

LM117HV/LM317HV 3-Terminal Adjustable Regulator

 Check for Samples: [LM117HV](#), [LM317HV](#)

FEATURES

- Adjustable Output Down to 1.2V
- Specified 1.5A Output Current
- Line Regulation Typically 0.01%/V
- Load Regulation Typically 0.1%
- Current Limit Constant with Temperature
- 100% Electrical Burn-in
- Eliminates the Need to Stock Many Voltages
- Standard 3-lead Transistor Package
- 80 dB Ripple Rejection
- Output is Short-circuit Protected
- P⁺ Product Enhancement Tested

DESCRIPTION

The LM117HV/LM317HV are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 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. Also, the LM117HV is packaged in standard transistor packages which are easily mounted and handled.

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.

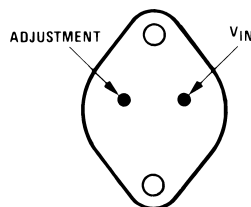
Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejections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

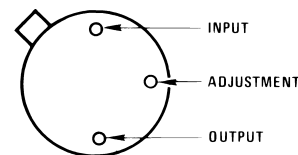
The LM117HVK STEEL and LM317HVK STEEL are packaged in standard TO-3 transistor packages, while the LM117HVH and LM317HVH are packaged in a solid Kovar base TO transistor package. The LM317HVT uses a TO-220 plastic package. The LM117HV is rated for operation from -55°C to +150°C, and the LM317HV from 0°C to +125°C.

Connection Diagrams



**Figure 1. (TO-3)
Metal Can Package
Case is Output
Bottom View**

See Package Number NDS0002A



**Figure 2. (TO)
Metal Can Package
Case is Output
Bottom View**

See Package Number NDT0003A



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.

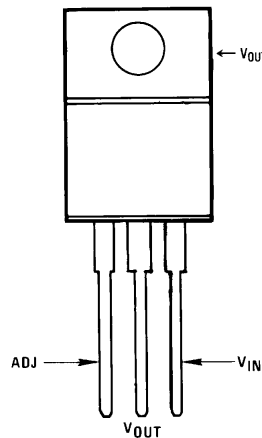
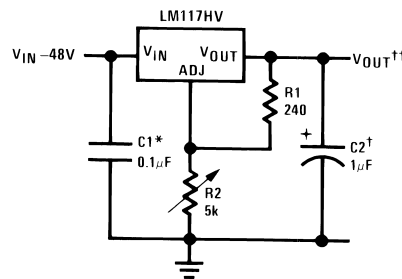


Figure 3. (TO-220) Plastic Package Front View
See Package Number NDE0003B

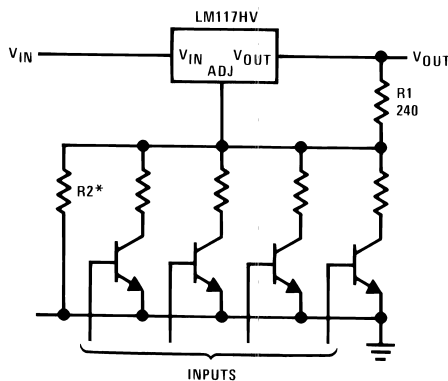
Typical Applications



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.

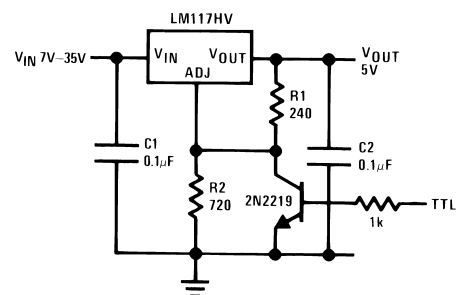
$$V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1} \right) + I_{ADJ} R_2$$

Figure 4. 1.2V-45V Adjustable Regulator



*Sets maximum V_{OUT}

Figure 5. Digitally Selected Outputs



*Min. output ≈ 1.2V

Figure 6. 5V Logic Regulator with Electronic Shutdown*



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⁾⁽²⁾

Power Dissipation		Internally limited
Input—Output Voltage Differential		+60V, -0.3V
Operating Junction Temperature Range	LM117HV	-55°C to +150°C
	LM317HV	0°C to +125°C
Storage Temperature		-65°C to +150°C
Lead Temperature (Soldering, 10 sec.)		300°C
ESD Tolerance ⁽³⁾		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.
 (2) Refer to RETS117HVH for LM117HVH or RETS117HVK for LM117HVK military specifications.
 (3) Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS⁽¹⁾

Parameter	Conditions	LM117HV			LM317HV			Units
		Min	Typ	Max	Min	Typ	Max	
Line Regulation	$T_J = 25^\circ\text{C}$, $3\text{V} \leq V_{IN} - V_{OUT} \leq 60\text{V}$ $I_L = 10\text{ mA}$ ⁽²⁾		0.01	0.02		0.01	0.04	%/V
Load Regulation	$T_J = 25^\circ\text{C}$, $10\text{ mA} \leq I_{OUT} \leq I_{MAX}$		0.1	0.3		0.1	0.5	%
Thermal Regulation	$T_J = 25^\circ\text{C}$, 20 ms Pulse		0.03	0.07		0.04	0.07	%/W
Adjustment Pin Current			50	100		50	100	μA
Adjustment Pin Current Change	$10\text{ mA} \leq I_L \leq I_{MAX}$ $3.0\text{ V} \leq (V_{IN} - V_{OUT}) \leq 60\text{V}$		0.2	5		0.2	5	μA
Reference Voltage	$3.0\text{ V} \leq (V_{IN} - V_{OUT}) \leq 60\text{V}$ ⁽³⁾ $10\text{ mA} \leq I_{OUT} \leq I_{MAX}$, $P \leq P_{MAX}$	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation	$3.0\text{V} \leq (V_{IN} - V_{OUT}) \leq 60\text{V}$, $I_L = 10\text{ mA}$, ⁽²⁾		0.02	0.05		0.02	0.07	%/V
Load Regulation	$10\text{ mA} \leq I_{OUT} \leq I_{MAX}$ ⁽²⁾		0.3	1		0.3	1.5	%
Temperature Stability	$T_{MIN} \leq T_J \leq T_{MAX}$		1			1		%
Minimum Load Current	$(V_{IN} - V_{OUT}) = 60\text{V}$		3.5	7		3.5	12	mA
Current Limit	$(V_{IN} - V_{OUT}) \leq 15\text{V}$ K, NDE Packages	1.5	2.2	3.5	1.5	2.2	3.7	A
			NDT Package	0.8		1.8	0.8	1.9
	$(V_{IN} - V_{OUT}) \leq 60\text{V}$ K, NDE Packages		0.3			0.3		A
		NDT Package		0.03			0.03	
RMS Output Noise, % of V_{OUT}	$T_J = 25^\circ\text{C}$, $10\text{ Hz} \leq f \leq 10\text{ kHz}$		0.003			0.003		%
Ripple Rejection Ratio	$V_{OUT} = 10\text{V}$, $f = 120\text{ Hz}$ $C_{ADJ} = 10\text{ }\mu\text{F}$		65			65		dB
		66	80		66	80		dB
Long-Term Stability	$T_J = 125^\circ\text{C}$		0.3	1		0.3	1	%

