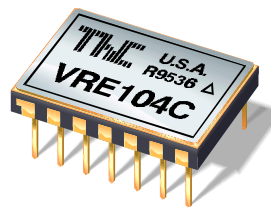




VRE104

Precision Reference Supplies



THALER CORPORATION • 2015 N. FORBES BOULEVARD • TUCSON, AZ. 85745 • (520) 882-4000

FEATURES

- **VERY HIGH ACCURACY:** 4.5000 V OUTPUT ± 0.4 mV
- **EXTREMELY LOW DRIFT:** 0.6 ppm/ $^{\circ}$ C -55 $^{\circ}$ C to +125 $^{\circ}$ C
- **EXCELLENT STABILITY:** 6 ppm/1000 Hrs. Typ.
- **EXCELLENT LINE REGULATION:** 6 ppm/V Typ.
- **WIDE SUPPLY RANGE:** +13.5 to +22.0 V
- **HERMETIC 14-PIN CERAMIC DIP**
- **MILITARY PROCESSING OPTIONS**

APPLICATIONS

- **PRECISION A/D and D/A CONVERTERS**
- **TRANSDUCER EXCITATION**
- **ACCURATE COMPARATOR THRESHOLD REFERENCE**
- **HIGH RESOLUTION SERVO SYSTEMS**
- **DIGITAL VOLTMETERS**
- **HIGH PRECISION TEST and MEASUREMENT INSTRUMENTS**

DESCRIPTION

VRE104 Series Precision Voltage References provide ultrastable +4.500 V outputs with up to ± 0.4 mV initial accuracy and temperature coefficient as low as 0.6 ppm/ $^{\circ}$ C over the full military temperature range.

These references are specifically designed to be used with the Crystal Semiconductor line of successive-approximation type Analog to Digital Converters (ADCs). This line of ADCs sets new standards for temperature drift, which can only be as good as the external reference used. The Thaler VRE104 combined with a Crystal ADC will provide the lowest drift data conversion obtainable.

VRE104 series devices are available in two operating temperature ranges, -25 $^{\circ}$ C to +85 $^{\circ}$ C and -55 $^{\circ}$ C to +125 $^{\circ}$ C, and two performance grades. All devices are packaged in 14-pin hermetic ceramic packages for maximum long-term stability. "M" versions are screened for high reliability and quality.

Superior stability, accuracy, and quality make the VRE104 ideal for all precision applications which may require a 4.5V reference. High-accuracy test and measurement instrumentation, and transducer excitation are some other applications which can benefit from the high accuracy of the VRE104.

SELECTION GUIDE

Type	Output	Temperature Operating Range	Max. Volt Deviation
VRE104C	+4.5V	-25 $^{\circ}$ C to +85 $^{\circ}$ C	0.4mV
VRE104CA	+4.5V	-25 $^{\circ}$ C to +85 $^{\circ}$ C	0.2mV
VRE104M	+4.5V	-55 $^{\circ}$ C to +125 $^{\circ}$ C	0.6mV
VRE104MA	+4.5V	-55 $^{\circ}$ C to +125 $^{\circ}$ C	0.3mV

ELECTRICAL SPECIFICATIONS

VRE104

Vps =+15V, T = 25°C, RL = 10KΩ unless otherwise noted.

MODEL	C			CA			M			MA			
PARAMETERS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
ABSOLUTE MAXIMUM RATINGS													
Power Supply	+13.5		+22	*		*	*		*	*		*	V
Operating Temperature	-25		85	*		*	-55		125	-55		125	°C
Storage Temperature	-65		150	*		*	*		*	*		*	°C
Short Circuit Protection	Continuous				*			*			*		
OUTPUT VOLTAGE													
VRE104		+4.5			*			*			*		V
OUTPUT VOLTAGE ERRORS													
Initial Error			800			400			800			400	μV
Warmup Drift		2			1			2			1		ppm
T _{min} - T _{max} ⁽¹⁾			400			200			600			300	μV
Long-Term Stability		6			*			*			*		ppm/1000hrs
Noise (.1-10Hz)		3			*			*			*		μVpp
OUTPUT CURRENT													
Range	±10			*			*			*			mA
REGULATION													
Line		6	10		*	*		*	*		*	*	ppm/V
Load		3			*			*			*		ppm/mA
OUTPUT ADJUSTMENT													
Range		10			*			*			*		mV
Temperature Coeff.		4			*			*			*		μV/°C/mV
POWER SUPPLY CURRENTS ⁽²⁾													
VRE104 +PS		5	7		*	*		*	*		*	*	mA

