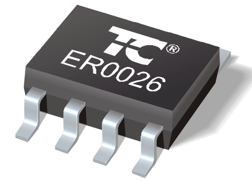
VRE4100 Series
Low Cost, SOIC-8
Precision References



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FEATURES

- **1.024, 1.250, 2.048, 2.500, 4.096V Output**
- **Initial Error: ± 0.05% max.**
- **Temperature Drift: 1.0 ppm/°C max.**
- **Low Noise: 2.2μV_{p-p} (0.1Hz-10Hz, 1.024V)**
- **Low Thermal Hysterisis: 20ppm**
- **±8mA Output Source**
- **Power Down Mode**
- **Industry Standard SOIC-8 pin out**
- **Commercial and Industrial Temp Ranges**
- **Second source for ADR29X, REF19X ,LT1460, LT1461, LT1798, MAX616X, REF102**

PIN CONFIGURATION

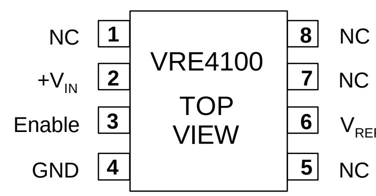


FIGURE 1

DESCRIPTION

The VRE4100 is a low cost, high precision bandgap reference that operates from +5V. The device features low noise, digital error correction, and an SOIC-8 package. The ultrastable output is 0.05% accurate with a temperature coefficient as low as 1.0 ppm/°C. The improvement in overall accuracy is made possible by using EEPROM registers and CMOS DAC's for temperature and initial error correction. The DAC trimming is done after assembly which eliminates assembly related shifts.

The VRE4100 is recommended for use as a reference for 14, 16, or 18 bit data converters which require a precision reference. The VRE4100 offers superior performance over standard on-chip references commonly found with data converters.

SELECTION GUIDE

Model	Output Voltage V	Temp. Coeff. ppm/°C	Temp. Range °C
VRE4110B	1.024	1.0	0°C to +70°C
VRE4110C	1.024	2.0	0°C to +70°C
VRE4110K	1.024	3.0	-40°C to +85°C
VRE4112B	1.250	1.0	0°C to +70°C
VRE4112C	1.250	2.0	0°C to +70°C
VRE4112K	1.250	3.0	-40°C to +85°C
VRE4120B	2.048	1.0	0°C to +70°C
VRE4120C	2.048	2.0	0°C to +70°C
VRE4120K	2.048	3.0	-40°C to +85°C
VRE4125B	2.500	1.0	0°C to +70°C
VRE4125C	2.500	2.0	0°C to +70°C
VRE4125K	2.500	3.0	-40°C to +85°C
VRE4141B	4.096	1.0	0°C to +70°C
VRE4141C	4.096	2.0	0°C to +70°C
VRE4141K	4.096	3.0	-40°C to +85°C

ABSOLUTE MAXIMUM RATINGS

Power supply to any input pin …….-0.3V to +5.6V
Operating Temp. (B,C) ………..…….0°C to 70°C
Operating Temp. (K)………………..-40°C to 85°C
Storage Temperature Range……..-65°C to 150°C

Output Short Circuit Duration ………………....Indefinite
ESD Susceptibility Human Body Model……….…..2kV
ESD Susceptibility Machine Model ..……………200V
Lead Temperature (soldering,10 sec)………..….260°C

ELECTRICAL SPECIFICATIONS

Vps =+3V for VRE4110 and VRE4112, Vps =+5V for VRE4125, VRE4125 and VRE4141. T = 25°C, I_{load}=1mA, C_{out}=1µF unless otherwise noted.

