Micro-Power, Zero-Drift, Rail-to-Rail Out Instrumentation Amplifier

1 FEATURES

- **Low Offset Voltage: 35µV (MAX), G ≥ 100**
- **Low Drift: 0.25µV/°C, G ≥ 100**
- **Low Noise: 50nV/$\sqrt{\mathrm{Hz}}$, G ≥ 100**
- **High CMRR: 110dB (TYP)**
- **Low Input Bias Current: 100pA (TYP)**
- **Supply Range: 1.8V to 5.5V**
- **Input Voltage: (V-) + 0.1V to (V+) - 0.1V**
- **Low Quiescent Current: 78µA**
- **RFI Filtered Inputs**
- **Operating Temperature: -40°C to 125°C**
- **Micro SIZE PACKAGES: MSOP8**

2 APPLICATIONS

- **Bridge Amplifiers**
- **ECG Amplifiers**
- **Pressure Sensors**
- **Medical Instrumentation**
- **Portable Instrumentation**
- **Weigh Scales**
- **Thermocouple Amplifiers**
- **RTD Sensor Amplifiers**
- **Data Acquisition**

3 DESCRIPTIONS

The RS333 device is a low-power, precision instrumentation amplifier offering excellent accuracy. The versatile 3-operational amplifier design, small size, and low power make it ideal for a wide range of portable applications.

A single external resistor sets any gain from 1 to 1000. The RS333 is designed to use an industry standard gain equation: G = 1 + (100 kΩ / R_G).

The RS333 device provides very low offset voltage (35µV, G≥100), excellent offset voltage drift (0.25µV/°C, G≥100), and high common-mode rejection (110 dB at G ≥ 10). It operates with power supplies as low as 1.8V (±0.9V) and quiescent current is only 78µA, making it ideal for battery operated systems. Using autocalibration techniques to ensure excellent precision over the extended industrial temperature range, the RS333 device also offers exceptionally low noise density (50nV/ $\sqrt{\mathrm{Hz}}$) that extends down to DC.

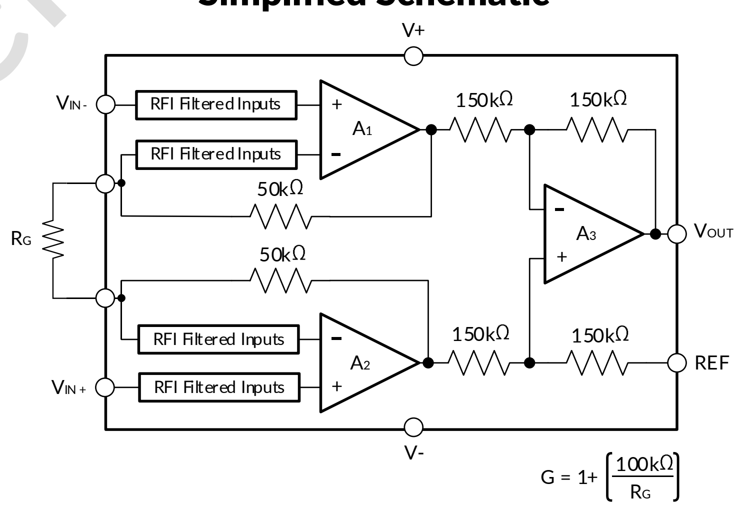
The RS333 device is available in the MSOP8 package. It operates over an ambient temperature range of −40°C to 125°C.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS333	MSOP8	3.00mm×3.00mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



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4 REVISION HISTORY

Note: Page numbers for previous revisions may different from page numbers in the current version.

Version	Change Date	Change Item
A.0	2025/10/14	Preliminary version completed
A.0.1	2026/07/29	Update Electrical Characteristics

5 PACKAGE/ORDERING INFORMATION (1)

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING (2)	MSL (3)	PACKAGE OPTION
RS333	RS333XM	-40°C ~125°C	MSOP8	RS333	MSL1	Tape and Reel,4000

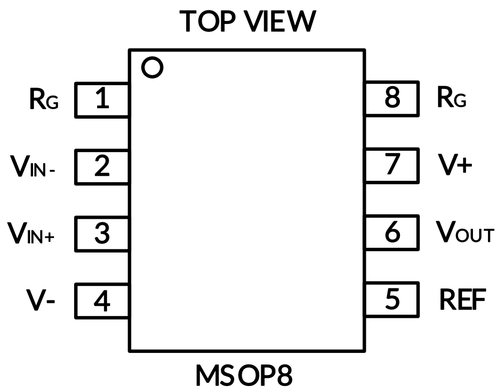
NOTE:

(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

(3) RUNIC classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with RUNIC if your end application is quite critical to the preconditioning setting or if you have special requirement.

6 PIN CONFIGURATION AND FUNCTIONS (TOP VIEW)



Pin Description

NAME	PIN	I/O (1)	DESCRIPTION
	MSOP8		
R_G	1,8	-	Gain setting pins. For gains greater than 1, place a gain resistor between pins 1 and 8.
V_{IN-}	2	I	Negative input
V_{IN+}	3	I	Positive input
V-	4	-	Negative (lowest) power supply
REF	5	I	Reference input. This pin must be driven by low impedance or connected to ground.
V_{OUT}	6	O	Output
V+	7	-	Positive (highest) power supply

(1) I = Input, O = Output.

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

			MIN	MAX	UNIT
Voltage	Supply Voltage			7	V
	Analog input voltage (2)		(V-)-0.3	(V+)+0.3	
Current	Output short-circuit (3)		Continuous		
θ_{JA}	Package thermal impedance (4)	MSOP8		170	°C/W
Temperature	Operating range, T_A		-40	150	°C
	Junction, T_J (5)			150	
	Storage, T_{stg}		-65	150	

(1) Stresses above 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.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less.
(3) Short-circuit to ground, one amplifier per package.
(4) The package thermal impedance is calculated in accordance with JESD-51.
(5) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), JESD22-a114	±2000	V
		Charged-device model (CDM), ANSI/ESDA/JEDEC JS-002-2022	±1500	

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage	Single-supply	1.8		5.5	V
	Dual-supply	±0.9		±2.75	
Operating temperature		-40		125	°C

7.4 Electrical Characteristics

At T_A = 25°C, Vs= 5.5V, V_{CM}=Vs/2, V_{REF} = V_S/2, R_L = 10kΩ, and G = 1, unless otherwise noted. (1)

