Low noise, Very Low Temperature Drift, High Precision Voltage Reference

1 Features

- Low temperature drift:
  - High grade (GD 30VR3100): 3 ppm/°C (max)
  - Standard grade (GD 30VR1100): 8 ppm/°C (max)
- High accuracy:
  - High grade (GD 30VR3100): 0.05% (maximum)
  - Standard grade (GD 30VR1100): 0.1% (max)
- Low noise: 1.5μVpp/V
- Excellent long-term stability:
  - 50ppm/1000 hours (typical value) first 1000 hours
  - 25ppm/1000 hours (typical value) after 1000 hours
- High output current: ±10mA
- Temperature range: −40°C to 125°C

2 Application

- Precision Data Acquisition System
- Semiconductor Test Equipment
- Industrial Process Control
- Medical Devices
- Pressure and Temperature Transmitters
- Laboratory and Field Instrumentation

3 Description

GD30VR1100 and GD30VR3100 are a family of low noise, low drift, and very high precision voltage references. These references support both current sinking and current sourcing, and have excellent line and load regulation.

Proprietary design techniques are used to achieve excellent temperature drift and high accuracy. These features combined with extremely low noise make the GD30VR1100 and GD30VR3100 series ideal for high-precision data acquisition systems.

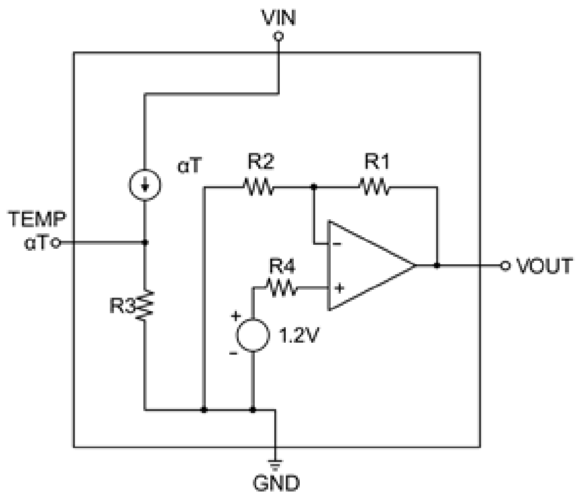
Each reference voltage is available in a premium grade (GD30VR3100) and a standard grade (GD30VR1100) in SOP8L and MSOP8L 8-pin packages and is specified over the −40°C to 125°C temperature range.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE(NOM)
GD30VR1100	SOP8L	5.00 mm x 4.90 mm
GD30VR3100	MSOP8L	3.00 mm x 4.90 mm

1. For packaging details, see *Packaging Information* section.

Block Diagram



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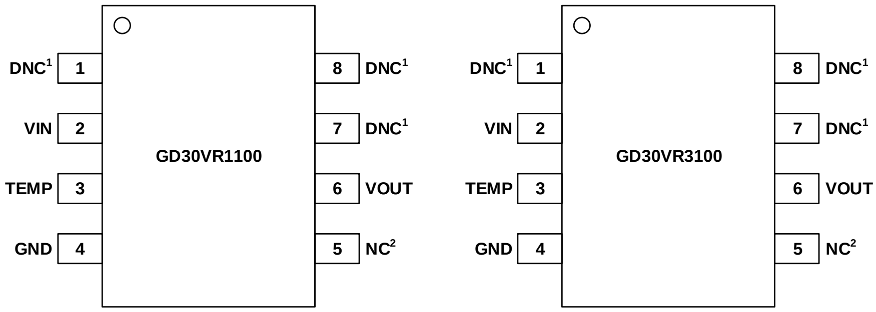
4 Device Overview

4.1 Pinout and Pin Assignment



1. DNC = DO NOT CONNECT.
2. NC = NO INTERNAL CONNECTION.

4.2 Pin Description

PIN NUMBER			PIN TYPE[1]	FUNCTION
NAME	SOP8L	MSOP8L		
DNC	1	1		Do Not Connect
VIN	2	2	P	Supply voltage
TEMP	3	3	O	Temperature monitoring pin. Provides output voltage related to temperature
GND	4	4	G	Ground
NC	5	5		No internal connections
VOUT	6	6	P	Reference voltage output
DNC	7	7		Do Not Connect
DNC	8	8		Do Not Connect

1. O = Output, P = Power, G = Ground.

5 Parameter Information

5.1 Absolute Maximum Ratings

Over free-air operating temperature range (unless otherwise stated)[1].

PARAMETER	MIN	MAX	UNIT
Input voltage (V_{IN})	−0.2	18	V
Output short circuit to ground	0	70	mA
Operating temperature (T_A)	−55	125	°C
Junction Temperature (T_J Max)		150	°C
Storage temperature, T_{stg}	−65	150	°C

1. Stresses exceeding these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only and functional operation of the device at these or any other conditions beyond those specified is not implied.

5.2 Recommended Operation Conditions

PARAMETER	MIN	MAX	UNIT
Input voltage (V_{IN})	V_{OUT} + 0.2	18	V
Output current (I_{OUT})	−10	10	mA

1. Except for GD30VR3100, VIN (min) = 2.7V.

5.3 Electrical Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD\ (HBM)}$	Human Body Model (HBM) , compliant with ANSI / ESDA / JEDEC JS-001[1]	±3000	V
$V_{ESD\ (CDM)}$	Charged Device Model (CDM) , compliant with JEDEC specification JESD22-C101[2]	±1000	V

1. JEDEC Document JEP155 states: 500V HBM Can be realized in standard ESD Safe production under controlled process.
2. JEDEC Document JEP157 states: 250V CDM Can be realized in standard ESD Safe production under controlled process.

