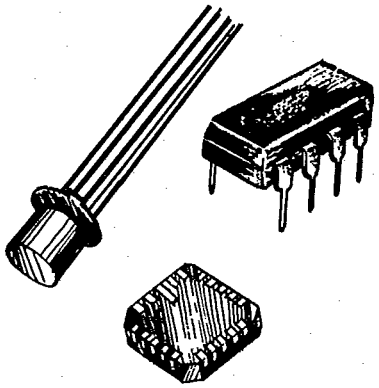
T-58-07

TELEDYNE SEMICONDUCTOR

REF-01

+10V PRECISION VOLTAGE REFERENCE



Features

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

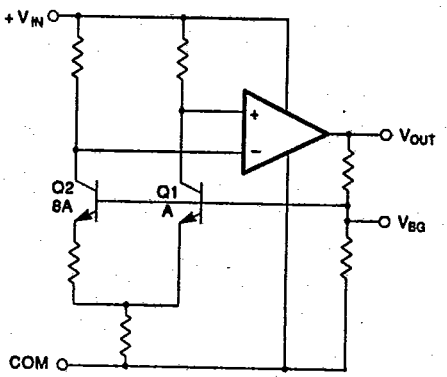
Applications

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

General 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 over a 3% range. The device can also be stacked to provide higher value voltage references, such as 20, 30, 100V, etc., as long as the total available output current is not exceeded. REF-01 is available in commercial and military temperature ranges.

Functional Diagram



Ordering Information[1]

T_A=25°C ΔV_{OS} Max (mV)	Package: To-99 8-pin	Hermetic DIP 8-pin	Plastic DIP 8-pin	Plastic SOIC 8-pin	LCC	Oper. Temp. Range
± 30	REF01AJ[2]	REF01AZ[2]				MIL
± 30	REF01EJ	REF01EZ				COM
± 50	REF01J[2]	REF01Z[2]			REF01RC/883	MIL
± 50	REF01HJ	REF01HZ	REF01HP	REF01HS		COM
± 100	REF01CJ	REF01CZ	REF01CP	REF01CS		COM

Notes: [1]All commercial and industrial temperature range parts are available with burn-in.
[2]For devices processed in total compliance to MIL-STD-883, add/883 after part number. Consult factory for 883 data sheet.

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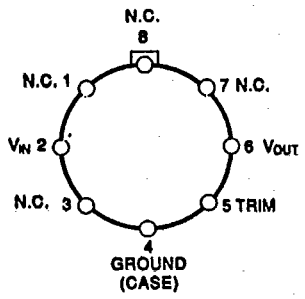
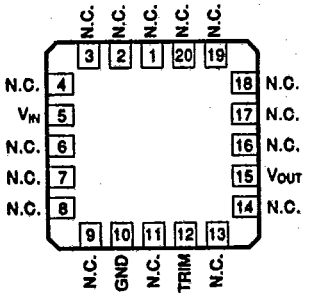
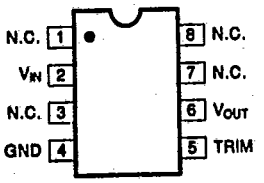
Pin Configuration



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[1]

Input Voltage
REF-01, A, E, H, RC, All DICE 40V
REF-01C 30V
Power Dissipation[2] 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]Absolute maximum ratings apply to both packaged parts and DICE, unless otherwise noted.
[2]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

Electrical Characteristics: V_{IN} = +15V, T_A = 25°C, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	REF-01A/E MIN	REF-01A/E TYP	REF-01A/E MAX	REF-01/H MIN	REF-01/H TYP	REF-01/H MAX	UNITS
V_O	Output Voltage	I_L = 0	9.97	10.00	10.03	9.95	10.00	10.05	V
ΔV_{trim}	Output Adjustment Range	R_p = 10kΩ	±3.0	±3.3		±3.0	±3.3		%
e_{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 6)		20	30		20	30	μV_{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
t_{ON}	Turn-on Setting Time	To ±0.1% of final value		5			5		μs
I_{SY}	Quiescent Supply Current	No Load		1.0	1.4		1.0	1.4	mA
I_L	Load Current		10	21		10	21		mA
I_S	Sink Current		-5	-10		-5	-10		mA
I_{SC}	Short-Circuit Current	V_O = 0		30			30		mA

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Electrical Characteristics: V_{IN} = +15V, -55°C≤T_A≤+125°C and I_L = 0mA, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	REF-01A/E MIN	REF-01A/E TYP	REF-01A/E MAX	REF-01/H MIN	REF-01/H TYP	REF-01/H MAX	UNITS
ΔV_{OT}	Output Voltage Change with Temperature (Notes 1, 2)	0°C≤T_A≤+70°C -55°C≤T_A≤+125°C		0.02 0.06	0.06 0.15		0.07 0.18	0.17 0.45	%
TCV_O	Output Voltage Temperature Coefficient	(Note 3)		3.0	8.5		10.0	25.0	ppm/°C
	Change in V_O Temperature Coefficient with Output Adjustment	R_p=10kΩ		0.7			0.7		ppm/%
	Line Regulation (V_{IN}=13V to 33V) (Note 4)	0°C≤T_A≤+70°C -55°C≤T_A≤+125°C		0.007 0.009	0.012 0.015		0.007 0.009	0.012 0.015	%/V
	Load Regulation (I_L=0 to 8mA) (Note 4)	0°C≤T_A≤+70°C -55°C≤T_A≤+125°C		0.006 0.007	0.010 0.012		0.007 0.009	0.012 0.015	%/V

