

## Precision Voltage Reference

### FEATURES

- ◆ +2.5 V Output, ± 0.40 mV (.016%)
- ◆ Temperature Drift: 1.0 ppm/°C
- ◆ Low Noise: 1.5  $\mu\text{V}_{\text{p-p}}$  (0.1-10Hz)
- ◆ Industry Standard Pinout: 8-pin DIP or Surface Mount Package
- ◆ Excellent Line Regulation: 6 ppm/V Typical
- ◆ Output Trim Capability

### APPLICATIONS

The VRE302 is recommended for use as a reference for 14, 16, or 18 bit D/A converters which require an external precision reference. The device is also ideal for calibrating scale factor on high resolution A/D converters. The VRE302 offers superior performance over monolithic references.

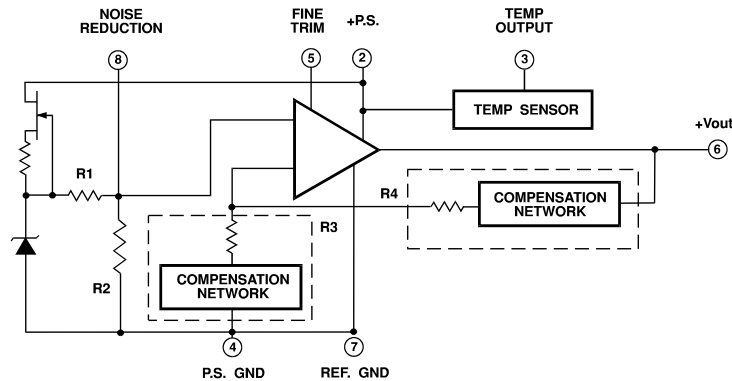
### DESCRIPTION

The VRE302 is a low cost, high precision +2.5 V reference. Packaged in the industry standard 8-pin DIP, the device is ideal for upgrading systems that use lower performance references.

The device provides ultrastable +2.5 V output with ±0.40 mV (.016%) initial accuracy and a temperature coefficient of 1.0 ppm/°C. This improvement in accuracy is made possible by a unique, patented multipoint laser compensation technique. Significant improvements have been made in other performance parameters as well, including initial accuracy, warm-up drift, line regulation, and long-term stability, making the VRE302 series the most accurate reference available in the standard 8-pin DIP package.

For enhanced performance, the VRE302 has an external trim option for users who want less than 0.01% initial error. A reference ground pin is provided to eliminate socket contact resistance errors.

**Figure 1. BLOCK DIAGRAM**

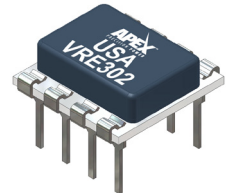


### SELECTION GUIDE

Model	Initial Error (mV)	Temp. Coeff. (ppm/°C)	Temp. Range (°C)	Package Options
VRE302CS	0.60	2.2	0°C to +70°C	SMT8 (GD)
VRE302CD	0.60	2.2	0°C to +70°C	DIP8 (KD)
VRE302JS	0.40	1.0	-40°C to +85°C	SMT8 (GD)
VRE302JD	0.40	1.0	-40°C to +85°C	DIP8 (KD)
VRE302KS	0.50	2.0	-40°C to +85°C	SMT8 (GD)
VRE302LS	0.60	2.2	-40°C to +85°C	SMT8 (GD)
VRE302LD	0.60	2.2	-40°C to +85°C	DIP8 (KD)



**8-pin Surface Mount  
Package Style GD**



**8-pin DIP  
Package Style KD**

## 1. CHARACTERISTICS AND SPECIFICATIONS

### ELECTRICAL SPECIFICATIONS

$V_{PS} = \pm 15V$ ,  $T = +25^{\circ}C$ ,  $R_L = 10K\Omega$  Unless Otherwise Noted.

Model	A/J			K			C/L			
Parameter	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Units
<b>ABSOLUTE MAXIMUM RATINGS</b>										
Power Supply	±13.5	±15	±22	*	*	*	*	*	*	V
Operating Temperature (A,B)	0		+70	*		*	*		*	°C
Operating Temperature (K)	-40		+85	*		*	*		*	°C
Storage Temperature	-65		+150	*		*	*		*	°C
Short Circuit Protection	Continuous			*			*			
<b>OUTPUT VOLTAGE</b>										
VRE302		+2.5			*			*		V
Temp. Sensor Voltage (Note 1)		630			*			*		mV
<b>OUTPUT VOLTAGE ERRORS</b>										
Initial Error (Note 2)			0.40			0.50			0.60	mV
Warmup Drift		1			2			3		ppm
$T_{MIN} - T_{MAX}$ (Note3)			1.0			2.0			2.2	ppm/°C
Long-Term Stability		6			*			*		ppm/1000hrs.
Noise (0.1 - 10Hz) (Note 4)		1.5			*			*		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
<b>POWER SUPPLY CURRENT (Note 5)</b>										
VRE302 +PS		5	7		*	*		*	*	mA

#### NOTES:

\* Same as A Models.