- (1) Unless otherwise specified, these specifications apply: $-55^\circ\text{C} \leq T_J \leq +150^\circ\text{C}$ for the LM117HV, and $0^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$ for the LM317HV; $V_{IN} - V_{OUT} = 5\text{V}$ and $I_{OUT} = 0.1\text{A}$ for the TO package and $I_{OUT} = 0.5\text{A}$ for the TO-3 and TO-220 packages. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO and 20W for the TO-3 and TO-220. I_{MAX} is 1.5A for the TO-3 and TO-220 and 0.5A for the TO package.
 (2) Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.
 (3) Refer to RETS117HVH for LM117HVH or RETS117HVK for LM117HVK military specifications.

ELECTRICAL CHARACTERISTICS⁽¹⁾ (continued)

Parameter	Conditions	LM117HV			LM317HV			Units
		Min	Typ	Max	Min	Typ	Max	
Thermal Resistance, Junction to Case	NDT Package		12	15		12	15	°C/W
	NDE Package					4	5	°C/W
	NDS Package		2.3	3		2.3	3	°C/W
Thermal Resistance, Junction to Ambient (no heat sink)	NDT Package		140			140		°C/W
	NDE Package					50		°C/W
	NDS Package		35			35		°C/W

TYPICAL PERFORMANCE CHARACTERISTICS

Output capacitor = 0 μ F unless otherwise noted.

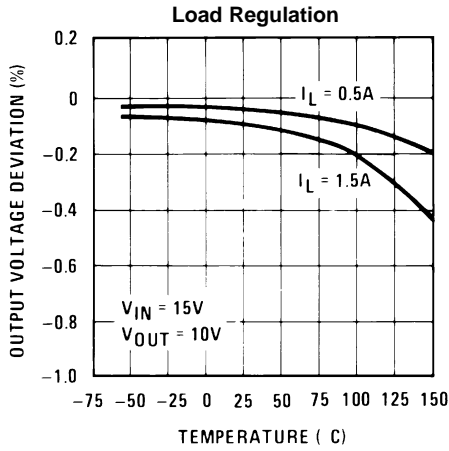


Figure 7.

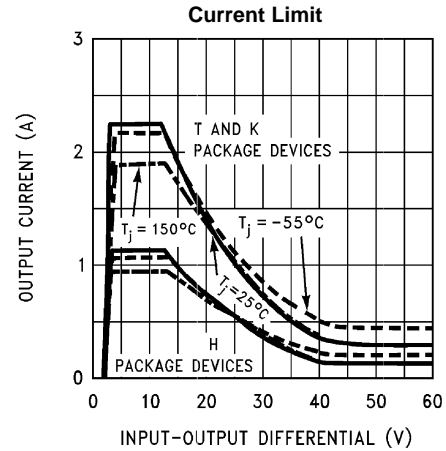


Figure 8.

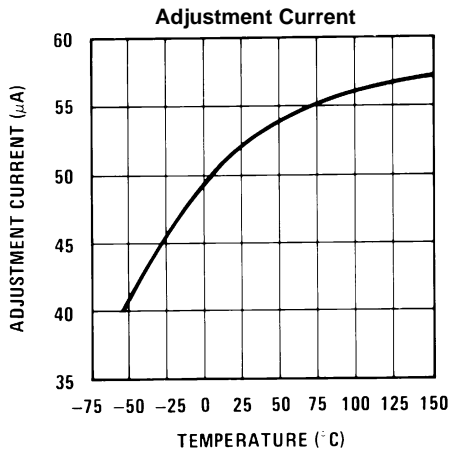


Figure 9.

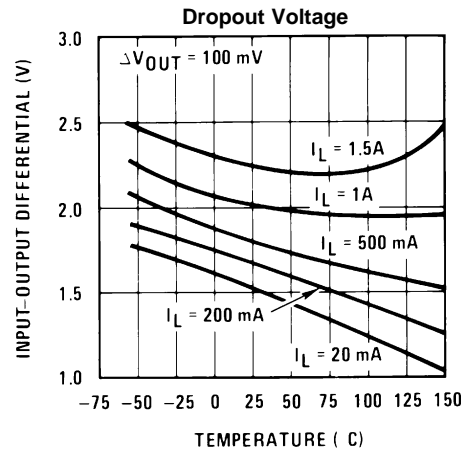


Figure 10.

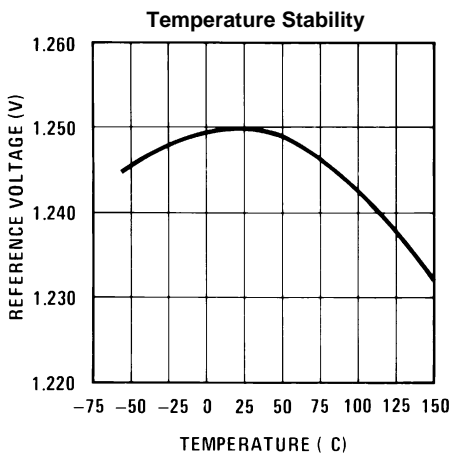


Figure 11.

