

FEATURES

- Trimmed Output $\pm 0.3\%$
- Low Drift—5ppm/°C Typical
- Low Noise—3ppm (p-p)
- High Line Rejection
- Temperature Output—REF-02
- Low Supply Current 1.4mA Max.

APPLICATIONS

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

DESCRIPTION

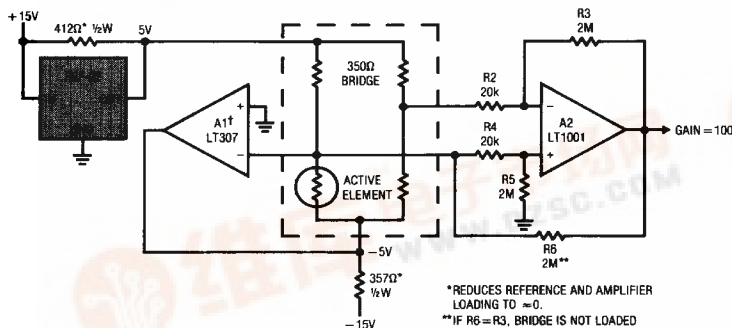
The REF-01/REF-02 are precision 10V and 5V bandgap references which provide stable output voltages over a wide range of operating conditions. Output voltage is accurate to $\pm 0.3\%$ with a low 5ppm/°C typical temperature coefficient. The REF-01 and REF-02 are excellent choices for applications where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

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Ultra Linear Strain Gauge Amplifier

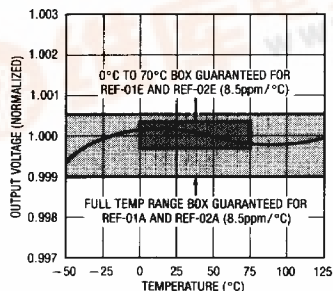


* REDUCES REFERENCE AND AMPLIFIER LOADING TO ≈ 0 .

** IF $R6 = R3$, BRIDGE IS NOT LOADED BY $R2$ AND $R4$.

† A1 V_{OS} AND DRIFT ARE NOT CRITICAL.

Output Voltage Temperature Drift

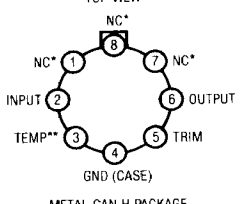
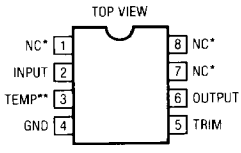


REF-01/REF-02

ABSOLUTE MAXIMUM RATINGS

REF-01/02, A, E, H	40V
REF-01C/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	−65°C to 150°C
Operating Temperature	
REF-01/02, REF-01A/02A	−55°C to 125°C
REF-01E/02E, REF-01H/02H,	
REF-01C/02C, REF-01D/02D	0°C to 70°C

PACKAGE/ORDER INFORMATION

TOP VIEW		ORDER PART NUMBER	
 METAL CAN H PACKAGE *INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY. **DO NOT CONNECT ON REF-01.		REF-01AH	REF-02AH
		REF-01H	REF-02H
		REF-01EH	REF-02EH
		REF-01HH	REF-02HH
		REF-01CH	REF-02CH
			REF-02DH
TOP VIEW			
 PLASTIC DIP N8 PACKAGE 8 PIN HERMETIC DIP *INTERNALLY CONNECTED. DO NOT CONNECT EXTERNALLY. **DO NOT CONNECT ON REF-01.		REF-01EJ8	REF-02EJ8
		REF-01HJ8	REF-02HJ8
		REF-01CJ8	REF-02CJ8
		REF-01EN8	REF-02DJ8
		REF-01HN8	REF-02EN8
		REF-01CN8	REF-02HN8
			REF-02CN8
			REF-02DN8

ELECTRICAL CHARACTERISTICS

$V_{IN} = +15V$, $T_A = 25^\circ C$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	REF-01A/E REF-02A/E			REF-01/H REF-02/H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_O	Output Voltage	$I_L = 0$	9.97	10.00	10.03	9.95	10.00	10.05	V
			4.985	5.000	5.015	4.975	5.000	5.025	V
	Output Adjustment Range	$R_p = 10k\Omega$	± 3.0	+5, −27	—	± 3.0	+5, −27	—	%
			± 3.0	+5, −13	—	± 3.0	+5, −13	—	%
e_{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 6)	—	20	—	—	20	—	$\mu Vp-p$
			—	10	—	—	10	—	$\mu Vp-p$
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 1)	$(V_{OUT} + 3V) \leq V_{IN} \leq 33V$	—	0.0001	0.010	—	0.0001	0.010	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 1)	$I_L = 0mA$ to 10mA	—	0.0005	0.008	—	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		10	20	—	10	20	—	mA
	Sink Current		−0.3	−20	—	−0.3	−20	—	mA
I_{SC}	Short Circuit Current	$V_O = 0$	—	25	—	—	25	—	mA
V_T	Temperature Voltage Output	(Note 2) 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 9.90	REF-02 10.00	10.10	4.900	5.000	5.100	V
	Output Adjustment Range	$R_P = 10k\Omega$	REF-01 ± 2.7	REF-02 $+5, -27$ $+5, -13$	—	—	—	—	% %
e_{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 6)	REF-01 —	REF-02 30 12	—	—	12	—	μV_{p-p} μV_{p-p}
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 1)	$(V_{OUT} + 3V) \leq V_{IN} \leq 33V$	—	0.0001	0.015	—	0.0001	0.04	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 1)	$I_L = 0mA$ to 8mA $I_L = 0mA$ to 4mA	—	0.0005	0.015	—	—	—	%/mA %/mA
I_Q	Quiescent Supply Current	No Load	—	0.65	1.6	—	0.65	2.0	mA
I_{OUT}	Load Current		8	20	—	8	20	—	mA
	Sink Current		-0.2	20	—	-0.2	20	—	mA
I_{SC}	Short Circuit Current	$V_O = 0$	—	25	—	—	25	—	mA
V_T	Temperature Voltage Output	(Note 2) REF-02 Only	—	620	—	—	620	—	mV