5.4 Thermal Resistance

SYMBOL	CONDITIONS	SOP8	MSOP8	UNIT
Θ_{JA}	Junction to ambient thermal resistance	160.9	115	°C/W
Θ_{JB}	Junction to board thermal resistance	82.3	57.1	°C/W
$\Theta_{JC\ (top)}$	Junction to case (top) thermal resistance	53.9	63.4	°C/W
Ψ_{JB}	Junction-to-Board Characterization Parameters	80.7	56.2	°C/W
Ψ_{JT}	Junction to Top Characteristic Parameters	5.1	15.4	°C/W

1. Thermal characteristics are based on simulation, and meet JEDEC document JESD51-7.

5.5 Electrical Characteristics

Unless otherwise noted, at T_A = 25 °C, I_{LOAD} = 0, C_L = 1μF, V_{IN} = (V_{OUT} + 0.2V) to 18V.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
OUTPUT VOLTAGE					
V_{OUT} Output voltage	GD30VRx100-I20 (1) 2.7V<V_{IN}<18V		2.048		V
	GD30VRx100-I25		2.5		
	GD30VRx100-I30		3.0		
	GD30VRx100-I40		4.096		
	GD30VRx100-I45		4.5		
	GD30VRx100-I50		5.0		
Initial accuracy: High grade (GD30VR3100)	All voltage options[1]	−0.05		0.05	%
Initial accuracy: Standard grade (GD30VR1100)	All voltage options[1]	−0.1		0.1	%
NOISE					
Output voltage noise	f = 0.1Hz to 10Hz		1.5		μV_{PP}/V
OUTPUT VOLTAGE TEMPERATURE DRIFT(δVOUT/dT OUTPUT VOLTAGE TEMPERATURE DRIFT)					
High-grade GD30VR3100			1	3	ppm/°C
Standard grade GD30VR1100			3	8	ppm/°C
LINEAR ADJUSTMENT RATE					
δV_O (δV_I) linear adjustment	V_{IN} = (V_{OUT} + 0.2) to 18V[2]		0.7	1	ppm/V
	V = V + 0.2V, T_A = –40°C to 125°C [2]			1	ppm/V
LOAD REGULATION					
δV_O (δIL) Load Regulation	–10mA < I_{LOAD} < 10mA, V_{IN} = V_{OUT} + 0.75V [3]		20	30	ppm/mA
	–10mA < I_{LOAD} < 10mA, V = V + 0.75V, T_A = –40°C to 125°C [3]			50	ppm/mA
SHORT-CIRCUIT CURRENT(When the power supply voltage is higher than 5.5V, do not short circuit the output with the power supply)					
I_{SC} short circuit current	V = 0		60		mA
THERMAL HYSTERESIS					
High-grade GD30VR3100	Cycle 1 , MSOP- 8		50		ppm
Standard grade GD30VR1100	Cycle 1 , MSOP- 8		70		
High-grade GD30VR3100	Cycle 1 , SOP- 8		70		

Electrical Characteristics(Continued)

Unless otherwise noted, at T_A = 25 °C, I_{LOAD} = 0, C_L = 1μF, V_{IN} = (V_{OUT} + 0.2V) to 18V.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Standard grade GD30VR1100	Cycle 1 , SOP- 8		90		ppm
High-grade GD30VR3100	Cycle 2 , MSOP- 8		40		
Standard grade GD30VR1100	Cycle 2 , MSOP- 8		40		
High-grade GD30VR3100	Cycle 2 , SOP- 8		50		ppm
Standard grade GD30VR1100	Cycle 2 , SOP- 8		50		
LONG-TERM STABILITY					
MSOP-8	0 to 1000 hours		50		ppm/1000 hours
MSOP-8	1000 to 2000 hours		25		ppm/1000 hours
SOP-8	0 to 1000 hours		100		ppm/1000 hours
SOP-8	1000 to 2000 hours		50		ppm/1000 hours
TEMP PIN					
Voltage output	At T_A = 25°C		692		mV
Temperature sensitivity	T_A = −40°C to 125°C		2.08		mV/°C
POWER SUPPLY					
Vs supply voltage	See Notes	V_{OUT} + 0.2		18	V
Quiescent Current			0.8	1	mA
	T_A = −40°C to 125°C			1.2	mA
TEMPERATURE RANGE					
Specified range			−40	125	°C
Working scope			−55	125	°C

1. For V_{OUT} ≤ 2.5V, the minimum supply voltage is 2.7V.
2. Except GD30VRx100-I20, its V_{IN} = 3V to 18V.
3. Except GD30VRx100-I20, V_{IN} = 3V.

5.6 Typical Characteristics

Unless otherwise noted, at T_A = 25°C, I_{LOAD} = 0, and V_S = V_{OUT} +0.2V. For V_{OUT}≤2.5V, the minimum supply voltage is 2.7V.

