

### REF-01

#### FEATURES

- 10V Output .....  $\pm 0.3\%$  Max.
- Adjustment Range .....  $\pm 3\%$  Min.
- Low Supply Current ..... 1.4mA Max.
- No External Components
- Short Circuit Proof
- Laser-Trimmed to High Accuracies
- Output Sources or Sinks Current

#### APPLICATIONS

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

#### DESCRIPTION

The REF-01 is a 10V precision bandgap voltage reference which provides a stable output voltage over a wide range of operating conditions, i.e. input voltage, output current, ambient temperature, etc. The output voltage can be adjusted within  $\pm 3\%$ . The devices can also be stacked to provide higher voltage references, such as 20, 30, 100V, etc., as long as the total usable current is not exceeded. REF-01 is available in commercial and military temperature ranges.

#### ORDERING INFORMATION†

$T_A = 25^\circ\text{C}$ $\Delta V_O \text{ MAX}$ (mV)	PACKAGE					OPER. TEMP. RANGE
	TO-99 8-PIN	HERMETIC DIP 8-PIN	PLASTIC DIP 8-PIN	PLASTIC SOIC 8-PIN	LCC	
$\pm 30$	REF01AJ*	REF01AZ*				MIL
$\pm 30$	REF01EJ	REF01EZ				COM
$\pm 50$	REF01J*	REF01Z*			REF01RC/883	MIL
$\pm 50$	REF01HJ	REF01HZ	REF01HP	REF01HS		COM
$\pm 100$	REF01CJ	REF01CZ	REF01CP	REF01CS		COM

\*For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

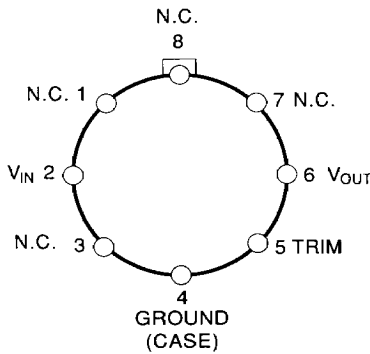
†All commercial and industrial temperature range parts are available with burn-in.

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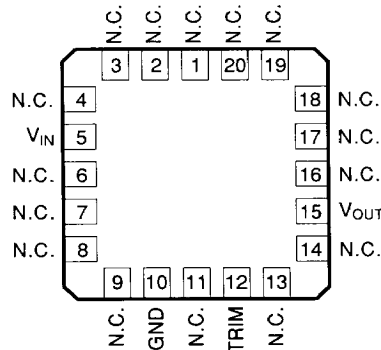
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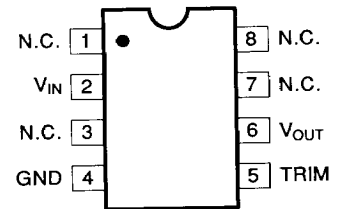
#### Pin Connections (Top View)



TO-99  
(J-Suffix)



REF-01RC/883  
LCC  
(RC-Suffix)



EPOXY MINI DIP  
(P-Suffix)  
8-PIN HERMETIC DIP  
(Z-Suffix)  
8-PIN PLASTIC SOIC  
(S-Suffix)

**ABSOLUTE MAXIMUM RATINGS (Note 2)**

Input Voltage	
REF-01, A, E, H, RC, All DICE	40V
REF-01C	30V
Power Dissipation (Note 1)	500mW
Output Short-Circuit Duration	
(to Ground or $V_{IN}$ )	Indefinite
Storage Temperature Range	
J, RC, and Z Packages	-65°C to +125°C
P Package	-65°C to +125°C
Operating Temperature Range	
REF-01A, REF-01, REF-01RC	-55°C to +125°C
REF-01E, REF-01H, REF-01C	0°C to +70°C
DICE Junction Temperature ( $T_j$ )	-65°C to +150°C
Lead Temperature (Soldering, 60 sec.)	300°C

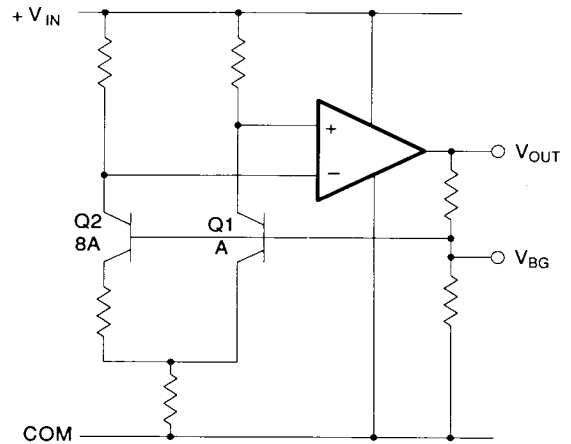
**NOTES:**

1. See table for maximum ambient temperature rating and derating factor.

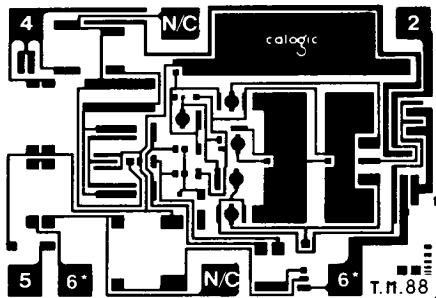
PACKAGE TYPE	MAXIMUM AMBIENT TEMPERATURE FOR RATING	DERATE ABOVE MAXIMUM AMBIENT TEMPERATURE
TO-99 (J)	80°C	7.1mW/°C
8-Pin Hermetic DIP (Z)	75°C	6.7mW/°C
8-Pin Plastic DIP (P)	36°C	5.6mW/°C
LCC (RC)	72°C	7.8mW/°C

