

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

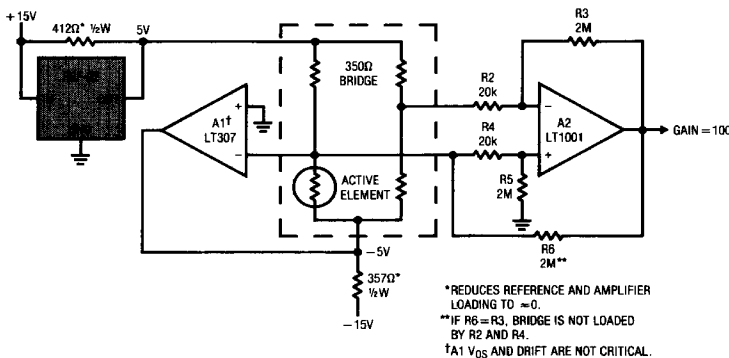
DESCRIPTION

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.

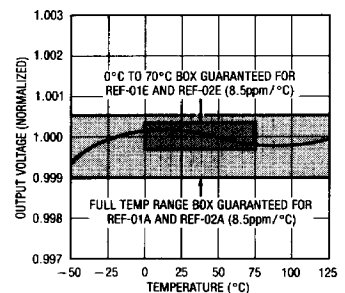
The REF-02 includes a temperature output pin which provides a linear voltage proportional to absolute temperature.

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

Ultra Linear Strain Gauge Amplifier



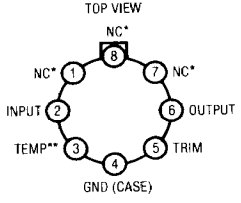
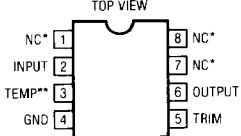
Output Voltage Temperature Drift



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
	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	$V_C = 0$	—	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 REF-02	9.90 4.950	10.00 5.000	10.10 5.050	4.900	5.000	5.100	V V
	Output Adjustment Range	R _p = 10kΩ	REF-01 REF-02	± 2.7	+ 5, - 27 + 5, - 13	—	— ± 2.0	— + 5, - 13	—	% %
e _{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 6)	REF-01 REF-02	—	30 12	— —	—	12	—	μVp-p μVp-p
	$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 1)	(V _{OUT} + 3V) ≤ V _{IN} ≤ 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 —	— —	— 0.001	— 0.04	% / 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 0.09	0.06 0.15	— —	0.035 0.144	0.17 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 0.0001	0.012 0.015	— —	0.0001 0.0001	0.012 0.015	%/V %/V
	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 0.002	0.010 0.012	— —	0.002 0.002	0.012 0.015	%/mA %/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°C ≤ T_A ≤ + 70°C and I_L = 0mA 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 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 = 10kΩ	●	—	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.

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

- 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.

