250MHz, Rail-to-Rail Input/Output CMOS Operational Amplifier

1 FEATURES

- **Qualified for Automotive Applications**
- **AEC-Q100 Qualified with the Grade 1**
- **Unity-Gain Bandwidth: 250MHz**
- **Gain Bandwidth: 120MHz**
- **High Slew Rate: 180V/µs**
- **Offset Voltage: 1mV typical**
- **Low Noise: 6nV/$\sqrt{Hz}$**
- **Input Voltage Range: -0.1V to V_S+0.1V with V_S = 5V**
- **High Output Current: >100mA**
- **Supply Range: +2.7V to +5.5V**
- **Specified Up To +125°C**

2 APPLICATIONS

- **Audio ADC Input Buffers**
- **Photodiode Preamp**
- **High-Density Systems**
- **Portable Systems**
- **Driving A/D Converters**
- **Video Processing**

3 DESCRIPTIONS

The voltage-feedback (VFB) product RS8762P-Q1 offer low voltage operation, rail to rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (250MHz) and slew rate of 180V/µs. The op-amps are unity gain stable and feature an ultra-low input bias current.

These amplifiers set an industry-leading power-to-performance ratio for rail-to-rail amplifiers. The operational amplifier RS8762P-Q1 is specified for a full temperature range of -40°C to 125°C under single or dual power supplies of 2.7V to 5.5V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8762P-Q1	MSOP8	3.00mm×3.00mm

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

Table of Contents

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	2024/10/14	Preliminary version completed
A.1	2024/11/25	Initial version completed
A.2	2025/02/26	Add I_{SINK}/I_{SOURCE} parameter limit values

5 PACKAGE/ORDERING INFORMATION [1]

Orderable Device	Package Type	Pin	Channel	Lead finish/Ball material [2]	MSL Peak Temp [3]	Op Temp(°C)	Device Marking [4]	Package Qty
RS8762PXM -Q1	MSOP8	8	2	SN	MSL1-260°-Unlimited	-40°C ~125°C	RS8762P	Tape and Reel, 4000

NOTE:

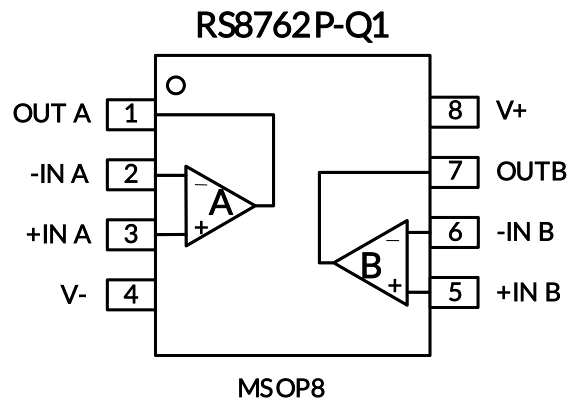
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) Lead finish/Ball material. Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(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.

(4) 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.

6 PIN CONFIGURATION AND FUNCTIONS (TOP VIEW)



Pin Description

NAME	PIN	I/O (1)	DESCRIPTION
	MSOP8		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
V-	4	-	Negative (lowest) power supply
V+	8	-	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, V_S=(V+) - (V-)			7	V
	Signal input pin (2)		(V-)-0.3	(V+) +0.3	
	Signal output pin (3)		(V-)-0.2	(V+) +0.2	
Current	Signal input pin (2)		-10	10	mA
	Signal output pin (3)		-50	50	mA
	Output short-circuit (4)		Continuous		
θ_{JA}	Package thermal impedance (5)	MSOP8		170	°C/W
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J (6)		-40	150	
	Storage, T_{stg}		-65	150	
	Lead temperature (Soldering, 10sec)		260		

(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) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.2V beyond the supply rails should be current-limited to ±50mA or less.
(4) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.
(5) The package thermal impedance is calculated in accordance with JESD-51.
(6) 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), per AEC Q100-002 (1)	±2000	V
		Charged-Device Model (CDM), per AEC Q100-011	±1000	
		Latch-Up (LU), per AEC Q100-004	±200	mA

