Low Noise Micropower 2.5 V and 4.096 V Precision Voltage References

ADR291/ADR292

FEATURES

Supply range
2.8 V to 15 V, ADR291
4.4 V to 15 V, ADR292
Supply current: 15 µA maximum
Low noise: 8 µV and 12 µV p-p (0.1 Hz to 10 Hz)
High output current: 5 mA
Temperature range: −40°C to +125°C
Pin-compatible with REF02/REF19x

APPLICATIONS

Portable instrumentation
Precision reference for 3 V and 5 V systems
Analog-to-digital and digital-to-analog converter reference
Solar-powered applications
Loop-current-powered instruments

CONNECTION DIAGRAMS

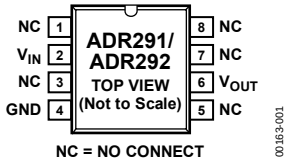

Figure 1. 8-Lead SOIC (R-8)

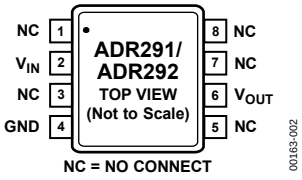

Figure 2. 8-Lead TSSOP (RU-8)

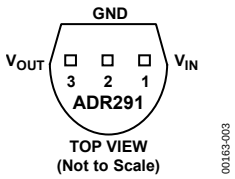

Figure 3. 3-Lead TO-92 (T-3)

GENERAL DESCRIPTION

The ADR291 and ADR292 are low noise, micropower precision voltage references that use an XFET® reference circuit. The new XFET architecture offers significant performance improvements over traditional band gap and buried Zener-based references. Improvements include one quarter the voltage noise output of band gap references operating at the same current, very low and ultralinear temperature drift, low thermal hysteresis, and excellent long-term stability.

The ADR291/ADR292 family is a series of voltage references providing stable and accurate output voltages from supplies as low as 2.8 V for the ADR291. Output voltage options are 2.5 V and 4.096 V for the ADR291 and ADR292, respectively.

Quiescent current is only 12 µA, making these devices ideal for battery-powered instrumentation. Three electrical grades are available offering initial output accuracies of ±2 mV, ±3 mV, and ±6 mV maximum for the ADR291, and ±3 mV, ±4 mV, and ±6 mV maximum for the ADR292. Temperature coefficients for the three grades are 8 ppm/°C, 15 ppm/°C, and 25 ppm/°C maximum, respectively. Line regulation and load regulation are typically 30 ppm/V and 30 ppm/mA, maintaining the reference's overall high performance. For a device with 5.0 V output, refer to the ADR293 data sheet.

The ADR291 and ADR292 references are specified over the extended industrial temperature range of −40°C to +125°C. Devices are available in the 8-lead SOIC, 8-lead TSSOP, and 3-lead TO-92 packages.

Table 1. ADR291/ADR292 Product

Part No.	Output Voltage (V)	Initial Accuracy (±%)	Temperature Coefficient (ppm/°C) Max
ADR291	2.500	0.08, 0.12, 0.24	8, 15, 25
ADR292	4.096	0.07, 0.10, 0.15	8, 15, 25

SPECIFICATIONS

ADR291 ELECTRICAL SPECIFICATIONS

V_S = 3.0 V to 15 V, T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
E GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	2.498	2.500	2.502	V
Initial Accuracy	V_{OERR}		−2		+2	mV
			−0.08		+0.08	%
F GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	2.497	2.500	2.503	V
Initial Accuracy	V_{OERR}		−3		+3	mV
			−0.12		+0.12	%
G GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	2.494	2.500	2.506	V
Initial Accuracy	V_{OERR}		−6		+6	mV
			−0.24		+0.24	%
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	I_{OUT} = 0 mA		30	100	ppm/V
G Grade				40	125	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		30	100	ppm/mA
G Grade				40	125	ppm/mA
LONG-TERM STABILITY	ΔV_{OUT}	After 1000 hours of operation @ 125°C		50		ppm
NOISE VOLTAGE	e_N	0.1 Hz to 10 Hz		8		µV p-p
WIDEBAND NOISE DENSITY	e_N	@ 1 kHz		480		nV/√Hz

V_S = 3.0 V to 15 V, T_A = −25°C to +85°C, unless otherwise noted.