2. Absolute maximum ratings apply to both packaged parts and DICE, unless otherwise noted.

**Simplified Schematic Diagram**



**Die Dimensions and Pad Connections**



- 2.  $V_{IN}$
- 4. GND
- 5. TRIM
- 6.  $V_{OUT}^*$

\*The two bonding pads are connected to pin 6.

DIE SIZE 0.067 x 0.05 inch, 3550 sq. mils  
(1.702 x 1.27mm, 2.16 sq. mm)

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

PARAMETER	SYMBOL	CONDITIONS	REF-01A/E			REF-01/H			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage	$V_O$	$I_L = 0$	9.97	10.00	10.03	9.95	10.00	10.05	V
Output Adjustment Range	$\Delta V_{trim}$	$R_p = 10k\Omega$	$\pm 3.0$	$\pm 3.3$	—	$\pm 3.0$	$\pm 3.3$	—	%
Output Voltage Noise	$e_{np-p}$	0.1Hz to 10Hz (Note 6)	—	20	30	—	20	30	$\mu V_{p-p}$
Line Regulation (Note 4)		$V_{IN} = 13V$ to 33V	—	0.006	0.010	—	0.006	0.010	%/V
Load Regulation (Note 4)		$I_L = 0$ to 10mA	—	0.005	0.008	—	0.006	0.010	%/mA
Turn-on Settling Time	$t_{on}$	To $\pm 0.1\%$ of final value	—	5	—	—	5	—	$\mu s$
Quiescent Supply Current	$I_{SY}$	No Load	—	1.0	1.4	—	1.0	1.4	mA
Load Current	$I_L$		10	21	—	10	21	—	mA
Sink Current	$I_S$		-5	-10	—	-5	-10	—	mA
Short-Circuit Current	$I_{SC}$	$V_O = 0$	—	30	—	—	30	—	mA

**ELECTRICAL CHARACTERISTICS** at  $V_{IN} = +15V$ ,  $-55^\circ C \leq T_A \leq +125^\circ C$  and  $I_L = 0mA$ , unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	REF-01A/E			REF-01/H			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Voltage Change with Temperature (Notes 1, 2)	$\Delta V_{OT}$	$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	—	0.02	0.06	—	0.07	0.17	%
Output Voltage Temperature Coefficient	$TCV_O$	(Note 3)	—	3.0	8.5	—	10.0	25.0	ppm/ $^\circ C$
Change in $V_O$ Temperature Coefficient with Output Adjustment		$R_p = 10k\Omega$	—	0.7	—	—	0.7	—	ppm/%
Line Regulation ( $V_{IN} = 13V$ to 33V) (Note 4)		$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	—	0.007	0.012	—	0.007	0.012	%/V
Load Regulation ( $I_L = 0$ to 8mA) (Note 4)		$0^\circ C \leq T_A \leq +70^\circ C$ $-55^\circ C \leq T_A \leq +125^\circ C$	—	0.006	0.010	—	0.007	0.012	%/V

**NOTES:**

1.  $\Delta V_{OT}$  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 10V:

$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{10V} \right| \times 100$$

2.  $\Delta V_{OT}$  specification applies trimmed to +10.000V or untrimmed.  
3.  $TCV_O$  is defined as  $\Delta V_{OT}$  divided by the temperature range, i.e.,

$$TCV_O (0^\circ \text{ to } +70^\circ C) = \frac{\Delta V_{OT} (0^\circ \text{ to } +70^\circ C)}{70^\circ C}$$

$$\text{and } TCV_O (-55^\circ \text{ to } +125^\circ C) = \frac{\Delta V_{OT} (-55^\circ \text{ to } +125^\circ C)}{180^\circ C}$$

4. Line and Load Regulation specifications include the effect of self heating.  
5. Guaranteed by design.  
6. Sample tested.