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

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	MAX	UNIT
Supply voltage, V_S= (V+) - (V-)	Single-supply	2.7	5.5	V
	Dual-supply	±1.35	±2.75	

7.4 Electrical Characteristics

At T_A = +25°C, Vs= ±2.5V, R_F = 0Ω, Full [9] = -40°C to +125°C, unless otherwise noted. [1]

PARAMETER		CONDITIONS	T_A	RS8762P-Q1			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		Full	2.7		5.5	V
I_Q	Quiescent Current per Amplifier	V_S = 2.7V	25°C		6.3	9	mA
			Full			11	
		V_S = 5V	25°C		8.3	10.5	
			Full			13	
PSRR	Power-Supply Rejection Ratio	V_S = 2.7V to 5.5V	25°C	60	80		dB
			Full	55			
INPUT							
Vos	Input Offset Voltage	V_S = 5V, V_{CM} = V_S/2	25°C	-2	±1	2	mV
			Full	-4		4	
Vos Tc	Input Offset Voltage Drift		Full		±10		μV/°C
I_B	Input Bias Current [4] [5]	V_S = 5V	25°C	-1	±0.1	1	nA
			Full	-10		10	
I_{OS}	Input Offset Current [4]	V_S = 5V	25°C	-1	±0.1	1	nA
			Full	-10		10	
C_{IN}	Input Capacitance	Differential Mode	25°C		3.5		pF
		Common Mode	25°C		2.5		
A_{OL}	Open-loop Voltage Gain	R_{LOAD} = 2kΩ, V_{OUT} = -2.4V to 2.4 V	25°C	95	105		dB
		R_{LOAD} = 2kΩ, V_{OUT} = -2.35V to 2.35 V	Full	90			
V_{CM}	Common-Mode Voltage Range		Full	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Mode Rejection Ratio	V_S=5.0V, V_{CM}=0 to 3V	25°C	60	80		dB
			Full	55			
		V_S=5.0V, V_{CM}=0 to 5V	25°C	60	75		
			Full	55			
OUTPUT							
V_{OH}	Output Swing from Positive Rail	R_{LOAD} = 100kΩ to V_S/2	25°C		7	20	mV
			Full			30	
V_{OL}	Output Swing from Negative Rail	R_{LOAD} = 100kΩ to V_S/2	25°C		4	20	mV
			Full			30	
I_{SC}	Short-Circuit Current [6] [7]	Source	25°C	160	200		mA
			Full	90			
		Sink	25°C	200	250		
			Full	170			
R_{OUT}	Closed-Loop Output Impedance [4]	G = 1, f =1kHz, I_{OUT} = 0	25°C		0.01		Ω
R_O	Open-Loop Output Impedance [4]	f = 1kHz, I_{OUT} = 0			21		Ω
AC Specifications							
f_{-3dB}	Small-Signal Bandwidth [4]	G = +1, V_O = 100mV_{PP}			250		MHz
		G = +2, V_O = 100mV_{PP}			90		MHz
GBW	Gain-Bandwidth Product	G = +10	25°C		120		MHz

SR	Slew Rate (8)	V_S = +5V, G=1,4V Step	25°C		200		V/µs
		V_S = +5V, G=1,2V Step			180		
		V_S = +3V, G=1,2V Step			140		
t_F	Rise-and-Fall Time	G = +1, V_O = 200mV_{PP}, 10% to 90%	25°C		7		ns
		G = +1, V_O = 2V_{PP}, 10% to 90%	25°C		2.5		ns
t_S	Settling Time, 0.1% (4)	G=1, 2V Step	25°C		25		ns
t_{OR}	Overload Recovery Time	V_{IN} * Gain = V_S	25°C		40		ns
PM	Phase Margin (4)	G=1	25°C		60		deg
NOISE							
En	Input Voltage Noise	V_S=5V, f=0.1Hz to 10Hz	25°C		51		µVpp
en	Input Voltage Noise Density (4)	f = 1MHz	25°C		6		$nV/\sqrt{Hz}$

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) This parameter is ensured by design and/or characterization and is not tested in production.

(5) Positive current corresponds to current flowing into the device.

(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{θJA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{θJA}$. All numbers apply for packages soldered directly onto a PCB.

