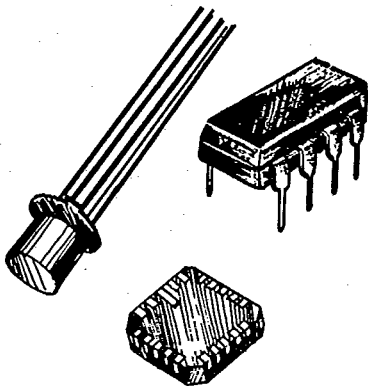


TELEDYNE SEMICONDUCTOR

REF-02

+5V PRECISION VOLTAGE REFERENCE/TEMPERATURE TRANSDUCER



Features

- 5V Output ±0.3% Max.
- Temperature Voltage Output 2.1mV/°C
- Adjustment Range ±3% Min.
- Low Supply Current 1.4mA Max.
- High-Load Driving Capability 20mA
- No External Components
- Short Circuit Proof
- Laser-Trimmed to High Accuracies
- Output Sources or Sinks Current

Applications

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

General Description

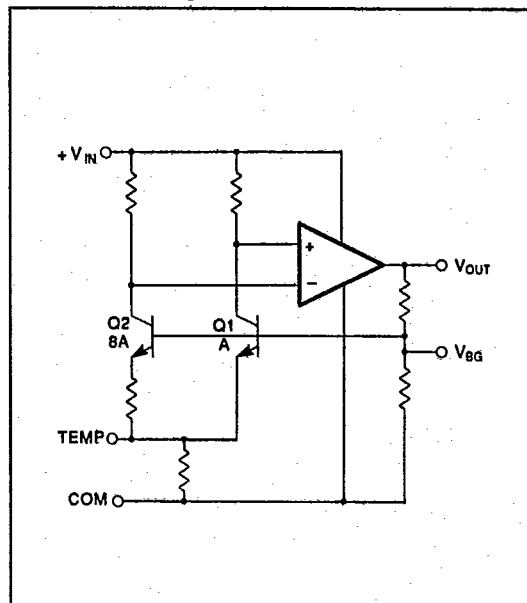
The REF-02 is a 5V precision bandgap voltage reference which provides a stable output voltage over a wide range of operating conditions, i.e. Input voltage, output current, ambient temperature, etc. The output voltage can be adjusted over a ±6% range. REF-02 also provides an output which varies linearly with temperature. Hence, the device can also be used in temperature controller applications. These devices can also be stacked to provide higher value voltage references, such as 25, 40, 100V, etc., as long as the total available output current is not exceeded. REF-02 is available in commercial and military temperature ranges.

Ordering Information¹

T _A = 25°C ΔV _{OS} Max (mV)	Package					Oper. Temp. Range
	To-99 8-pin	Hermetic DIP 8-pin	Plastic DIP 8-pin	Plastic SOIC 8-pin	LCC	
± 15	REF02AJ ²	REF02AZ ²				MIL
± 15	REF02EJ	REF02EZ				COM
± 25	REF02J ²	REF02Z ²			REF02RC/883	MIL
± 25	REF02HJ	REF02HZ	REF02HP	REF02HS		COM
± 50	REF02CJ	REF02CZ	REF02CP	REF02CS		COM
± 100	REF02DJ	REF02DZ	REF02DP	REF02DS		COM

