in series with 100 pF.

Recommended Operating Conditions

Operating Temperature Range	−55°C ≤ T_A ≤ +125°C

Table 2. 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

Product Folder Links: *LM117HVQML LM117HVQML-SP*

Table 2. Quality Conformance Inspection (continued)

Mil-Std-883, Method 5005 - Group A		
Subgroup	Description	Temp °C
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. $V_{Diff} = (V_I - V_O)$, $I_L = 8mA$, $V_{OUT} = 1.25V$ (Nominal)

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
		$V_I = 40V$, $V_O = 1.7V$			5.0	mA	1, 2, 3
		$V_I = 60V$, $V_O = 1.7V$			8.2	mA	1
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	$3V \leq V_{Diff} \leq 40V$, $V_O = V_{Ref}$		-8.64	8.64	mV	1
		$3.3V \leq V_{Diff} \leq 40V$, $V_O = V_{Ref}$		-18	18	mV	2, 3
		$40V \leq V_{Diff} \leq 60V$, $I_L = 60mA$		-25	25	mV	1
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
Delta I_{Adj} / Load	Adjustment Pin 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

LM117HVH, HVWG Electrical Characteristics DC Parameters (continued)

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

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
Delta I_{Adj} / Line	Adjustment Pin 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	$V_{Diff} = 60V$		0.0	0.4	A	1
		$V_{Diff} = 4.25V$		0.5	1.8	A	1
$θ_R$	Thermal Regulation	$V_{Diff} = 40V$, $I_L = 150mA$, $t = 20mS$			6.0	mV	1

LM117HVH, HVWG Electrical Characteristics AC Parameters

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

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

(1)   Tested @ 25°C; specified, but not tested @ 125°C & −55°C

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	$V_{Diff} = 3V$		-10	10	µA	1
		$V_{Diff} = 40V$		-10	10	µA	1
V_{Ref}	Reference Voltage	$V_{Diff} = 3V$		-0.01	0.01	V	1
		$V_{Diff} = 40V$		-0.01	0.01	V	1
V_{RLine}	Line Regulation	$3V ≤ V_{Diff} ≤ 40V$, $V_O = V_{Ref}$		-4.0	4.0	mV	1
		$40V ≤ V_{Diff} ≤ 60V$, $I_L = 60mA$		-6.0	6.0	mV	1

LM117HVH, HVWG Post Radiation Electrical Characteristics DC Parameters

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

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

LM117HVH, HVWG Post Radiation Electrical Characteristics AC Parameters

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

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

LM117HVK Electrical Characteristics DC Parameters

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

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_I = 40V, V_O = 1.7V			5.0	mA	1, 2, 3
		V_I = 60V, V_O = 1.7V		0.25	8.2	mA	1
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	$3V \leq V_{Diff} \leq 40V$, $V_O = V_{Ref}$		-8.64	8.64	mV	1
		$3.3V \leq V_{Diff} \leq 40V$, $V_O = V_{Ref}$		-18	18	mV	2, 3
		$40V \leq V_{Diff} \leq 60V$, I_L = 60mA		-25	25	mV	1
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
Delta I_{Adj} / Load	Adjustment Pin 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
Delta I_{Adj} / Line	Adjustment Pin 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} = 60V		0.0	0.4	A	1
		V_{Diff} = 3V		1.5	3.5	A	1
θ_R	Thermal Regulation	V_{Diff} = 40V, I_L = 300mA, t = 20mS			10.5	mV	1

LM117HVK Electrical Characteristics AC 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
RR	Ripple Rejection	V_I = +6.25V, f = 120Hz, e_I = $1V_{RMS}$, I_L = 0.5A, $V_O = V_{Ref}$	See[1]	66		dB	4, 5, 6

(1)   Tested @ 25°C; specified, but not tested @ 125°C & −55°C

Typical Performance Characteristics
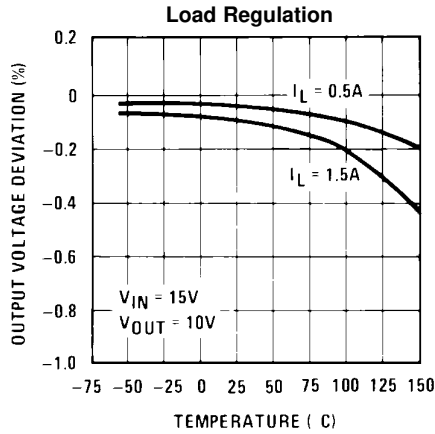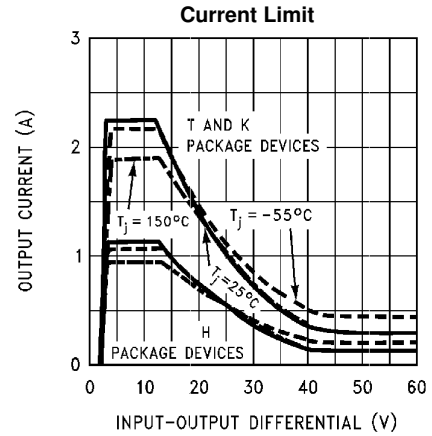
Output capacitor = 0 μF unless otherwise noted.

Load Regulation

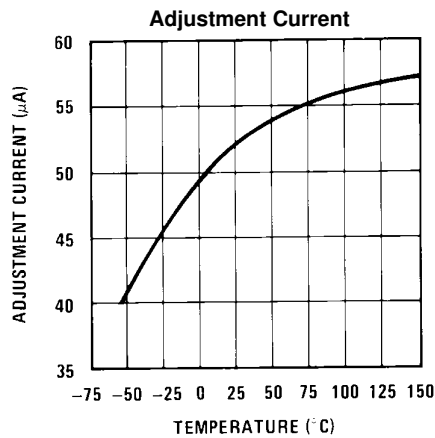Figure 4.

