10 V Precision Voltage Reference

REF01

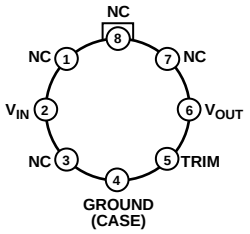
FEATURES

10 V output, ±0.3% maximum
Adjustment range, ±3% minimum
Excellent temperature stability, 8.5 ppm/°C maximum
Low noise, 30 µV p-p maximum
Low supply current, 1.4 mA maximum
Wide input voltage range, 12 V to 40 V
High load driving capability, 10 mA
No external components
Short-circuit proof

GENERAL DESCRIPTION

The REF01 precision voltage reference provides a stable 10 V output that can be adjusted over a 3% range with minimal effect on temperature stability. Single-supply operation over an input voltage range of 12 V to 40 V, a low current drain of 1 mA, and excellent temperature stability are achieved with an improved band gap design. Low cost, low noise, and low power make the REF01 an excellent choice whenever a stable voltage reference is required. Applications include DACs and ADCs, portable instrumentation, and digital voltmeters. Full military temperature range devices with screening to MIL-STD-883 are available. For new designs, refer to ADR01.

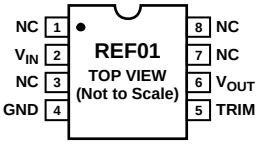
PIN CONFIGURATIONS



NC = NO CONNECT. DO NOT CONNECT ANYTHING ON THESE PINS. SOME OF THEM ARE RESERVED FOR FACTORY TESTING PURPOSES.

00373-F-001

Figure 1. TO-99 (J Suffix)



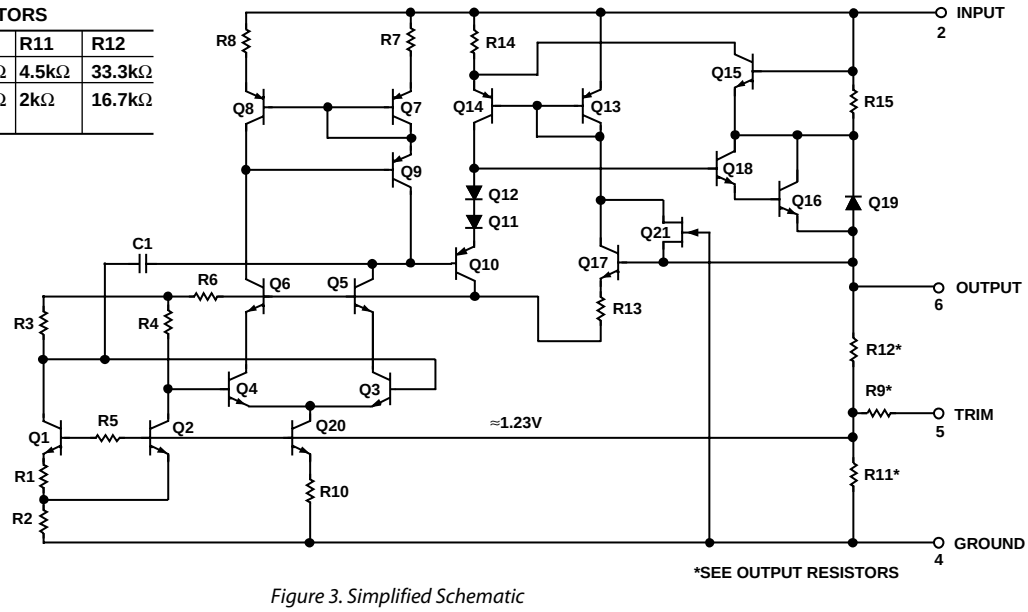
NC = NO CONNECT. DO NOT CONNECT ANYTHING ON THESE PINS. SOME OF THEM ARE RESERVED FOR FACTORY TESTING PURPOSES.

00373-F-002

Figure 2. 8-Lead PDIP (P-Suffix)
8-Lead CERDIP (Z-Suffix)
8-Lead SOIC (S-Suffix)

OUTPUT RESISTORS

REF01 OPTION	R9	R11	R12
P AND S PACKAGES	18kΩ	4.5kΩ	33.3kΩ
J AND Z PACKAGES, AND 883C PRODUCT	50kΩ	2kΩ	16.7kΩ



00373-F-003

Figure 3. Simplified Schematic

Rev. H

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7/04—Rev. E to Rev. F
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SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

@ V_{IN} = 15 V, T_A = 25°C, unless otherwise noted.

Table 1.

			REF01A/REF01E			REF01H			
Parameter	**Symbol**	**Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage	V_O	I_L = 0 mA	9.97	10.00	10.03	9.95	10.00	10.05	V
Output Adjustment Range	ΔV_{TRIM}	R_P = 10 kΩ	±3.0	±3.3		±3.0	±3.3		%
Output Voltage Noise[1]									
S, Z, P Packages	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		30			30		µV p-p
J, 883 Parts	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		35			35		µV p-p
Line Regulation[2]		V_{IN} = 13 V to 33 V		0.006	0.010		0.006	0.010	%/V
Load Regulation[2]		I_L = 0 mA to 10 mA		0.005	0.008		0.006	0.010	%/mA
Turn-On Settling Time[3]	t_{ON}	To ± 0.1% of final value		5			5		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.4		1.0	1.4	mA
Load Current	I_L		10			10			mA
Sink Current[4]	I_S		−0.3	−0.5		−0.3	−0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0		30			30		mA

[1] Sample tested.
[2] Line and load regulation specifications include the effect of self-heating.
[3] Guaranteed by design, not production tested.
[4] During sink current test, the device meets the output voltage specified.

@ V_{IN} = 15 V, −55°C ≤ T_A ≤ +125°C for REF01A/REF01E, and 0°C ≤ T_A ≤ 70°C for REF01H, and I_L = 0 mA, unless otherwise noted.

Table 2.

			REF01A/REF01E			REF01H			
Parameter	**Symbol**	**Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage Change	ΔV_{OT}	0°C ≤ T_A ≤ 70°C		0.02	0.06		0.07	0.17	%
with Temperature[1, 2]		−55°C ≤ T_A ≤+ 125°C		0.06	0.15		0.18	0.45	%
Output Voltage	TCV_O			3.0	8.5		10.0	25.0	ppm/°C
Temperature Coefficient[3]									
Change in V_O Temperature Coefficient		R_P = 10 kΩ		0.7			0.7		ppm/%
with Output Adjustment									
Line Regulation		0°C ≤ T_A ≤ 70°C		0.007	0.012		0.007	0.012	%/V
(V_{IN} = 13 V to 33 V)[4]		−55°C ≤ T_A ≤ + 125°C		0.009	0.015		0.009	0.015	%/V
Load Regulation		0°C ≤ T_A ≤ 70°C		0.006	0.010		0.007	0.012	%/mA
(I_L = 0 mA to 8 mA)[4]		−55°C ≤ T_A ≤ + 125°C		0.007	0.012		0.009	0.015	%/mA

[1] ΔV_{OT} is defined as the absolute difference between the maximum output voltage and the minimum output voltage over the specified temperature range expressed as a percentage of 10 V:

$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{10\ \text{V}} \right| \times 100$$

[2] ΔV_{OT} specification applies trimmed to 10000 V or untrimmed.
[3] TCV_O is defined as ΔVar divided by the temperature range; therefore,

$$TCV_O(0°\text{C}\ to + 70°\text{C}) = \frac{\Delta V_{OT}(0°\text{C}\ to + 70°\text{C})}{70°\text{C}} \text{ and } TCV_O(-55°\text{C}\ to + 125°\text{C}) = \frac{\Delta V_{OT}(-55°\text{C}\ to + 125°\text{C})}{180°\text{C}}$$

[4] Line and load regulation specifications include the effect of self-heating.

@ V_{IN} = 15 V, T_A = 25°C, unless otherwise noted.

Table 3.

Parameter	Symbol	Conditions	REF01C Min	REF01C Typ	REF01C Max	Unit
Output Voltage	V_O	I_L = 0 mA	9.90	10.00	10.10	V
Output Adjustment Range	ΔV_{TRIM}	R_P = 10 kΩ	±2.7	±3.3		%
Output Voltage Noise[1]						
S, Z, P Packages	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		30		µV p-p
J, 883 Parts	$e_{n\ p\text{-}p}$	0.1 Hz to 10 Hz		35		µV p-p
Line Regulation[2]		V_{IN} = 13 V to 33 V		0.009	0.015	%/V
Load Regulation[2]		I_L = 0 mA to 8 mA		0.006	0.015	%/mA
Turn-On Settling Time[3]	t_{ON}	To ±0.1% of final value		5		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.6	mA
Load Current	I_L		8			mA
Sink Current[4]	I_S		−0.3	−0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0		30		mA

[1] Sample tested.
[2] Line and load regulation specifications include the effect of self-heating.
[3] Guaranteed by design, not production tested.
[4] During sink current test, the device meets the output voltage specified.

@ V_{IN} = 15 V, 0°C ≤ T_A ≤ +70°C for REF01CJ, REF01CZ, and −40°C ≤ T_A ≤ +85°C for REF01CP and REF01CS, unless otherwise noted.

Table 4.

Parameter	Symbol	Conditions	REF01C Min	REF01C Typ	REF01C Max	Unit
Output Voltage Change with Temperature[1, 2]	ΔV_{OT}			0.14	0.45	%
Output Voltage Temperature Coefficient[3]	TCV_O			20	65	ppm/°C
Change in V_O Temperature Coefficient with Output Adjustment		R_P = 10 kΩ		0.7		ppm/°C
Line Regulation[4]		V_{IN} =13 V to 30 V		0.011	0.018	%/V
Load Regulation[4]		I_L = 0 to 5 mV		0.008	0.018	%/mA

[1] ΔV_{OT} is defined as the absolute difference between the maximum output voltage and the minimum output voltage over the specified temperature range expressed as a percentage of 10 V:

$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{10\ V} \right| \times 100$$

[2] ΔV_{OT} specification applies trimmed to +10,000 V or untrimmed.
[3] TCV_O is defined as ΔVar divided by the temperature range; therefore,

$$TCV_O(0°C\ to + 70°C) = \frac{\Delta V_{OT}(0°C\ to + 70°C)}{70°C} \text{ and } TCV_O(-55°C\ to + 125°C) = \frac{\Delta V_{OT}(-55°C\ to + 125°C)}{180°C}$$

[4] Line and load regulation specifications include the effect of self-heating.