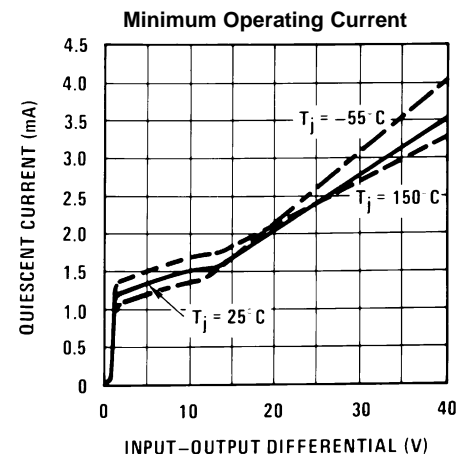


Figure 12.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Output capacitor = 0 μ F unless otherwise noted.

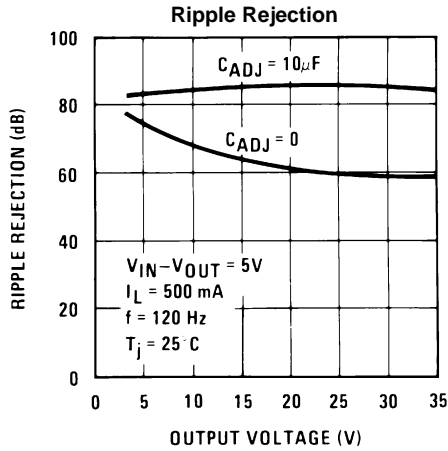


Figure 13.

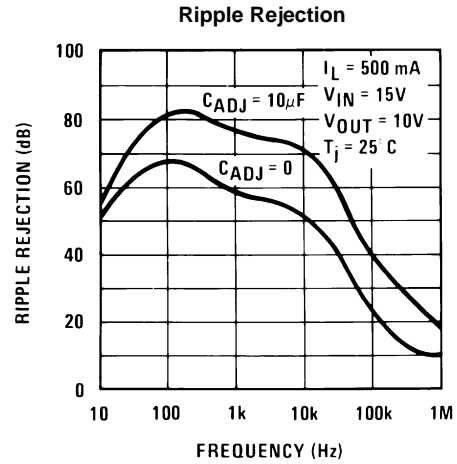


Figure 14.

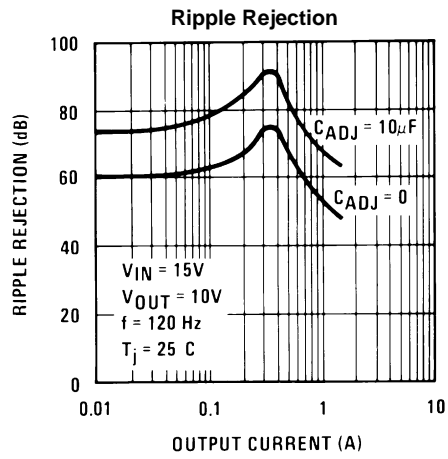


Figure 15.

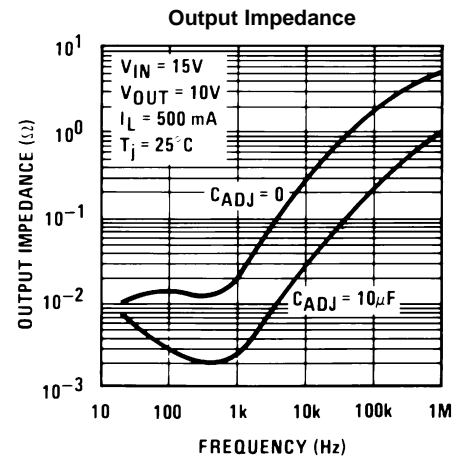


Figure 16.

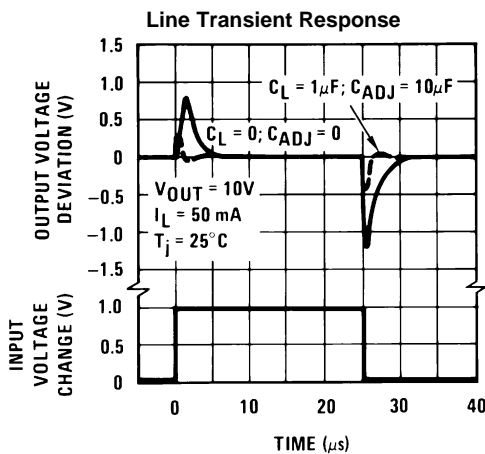


Figure 17.

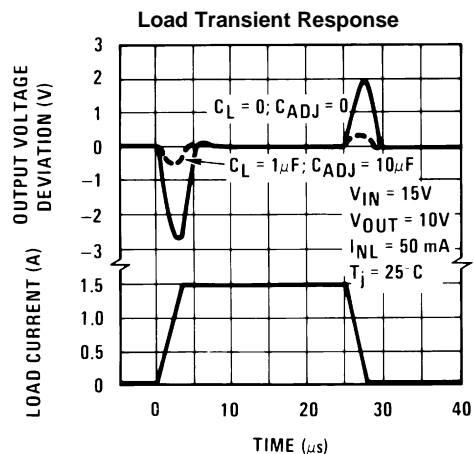
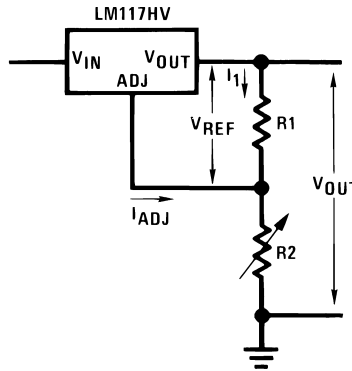


Figure 18.

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

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



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 capacitance 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 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 $0.05\Omega \times I_L$. If the set resistor is connected near the load the effective line resistance will be $0.05\Omega (1 + R_2/R_1)$ or in this case, 11.5 times worse.

Figure 19 shows the effect of resistance between the regulator and 240Ω set resistor.

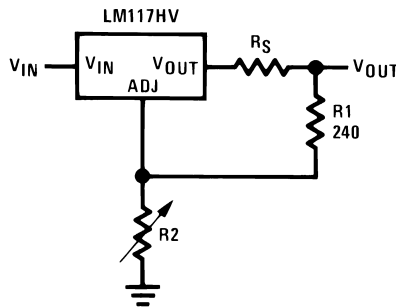


Figure 19. Regulator with Line Resistance in Output Lead

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 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 20 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.