(7) Short circuit test is a momentary test.

(8) Number specified is the slower of positive and negative slew rates.

(9) Specified by characterization only.

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.

V_S = 5V, G = +1, R_F = 0Ω, R_L = 1kΩ, and connected to V_S/2, unless otherwise specified

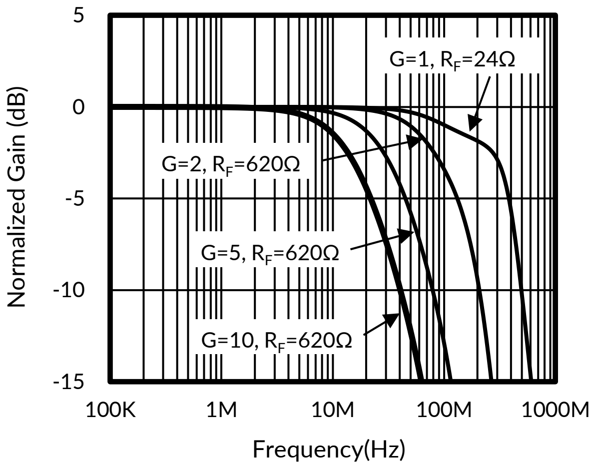


Figure 1. Noninverting Small Signal Frequency Response

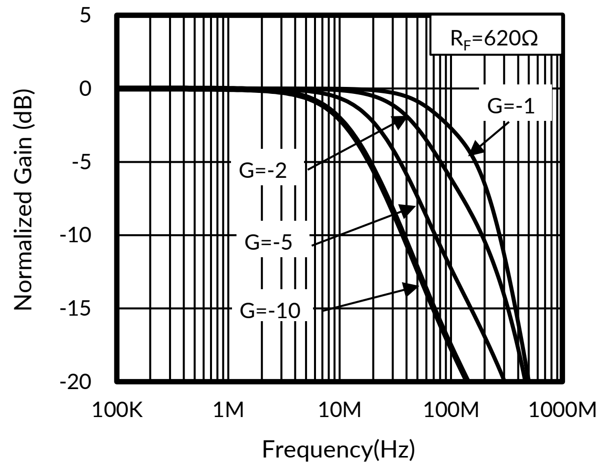


Figure 2. Inverting Small Signal Frequency Response

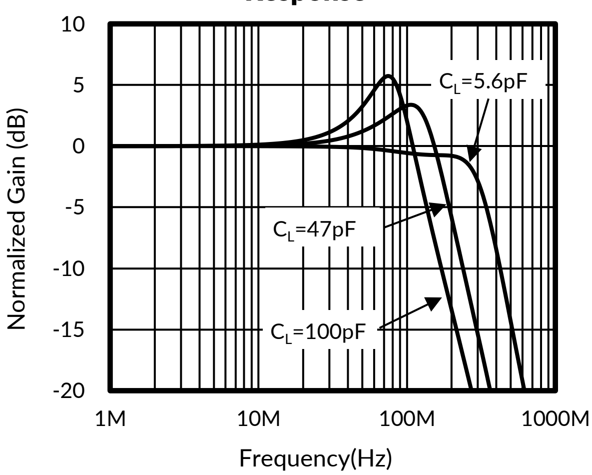


Figure 3. Frequency Response for Various C_L

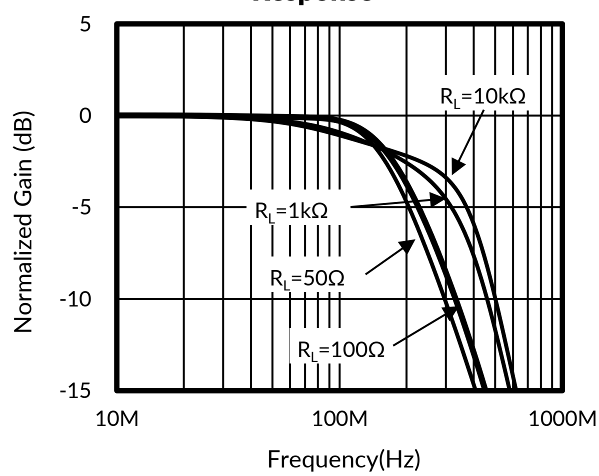


Figure 4. Frequency Response for Various R_L

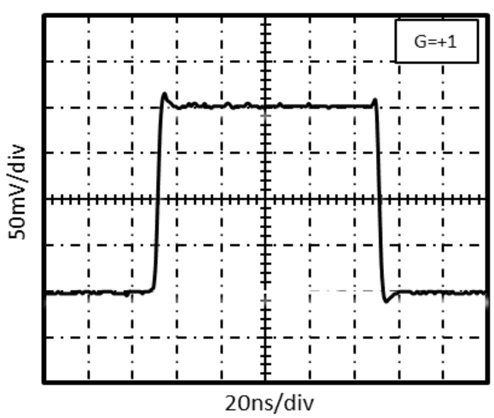


Figure 5. Small Signal Step Response

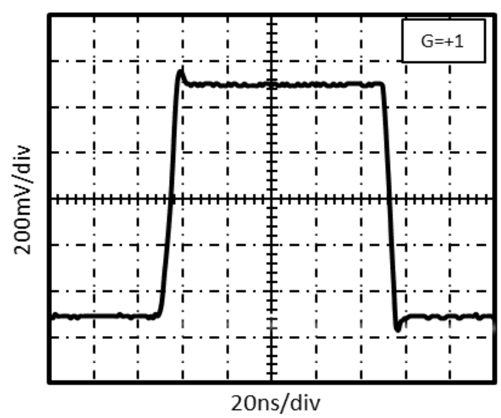


Figure 6. Large Signal Step Response

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.

V_S = 5V, G = +1, R_F = 0Ω, R_L = 1kΩ, and connected to $V_S/2$, unless otherwise specified