PARAMETER		TEST CONDITIONS	MIN(2)	TYP(3)	MAX(2)	UNIT
INPUT (4)						
V_{OS}	Offset Voltage	At RTI (5)		±10 ±25/G	±35 ±95/G	µV
		At RTI, T_A=-40°C to 125°C		±0.25 ±0.15/G		µV/°C
PSRR	Power-Supply Rejection Ratio	G=1		±5		µV/V
		G=10		±4	±10	
		G=100		±4	±10	
		G=1000		±4	±10	
Z_{id}	Differential Input Impedance			70 || 6		GΩ || pF
Z_{ic}	Common-Mode Input Impedance			70 || 9.5		
V_{CM}	Common-Mode Voltage Range	The input signal common-mode range can be calculated with this tool	(V-)+0.1		(V+)-0.1	V
CMRR	Common-Mode Rejection Ratio	G=1, V_{CM}=(V-)+0.1V to (V+)-0.1V	80	90		dB
		G=10, V_{CM}=(V-)+0.1V to (V+)-0.1V	100	110		
		G=100, V_{CM}=(V-)+0.1V to (V+)-0.1V	100	115		
		G=1000, V_{CM}=(V-)+0.1V to (V+)-0.1V	100	115		
INPUT BIAS CURRENT						
I_{IB}	Input Bias Current			±100	±300	pA
		T_A=-40°C to 125°C		See Figure 14		pA/°C
I_{OS}	Input Offset Current			±100	±300	pA
		T_A=-40°C to 125°C		See Figure 16		pA/°C
INPUT VOLTAGE NOISE						
e_{NI}	Input Voltage Noise	G=100, RS = 0Ω, f = 1kHz		50		nV/$\sqrt{Hz}$
		G=10, RS = 0Ω, f = 0.1 Hz to 10 Hz		2.2		$µV_{PP}$
		G=100, RS = 0Ω, f = 0.1 Hz to 10 Hz		1.8		$µV_{PP}$
GAIN						
G	Gain Equation			1 + (100kΩ/R_G)		V/V
	Gain Range		1		1000	V/V
E_G	Gain Error (6)	G=1, (V-)+0.1V ≤ V_O ≤ (V+)-0.1V		±0.01%	±0.05%	
		G=10, (V-)+0.1V ≤ V_O ≤ (V+)-0.1V		±0.05%	±0.25%	
		G=100, (V-)+0.1V ≤ V_O ≤ (V+)-0.1V		±0.1%	±0.25%	
		G=1000, (V-)+0.1V ≤ V_O ≤ (V+)-0.1V		±0.25%	±0.5%	
	Gain Versus Temperature	G=1, T_A=-40°C to 125°C		1	5	ppm/°C
		G>1, T_A=-40°C to 125°C		25	50	
	Gain Nonlinearity	G=1 to 100, (V-)+0.1V ≤ V_O ≤ (V+)-0.1V		20		ppm
OUTPUT						
V_{OH}	Output Voltage Swing from Positive Rail	Io = 1mA		90	180	mV
V_{OL}	Output Voltage Swing from Negative Rail (7)	Io = -1mA		25	50	mV
	Capacitive Load Drive			1		nF

I_{SC}	Short-Circuit Current		SOURCE	6	12		mA
			SINK	30	65		mA
FREQUENCY RESPONSE							
BW	Bandwidth, −3dB		G = 1		125		kHz
			G = 10		30		
			G = 100		3		
			G = 1000		0.3		
SR	Slew Rate		G = 1, V_S = 5V, V_O = 4V step		0.13		V/µs
			G = 100, V_S = 5V, V_O = 4V step		0.03		
t_S	Settling Time	To 0.01%	G = 1, V_S = 5V, V_{STEP} =4V		50		µs
			G = 100, V_S = 5V, V_{STEP} =4V		400		
	Overload recovery		G=10, 50% overdrive		25		µs
REFERENCE INPUT							
R_{IN}	Input Impedance				300		kΩ
	Voltage Range			V-		V+	V
POWER SUPPLY							
	Voltage Range	Single		1.8		5.5	V
		Dual		±0.9		±2.75	
I_Q	Quiescent Current		V_{IN} = V_S / 2		78	120	µA
			T_A = −40°C to 125°C			130	
TEMPERATURE RANGE							
	Operating Temperature Range			-40		125	°C

NOTE:

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(4) Total V_{OS}, referred-to-input = (V_{OSI}) + (V_{OSO} / G).
(5) RTI = Referred-to-input.
(6) Does not include effects of external resistor R_G.
(7) See Typical Characteristics curves, Output Voltage Swing vs Output Current (Figure 17).

7.5 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_L = 10kΩ, V_{REF}=mid-supply, and G=1, unless otherwise noted.