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

Functional Diagram



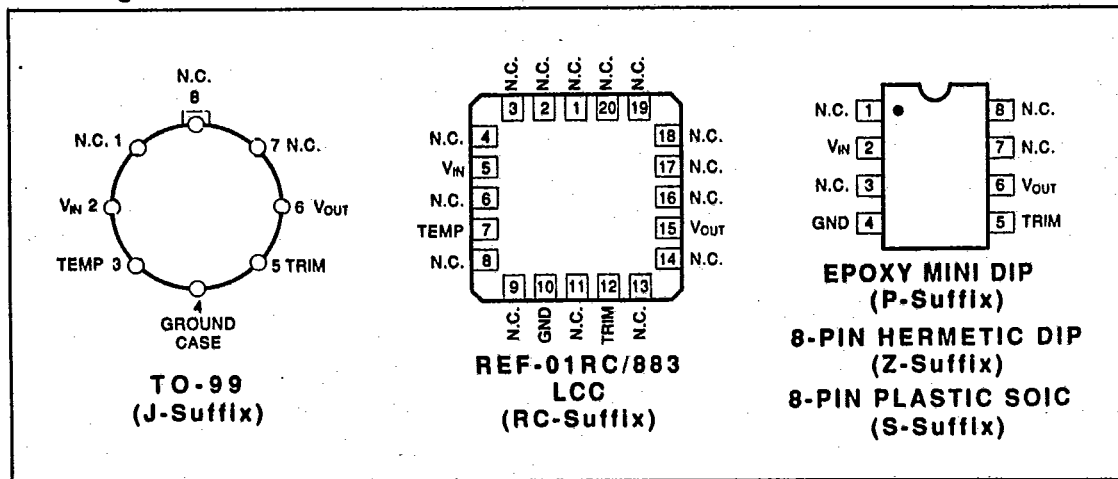
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+5V PRECISION VOLTAGE REFERENCE/TEMPERATURE TRANSDUCER

REF-02

T-58-07

Pin Configuration



Absolute Maximum Ratings¹

Input Voltage	
REF-02, A, E, H, RC, All DICE	40V
REF-02C, D	30V
Power Dissipation ²	500mW
Output Short-Circuit Duration (to Ground or VIN)	Indefinite
Storage Temperature Range	
J, RC, and Z Packages	-65°C to +150°C
P Package	-65°C to +125°C
Operating Temperature Range	
REF-02A, REF-02, REF-02RC	-55°C to +125°C
REF-02E, REF-02H	0°C to +70°C
REF-02C, REF-02D	0°C to +70°C

DICE Junction Temperature (T_j) -65°C to +150°C
 Lead Temperature (Soldering, 60 sec.) 300°C

Notes: ¹Absolute maximum ratings apply to both packaged parts and DICE, unless otherwise noted.
²See 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)	38°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-02A/E			REF-02/H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V _O	Output Voltage	I _L = 0	4.985	5.000	5.015	4.975	5.000	5.025	V
ΔV _{trim}	Output Adjustment Range	R _p = 10kΩ	±3	±6		±3	±6		%
e _{npp}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)		10	15		10	15	μV _{p-p}
	Line Regulation (Note 4)	V _{IN} = 8V to 33V		0.006	0.010		0.006	0.010	%/V
	Load Regulation (Note 1)	I _L = 0 to 10mA		0.005	0.010		0.006	0.010	%/mA
t _{ON}	Turn-on Settling 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
V _T	Temperature Voltage Output	(Note 3)		630			630		mV

NEW PRODUCT INFORMATION

REF-02

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

SYMBOL	PARAMETER	CONDITIONS	REF-02A/E			REF-02/H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
ΔV_{OT}	Output Voltage Change with Temperature (Notes 1, 2)	$0^{\circ}C \leq T_A \leq +70^{\circ}C$ $-55^{\circ}C \leq T_A \leq +125^{\circ}C$	0.02 0.06	0.06 0.15		0.07 0.18	0.17 0.45	%	
TCV_O	Output Voltage Temperature Coefficient	(Note 3)	3.0	8.5		10	25	ppm/ $^{\circ}C$	
	Change in V_O Temperature Coefficient with Output Adjustment	$R_p = 10k\Omega$	0.7			0.7		ppm/%	
	Line Regulation ($V_{IN} = 8V$ 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 0.009	0.012 0.015		0.007 0.009	0.012 0.015	%/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 0.007	0.010 0.012		0.007 0.009	0.012 0.015	%/V	
TCV_T	Temperature Voltage Output Temperature Coefficient	(Note 5)	2.1			2.1		mV/ $^{\circ}C$	

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 5V:

$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{5V} \right| \times 100$$

2. ΔV_{OT} specification applies trimmed to +5.000V or untrimmed.