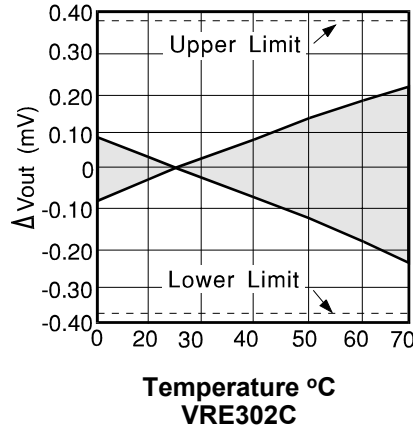
1. The temp. reference TC is 2.1mV/ °C
2. The specified values are without external trim.
3. The temperature coefficient is determined by the box method using the following formula:

$$T.C. = \frac{V_{MAX} - V_{MIN}}{V_{NOMINAL} \times (T_{MAX} - T_{MIN})} \times 10^6$$

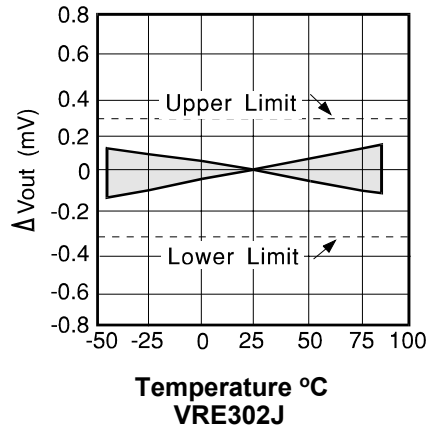
4. The specified values are without the external noise reduction capacitor.
5. The specified values are unloaded.

## 2. TYPICAL PERFORMANCE CURVES

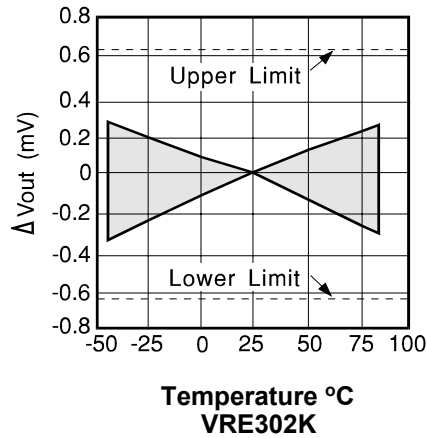
**V<sub>OUT</sub> vs. TEMPERATURE**



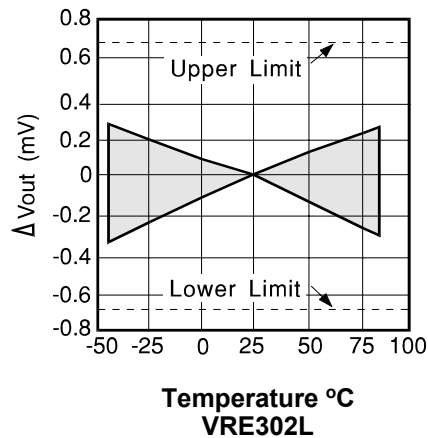
**V<sub>OUT</sub> vs. TEMPERATURE**



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

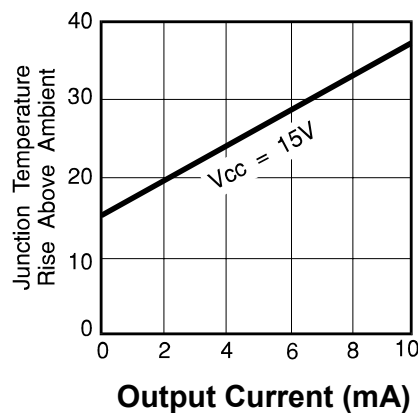
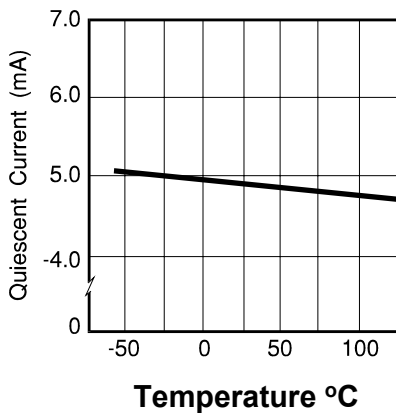