Table 3.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
TEMPERATURE COEFFICIENT						
E Grade	TCV_{OUT}	I_{OUT} = 0 mA		3	8	ppm/°C
F Grade				5	15	ppm/°C
G Grade				10	25	ppm/°C
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	I_{OUT} = 0 mA		35	125	ppm/V
G Grade				50	150	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		20	125	ppm/mA
G Grade				30	150	ppm/mA

V_S = 3.0 V to 15 V, T_A = −40°C to+125°C, unless otherwise noted.

Table 4.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
TEMPERATURE COEFFICIENT						
E Grade	TCV_{OUT}	I_{OUT} = 0 mA		3	10	ppm/°C
F Grade				5	20	ppm/°C
G Grade				10	30	ppm/°C
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	I_{OUT} = 0 mA		40	200	ppm/V
G Grade				70	250	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		20	200	ppm/mA
G Grade				30	300	ppm/mA
SUPPLY CURRENT	I_S	T_A = 25°C		9	12	µA
		−40°C ≤ T_A ≤ +125°C		12	15	µA
THERMAL HYSTERESIS	$V_{OUT-HYS}$	8-lead SOIC, 8-lead TSSOP		50		ppm

ADR292 ELECTRICAL SPECIFICATIONS

V_S = 5 V to 15 V, T_A = 25°C, unless otherwise noted.

Table 5.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
E GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	4.093	4.096	4.099	V
Initial Accuracy	V_{OERR}		−3		+3	mV
			−0.07		+0.07	%
F GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	4.092	4.096	4.1	V
Initial Accuracy	V_{OERR}		−4		+4	mV
			−0.10		+0.10	%
G GRADE						
Output Voltage	V_{OUT}	I_{OUT} = 0 mA	4.090	4.096	4.102	V
Initial Accuracy	V_{OERR}		−6		+6	mV
			−0.15		+0.15	%
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	V_S = 4.5 V to 15 V, I_{OUT} = 0 mA		30	100	ppm/V
G Grade				40	125	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		30	100	ppm/mA
G Grade				40	125	ppm/mA
LONG-TERM STABILITY	ΔV_{OUT}	After 1000 hours of operation @ 125°C		50		ppm
NOISE VOLTAGE	e_N	0.1 Hz to 10 Hz		12		µV p-p
WIDEBAND NOISE DENSITY	e_N	@ 1 kHz		640		nV/√Hz

V_S = 5 V to 15 V, T_A = −25°C to +85°C, unless otherwise noted.

Table 6.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
TEMPERATURE COEFFICIENT						
E Grade	TCV_{OUT}	I_{OUT} = 0 mA		3	8	ppm/°C
F Grade				5	15	ppm/°C
G Grade				10	25	ppm/°C
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	V_S = 4.5 V to 15 V, I_{OUT} = 0 mA		35	125	ppm/V
G Grade				50	150	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		20	125	ppm/mA
G Grade				30	150	ppm/mA

V_S = 5 V to 15 V, T_A = −40°C to +125°C, unless otherwise noted.

Table 7.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
TEMPERATURE COEFFICIENT						
E Grade	TCV_{OUT}	I_{OUT} = 0 mA		3	10	ppm/°C
F Grade				5	20	ppm/°C
G Grade				10	30	ppm/°C
LINE REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta V_{IN}$	V_S = 4.5 V to 15 V, I_{OUT} = 0 mA		40	200	ppm/V
G Grade				70	250	ppm/V
LOAD REGULATION						
E/F Grades	$\Delta V_{OUT}/\Delta I_{LOAD}$	V_S = 5.0 V, I_{OUT} = 0 mA to 5 mA		20	200	ppm/mA
G Grade				30	300	ppm/mA
SUPPLY CURRENT	I_S	T_A = 25°C		10	15	µA
		−40°C ≤ T_A ≤ +125°C		12	18	µA
THERMAL HYSTERESIS	$V_{OUT-HYS}$	8-lead SOIC, 8-lead TSSOP		50		ppm

ABSOLUTE MAXIMUM RATINGS

Remove power before inserting or removing units from their sockets.

Table 8.

