

LM10 Operational Amplifier and Voltage Reference

 Check for Samples: [LM10](#)

FEATURES

- input offset voltage: 2.0 mV (max)
- input offset current: 0.7 nA (max)
- input bias current: 20 nA (max)
- reference regulation: 0.1% (max)
- offset voltage drift: 2 μ V/ $^{\circ}$ C
- reference drift: 0.002%/ $^{\circ}$ C

DESCRIPTION

The LM10 series are monolithic linear ICs consisting of a precision reference, an adjustable reference buffer and an independent, high quality op amp.

The unit can operate from a total supply voltage as low as 1.1V or as high as 40V, drawing only 270 μ A. A complementary output stage swings within 15 mV of the supply terminals or will deliver \pm 20 mA output current with \pm 0.4V saturation. Reference output can be as low as 200 mV.

The circuit is recommended for portable equipment and is completely specified for operation from a single power cell. In contrast, high output-drive capability, both voltage and current, along with thermal overload protection, suggest it in demanding general-purpose applications.

The device is capable of operating in a floating mode, independent of fixed supplies. It can function as a remote comparator, signal conditioner, SCR controller or transmitter for analog signals, delivering the processed signal on the same line used to supply power. It is also suited for operation in a wide range of voltage- and current-regulator applications, from low voltages to several hundred volts, providing greater precision than existing ICs.

This series is available in the three standard temperature ranges, with the commercial part having relaxed limits. In addition, a low-voltage specification (suffix "L") is available in the limited temperature ranges at a cost savings.

Connection and Functional Diagrams

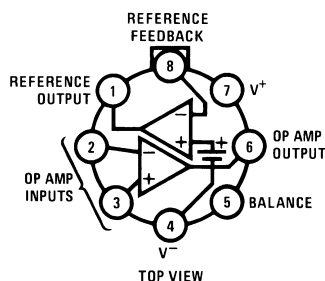


Figure 1. Metal Can Package (H)

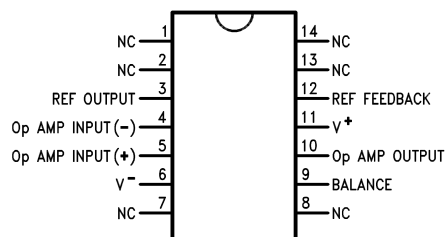


Figure 2. Small Outline Package (WM)



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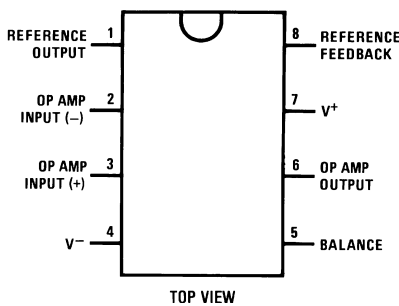
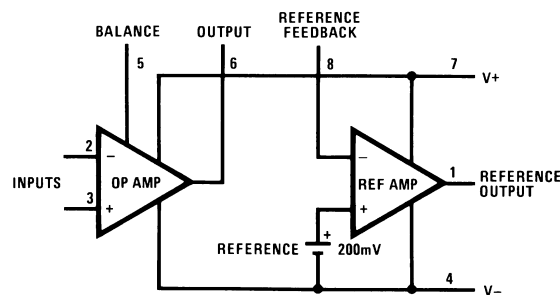


Figure 3. Dual-In-Line Package (N)



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⁾

	LM10/LM10B/ LM10C	LM10BL/ LM10CL
Total Supply Voltage	45V	7V
Differential Input Voltage ⁽³⁾	±40V	±7V
Power Dissipation ⁽⁴⁾	internally limited	
Output Short-circuit Duration ⁽⁵⁾	continuous	
Storage-Temp. Range	-55°C to +150°C	
Lead Temp. (Soldering, 10 seconds)		
Metal Can	300°C	
Lead Temp. (Soldering, 10 seconds) DIP	260°C	
Vapor Phase (60 seconds)	215°C	
Infrared (15 seconds)	220°C	
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.		
ESD rating is to be determined.		
Maximum Junction Temperature		
LM10		150°C
LM10B		100°C
LM10C		85°C

- (1) Refer to RETS10X for LM10H military specifications.
- (2) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.
- (3) The Input voltage can exceed the supply voltages provided that the voltage from the input to any other terminal does not exceed the maximum differential input voltage and excess dissipation is accounted for when $V_{IN} < V^-$.
- (4) The maximum, operating-junction temperature is 150°C for the LM10, 100°C for the LM10B(L) and 85°C for the LM10C(L). At elevated temperatures, devices must be derated based on package thermal resistance.
- (5) Internal thermal limiting prevents excessive heating that could result in sudden failure, but the IC can be subjected to accelerated stress with a shorted output and worst-case conditions.

Operating Ratings

Package Thermal Resistance	
θ_{JA}	
H Package	150°C/W
N Package	87°C/W
WM Package	90°C/W
θ_{JC}	
H Package	45°C/W

Electrical Characteristics

$T_J=25^\circ\text{C}$, $T_{\text{MIN}} \leq T_J \leq T_{\text{MAX}}$ (**Boldface type refers to limits over temperature range**)⁽¹⁾

Parameter	Conditions	LM10/LM10B			LM10C			Units
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage			0.3	2.0		0.5	4.0	mV
				3.0			5.0	mV
Input offset current (2)			0.25	0.7		0.4	2.0	nA
				1.5			3.0	nA
Input bias current			10	20		12	30	nA
				30			40	nA
Input resistance		250	500		150	400		k Ω
		150			115			k Ω
Large signal voltage gain	$V_S = \pm 20\text{V}$, $I_{\text{OUT}} = 0$	120	400		80	400		V/mV
	$V_{\text{OUT}} = \pm 19.95\text{V}$	80			50			V/mV
	$V_S = \pm 20\text{V}$, $V_{\text{OUT}} = \pm 19.4\text{V}$	50	130		25	130		V/mV
	$I_{\text{OUT}} = \pm 20\text{ mA}$ ($\pm 15\text{ mA}$)	20			15			V/mV
	$V_S = \pm 0.6\text{V}$ (0.65V), $I_{\text{OUT}} = \pm 2\text{ mA}$	1.5	3.0		1.0	3.0		V/mV
	$V_{\text{OUT}} = \pm 0.4\text{V}$ ($\pm 0.3\text{V}$), $V_{\text{CM}} = -0.4\text{V}$	0.5			0.75			V/mV
Shunt gain ⁽³⁾	1.2V (1.3V) $\leq V_{\text{OUT}} \leq 40\text{V}$,	14	33		10	33		V/mV
	$R_L = 1.1\text{ k}\Omega$							
	$0.1\text{ mA} \leq I_{\text{OUT}} \leq 5\text{ mA}$	6			6			V/mV
	$1.5\text{V} \leq V^+ \leq 40\text{V}$, $R_L = 250\Omega$	8	25		6	25		V/mV
	$0.1\text{ mA} \leq I_{\text{OUT}} \leq 20\text{ mA}$	4			4			V/mV
Common-mode rejection	$-20\text{V} \leq V_{\text{CM}} \leq 19.15\text{V}$ (19V)	93	102		90	102		dB
	$V_S = \pm 20\text{V}$	87			87			dB
Supply-voltage rejection	$-0.2\text{V} \geq V^- \geq -39\text{V}$	90	96		87	96		dB
	$V^+ = 1.0\text{V}$ (1.1V)	84			84			dB
	1.0V (1.1V) $\leq V^+ \leq 39.8\text{V}$	96	106		93	106		dB
	$V^- = -0.2\text{V}$	90			90			dB
Offset voltage drift			2.0			5.0		$\mu\text{V}/^\circ\text{C}$
Offset current drift			2.0			5.0		$\text{pA}/^\circ\text{C}$
Bias current drift	$T_C < 100^\circ\text{C}$		60			90		$\text{pA}/^\circ\text{C}$
Line regulation	1.2V (1.3V) $\leq V_S \leq 40\text{V}$		0.001	0.003		0.001	0.008	%/V
	$0 \leq I_{\text{REF}} \leq 1.0\text{ mA}$, $V_{\text{REF}} = 200\text{ mV}$			0.006			0.01	%/V
Load regulation	$0 \leq I_{\text{REF}} \leq 1.0\text{ mA}$		0.01	0.1		0.01	0.15	%
	$V^+ - V_{\text{REF}} \geq 1.0\text{V}$ (1.1V)			0.15			0.2	%
Amplifier gain	$0.2\text{V} \leq V_{\text{REF}} \leq 35\text{V}$	50	75		25	70		V/mV
		23			15			V/mV
Feedback sense voltage		195	200	205	190	200	210	mV
		194		206	189		211	mV
Feedback current			20	50		22	75	nA
				65			90	nA
Reference drift			0.002			0.003		%/°C

