

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.

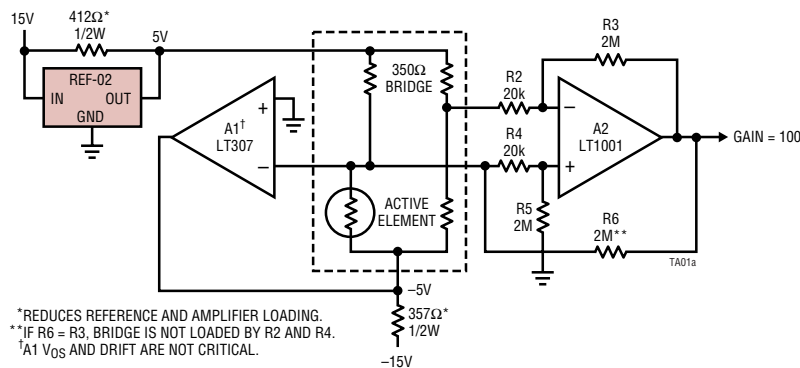
The REF-02 includes a temperature output pin which provides a linear voltage proportional to absolute temperature.

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

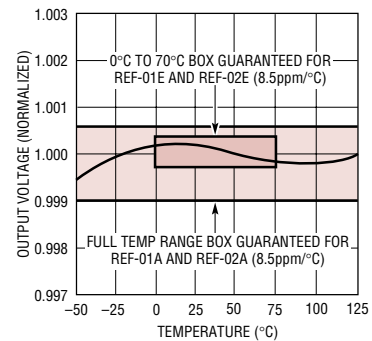
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TYPICAL APPLICATION

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>TOP VIEW</p> <p>NC* 8</p> <p>NC* 1</p> <p>INPUT 2</p> <p>TEMP** 3</p> <p>GND 4</p> <p>OUTPUT 6</p> <p>TRIM 5</p> <p>NC* 7</p> <p>NC* 8</p> <p>GND (CASE)</p> <p>H PACKAGE</p> <p>8-LEAD TO-5 METAL CAN</p> <p>$T_{JMAX} = 150^{\circ}C$, $\theta_{JA} = 150^{\circ}C/W$, $\theta_{JC} = 45^{\circ}C/W$</p> <p>* INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY.</p> <p>** DO NOT CONNECT ON REF-01</p>	ORDER PART NUMBER		<p>TOP VIEW</p> <p>NC* 1</p> <p>INPUT 2</p> <p>TEMP** 3</p> <p>GND 4</p> <p>OUTPUT 6</p> <p>TRIM 5</p> <p>NC* 7</p> <p>NC* 8</p> <p>N8 PACKAGE</p> <p>8-LEAD PDIP</p> <p>$T_{JMAX} = 100^{\circ}C$, $\theta_{JA} = 130^{\circ}C/W$</p> <p>* INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY.</p> <p>** DO NOT CONNECT ON REF-01</p>	ORDER PART NUMBER	
	<p>REF01AH REF02AH</p> <p>REF01H REF02H</p> <p>REF01EH REF02EH</p> <p>REF01HH REF02HH</p> <p>REF01CH REF02CH</p> <p>REF02DH</p>	<p>REF01EN8 REF02EN8</p> <p>REF01HN8 REF02HN8</p> <p>REF01CN8 REF02CN8</p> <p>REF02DN8</p>		<p>REF01EJ8 REF02EJ8</p> <p>REF01HJ8 REF02HJ8</p> <p>REF01CJ8 REF02CJ8</p> <p>REF02DJ8</p>	
<p>OBSOLETE PACKAGE</p> <p>Consider the N Package for Alternate Source</p>		<p>OBSOLETE PACKAGE</p> <p>Consider the N Package for Alternate Source</p>			

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, REF-02H	9.95	10	10.05	V
			REF-02	4.985	5	5.015		4.975	5	5.025	V
	Output Adjustment Range	$R_P = 10k\Omega$	REF-01	± 3	5, -27		REF-01H, REF-02H	± 3	5, -27		%
			REF-02	± 3	5, -13		REF-01H, REF-02H	± 3	5, -13		%
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01	20			REF-01H, REF-02H	20		μV_{P-P}	
			REF-02	10			REF-01H, REF-02H	10		μV_{P-P}	
V_{IN}	Input Voltage Range		REF-01	12		40	REF-01H, REF-02H	12		40	V
			REF-02	7		40	REF-01H, 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, REF-02H	0.0005	0.010	%/mA	
			REF-02	0.0010	0.010		REF-01H, 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	
				-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			REF-02 Only	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	± 2.7	5, -27 5, -13		± 2	5, -13	% %	
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	REF-01 REF-02		30 12			12	μV_{P-P} μV_{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 30V	●		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 5mA	●		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: 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.

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

Note 5: ΔV specification applies trimmed or untrimmed.