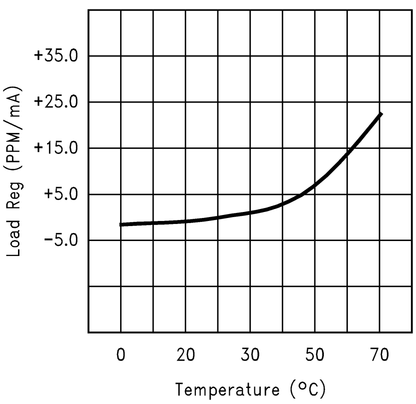
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage	V_{IN}		1.8		5.5	V
Output Voltage Error (Note 1)	V_{OUT}	VRE4100B		± 0.025%	± 0.050%	%
		VRE4100C/K		± 0.040%	± 0.080%	
Output Voltage Temperature Coefficient (Note 2)	TCV_{OUT}	VRE4100B		0.5	1.0	ppm/°C
		VRE4100C		1.0	2.0	
		VRE4100K		1.5	3.0	
Dropout Voltage (Note 3)	$V_{IN}-V_{OUT}$	I_L = 8 mA		160	235	mV
Turn-On Settling Time	T_{ON}	To 0.01% of final value		2		µs
Output Noise Voltage (Note 4)	E_n	0.1Hz<f<10Hz		2.2		µVp-p
Temperature Hysterisis		Note 5		20		ppm
Long Term Stability	$\Delta V_{OUT/T}$	1000 Hours		50		ppm
Supply Current	I_{IN}	V_{load} = 0mA		230	320	µA
Load Regulation (Note 6)	$\Delta V_{OUT}/\Delta I_{OUT}$	1mA ≤ I_{Load} ≤ 8mA		1	20	ppm/mA
Line Regulation (Note 6)	$\Delta V_{OUT}/\Delta V_{IN}$	V_{ref} + 200mV ≤ V_{IN} ≤ 5.5V		20	200	ppm/V
Logic High Input Voltage	V_H		0.8			V
Logic High Input Current	I_H			2		nA
Logic Low Input Voltage	V_L				0.4	V
Logic Low Input Current	I_L			1		nA

Notes:

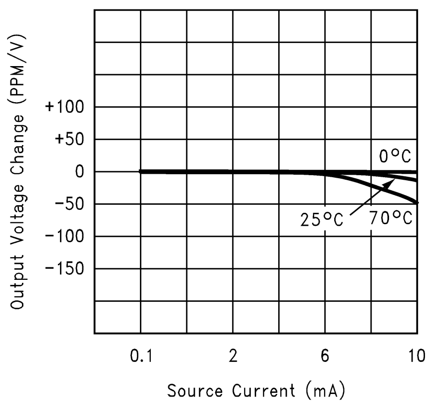
1. High temperature and mechanical stress can effect the initial accuracy of the VRE4100 series references.See discussion on output accuracy.
2. The temperature coefficient is determined by the box method. See discussion on temperature performance. All units are 100% tested over temperature.
3. The minimum input to output differential voltage at which the output voltage drops by 0.5% from nominal.
4. Based on 1.024V output. Noise is linearly proportional to $V_{REF.}$
5. Defined as change in 25°C output voltage after cycling device over operating temperature range.
6. Line and load regulation are measured with pulses and do not include output voltage changes due to self heating.