(1) These specifications apply for $V^- \leq V_{\text{CM}} \leq V^+ - 0.85\text{V}$ (**1.0V**), 1.2V (**1.3V**) $< V_S \leq V_{\text{MAX}}$, $V_{\text{REF}} = 0.2\text{V}$ and $0 \leq I_{\text{REF}} \leq 1.0\text{ mA}$, unless otherwise specified: $V_{\text{MAX}} = 40\text{V}$ for the standard part and 6.5V for the low voltage part. Normal typeface indicates 25°C limits. **Boldface type indicates limits and altered test conditions for full-temperature-range operation**; this is -55°C to 125°C for the LM10, -25°C to 85°C for the LM10B(L) and 0°C to 70°C for the LM10C(L). The specifications do not include the effects of thermal gradients ($\tau_1 = 20\text{ ms}$), die heating ($\tau_2 = 0.2\text{ s}$) or package heating. Gradient effects are small and tend to offset the electrical error (see curves).

(2) For $T_J > 90^\circ\text{C}$, I_{OS} may exceed 1.5 nA for $V_{\text{CM}} = V^-$. With $T_J = 125^\circ\text{C}$ and $V^- \leq V_{\text{CM}} \leq V^- + 0.1\text{V}$, $I_{\text{OS}} \leq 5\text{ nA}$.

(3) This defines operation in floating applications such as the bootstrapped regulator or two-wire transmitter. Output is connected to the V^+ terminal of the IC and input common mode is referred to V^- (see typical applications). Effect of larger output-voltage swings with higher load resistance can be accounted for by adding the positive-supply rejection error.

Electrical Characteristics (continued)
 $T_J = 25^\circ\text{C}$, $T_{\text{MIN}} \leq T_J \leq T_{\text{MAX}}$ (Boldface type refers to limits over temperature range)⁽¹⁾

Parameter	Conditions	LM10/LM10B			LM10C			Units
		Min	Typ	Max	Min	Typ	Max	
Supply current			270	400		300	500	μA
				500			570	μA
Supply current change	$1.2\text{V} \text{ (1.3V)} \leq V_S \leq 40\text{V}$		15	75		15	75	μA

Electrical Characteristics

$T_J=25^\circ\text{C}$, $T_{\text{MIN}} \leq T_J \leq T_{\text{MAX}}$ (Boldface type refers to limits over temperature range)⁽¹⁾

Parameter	Conditions	LM10BL			LM10CL			Units
		Min	Typ	Max	Min	Typ	Max	
Input offset voltage			0.3	2.0		0.5	4.0	mV
				3.0			5.0	mV
Input offset current (2)			0.1	0.7		0.2	2.0	nA
				1.5			3.0	nA
Input bias current			10	20		12	30	nA
				30			40	nA
Input resistance		250	500		150	400		k Ω
		150			115			k Ω
Large signal voltage gain	$V_S = \pm 3.25\text{V}$, $I_{\text{OUT}} = 0$	60	300		40	300		V/mV
	$V_{\text{OUT}} = \pm 3.2\text{V}$	40			25			V/mV
	$V_S = \pm 3.25\text{V}$, $I_{\text{OUT}} = 10\text{ mA}$	10	25		5	25		V/mV
	$V_{\text{OUT}} = \pm 2.75\text{ V}$	4			3			V/mV
	$V_S = \pm 0.6\text{V}$ (0.65V), $I_{\text{OUT}} = \pm 2\text{ mA}$	1.5	3.0		1.0	3.0		V/mV
	$V_{\text{OUT}} = \pm 0.4\text{V}$ ($\pm 0.3\text{V}$), $V_{\text{CM}} = -0.4\text{V}$	0.5			0.75			V/mV
Shunt gain ⁽³⁾	$1.5\text{V} \leq V^+ \leq 6.5\text{V}$, $R_L = 500\Omega$	8	30		6	30		V/mV
	$0.1\text{ mA} \leq I_{\text{OUT}} \leq 10\text{ mA}$	4			4			V/mV
Common-mode rejection	$-3.25\text{V} \leq V_{\text{CM}} \leq 2.4\text{V}$ (2.25V)	89	102		80	102		dB
	$V_S = \pm 3.25\text{V}$	83			74			dB
Supply-voltage rejection	$-0.2\text{V} \geq V^- \geq -5.4\text{V}$	86	96		80	96		dB
	$V^+ = 1.0\text{V}$ (1.2V)	80			74			dB
	1.0V (1.1V) $\leq V^+ \leq 6.3\text{V}$	94	106		80	106		dB
	$V^- = 0.2\text{V}$	88			74			dB
Offset voltage drift			2.0			5.0		$\mu\text{V}/^\circ\text{C}$
Offset current drift			2.0			5.0		$\text{pA}/^\circ\text{C}$
Bias current drift			60			90		$\text{pA}/^\circ\text{C}$
Line regulation	1.2V (1.3V) $\leq V_S \leq 6.5\text{V}$		0.001	0.01		0.001	0.02	%/V
	$0 \leq I_{\text{REF}} \leq 0.5\text{ mA}$, $V_{\text{REF}} = 200\text{ mV}$			0.02			0.03	%/V
Load regulation	$0 \leq I_{\text{REF}} \leq 0.5\text{ mA}$		0.01	0.1		0.01	0.15	%
	$V^+ - V_{\text{REF}} \geq 1.0\text{V}$ (1.1V)			0.15			0.2	%
Amplifier gain	$0.2\text{V} \leq V_{\text{REF}} \leq 5.5\text{V}$	30	70		20	70		V/mV
		20			15			V/mV
Feedback sense voltage		195	200	205	190	200	210	mV
		194		206	189		211	mV
Feedback current			20	50		22	75	nA
				65			90	nA
Reference drift			0.002			0.003		%/°C
Supply current			260	400		280	500	μA
				500			570	μA

(1) These specifications apply for $V^- \leq V_{\text{CM}} \leq V^+ - 0.85\text{V}$ (**1.0V**), 1.2V (**1.3V**) $< V_S \leq V_{\text{MAX}}$, $V_{\text{REF}} = 0.2\text{V}$ and $0 \leq I_{\text{REF}} \leq 1.0\text{ mA}$, unless otherwise specified: $V_{\text{MAX}} = 40\text{V}$ for the standard part and 6.5V for the low voltage part. Normal typeface indicates 25°C limits. **Boldface type indicates limits and altered test conditions for full-temperature-range operation**; this is -55°C to 125°C for the LM10, -25°C to 85°C for the LM10B(L) and 0°C to 70°C for the LM10C(L). The specifications do not include the effects of thermal gradients ($\tau_1 = 20\text{ ms}$), die heating ($\tau_2 = 0.2\text{ s}$) or package heating. Gradient effects are small and tend to offset the electrical error (see curves).

(2) For $T_J > 90^\circ\text{C}$, I_{OS} may exceed 1.5 nA for $V_{\text{CM}} = V^-$. With $T_J = 125^\circ\text{C}$ and $V^- \leq V_{\text{CM}} \leq V^- + 0.1\text{V}$, $I_{\text{OS}} \leq 5\text{ nA}$.

(3) This defines operation in floating applications such as the bootstrapped regulator or two-wire transmitter. Output is connected to the V^+ terminal of the IC and input common mode is referred to V^- (see typical applications). Effect of larger output-voltage swings with higher load resistance can be accounted for by adding the positive-supply rejection error.