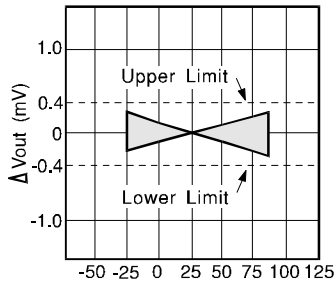
NOTES: *Same as C Models.

1. Using the box method, the specified value is the maximum deviation from the output voltage at 25°C over the specified operating temperature range.

2. The specified values are unloaded.

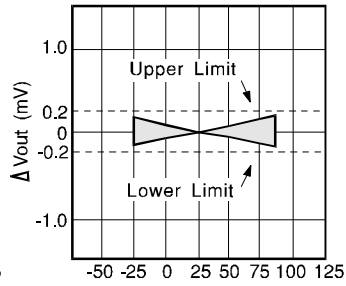
TYPICAL PERFORMANCE CURVES

V_{OUT} vs. TEMPERATURE



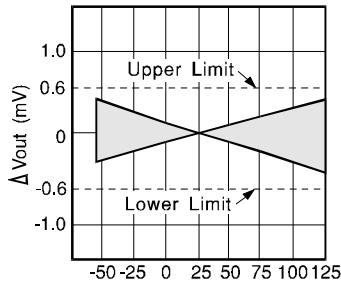
Temperature °C
VRE104C

V_{OUT} vs. TEMPERATURE



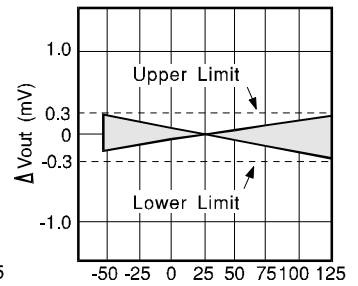
Temperature °C
VRE104CA

V_{OUT} vs. TEMPERATURE



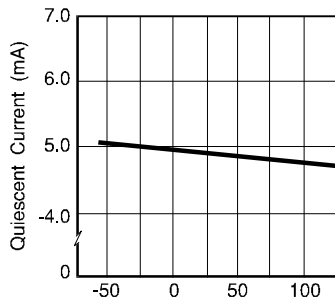
Temperature °C
VRE104M

V_{OUT} vs. TEMPERATURE



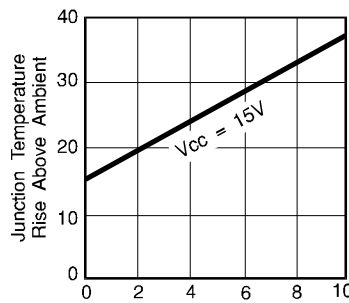
Temperature °C
VRE104MA

QUIESCENT CURRENT vs. TEMP



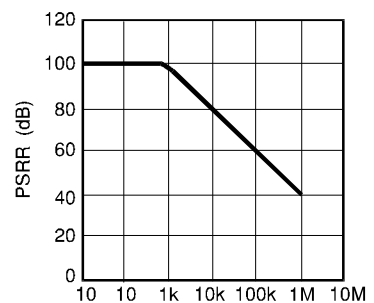
Temperature °C

JUNCTION TEMP. RISE vs. OUTPUT CURRENT



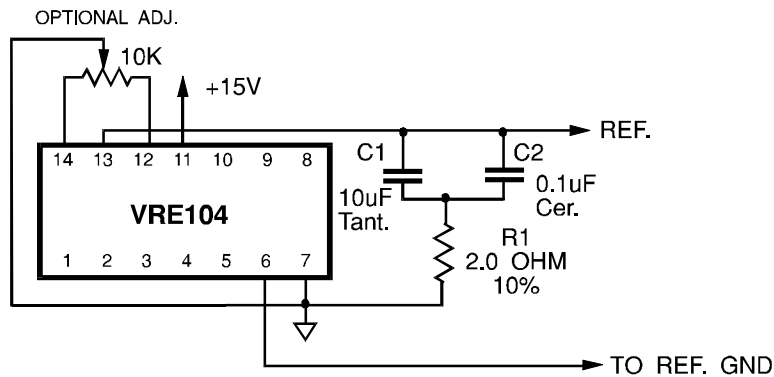
Output Current (mA)

PSRR vs. FREQUENCY



Frequency (Hz)

VRE104 Used With Crystal Semiconductor ADC



Suggested Reading: Crystal Semiconductor Application Note: "Voltage References for the CS501X/CS251IX Series of A/D Converters"

DISCUSSION OF PERFORMANCE

THEORY OF OPERATION

The following discussion refers to the schematic below. A FET current source is used to bias a 6.3 zener diode. The zener voltage is divided by the resistor network R1 and R2. This voltage is then applied to the noninverting input of the operational amplifier which amplifies the voltage to produce a 4.5000V output. The gain is determined by the resistor networks R3 and R4: $G=1 + R4/R3$. The 6.3 zener diode is used because it is the most stable diode over time and temperature.

