

## VR02

### FEATURES

- ◆ Very High Accuracy: +2.5 V Output,  $\pm 200 \mu\text{V}$
- ◆ Extremely Low Drift:  $0.6 \text{ ppm}/^\circ\text{C}$  ( $25^\circ\text{C}$  to  $+85^\circ\text{C}$ )
- ◆ Low Warm-up Drift: 1 ppm Typical
- ◆ Excellent Stability: 6 ppm/1000 Hrs. Typical
- ◆ Excellent Line Regulation: 6 ppm/V Typical
- ◆ Hermetic 20-Terminal Ceramic LCC
- ◆ Military Processing Option

### 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

#### VR02

ultrastable +2.5 V outputs with  $\pm 200 \mu\text{V}$  initial accuracy and temperature coefficient as low as  $0.6 \text{ ppm}/^\circ\text{C}$  over the full military temperature range. This improvement in accuracy is made possible by a unique, proprietary multipoint laser compensation technique. Significant

parameters as well, including initial accuracy, warm-up drift, line regulation, and longterm stability, making

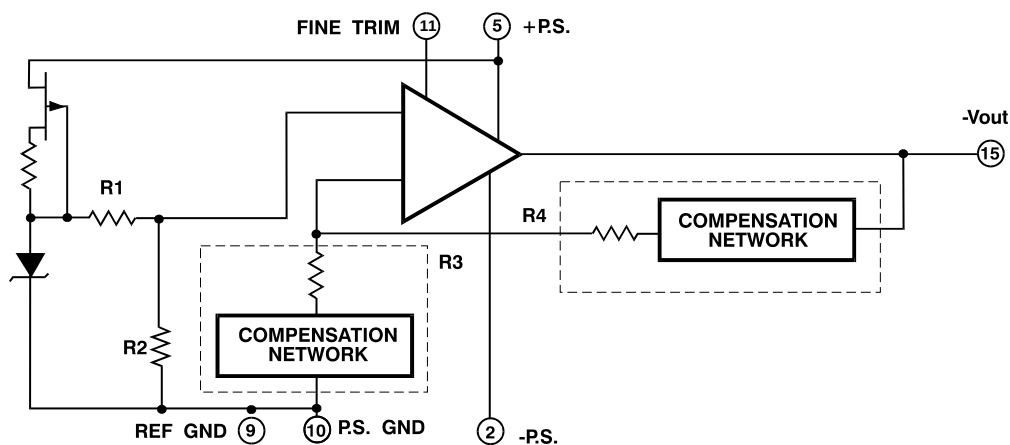
#### VR02

#### VR02

perature ranges,  $-25^\circ\text{C}$  to  $+85^\circ\text{C}$  and  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ , are

are packaged in 20-terminal ceramic LCC packages for maximum long-term stability. "M" versions are screened for high reliability and quality.

### BLOCK DIAGRAM



### SECTION GUIDE

| Model  | Output (V) | Temp. Range                                 | Initial Accuracy (mV) |
|--------|------------|---------------------------------------------|-----------------------|
| VR02C  | 2.5        | $-25^\circ\text{C}$ to $+85^\circ\text{C}$  | $\pm 200 \mu\text{V}$ |
| VR02CA | 2.5        | $-25^\circ\text{C}$ to $+85^\circ\text{C}$  | $\pm 100 \mu\text{V}$ |
| VR02M  | 2.5        | $-55^\circ\text{C}$ to $+125^\circ\text{C}$ | $\pm 400 \mu\text{V}$ |
| VR02MA | 2.5        | $-55^\circ\text{C}$ to $+125^\circ\text{C}$ | $\pm 200 \mu\text{V}$ |



20-pin LCC

Package Style HD

## 1. CHARACTERISTICS AND SPECIFICATIONS

### ELECTRICAL SPECIFICATIONS

$V_{PS} = 5V$ ,  $T = +25^{\circ}C$ ,  $R_L = 10K\Omega$  UNLESS OTHERWISE NOTED.

| General                                     | C          |     |      | CA  |     |     |              |
|---------------------------------------------|------------|-----|------|-----|-----|-----|--------------|
| Pin                                         | Min        | Typ | Max  | Min | Typ | Max | Units        |
| OUTPUT VOLTAGE                              |            |     |      |     |     |     |              |
| Power Supply                                | +13.5      |     | 22   | *   |     | *   | V            |
| Operating Temperature                       | -25        |     | +85  | *   |     | *   | °C           |
| Storage Temperature                         | -65        |     | +150 | *   |     | *   | °C           |
| Short Circuit Protection                    | Continuous |     |      | *   |     |     |              |
| OUTPUT VOLTAGE TOLERANCES                   |            |     |      |     |     |     |              |
| VRE202                                      |            | 25  |      |     | *   |     | V            |
| OUTPUT VOLTAGE TOLERANCES                   |            |     |      |     |     |     |              |
| Initial Error                               |            |     | ±300 |     |     | 200 | μV           |
| Warmup Drift                                |            | 2   |      |     | 1   |     | mV           |
| T <sub>MIN</sub> - T <sub>MAX</sub> (Note1) |            |     | 200  |     |     | 100 | μV           |
| Long-Term Stability                         |            | 6   |      |     | *   |     | ppm/1000hrs. |
| Noise (0.1 - 10Hz)                          |            | 1.5 |      |     | *   |     | μVpp         |
| OUTPUT CURRENT                              |            |     |      |     |     |     |              |
| Rg                                          | ±10        |     |      | *   |     |     | mA           |
| REGULATION                                  |            |     |      |     |     |     |              |
| Line                                        |            | 6   | 10   |     | *   | *   | ppm/V        |
| Load                                        |            | 3   |      |     | *   |     | ppm/mA       |
| OUTPUT RESISTANCE                           |            |     |      |     |     |     |              |
| Rg                                          |            | 10  |      |     | *   |     | mΩ           |
| Temperature Coefficient                     |            | 4   |      |     | *   |     | μV/°C/mV     |
| QUASISTATIC CURRENT (Note 2)                |            |     |      |     |     |     |              |
| VRE202 PS                                   |            | 5   | 7    |     | *   | *   | mA           |
| VRE202 -PS                                  |            | 5   | 7    |     | *   | *   | mA           |