Definition of Terms

Input offset voltage: That voltage which must be applied between the input terminals to bias the unloaded output in the linear region.

Input offset current: The difference in the currents at the input terminals when the unloaded output is in the linear region.

Input bias current: The absolute value of the average of the two input currents.

Input resistance: The ratio of the change in input voltage to the change in input current on either input with the other grounded.

Large signal voltage gain: The ratio of the specified output voltage swing to the change in differential input voltage required to produce it.

Shunt gain: The ratio of the specified output voltage swing to the change in differential input voltage required to produce it with the output tied to the V^+ terminal of the IC. The load and power source are connected between the V^+ and V^- terminals, and input common-mode is referred to the V^- terminal.

Common-mode rejection: The ratio of the input voltage range to the change in offset voltage between the extremes.

Supply-voltage rejection: The ratio of the specified supply-voltage change to the change in offset voltage between the extremes.

Line regulation: The average change in reference output voltage over the specified supply voltage range.

Load regulation: The change in reference output voltage from no load to that load specified.

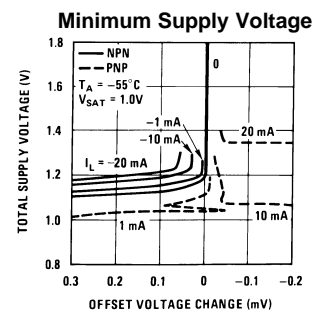
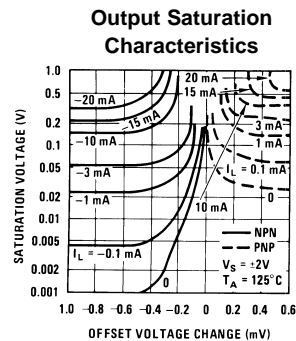
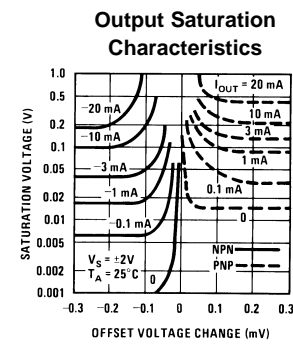
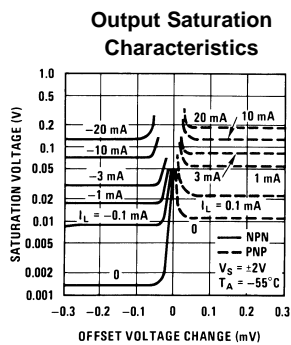
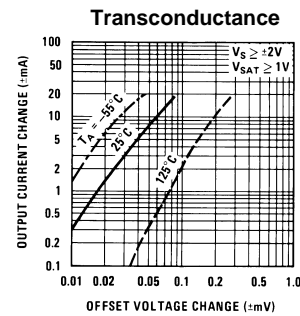
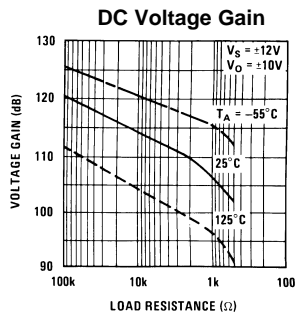
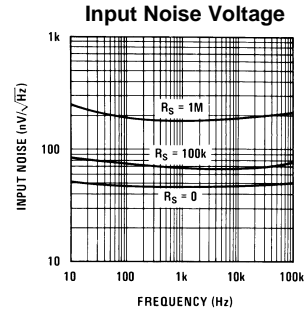
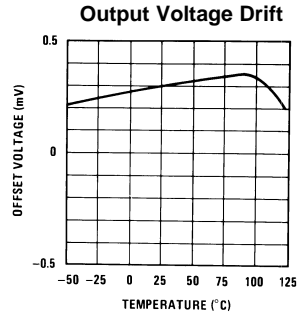
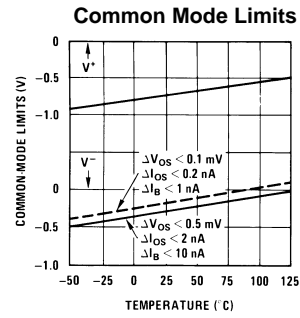
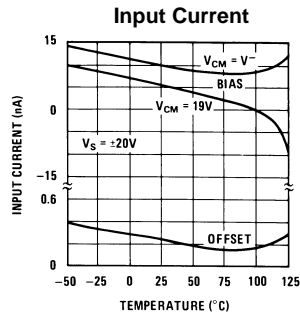
Feedback sense voltage: The voltage, referred to V^- , on the reference feedback terminal while operating in regulation.

Reference amplifier gain: The ratio of the specified reference output change to the change in feedback sense voltage required to produce it.

Feedback current: The absolute value of the current at the feedback terminal when operating in regulation.

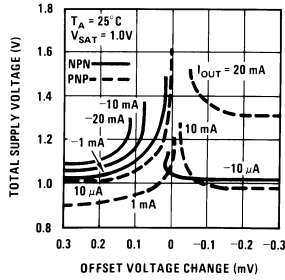
Supply current: The current required from the power source to operate the amplifier and reference with their outputs unloaded and operating in the linear range.

Typical Performance Characteristics (Op Amp)

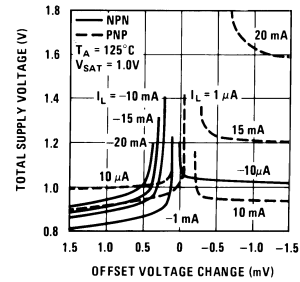


Typical Performance Characteristics (Op Amp) (continued)

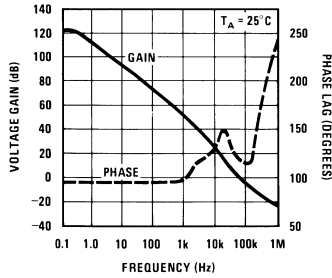
Minimum Supply Voltage



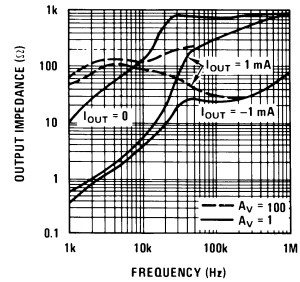
Minimum Supply Voltage



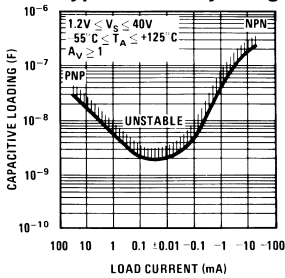
Frequency Response



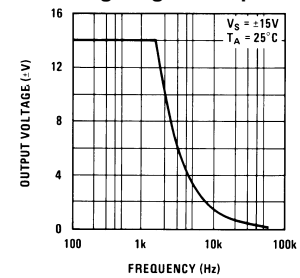
Output Impedance



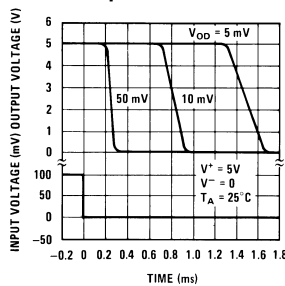
Typical Stability Range



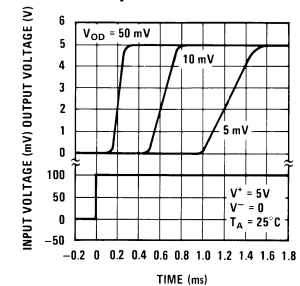
Large Signal Response



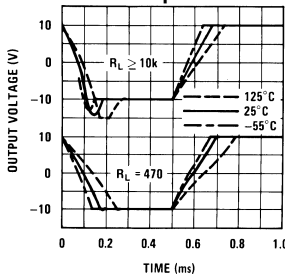
Comparator Response Time For Various Input Overdrives



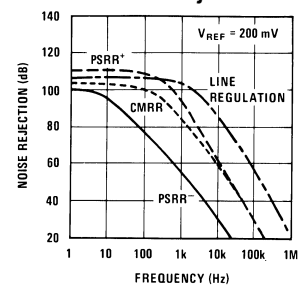
Comparator Response Time For Various Input Overdrives