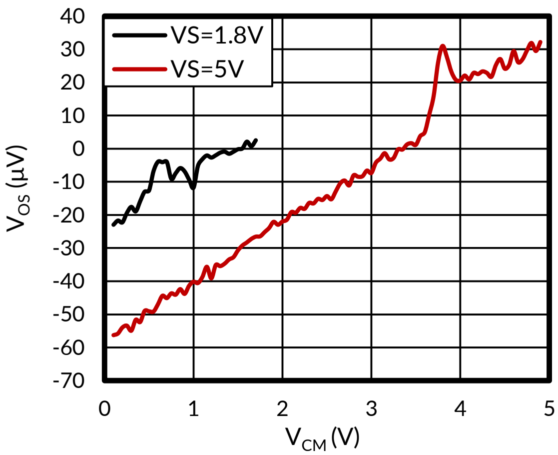


Figure 1. Offset Voltage vs Common-Mode Voltage

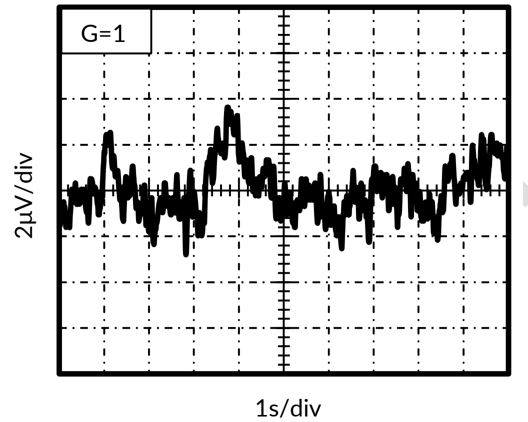


Figure 2. 0.1Hz to 10Hz Input Voltage Noise

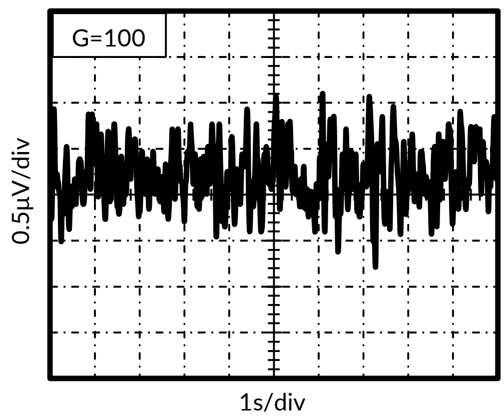


Figure 3. 0.1Hz to 10Hz Input Voltage Noise

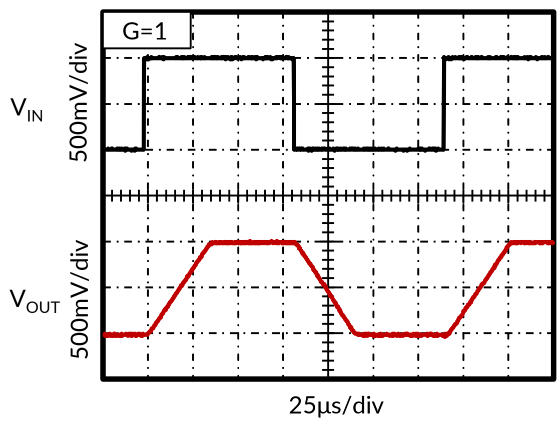


Figure 4. Large-Signal Step Response

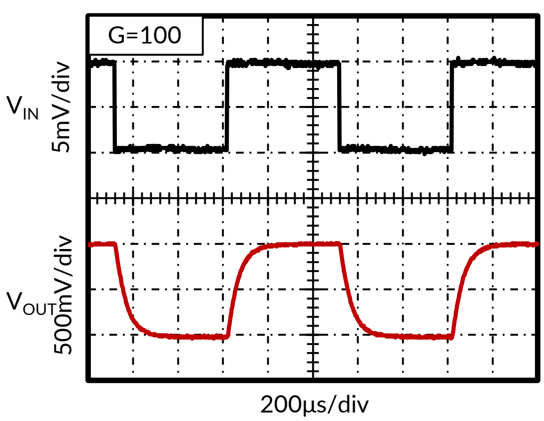


Figure 5. Large-Signal Step Response

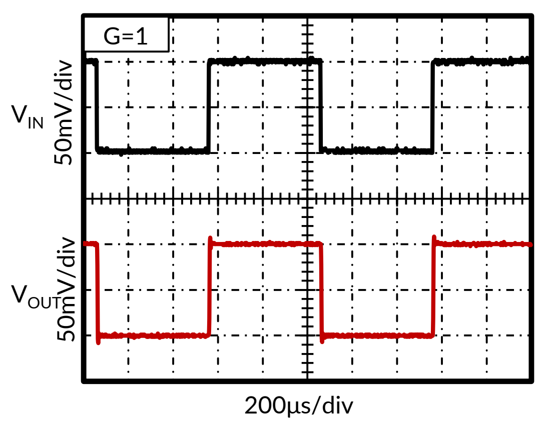


Figure 6. Small-Signal Step Response

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.
At T_A = +25°C, V_S=5V, R_L = 10kΩ, V_{REF}=mid-supply, and G=1, unless otherwise noted.