ABSOLUTE MAXIMUM RATINGS

Table 5.

Parameter	Rating[1]
Input Voltage	40 V
Output Short-Circuit Duration	
(to Ground or V_{IN})	Indefinite
Storage Temperature Range	
J, S, and Z Packages	−65°C to +150°C
P Package	−65°C to +125°C
Operating Temperature Range	
REF01A	−55°C to +125°C
REF01CJ	0°C to 70°C
REF01CP, REF01CS, REF01E, REF01H	−40°C to +85°C
Junction Temperature (T_J)	−65°C to +150°C
Lead Temperature (Soldering @ 60 sec)	300°C

[1] Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

THERMAL RESISTANCE

Table 6.

Package Type	θ_{JA}[1]	θ_{JC}	Unit
TO-99 (J)	170	24	°C/W
8-Lead CERDIP (Z)	162	26	°C/W
8-Lead PDIP (P)	110	50	°C/W
8-Pin SOIC (S)	160	44	°C/W

[1] θ_{JA} is specified for worst-case mounting conditions; that is, θ_{JA} is specified for device in socket for TO, CERDIP, and PDIP packages. θ_{JA} is specified for device soldered to printed circuit board for SOIC package.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

TYPICAL PERFORMANCE CHARACTERISTICS

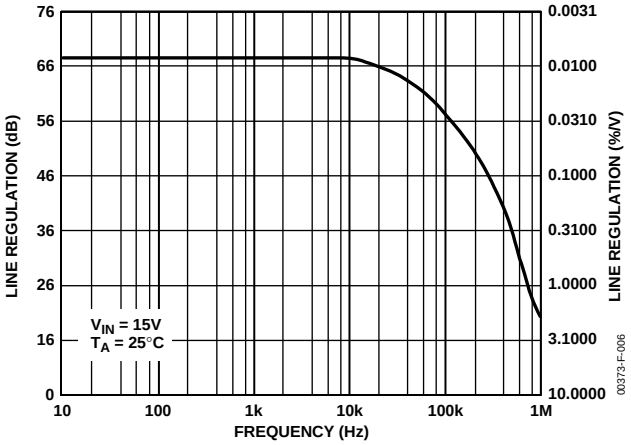


Figure 4. Line Regulation vs. Frequency

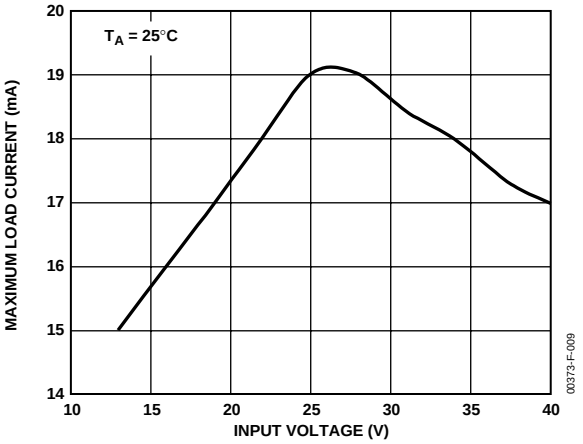


Figure 7. Maximum Load Current vs. Input Voltage

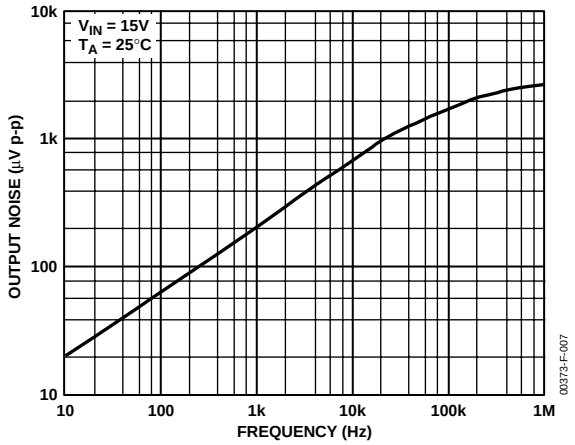


Figure 5. Output Wideband Noise vs. Bandwidth (0.1 Hz to Frequency Indicated)

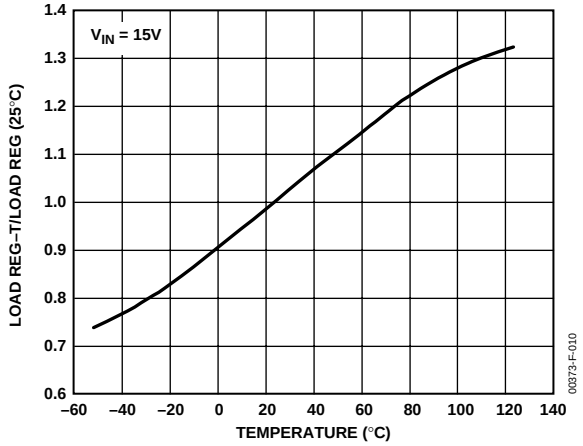


Figure 8. Normalized Load Regulation (ΔI_L = 10 mA) vs. Temperature

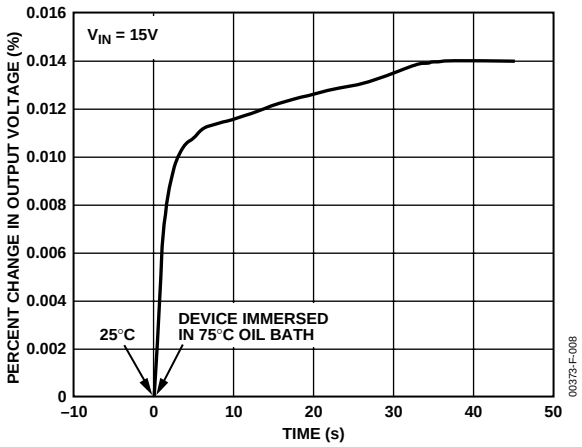


Figure 6. Output Change due to Thermal Shock

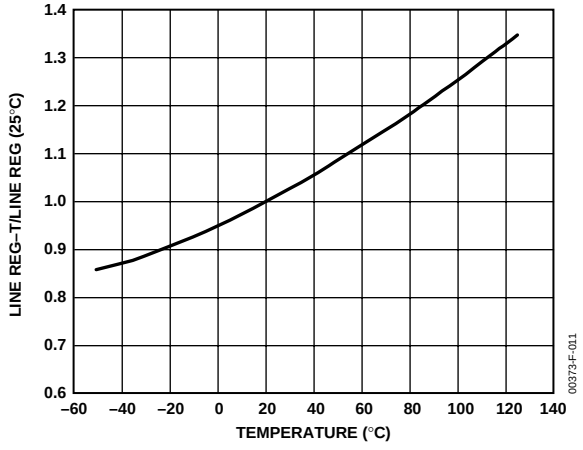


Figure 9. Normalized Line Regulation vs. Temperature

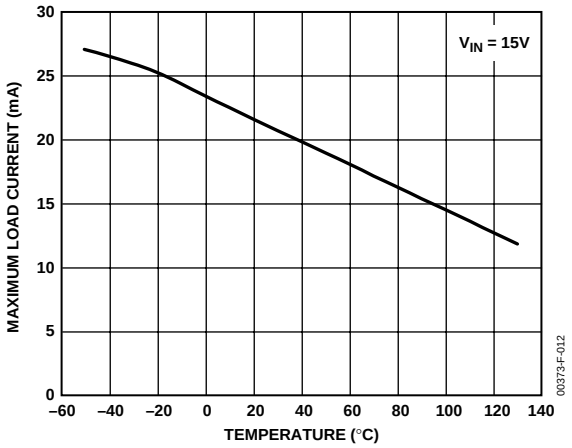


Figure 10. Maximum Load Current vs. Temperature

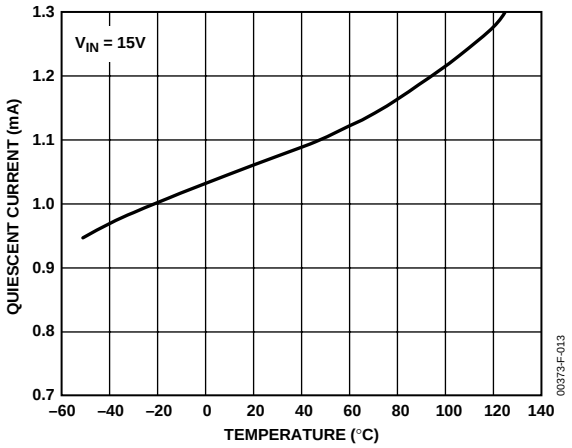


Figure 11. Quiescent Current vs. Temperature

APPLICATIONS

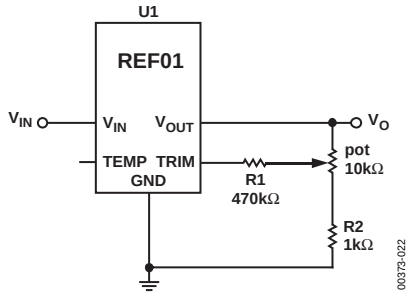


Figure 12. Output Adjustment

The REF01 trim terminal can be used to adjust the output voltage over a 10 V ± 300 mV range. This feature lets the system designer trim system errors by setting the reference to a voltage other than 10 V. The output also can be set exactly to 10.000 V or to 10.240 V for binary applications.

Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately 0.7 ppm/°C for 100 mV of output adjustment.