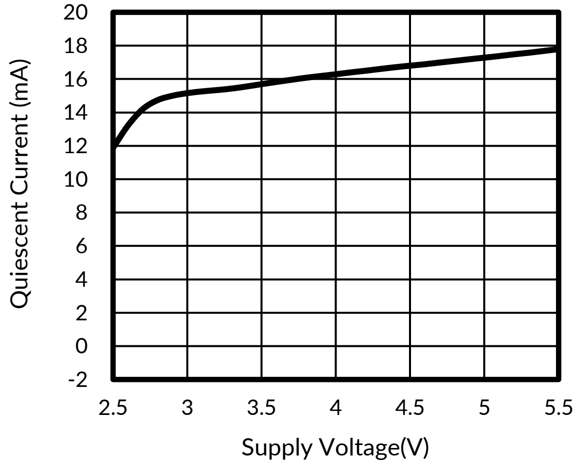


Figure 7. Quiescent Current vs Supply Voltage

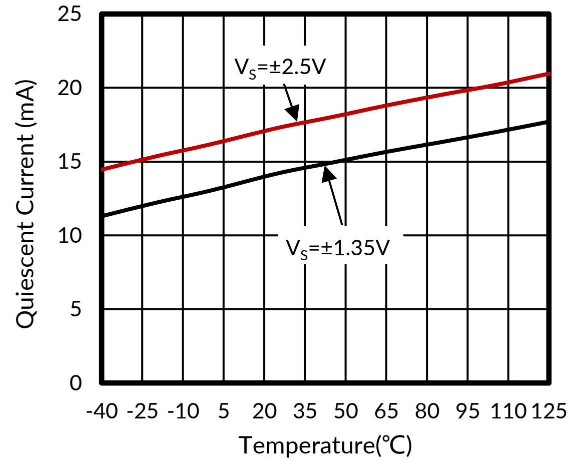


Figure 8. Quiescent Current vs Temperature

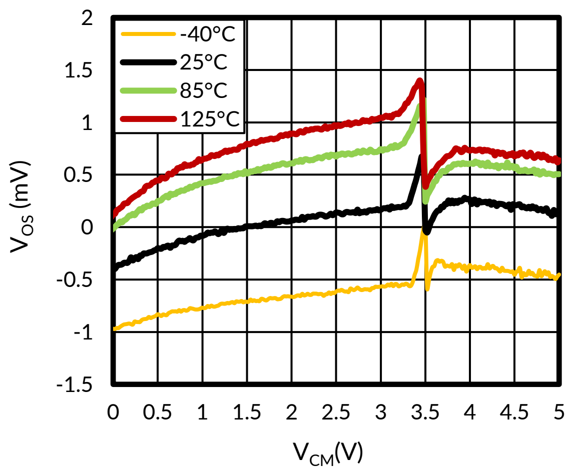


Figure 9. Input Offset Voltage vs Common Mode Voltage

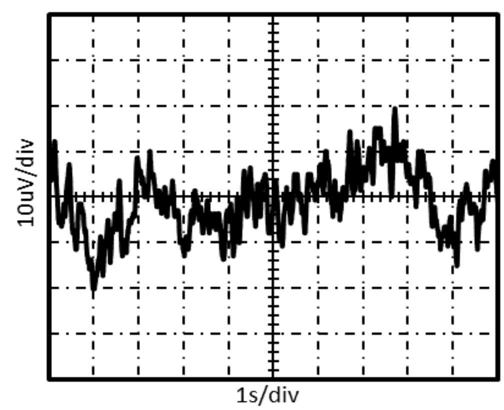


Figure 10. 0.1Hz to 10Hz Noise

8 DETAILED DESCRIPTION

8.1 Overview

The RS8762P-Q1 devices are unity-gain stable, dual channel op amps with low noise and distortion. The device consists of a low noise input stage with a folded cascade and a rail-to-rail output stage. This topology exhibits superior noise and distortion performance across a wide range of supply voltages that are not delivered by legacy commodity audio operational amplifiers.

8.2 Power On Requirement

For the high-speed amplifier, in order to avoid the bandwidth limit of the input transistors parasitic capacitance, it is generally not large enough, so the offset voltage is larger than the general amplifier. RS8762P-Q1 uses internal calibration circuits to calibrate the offset voltage under high and low common mode conditions, so the typical value of the offset