Current Limit

Figure 5.

Adjustment Current

Figure 6.

Dropout Voltage

Figure 7.

Temperature Stability

Figure 8.

Minimum Operating Current

Figure 9.

Product Folder Links: *LM117HVQML LM117HVQML-SP*
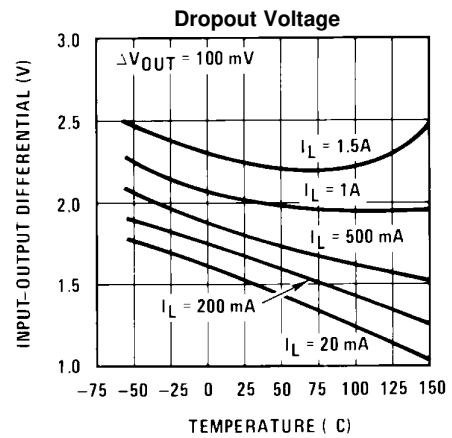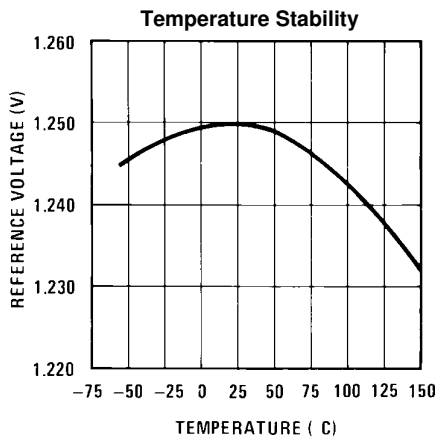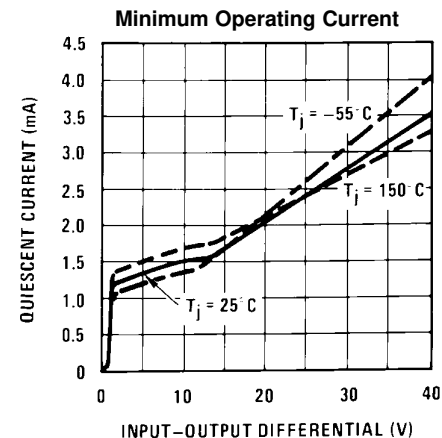
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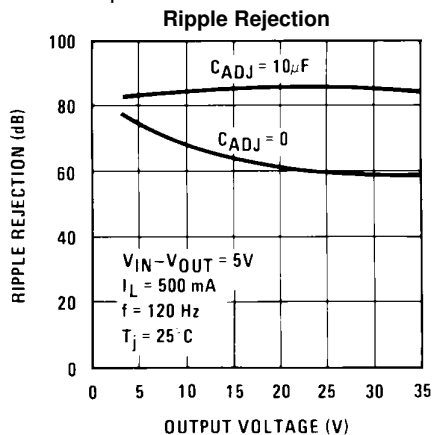
Ripple Rejection

Figure 10.

Ripple Rejection

Figure 11.

Ripple Rejection

Figure 12.

Output Impedance

Figure 13.

Line Transient Response

Figure 14.

Load Transient Response

Figure 15.
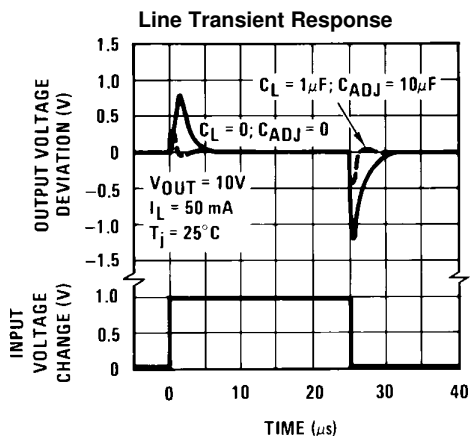
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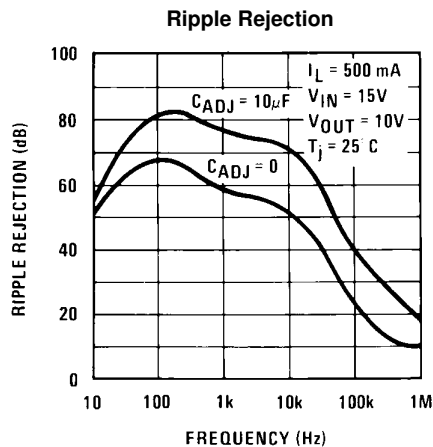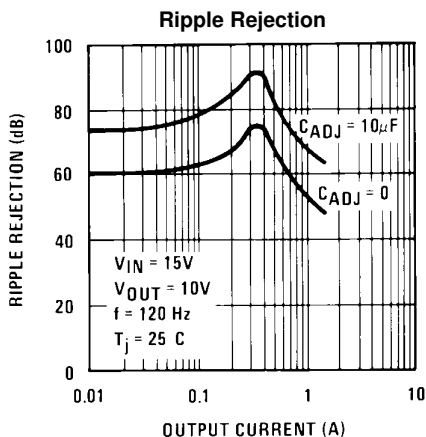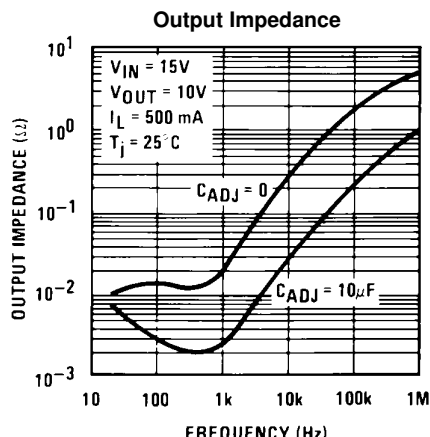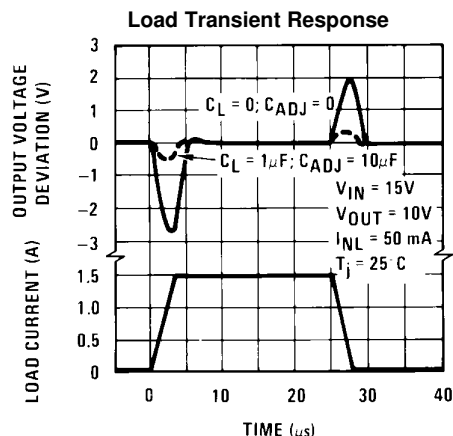
Typical Radiation Characteristics

Irradiation conditions: V_I = 60V; low dose rate = 10 mrad(Si)/s

Reference Voltage

Figure 16.