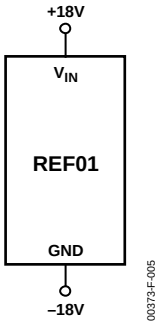
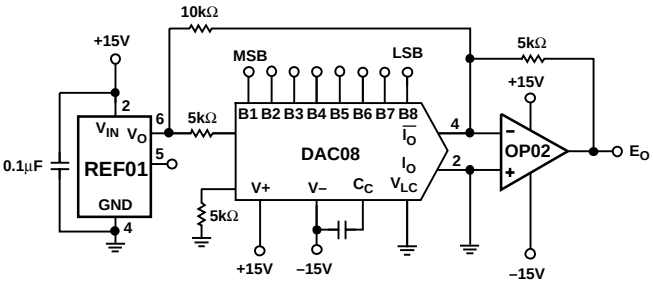


Figure 13. Burn-In Circuit



	B1	B2	B3	B4	B5	B6	B7	B8	E
POS. FULL SCALE –1LSB	1	1	1	1	1	1	1	1	+4.960
ZERO SCALE	1	0	0	0	0	0	0	0	0.000
NEG. FULL SCALE +1LSB	0	0	0	0	0	0	0	1	–4.960
NEG. FULL SCALE	0	0	0	0	0	0	0	0	–5.000

Figure 14. Burn-In Circuit

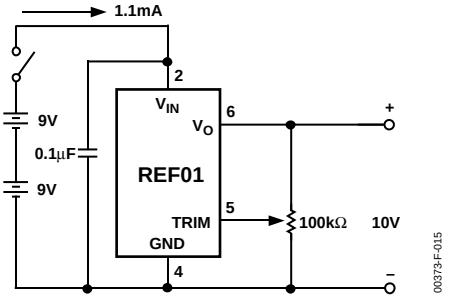


Figure 15. Precision Calibration Standard

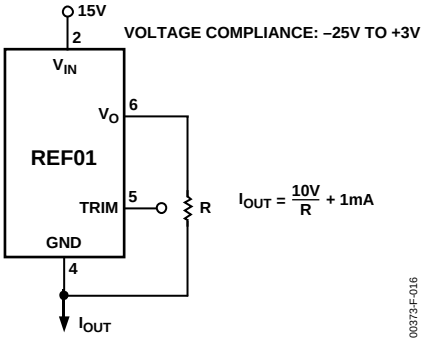


Figure 16. Current Source

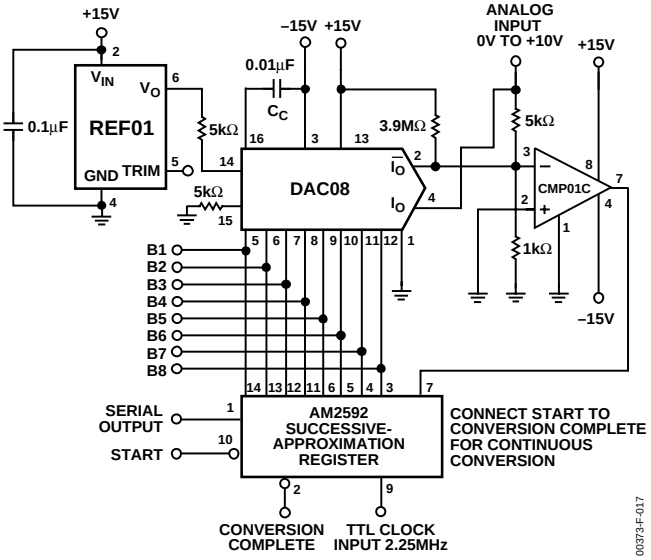


Figure 17. DAC Reference

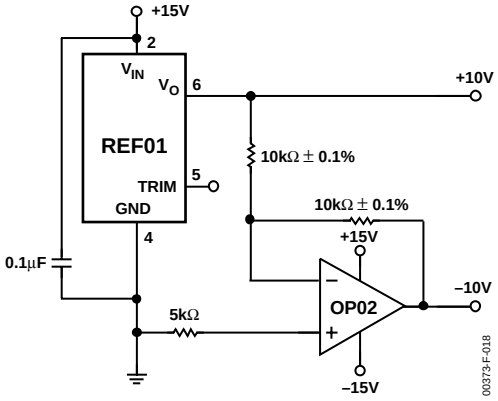


Figure 18. ±10 V Reference

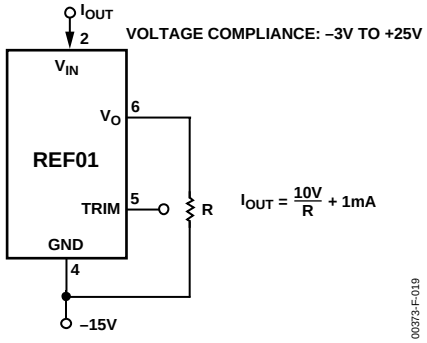


Figure 19. Current Sink

PRECISION CURRENT SOURCE

A current source with 25 V output compliance and excellent output impedance can be obtained using this circuit. REF01 keeps the line voltage and power dissipation constant in the device; the only important error consideration at room temperature is the negative supply rejection of the op amp. The typical 3 μV/V PSRR of the OP02E creates an 8 ppm change (3 μV/V × 25 V/10 V) in output current over a 25 V range. For example, a 10 mA current source can be built (R = 1 kΩ) with 300 MΩ output impedance.

$$R_O = \frac{25\ \text{V}}{8\times10^{-6}\times10\ \text{mA}}$$

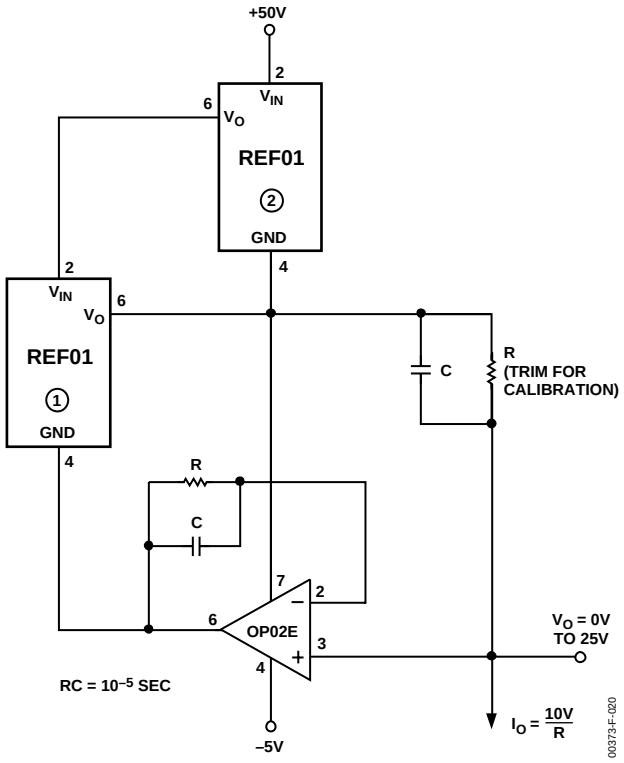


Figure 20. Precision Current Source

SUPPLY BYPASSING

For best results, it is recommended that the power supply pin be bypassed with a 0.1 μF disc ceramic capacitor.

REFERENCE STACK WITH EXCELLENT LINE REGULATION

Three REF01s can be stacked to yield 10 V, 20 V, and 30 V outputs. An additional advantage is near-perfect line regulation of the 10.0 V and 20.0 V output. A 32 V to 60 V input change produces an output change that is less than the noise voltage of the devices. A load bypass resistor (R_B) provides a path for the supply current (I_{SY}) of the 20 V regulator.

In general, any number of REF01s can be stacked this way. For example, 10 devices will yield outputs of 10 V, 20 V, 30 V . . . 100 V. The line voltage can change from 105 V to 130 V. However, care must be taken to ensure that the total load currents do not exceed the maximum usable current (typically 21 mA).

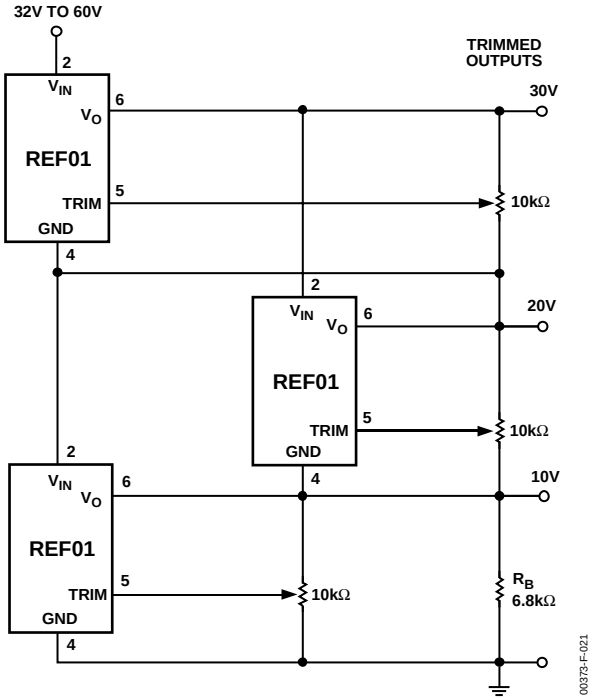
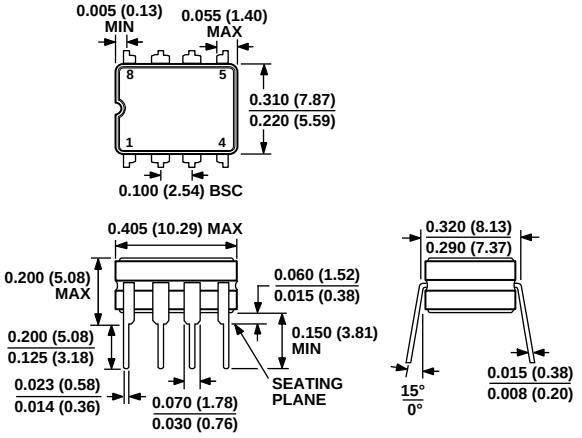


