LM137HV/LM337HV 3-Terminal Adjustable Negative Regulators (High Voltage)

Check for Samples: LM137HV, LM337HV

FEATURES

- **Output Voltage Adjustable from −1.2V to −47V**
- **1.5A Output Current Specified, −55°C to +150°C**
- **Line Regulation Typically 0.01%/V**
- **Load Regulation Typically 0.3%**
- **Excellent Thermal Regulation, 0.002%/W**
- **77 dB Ripple Rejection**
- **Excellent Rejection of Thermal Transients**
- **50 ppm/°C Temperature Coefficient**
- **Temperature-Independent Current Limit**
- **Internal Thermal Overload Protection**
- **P^+ Product Enhancement tested**
- **Standard 3-Lead Transistor Package**
- **Output Short Circuit Protected**

DESCRIPTION

The LM137HV/LM337HV are adjustable 3-terminal negative voltage regulators capable of supplying in excess of −1.5A over an output voltage range of −1.2V to −47V. These regulators are exceptionally easy to apply, requiring only 2 external resistors to set the output voltage and 1 output capacitor for frequency compensation. The circuit design has been optimized for excellent regulation and low thermal transients. Further, the LM137HV series features internal current limiting, thermal shutdown and safe-area compensation, making them virtually blowout-proof against overloads.

The LM137HV/LM337HV serve a wide variety of applications including local on-card regulation, programmable-output voltage regulation or precision current regulation. The LM137HV/LM337HV are ideal complements to the LM117HV/LM317HV adjustable positive regulators.

Connection Diagram

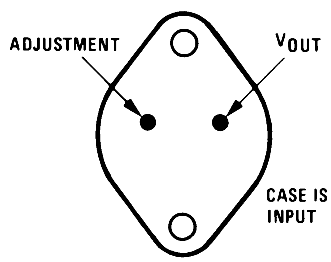


Figure 1. TO-3
Bottom View
See Package Number K0002C
See Package Number NDS0002A

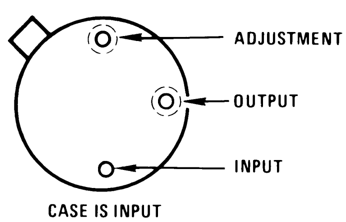
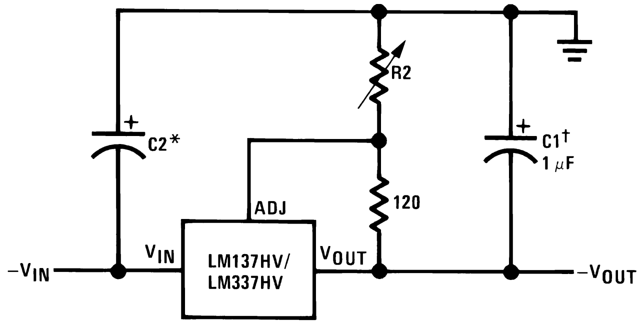


Figure 2. TO
Bottom View
See Package Number NDT0003A

Typical Applications



$$-V_{OUT} = -1.25V\left(1 + \frac{R2}{120\Omega}\right) + \left[-I_{Adj}(R_2)\right]$$

†C1 = 1 μF solid tantalum or 10 μF aluminum electrolytic required for stability. 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.

*C2 = 1 μF solid tantalum is required only if regulator is more than 4″ from power-supply filter capacitor.

Figure 3. Adjustable Negative Voltage Regulator

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)(3)

Power Dissipation		Internally limited
Input—Output Voltage Differential		50V
Operating Junction Temperature Range	LM137HV	−55°C to +150°C
	LM337HV	0°C to +125°C
Storage Temperature		−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)		300°
ESD rating is to be determined.		