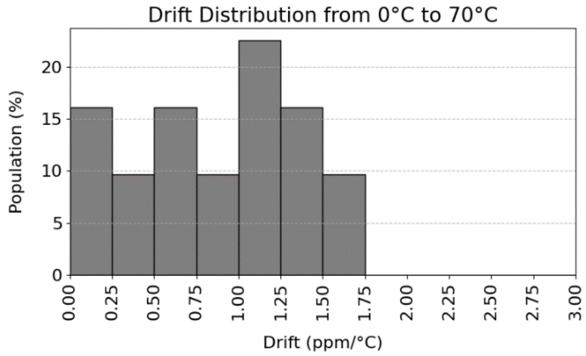


Figure 1. 0°C ~ 70 °C Temperature Drift

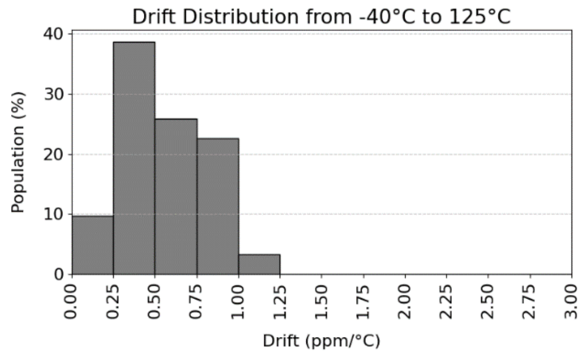


Figure 2. -40°C ~ 125°C Temperature Drift

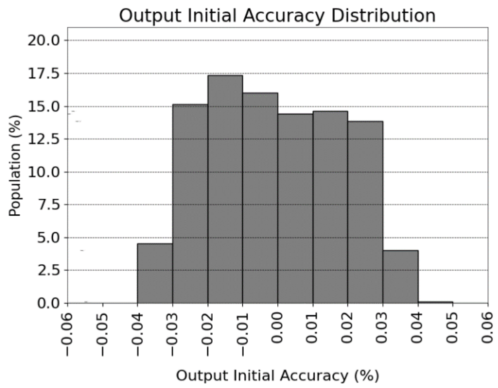


Figure 3. Output Voltage Accuracy

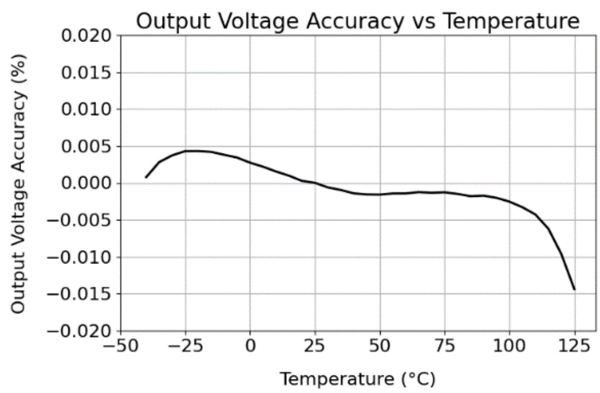


Figure 4. Output Voltage Accuracy vs. Temperature

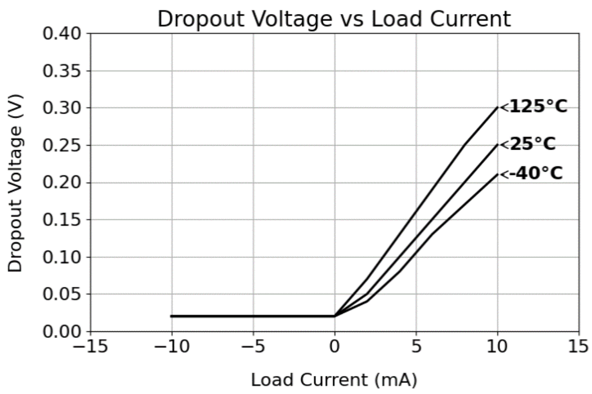


Figure 5. Voltage Drop vs. Load Current

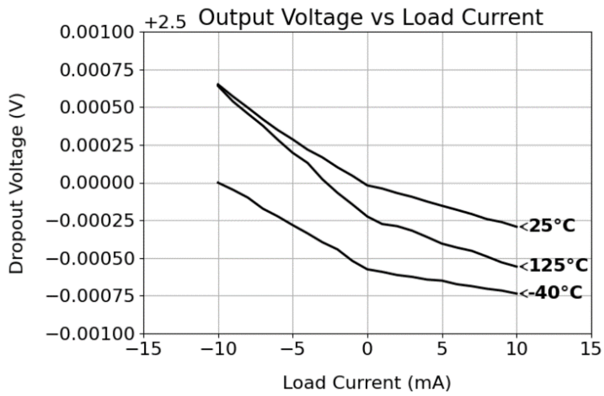


Figure 6. Output Voltage vs. Load Current

Typical Characteristics (Continued)

Unless otherwise noted, at T_A=25°C, I_{LOAD} = 0, and V_S = V_{OUT} +0.2V. For V_{OUT}≤2.5V, the minimum supply voltage is 2.7V.