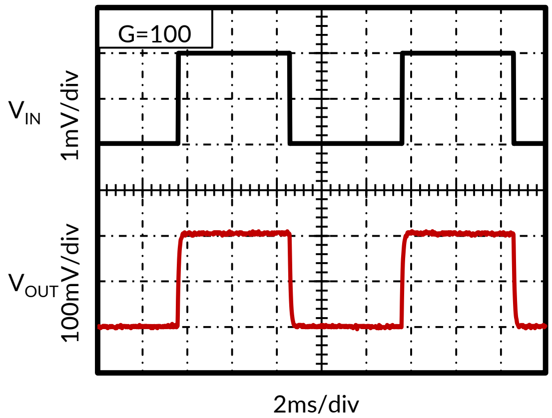


Figure 7. Small-Signal Step Response

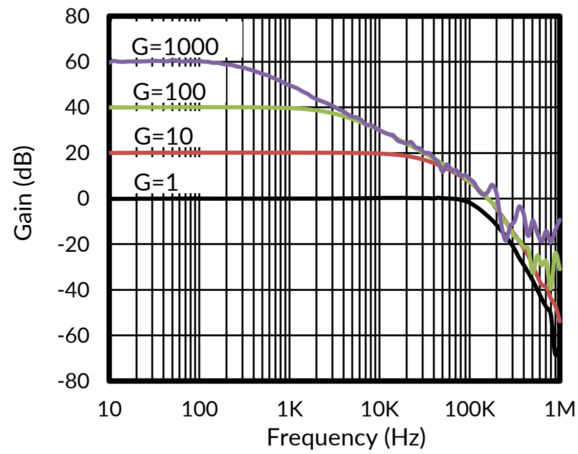


Figure 8. Gain vs Frequency

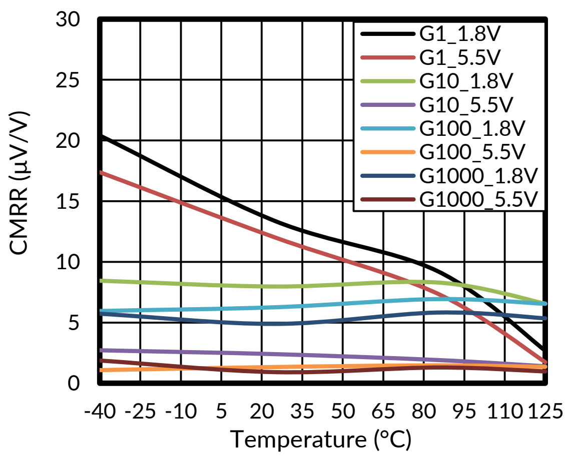


Figure 9. Common-Mode Rejection Ratio vs Temperature

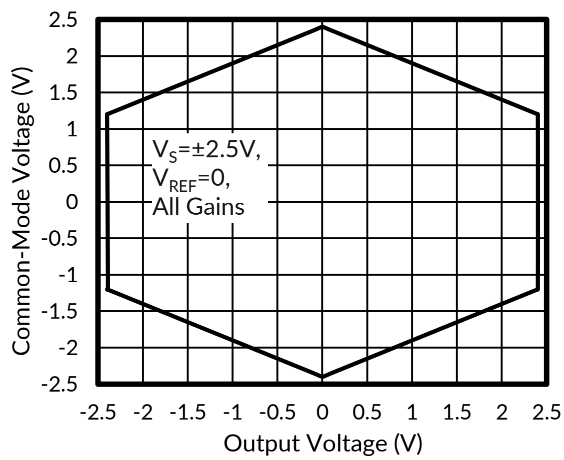


Figure 10. Typical Common-Mode Range vs Output Voltage

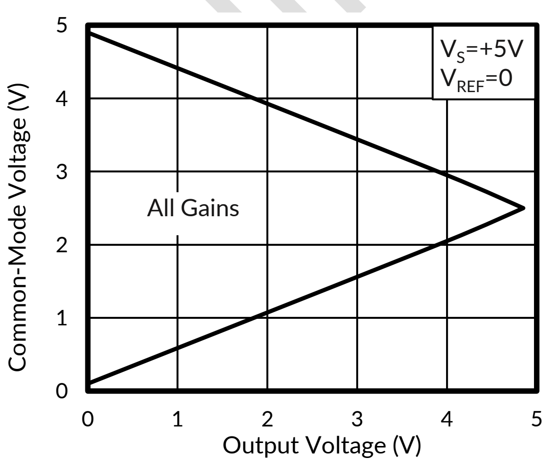


Figure 11. Typical Common-Mode Range vs Output Voltage

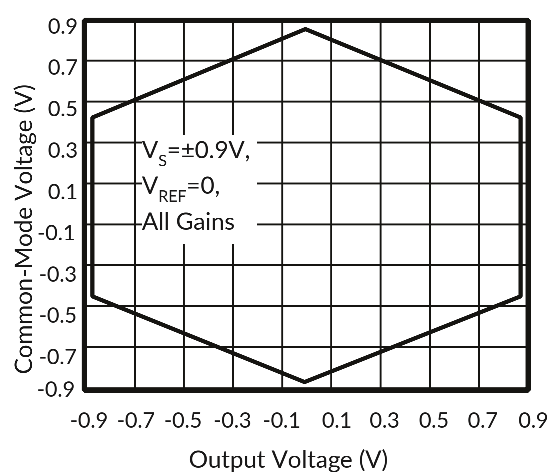


Figure 12. Typical Common-Mode Range vs Output Voltage

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_L = 10kΩ, V_{REF}=mid-supply, and G=1, unless otherwise noted.