Follower Pulse Response

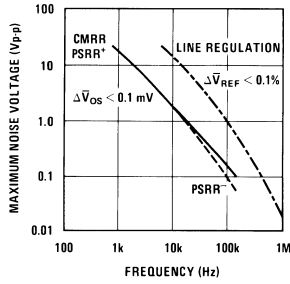


Noise Rejection

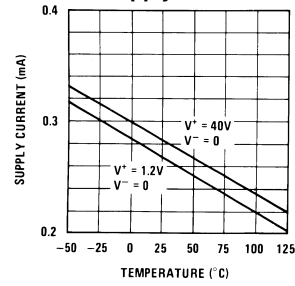


Typical Performance Characteristics (Op Amp) (continued)

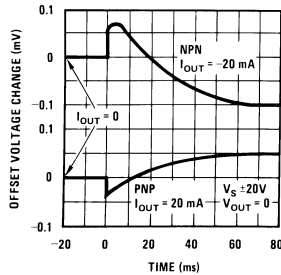
Rejection Slew Limiting



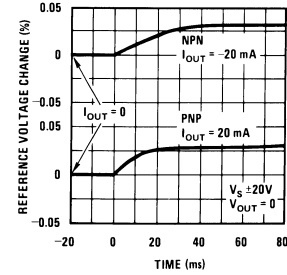
Supply Current



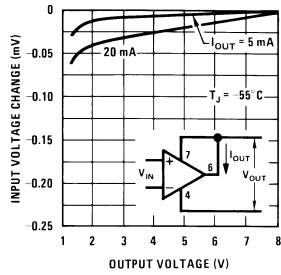
Thermal Gradient Feedback



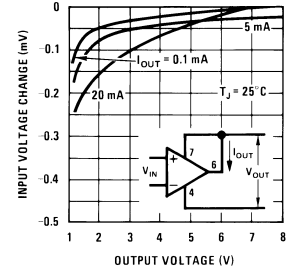
Thermal Gradient Cross-coupling



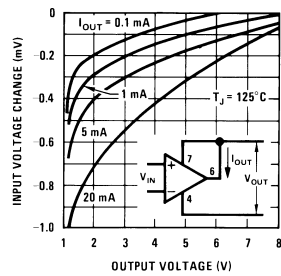
Shunt Gain



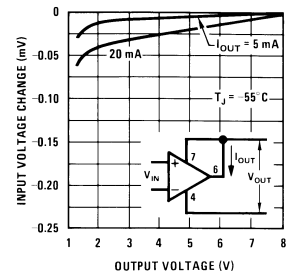
Shunt Gain



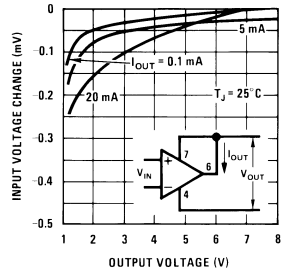
Shunt Gain



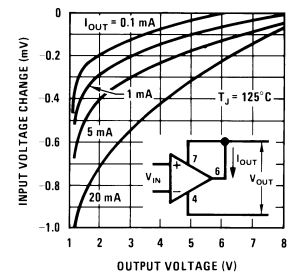
Shunt Gain



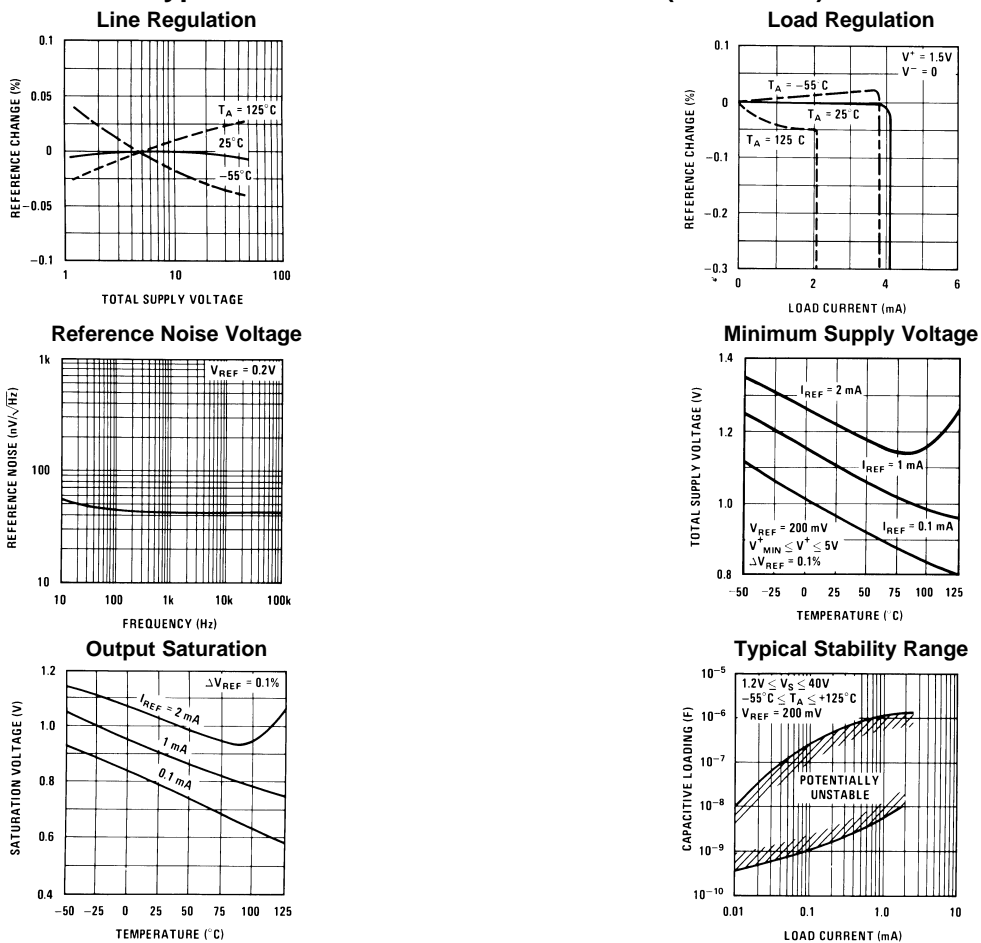
Shunt Gain



Shunt Gain



Typical Performance Characteristics (Reference)

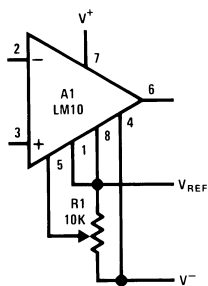


Typical Applications

(Pin numbers are for devices in 8-pin packages)

Op Amp Offset Adjustment

Figure 4. Standard



(Pin numbers are for devices in 8-pin packages)

Figure 5. Limited Range

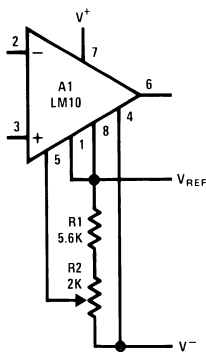
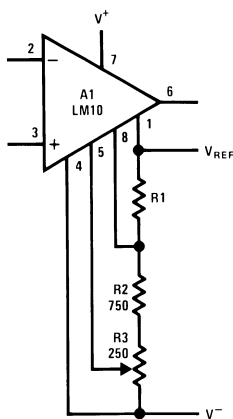
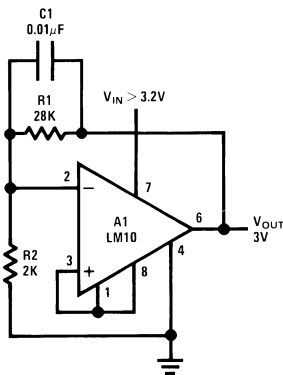


Figure 6. Limited Range With Boosted Reference



Positive Regulators

Figure 7. Low Voltage



(Pin numbers are for devices in 8-pin packages)