(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 RETS137HVH drawing for LM137HVH or RETS137HVK for LM137HVK military specifications.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

ELECTRICAL CHARACTERISTICS(1)

Parameter	Conditions	LM137HV			LM337HV			Units
		Min	Typ	Max	Min	Typ	Max	
Line Regulation	T_J = 25°C, 3V ≤ $\|V_{IN}-V_{OUT}\|$ ≤ 50V,(2) I_L = 10 mA		0.01	0.02		0.01	0.04	%/V
Load Regulation	T_J = 25°C, 10 mA ≤ I_{OUT} ≤ I_{MAX}		0.3	0.5		0.3	1.0	%
Thermal Regulation	T_J = 25°C, 10 ms Pulse		0.002	0.02		0.003	0.04	%/W
Adjustment Pin Current			65	100		65	100	μA
Adjustment Pin Current Change	10 mA ≤ I_L ≤ I_{MAX}		2	5		2	5	μA
	3.0V ≤ $\|V_{IN}-V_{OUT}\|$ ≤ 50V, T_J = 25°		4	6		3	6	μA

(1) Unless otherwise specified, these specifications apply: −55°C ≤ T_j ≤ +150°C for the LM137HV, 0°C ≤ T_j ≤ +125°C for the LM337HV; $V_{IN}-V_{OUT}$ = 5V; and I_{OUT} = 0.1A for the TO package and I_{OUT} = 0.5A for the TO-3 package. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO and 20W for the TO-3. I_{MAX} is 1.5A for the TO-3 package and 0.2A for the TO package.
(2) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulations. Load regulation is measured on the output pin at a point ⅛″ below the base of the TO-3 and TO packages.

ELECTRICAL CHARACTERISTICS(1) (continued)

Parameter	Conditions	LM137HV			LM337HV			Units
		Min	Typ	Max	Min	Typ	Max	
Reference Voltage	T_J = 25°C,(3)	−1.225	−1.250	−1.275	−1.213	−1.250	−1.287	V
	3V ≤ $\|V_{IN}−V_{OUT}\|$ ≤ 50V,(3) 10 mA ≤ I_{OUT} ≤ I_{MAX}, P≤ P_{MAX}	−1.200	−1.250	−1.300	−1.200	−1.250	−1.300	V
Line Regulation	3V ≤ $\|V_{IN}−V_{OUT}\|$ ≤ 50V,(2) I_L = 10 mA		0.02	0.05		0.02	0.07	%/V
Load Regulation	10 mA ≤ I_{OUT} ≤ I_{MAX},(2)		0.3	1		0.3	1.5	%
Temperature Stability	T_{MIN} ≤ T_j ≤ T_{MAX}		0.6			0.6		%
Minimum Load Current	$\|V_{IN}−V_{OUT}\|$ ≤ 50V		2.5	5		2.5	10	mA
	$\|V_{IN}−V_{OUT}\|$ ≤ 10V		1.2	3		1.5	6	mA
Current Limit	$\|V_{IN}−V_{OUT}\|$ ≤ 13V							
	K Package	1.5	2.2	3.2	1.5	2.2	3.5	A
	H Package	0.5	0.8	1.6	0.5	0.8	1.8	A
	$\|V_{IN}−V_{OUT}\|$ = 50V							
	K Package	0.2	0.4	0.8	0.1	0.4	0.8	A
	H Package	0.1	0.17	0.5	0.050	0.17	0.5	A
RMS Output Noise, % of V_{OUT}	T_J = 25°C, 10 Hz ≤ f ≤ 10 kHz		0.003			0.003		%
Ripple Rejection Ratio	V_{OUT} = −10V, f = 120 Hz		60			60		dB
	C_{ADJ} = 10 μF	66	77		66	77		dB
Long-Term Stability	T_A = 125°C, 1000 Hours		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	H Package		12	15		12	15	°C/W
	K Package		2.3	3		2.3	3	°C/W
Thermal Resistance, Junction to Ambient	H Package		140			140		°C/W
	K Package		35			35		°C/W

(3) Refer to RETS137HVH drawing for LM137HVH or RETS137HVK for LM137HVK military specifications.