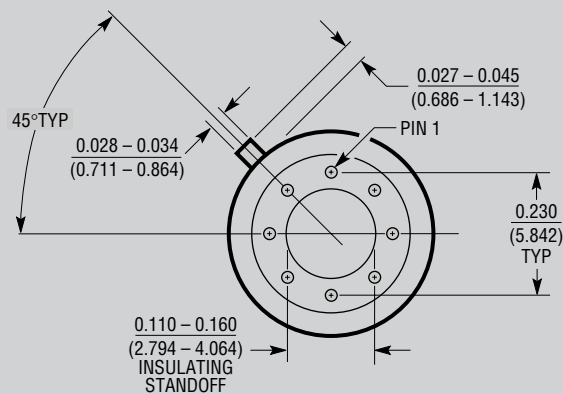
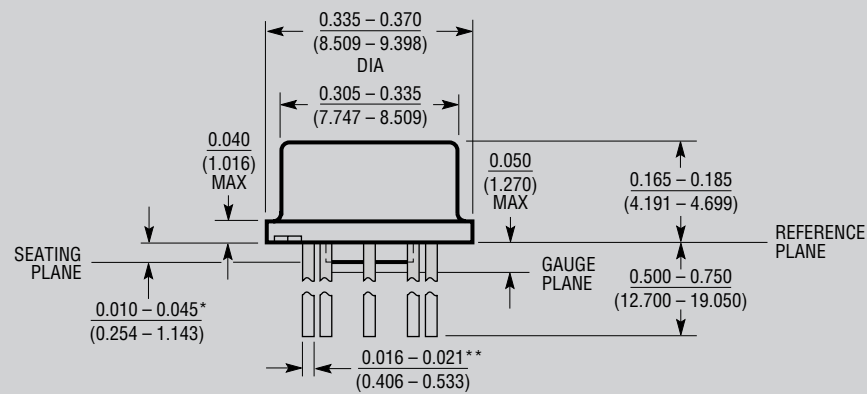
Note 6: TC is defined as ΔV divided by the temperature range, i.e.,

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

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

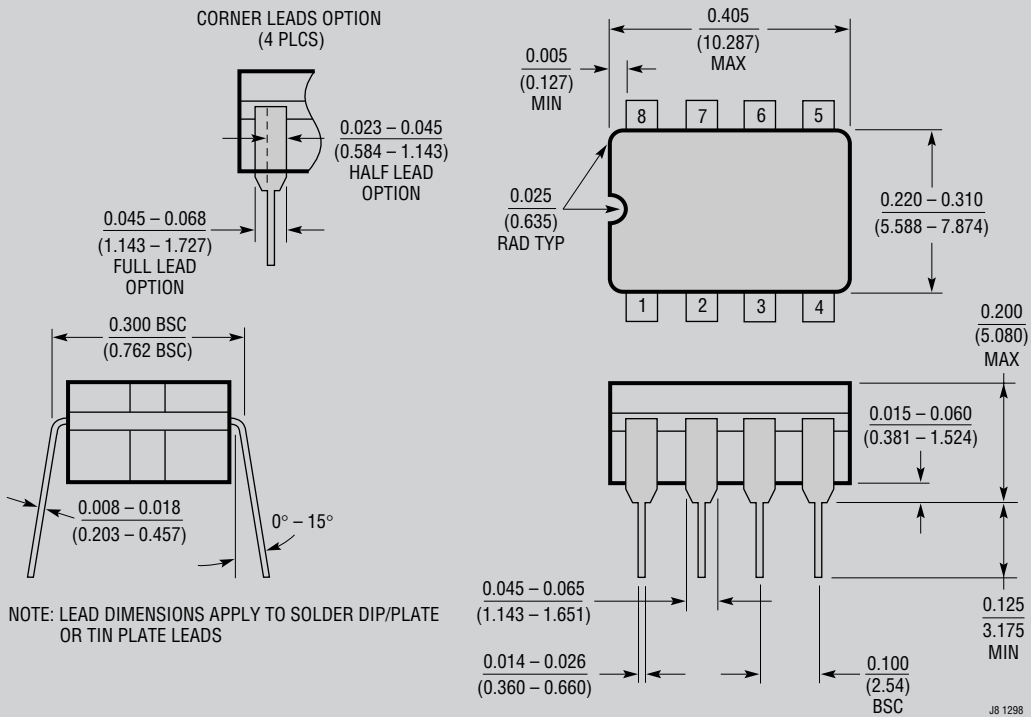
** FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $0.016 - 0.024$ (0.406 - 0.610)

H8 (TO-5) 0.230 PCD 1197

OBSELETE PACKAGE

PACKAGE DESCRIPTION

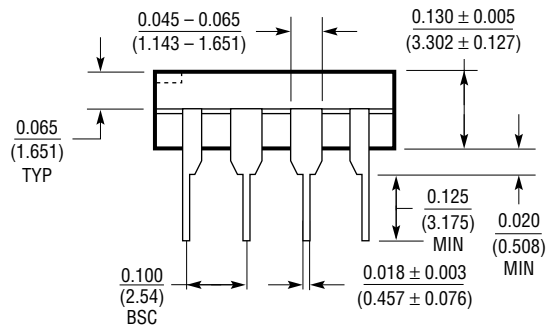
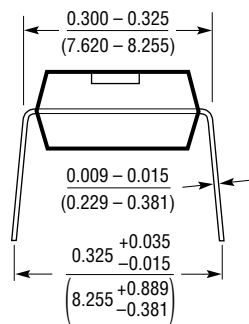
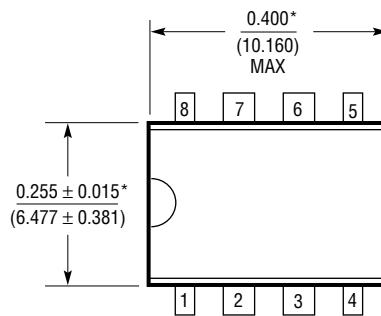
J8 Package
8-Lead CERDIP (Narrow .300 Inch, Hermetic)
 (Reference LTC DWG # 05-08-1110)



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)

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