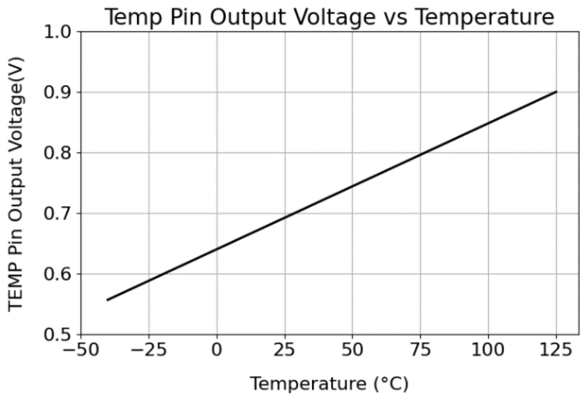


Figure 7. Temp Pin Output Voltage vs. Temperature

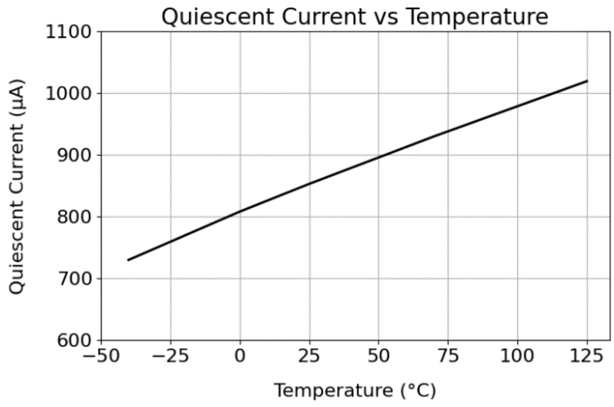


Figure 8. Quiescent Current vs. Temperature

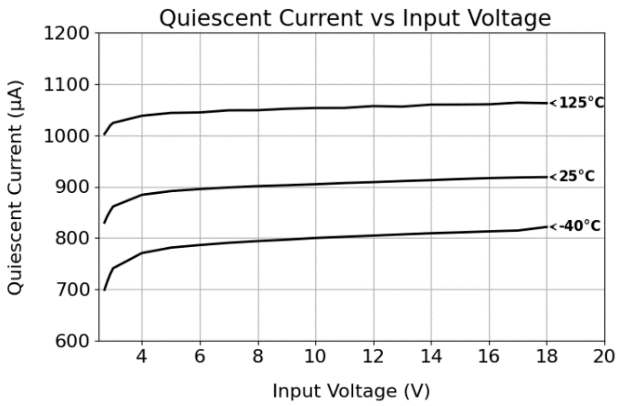


Figure 9. Quiescent Current vs. Input Voltage

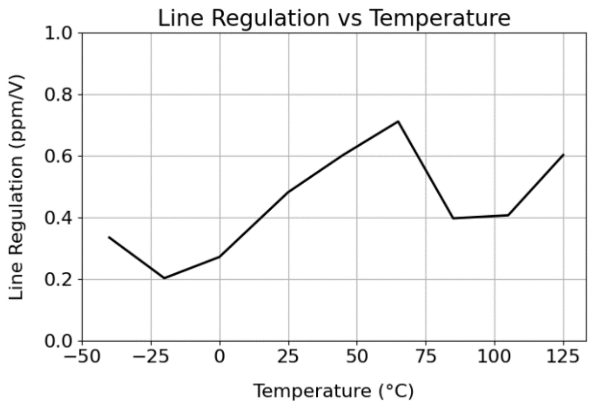


Figure 10. Line Regulation vs. Temperature

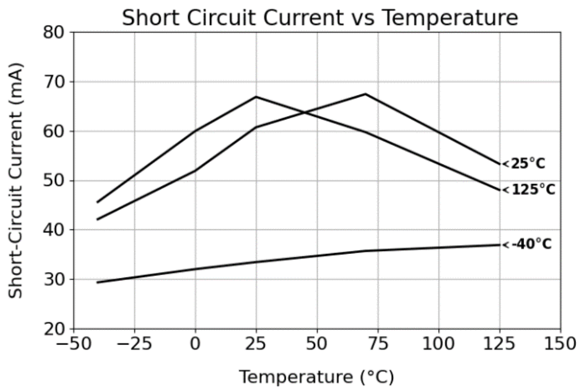


Figure 11. Short-Circuit Current vs. Temperature

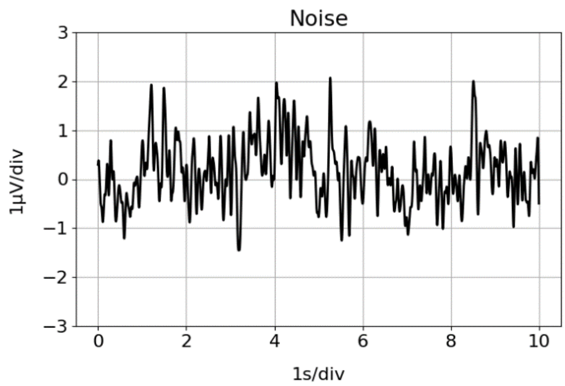


Figure 12. 0.1 Hz to 10 Hz noise

Typical Characteristics (Continued)

Unless otherwise noted, at T_A=25°C, I_{LOAD} = 0, and V_S = V_{OUT} +0.2V. For V_{OUT}≤2.5V, the minimum supply voltage is 2.7V.