Parameter	Rating
Supply Voltage	18 V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	
T, R, RU Packages	−65°C to +150°C
Operating Temperature Range	
ADR291/ADR292	−40°C to +125°C
Junction Temperature Range	
T, R, RU Packages	−65°C to +125°C
Lead Temperature (Soldering, 60 sec)	300°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 9. Package Types

Package Type	θ_{JA}[1]	θ_{JC}	Unit
8-Lead SOIC (R)	158	43	°C/W
8-Lead TSSOP (RU)	240	43	°C/W
3-Lead TO-92 (T)	160	–	°C/W

[1] θ_{JA} is specified for worst-case conditions. For example, θ_{JA} is specified for a device in socket testing. In practice, θ_{JA} is specified for a device soldered in the circuit board.

Table 10. Other XFET Products

Part Number	Nominal Output Voltage (V)	Package Type
ADR420	2.048	8-Lead MSOP/SOIC
ADR421	2.50	8-Lead MSOP/SOIC
ADR423	3.0	8-Lead MSOP/SOIC
ADR425	5.0	8-Lead MSOP/SOIC

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

OUTLINE DIMENSIONS

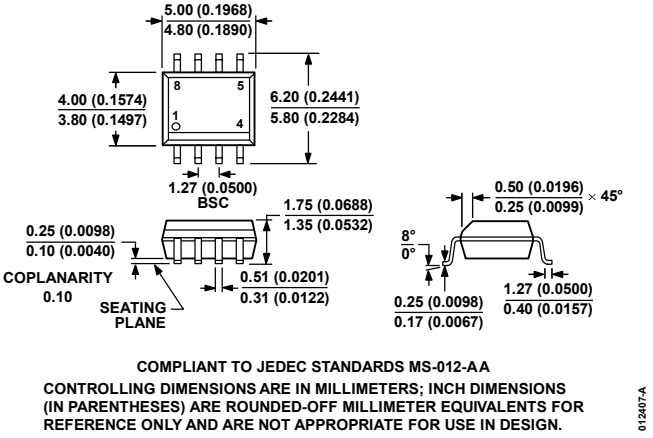

Figure 39. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)
Dimensions shown in millimeters and (inches)

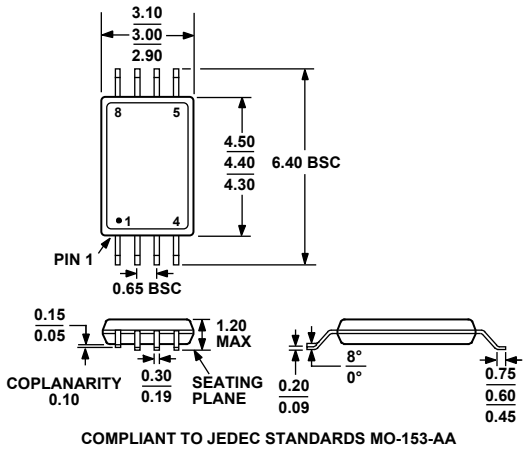

Figure 40. 8-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-8)
Dimensions shown in millimeters

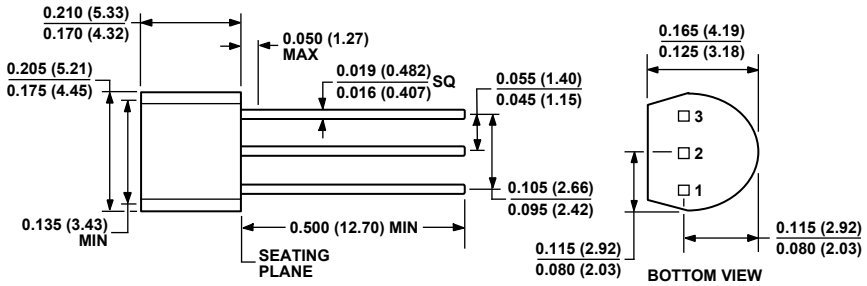

Figure 41. 3-Lead Plastic Header-Style Package [TO-92]
(T-3)
Dimensions shown in inches and (millimeters)