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

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

4. Line and Load Regulation specifications include the effect of self-heating.
 5. Limit current in or out of pin 3 to 50nA and capacitance on pin 3 to 30 pF.
 6. Guaranteed by design.
 7. Sample tested.

Electrical Characteristics: $V_{IN} = +15V$, $T_A = 25^{\circ}C$, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	REF-02A/E			REF-02/H			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_O	Output Voltage	$I_L = 0mA$	4.950	5.000	5.050	4.900	5.000	5.100	V
ΔV_{trim}	Output Adjustment Range	$R_p = 10k\Omega$	± 2.7	± 6.0		± 2.0	± 6.0		%
e_{np-p}	Output Voltage Noise	0.1Hz to 10Hz (Note 7)	12	18		12			μV_{p-p}
	Line Regulation (Note 4)	$V_{IN} = 8V$ to $30V$	0.009	0.015		0.010	0.04		%/V
	Load Regulation (Note 1)	$I_L = 0$ to $8mA$ $I_L = 0$ to $4mA$	0.006	0.015		0.015	0.04		%/mA
t_{ON}	Turn-on Settling Time	To $\pm 0.1\%$ of final value	5			5			μs
I_{SY}	Quiescent Supply Current	No Load	1.0	1.6		1.0	2.0		mA
I_L	Load Current		8	21		8	21		mA
I_S	Sink Current		-5	-10		-5	-10		mA
I_{SC}	Short-Circuit Current	$V_O = 0$	30			30			mA
V_T	Temperature Voltage Output	(Note 5)	630			630			mV

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**+5V PRECISION VOLTAGE
REFERENCE/TEMPERATURE TRANSDUCER**

REF-02

T-58-07

Electrical Characteristics: $V_{IN} = +15V$, $0^{\circ}C \leq T_A \leq +70^{\circ}C$ and $I_L = 0mA$, unless otherwise indicated.

SYMBOL	PARAMETER	CONDITIONS	REF-02C			REF-02D			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
ΔV_{OT}	Output Voltage Change with Temperature	(Notes 1 and 2)		0.14	0.45		0.49	1.7	%
TCV_O	Output Voltage Temperature Coefficient	(Note 3)		20	65		70	250	ppm/ $^{\circ}C$
	Change in V_O Temperature Coefficient with Output Adjustment	$R_p = 10k\Omega$		0.7			0.7		ppm/%
	Line Regulation (Note 4)	$V_{IN} = 8V$ to $30V$		0.011	0.018		0.012	0.05	%/V
	Load Regulation (Note 4)	$I_L = 0$ to $5mA$		0.008	0.018		0.016	0.05	%/V
TCV_T	Temperature Voltage Output Temperature Coefficient	(Note 5)		2.1			2.1		mV/ $^{\circ}C$

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 5V:

$$\Delta V_{OT} = \left| \frac{V_{MAX} - V_{MIN}}{5V} \right| \times 100$$

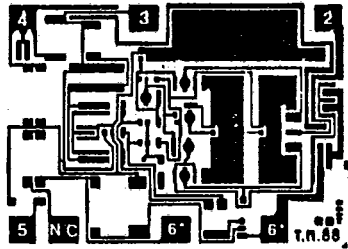
2. ΔV_{OT} specification applies trimmed to +5.000V or untrimmed.

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

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

- 4. Line and Load Regulation specifications include the effect of self-heating.
- 5. Limit current in or out of pin 3 to 50nA and capacitance on pin 3 to 30pF.
- 6. Guaranteed by design.
- 7. Sample Tested.

Bonding Diagram



- 2. V_{IN}
- 3. TEMP
- 4. GND
- 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)