Load Regulation

Figure 17.

Line Regulation

Figure 18.

Ripple Rejection

Figure 19.

Product Folder Links: *LM117HVQML LM117HVQML-SP*
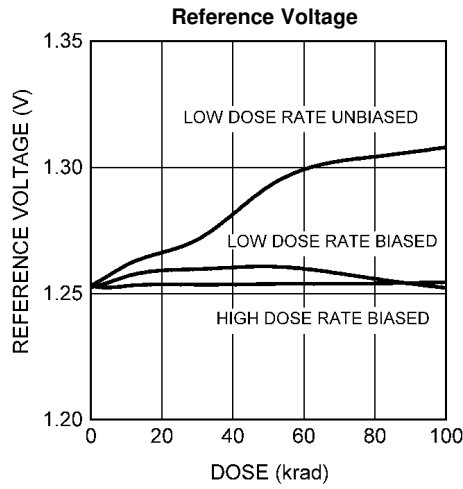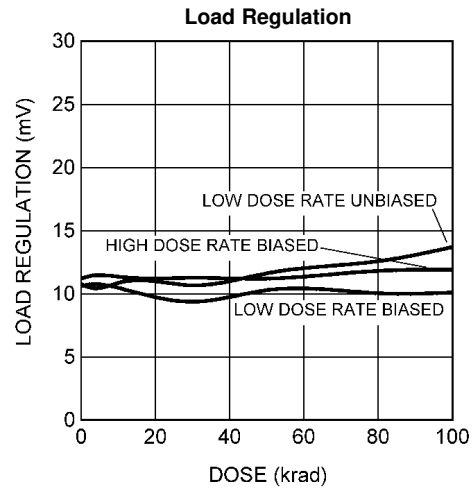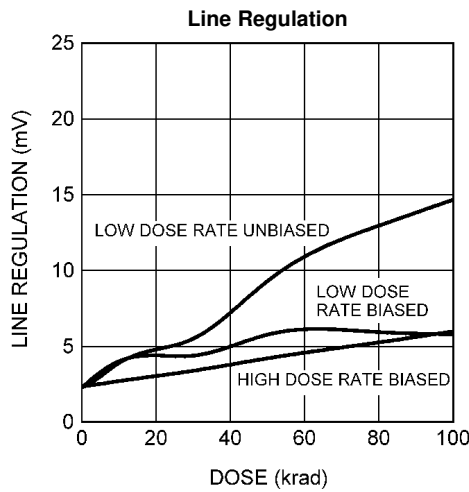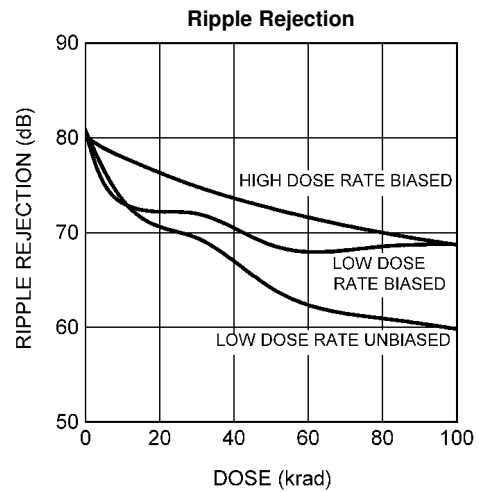
APPLICATION HINTS

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

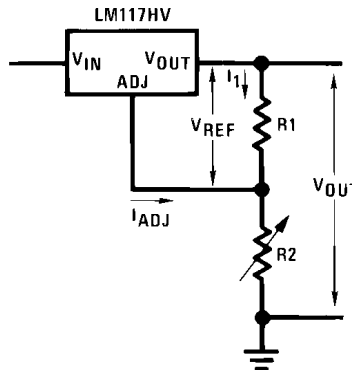$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

(1)

Figure 20.

Since the 100 µA 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 µF disc or 1 µF 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 µF bypass capacitor 80 dB ripple rejection is obtainable at any output level. Increases over 10 µF 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 µF in aluminum electrolytic to equal 1 µF 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 µF disc may seem to work better than a 0.1 µF disc as a bypass.

Although the LM117HV 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 1 µF solid tantalum (or 25 µF aluminum electrolytic) on the output swamps this effect and insures stability. Any increase of load capacitance larger than 10 µF 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 240Ω) 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 0.05Ω 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 21 shows the effect of resistance between the regulator and 240Ω set resistor.
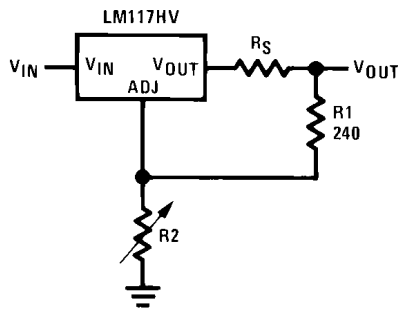
Figure 21. Regulator with Line Resistance in Output Lead