voltage can be 1 mV. The performance is better than most high-speed amplifiers. To ensure the normal calibration function. When using the amplifier, users should pay attention to the high and low V_{CM} switching points, generally near V_{DD}-1.5V. To guarantee the calibration block works properly, good power on of the amplifier power supply is recommended:

- Fast power on time to produce the power on reset signal of calibration block. The maximum value of power on time is 1ms.
- Avoid the voltage glitch reaching in 0.4V to 1V range on power supply. For example, power supply drop to 0.5V then recovery to 5V may cause error of calibration block.

If the power on signal is not good, the amplifier has probability to enter an unexpected status.

8.3 Phase Reversal Protection

The RS8762P-Q1 has internal phase-reversal protection. Many op amps exhibit phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the RS8762P-Q1 prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage. This performance is shown in figure 11.

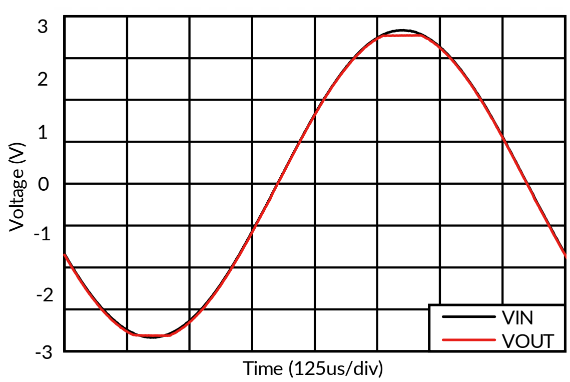


Figure 11. Output Waveform Devoid of Phase Reversal during an Input Overdrive Condition