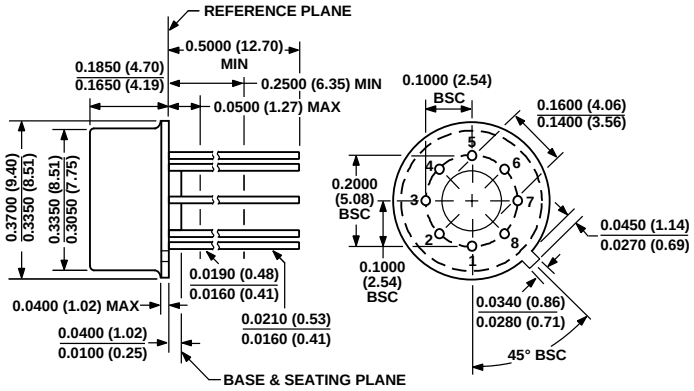
Figure 21. Reference Stack

OUTLINE DIMENSIONS



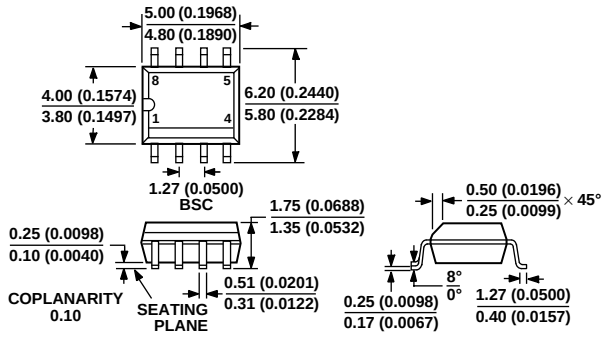
CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 22. 8-Lead Ceramic Dual In-Line Package [CERDIP]
(Q-8)
Z-Suffix
Dimensions shown in inches and (millimeters)



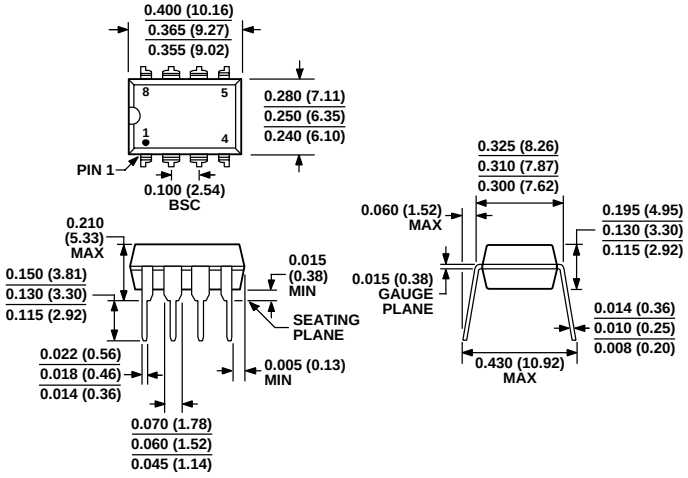
COMPLIANT TO JEDEC STANDARDS MO-002-AK
CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 23. 8-Lead Metal Header [TO-99]
(H-08)
J-Suffix
Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MS-012-AA
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 24. 8-Lead Standard Small Outline Package [SOIC]
Narrow Body
(R-8)
S-Suffix
Dimensions shown in millimeters and (inches



COMPLIANT TO JEDEC STANDARDS MS-001-BA
CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN. CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.

Figure 25. 8-Lead Plastic Dual In-Line Package [PDIP]
Narrow Body
(N-8)
P-Suffix
Dimensions shown in inches and (millimeters)

ORDERING GUIDE

Model	T_A = 25° C ΔV_{OS} Max (mV)	Temperature Range (°C)	Package Description[1]	Package Option
REF01AJ/883C	±30	−55 to +125	8-Lead TO-99	J-Suffix (H-08)
REF01EJ	±30	−40 to +85	8-Lead TO-99	J-Suffix (H-08)
REF01CJ	±100	0 to 70	8-Lead TO-99	J-Suffix (H-08)
REF01EZ	±30	−40 to +85	8-Lead CERDIP	Z-Suffix (Q-8)
REF01HZ	±50	−40 to +85	8-Lead CERDIP	Z-Suffix (Q-8)
REF01AZ/883C	±30	−55 to +125	8-Lead CERDIP	Z-Suffix (Q-8)
REF01CP	±100	−40 to +85	8-Lead PDIP	P-Suffix (N-8)
REF01CPZ[2]	±100	−40 to +85	8-Lead PDIP	P-Suffix (N-8)
REF01HPZ[2]	±50	−40 to +85	8-Lead PDIP	P-Suffix (N-8)
REF01HP	±50	−40 to +85	8-Lead PDIP	P-Suffix (N-8)
REF01HS[3]	±50	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01HS-REEL[3]	±50	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01HSZ[2, 3]	±50	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01HSZ-REEL[2, 3]	±50	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CS[3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CS-REEL[3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CS-REEL7[3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CSZ-REEL[2, 3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CSZ-REEL7[2, 3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)
REF01CSZ[2, 3]	±100	−40 to +85	8-Lead SOIC	S-Suffix (R-8)

[1] Burn-in is available on commercial and industrial temperature range parts in CERDIP, PDIP, and TO-99 packages.
[2] Z = Pb-free part.
[3] For availability and burn-in information on SOIC packages, contact your local Sales office.

C00373-0-12/05(H)

19-0887; Rev 7; 4/07

+5V, +10V Precision Voltage References

General Description

The REF01/REF02 are industry-standard precision voltage references. The stable 10V output of the REF01 can be adjusted over a ±6% range with minimal effect on temperature stability. The 5V output REF02 can also be adjusted over a ±6% range. The 10V REF01 has a single-supply operation over an input voltage range of 13V to 33V, while the 5V REF02 has a single-supply operation over an input voltage range of 7V to 33V. Both devices offer a low-current drain of 1mA. The REF02 also provides a TEMP pin whose output voltage varies linearly with temperature, making this device suitable for a wide variety of temperature-sensing and control applications. For new designs, refer to the MAX6035 or MAX6143 data sheets.

Features

- ♦ **Pretrimmed to +5V, +10V**
- ♦ **Excellent Temperature Stability: 3ppm/°C (typ)**
- ♦ **Low Noise: 10µVP-P (REF02)**
- ♦ **Short-Circuit Protected**
- ♦ **Linear Temperature Transducer Output (REF02)**

Ordering Information

PART	TEMP RANGE	MAX TEMPCO (ppm/°C)	INITIAL ERROR (mV)	PIN-PACKAGE	PKG CODE
REF01EP	0°C to +70°C	8.5	±30	8 Plastic DIP	P8-2
REF01EP+	0°C to +70°C	8.5	±30	8 Plastic DIP	P8-2
REF01HP	0°C to +70°C	25	±50	8 Plastic DIP	P8-2
REF01HP+	0°C to +70°C	25	±50	8 Plastic DIP	P8-2
REF01HSA	0°C to +70°C	25	±50	8 SO	S8-2
REF01HSA+	0°C to +70°C	25	±50	8 SO	S8-2
REF01CP	0°C to +70°C	65	±100	8 Plastic DIP	P8-2
REF01CP+	0°C to +70°C	65	±100	8 Plastic DIP	P8-2
REF01CSA	0°C to +70°C	65	±100	8 SO	S8-2
REF01CSA+	0°C to +70°C	65	±100	8 SO	S8-2
REF01CESA	-40°C to +85°C	65	±100	8 SO	S8-2
REF01CESA+	-40°C to +85°C	65	±100	8 SO	S8-2

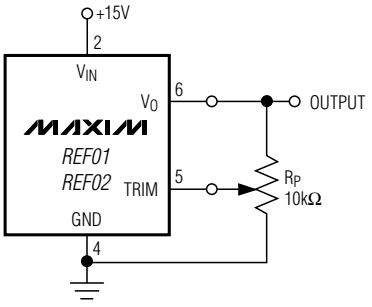
+Denotes a lead-free package.

Ordering Information continued at end of data sheet.

Applications

Analog-to-Digitial Converters
Digitial-to-Analog Converters
Digital Voltmeters
Voltage Regulators
Threshold Detectors

Typical Operating Circuit



REFERENCE WITH TRIMMED OUTPUT.

ABSOLUTE MAXIMUM RATINGS–REF01

Input Voltage
REF01, E, H 40V
REF01C 30V
Continuous Power Dissipation
Plastic Dip (P) (derate at 5.6mW/°C above +36°C) 500mW
Small Outline (S) (derate at 5.0mW/°C above +55°C) ..300mW

Output Short-Circuit Duration
(to ground or V_{IN}) .....Indefinite
Storage Temperature Range .....-65°C to +150°C
Operating Temperature Range
REF01E, REF01H, REF01C
(except REF01CESA).....0°C to +70°C
REF01CESA.....-40°C to +85°C
Lead Temperature (soldering, 60s) .....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—REF01E/REF01H

(V_{IN} = +15V, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF01E			REF01H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage	V_O	I_L = 0	9.97	10.00	10.03	9.95	10.00	10.05	V
Output Adjustment Range	ΔV_{trim}	R_P = 10kΩ	±3.0	±6.0		±3.0	±6.0		%
Output Voltage Noise	e_{nP-P}	0.1Hz to 10Hz (Note 1)		20	30		20	30	μV_{P-P}
Line Regulation		V_{IN} = 13V to 33V (Note 2)		0.006	0.010		0.006	0.010	%/V
Load Regulation		I_L = 0 to 10mA (Note 2)		0.005	0.008		0.006	0.010	%/mA
Turn-On Settling Time	t_{ON}	To ±0.1% of final value		400			400		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.4		1.0	1.4	mA
Load Current	I_L	To specified output voltage tolerance	10	21		10	21		mA
Sink Current	I_S	To specified output voltage tolerance	0.3	0.5		0.3	0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0V		30			30		mA

ELECTRICAL CHARACTERISTICS—REF01E/REF01H

(V_{IN} = +15V, **0°C ≤ T_A ≤ +70°C for REF01E and REF01H**, I_L = 0mA, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF01E			REF01H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage Change with Temperature	ΔV_{OT}	0°C ≤ T_A ≤ +70°C (Note 3)		0.02	0.06		0.07	0.17	%
Output Voltage Temperature Coefficient	TCV_O	(Note 4)		3	8.5		10.0	25.0	ppm/°C
Change in V_O Temperature Coefficient with Output Adjustment		R_P = 10kΩ		0.7			0.7		ppm/%
Line Regulation (V_{IN} = 13V to 33V)		0°C ≤ T_A ≤ +70°C (Note 2)		0.007	0.012		0.007	0.012	%/V
Load Regulation (I_L = 0 to 8mA)		0°C ≤ T_A ≤ +70°C (Note 2)		0.006	0.010		0.007	0.012	%/mA

ELECTRICAL CHARACTERISTICS—REF01C

(V_{IN} = +15V, **T_A = +25°C**, I_L = 0mA, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF01C			UNITS
			MIN	TYP	MAX	
Output Voltage	V_O	I_L = 0mA	9.90	10.00	10.10	V
Output Adjustment Range	ΔV_{trim}	R_P = 10kΩ	±2.7	±6.0		%
Output Voltage Noise	e_{nP-P}	0.1Hz to 10Hz (Note 1)		25	35	µV$_{P-P}$
Line Regulation		V_{IN} = 13V to 30V (Note 2)		0.009	0.015	%/V
Load Regulation (Note 2)		I_L = 0 to 8mA		0.006	0.015	%/mA
		I_L = 0 to 4mA		0.006	0.015	
Turn-On Settling Time	t_{ON}	To ±0.1% of final value		400		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.6	mA
Load Current	I_L	To specified output voltage tolerance	8	21		mA
Sink Current	I_S	To specified output voltage tolerance	0.2	0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0V		30		mA

ELECTRICAL CHARACTERISTICS—REF01C

(V_{IN} = +15V, **$T_A = T_{MIN}$ to T_{MAX}**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF01C			UNITS
			MIN	TYP	MAX	
Output Voltage Change with Temperature	ΔV_{OT}	(Note 3)		0.14	0.45	%
Output Voltage Temperature Coefficient	TCV_O	(Note 4)		20	65	ppm/°C
Change in V_O Temperature Coefficient with Output Adjustment		R_P = 10kΩ		0.7		ppm/%
Line Regulation		V_{IN} = 13V to 30V (Note 2)		0.011	0.018	%/V
Load Regulation		I_L = 0 to 5mA (Note 2)		0.008	0.018	%/mA

Note 1: Guaranteed by design.