Figure 8. Best Regulation

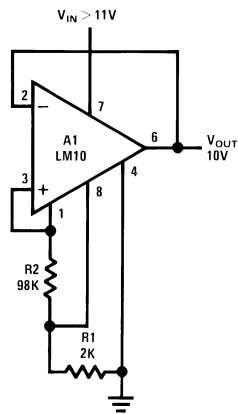
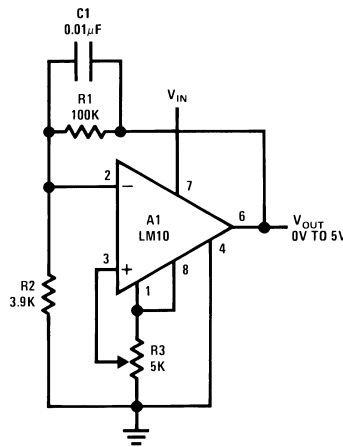
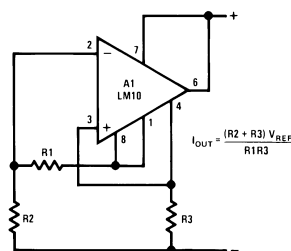


Figure 9. Zero Output



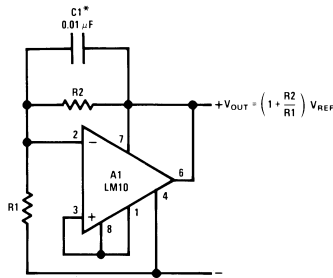
- (1) Use only electrolytic output capacitors.

Figure 10. Current Regulator



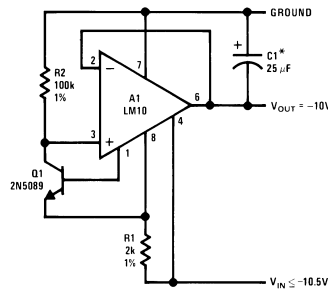
(Pin numbers are for devices in 8-pin packages)

Figure 11. Shunt Regulator



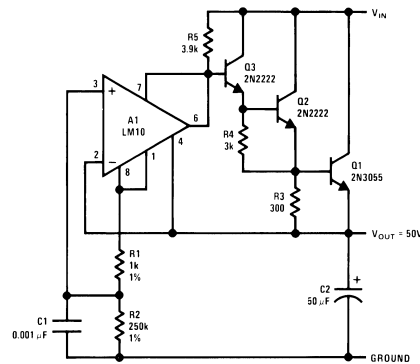
Required For Capacitive Loading

Figure 12. Negative Regulator



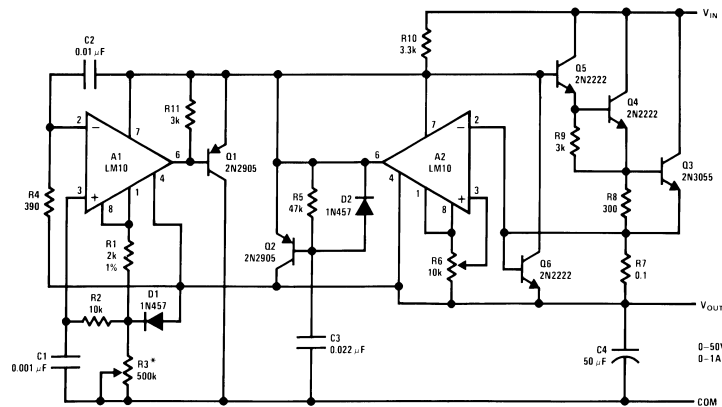
*Electrolytic

Figure 13. Precision Regulator



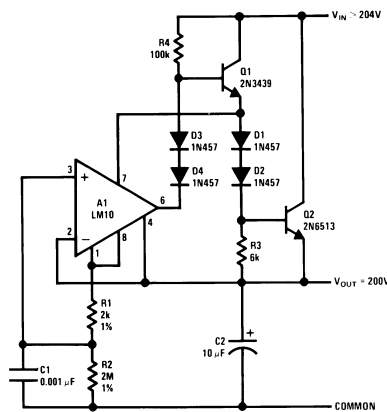
(Pin numbers are for devices in 8-pin packages)

Figure 14. Laboratory Power Supply



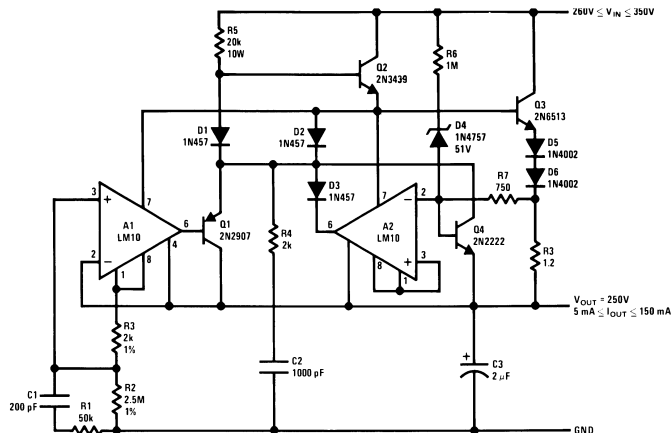
$$*V_{OUT} = 10^{-4} R_3$$

Figure 15. HV Regulator



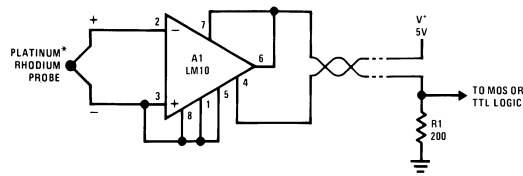
$$V_{OUT} = \frac{R_2}{R_1} V_{REF}$$

Figure 16. Protected HV Regulator



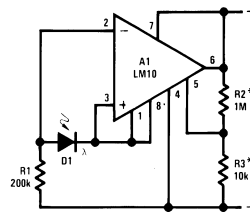
(Pin numbers are for devices in 8-pin packages)

Figure 17. Flame Detector



*800°C Threshold Is Established By Connecting Balance To V_{REF} .

Figure 18. Light Level Sensor



*Provides Hysteresis

Figure 19. Remote Amplifier

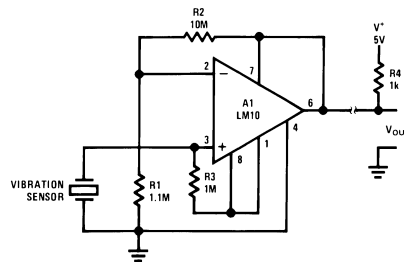
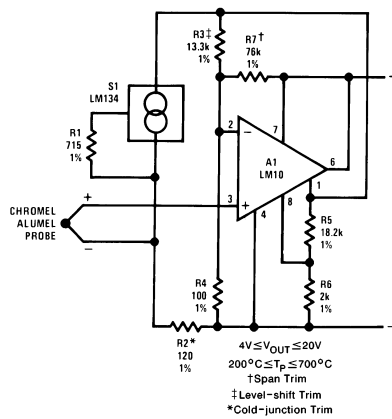


Figure 20. Remote Thermocouple Amplifier



(Pin numbers are for devices in 8-pin packages)