TYPICAL PERFORMANCE CURVES

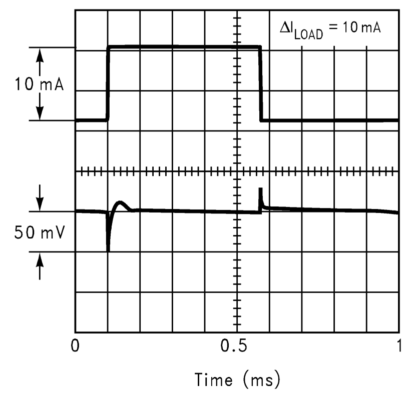
Load Regulation vs Temperature



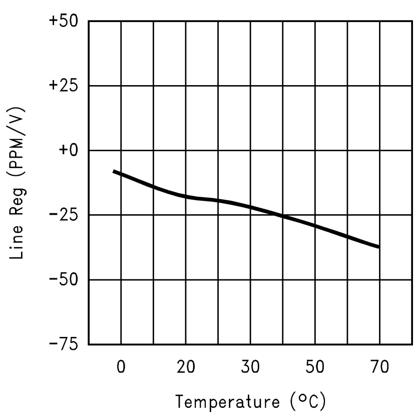
Output Voltage vs Load Current



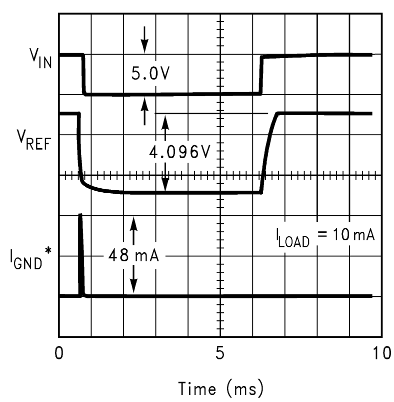
Load Transient Response



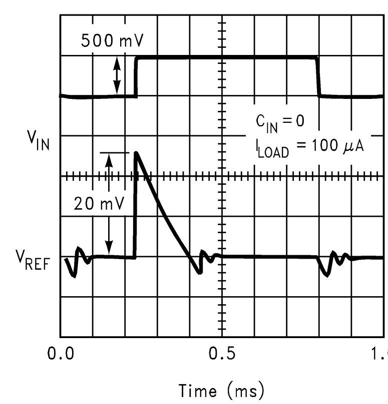
Line Regulation vs Temperature



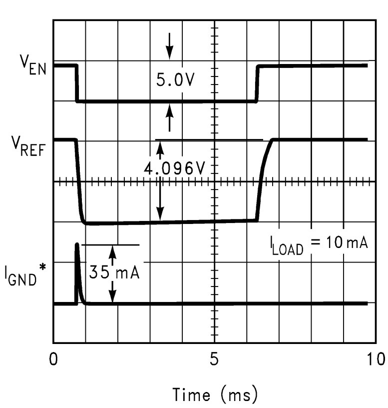
Power Up/Down Ground Current



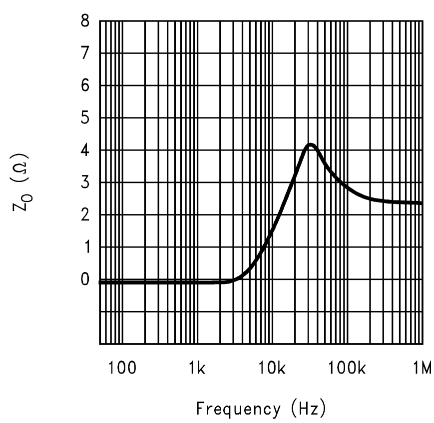
Line Transient Response



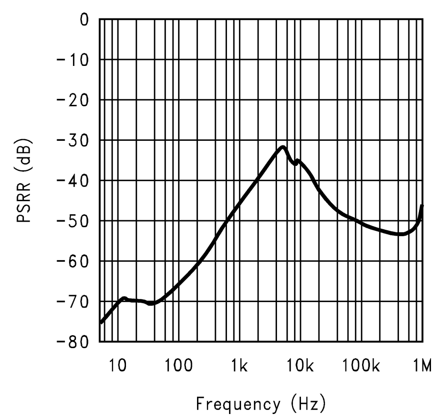
Enable Response