Note 2: Line and load regulation specifications include the effect of self heating. 100% production tested at T_A = +25°C and guaranteed by design for $T_A = T_{MIN}$ to T_{MAX}, as specified.

Note 3: ΔV_{OT} is defined as the absolute difference between the maximum output voltage and the minimum output voltage over the specified temperature range expressed as a percentage of 10V. Guaranteed by design.

$$\Delta V_{OT} = \left[\frac{V_{MAX} - V_{MIN}}{10V}\right] \times 100$$

Note 4: TCV_O is defined as ΔV_{OT} divided by the temperature range. Guaranteed by design.

Output Adjustment

The REF01 trim terminal can be used to adjust the voltage over a 10V ±600mV range. This feature allows the system designer to trim system errors by setting the reference to a voltage other than 10V, including 10.240V for binary applications (see the *Typical Operating Circuit*).

Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately 0.7ppm/°C for 100mV of output adjustment.

+5V, +10V Precision Voltage References

ABSOLUTE MAXIMUM RATINGS–REF02

Input Voltage
- REF02, E, H 40V
- REF02C 30V

Continuous Power Dissipation
- Plastic Dip (P) (derate at 5.6mW/°C above +36°C) 500mW
- Small Outline (S) (derate at 5.0mW/°C above +55°C) .. 300mW

Storage Temperature Range ..... -65°C to +150°C

Operating Temperature Range
- REF02E, REF02H ..... 0°C to +70°C
- REF02C (except REF02CESA) ..... 0°C to +70°C
- REF02CESA ..... -40°C to +85°C

Output Short-Circuit Duration
- (to ground or V_{IN}) ..... Indefinite

Lead Temperature (soldering, 60s) ..... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—REF02E/REF02H

(V_{IN} = +15V, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF02E			REF02H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage	V_O	I_L = 0	4.985	5.000	5.015	4.975	5.000	5.025	V
Output Adjustment Range	ΔV_{trim}	R_P = 10kΩ	±3	±6		±3	±6		%
Output Voltage Noise	e_{nP-P}	0.1Hz to 10Hz (Note 5)		10	15		10	15	µVP-P
Line Regulation		V_{IN} = 8V to 33V (Note 6)		0.006	0.010		0.006	0.010	%/V
Load Regulation		I_L = 0 to 10mA (Note 6)		0.005	0.010		0.006	0.010	%/mA
Turn-On Settling Time	t_{ON}	To ±0.1% of final value		230			230		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.4		1.0	1.4	mA
Load Current	I_L	To specified output voltage tolerance	10	21		10	21		mA
Sink Current	I_S	To specified output voltage tolerance	0.3	0.5		0.3	0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0V		30			30		mA
Temperature Voltage Output	V_T	(Note 7)		630			630		mV

ELECTRICAL CHARACTERISTICS—REF02E/REF02H

(V_{IN} = +15V, **0°C ≤ T_A ≤ +70°C for REF02E and REF02H**, I_L = 0mA, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF02E			REF02H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage Change with Temperature	ΔV_{OT}	0°C ≤ T_A ≤ +70°C (Note 8)		0.02	0.06		0.07	0.17	%
Output Voltage Temperature Coefficient	TCV_O	(Note 9)		3	8.5		10	25	ppm/°C
Change in V_O Temperature Coefficient with Output Adjustment		R_P = 10kΩ		0.7			0.7		ppm/%
Line Regulation (V_{IN} = 8V to 33V)		0°C ≤ T_A ≤ +70°C (Note 6)		0.007	0.012		0.007	0.012	%/V
Load Regulation (I_L = 0 to 8mA)		0°C ≤ T_A ≤ +70°C (Note 6)		0.006	0.010		0.007	0.012	%/mA

ELECTRICAL CHARACTERISTICS—REF02E/REF02H (continued)

(V_{IN} = +15V, **0°C ≤ T_A ≤ +70°C for REF02E and REF02H**, I_L = 0mA, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF02E			REF02H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Temperature Voltage Output Temperature Coefficient	TCV_T	(Note 7)		2.1			2.1		mV/°C

ELECTRICAL CHARACTERISTICS—REF02C

(V_{IN} = +15V, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF02C			UNITS
			MIN	TYP	MAX	
Output Voltage	V_O	I_L = 0mA	4.950	5.000	5.050	V
Output Adjustment Range	ΔV_{trim}	R_P = 10kΩ	±2.7	±6.0		%
Output Voltage Noise	e_{nP-P}	0.1Hz to 10Hz (Note 5)		12	18	μV_{P-P}
Line Regulation		V_{IN} = 8V to 30V (Note 6)		0.009	0.015	%/V
Load Regulation (Note 6)		I_L = 0 to 8mA		0.006	0.015	%/mA
		I_L = 0 to 4mA				
Turn-On Settling Time	t_{ON}	To ±0.1% of final value		230		µs
Quiescent Supply Current	I_{SY}	No load		1.0	1.6	mA
Load Current	I_L	To specified output voltage tolerance	8	21		mA
Sink Current	I_S	To specified output voltage tolerance	0.2	0.5		mA
Short-Circuit Current	I_{SC}	V_O = 0V		30		mA
Temperature Voltage Output	V_T	(Note 7)		630		mV

ELECTRICAL CHARACTERISTICS—REF02C

(V_{IN} = +15V, **T_A = T_{MIN} to T_{MAX}**, I_L = 0mA, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	REF02C			UNITS
			MIN	TYP	MAX	
Output Voltage Change with Temperature	ΔV_{OT}	(Note 8)		0.14	0.45	%
Output Voltage Temperature Coefficient	TCV_O	(Note 9)		20	65	ppm/°C
Change in V_O Temperature Coefficient with Output Adjustment		R_P = 10kΩ		0.7		ppm/%
Line Regulation		V_{IN} = 8V to 30V (Note 6)		0.011	0.018	%/V
Load Regulation		I_L = 0 to 5mA (Note 6)		0.008	0.018	%/mA
Temperature Voltage Output Temperature Coefficient	TCV_T	(Note 7)		2.1		mV/°C

+5V, +10V Precision Voltage References

ELECTRICAL CHARACTERISTICS–REF02 (continued)

(V_{IN} = +15V, **T_A = T_{MIN} to T_{MAX}**, I_L = 0mA, unless otherwise noted.)

Note 5: Guaranteed by design.

Note 6: Line and load regulation specifications include the effect of self heating. 100% production tested at T_A = +25°C and guaranteed by design for T_A = T_{MIN} to T_{MAX}, as specified.

Note 7: Limit current in or out of pin 3 to 50nA and capacitance on pin 3 to 30pF.

Note 8: ΔV_{OT} is defined as the absolute difference between the maximum output voltage and the minimum output voltage over the specified temperature range expressed as a percentage of 5V. Guaranteed by design.

$$\Delta V_{OT} = \left[\frac{V_{MAX} - V_{MIN}}{5V}\right] \times 100$$

Note 9: TCV_O is defined as ΔV_{OT} divided by the temperature range. Guaranteed by design.

Output Adjustment

The REF02 trim terminal can be used to adjust the output voltage over a 5V ±300mV range. This feature allows the system designer to trim system errors by setting the reference to a voltage other than 5V (refer to the *Typical Operating Circuit*).

Adjustment of the output does not significantly affect the temperature performance of the device. Typically, the temperature coefficient change is 0.7ppm/°C for 100mV of output adjustment.

Temperature Voltage Output

The REF02 provides a temperature-dependent output voltage on the TEMP pin. This voltage is proportional to the absolute temperature, and has a scale factor of approximately 2.1mV/°C (Figure 1).

Output Voltage = 2.1(T + 273)mV

where T = Temperature in °C.