With the TO package, it is easy to minimize the resistance from the case to the set resistor, by using two separate leads to the case. However, 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.
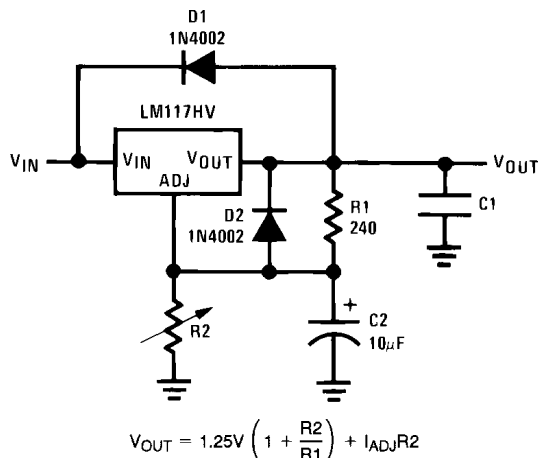
PROTECTION DIODES

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 μF 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 μF 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 22 shows an LM117HV with protection diodes included for use with outputs greater than 25V and high values of output capacitance.

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.

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

D1 protects against C1
D2 protects against C2

Figure 22. Regulator with Protection Diodes

Typical Applications
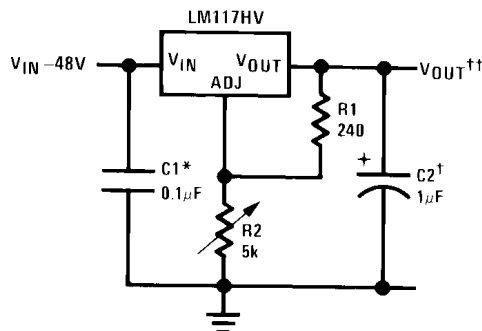
Full output current not available at high input-output voltages
†Optional—improves transient response. Output capacitors in the range of 1 µF to 1000 µF of aluminum or tantalum electrolytic
are commonly used to provide improved output impedance and rejection of transients.
*Needed if device is more than 6 inches from filter capacitors.
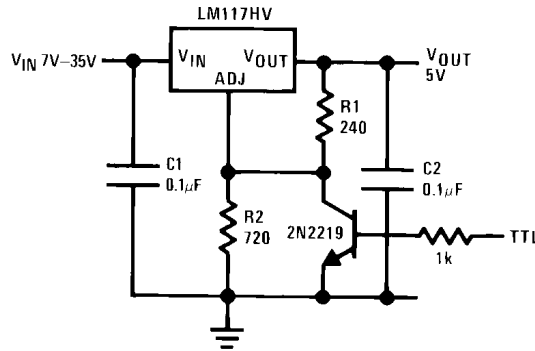
$$\dagger\dagger V_{OUT} = 1.25V \left(1 + \frac{R2}{R1} \right) + I_{ADJ}R_2$$

Figure 23. 1.2V-45V Adjustable Regulator
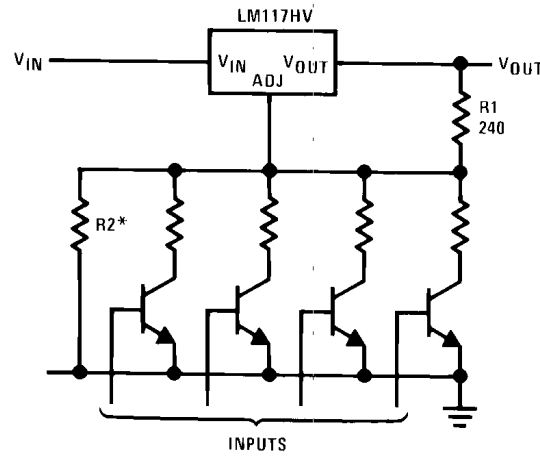
*Sets maximum V_{OUT}

Figure 24. Digitally Selected Outputs

*Min. output ≈ 1.2V

Figure 25. 5V Logic Regulator with Electronic Shutdown*
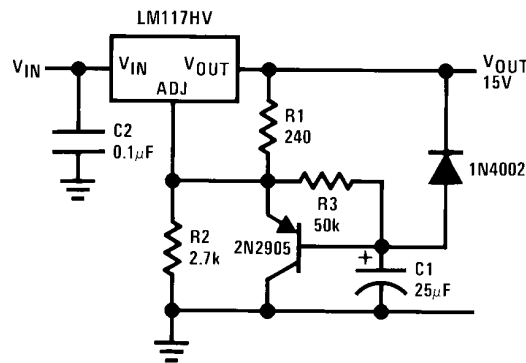
Figure 26. Slow Turn-On 15V Regulator

Product Folder Links: *LM117HVQML LM117HVQML-SP*
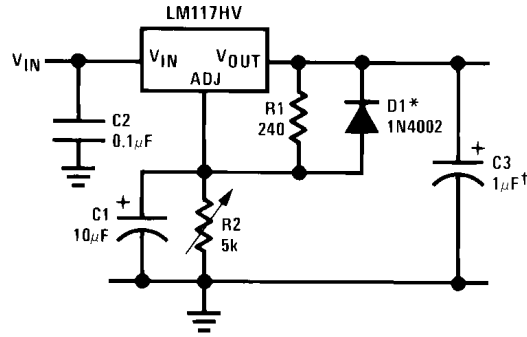
†Solid tantalum
*Discharges C1 if output is shorted to ground