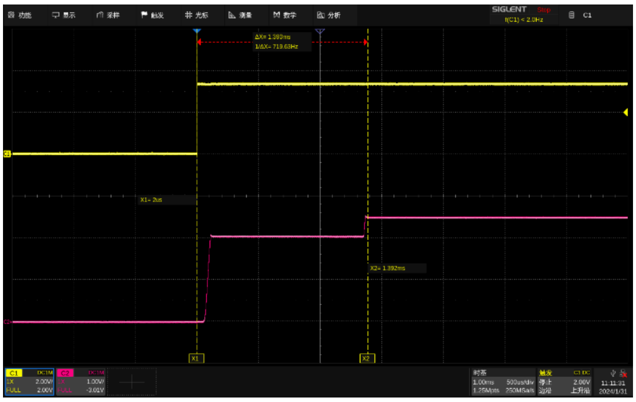


Figure 13. C_L=1uF Power-On

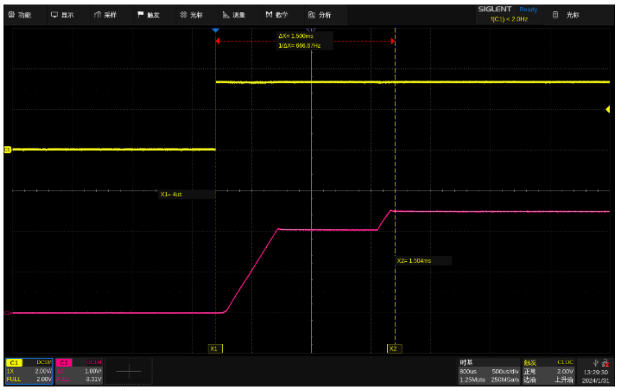


Figure 14. C_L=10uF Power-On

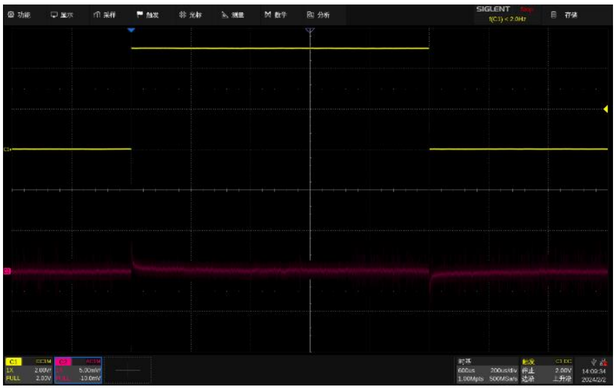


Figure 15. C_L=1uF, I_{OUT} = 1mA Dynamic Load Response

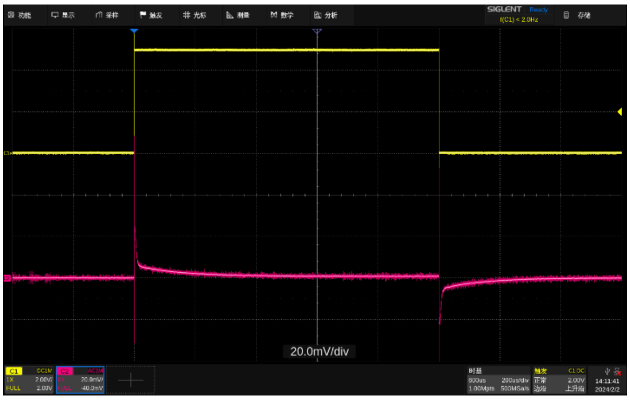


Figure 16. C_L=1uF, I_{OUT} = 10mA Dynamic Load Response

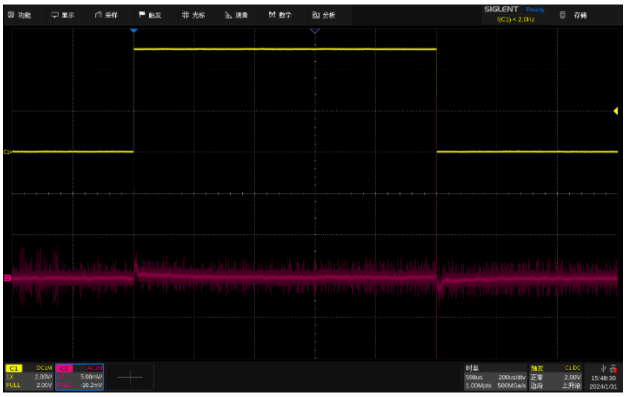


Figure 17. C_L=10uF, I_{OUT} = 1mA Dynamic Load Response

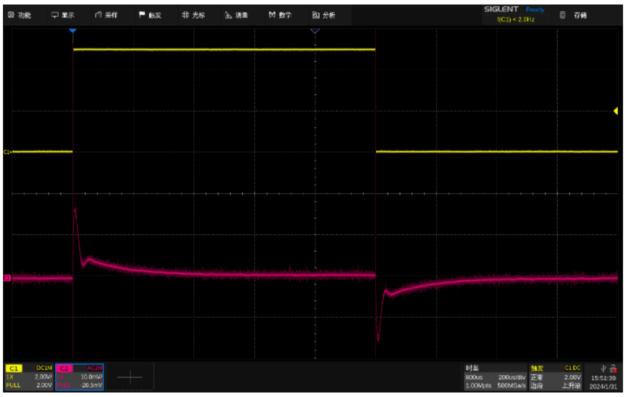


Figure 18. C_L=10uF, I_{OUT} = 10mA Dynamic Load Response

Typical Characteristics (Continued)

Unless otherwise noted, at T_A=25°C, I_{LOAD} = 0, and V_S = V_{OUT} +0.2V. For V_{OUT}≤2.5V, the minimum supply voltage is 2.7V.

Figure 19. C_L=1uF Linear Dynamic Response

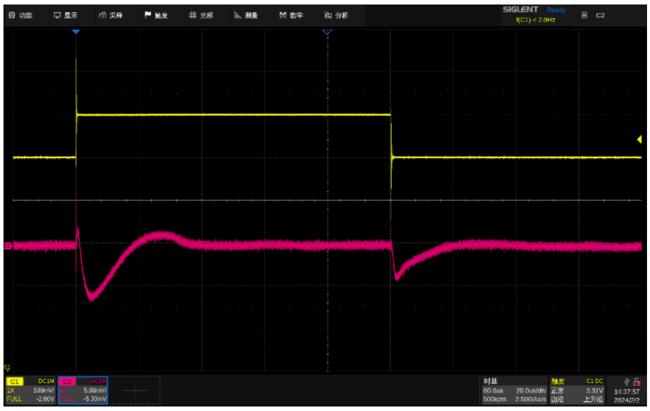


Figure 20. C_L=10uF Linear Dynamic Response

6 Functional Description

6.1 Overview

The GD30VR1100 and GD30VR3100 are a family of low noise, precision bandgap voltage reference products designed for excellent initial voltage accuracy and drift. See the figure below for a simplified block diagram of the GD30VR1100 and GD30VR3100.

6.2 Module Block Diagram

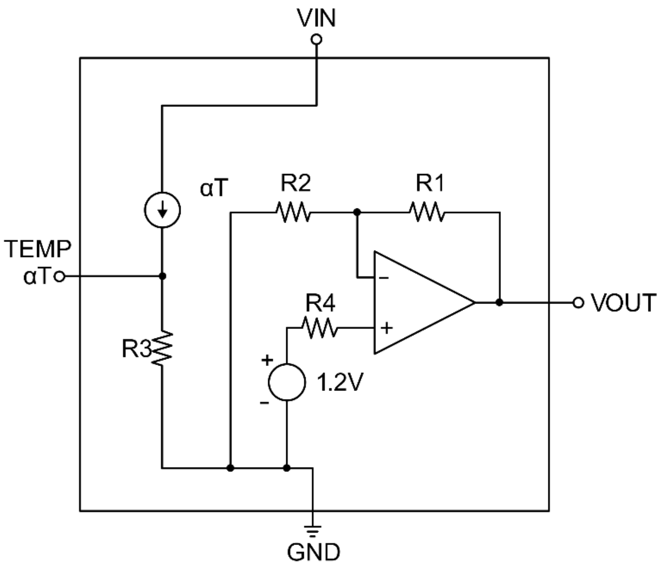


Figure 21. GD30VR1100 and GD30VR3100 Functional Block Diagram

6.3 Features

6.3.1 Overview

6.3.2 Temperature Monitoring

The temperature output terminal (TEMP, Pin 3) provides a temperature-dependent voltage output. As shown in the following figure, the output voltage follows the nominal relationship:

$$V_{TEMP\_PIN} = 668mV + 1.91 \times T(°C) \quad (1)$$

This pin indicates the general die temperature with an accuracy of approximately ±15°C. Although not generally suitable for precise temperature measurements, this pin can be used to indicate temperature changes or for temperature compensation in analog circuits. A 30°C temperature change corresponds to a voltage change of approximately 62mV on the TEMP pin.

TEMP pin has high output impedance. Loading this pin with a low impedance circuit can cause measurement errors; however, this pin has no effect on V_{OUT} accuracy.

To avoid errors caused by low impedance loads, use a suitable low temperature drift op amp to buffer the TEMP pin output as shown in the following figure.

