

## FEATURES

- Trimmed Output  $\pm 0.3\%$
- Low Drift— $5\text{ppm}/^\circ\text{C}$  Typ
- Low Noise— $3\text{ppm}_{(P-P)}$
- 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  $\pm 0.3\%$  with a low  $5\text{ppm}/^\circ\text{C}$  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.

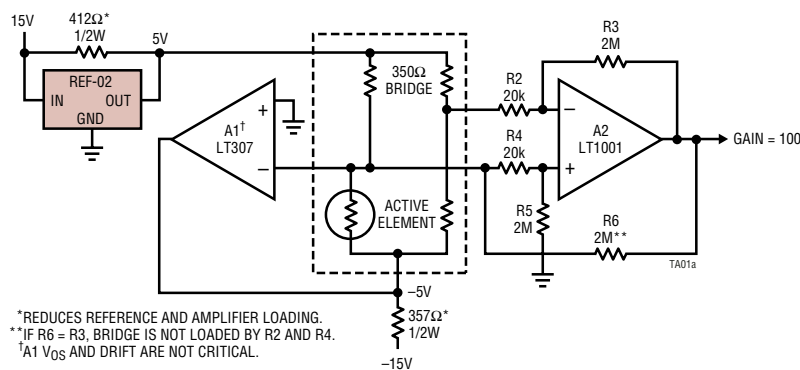
The REF-02 includes a temperature output pin which provides a linear voltage proportional to absolute temperature.

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

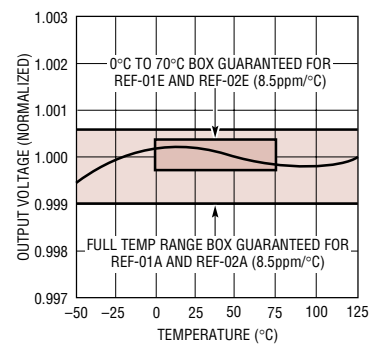
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## TYPICAL APPLICATION

Ultra Linear Strain Gauge Amplifier



Output Voltage Temperature Drift



# REF-01/REF-02

## ABSOLUTE MAXIMUM RATINGS (Note 1)

REF-01/REF-02 A, E, H .....	40V	Storage Temperature Range .....	-65°C to 150°C
REF-01C/REF-02C .....	30V	Operating Temperature	
Power Dissipation .....	500mW	REF-01/REF-02, REF-01A/REF-02A ...	-55°C to 125°C
Output Short-Circuit Duration		REF-01E/REF-02E, REF-01H/REF-02H,	
To Ground .....	Indefinite	REF-01C/REF-02C, REF-01D/REF-02D ....	0°C to 70°C
To $V_{IN} \leq 16V$ .....	Indefinite	Lead Temperature (Soldering, 10 sec) .....	300°C
To $V_{IN} > 16V$ .....	Not Allowed		

## PACKAGE/ORDER INFORMATION

<p><b>OBSOLETE PACKAGE</b> Consider the N Package for Alternate Source</p>	<p>ORDER PART NUMBER</p> <table border="0"> <tr><td>REF01AH</td><td>REF02AH</td></tr> <tr><td>REF01H</td><td>REF02H</td></tr> <tr><td>REF01EH</td><td>REF02EH</td></tr> <tr><td>REF01HH</td><td>REF02HH</td></tr> <tr><td>REF01CH</td><td>REF02CH</td></tr> <tr><td></td><td>REF02DH</td></tr> </table>	REF01AH	REF02AH	REF01H	REF02H	REF01EH	REF02EH	REF01HH	REF02HH	REF01CH	REF02CH		REF02DH	<p><b>OBSOLETE PACKAGE</b> Consider the N Package for Alternate Source</p>	<p>ORDER PART NUMBER</p> <table border="0"> <tr><td>REF01EN8</td><td>REF02EN8</td></tr> <tr><td>REF01HN8</td><td>REF02HN8</td></tr> <tr><td>REF01CN8</td><td>REF02CN8</td></tr> <tr><td></td><td>REF02DN8</td></tr> <tr><td>REF01EJ8</td><td>REF02EJ8</td></tr> <tr><td>REF01HJ8</td><td>REF02HJ8</td></tr> <tr><td>REF01CJ8</td><td>REF02CJ8</td></tr> <tr><td></td><td>REF02DJ8</td></tr> </table>	REF01EN8	REF02EN8	REF01HN8	REF02HN8	REF01CN8	REF02CN8		REF02DN8	REF01EJ8	REF02EJ8	REF01HJ8	REF02HJ8	REF01CJ8	REF02CJ8		REF02DJ8
	REF01AH	REF02AH																													
REF01H	REF02H																														
REF01EH	REF02EH																														
REF01HH	REF02HH																														
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REF01EN8	REF02EN8																														
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REF01CN8	REF02CN8																														
	REF02DN8																														
REF01EJ8	REF02EJ8																														
REF01HJ8	REF02HJ8																														
REF01CJ8	REF02CJ8																														
	REF02DJ8																														