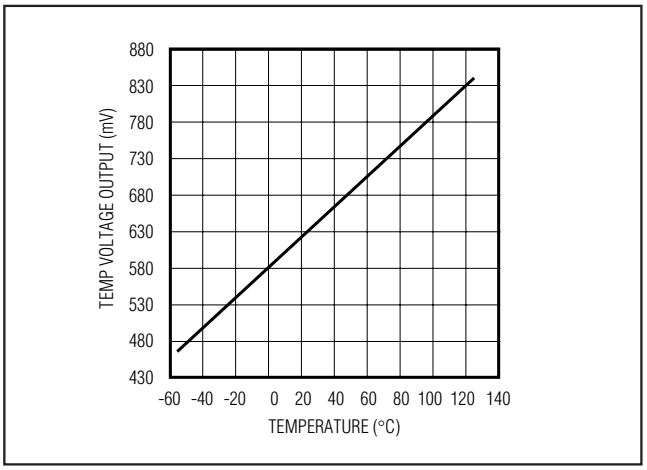
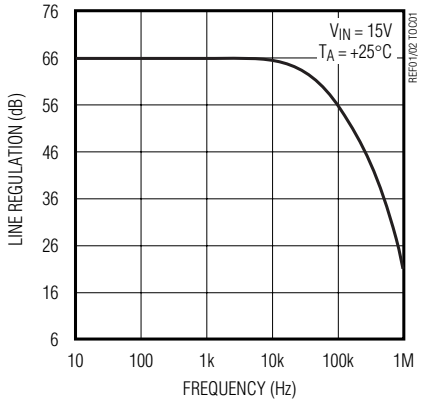


Figure 1. REF02 Temperature/Voltage Output vs. Temperature

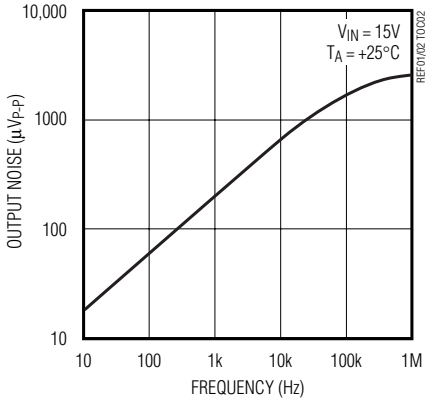
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

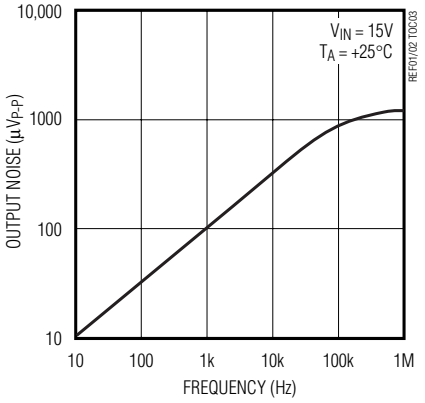
LINE REGULATION vs. FREQUENCY



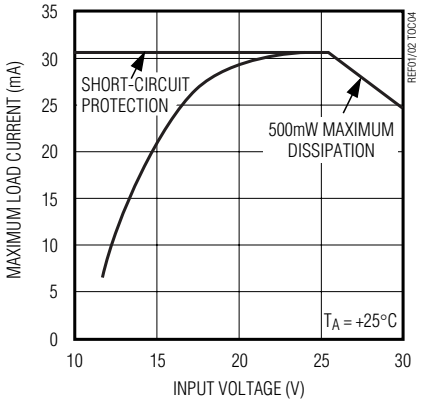
REF01 OUTPUT WIDEBAND NOISE vs. BANDWIDTH (0.1Hz TO FREQUENCY INDICATED)



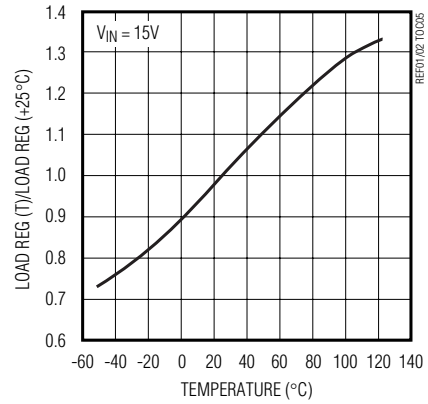
REF02 OUTPUT WIDEBAND NOISE vs. BANDWIDTH (0.1Hz TO FREQUENCY INDICATED)



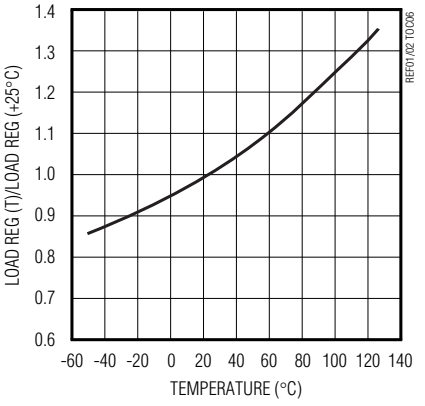
MAXIMUM LOAD CURRENT vs. INPUT VOLTAGE



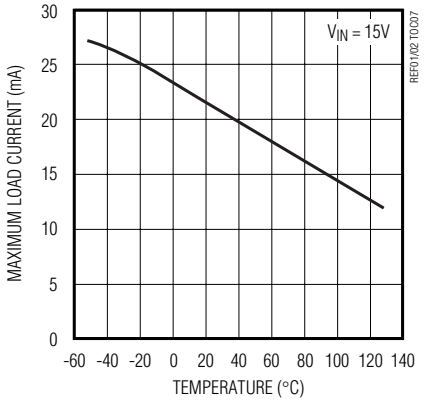
NORMALIZED LOAD REGULATION (ΔI_L = 10mA) vs. TEMPERATURE



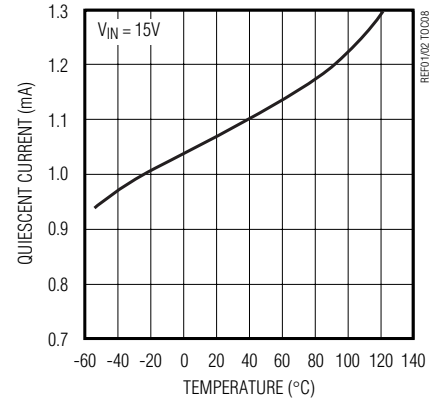
NORMALIZED LINE REGULATION vs. TEMPERATURE



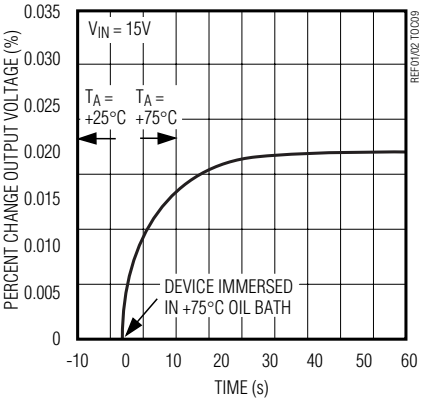
MAXIMUM LOAD CURRENT vs. TEMPERATURE



QUIESCENT CURRENT vs. TEMPERATURE



OUTPUT CHANGE DUE TO THERMAL SHOCK



+5V, +10V Precision Voltage References

Typical Applications

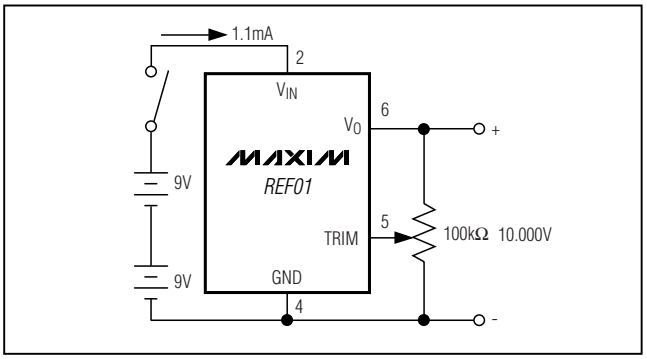


Figure 2. Precision Calibration Standard

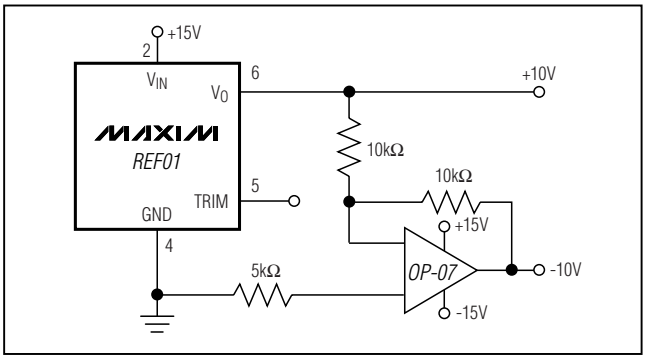


Figure 3. ±10V Reference

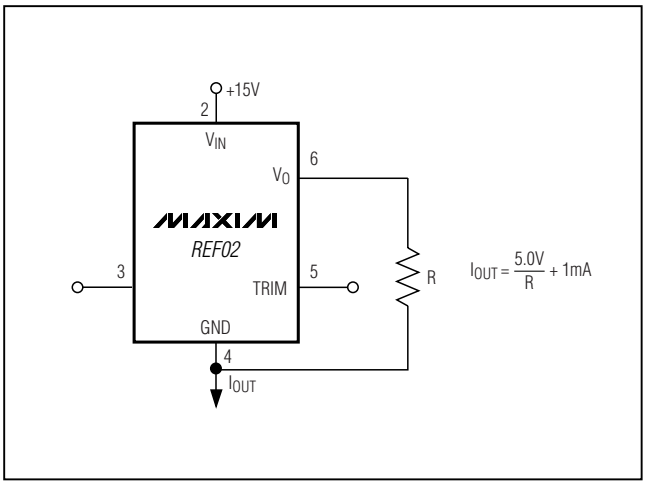


Figure 4. Current Source

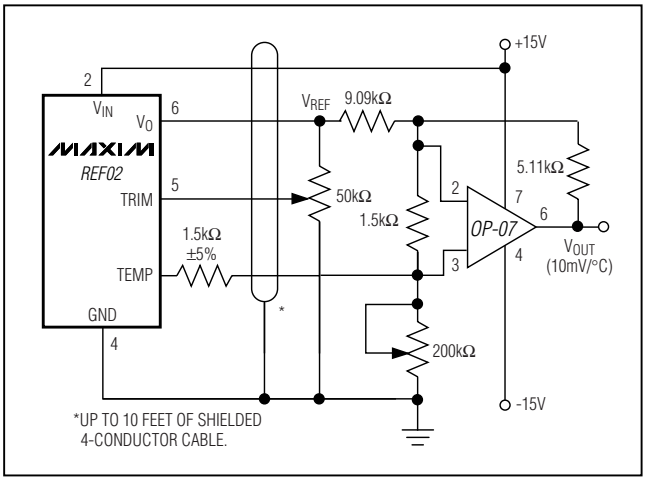
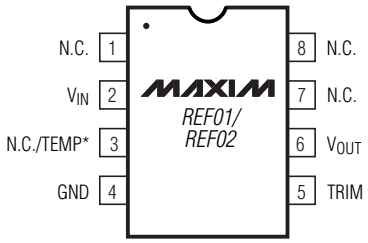


Figure 5. Precision Temperature Transducer with Remote Sensor

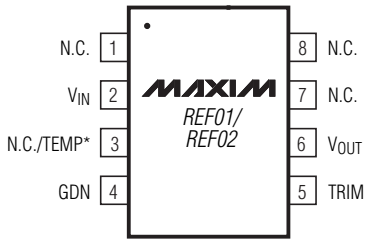
+5V, +10V Precision Voltage References

Pin Configurations

TOP VIEW



DIP



SO

*__NOTE:__ PIN 3 IS N.C. (NO CONNECTION) ON REF01, TEMP OUTPUT ON REF02.