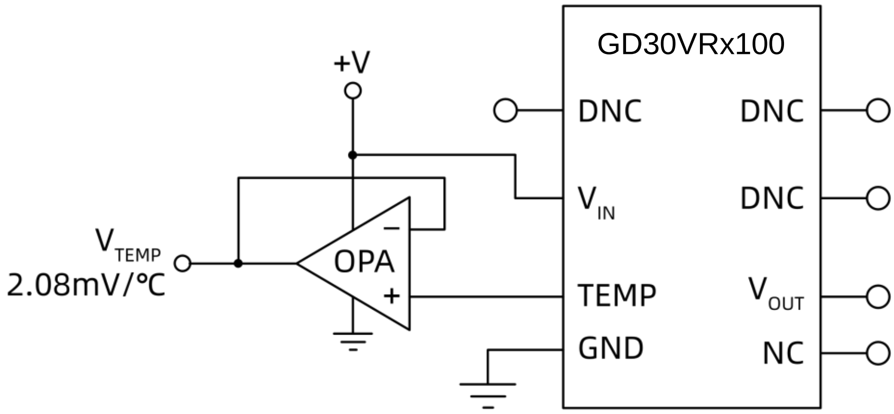


Figure 22. Buffered TEMP Pin Output

6.3.3 Temperature Drift

The GD30VR1100 and GD30VR3100 are designed for minimum drift error, which is defined as the change in output voltage with temperature. The temperature drift is calculated using the logic box method, as described in Equation (2).

$$Drift = \left(\frac{V_{OUTMAX} - V_{OUTMIN}}{V_{OUT} \times TempRange}\right) \times 10^{6} (ppm) \quad (2)$$

The maximum drift coefficient is 3ppm/°C for the high-grade version, GD30VR3100, and 8ppm/°C for the standard grade, GD30VR1100.

6.3.4 Thermal Hysteresis

The GD30VR1100 and GD30VR3100 is defined as the change in output voltage after the device is operated at 25°C, cycled through the specified temperature range, and returned to 25°C. Thermal hysteresis can be expressed as Equation (3):

$$V_{HYST} = \left(\frac{V_{PRE} - V_{POST}}{V_{NOM}}\right) \times 10^{6} (ppm) \quad (3)$$

in:

- V_{HYST} = Thermal hysteresis (in ppm)
- V_{NOM} = Specified output voltage
- V_{PRE} = Output voltage measured during a 25°C warm- up cycle
- V_{POST} = Output voltage measured after the device has cycled through the −40°C to 125°C rated temperature range starting at 25 °C and returning to 25°C

6.3.5 Long-Term Stability

All semiconductor devices experience physical changes in the semiconductor die and packaging materials over time due to aging and environmental effects. These changes, along with the associated package stresses on the die, cause the output voltage in a precision voltage reference to drift over time. The value of this change is specified in the datasheet by a parameter called long-term stability, also known as long-term drift (LTD). Equation (4) shows how to calculate LTD. Note that the LTD value is positive if the output voltage drifts higher over time and negative if the voltage drifts lower over time.

$$LTD(ppm)\,|_{t=n} = \frac{(V_{OUT}\,|_{t=0} - V_{OUT}\,|_{t=n})}{V_{OUT}\,|_{t=0}} \times 10^6 \qquad (4)$$

in:

- $LTD(ppm)|_{t=n}$ = Long-term stability (in ppm)
- $VOUT|_{t=0}$ = Output voltage at time 0 hours
- $VOUT|_{t=n}$ = Output voltage for n hours

6.4 Device Functional Mode

6.4.1 Basic Connections

The following figure shows the typical connections for the GD30VR1100 and GD30VR3100. The recommended power supply bypass capacitor range is 1µF to 10µF. A 1µF to 50µF output capacitor (CL) must be connected from V_{OUT} to GND.

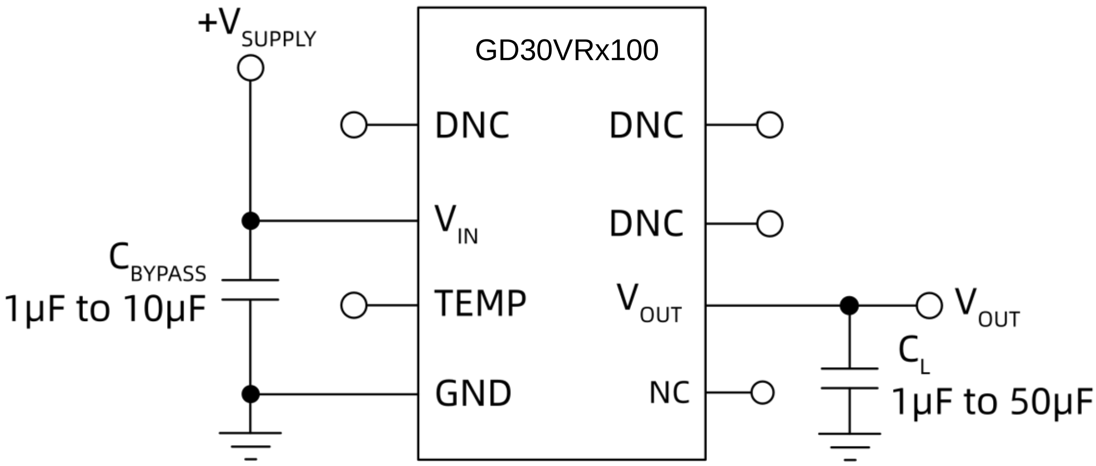


Figure 23. Basic Connections

6.4.2 Supply Voltage

The GD30VR1100 and GD30VR3100 product families have extremely low dropout voltages. Except for the GD30VR1100 and GD30VR3100, which have a minimum power requirement of 2.7V, these references can operate with a power supply that exceeds the output voltage by 200mV under no-load conditions. The figure above provides a typical dropout voltage vs. load graph under loaded conditions.

6.4.3 Negative Reference Voltage

For applications that require both negative and positive reference voltages, the GD30VR1100, GD30VR3100, and OPA can be used to provide a dual supply reference from a 5V supply. The following figure shows the circuit diagram for providing a 2.5V supply reference voltage. GD30VR1100, GD30VR3100. The low drift performance of the GD30VR1100 and GD30VR3100 complements the low offset voltage and zero drift of the OPA, providing an accurate solution for split power applications. Pay attention to matching the temperature coefficients of R1 and R2.