SCHEMATIC DIAGRAM

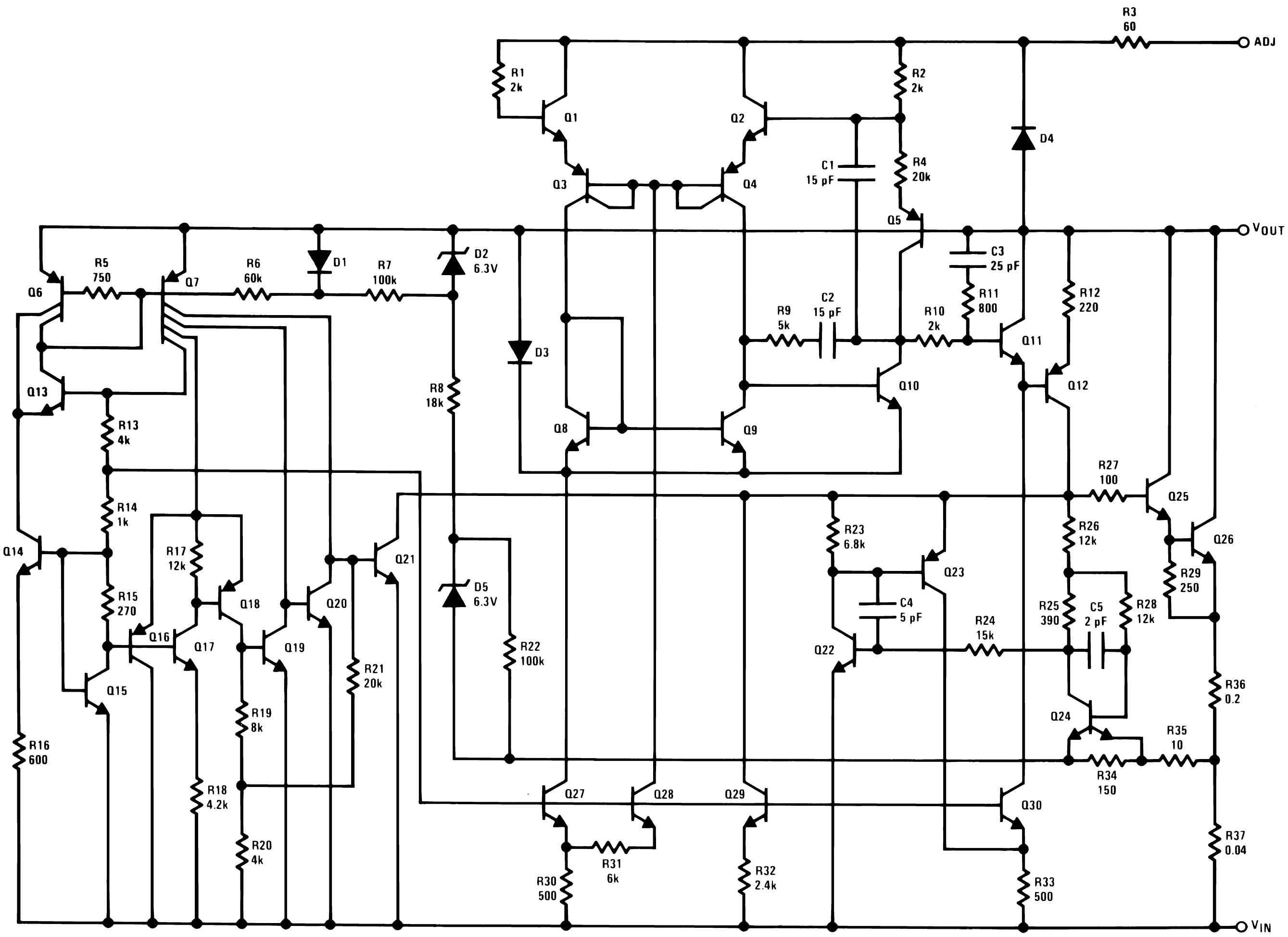
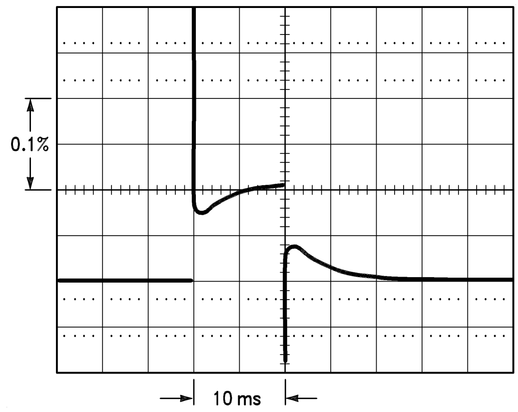


