

Precision Voltage References

FEATURES

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

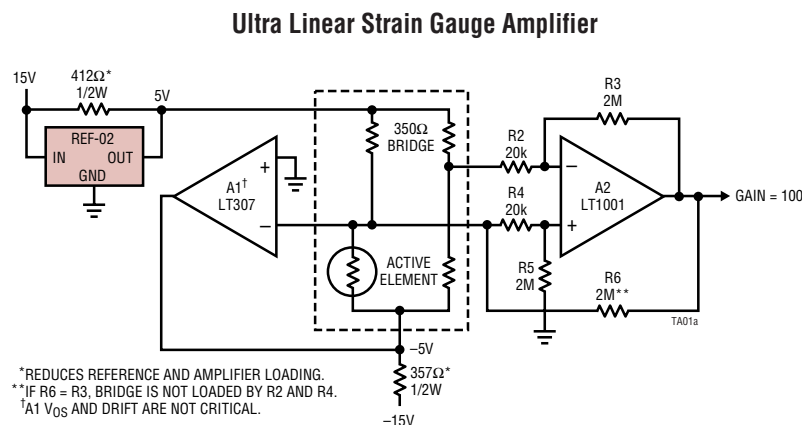
The REF-01/REF-02 are precision 10V and 5V bandgap references which provide stable output voltages over a wide range of operating conditions. Output voltage is accurate to $\pm 0.3\%$ with a low $5\text{ppm}/^\circ\text{C}$ typical temperature coefficient. The REF-01 and REF-02 are excellent choices 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.

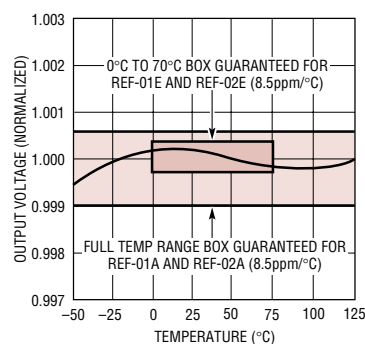
For lower drift and higher accuracy references, please see the LT1019 and LT1021 data sheets.

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TYPICAL APPLICATION



Output Voltage Temperature Drift



REF-01/REF-02

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

TOP VIEW NC* 1 8 NC* INPUT 2 7 NC* TEMP** 3 6 OUTPUT GND (CASE) 4 5 TRIM H PACKAGE 8-LEAD TO-5 METAL CAN $T_{JMAX} = 150^{\circ}C$, $\theta_{JA} = 150^{\circ}C/W$, $\theta_{JC} = 45^{\circ}C/W$ * INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY. ** DO NOT CONNECT ON REF-01	ORDER PART NUMBER <table><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	TOP VIEW NC* 1 8 NC* INPUT 2 7 NC* TEMP** 3 6 OUTPUT GND 4 5 TRIM N8 PACKAGE 8-LEAD PDIP $T_{JMAX} = 100^{\circ}C$, $\theta_{JA} = 130^{\circ}C/W$ * INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY. ** DO NOT CONNECT ON REF-01	ORDER PART NUMBER <table><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></table>	REF01EN8	REF02EN8	REF01HN8	REF02HN8	REF01CN8	REF02CN8		REF02DN8
REF01AH	REF02AH																						
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REF01CN8	REF02CN8																						
	REF02DN8																						
OBSOLETE PACKAGE Consider the N Package for Alternate Source		J8 PACKAGE 8-LEAD Cerdip $T_{JMAX} = 150^{\circ}C$, $\theta_{JA} = 100^{\circ}C/W$	<table><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>	REF01EJ8	REF02EJ8	REF01HJ8	REF02HJ8	REF01CJ8	REF02CJ8		REF02DJ8												
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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	$I_L = 0mA$	9.97	10	10.03	9.95	10	10.05	V
			4.985	5	5.015	4.975	5	5.025	V
	Output Adjustment Range	$R_P = 10k\Omega$	± 3	5, -27		± 3	5, -27		%
			± 3	5, -13		± 3	5, -13		%
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)		20			20		μV_{P-P}
				10			10		μV_{P-P}
V_{IN}	Input Voltage Range		12		40	12		40	V
			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	REF-01	0.0005	0.010	%/mA
				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 Sink 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)		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	$I_L = 0mA$	9.9	10	10.1				V
		REF-01 REF-02	4.95	5	5.05	4.9	5	5.1	V
	Output Adjustment Range	$R_P = 10k\Omega$		5, -27					%
		REF-01 REF-02	± 2.7	5, -13		± 2	5, -13		%
e_{nP-P}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)		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 Sink Current		8 -0.2	20 20		8 -0.2	20 20		mA 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)	$0^\circ C \leq T_A \leq 70^\circ C$ $-55^\circ C \leq T_A \leq 125^\circ C$	● ●		0.02 0.09	0.06 0.15		0.035 0.144	0.17 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)	$0^\circ C \leq T_A \leq 70^\circ C$ $-55^\circ C \leq T_A \leq 125^\circ C$	● ●		0.0001 0.0001	0.012 0.015		0.0001 0.0001	0.012 0.015	%/V %/V
	Load Regulation ($I_L = 0mA$ to 8mA) (Note 2)	$0^\circ C \leq T_A \leq 70^\circ C$ $-55^\circ C \leq T_A \leq 125^\circ C$	● ●		0.002 0.002	0.010 0.012		0.002 0.002	0.012 0.015	%/mA %/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: 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.