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

## ELECTRICAL CHARACTERISTICS $V_{IN} = 15V, T_A = 25^\circ C$ unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	REF-01A/E, REF-02A/E			REF-01H, REF-02H			UNITS		
			MIN	TYP	MAX	MIN	TYP	MAX			
$V_O$	Output Voltage	$I_L = 0mA$	REF-01	9.97	10	10.03	REF-01H	9.95	10	10.05	V
			REF-02	4.985	5	5.015	REF-02H	4.975	5	5.025	V
	Output Adjustment Range	$R_P = 10k\Omega$	REF-01	$\pm 3$	5, -27		REF-02H	$\pm 3$	5, -27		%
		REF-02	$\pm 3$	5, -13		REF-02H	$\pm 3$	5, -13		%	
$e_{nP-P}$	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01	20		REF-01H	20			$\mu V_{P-P}$	
			REF-02	10		REF-02H	10			$\mu V_{P-P}$	
$V_{IN}$	Input Voltage Range		REF-01	12		40	REF-01H	12		40	V
			REF-02	7		40	REF-02H	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		REF-01H	0.0005	0.010		%/mA
			REF-02	0.0010	0.010		REF-02H	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 $V_{IN} = 15V$ , $T_A = 25^\circ C$ unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	REF-01C, REF-02C			REF-02D			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_O$	Output Voltage	$I_L = 0mA$	REF-01 REF-02	9.9 4.95	10 5	10.1 5.05	4.9 5	5.1	V V
	Output Adjustment Range	$R_P = 10k\Omega$	REF-01 REF-02	$\pm 2.7$	5, -27 5, -13		$\pm 2$	5, -13	% %
$e_{nP-P}$	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01 REF-02	30 12			12		$\mu V_{P-P}$ $\mu V_{P-P}$
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 2)	$(V_{OUT} + 3V) \leq V_{IN} \leq 33V$		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 $I_L = 0mA$ to 4mA		0.0005	0.015		0.001	0.04	%/mA %/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  $T_A = 25^\circ C$ .  $V_{IN} = 15V$ ,  $-55^\circ C \leq T_A \leq \pm 125^\circ C$  for REF-01A/REF-02A and REF-01/REF-02,  $0^\circ C \leq T_A \leq 70^\circ C$  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			REF-01H/REF-02H			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
$\frac{\Delta V}{\Delta T}$	Output Voltage Change with Temperature (Notes 4, 5)	$0^\circ C \leq T_A \leq 70^\circ C$	●	0.02	0.06		0.035	0.17	%	
		$-55^\circ C \leq T_A \leq 125^\circ C$	●	0.09	0.15		0.144	0.45	%	
TC	Output Voltage Temperature Coefficient	(Note 6)	●	5	8.5		8	25	ppm/ $^\circ C$	
	Change in $V_O$ Temperature Coefficient with Output Adjustment	$R_P = 10k\Omega$	●	0.5			0.5		ppm/%	
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation ( $V_{OUT} + 3V) \leq V_{IN} \leq 33V$ (Note 2)	$0^\circ C \leq T_A \leq 70^\circ C$	●	0.0001	0.012		0.0001	0.012	%/V	
		$-55^\circ C \leq T_A \leq 125^\circ C$	●	0.0001	0.015		0.0001	0.015	%/V	
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation ( $I_L = 0mA$ to 8mA) (Note 2)	$0^\circ C \leq T_A \leq 70^\circ C$	●	0.002	0.010		0.002	0.012	%/mA	
		$-55^\circ C \leq T_A \leq 125^\circ C$	●	0.002	0.012		0.002	0.015	%/mA	
	Temperature Voltage Output Temperature Coefficient	(Note 3) REF-02	●	2.1			2.1		mV/ $^\circ C$	

## ELECTRICAL CHARACTERISTICS

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

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

**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:**  $\Delta V$  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.

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

**Note 5:**  $\Delta V$  specification applies trimmed or untrimmed.

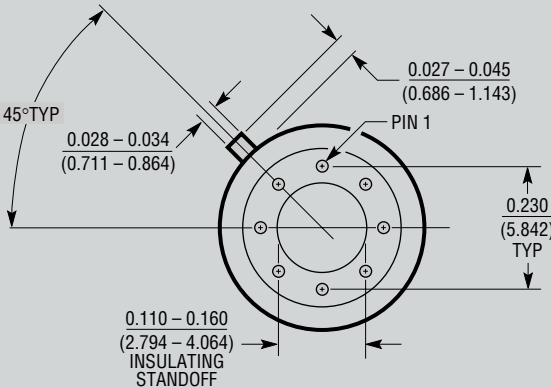
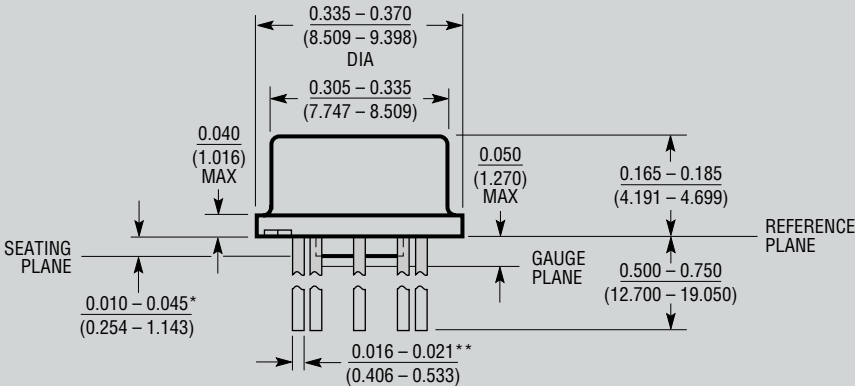
**Note 6:** TC is defined as  $\Delta V$  divided by the temperature range, i.e.,