ORDERING GUIDE

Model	Output Voltage	Initial Accuracy (±%)	Temperature Coefficient Max (ppm/°C)	Package Description	Package Option	Ordering Quantity
ADR291ER	2.50	0.08	8	8-Lead SOIC_N	R-8	98
ADR291ER-REEL7	2.50	0.08	8	8-Lead SOIC_N	R-8	1,000
ADR291ERZ[1]	2.50	0.08	8	8-Lead SOIC_N	R-8	98
ADR291ERZ-REEL7[1]	2.50	0.08	8	8-Lead SOIC_N	R-8	1,000
ADR291FR	2.50	0.12	15	8-Lead SOIC_N	R-8	98
ADR291FR-REEL	2.50	0.12	15	8-Lead SOIC_N	R-8	2,500
ADR291FR-REEL7	2.50	0.12	15	8-Lead SOIC_N	R-8	1,000
ADR291FRZ[1]	2.50	0.12	15	8-Lead SOIC_N	R-8	98
ADR291FRZ-REEL[1]	2.50	0.12	15	8-Lead SOIC_N	R-8	2,500
ADR291FRZ-REEL7[1]	2.50	0.12	15	8-Lead SOIC_N	R-8	1,000
ADR291GR	2.50	0.24	25	8-Lead SOIC_N	R-8	98
ADR291GR-REEL	2.50	0.24	25	8-Lead SOIC_N	R-8	2,500
ADR291GR-REEL7	2.50	0.24	25	8-Lead SOIC_N	R-8	1,000
ADR291GRZ[1]	2.50	0.24	25	8-Lead SOIC_N	R-8	98
ADR291GRZ-REEL[1]	2.50	0.24	25	8-Lead SOIC_N	R-8	2,500
ADR291GRZ-REEL7[1]	2.50	0.24	25	8-Lead SOIC_N	R-8	1,000
ADR291GRU	2.50	0.24	25	8-Lead TSSOP	RU-8	98
ADR291GRU-REEL7	2.50	0.24	25	8-Lead TSSOP	RU-8	1,000
ADR291GRUZ[1]	2.50	0.24	25	8-Lead TSSOP	RU-8	98
ADR291GRUZ-REEL[1]	2.50	0.24	25	8-Lead TSSOP	RU-8	1,000
ADR291GRUZ-REEL7[1]	2.50	0.24	25	8-Lead TSSOP	RU-8	1,000
ADR291GT9	2.50	0.24	25	3-Lead TO-92	T-3	98
ADR291GT9-REEL	2.50	0.24	25	3-Lead TO-92	T-3	2,000
ADR291GT9Z[1]	2.50	0.24	25	3-Lead TO-92	T-3	98
ADR292ER	4.096	0.07	8	8-Lead SOIC_N	R-8	98
ADR292ER-REEL	4.096	0.07	8	8-Lead SOIC_N	R-8	2,500
ADR292ERZ[1]	4.096	0.07	8	8-Lead SOIC_N	R-8	98
ADR292ERZ-REEL[1]	4.096	0.07	8	8-Lead SOIC_N	R-8	2,500
ADR292FR	4.096	0.10	15	8-Lead SOIC_N	R-8	98
ADR292FR-REEL	4.096	0.10	15	8-Lead SOIC_N	R-8	2,500
ADR292FR-REEL7	4.096	0.10	15	8-Lead SOIC_N	R-8	1,000
ADR292FRZ[1]	4.096	0.10	15	8-Lead SOIC_N	R-8	98
ADR292FRZ-REEL[1]	4.096	0.10	15	8-Lead SOIC_N	R-8	2,500
ADR292FRZ-REEL7[1]	4.096	0.10	15	8-Lead SOIC_N	R-8	1,000
ADR292GR	4.096	0.15	25	8-Lead SOIC_N	R-8	98
ADR292GR-REEL7	4.096	0.15	25	8-Lead SOIC_N	R-8	1,000
ADR292GRZ[1]	4.096	0.15	25	8-Lead SOIC_N	R-8	98
ADR292GRZ-REEL7[1]	4.096	0.15	25	8-Lead SOIC_N	R-8	1,000
ADR292GRU	4.096	0.24	25	8-Lead TSSOP	RU-8	98
ADR292GRU-REEL7	4.096	0.15	25	8-Lead TSSOP	RU-8	1,000
ADR292GRUZ[1]	4.096	0.24	25	8-Lead TSSOP	RU-8	98
ADR292GRUZ-REEL7[1]	4.096	0.15	25	8-Lead TSSOP	RU-8	1,000

[1] Z = RoHS Compliant Part.