**V<sub>OUT</sub> vs. TEMPERATURE**

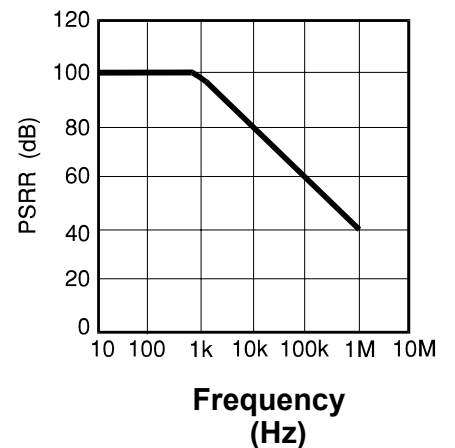


————— POSITIVE OUTPUT (TYP) —————

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



**PSRR vs. FREQUENCY**



### 3. THEORY OF OPERATION

The following discussion refers to the schematic 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 non-inverting 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 diode over time and temperature.

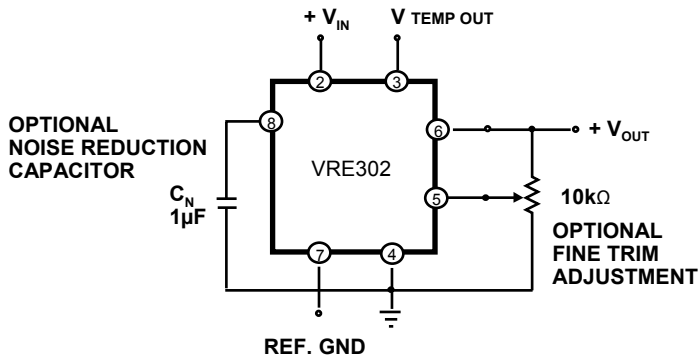
The current source provides a closely regulated zener current, which determines the slope of the references' voltage vs. temperature function. By trimming the zener current a lower drift over temperature can be achieved. But since the voltage vs. temperature function is nonlinear this compensation technique 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 adjusting the slope, a very stable voltage is produced over wide temperature ranges.

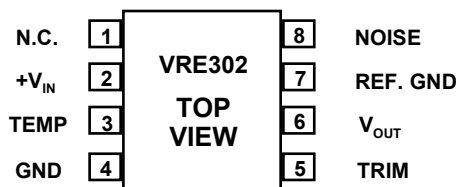
This network is less than 2% of the overall network resistance so it has a negligible effect on long term stability.

The proper connection of the VRE302 series voltage references with the optional trim resistor for initial error is shown below. The VRE302 reference has the ground terminal brought out on two pins (pin 4 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 20 ppm. By connecting pin 4 to the power supply ground and pin 7 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. Pay careful attention to the circuit layout to avoid noise pickup and voltage drops in the lines.

### EXTERNAL CONNECTIONS



### PIN CONFIGURATION





---

## CONTACTING CIRRUS LOGIC SUPPORT

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

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

International customers can also request support by contacting their local Cirrus Logic Sales Representative.

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

---

### IMPORTANT NOTICE

Cirrus Logic, Inc. and its subsidiaries ("Cirrus") believe that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (express or implied). Customers are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, indemnification, and limitation of liability. No responsibility is assumed by Cirrus for the use of this information, including use of this information as the basis for manufacture or sale of any items, or for infringement of patents or other rights of third parties. This document is the property of Cirrus and by furnishing this information, Cirrus grants no license, express or implied under any patents, mask work rights, copyrights, trademarks, trade secrets or other intellectual property rights. Cirrus 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 Cirrus integrated circuits or other products of Cirrus. 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.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). CIRRUS PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN PRODUCTS SURGICALLY IMPLANTED INTO THE BODY, AUTOMOTIVE SAFETY OR SECURITY DEVICES, LIFE SUPPORT PRODUCTS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF CIRRUS PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK AND CIRRUS DISCLAIMS AND MAKES NO WARRANTY, EXPRESS, STATUTORY OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WITH REGARD TO ANY CIRRUS PRODUCT THAT IS USED IN SUCH A MANNER. IF THE CUSTOMER OR CUSTOMER'S CUSTOMER USES OR PERMITS THE USE OF CIRRUS PRODUCTS IN CRITICAL APPLICATIONS, CUSTOMER AGREES, BY SUCH USE, TO FULLY INDEMNIFY CIRRUS, ITS OFFICERS, DIRECTORS, EMPLOYEES, DISTRIBUTORS AND OTHER AGENTS FROM ANY AND ALL LIABILITY, INCLUDING ATTORNEYS' FEES AND COSTS, THAT MAY RESULT FROM OR ARISE IN CONNECTION WITH THESE USES.

Cirrus Logic, Cirrus, and the Cirrus Logic logo designs, Apex Precision Power, Apex and the Apex Precision Power logo designs are trademarks of Cirrus Logic, Inc. All other brand and product names in this document may be trademarks or service marks of their respective owners.

---