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

**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

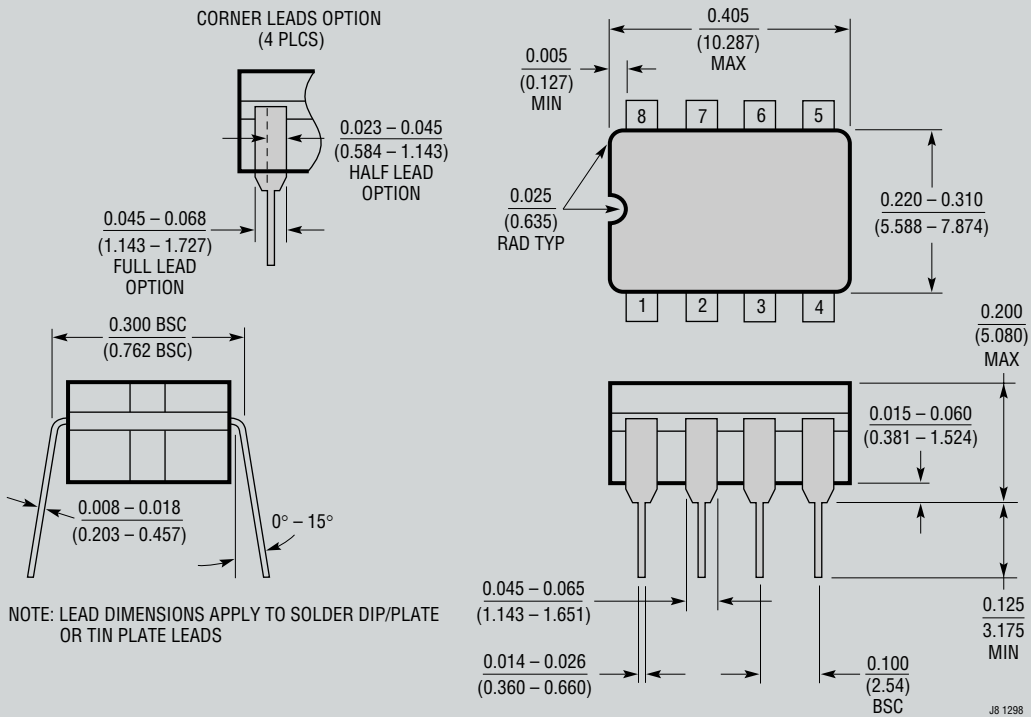
\*\*FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS  $\frac{0.016 - 0.024}{(0.406 - 0.610)}$

H8 (TO-5) 0.230 PCD 1197

**OBSELETE PACKAGE**

**PACKAGE DESCRIPTION**

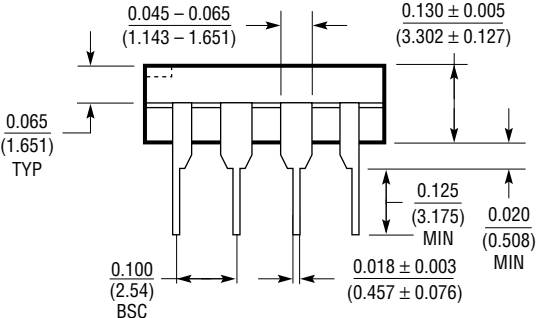
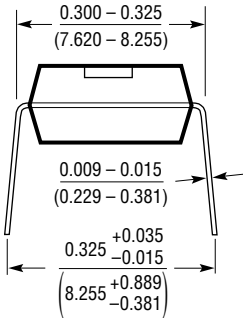
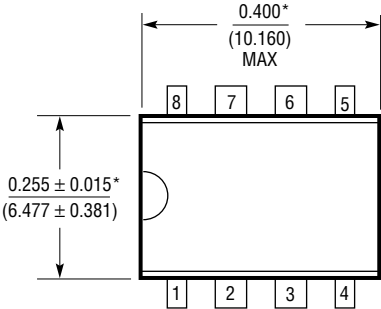
**J8 Package**  
**8-Lead CERDIP (Narrow .300 Inch, Hermetic)**  
 (Reference LTC DWG # 05-08-1110)



**OBSELETE 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)

N8 1098

## RELATED PARTS

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