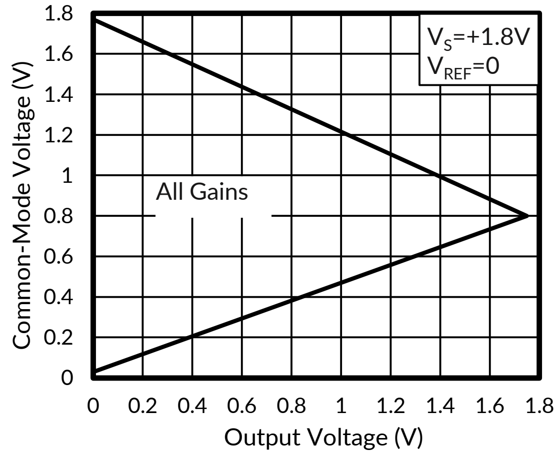


Figure 13. Typical Common-Mode Range vs Output Voltage

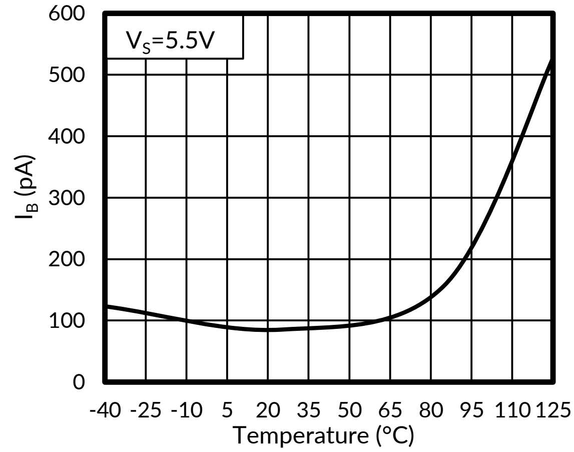


Figure 14. Input Bias Current vs Temperature

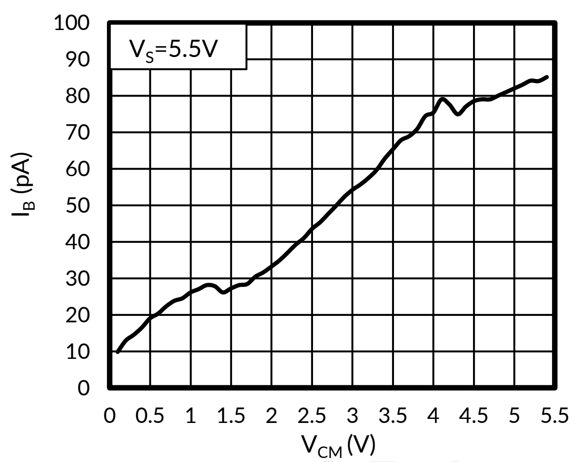


Figure 15. Input Bias Current vs Common-Mode Voltage

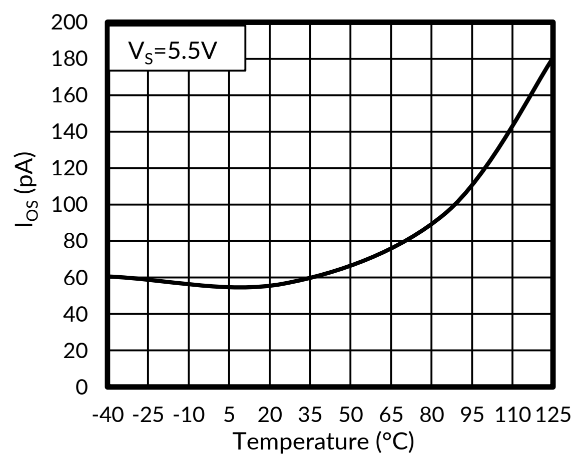


Figure 16. Input Offset Current vs Temperature

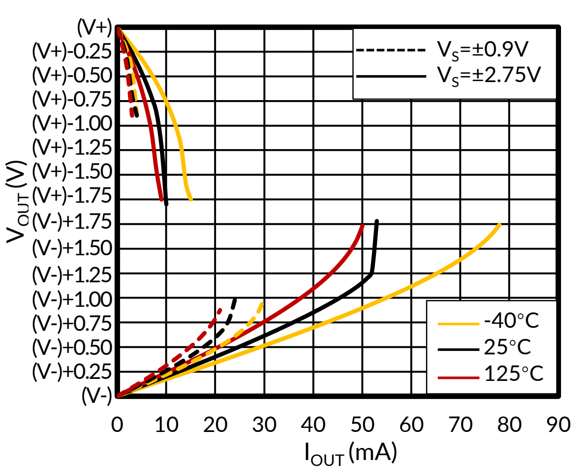


Figure 17. Output Voltage Swing vs Output Current

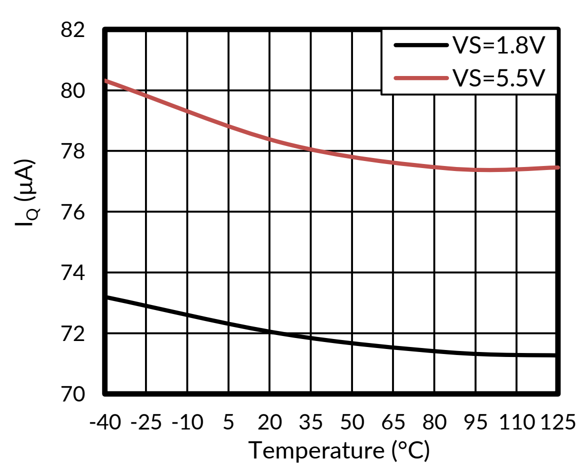


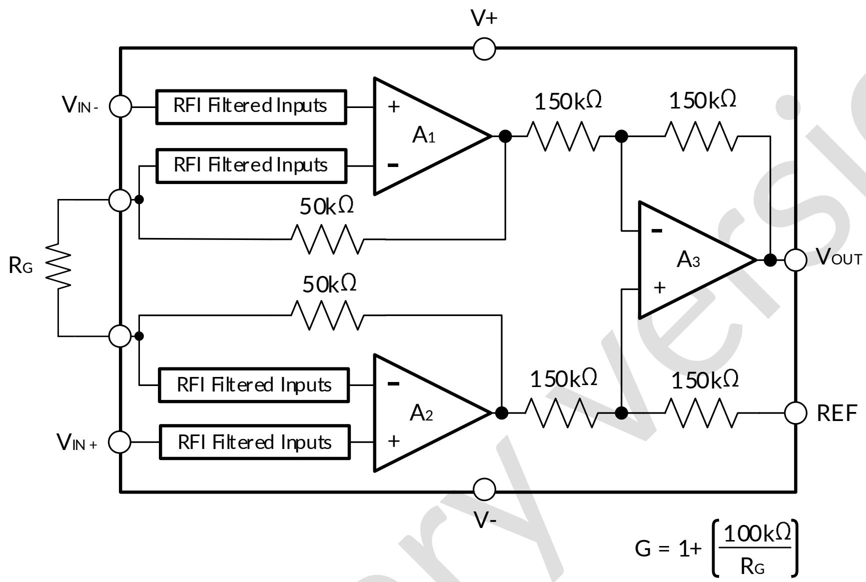
Figure 18. Quiescent current vs Temperature

8 DETAILED DESCRIPTION

8.1 Overview

The RS333 is a monolithic instrumentation amplifier (INA) based on the precision zero-drift operational amplifier core. The RS333 also integrates laser-trimmed resistors to ensure excellent common-mode rejection and low gain error. The combination of the zero-drift amplifier core and the precision resistors allows this device to achieve outstanding DC precision and makes the RS333 ideal for many 3.3V and 5V industrial applications.

8.2 Functional Block Diagram



8.3 Feature Description

The RS333 is a low-power, zero-drift instrumentation amplifier offering excellent accuracy. The versatile three operational-amplifier design and small size make the amplifiers ideal for a wide range of applications. Zero-drift chopper circuitry provides excellent DC specifications. A single external resistor sets any gain from 1 to 10,000. The RS333 is laser trimmed for very high common-mode rejection (110dB at G =10). This device operates with power supplies as low as 1.8V, and quiescent current of 78uA, typically.

8.4 Device Functional Modes

8.4.1 Internal Offset Correction

RS333 internal operational amplifiers use an auto-calibration technique with a time-continuous 350kHz operational amplifier in the signal path. The amplifier is zero-corrected every 8 µs using a proprietary technique. Upon power up, the amplifier requires approximately 100µs to achieve specified V_{OS} accuracy. This design has no aliasing or flicker noise.

8.4.2 Input Common-Mode Range

The linear input voltage range of the input circuitry of the RS333 is from approximately 0.1V below the positive supply voltage to 0.1V above the negative supply. As a differential input voltage causes the output voltage to increase, however, the linear input range is limited by the output voltage swing of amplifiers A1 and A2. Thus, the linear common-mode input range is related to the output voltage of the complete amplifier. This behavior also depends on supply voltage.

Input overload conditions can produce an output voltage that appears normal. For example, if an input overload condition drives both input amplifiers to the respective positive output swing limit, the difference voltage measured by the output amplifier is near zero. The output of the RS333 is near 0 V even though both inputs are overloaded.

9 APPLICATION AND IMPLEMENTATION

Information in the following applications sections is not part of the RUNIC component specification, and RUNIC does not warrant its accuracy or completeness. RUNIC's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The RS333 measures small differential voltage with high common-mode voltage developed between the noninverting and inverting input. The high input impedance makes the RS333 suitable for a wide range of applications. The ability to set the reference pin to adjust the functionality of the output signal offers additional flexibility that is practical for multiple configurations.

9.2 Typical Application

Figure 19 shows the basic connections required for operation of the RS333 device. Good layout practice mandates the use of bypass capacitors placed close to the device pins as shown.

The output of the RS333 device is referred to the output reference (REF) pin, which is normally grounded. This connection must be low-impedance to assure good common-mode rejection. Although 15Ω or less of stray resistance can be tolerated while maintaining specified CMRR, small stray resistances of tens of Ωs in series with the REF pin can cause noticeable degradation in CMRR.