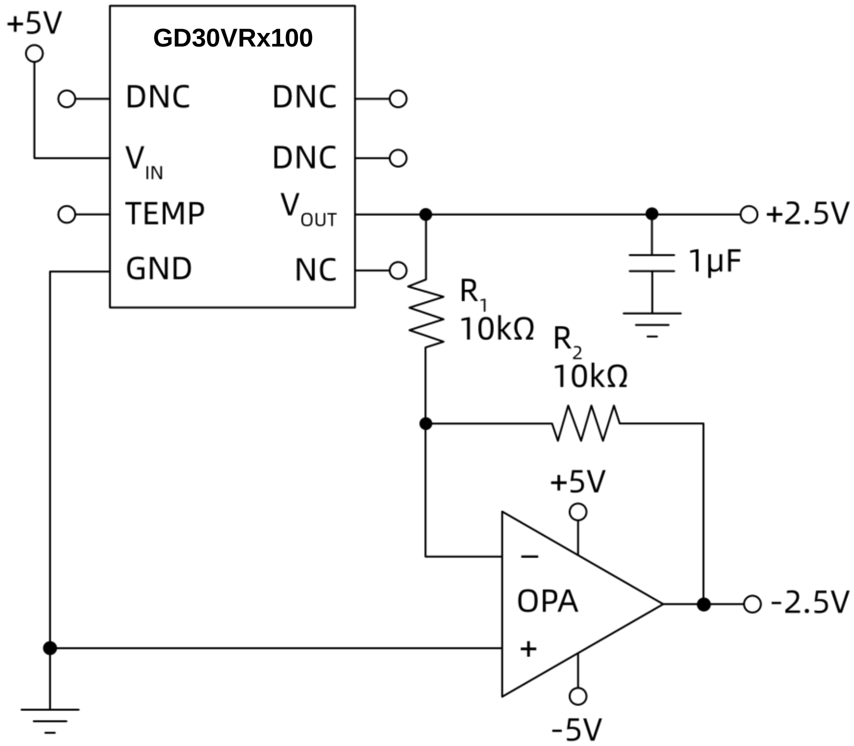


Figure 24. GD30VR1100, GD30VR3100 and OPA Create Positive and Negative Reference Voltages

7 Layout Guides and Example

7.1 Layout Guides

Place the power supply bypass capacitors as close to the power supply and ground pins as possible. The recommended value for this bypass capacitor is 1μF to 10μF. If necessary, additional decoupling capacitors can be added to compensate for noisy or high impedance power supplies.

Must be decoupled with a 1μF to 50μF capacitor. Adding a resistor in series with the output capacitor is optional. For better noise performance, a high-frequency, 1μF capacitor can be placed in parallel between the output and ground to filter the noise and act as a load switch for the data converter.

7.2 Layout Example

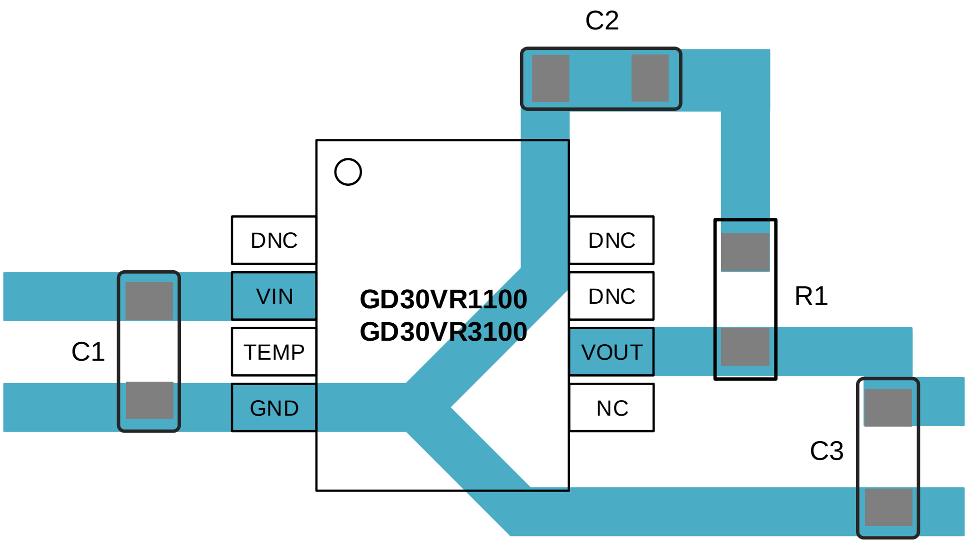


Figure 25. Layout Example

7.3 Power Dissipation

The GD30VR1100 and GD30VR3100 product families provide a current load of ±10mA over the specified input voltage range. The device temperature rises according to Equation (5):

$$T_J = T_A + P_D \times \theta_{JA} \quad (5)$$

in:

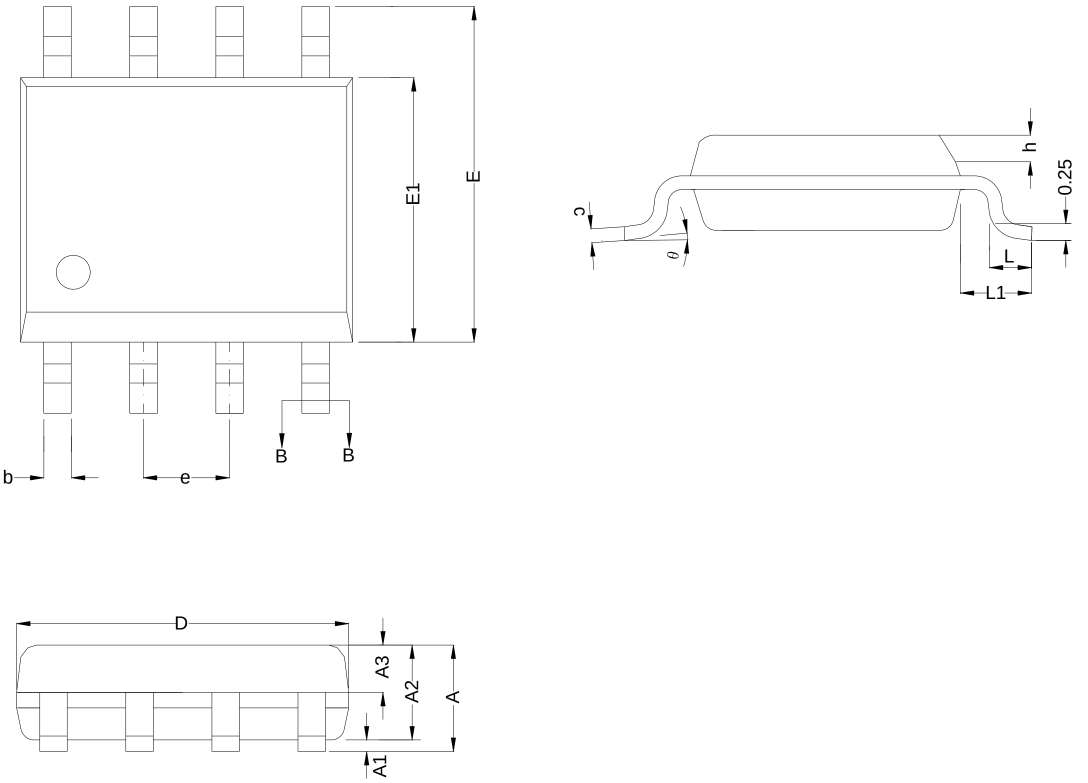
- T_J = Junction temperature (°C)
- T_A = ambient temperature (°C)
- P_D = Power dissipated (W)
- θ_{JA} = junction -to-ambient thermal resistance (°C/W)