Notes: 1. ΔV_{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. ΔV_{OT} specification applies trimmed to +10.000V or untrimmed.
3. TCV_O is defined as ΔV_{OT} divided by the temperature range, i.e.,

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

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

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

Electrical Characteristics: V_{IN} = +15V, T_A = 25°C, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	MIN	REF-01C TYP	MAX	UNITS
V_O	Output Voltage	I_L = 0mA	9.90	10.00	10.10	V
ΔV_{trim}	Output Adjustment Range	R_p=10kΩ	±2.7	±3.3		%
e_{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 6)		25	35	μV_{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 0.006	0.015 0.015	%/mA
t_{ON}	Turn-on Setting Time	To ±0.1% of final value		5		μs
I_{SY}	Quiescent Supply Current	No Load		1.0	1.6	mA
I_L	Load Current		8	21		mA
I_S	Sink Current		-5	-10		mA
I_{SC}	Short-Circuit Current	V_O=0		30		mA

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Electrical Characteristics: V_{IN} = +15V, 0°C≤T_A≤+70°C, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	MIN	REF-01C TYP	MAX	UNITS
ΔV_{OT}	Output Voltage Change with Temperature	(Notes 1 and 2)		0.14	0.45	%
TCV_O	Output Voltage Temperature Coefficient	(Note 3)		20	65	ppm/°C

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Electrical Characteristics (cont.): V_{IN} = +15V, 0°C≤T_A≤+70°C, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	REF-01C MIN	REF-01C TYP	REF-01C MAX	UNITS
	Change in V_O Temperature Coefficient with Output Adjustment	R_p=10kΩ		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. ΔV_{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:

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

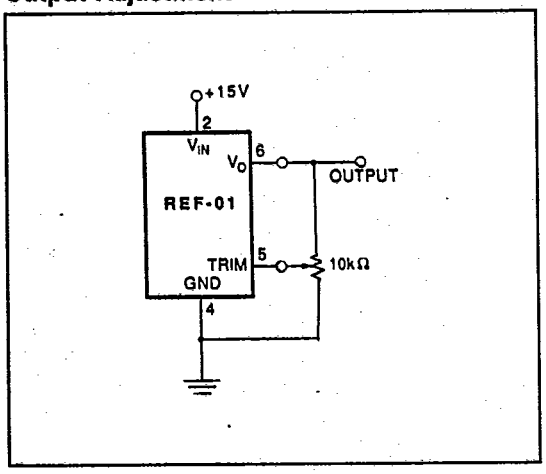
2. ΔV_{OT} specification applies trimmed to +10.000V or untrimmed.

3. TCV_O is defined as ΔV_{OT} divided by the temperature range, i.e.,

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

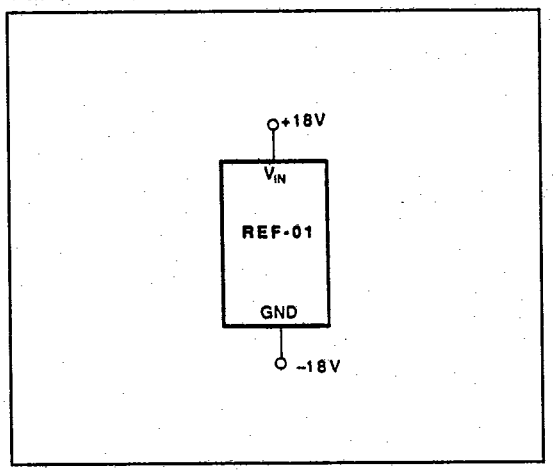
4. Line and Load Regulation specifications include the effect of self-heating.
5. Guaranteed by design.
6. Sample tested.

Output Adjustment



The REF-01 trim terminal can be used to adjust the output voltage over a 10V ±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.

Burn-In Circuit



Adjustment of the output does not significantly affect the temperature performance of the device. The temperature coefficient change is approximately 0.7 ppm/°C for 100mV of output adjustment.

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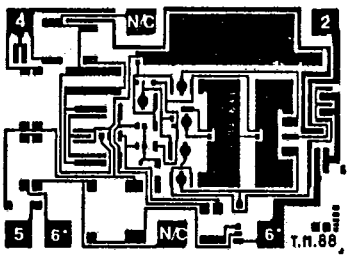
Bonding Diagram



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

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

*The two bonding pads are connected to pin 6.

Reference Stack with Excellent Line Regulation

Three REF-01s can be stacked to yield 10.000, 20.000, and 30.000V outputs. An additional advantage is near-perfect line regulation of the 10.0V and 20.0V output. A 32V to 60V input change produces an output change which is less than the noise voltage of the devices. A load bypass resistor (R_S) provides a path for the supply current (I_{SY}) of the 20.000V regulator.

In general, any number of REF-01s can be stacked this way. For example, ten devices will yield outputs of 10, 20, 30. . . 100V. The line voltage can range from 105V to 130V. However, care must be taken to ensure that the total load currents do not exceed the maximum usable current (typically 21mA).