Figure 4. Schematic Diagram

Thermal Regulation

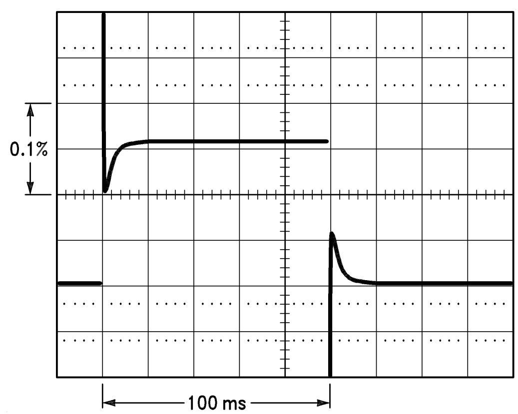
When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per Watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5 ms to 50 ms after a change in power dissipation. Thermal regulation depends on IC layout as well as electrical design. The thermal regulation of a voltage regulator is defined as the percentage change of V_{OUT}, per Watt, within the first 10 ms after a step of power is applied. The LM137HV's specification is 0.02%/W, max.

In Figure 5, a typical LM137HV's output drifts only 3 mV (or 0.03% of V_{OUT} = −10V) when a 10W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.02%/W x 10W = 0.2% max. When the 10W pulse is ended, the thermal regulation again shows a 3 mV step as the LM137HV chip cools off. Note that the load regulation error of about 8 mV (0.08%) is additional to the thermal regulation error. In Figure 6, when the 10W pulse is applied for 100 ms, the output drifts only slightly beyond the drift in the first 10 ms, and the thermal error stays well within 0.1% (10 mV).



LM137HV, V_{OUT} = −10V
V_{IN}−V_{OUT} = −40V
I_L = 0A→0.25A→0A
Vertical sensitivity, 5 mV/div

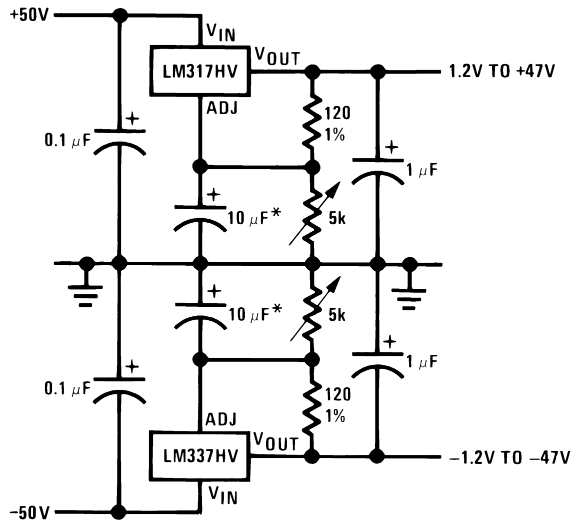
Figure 5.



LM137HV, V_{OUT} = −10V
V_{IN}−V_{OUT} = −40V
I_L = 0A→0.25A→0A
Horizontal sensitivity, 20 ms/div

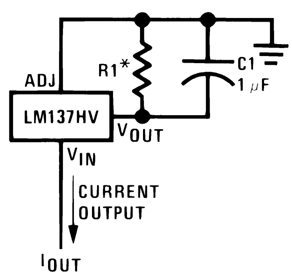
Figure 6.