The GD30VR3100 junction temperature must not exceed the absolute maximum rated temperature of 150°C.

8 Packaging Information

8.1 Outline Dimensions

SOP-8 Package Outline



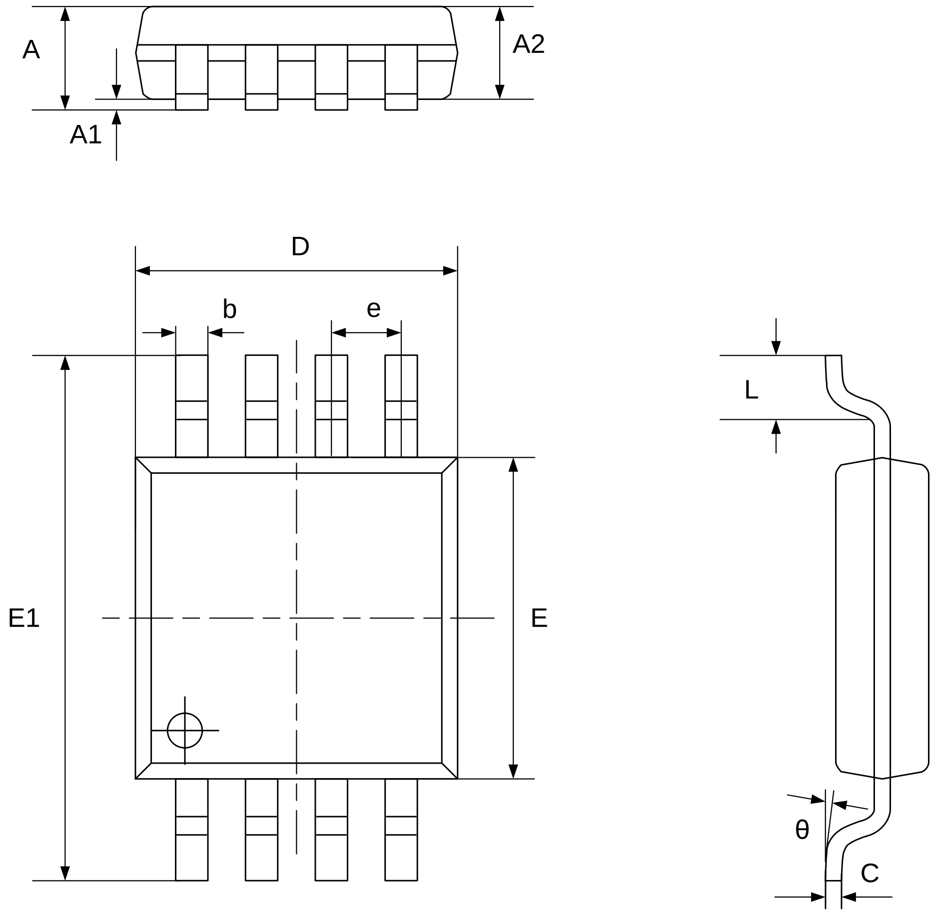
NOTES:

1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to Table 1. *SOP-8 Dimensions (mm)*.

Table 1. SOP-8 Dimensions (mm)

SYMBOL	MIN	MAX
A	1.450	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	4.700	5.100
E	5.800	6.200
E1	3.800	4.000
e	1.270 BSC	
L	0.400	1.270
θ	0°	8°

MSOP-8 Package Outline



NOTES: (Continued)

1. Refer to Table 2. *MSOP-8 Dimensions (mm)*.

Table 2. MSOP-8 Dimensions (mm)

SYMBOL	MIN	MAX
A		1.100
A1	0.020	0.150
A2	0.750	0.950
b	0.250	0.380
c	0.090	0.230
D	2.900	3.100
E	4.750	5.050
E1	2.900	3.100
e	0.650 (BSC)	
L	0.400	0.800
θ	0°	6°

9 Ordering Information

Ordering Code	Output Voltage	Package Type	Packaging Type	MOQ	OP Temp(°C)
GD30VR1100WMTR-I20	2.048V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I20	2.048V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR1100WMTR-I25	2.5V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I25	2.5V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR1100WMTR-I30	3.0V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I30	3.0V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR1100WMTR-I40	4.096V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I40	4.096V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR1100WMTR-I45	4.5V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I45	4.5V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR1100WMTR-I50	5.0V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR1100WGTR-I50	5.0V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I20	2.048V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I20	2.048V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I25	2.5V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I25	2.5V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I30	3.0V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I30	3.0V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I40	4.096V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I40	4.096V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I45	4.5V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I45	4.5V	SOP8	Tape & Reel	2000	−40°C to +125°C
GD30VR3100WMTR-I50	5.0V	MSOP8	Tape & Reel	3000	−40°C to +125°C
GD30VR3100WGTR-I50	5.0V	SOP8	Tape & Reel	2000	−40°C to +125°C

10 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024

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