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

PARAMETER	SYMBOL	CONDITIONS	MIN.	REF-01C	MAX.	UNITS
				TYP.		
Output Voltage	$V_O$	$I_L = 0mA$	9.90	10.00	10.10	V
Output Adjustment Range	$\Delta V_{trim}$	$R_p = 10k\Omega$	$\pm 2.7$	$\pm 3.3$	—	%
Output Voltage Noise	$e_{np-p}$	0.1Hz to 10Hz (Note 6)	—	25	35	$\mu V_{p-p}$
Line Regulation (Note 4)		$V_{IN} = 13V$ to 30V	—	0.009	0.015	%/V
Load Regulation (Note 4)		$I_L = 0$ to 8mA $I_L = 0$ to 4mV	—	0.006	0.015	%/mA
Turn-on Settling Time	$t_{ON}$	To $\pm 0.1\%$ of final value	—	5	—	$\mu s$
Quiescent Supply Current	$I_{SY}$	No Load	—	1.0	1.6	mA
Load Current	$I_L$		8	21	—	mA
Sink Current	$I_S$		-5	-10	—	mA
Short-Circuit Current	$I_{SC}$	$V_O = 0$	—	30	—	mA

**ELECTRICAL CHARACTERISTICS** at  $V_{IN} = +15V$ ,  $0^{\circ}C \leq T_A \leq +70^{\circ}C$ , unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	MIN.	REF-01C TYP.	MAX.	UNITS
Output Voltage Change with Temperature	$\Delta V_{OT}$	(Note 1 and 2)	—	0.14	0.45	%
Output Voltage Temperature Coefficient	$TCV_O$	(Note 3)	—	20	65	ppm/ $^{\circ}C$
Change in $V_O$ Temperature Coefficient with Output Adjustment		$R_p = 10k\Omega$	—	0.7	—	ppm/%
Line Regulation (Note 4)		$V_{IN} = 13V$ to $30V$	—	0.011	0.018	%/V
Load Regulation (Note 4)		$I_L = 0$ to $5mA$	—	0.008	0.018	%/mA

**NOTES:**

1.  $\Delta V_{OT}$  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 10V:

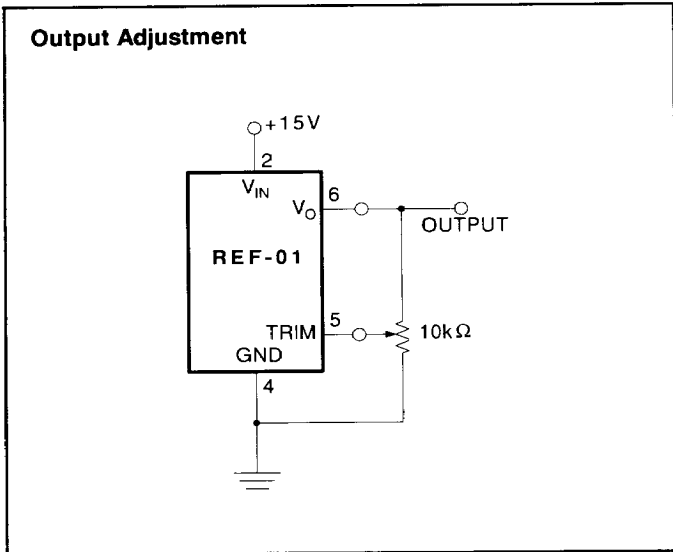
$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{10V} \right| \times 100$$

2.  $\Delta V_{OT}$  specification applies trimmed to +10.000V or untrimmed.

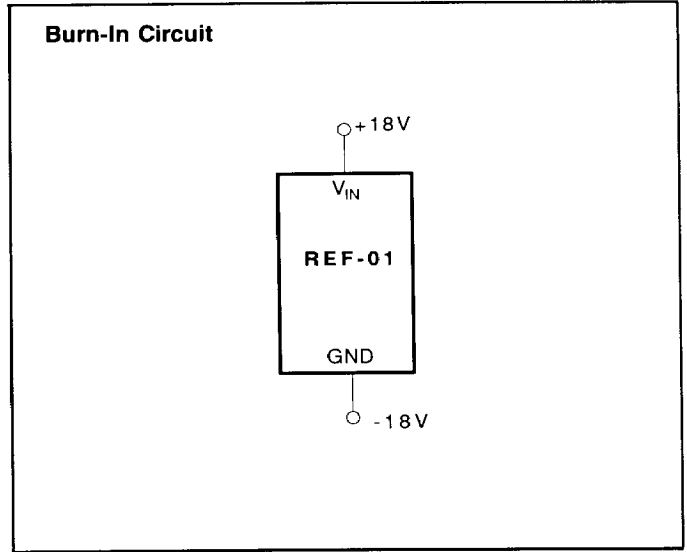
3.  $TCV_O$  is defined as  $\Delta V_{OT}$  divided by the temperature range, i.e.,

$$TCV_O = \frac{\Delta V_{OT}}{70^{\circ}C}$$

- 4. Line and Load Regulation specifications include the effect of self heating.
- 5. Guaranteed by design.
- 6. Sample tested.



The REF-01 trim terminal can be used to adjust the output voltage over a 10V  $\pm 300mV$  range. This feature allows the system designer to trim system errors by setting the reference to a voltage other than 10V. Of course, the output can also be set to exactly 10.000V, or to 10.240V for binary applications.



Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately 0.7 ppm/ $^{\circ}C$  for 100mV of output adjustment.