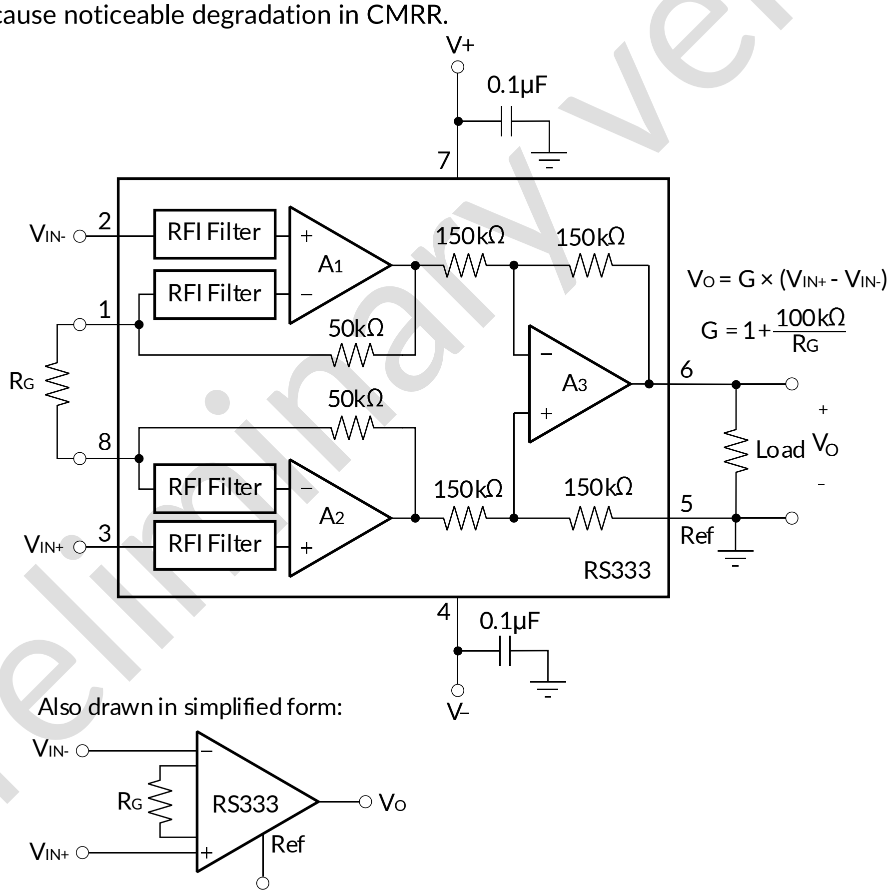


Figure 19. Basic Connections

9.2.1 Design Requirements

The device can be configured to monitor the input differential voltage when the gain of the input signal is set by the external resistor RG. The output signal references to the Ref pin. The most common application is where the output is referenced to ground when no input signal is present by connecting the Ref pin to ground. When the input signal increases, the output voltage at the OUT pin increases, too.

9.2.2 Detailed Design Procedure

9.2.2.1 Setting the Gain

Gain of the RS333 device is set by a single external resistor, R_G, connected between pins 1 and 8. The value of R_G is selected according to Equation 1:

$$G = 1 + (100\ k\Omega\ /\ R_G) \tag{1}$$

Table 1 lists several commonly-used gains and resistor values. The 100kΩ in Equation 1 comes from the sum of the two internal feedback resistors of A_1 and A_2. These on-chip resistors are laser trimmed to accurate absolute values. The accuracy and temperature coefficient of these resistors are included in the gain accuracy and drift specifications of the RS333 device.

The stability and temperature drift of the external gain setting resistor, R_G, also affects gain. The contribution of R_G to gain accuracy and drift can be directly inferred from the gain Equation 1. Low resistor values required for high gain can make wiring resistance important. Sockets add to the wiring resistance and contribute additional gain error (possibly an unstable gain error) in gains of approximately 100 or greater. To ensure stability, avoid parasitic capacitance of more than a few picofarads at the R_G connections. Careful matching of any parasitics on both R_G pins maintains optimal CMRR over frequency.

Table 1. Commonly-Used Gains and Resistor Values

DESIRED GAIN	R_G (Ω)	NEAREST 1% R_G (Ω)
1	NC (1)	NC
2	100k	100k
5	25k	24.9k
10	11.1k	11k
20	5.26k	5.23k
50	2.04k	2.05k
100	1.01k	1k
200	502.5	499
500	200.4	200
1000	100.1	100

(1) NC denotes no connection. When using the SPICE model, the simulation will not converge unless a resistor is connected to the R_G pins; use a very large resistor value.

9.2.2.2 Internal Offset Correction

RS333 internal operational amplifiers use an auto-calibration technique with a time-continuous 350kHz operational amplifier in the signal path. The amplifier is zero-corrected ever 8µs using a proprietary technique. Upon power up, the amplifier requires approximately 100µs to achieve specified V_{OS} accuracy. This design has no aliasing or flicker noise.

9.2.2.3 Offset Trimming

Most applications require no external offset adjustment; however, if necessary, adjustments can be made by applying a voltage to the REF pin. Figure 20 shows an optional circuit for trimming the output offset voltage. The voltage applied to REF pin is summed at the output. The operational amplifier buffer provides low impedance at the REF pin to preserve good common-mode rejection.

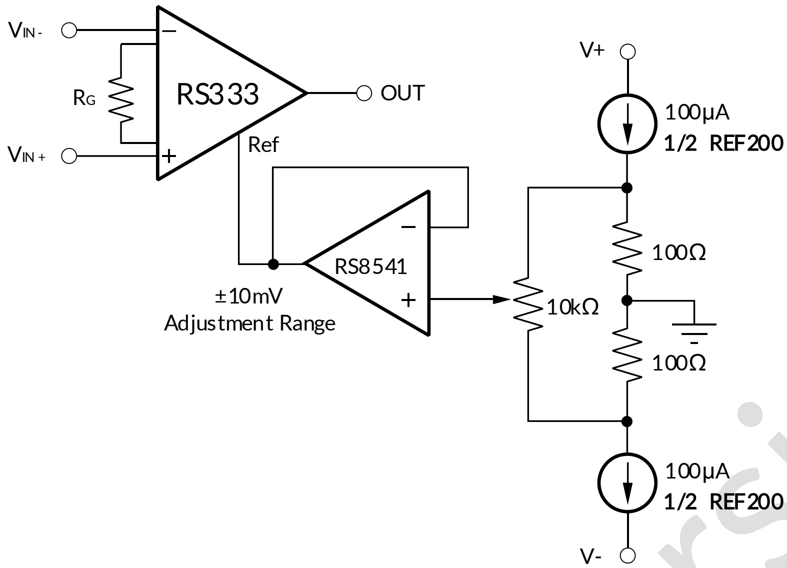


Figure 20. Optional Trimming of Output Offset Voltage

9.2.2.4 Noise Performance

The auto-calibration technique used by the RS333 device results in reduced low frequency noise, typically only 50nV/$\sqrt{\text{Hz}}$, (G = 100). Low frequency noise of the RS333 device is approximately 1.8µV_{PP} measured from 0.1Hz to 10Hz, (G = 100).