Output Impedance

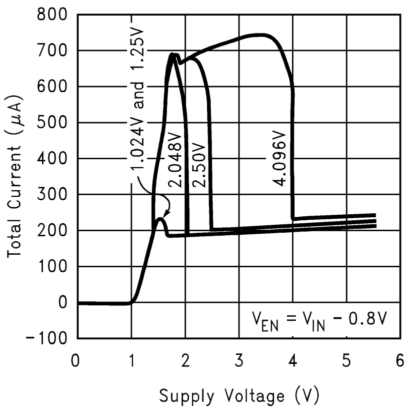


Power Supply Rejection Ratio

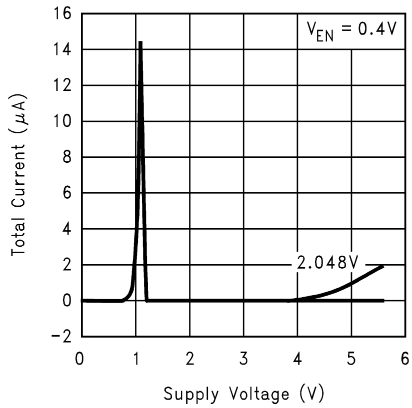


TYPICAL PERFORMANCE CURVES

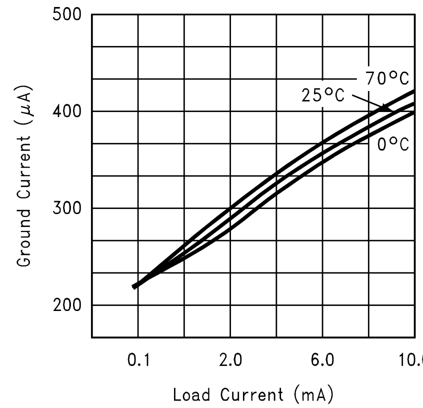
Total Current ($Is_{(ON)}$) vs Supply Voltage



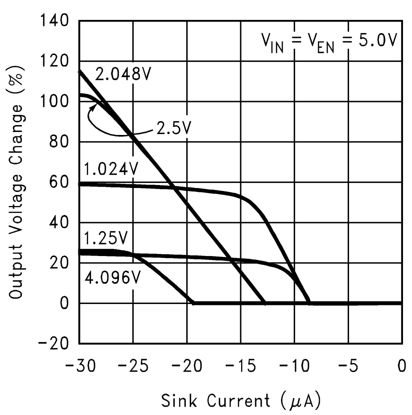
Total Current ($Is_{(OFF)}$) vs Supply Voltage



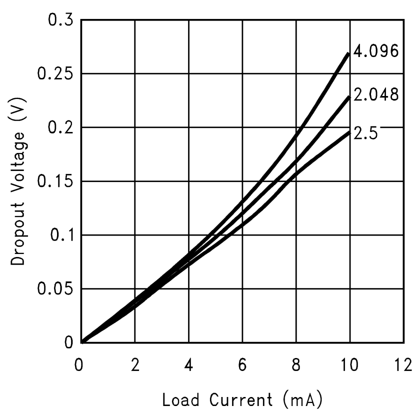
Ground Current vs Load Current



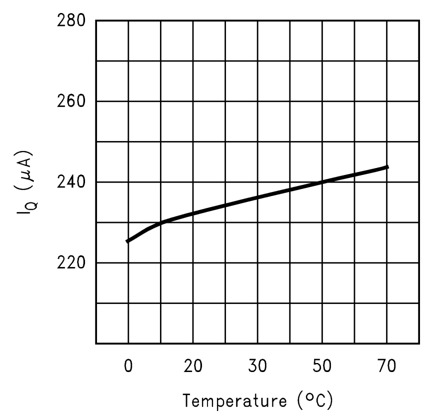
Output Voltage Change vs Sink Current $I_{(SINK)}$