Figure 21. Transmitter for Bridge Sensor

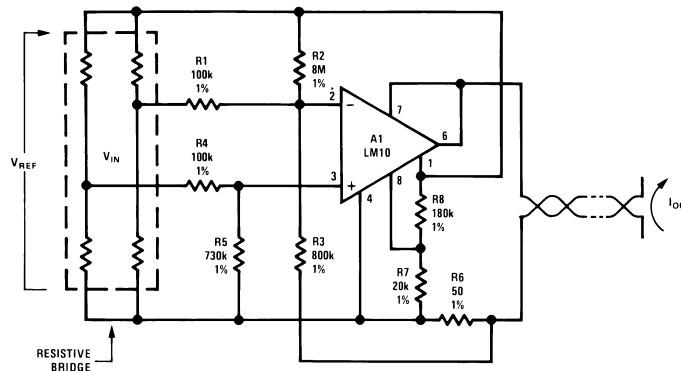
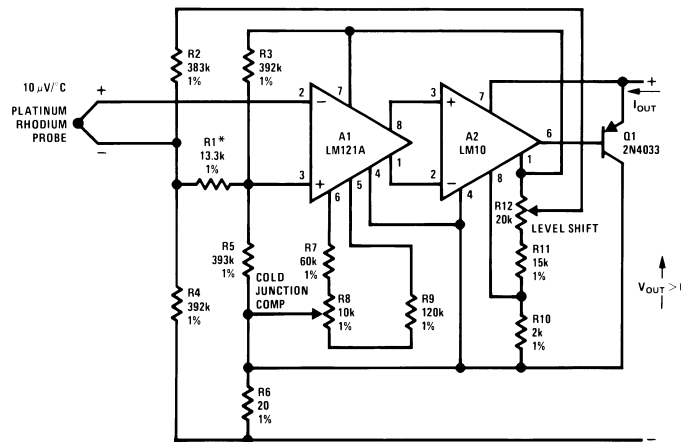
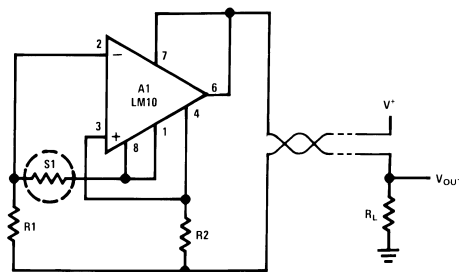


Figure 22. Precision Thermocouple Transmitter

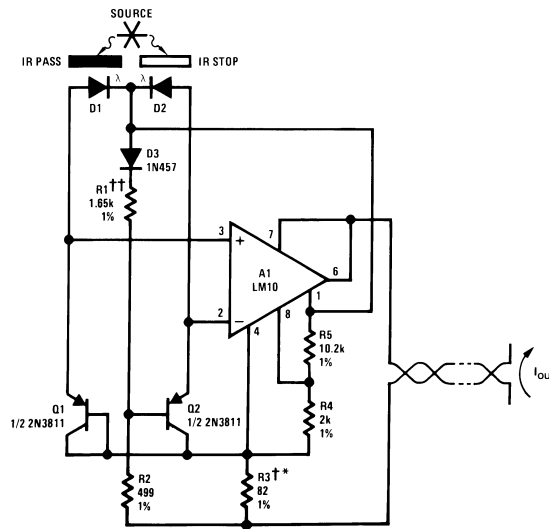


10 mA ≤ I_{OUT} ≤ 50 mA
 500°C ≤ T_P ≤ 1500°C
 *Gain Trim

Figure 23. Resistance Thermometer Transmitter



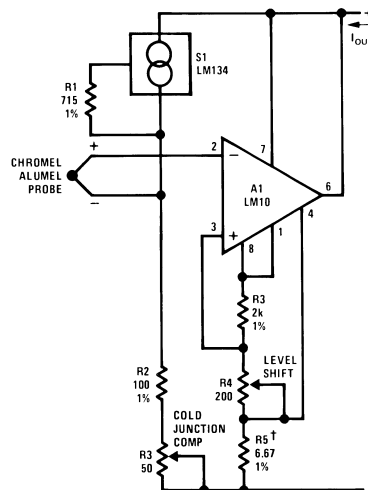
(Pin numbers are for devices in 8-pin packages)

Figure 24. Optical Pyrometer

††Level-shift Trim

*Scale Factor Trim

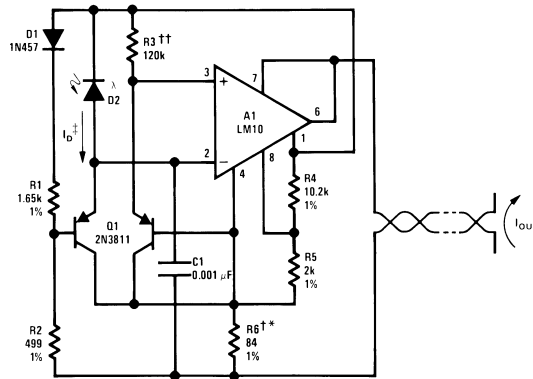
†Copper Wire Wound

 $1 \text{ mA} \leq I_{OUT} \leq 5 \text{ mA}$ $0.01 \leq \frac{I_{O2}}{I_{O1}} \leq 100$ **Figure 25. Thermocouple Transmitter** $200^{\circ}\text{C} \leq T_p \leq 700^{\circ}\text{C}$ $1 \text{ mA} \leq I_{OUT} \leq 5 \text{ mA}$

†Gain Trim

(Pin numbers are for devices in 8-pin packages)

Figure 26. Logarithmic Light Sensor



$1 \text{ mA} \leq I_{OUT} \leq 5 \text{ mA}$
 $\pm 50 \text{ } \mu\text{A} \leq I_D \leq 500 \text{ } \mu\text{A}$
 ††Center Scale Trim
 †Scale Factor Trim
 *Copper Wire Wound

Figure 27. Battery-level Indicator

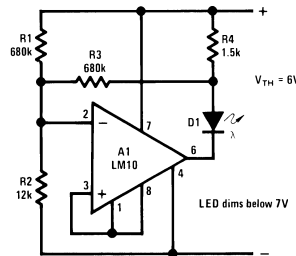
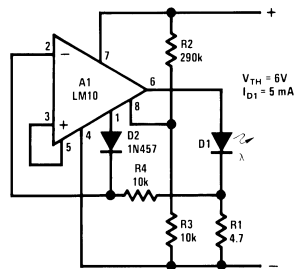
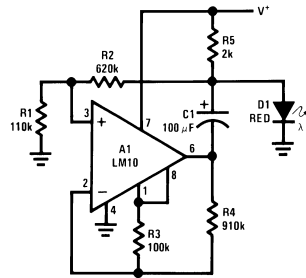


Figure 28. Battery-threshold Indicator



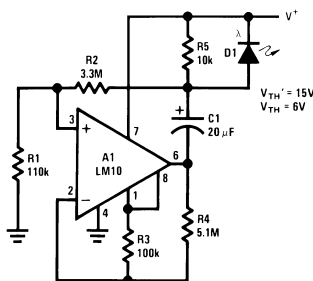
(Pin numbers are for devices in 8-pin packages)

Figure 29. Single-cell Voltage Monitor



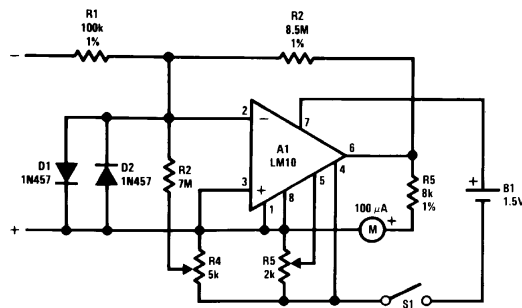
Flashes Above 1.2V
Rate Increases With
Voltage

Figure 30. Double-ended Voltage Monitor



Flash Rate Increases
Above 6V and Below 15V

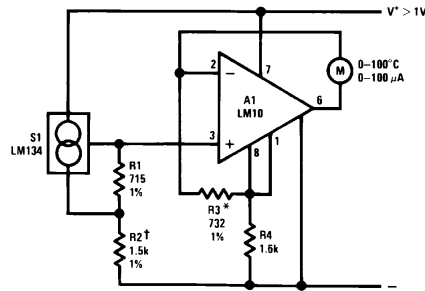
Figure 31. Meter Amplifier



INPUT
10 mV, 100nA
FULL-SCALE

(Pin numbers are for devices in 8-pin packages)