Figure 27. Adjustable Regulator with Improved Ripple Rejection
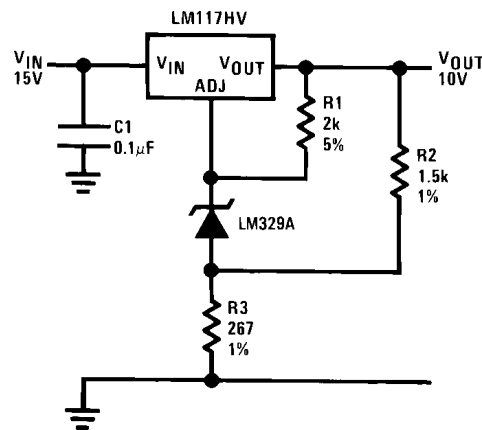
Figure 28. High Stability 10V Regulator
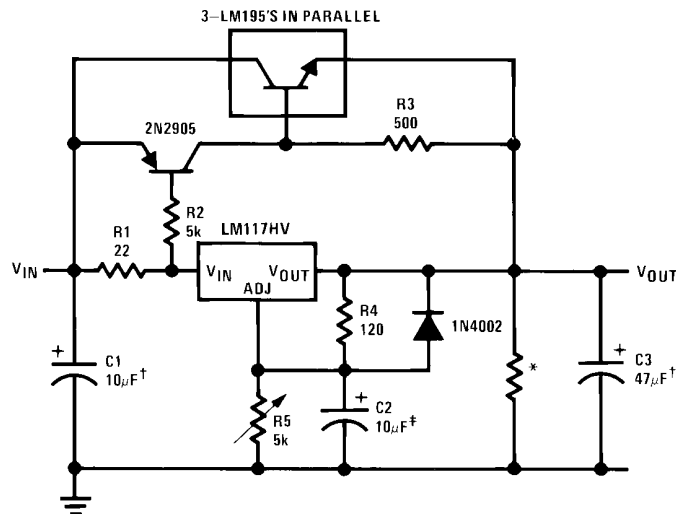
†Solid tantalum
*Minimum load current = 30 mA
‡Optional—improves ripple rejection

Figure 29. High Current Adjustable Regulator
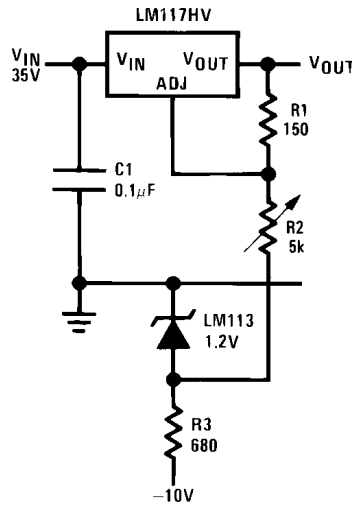
Full output current not available at high input-output voltages

Figure 30. 0 to 30V Regulator
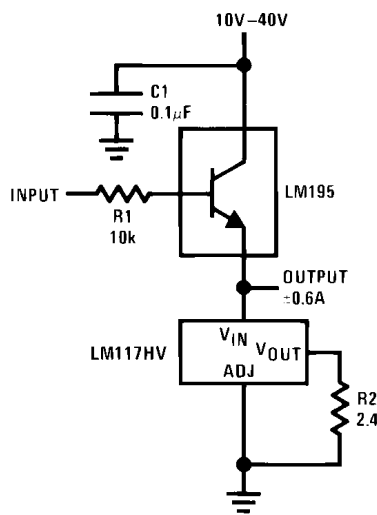
Figure 31. Power Follower
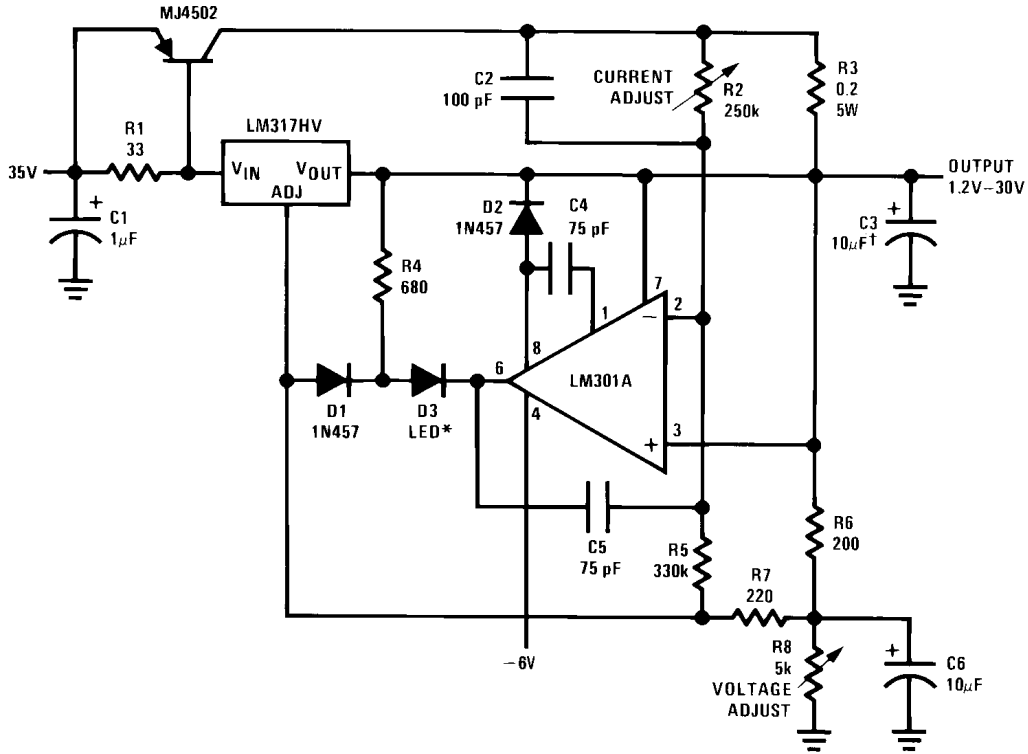
†Solid tantalum
*Lights in constant current mode