9.2.2.5 Input Bias Current Return Path

The input impedance of the RS333 device is extremely high-approximately 100GΩ. However, a path must be provided for the input bias current of both inputs. This input bias current is typically ±100pA. High input impedance means that this input bias current changes very little with varying input voltage.
Input circuitry must provide a path for this input bias current for proper operation. Figure 21 shows various provisions for an input bias current path. Without a bias current path, the inputs float to a potential that exceeds the common-mode range of the RS333 device, and the input amplifiers will saturate. If the differential source resistance is low, the bias current return path can be connected to one input (see the thermocouple example in Figure 21). With higher source impedance, using two equal resistors provides a balanced input with possible advantages of lower input offset voltage as a result of bias current and better high-frequency common-mode rejection.

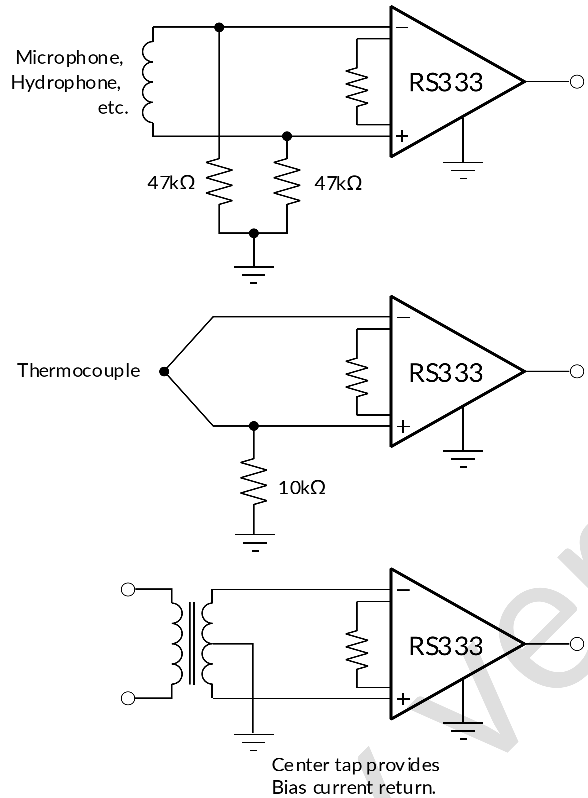


Figure 21. Providing an Input Common-Mode Current Path

9.2.2.6 Input Common-Mode Range

The linear input voltage range of the input circuitry of the RS333 is from approximately 0.1V below the positive supply voltage to 0.1V above the negative supply. As a differential input voltage causes the output voltage to increase, however, the linear input range is limited by the output voltage swing of amplifiers A_1 and A_2. Thus, the linear common-mode input range is related to the output voltage of the complete amplifier. This behavior also depends on supply voltage.

Input overload conditions can produce an output voltage that appears normal. For example, if an input overload condition drives both input amplifiers to the respective positive output swing limit, the difference voltage measured by the output amplifier is near zero. The output of the RS333 is near 0V even though both inputs are overloaded.

9.2.2.7 Operating Voltage

The RS333 operates over a power-supply range of 1.8V to 5.5V (±0.9V to ±2.75V). Supply voltages higher than 7V (absolute maximum) can permanently damage the device.

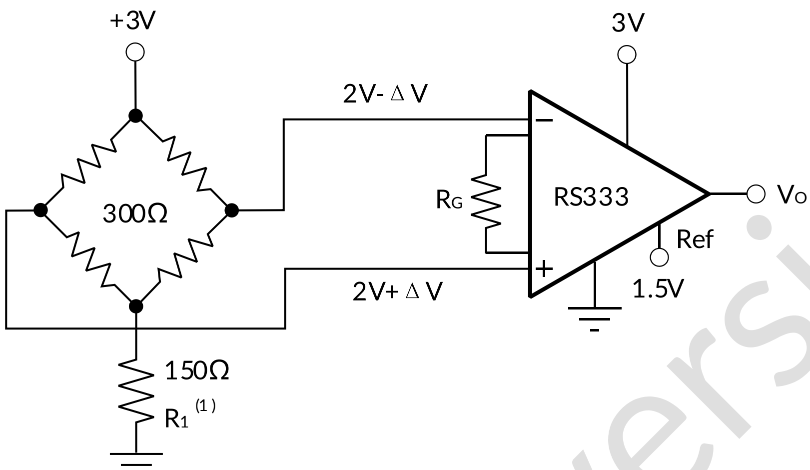
9.2.2.8 Low Voltage Operation

The RS333 device can be operated on power supplies as low as ±0.9V. Most parameters vary only slightly throughout this supply voltage range. Operation at very low supply voltage requires careful attention to assure that the input voltages remain within the linear range. Voltage swing requirements of internal nodes limit the input common-mode range with low power-supply voltage.

9.2.2.9 Single-Supply Operation

The RS333 device can be used on single power supplies of 1.8V to 5.5V. Figure 22 shows a basic single supply circuit. The output REF pin is connected to mid-supply. Zero differential input voltage demands an output voltage of mid-supply. Actual output voltage swing is limited to approximately 50mV more than ground, when the load is referred to ground as shown.

With single-supply operation, V_{IN-} and V_{IN+} must both be 0.1V more than ground for linear operation. For instance, the inverting input cannot be connected to ground to measure a voltage connected to the noninverting input.
To show the issues affecting low voltage operation, consider the circuit in Figure 22. It shows the RS333 device operating from a single 3V supply. A resistor in series with the low side of the bridge assures that the bridge output voltage is within the common-mode range of the amplifier inputs.



(1) R_1 creates proper common-mode voltage, only for low-voltage operation—see Single-Supply Operation.

Figure 22. Single-Supply Bridge Amplifier

9.2.2.10 Input Protection

The input pins of the RS333 device are protected with internal diodes connected to the power-supply rails. These diodes clamp the applied signal to prevent it from damaging the input circuitry. If the input signal voltage can exceed the power supplies by more than 0.3V, the input signal current should be limited to less than 10mA to protect the internal clamp diodes. This current limiting can generally be done with a series input resistor. Some signal sources are inherently current-limited and do not require limiting resistors.

10 POWER SUPPLY RECOMMENDATIONS

The minimum power supply voltage for RS333 is 1.8V and the maximum power supply voltage is 5.5V. For optimum performance, 3.3V to 5V is recommended. Recommends adding a bypass capacitor at the input to compensate for the layout and power supply source impedance.

11 LAYOUT

11.1 Layout Guidelines

Attention to good layout practices is always recommended. Keep traces short and, when possible, use a printed-circuit-board (PCB) ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1μF bypass capacitor closely across the supply pins. These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the electromagnetic interference (EMI) susceptibility.