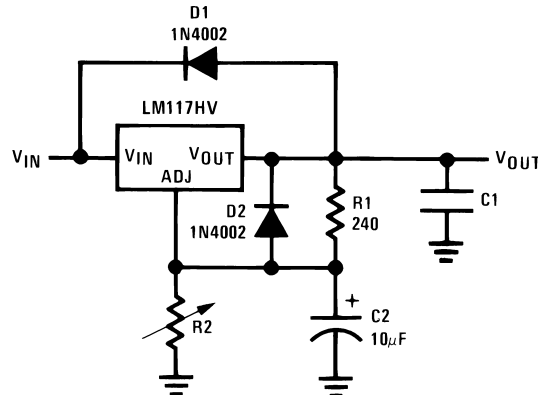
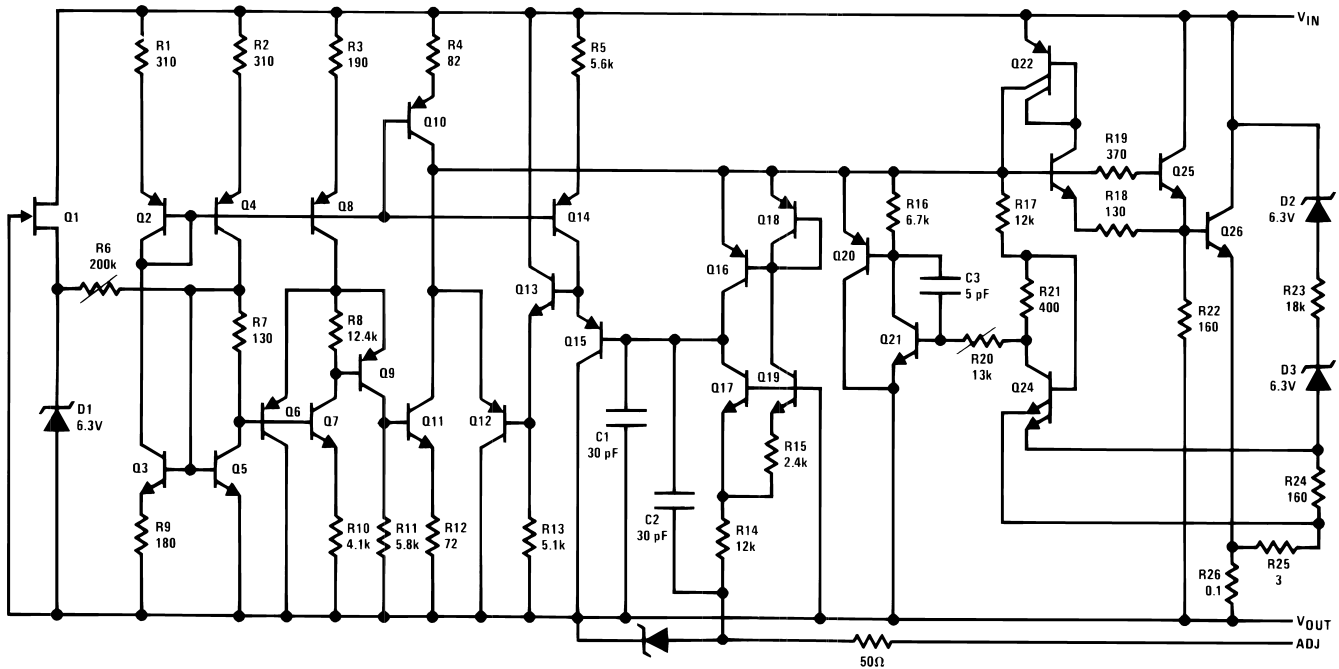


Figure 20. Regulator with Protection Diodes

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

- D1 protects against C1
- D2 protects against C2

Schematic Diagram



Typical Applications

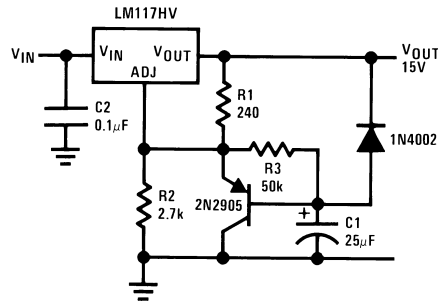
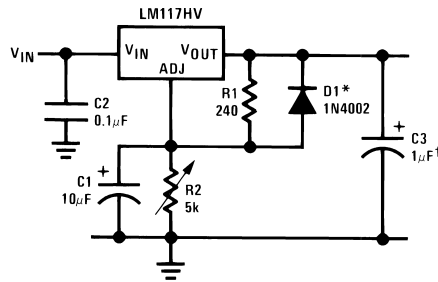


Figure 21. Slow Turn-On 15V Regulator



†Solid tantalum

*Discharges C1 if output is shorted to ground

Figure 22. Adjustable Regulator with Improved Ripple Rejection

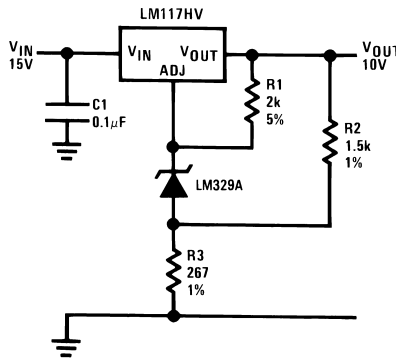
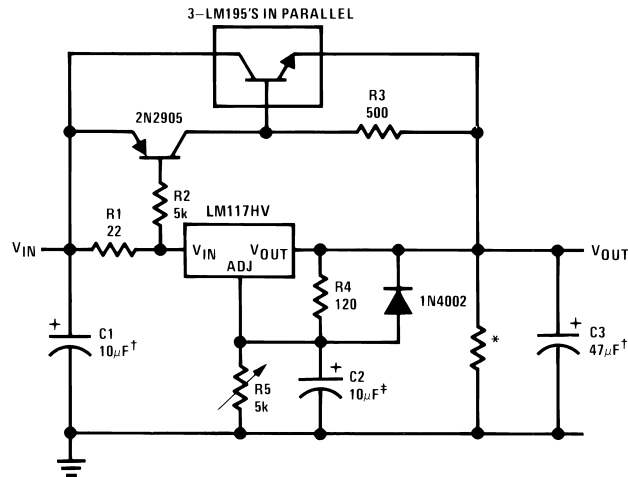