Figure 32. 5A Constant Voltage/Constant Current Regulator
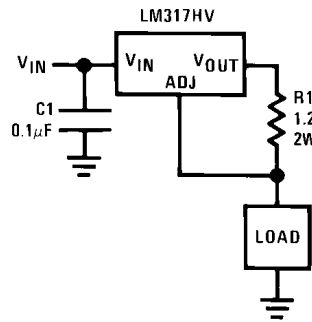
Figure 33. 1A Current Regulator
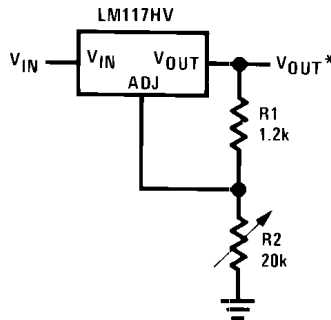
*Minimum load current ≈ 4 mA

Figure 34. 1.2V–20V Regulator with Minimum Program Current
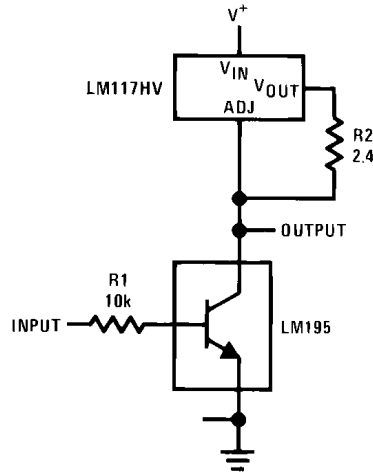
Figure 35. High Gain Amplifier
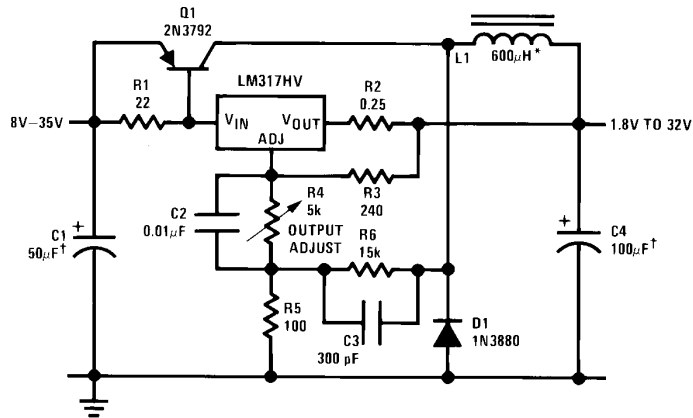
†Solid tantalum
*Core—Arnold A-254168-2 60 turns

Figure 36. Low Cost 3A Switching Regulator

Product Folder Links: *LM117HVQML LM117HVQML-SP*
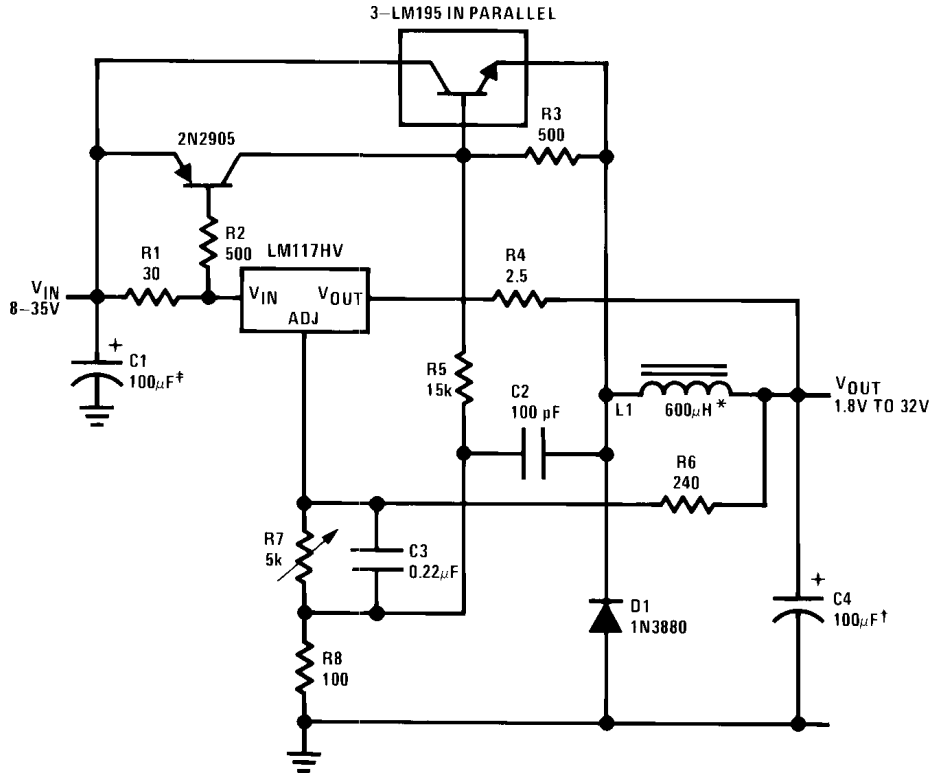
†Solid tantalum
*Core—Arnold A-254168-2 60 turns