Instrumentation amplifiers vary in the susceptibility to radio-frequency interference (RFI). RFI can generally be identified as a variation in offset voltage or DC signal levels with changes in the interfering RF signal. The RS333 device has been specifically designed to minimize susceptibility to RFI by incorporating passive RC filters with an 8MHz corner frequency at the V_{IN-} and V_{IN+} inputs. As a result, the RS333 device demonstrates remarkably low sensitivity compared to previous generation devices. Strong RF fields may continue to cause varying offset levels, however, and may require additional shielding.

11.2 Layout Example

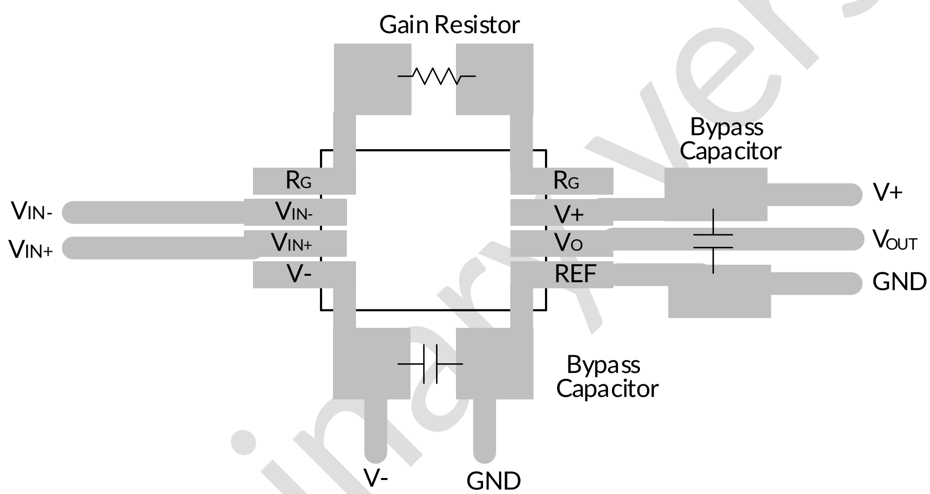
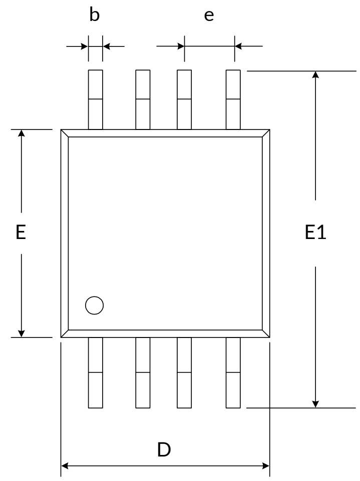
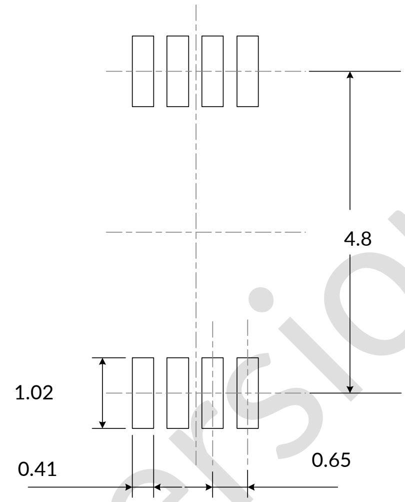


Figure 23. RS333 Layout

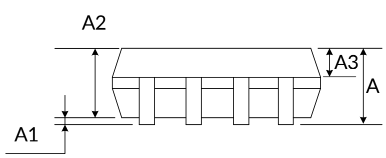
12 PACKAGE OUTLINE DIMENSIONS

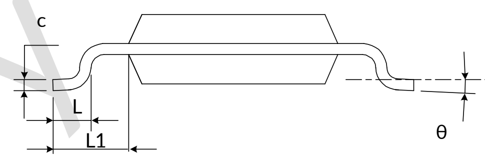
MSOP8 (4)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.750	0.950	0.030	0.037
A3	0.300	0.400	0.012	0.016
b	0.280	0.360	0.011	0.014
c	0.150	0.190	0.006	0.007
D (1)	2.900	3.100	0.114	0.122
e	0.650(BSC) (2)		0.026(BSC) (2)	
E (1)	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.200
L	0.400	0.700	0.016	0.027
L1	0.950(REF) (3)		0.037(REF) (3)	
θ	0°	8°	0°	8°

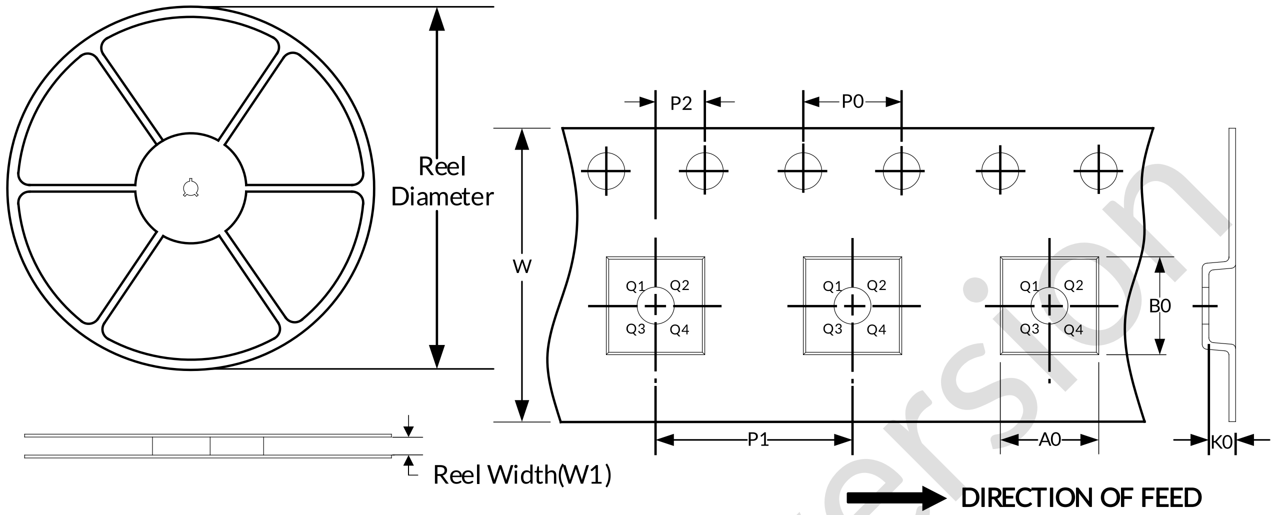
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. REF is the abbreviation for Reference.
4. This drawing is subject to change without notice.

13 TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
MSOP8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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