Ordering Information (continued)

PART	TEMP RANGE	MAX TEMPCO (ppm/°C)	INITIAL ERROR (mV)	PIN-PACKAGE	PKG CODE
REF02EP	0°C to +70°C	8.5	±15	8 Plastic DIP	P8-2
REF02EP+	0°C to +70°C	8.5	±15	8 Plastic DIP	P8-2
REF02HP	0°C to +70°C	25	±25	8 Plastic DIP	P8-2
REF02HP+	0°C to +70°C	25	±25	8 Plastic DIP	P8-2
REF02HSA	0°C to +70°C	25	±25	8 SO	S8-2
REF02HSA+	0°C to +70°C	25	±25	8 SO	S8-2
REF02CP	0°C to +70°C	65	±50	8 Plastic DIP	P8-2
REF02CP+	0°C to +70°C	65	±50	8 Plastic DIP	P8-2
REF02CSA	0°C to +70°C	65	±50	8 SO	S8-2
REF02CSA+	0°C to +70°C	65	±50	8 SO	S8-2
REF02CESA	-40°C to +85°C	65	±50	8 SO	S8-2
REF02CESA+	-40°C to +85°C	65	±50	8 SO	S8-2

+Denotes a lead-free package.

Revision History

Pages changed at Rev 7: 1, 9

Package Information

For the latest package outline information, go to **www.maxim-ic.com/packages**.

Precision Voltage References

FEATURES

- Trimmed Output ±0.3%
- Low Drift—5ppm/°C Typ
- Low Noise—3ppm$_{(P-P)}$
- High Line Rejection
- Temperature Output—REF-02
- Low Supply Current 1.4mA Max

APPLICATIONS

- A/D and D/A Converters
- Precision Regulators
- Constant Current Sources
- V/F Converters
- Bridge Excitation

DESCRIPTION

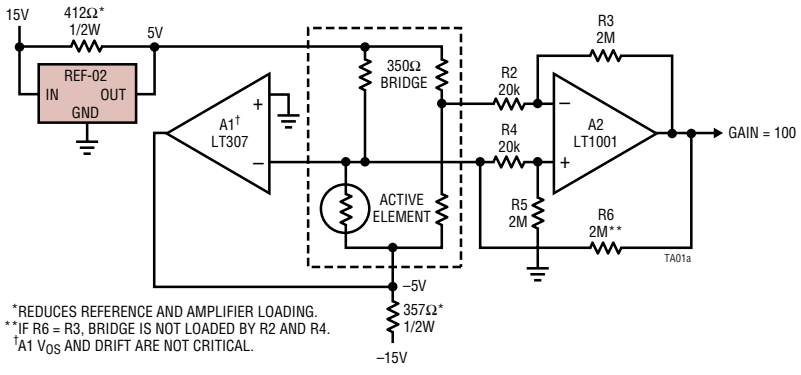
The REF-01/REF-02 are precision 10V and 5V bandgap references which provide stable output voltages over a wide range of operating conditions. Output voltage is accurate to ±0.3% with a low 5ppm/°C typical temperature coefficient. The REF-01 and REF-02 are excellent choices for applications where low drift, moderate accuracy, low power consumption and low cost are considerations.

The REF-02 includes a temperature output pin which provides a linear voltage proportional to absolute temperature.

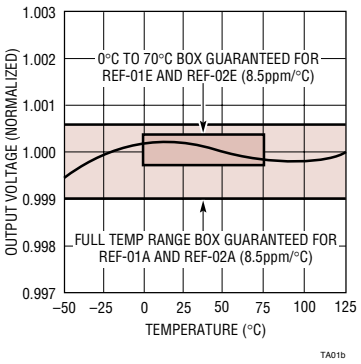
For lower drift and higher accuracy references, please see the LT1019 and LT1021 data sheets.

TYPICAL APPLICATION

Ultra Linear Strain Gauge Amplifier



Output Voltage Temperature Drift

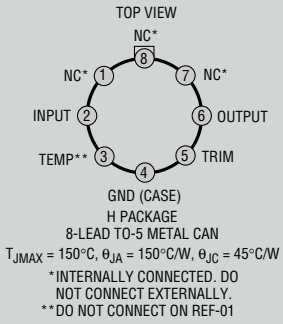


ABSOLUTE MAXIMUM RATINGS (Note 1)

REF-01/REF-02 A, E, H 40V
REF-01C/REF-02C 30V
Power Dissipation 500mW
Output Short-Circuit Duration
To Ground ..... Indefinite
To $V_{IN} \leq 16V$ ..... Indefinite
To $V_{IN} > 16V$ ..... Not Allowed

Storage Temperature Range ..... –65°C to 150°C
Operating Temperature
REF-01/REF-02, REF-01A/REF-02A ... –55°C to 125°C
REF-01E/REF-02E, REF-01H/REF-02H,
REF-01C/REF-02C, REF-01D/REF-02D .... 0°C to 70°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

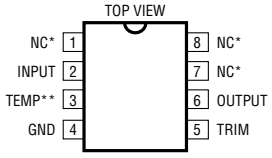
PACKAGE/ORDER INFORMATION



H PACKAGE
8-LEAD TO-5 METAL CAN
T_{JMAX} = 150°C, θ_{JA} = 150°C/W, θ_{JC} = 45°C/W
*INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY.
**DO NOT CONNECT ON REF-01

ORDER PART NUMBER	
REF01AH	REF02AH
REF01H	REF02H
REF01EH	REF02EH
REF01HH	REF02HH
REF01CH	REF02CH
	REF02DH

OBSOLETE PACKAGE
Consider the N Package for Alternate Source



N8 PACKAGE
8-LEAD PDIP
T_{JMAX} = 100°C, θ_{JA} = 130°C/W
*INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY.
**DO NOT CONNECT ON REF-01

J8 PACKAGE
8-LEAD CERDIP
T_{JMAX} = 150°C, θ_{JA} = 100°C/W

ORDER PART NUMBER	
REF01EN8	REF02EN8
REF01HN8	REF02HN8
REF01CN8	REF02CN8
	REF02DN8
REF01EJ8	REF02EJ8
REF01HJ8	REF02HJ8
REF01CJ8	REF02CJ8
	REF02DJ8

OBSOLETE PACKAGE
Consider the N Package for Alternate Source

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

V_{IN} = 15V, T_A = 25°C unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		REF-01A/E, REF-02A/E MIN	REF-01A/E, REF-02A/E TYP	REF-01A/E, REF-02A/E MAX	REF-01H, REF-02H MIN	REF-01H, REF-02H TYP	REF-01H, REF-02H MAX	UNITS
V_O	Output Voltage	I_L = 0mA	REF-01	9.97	10	10.03	9.95	10	10.05	V
			REF-02	4.985	5	5.015	4.975	5	5.025	V
	Output Adjustment Range	R_P = 10kΩ	REF-01	±3	5, –27		±3	5, –27		%
			REF-02	±3	5, –13		±3	5, –13		%
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01		20			20		μV_{P-P}
			REF-02		10			10		μV_{P-P}
V_{IN}	Input Voltage Range		REF-01	12		40	12		40	V
			REF-02	7		40	7		40	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 2)	$(V_{OUT} + 3V) \leq V_{IN} \leq 33V$			0.0001	0.010		0.0001	0.010	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 2)	I_L = 0mA to 10mA	REF-01		0.0005	0.008		0.0005	0.010	%/mA
			REF-02		0.0010	0.010		0.001	0.010	%/mA
I_Q	Quiescent Supply Current	No Load			0.65	1.4		0.65	1.4	mA
I_{OUT}	Load Current			10	20		10	20		mA
	Sink Current			–0.3	–20		–0.3	–20		mA
I_{SC}	Short-Circuit Current	V_O = 0V			25			25		mA
V_T	Temperature Voltage Output	(Note 3)	REF-02 Only		620			620		mV

ELECTRICAL CHARACTERISTICS

V_{IN} = 15V, T_A = 25°C unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		REF-01C, REF-02C MIN	REF-01C, REF-02C TYP	REF-01C, REF-02C MAX	REF-02D MIN	REF-02D TYP	REF-02D MAX	UNITS
V_O	Output Voltage	I_L = 0mA	REF-01	9.9	10	10.1				V
			REF-02	4.95	5	5.05	4.9	5	5.1	V
	Output Adjustment Range	R_P = 10kΩ	REF-01		5, –27					%
			REF-02	±2.7	5, –13		±2	5, –13		%
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01		30					μV_{P-P}
			REF-02		12			12		μV_{P-P}
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 2)	$(V_{OUT} + 3V) \le V_{IN} \le 33V$			0.0001	0.015		0.0001	0.04	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 2)	I_L = 0mA to 8mA			0.0005	0.015				%/mA
		I_L = 0mA to 4mA						0.001	0.04	%/mA
I_Q	Quiescent Supply Current	No Load			0.65	1.6		0.65	2	mA
I_{OUT}	Load Current			8	20		8	20		mA
	Sink Current			–0.2	20		–0.2	20		mA
I_{SC}	Short-Circuit Current	V_O = 0V			25			25		mA
V_T	Temperature Voltage Output	(Note 3)	REF-02 Only		620			620		mV