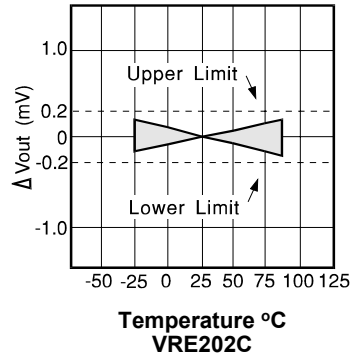
#### NOTES:

- \* 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.

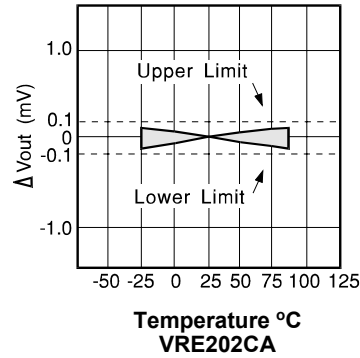
## 2. TPCA

## PERFORMANCE CURVES

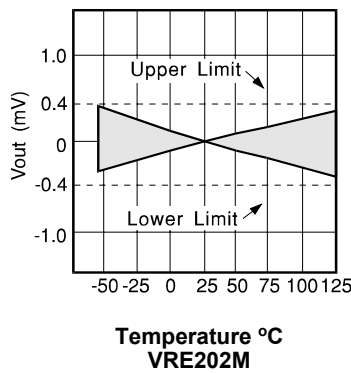
**V<sub>OUT</sub> vs. TEMPERATURE**



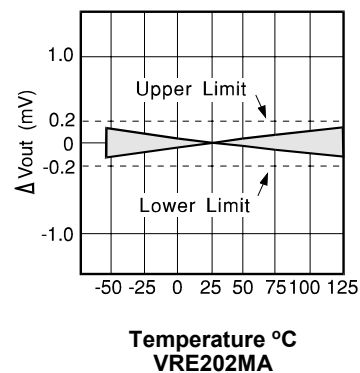
**V<sub>OUT</sub> vs. TEMPERATURE**



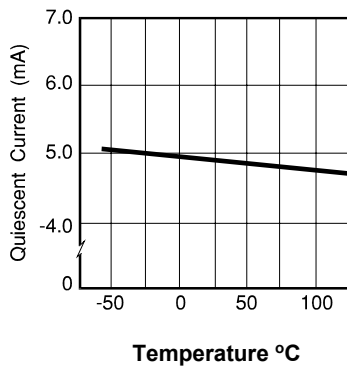
**V<sub>OUT</sub> vs. TEMPERATURE**



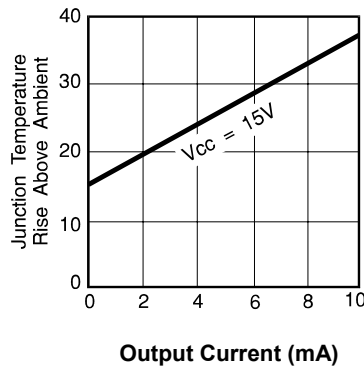
**V<sub>OUT</sub> vs. TEMPERATURE**



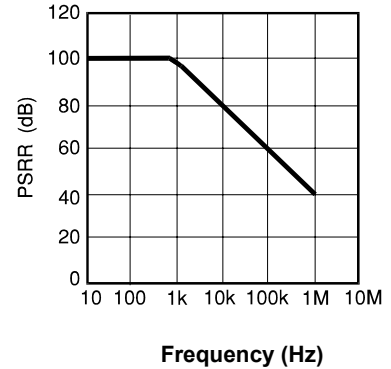
**QUIESCENT CURRENT vs. TEMP**



**JUNCTION TEMP. RISE vs. OUTPUT CURRENT**



**PSRR vs. FREQUENCY**



### 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 V 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 2.5 V output. The gain is determined by the resistor networks R3 and R4:  $G = 1 + R4/R3$ . The 6.3 V zener diode is used because it is the most stable

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

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. Then by adjusting the slope, a very stable voltage over wide temperature ranges is produced. 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, a voltage reference is produced that also has very good long term stability.

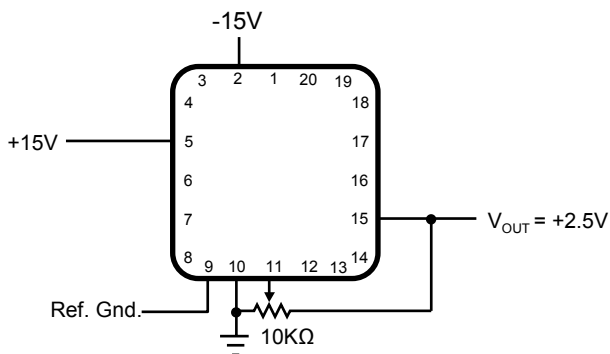
### 4. RECOMMENDATION INFORMATION

The proper connection of the VRE202 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 VRE202 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.

#### RECOMMENDATIONS

#### CONNECTIONS



#### PIN CONFIGURATION