The current source provides a closely regulated zener current, which determines the slope of the references' voltage vs. temperature function. By trimming the zener current a lower drift over temperature can be achieved. But since the voltage vs. temperature function is nonlinear, this method leaves a residual error over wide temperature ranges.

To remove this residual error, Thaler has developed a nonlinear compensation network of thermistors and resistors that is used in the VRE104 series references. This proprietary network eliminates most of the nonlinearity in the voltage vs. temperature function. By then adjusting the slope, Thaler Corporation produces a very stable voltage over wide temperature ranges. This network is less than 2% of the overall network resistance so it has a negligible effect on long term stability.

APPLICATION INFORMATION

Figure 2 shows the proper connection of the VRE104 series voltage references with the optional trim resistors. Pay careful attention to the circuit layout to avoid noise pickup and voltage drops in the lines.

The VRE104 series voltage references have the ground terminal brought out on two pins (pin 6 and pin 7) which are connected together internally. This allows the user to achieve greater accuracy when using a socket. Voltage references have a voltage drop across their power supply ground pin due to quiescent current flowing through the contact resistance. If the contact resistance was constant with time and temperature, this voltage drop could be trimmed out. When the reference is plugged into a socket, this source of error can be as high as 20ppm. By connecting pin 7 to the power supply ground and pin 6 to a high impedance ground point in the measurement circuit, the error due to the contact resistance can be eliminated. If the unit is soldered into place, the contact resistance is sufficiently small that it does not effect performance.