8.4 Gain Bandwidth Product

For applications that require a gain of +1, no feedback resistor is required. Just short the output pin to the inverting input pin. For gains greater than +1, the feedback resistor forms a pole with the parasitic capacitance at the inverting input. As this pole becomes smaller, the amplifier's phase margin is reduced. This causes ringing in the time domain and peaking in the frequency domain. Therefore, R_F has some maximum value that should not be exceeded for optimum performance. If a large value of R_F must be used, a small capacitor in the few Pico farad range in parallel with R_F can help to reduce the ringing and peaking at the expense of reducing the bandwidth. As far as the output stage of the amplifier is concerned, the output stage is also a gain stage with the load. R_F and R_G appear in parallel with R_L for gains other than +1. As this combination gets smaller, the bandwidth falls off. Consequently, R_F also has a minimum value that should not be exceeded for optimum performance. For gain of +1, R_F=0 is optimum. For the gains other than +1, optimum response is obtained with R_F between 300Ω to 1kΩ, The RS8762P-Q1 have again bandwidth product of 120MHz. For gains ≥5, its bandwidth can be predicted by the following equation:

$$\text{Gain} \times \text{BW} = 120\text{MHz}$$

8.5 Capacitive Load Driving Capability

RS8762P-Q1 has large output current driving ability and good stability. When the drive output load resistance is 1kΩ and the output capacitor is 40 pF, the frequency response curve peak is less than 5dB. If less peaking is desired in applications, a small series resistor (usually 50Ω) can be placed in series with the output to eliminate most peaking. However, this will reduce the gain slightly. If the gain setting is greater than 1, the gain resistor RG can then be chosen to make up for any gain loss which may be created by the additional series resistor at the output. When used as a cable driver, double termination is always recommended for reflection-free performance. For those applications, a back-termination series resistor at the amplifier's output will isolate the amplifier from the cable and allow extensive capacitive drive. However, other applications may have high capacitive loads without a back-termination resistor. Again, a small series resistor at the output can help to reduce peaking.

8.6 Video Performance

For good video performance, an amplifier is required to maintain the same output impedance and the same frequency response as DC levels are changed at the output. This is especially difficult when driving a standard video load of 150Ω, because the change in output current with DC level. Special circuitry has been incorporated in the RS8762P-Q1 to reduce the variation of the output impedance with the current output. This results in Dg and Dp specifications of 0.03% and 0.3°, while driving 150Ω at a gain of 2. Driving high impedance loads would give a similar or better Dg and Dp performance.

8.7 Output Drive Capability

The RS8762P-Q1 output stage can supply a continuous output current of ±100mA and still provide approximately 2.7V of output swing on a 5V supply. For maximum reliability, it is not recommended to run a continuous DC current in excess of ±100mA. Refer to the typical characteristic curve Output Voltage Swing vs Output Current. For supplying continuous output currents greater than ±100mA, the RS8762P-Q1 may be operated in parallel. The RS8762P-Q1 will provide peak currents up to 200mA, which corresponds to the typical short-circuit current.

8.8 Input ESD Diode Protection

The RS8762P-Q1 uses internal electrostatic discharge (ESD) protection circuits on all pins. In the case of input and output pins, this protection primarily consists of current-steering diodes connected between the input and power-supply pins. The following figure shows the schematic diagram of the ESD structure.

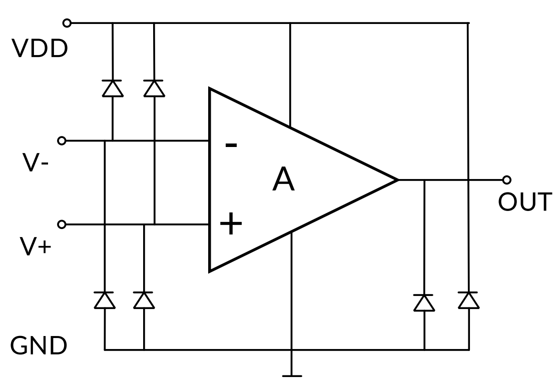


Figure 12. Input ESD Diode

8.9 Power Supply Bypassing and Printed Circuit Board Layout

As with any high frequency device, a good printed circuit board layout is necessary for optimum performance. Lead lengths should be as sort as possible. The power supply pin must be well bypassed to reduce the risk of oscillation. For normal single supply operation, where the V_- pin is connected to the ground plane, a single 4.7mF tantalum capacitor in parallel with a 0.1mF ceramic capacitor from V_+ to GND will suffice. This same capacitor combination should be placed at each supply pin to ground if split supplies are to be used. In this case, the V_- pin becomes the negative supply rail. For good AC performance, parasitic capacitance should be kept to a minimum. Use of wire wound resistors should be avoided because of their additional series inductance. Use of sockets should also be avoided if possible. Sockets add parasitic inductance and capacitance that can result in compromised performance. Minimizing parasitic capacitance at the amplifier’s inverting input pin is very important. The feedback resistor should be placed very close to the inverting input pin. Strip line design techniques are recommended for the signal traces.