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ELECTRICAL CHARACTERISTICS

$V_{IN} = +15V$, $-55^\circ C \leq T_A \leq +125^\circ C$ for REF-01A/02A and REF-01/REF-02, $0^\circ C \leq T_A \leq +70^\circ C$ for REF-01E/02E and REF-01H/02H, $I_L = 0mA$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS		REF-01A/E REF-02A/E			REF-01/H REF-02/H			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
$\frac{\Delta V}{\Delta T}$	Output Voltage Change with Temperature (Notes 3 and 4)	$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	●	—	0.02	0.06	—	0.035	0.17	%
			●	—	0.09	0.15	—	0.144	0.45	%
TC	Output Voltage Temperature Coefficient	(Note 5)	●	—	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 ($V_{IN} = 8V$ to 33V) (Note 1)	$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	●	—	0.0001	0.012	—	0.0001	0.012	%/V
			●	—	0.0001	0.015	—	0.0001	0.015	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation ($I_L = 0mA$ to 8mA) (Note 1)	$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	●	—	0.002	0.010	—	0.002	0.012	%/mA
			●	—	0.002	0.012	—	0.002	0.015	%/mA
	Temperature Voltage Output Temperature Coefficient	(Note 2) REF-02	●	—	2.1	—	—	2.1	—	mV/ $^\circ C$

The ● denotes the specifications which apply over the full operating temperature range.

ELECTRICAL CHARACTERISTICS

$V_{IN} = +15V$, $0^{\circ}C \leq T_A \leq +70^{\circ}C$ and $I_L = 0mA$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS		REF-01C REF-02C TYP		REF-02D TYP		UNITS		
				MIN	MAX	MIN	MAX			
$\frac{\Delta V}{\Delta T}$	Output Voltage Change with Temperature	(Notes 3 and 4)	●	—	0.45	—	1.7	%		
TC	Output Voltage Temperature Coefficient	(Note 5)	●	—	8	65	—	8	250	ppm/°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 (Note 1)	$V_{IN} = 8V$ to $30V$	●	—	0.0001	0.018	—	0.0001	0.05	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation (Note 1)	$I_L = 0mA$ to $5mA$	●	—	0.002	0.018	—	0.002	0.05	%/mA
	Temperature Voltage Output Temperature Coefficient	(Note 2) REF-02	●	—	2.1	—	—	2.1	—	mV/°C

Note 1: Line and load regulation specifications include the effect of self heating.

Note 2: Limit current in or out of pin 3 to 50nA and capacitance on pin 3 to 30pF.

Note 3: 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.

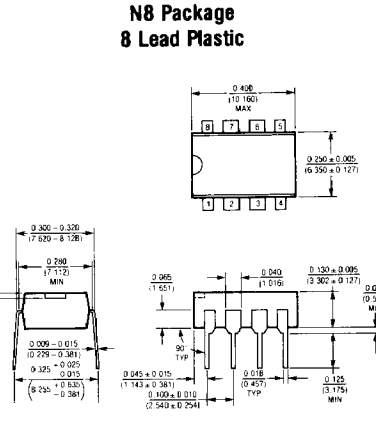
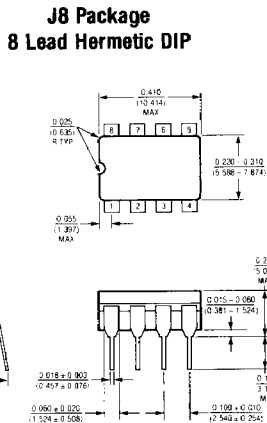
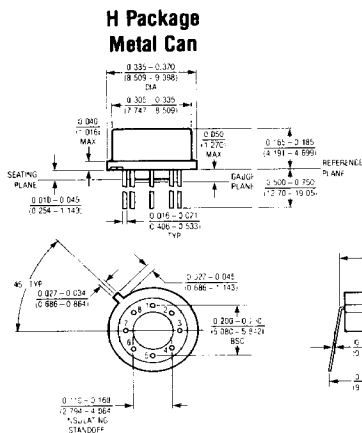
$$\Delta V = \left| \frac{V_{\text{MAX}} - V_{\text{MIN}}}{V_{\text{OUT}}} \right| \times 100$$

Note 4: ΔV specification applies trimmed or untrimmed.

Note 5: TC is defined as ΔV divided by the temperature range, i.e.,

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

Note 6: 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 Dimensions in inches (millimeters) unless otherwise noted.

*LEADS WITHIN 0.007 OF TRUE POSITION (TP) AT GAUGE PLANE

*LEADS WITHIN 0.007 OF TRUE POSITION (TP) AT GAUGE PLANE

$T_{j\max}$ 150°C	θ_{ja} 150°C/W	θ_{jc} 45°C/W
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T_{jmax}	θ_{ja}
150°C	100°C/W

T_{jmax}	θ_{ja}
100°C	130°C/W