TYPICAL APPLICATIONS



Full output current not available at high input-output voltages
*The 10 μF capacitors are optional to improve ripple rejection

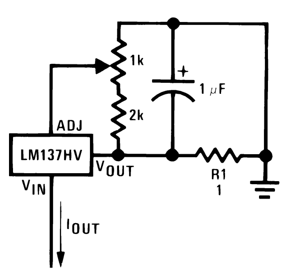
Figure 7. Adjustable High Voltage Regulator



$$I_{OUT} = \frac{V_{REF}}{R1}$$

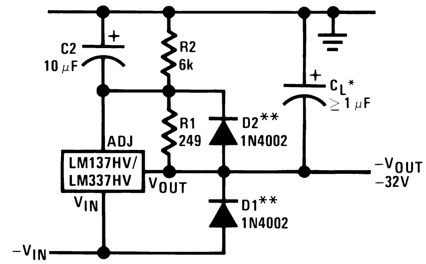
* 0.8Ω ≤ R1 ≤ 120Ω

Figure 8. Current Regulator



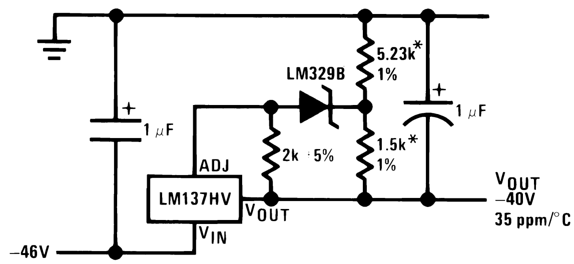
$$I_{OUT} = \left(\frac{1.5V}{R1}\right) \pm 15\% \text{ adjustable}$$

Figure 9. Adjustable Current Regulator



*When C_L is larger than 20 µF, D1 protects the LM137HV in case the input supply is shorted
**When C2 is larger than 10 µF and $-V_{OUT}$ is larger than −25V, D2 protects the LM137HV is case the output is shorted

Figure 10. Negative Regulator with Protection Diodes



*Use resistors with good tracking TC < 25 ppm/°C

Figure 11. High Stability −40V Regulator

TYPICAL PERFORMANCE CHARACTERISTICS

(H and K-STEEL Package)

Load Regulation

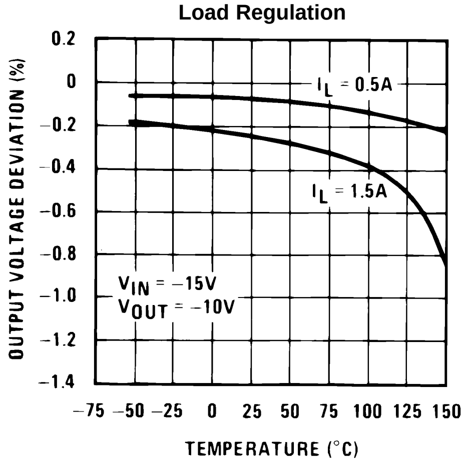


Figure 12.

Current Limit

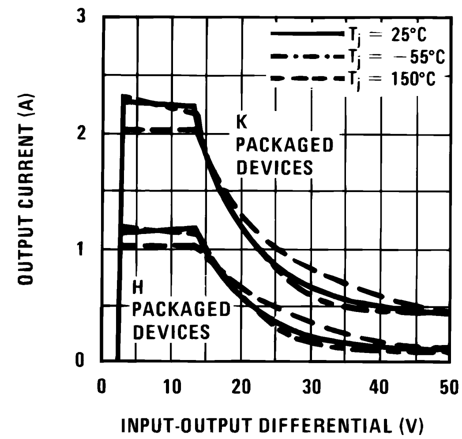


Figure 13.