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 Note

The RS8762P-Q1 are high precision, rail-to-rail operational amplifiers that can be run from a single- supply voltage 2.7V to 5.5V (±1.35V to ±2.75V). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier. Rail-to-rail output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a 0.1μF capacitor place closely across the supply pins.

9.2 Single Supply Video Line Driver

The RS8762P-Q1 are wide band rail-to-rail output op amplifiers with large output current, excellent Dg, Dp, and low distortion that allow them to drive video signals in low supply applications. Figure below is the single supply non-inverting video line driver configuration and inverting video ling driver configuration. The signal is AC coupled by C1. R1 and R2 are used to level shift the input and output to provide the largest output swing. RF and RG set the AC gain. C2 isolates the virtual ground potential. RT and R3 are the termination resistors for the line. C1, C2 and C3 are selected big enough to minimize the drop of the luminance signal.

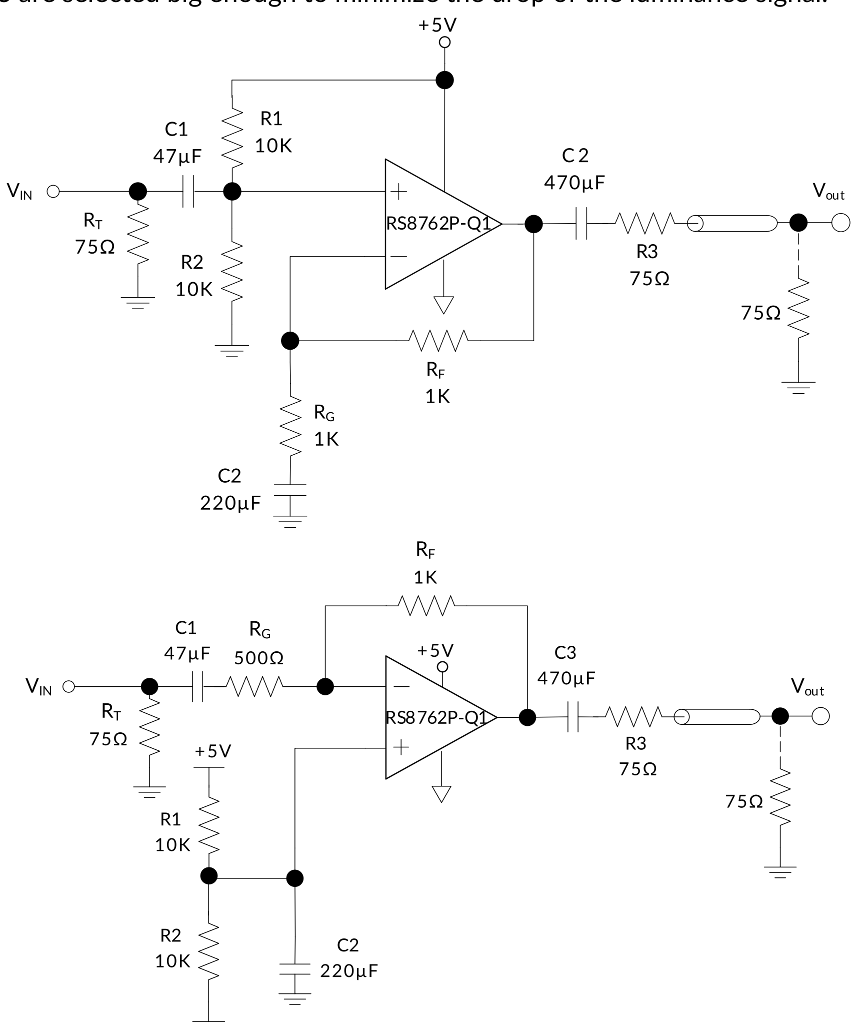
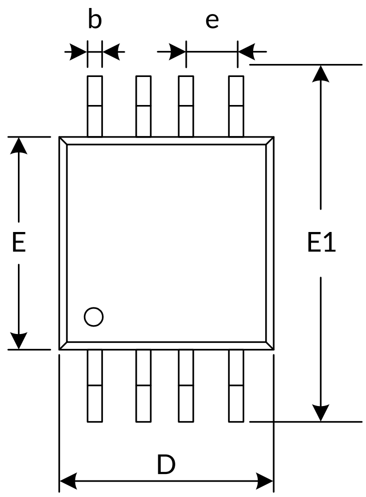
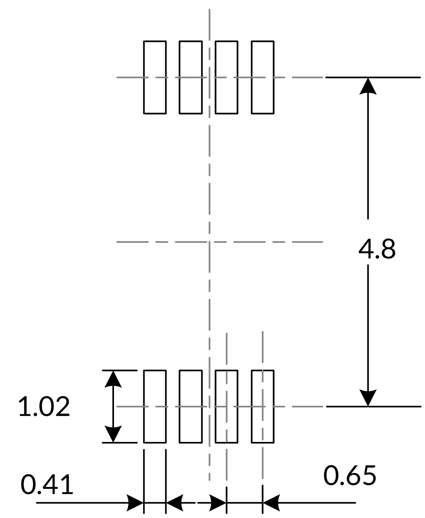