Figure 37. 4A Switching Regulator with Overload Protection

* 0.8Ω ≤ R1 ≤ 120Ω
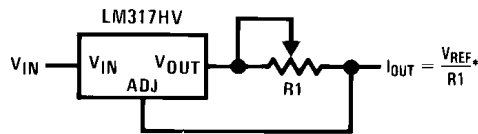
Figure 38. Precision Current Limiter
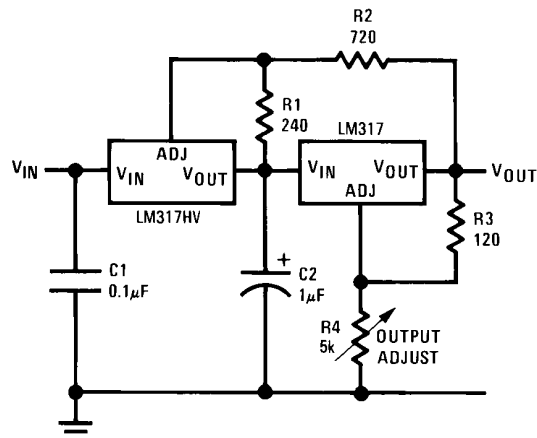
Figure 39. Tracking Preregulator
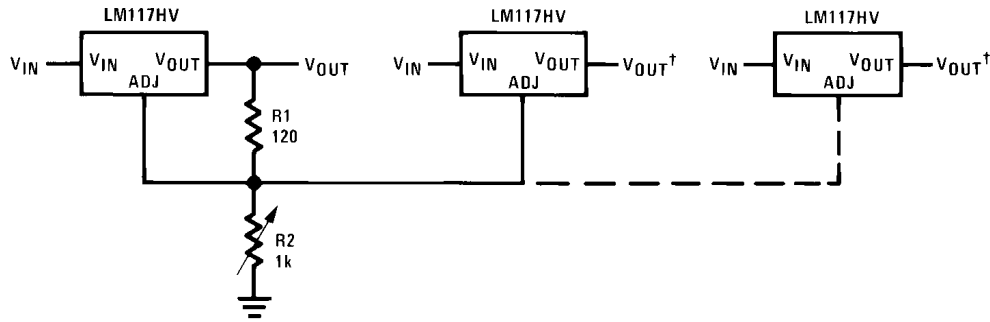
*All outputs within ±100 mV
†Minimum load—10 mA

Figure 40. Adjustable Multiple On-Card Regulators with Single Control*
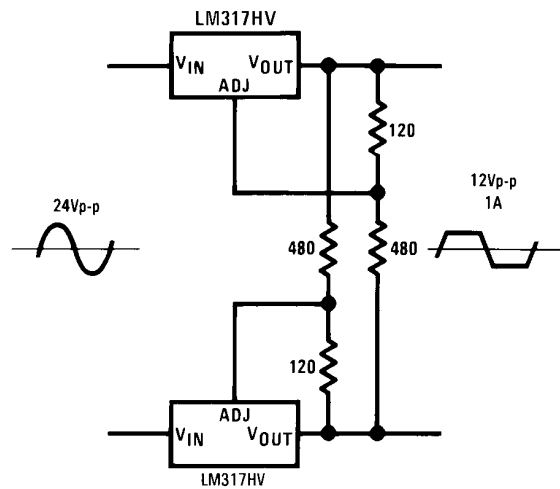
Figure 41. AC Voltage Regulator
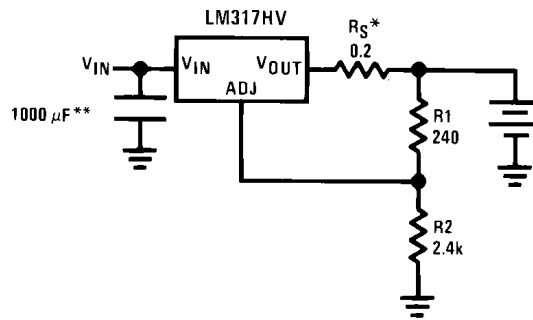
$$*R_S\text{—sets output impedance of charger } Z_{OUT} = R_S \left(1 + \frac{R2}{R1} \right)$$

Use of R_S allows low charging rates with fully charged battery.
**The 1000 μF is recommended to filter out input transients

Figure 42. 12V Battery Charger

Product Folder Links: *LM117HVQML LM117HVQML-SP*
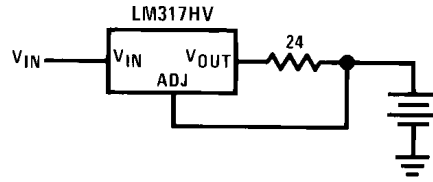
Figure 43. 50 mA Constant Current Battery Charger
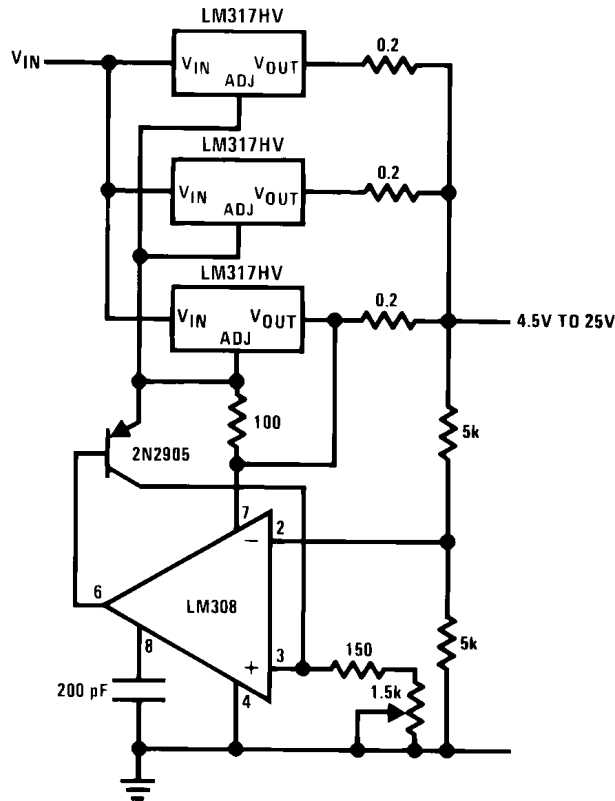
Figure 44. Adjustable 4A Regulator
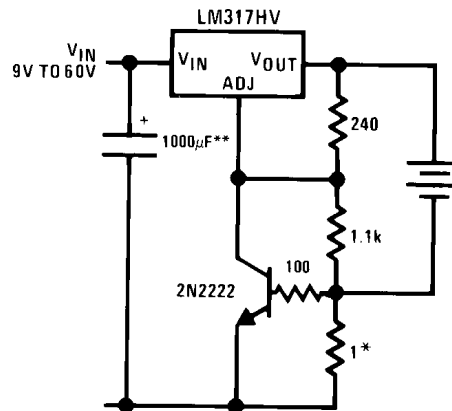
*Sets peak current (0.6A for 1Ω)
**The 1000 µF is recommended to filter out input transients

Figure 45. Current Limited 6V Charger

Product Folder Links: *LM117HVQML LM117HVQML-SP*

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. Deleted Ordering Information table.
04/17/2013	D			Changed layout of National Data Sheet to TI format.