Figure 23. High Stability 10V Regulator

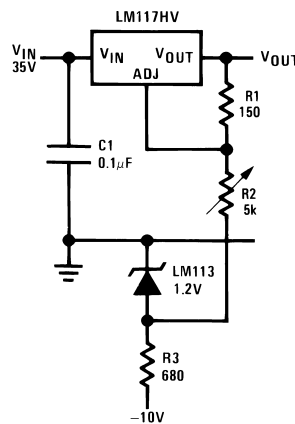


†Solid tantalum

*Minimum load current = 30 mA

‡Optional—improves ripple rejection

Figure 24. High Current Adjustable Regulator



Full output current not available at high input-output voltages

Figure 25. 0 to 30V Regulator

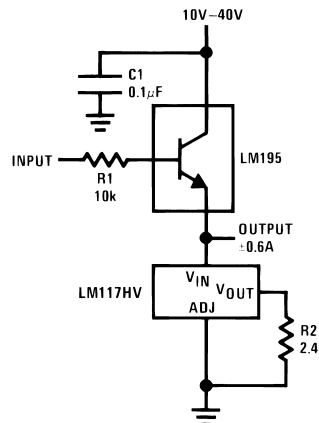
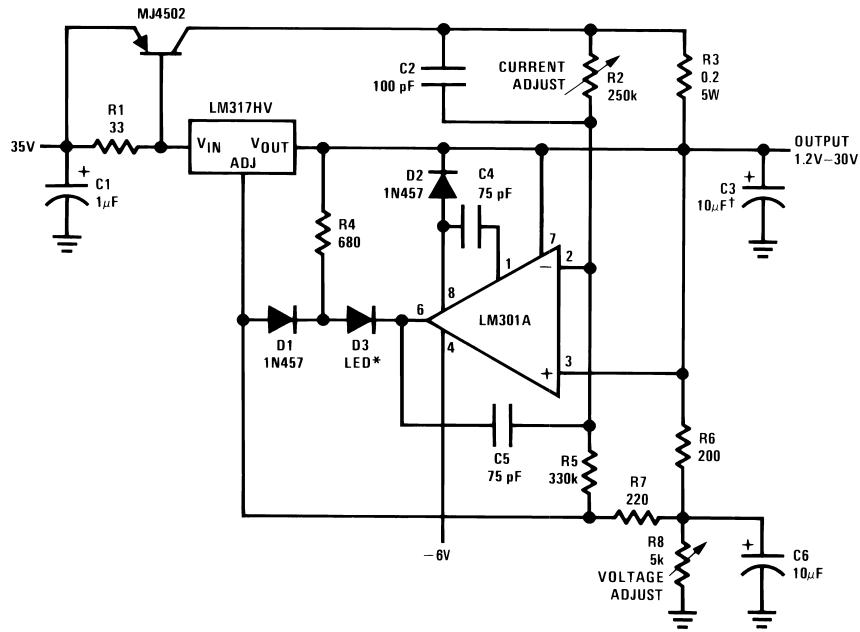


Figure 26. Power Follower



†Solid tantalum

*Lights in constant current mode

Figure 27. 5A Constant Voltage/Constant Current Regulator

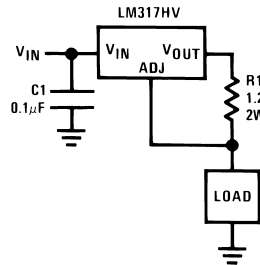
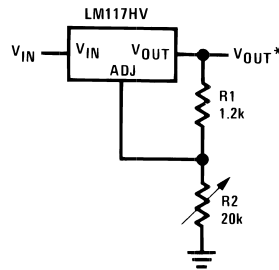


Figure 28. 1A Current Regulator



*Minimum load current ≈ 4 mA

Figure 29. 1.2V–20V Regulator with Minimum Program Current

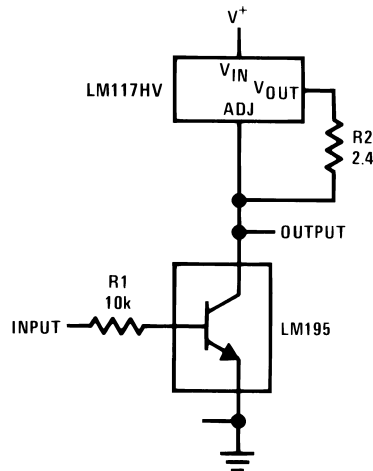
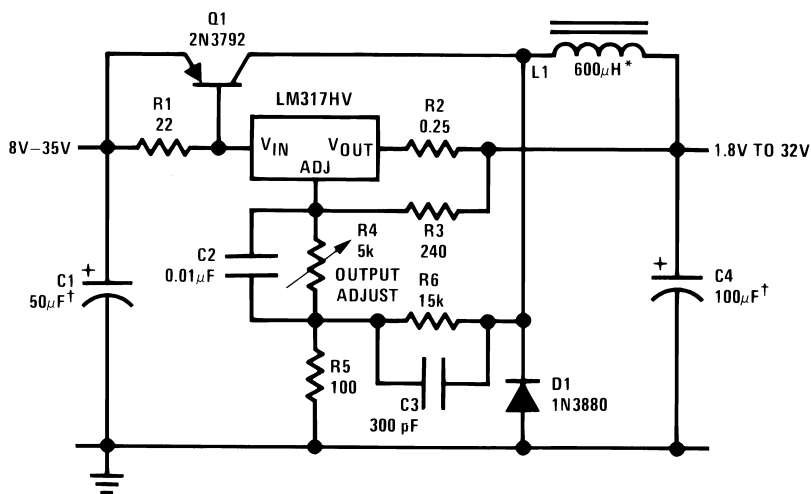


