

## Precision Voltage Reference

### FEATURES

- ◆ Very High Accuracy: +4.5 V Output,  $\pm 0.8 \text{ mV}$
- ◆ Extremely Low Drift:  $1.48 \text{ ppm}/^\circ\text{C}$  (-55°C to +125°C)
- ◆ Excellent Stability: 6 ppm/1000 Hrs. Typical
- ◆ Excellent Line Regulation: 6 ppm/V Typical
- ◆ Wide Supply Range: +13.5 V to +22.0 V
- ◆ Hermetic 20-terminal Ceramic LCC
- ◆ Military Processing Available

### 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

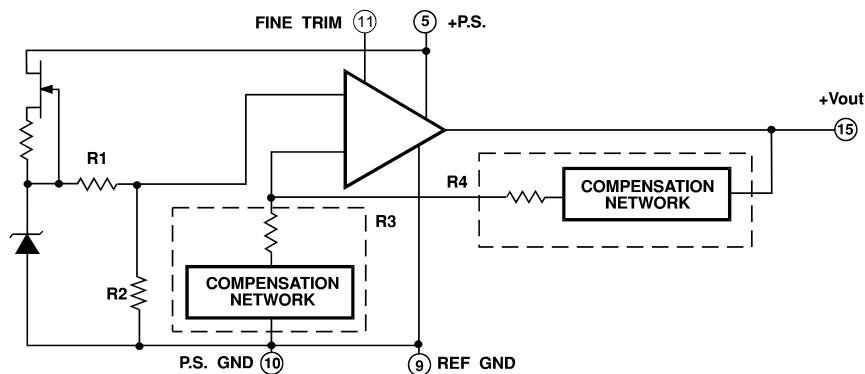
VRE204 Series Precision Voltage References provide ultrastable +4.5 V outputs with up to  $\pm 0.8 \text{ mV}$  initial accuracy and temperature coefficient as low as  $1.48 \text{ ppm}/^\circ\text{C}$  over the full military temperature range.

These references are specifically designed to be used with successive-approximation type Analog-to-Digital Converters (ADCs). Specify an ADC with exceptional temperature drift, which can only be as good as the external reference used. The VRE204 combined with the right ADC will provide the lowest drift data conversion obtainable.

The VRE204 series is available in the military operating temperature range -55°C to +125°C, and two performance grades. All devices are packaged in 20-terminal LCC ceramic packages for maximum long-term stability. These "M" versions are screened for high reliability and quality.

Superior stability, accuracy, and quality make the VRE204 ideal for all precision applications which may require a 4.5 V reference. High-accuracy test and measurement instrumentation, and transducer excitation are some other applications which can benefit from the high accuracy of the VRE204.

**Figure 1. BLOCK DIAGRAM**



### SELECTION GUIDE

Model	Output (V)	Temperature Operating Range	Volt Deviation (MAX)
VRE204M	+4.5V	-55°C to +125°C	$\pm 0.69\text{mV}$
VRE204MA	+4.5V	-55°C to +125°C	$\pm 0.60\text{mV}$



20-terminal Ceramic LCC  
Package Style HD

# VRE204

## 1. CHARACTERISTICS AND SPECIFICATIONS

### ELECTRICAL SPECIFICATIONS

$V_{PS} = +15V$ ,  $T = +25^{\circ}C$ ,  $R_L = 10K \Omega$  UNLESS OTHERWISE NOTED.

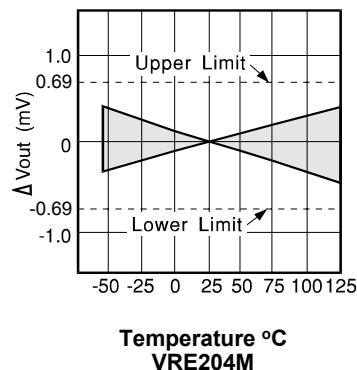
Model	M			MA			
Parameter	Min	Typ	Max	Min	Typ	Max	Units
<b>ABSOLUTE MAXIMUM RATINGS</b>							
Power Supply	+13.5		+22	*		*	V
Operating Temperature	-55		+125	*		*	°C
Storage Temperature	-65		+150	*		*	°C
Short Circuit Protection	Continuous			*			
<b>OUTPUT VOLTAGE</b>							
VRE204		+4.5			*		V
<b>OUTPUT VOLTAGE ERRORS</b>							
Initial Error			±890			±800	µV
Warmup Drift		2			1		ppm
$T_{MIN} - T_{MAX}$ (Note1)			690			600	µV
Long-Term Stability		6			*		ppm/1000hrs.
Noise (0.1 - 10Hz)		3			*		µVpp
<b>OUTPUT CURRENT</b>							
Range	±10			*			mA
<b>REGULATION</b>							
Line		6	10		*	*	ppm/V
Load		3			*		ppm/mA
<b>OUTPUT ADJUSTMENT</b>							
Range		10			*		mV
Temperature Coefficient		4			*		µV/°C/mV
<b>POWER SUPPLY CURRENT (Note 2)</b>							
VRE204 +PS		5	7		*	*	mA

#### NOTES:

- \* Same as M 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.