Adjustment Current

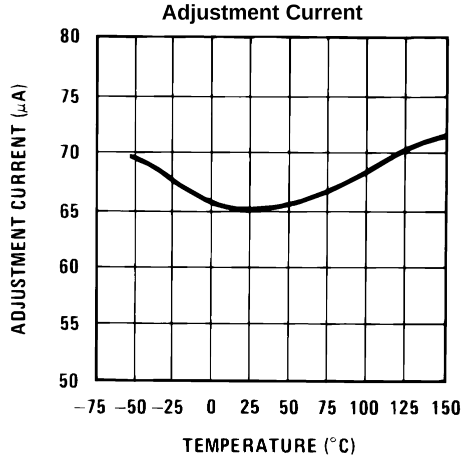


Figure 14.

Dropout Voltage

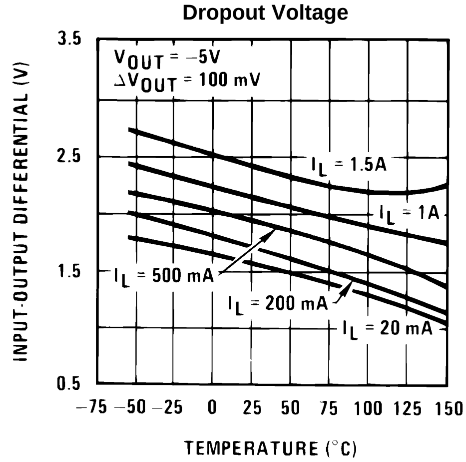


Figure 15.

Temperature Stability

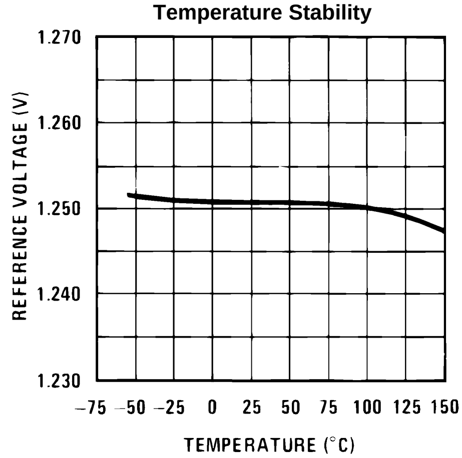


Figure 16.

Minimum Operating Current

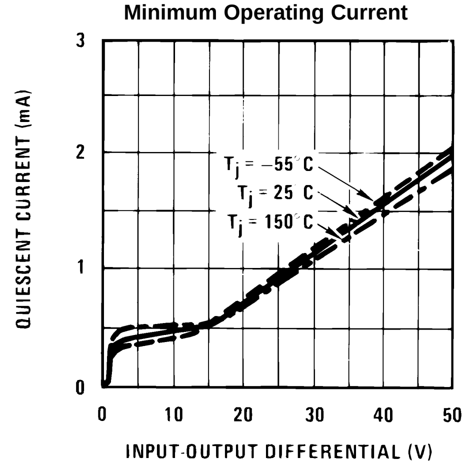


Figure 17.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

(H and K-STEEL Package)

Ripple Rejection

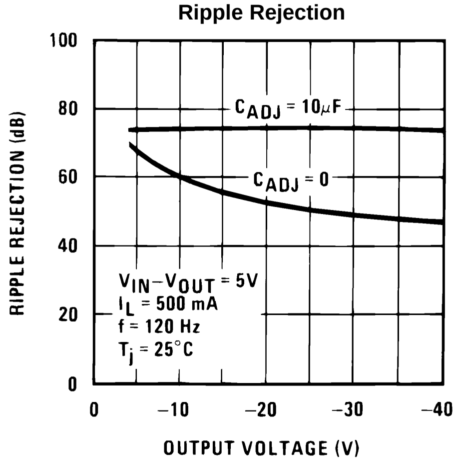


Figure 18.