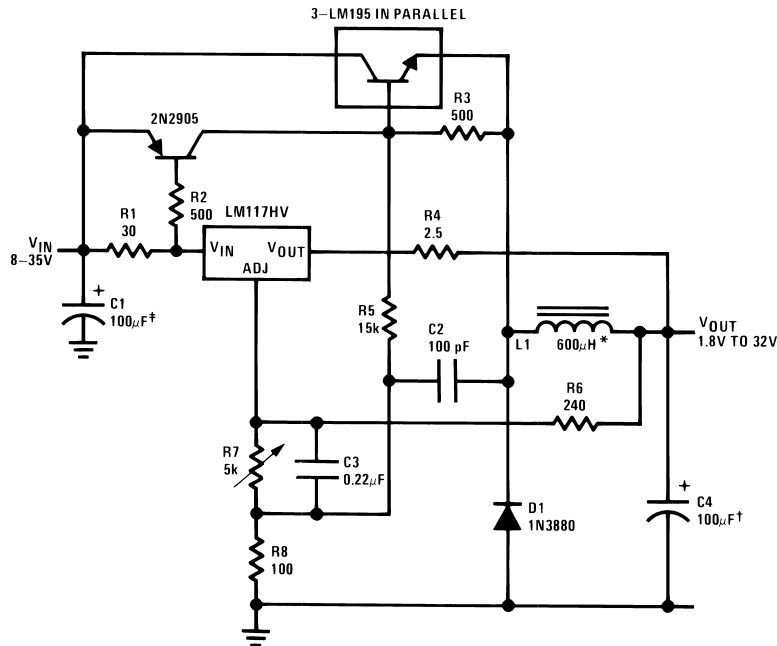
Figure 30. High Gain Amplifier



†Solid tantalum

*Core—Arnold A-254168-2 60 turns

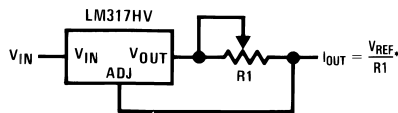
Figure 31. Low Cost 3A Switching Regulator



†Solid tantalum

*Core—Arnold A-254168-2 60 turns

Figure 32. 4A Switching Regulator with Overload Protection



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

Figure 33. Precision Current Limiter

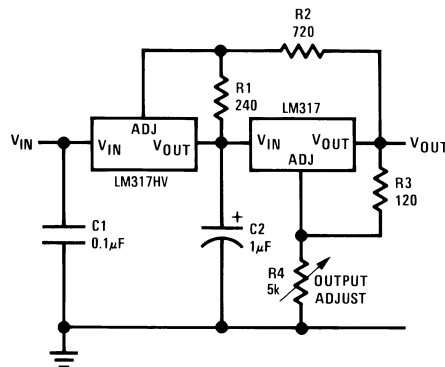
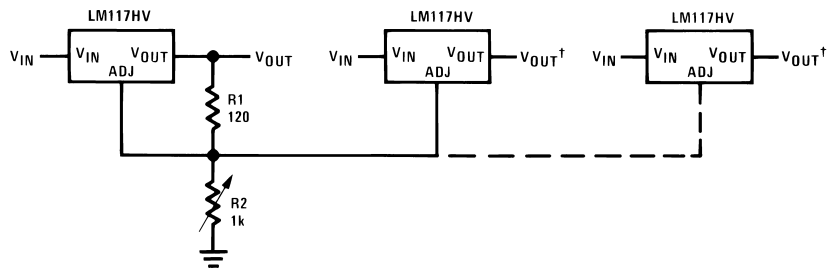


Figure 34. Tracking Preregulator



*All outputs within ± 100 mV

†Minimum load—10 mA

Figure 35. Adjustable Multiple On-Card Regulators with Single Control*

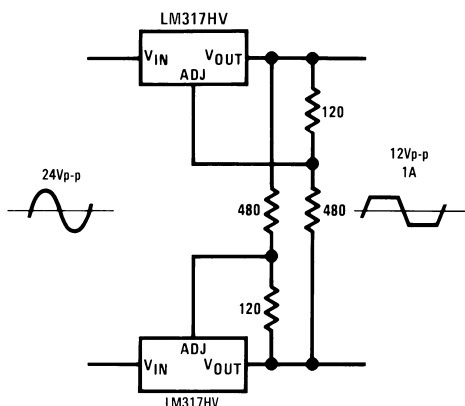
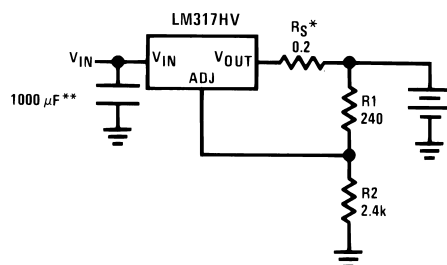


Figure 36. AC Voltage Regulator



* R_S —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 μ F is recommended to filter out input transients

Figure 37. 12V Battery Charger

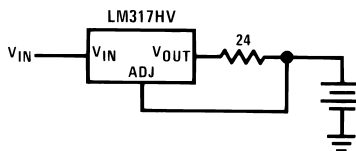


Figure 38. 50 mA Constant Current Battery Charger

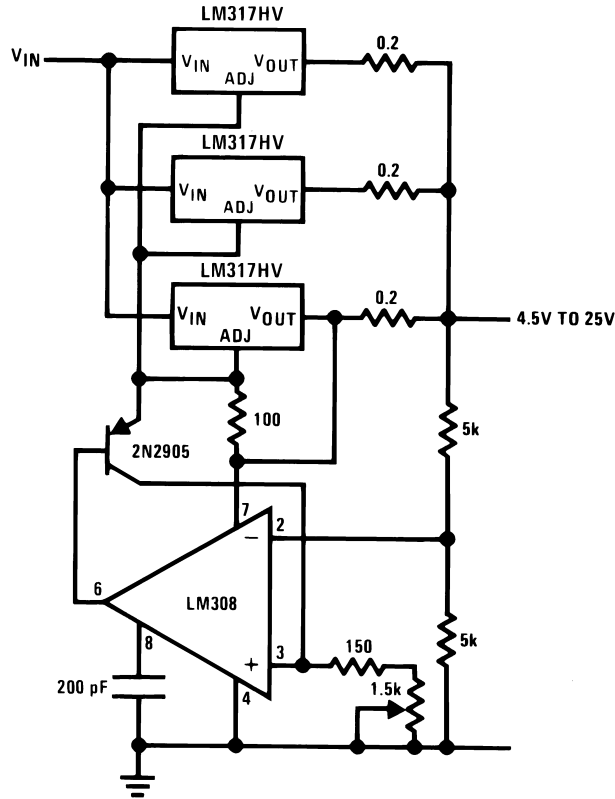
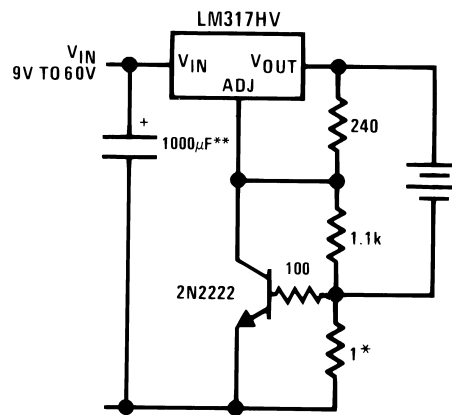