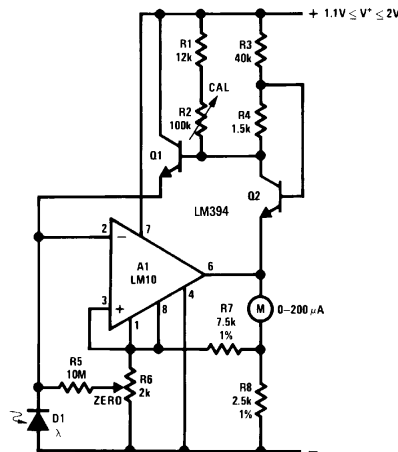
Figure 32. Thermometer



*Trim For Span

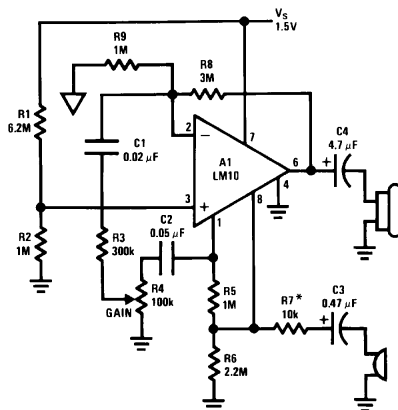
†Trim For Zero

Figure 33. Light Meter



$1 \leq \lambda_0 \leq 10^5$

Figure 34. Microphone Amplifier



$Z_{OUT} \sim 680\Omega @ 5 \text{ kHz}$

$A_V \leq 1k$

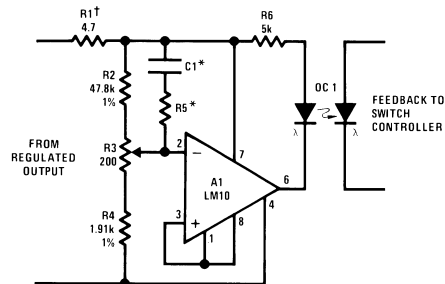
$f_1 \sim 100 \text{ Hz}$

$f_2 \sim 5 \text{ kHz}$

$R_L \sim 500$

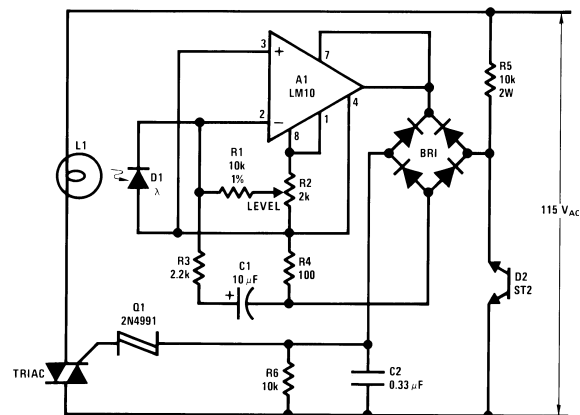
*Max Gain Trim

(Pin numbers are for devices in 8-pin packages)

Figure 35. Isolated Voltage Sensor

†Controls "Loop Gain"

*Optional Frequency Shaping

Figure 36. Light-level Controller

(1) Circuit descriptions available in application note AN-211.

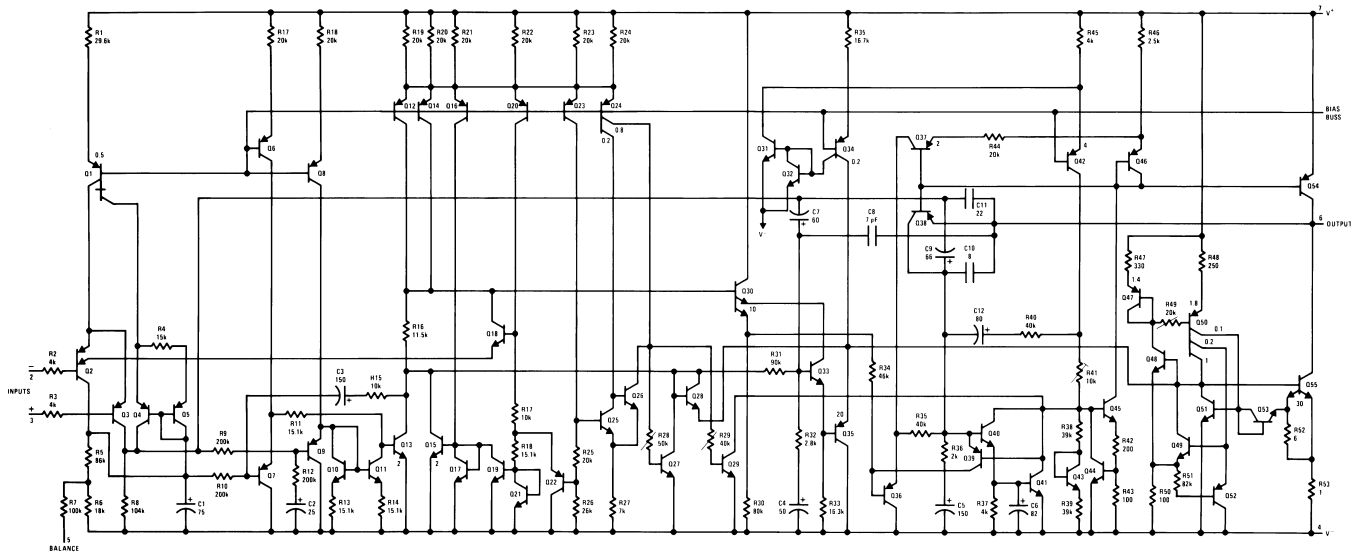
Application Hints

With heavy amplifier loading to V^- , resistance drops in the V^- lead can adversely affect reference regulation. Lead resistance can approach 1Ω . Therefore, the common to the reference circuitry should be connected as close as possible to the package.

Operational Amplifier Schematic

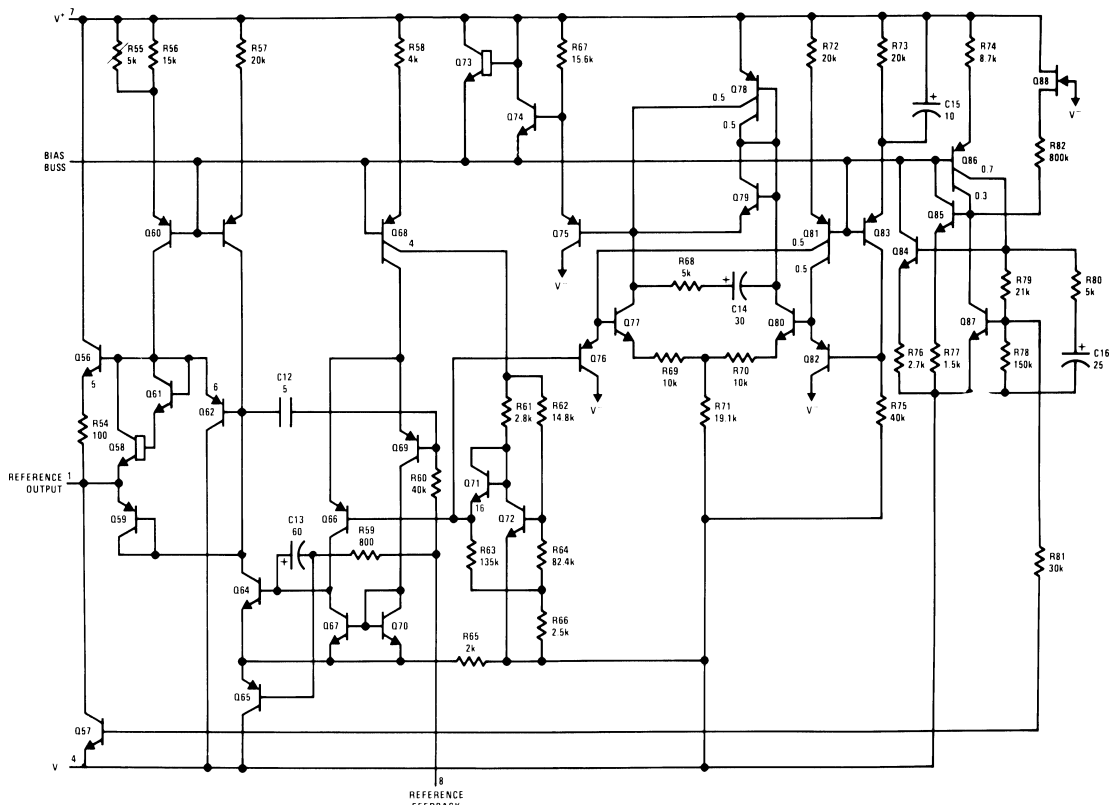
(Pin numbers are for 8-pin packages)