Ripple Rejection

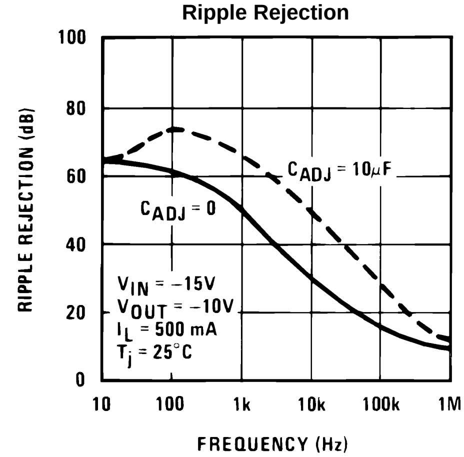


Figure 19.

Ripple Rejection

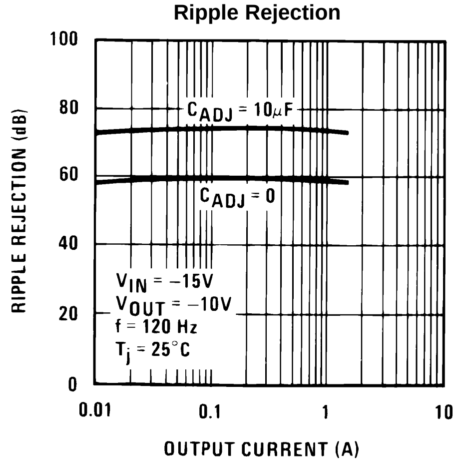


Figure 20.

Output Impedance

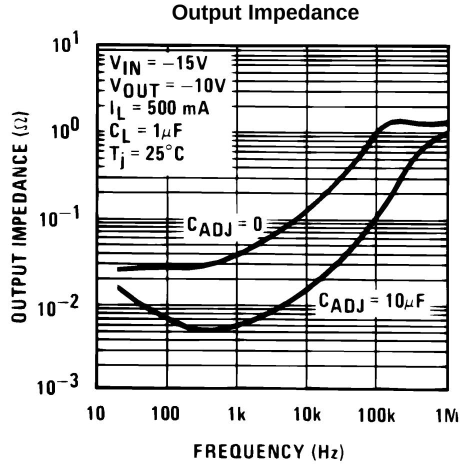


Figure 21.

Line Transient Response

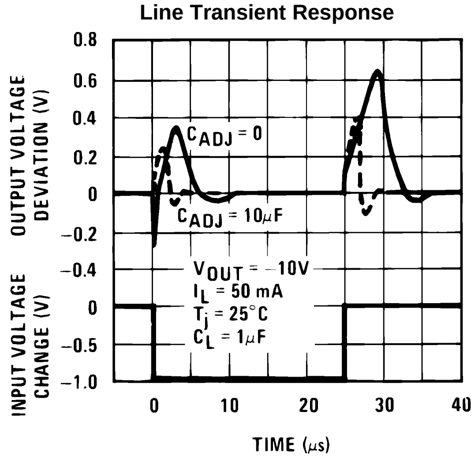


Figure 22.

Load Transient Response

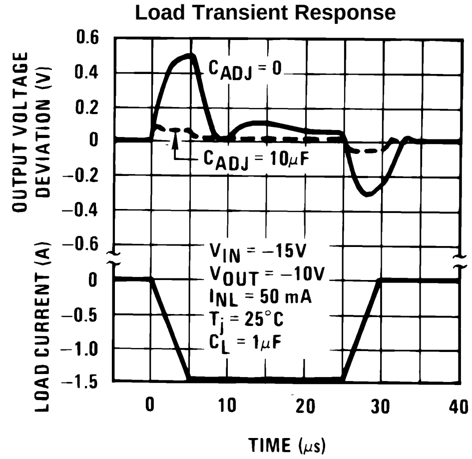


Figure 23.

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