Figure 39. Adjustable 4A Regulator



*Sets peak current (0.6A for 1 Ω)

**The 1000 μ F is recommended to filter out input transients

Figure 40. Current Limited 6V Charger

REVISION HISTORY

Changes from Revision B (April 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format	16

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
LM117HVH	ACTIVE	TO	NDT	3	500	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM117HVHP+ ~ LM117HVHP+)	Samples
LM117HVH/NOPB	ACTIVE	TO	NDT	3	500	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM117HVHP+ ~ LM117HVHP+)	Samples
LM317HVH	ACTIVE	TO	NDT	3	500	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	0 to 125	(LM317HVHP+ ~ LM317HVHP+)	Samples
LM317HVH/NOPB	ACTIVE	TO	NDT	3	500	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	0 to 125	(LM317HVHP+ ~ LM317HVHP+)	Samples
LM317HVK STEEL	ACTIVE	TO-3	NDS	2	50	TBD	Call TI	Call TI	0 to 125	LM317HVK STEELP+	Samples
LM317HVK STEEL/NOPB	ACTIVE	TO-3	NDS	2	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	0 to 125	LM317HVK STEELP+	Samples
LM317HVT/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 125	LM317 HVT P+	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.

OBSELETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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.

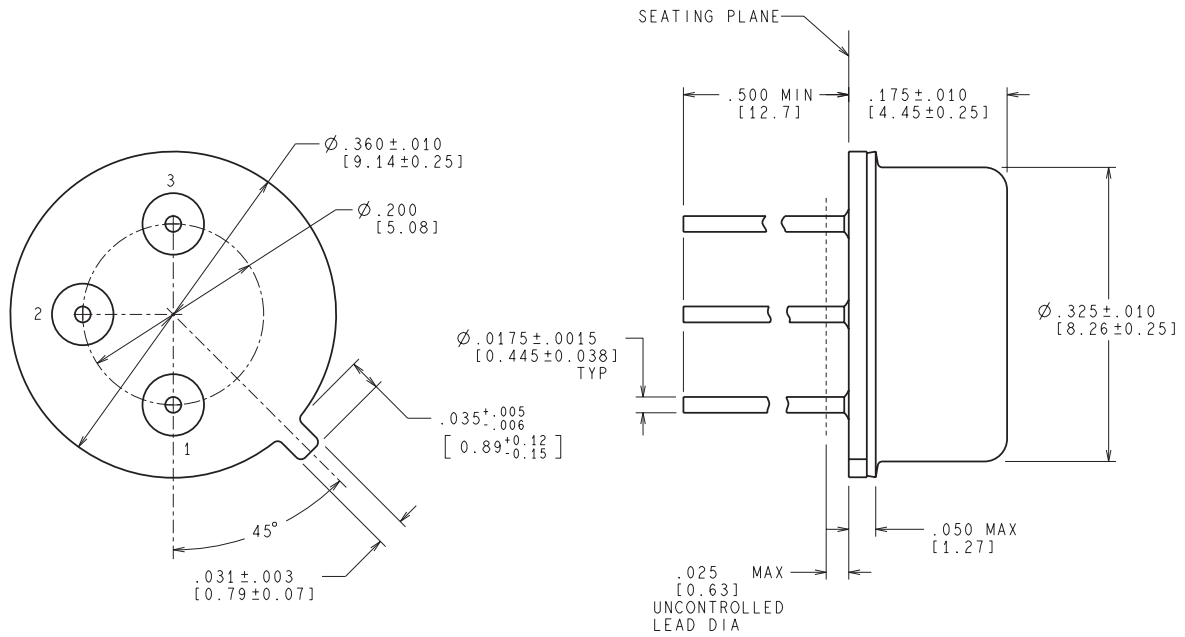
⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽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.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