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{IN} = 15V, –55°C ≤ T_A ≤ ±125°C for REF-01A/REF-02A and REF-01/REF-02, 0°C ≤ T_A ≤ 70°C for REF-01E/REF-02E and REF-01H/REF-02H, I_L = 0mA unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		REF-01A/E, REF-02A/E MIN	REF-01A/E, REF-02A/E TYP	REF-01A/E, REF-02A/E MAX	REF-01H/REF-02H MIN	REF-01H/REF-02H TYP	REF-01H/REF-02H MAX	UNITS
$\frac{\Delta V}{\Delta T}$	Output Voltage Change with Temperature (Notes 4, 5)	0°C ≤ T_A ≤ 70°C	●		0.02	0.06		0.035	0.17	%
		–55°C ≤ T_A ≤ 125°C	●		0.09	0.15		0.144	0.45	%
TC	Output Voltage Temperature Coefficient	(Note 6)	●		5	8.5		8	25	ppm/°C
	Change in V_O Temperature Coefficient with Output Adjustment	R_P = 10kΩ	●		0.5			0.5		ppm/%
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	0°C ≤ T_A ≤ 70°C	●		0.0001	0.012		0.0001	0.012	%/V
	$(V_{OUT} + 3V) \le V_{IN} \le$ 33V (Note 2)	–55°C ≤ T_A ≤ 125°C	●		0.0001	0.015		0.0001	0.015	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	0°C ≤ T_A ≤ 70°C	●		0.002	0.010		0.002	0.012	%/mA
	(I_L = 0mA to 8mA) (Note 2)	–55°C ≤ T_A ≤ 125°C	●		0.002	0.012		0.002	0.015	%/mA
	Temperature Voltage Output Temperature Coefficient	(Note 3) REF-02	●		2.1			2.1		mV/°C

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{IN} = 15V, 0°C ≤ T_A ≤ 70°C and I_L = 0mA unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		REF-01C, REF-02C MIN	REF-01C, REF-02C TYP	REF-01C, REF-02C MAX	REF-02D MIN	REF-02D TYP	REF-02D MAX	UNITS
$\frac{\Delta V}{\Delta T}$	Output Voltage Change with Temperature	(Notes 4, 5)	●			0.45			1.7	%
TC	Output Voltage Temperature Coefficient	(Note 6)	●		8	65		8	250	ppm/°C
	Change in V_O Temperature Coefficient with Output Adjustment	R_P = 10kΩ	●		0.5			0.5		ppm/%
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 2)	V_{IN} = 8V to 30V	●		0.0001	0.018		0.0001	0.05	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 2)	I_L = 0mA to 5mA	●		0.002	0.018		0.002	0.05	%/mA
	Temperature Voltage Output Temperature Coefficient	(Note 3) REF-02	●		2.1			2.1		mV/°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: Line and load regulation specifications include the effect of self heating.

Note 3: Limit current in or out of Pin 3 to 50nA and capacitance on Pin 3 to 30pF.

Note 4: ΔV is defined as the absolute difference between the maximum output voltage and the minimum output voltage over the specified temperature range expressed as a percentage of nominal output.

$$\Delta V = \left| \frac{V_{MAX} - V_{MIN}}{V_{OUT}} \right| \bullet 100$$

Note 5: ΔV specification applies trimmed or untrimmed.

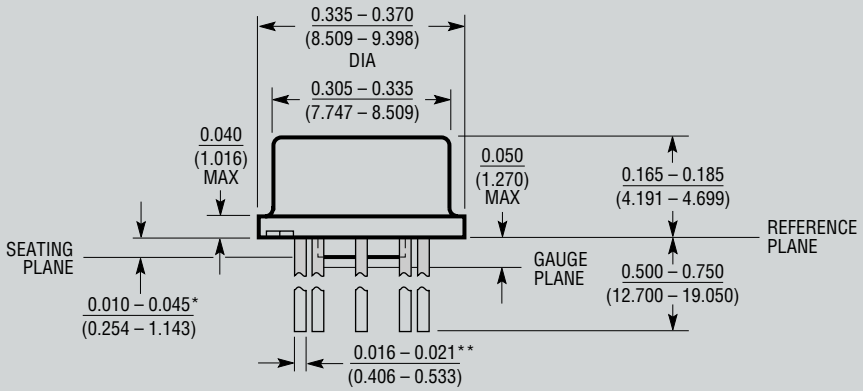
Note 6: TC is defined as ΔV divided by the temperature range, i.e.,

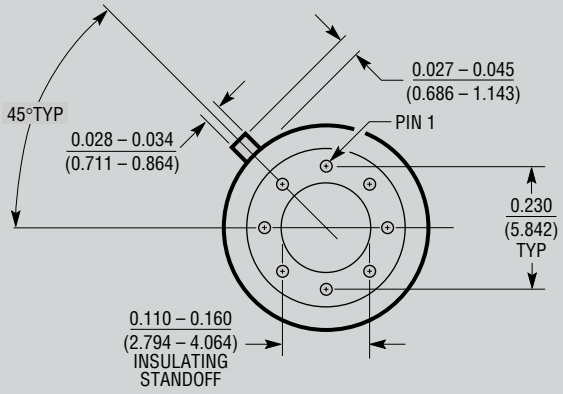
$$TC = \frac{\Delta V}{T_{MAX} \pm T_{MIN}}$$

Note 7: 0.1Hz to 10Hz noise cannot be 100% tested on modern high speed test equipment, so Linear Technology does not put a guaranteed maximum specification on this parameter for standard units. 100% bench testing of 0.1Hz to 10Hz noise is available on special request. To ensure low output noise, Linear Technology *does* 100% test 10Hz to 1kHz noise. Consult factory for details.

PACKAGE DESCRIPTION

H Package
8-Lead TO-5 Metal Can (.230 Inch PCD)
(Reference LTC DWG # 05-08-1321)





*LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND 0.045" BELOW THE REFERENCE PLANE

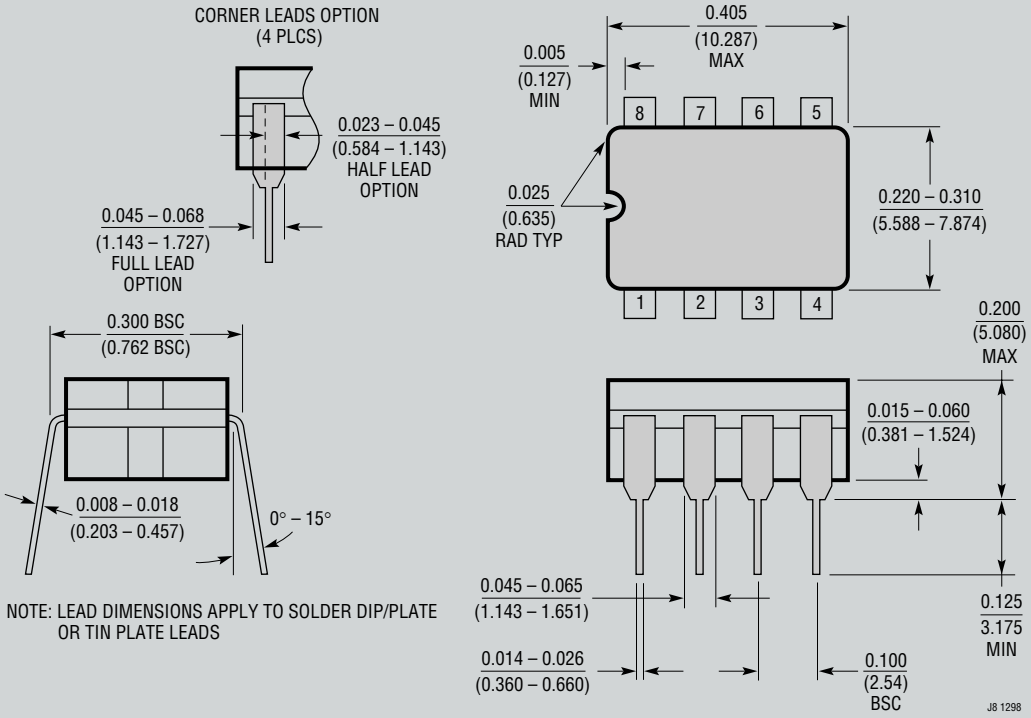
**FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS 0.016 – 0.024 (0.406 – 0.610)

H8 (TO-5) 0.230 PCD 1197

OBSOLETE PACKAGE

PACKAGE DESCRIPTION

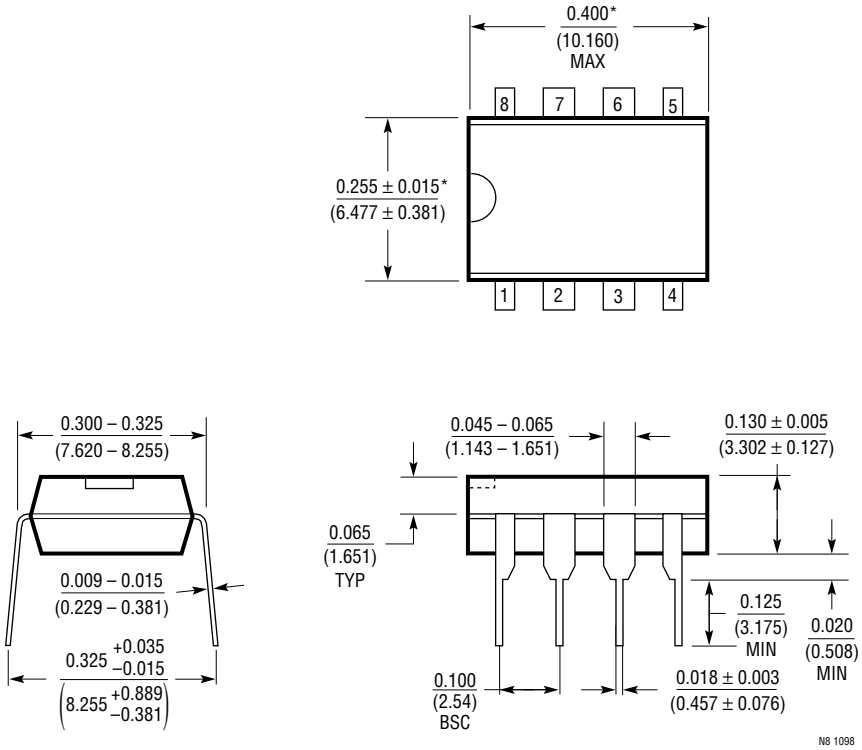
J8 Package
8-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



OBSOLETE PACKAGE

PACKAGE DESCRIPTION

N8 Package
8-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)



*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1019	0.05%, 5ppm/°C Precision Reference	Pin Compatible with the REF-01, REF-02, Improved Specs

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

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