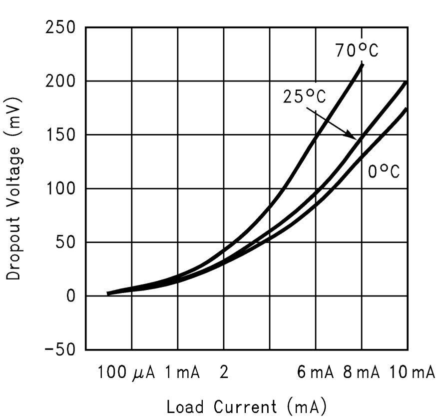
Dropout Voltage vs Load Current



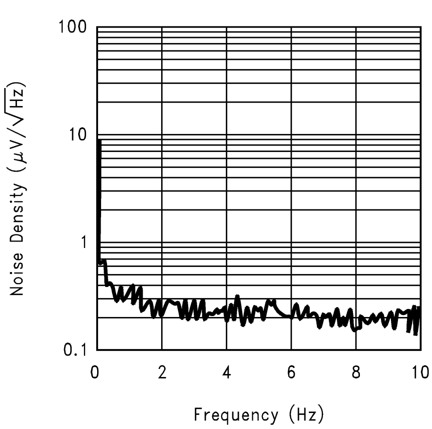
I_Q vs Temperature



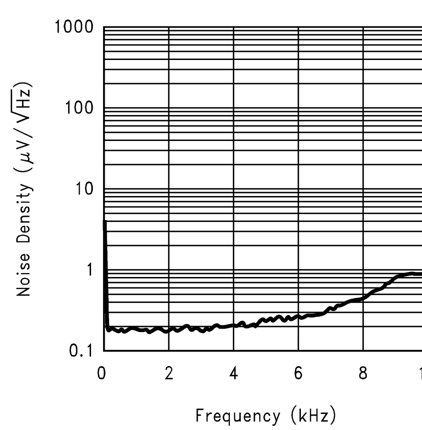
Dropout Voltage vs Load Current (V_{OUT}) = 2.0V



Spectral Noise Density (0.1Hz to 10Hz)



Spectral Noise Density (10Hz to 100kHz)



BASIC CIRCUIT CONNECTION

Figure 3 shows the proper connection of the VRE4100 series voltage reference.

To achieve the specified performance, pay careful attention to the layout. Commons should be connected to a single point to minimize interconnect resistances. This will reduce voltage errors, noise pickup, and noise coupled from the power supply.

TEMPERATURE PERFORMANCE

The VRE4100 is designed for applications where the initial error at room temperature and drift over temperature are important to the user. For many instrument manufacturers, a voltage reference with a temperature coefficient of 1ppm/°C makes it possible to eliminate a system temperature calibration, a slow and costly process.

Of the three TC specification methods (slope, butterfly, and box), the box method is most commonly used. A box is formed by the min/max limits for the nominal output voltage over the operating temperature range. The equation follows:

$$T.C. = \frac{V_{\max} - V_{\min}}{V_{nominal}(T_{\max} - T_{\min})}(10^6)$$

This method corresponds more accurately to the method of test and provides a closer estimate of actual error than the other methods. The box method guarantees limits for the temperature error but does not specify the exact shape or slope of the device under test.

PIN DESCRIPTION

4	GND	These must be connected to ground
2	Vin	Positive power supply input
3	Enable	Pulled to V_{in} for normal operation.
1,5,7,8	NC	This pin must be left open
6	Vout	Reference output

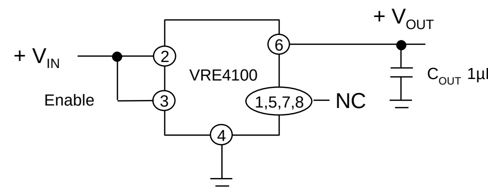
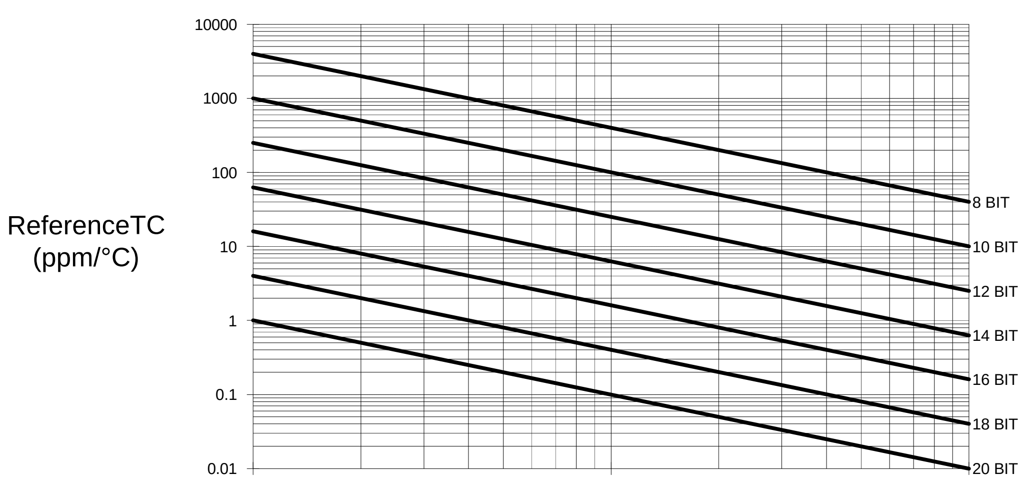


Figure 2 *External Connections*

For example a designer who needs a 14-bit accurate data acquisition system over the industrial temperature range (-40°C to +85°C), will need a voltage reference with a temperature coefficient (TC) of 1.0ppm/°C if the reference is allowed to contribute an error equivalent to 1LSB. Figure 3 shows the required reference TC vs.ΔT change from 25°C for resolution ranging from 8 bits to 20 bits.