NDT0003A

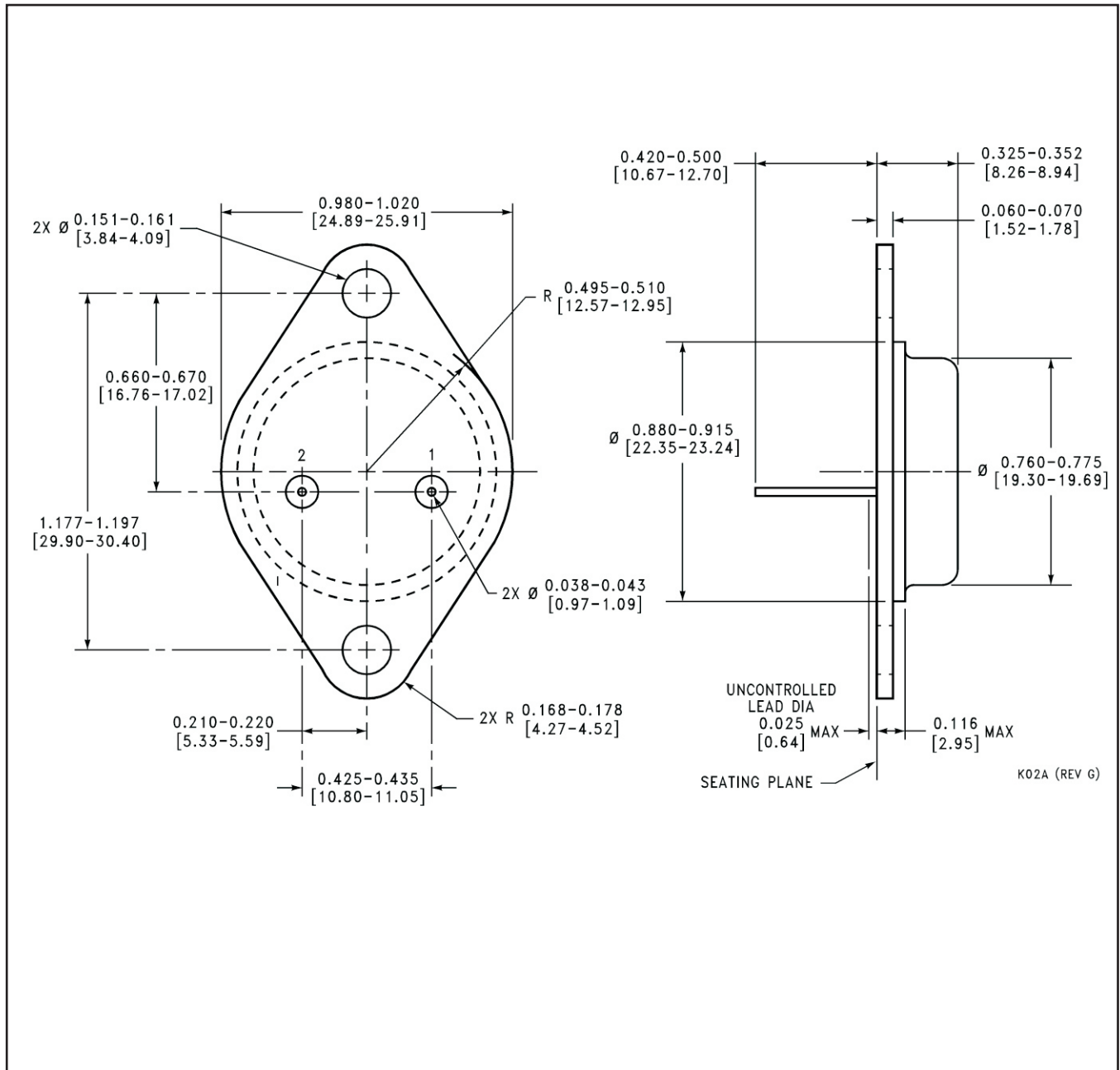


CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

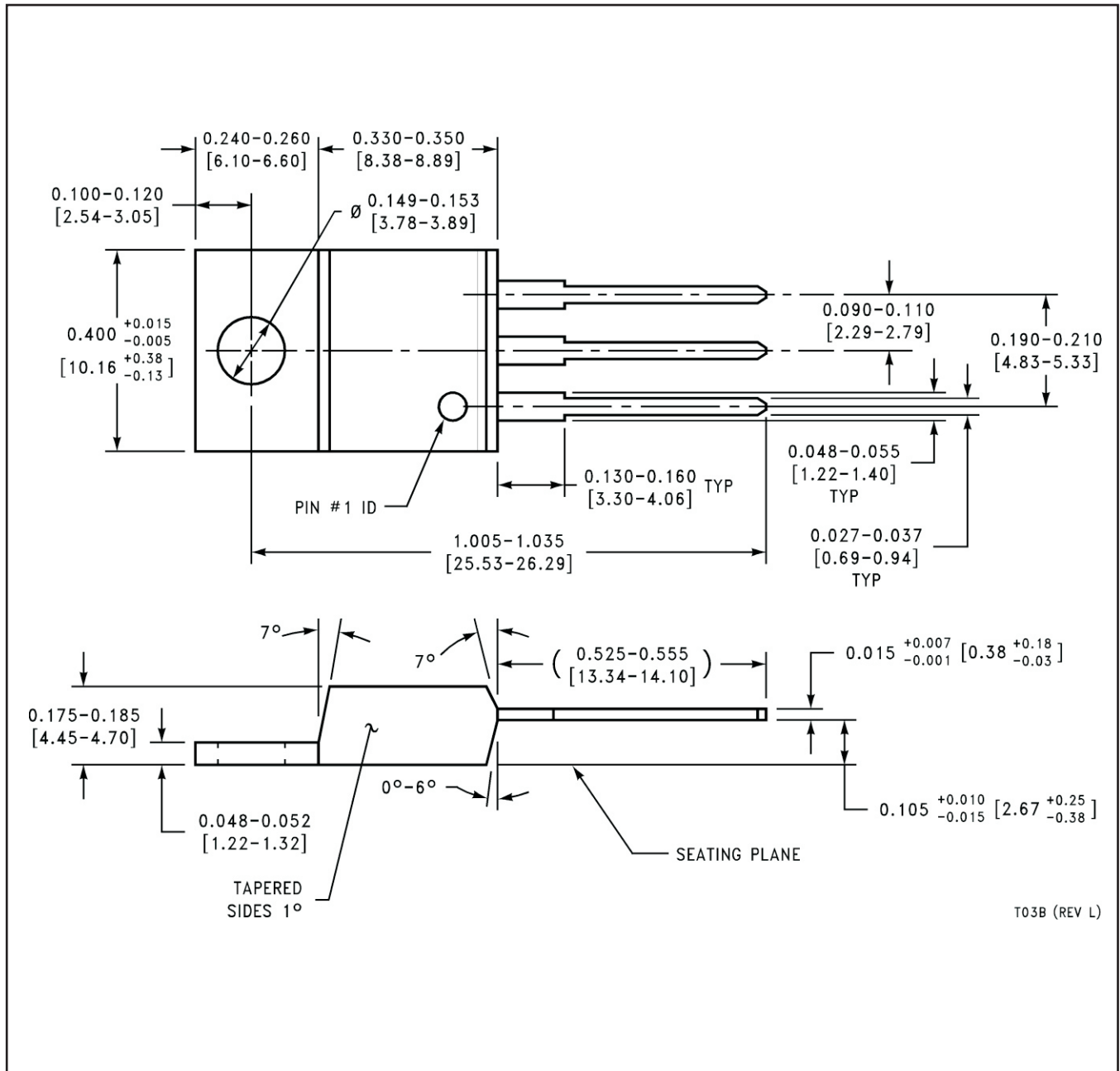
MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

NDS0002A



NDE0003B



IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com