VRE104

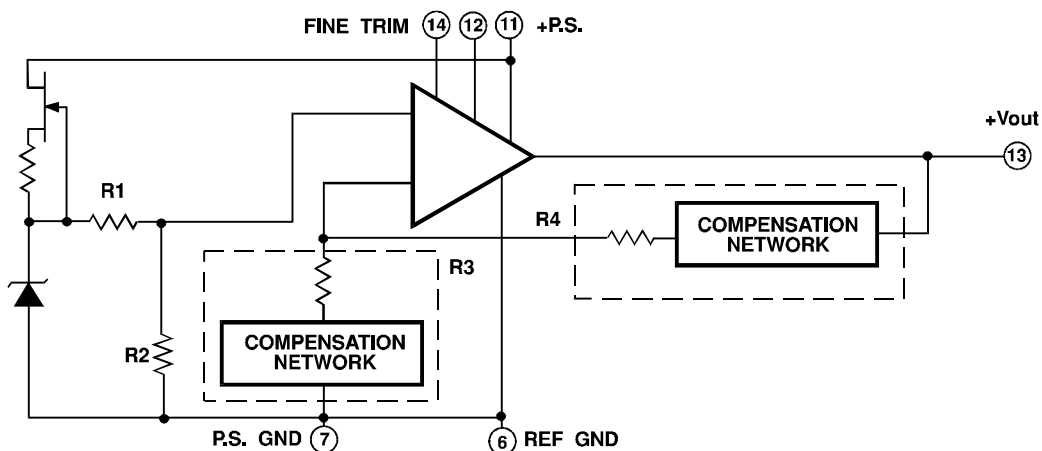


FIGURE 1

EXTERNAL CONNECTIONS

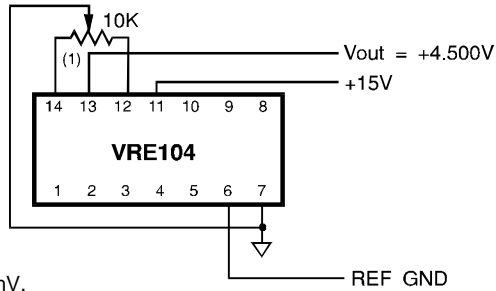
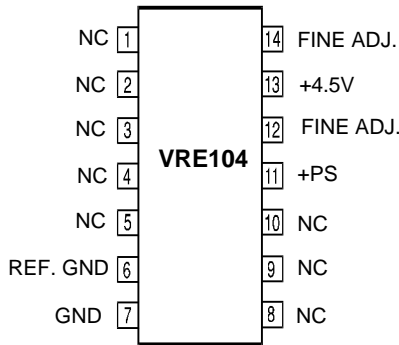


FIGURE 2

1. Optional Fine Adjust for approximately $\pm 10\text{mV}$.

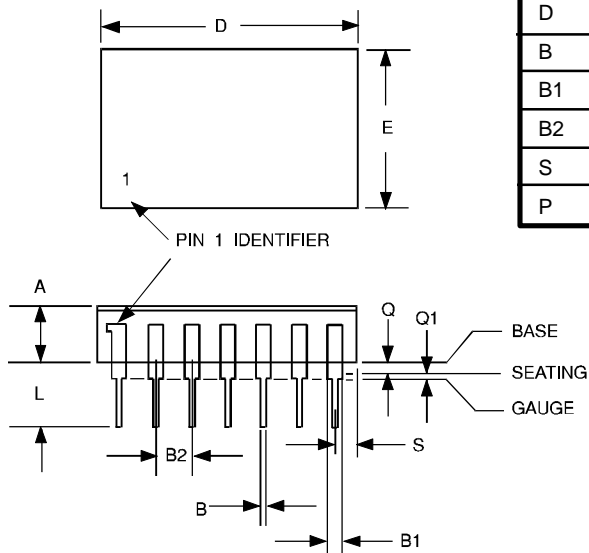
PIN CONFIGURATION

TOP VIEW



MECHANICAL

14-PIN HYBRID PACKAGE



DIM	INCHES		MILLIMETER		DIM	INCHES		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
E	.480	.500	12.1	12.7	A	.120	.155	3.0	4.0
L	.195	.215	4.9	5.4	Q	.015	.035	0.4	0.9
D	.775	.805	19.7	20.4	Q1	N/A	.030	N/A	0.7
B	.016	.020	0.4	0.5	C	.009	.012	0.2	0.3
B1	.038	.042	0.9	1.0	G1	.290	.310	7.3	7.8
B2	.095	.105	2.4	2.6					
S	.085	.105	2.1	2.6					
P	.004	.006	0.10	0.15					