Figure 3 Reference TC vs.ΔT change from 25°C for 1 LSB change



OPERATIONAL NOTES

Input Capacitor

An input capacitor is recommended on the VRE4100 device. A supply bypass capacitor on the input will assure that the reference is working from a low impedance source which will improve stability. It can improve the transient response when the load current is suddenly increased.

Output Capacitor

The VRE4100 requires a 1µF output capacitor for loop stabilization (compensation) as well as transient response. When the load current changes, the output capacitor must source or sink current during the time it takes the control loop of the VRE4100 to respond.

The output capacitor must meet the requirements of minimum capacitance and equivalent series resistance (ESR) range. See Capacitor Selection below.

Capacitor Selection

A minimum value of 0.2µF over the operating temperature range is recommended. For a 0.22µF capacitor the ESR range for 0°C -70°C is 0.9 to 6.0, 1.0µF is 0.8 to 6.0, and 10µF is 0.4 to 7.0.

Surface mount tantalum capacitors offer small size for the value and ESR in the range required for the VRE4100. The optimum performance for the output capacitor is achieved with a 1.0µF value.

Aluminum electrolytic capacitors have a relatively large size for the value. They meet the ESR requirements at 1.0µF as long as the temperature is above 0°C. Below 0°C, the ESR increases and it may exceed the limits indicated in the figures.

Multilayer ceramic capacitors have a small size for the value, are available in surface mount, and have excellent RF characteristics. They may not meet the minimum ESR requirements and have a large change in value with temperature.

Reverse Current Path

The P-channel pass transistor used in the VRE4100 has an inherent diode connected between the V_{in} and V_{OUT} pins. Forcing the output to voltages higher than the input or pulling V_{in} below the voltage stored in the output capacitor by more than the V_{be} will forward bias this diode and current will flow from the V_{out} pin to V_{in}. This will not damage the VRE4100 as long as the current does not exceed 50mA.

ON/OFF Operation

The VRE4100 features a sleep mode that is activated by pulling the enable pin low. To turn the reference on, the enable pin is pulled high. If this feature is not used, the the enable pin should be tied to V_{in} to keep the reference on at all times. The enable pin must not be left unconnected (floating).

When powered off, the VRE4100 will quickly reduce both V_{out} and I_Q to zero. During power down, the charge across the output capacitor is discharged to ground through the internal circuitry. On power up, the V_{out} is restored in less than 200µs.

The signal source used to drive the enable pin can come from either a totem-pole output or an open collector output with a pull-up resistor to the VRE4100 input voltage. The signal source must be able to swing above and below the voltage thresholds to guarantee an ON or OFF state. It must not exceed the absolute maximum rating for the enable pin.

Output Accuracy

The output accuracy after assembly at room temperature is made up of three components: initial accuracy of the device, thermal hysterisis, and mechanical stress. The initial accuracy is measured at the factory and may not reflect the actual output voltage when the devices are mounted to a PCB. The effects of mechanical stress and thermal hysterisis can shift the output voltage.

Thermal Hysterisis

Thermal hysterisis is a change in output voltage as a result of a temperature change. When references experience a temperature change and return to the initial temperature, they do not always have the same initial voltage. Thermal hysterisis is difficult to correct and is a major error source in systems that experience temperature changes greater than 25°C. Reference vendors are starting to include this important specification in their datasheets

Mechanical Hysterisis

Recommendations to minimize mechanical stress:

1) Mount the VRE4100 near the edges or corners of the PCB. The center of the board generally has the highest mechanical and thermal stress.

2) Mechanically isolate the device by cutting a U shaped slot around the VRE4100. This provides some mechanical and thermal isolation from the rest of the circuit.

MECHANICAL SPECIFICATIONS