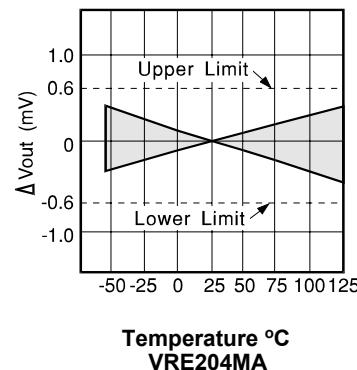
## 2. TYPICAL PERFORMANCE GRAPHS

**V<sub>OUT</sub> vs. TEMPERATURE**



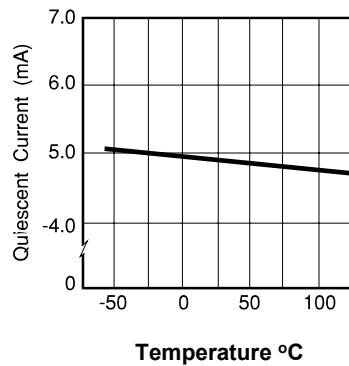
Temperature °C  
VRE204M

**V<sub>OUT</sub> vs. TEMPERATURE**



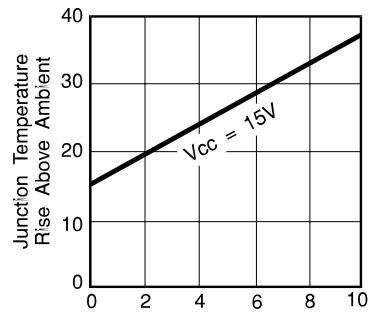
Temperature °C  
VRE204MA

**QUIESCENT CURRENT VS. TEMP**



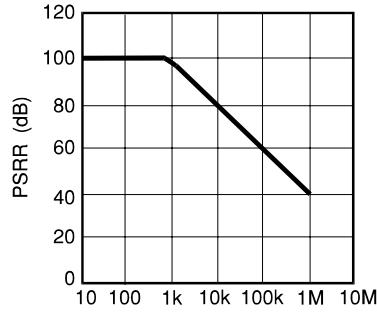
Temperature °C

**JUNCTION TEMP. RISE VS OUTPUT CURRENT**



Output Current (mA)

**PSRR VS. FREQUENCY**



Frequency (Hz)

## 3. THEORY OF OPERATION

The following discussion refers to the block diagram in Figure 1. 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 4.5 V 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 compensation technique is not well suited for wide temperature ranges.

A nonlinear compensation network of thermistors and resistors is used in the VRE series voltage references. This proprietary network eliminates most of the nonlinearity in the voltage vs. temperature function. By then adjusting the slope, the VRE204 series 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. By using highly stable resistors in our network, we produce a voltage reference that also has very good long term stability.

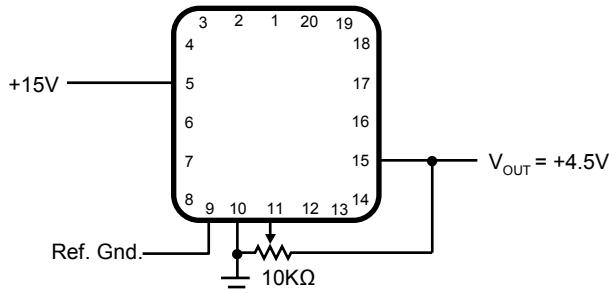
## VRE204

### 4. APPLICATION INFORMATION

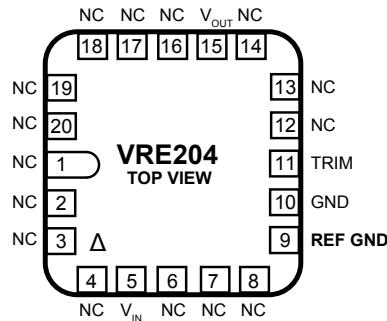
The proper connection of the VRE204 series voltage references with the optional trim resistors is shown below. Pay careful attention to the circuit layout to avoid noise pickup and voltage drops in the lines.

The VRE204 series voltage references have the ground terminal brought out on two pins (pin 9 and pin 10) 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 20 ppm. By connecting pin 10 to the power supply ground and pin 9 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.

### EXTERNAL CONNECTIONS



### PIN CONFIGURATION



### NEED TECHNICAL HELP? CONTACT APEX SUPPORT!

For all Apex Microtechnology product questions and inquiries, call toll free 800-546-2739 in North America.

For inquiries via email, please contact [apex.support@apexanalog.com](mailto:apex.support@apexanalog.com).

International customers can also request support by contacting their local Apex Microtechnology Sales Representative.

To find the one nearest to you, go to [www.apexanalog.com](http://www.apexanalog.com)

#### IMPORTANT NOTICE

Apex Microtechnology, Inc. has made every effort to insure the accuracy of the content contained in this document. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (expressed or implied). Apex Microtechnology reserves the right to make changes without further notice to any specifications or products mentioned herein to improve reliability. This document is the property of Apex Microtechnology and by furnishing this information, Apex Microtechnology grants no license, expressed or implied under any patents, mask work rights, copyrights, trademarks, trade secrets or other intellectual property rights. Apex Microtechnology owns the copyrights associated with the information contained herein and gives consent for copies to be made of the information only for use within your organization with respect to Apex Microtechnology integrated circuits or other products of Apex Microtechnology. This consent does not extend to other copying such as copying for general distribution, advertising or promotional purposes, or for creating any work for resale.

APEX MICROMECHANICS PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN PRODUCTS USED FOR LIFE SUPPORT, AUTOMOTIVE SAFETY, SECURITY DEVICES, OR OTHER CRITICAL APPLICATIONS. PRODUCTS IN SUCH APPLICATIONS ARE UNDERSTOOD TO BE FULLY AT THE CUSTOMER OR THE CUSTOMER'S RISK.

Apex Microtechnology, Apex and Apex Precision Power are trademarks of Apex Microtechnology, Inc. All other corporate names noted herein may be trademarks of their respective holders.