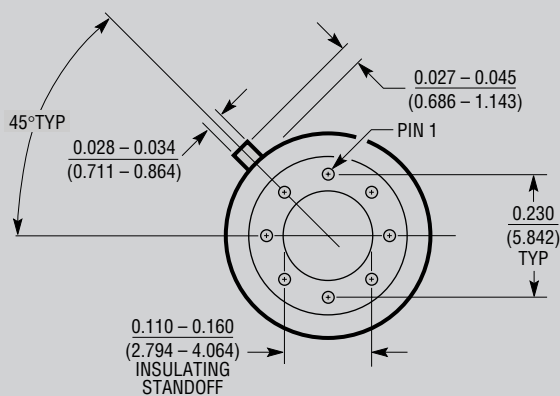
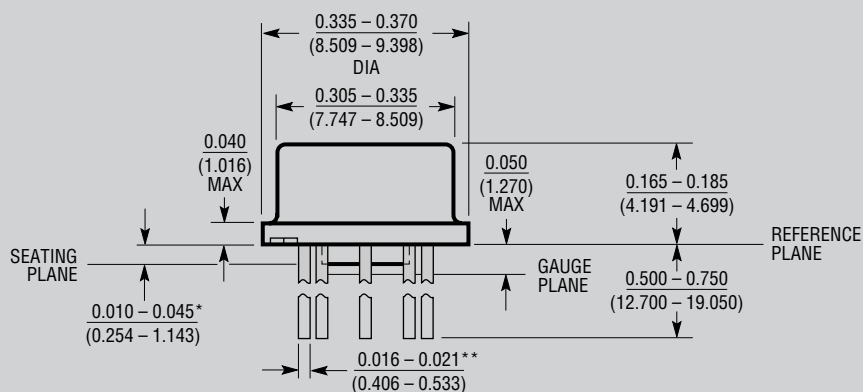
Note 6: TC is defined as ΔV divided by the temperature range, i.e.,

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

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

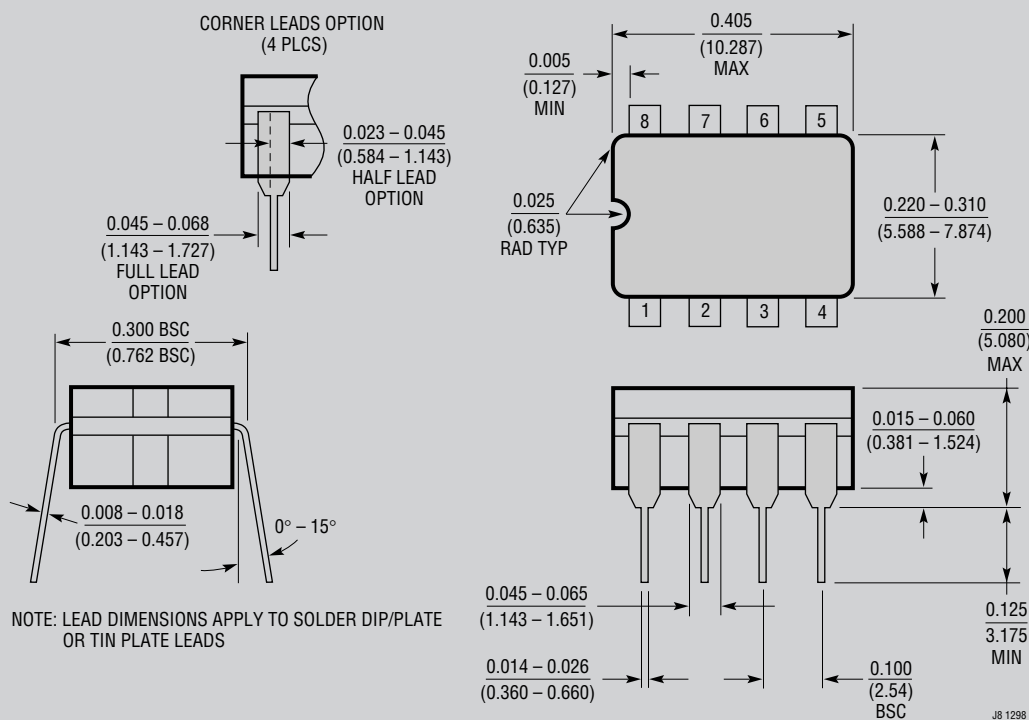
** FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $0.016 - 0.024$ (0.406 - 0.610)

H8 (TO-5) 0.230 PCD 1197

OBSOLETE PACKAGE

PACKAGE DESCRIPTION

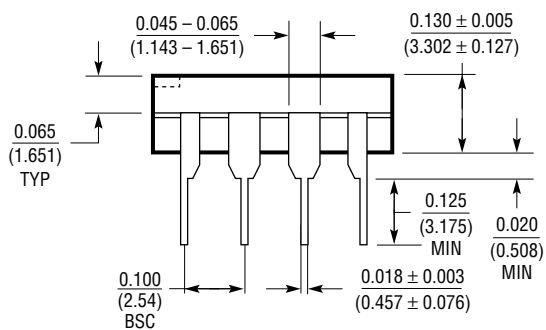
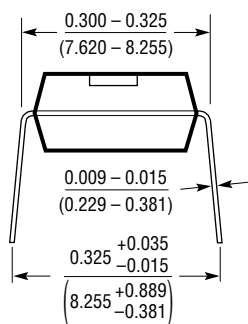
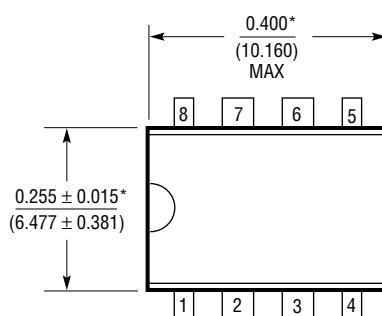
J8 Package
8-Lead Cerdip (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



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)

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