Figure 13. 5V Single Supply Non-Inverting and Inverting Video Line Driver

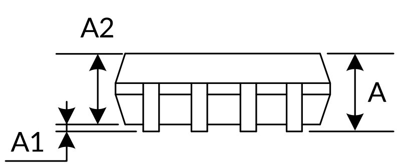
10 PACKAGE OUTLINE DIMENSIONS

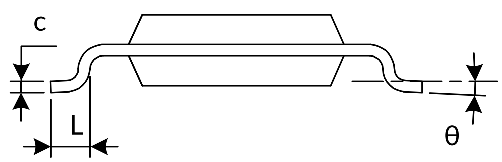
MSOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
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	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

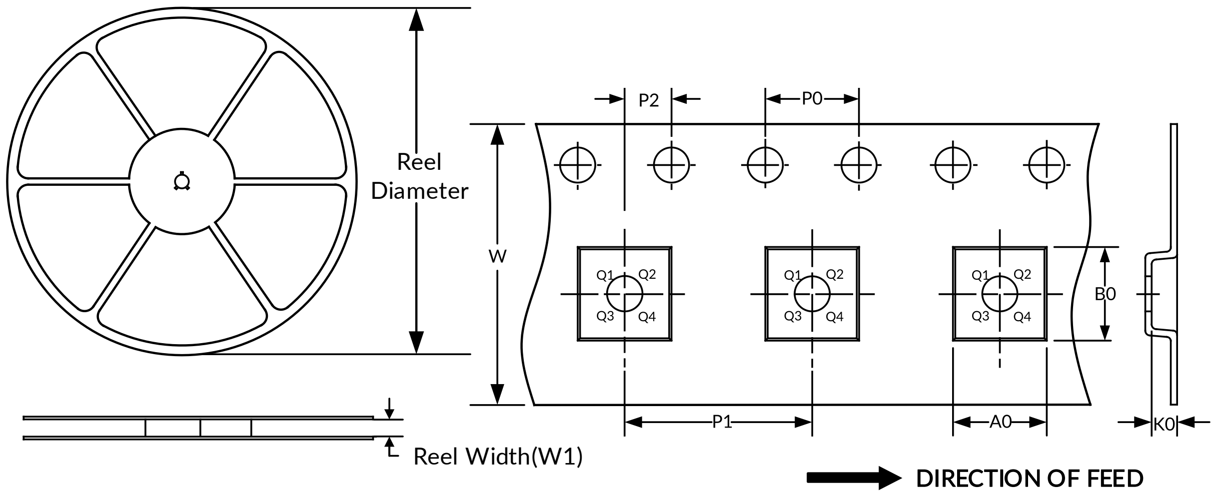
NOTE:

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. This drawing is subject to change without notice.

11 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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