Product Folder Links: *LM117HVQML LM117HVQML-SP*

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-0722901QXA	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVH-QML 5962-0722901QXA Q ACO 5962-0722901QXA Q >T	Samples
5962-0722902QZA	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGW QML Q 5962-07229 02QZA ACO 02QZA >T	Samples
5962R0722901V9A	ACTIVE	DIESALE	Y	0	42	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
5962R0722901VXA	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVHRQMLV 5962R0722901VXA Q ACO 5962R0722901VXA Q >T	Samples
5962R0722902VXA	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVHRLQMLV 5962R0722961VXA Q ACO 5962R0722961VXA Q >T	Samples
5962R0722902VZA	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGWR QMLV Q 5962R07229 02VZA ACO 02VZA >T	Samples
5962R0722961V9A	ACTIVE	DIESALE	Y	0	42	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
5962R0722961VXA	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVHRLQMLV 5962R0722961VXA Q ACO 5962R0722961VXA Q >T	Samples
5962R0722962VZA	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGWRL QMLV Q 5962R07229	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
										62VZA ACO 62VZA >T	
LM117HVGW-QML	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGW QML Q 5962-07229 02QZA ACO 02QZA >T	Samples
LM117HVGWRLQMLV	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGWRL QMLV Q 5962R07229 62VZA ACO 62VZA >T	Samples
LM117HVGWRQMLV	ACTIVE	CFP	NAC	16	42	TBD	Call TI	Call TI	-55 to 125	LM117HVGWR QMLV Q 5962R07229 02VZA ACO 02VZA >T	Samples
LM117HVH MDE	ACTIVE	DIESALE	Y	0	42	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM117HVH MDR	ACTIVE	DIESALE	Y	0	42	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM117HVH-QML	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVH-QML 5962-0722901QXA Q ACO 5962-0722901QXA Q >T	Samples
LM117HVH/883	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVH/883 Q ACO LM117HVH/883 Q >T	Samples
LM117HVHRLQMLV	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVHRLQMLV 5962R0722961VXA Q ACO 5962R0722961VXA Q >T	Samples
LM117HVHRQMLV	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 125	LM117HVHRQMLV 5962R0722901VXA Q ACO 5962R0722901VXA Q >T	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM117HVK/883	ACTIVE	TO	K	2	50	TBD	Call TI	Call TI	-55 to 125	LM117HVK /883 Q ACO /883 Q >T	Samples
LM117HVKG MD8	ACTIVE	DIESALE	Y	0	196	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF LM117HVQML, LM117HVQML-SP :

● Military: LM117HVQML

● Space: LM117HVQML-SP

NOTE: Qualified Version Definitions:

    ● Military - QML certified for Military and Defense Applications

    ● Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

K0002C

.460±.040
[11.68 1.02]

.293±.012
[7.44 0.30]

.065±.005
[1.65 0.12]

1.00±.02
[25.4±0.5]

2X Ø.156±.005
[3.96 0.12]

.665±.005
[16.89±0.12]

1.187±.010
[30.15 0.25]

R.503±.008
[12.78±0.20]

2X Ø.120 MAX
[3.05]

2X Ø.041 +.002 -.003
[1.04 +0.05 -0.08]

2X R.173±.005
[4.39±0.12]

.215±.005
[5.46±0.12]

.430±.005
[10.92±0.12]

.897 +.018 -.017
[22.78 +0.46 -0.43]

.767 +.008 -.007
[19.48 +0.20 -0.18]

.085 MAX
[2.16]

UNCONTROLLED
LEAD DIA
.030 MAX
[0.77]

SEATING PLANE

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

K02C (Rev E)

4214774/A 03/2013

NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

2. This drawing is subject to change without notice.

3. Leads not to be bent greater than 15º

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NAC0016A

.010±.002
[0.25±0.05]

LEAD 1 ID
NOTE 3

SUPPLIER OPTION
NOTE 3

.00 MIN TYP
[0.0]

.018 MAX TYP
[0.46]

.390 MAX
[9.91]

14X .050±.002
[1.27±0.05]

16X .017±.002
[0.43±0.05]

.250 +.020 -.005
[6.35 +0.50 -0.12]

.410±.010
[10.41±0.25]

.070 +.010 -.020
[1.78 +0.25 -0.50]

.008±.004 TYP
[0.2±0.1]

SEE DETAIL A

.006±.002 TYP
[0.15±0.05]

.004 [0.1]

SEATING PLANE

R.015±.002
[0.38±0.05]

0° - 4°

.040±.003
[1.02±0.07]

**MIL-PRF-38535
CONFIGURATION CONTROL**

DETAIL A
TYPICAL

WG16A (RevG)

Texas Instruments
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NDT0003A

SEATING PLANE

.500 MIN
[12.7]

.175±.010
[4.45±0.25]

Ø .360±.010
[9.14±0.25]

Ø .200
[5.08]

Ø .325±.010
[8.26±0.25]

Ø .0175±.0015
[0.445±0.038]
TYP

.035 +.005
-.006
[0.89 +0.12
-0.15]

3

2

1

45°

.031±.003
[0.79±0.07]

.050 MAX
[1.27]

.025   MAX
[0.63]
UNCONTROLLED
LEAD DIA

CONTROLLING DIMENSION IS INCH
VALUES IN [   ] ARE MILLIMETERS

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CONFIGURATION CONTROL

H03A (Rev D)

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