(Pin numbers are for devices in 8-pin packages)



Reference and Internal Regulator

(Pin numbers are for 8-pin packages)



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LM10BH	ACTIVE	TO	NEV	8	500	TBD	POST-PLATE	Level-1-NA-UNLIM	
LM10BH/NOPB	ACTIVE	TO	NEV	8	500	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	
LM10CH	ACTIVE	TO	NEV	8	500	TBD	POST-PLATE	Level-1-NA-UNLIM	
LM10CH/NOPB	ACTIVE	TO	NEV	8	500	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	
LM10CLN	ACTIVE	PDIP	P	8	40	TBD	Call TI	Level-1-NA-UNLIM	
LM10CLN/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	
LM10CN	ACTIVE	PDIP	P	8	40	TBD	Call TI	Level-1-NA-UNLIM	
LM10CN/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM	
LM10CWM	ACTIVE	SOIC	NPA	14	50	TBD	CU SNPB	Level-2A-220C-4 WEEK	
LM10CWM/NOPB	ACTIVE	SOIC	NPA	14	50	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	
LM10CWMX	ACTIVE	SOIC	NPA	14	1000	TBD	CU SNPB	Level-2A-220C-4 WEEK	
LM10CWMX/NOPB	ACTIVE	SOIC	NPA	14	1000	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	

(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.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM10CWMX	SOIC	NPA	14	1000	330.0	16.4	10.9	9.5	3.2	12.0	16.0	Q1
LM10CWMX/NOPB	SOIC	NPA	14	1000	330.0	16.4	10.9	9.5	3.2	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM10CWMX	SOIC	NPA	14	1000	358.0	343.0	63.0
LM10CWMX/NOPB	SOIC	NPA	14	1000	358.0	343.0	63.0

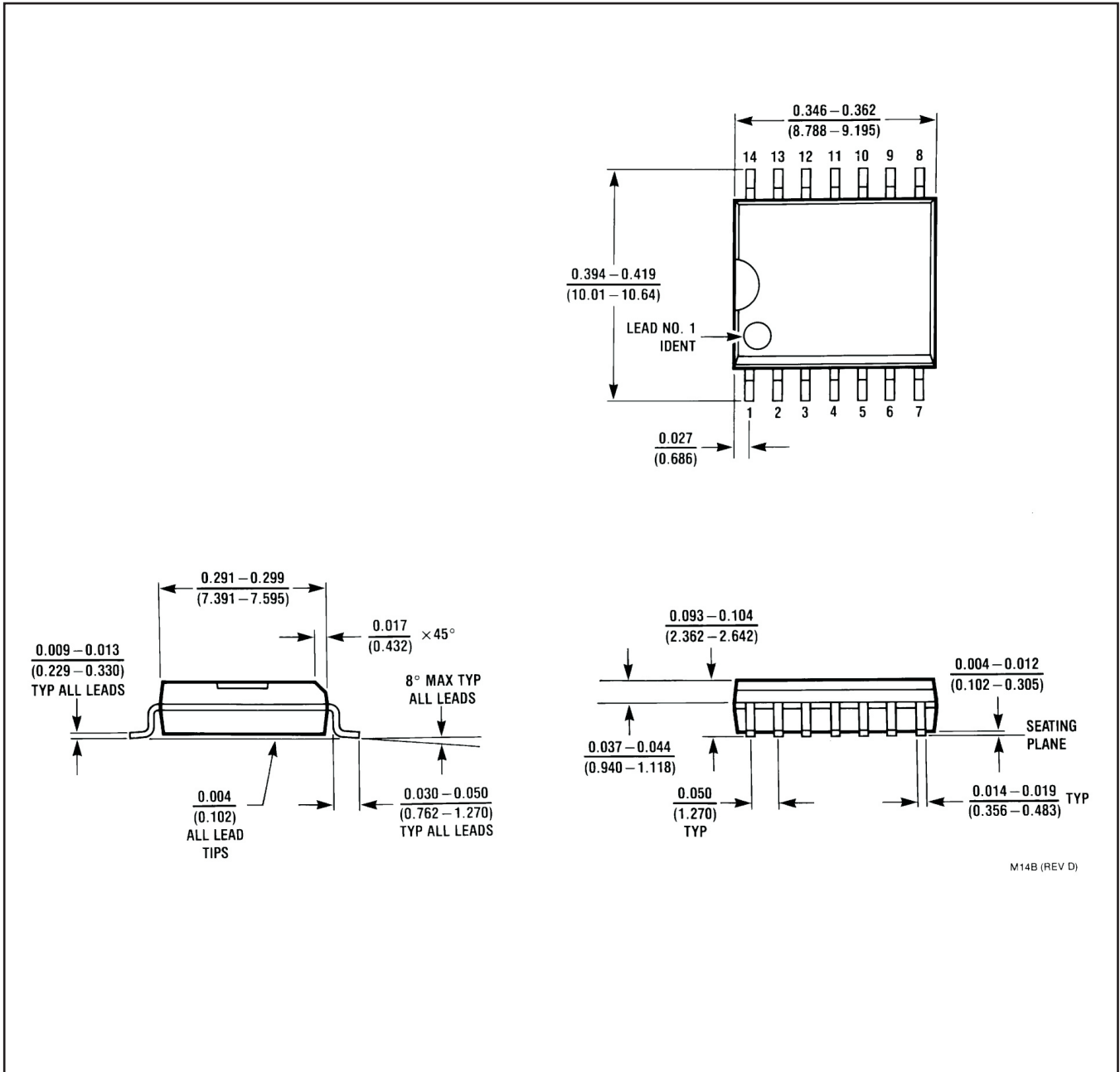
P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



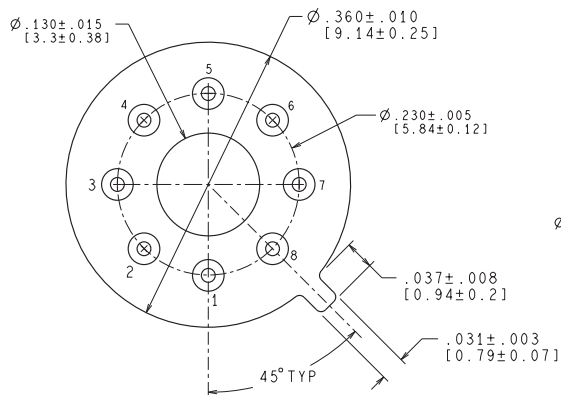
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MS-001 variation BA.

NPA0014B



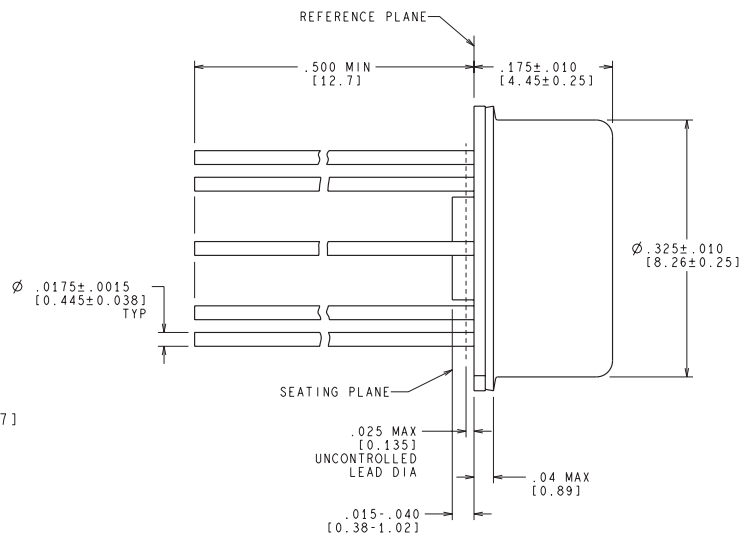
M14B (REV D)

NEV0008A



MIL-PRF-38535
CONFIGURATION CONTROL

CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE IN MILLIMETERS



H08A (REV C)

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