36V, 11MHz Rail-to-Rail Output
Zero Drift Operational Amplifier

1 Features

- **Low Offset Voltage: ±5μV**
- **Low Bias Current**
- **Gain Bandwidth Product: 11MHz**
- **Rail-to-Rail Output**
- **High Slew Rate:15V/μs**
- **Low Quiescent Current: 2.0mA (TYP)**
- **Supply Voltage Range: 4.5V to 36V**
- **Over-Temperature Protection**
- **Low Noise: 8nV/$\sqrt{\text{HZ}}$ at 1kHz**
- **Differential Input Voltage Up to Supply Rail, can Work as Comparator**
- **Extended Temperature: -40°C to +125°C**
- **Micro SIZE PACKAGES: SOT23-5, SOP8, MSOP8 and SOP14**

2 Applications

- **Sensors**
- **Photodiode Amplification**
- **Active Filters**
- **Test Equipment**
- **Driving A/D Converters**
- **Industrial Control**

3 Descriptions

The ZM866X is a low noise, low offset voltage and high voltage operational amplifier, which can be designed into a wide range of applications. The ZM866X has a gain-bandwidth product of 11MHz, a slew rate of 15V/μs and a quiescent current of 2.0mA at wide power supply range.

The ZM866X is designed to provide optimal performance in low noise systems. It provides rail-to rail output swing into heavy loads.

The ZM866X has over-temperature protection feature to guarantee the chip safe. The output of ZM866X will enter high impendence when die temperature reach around 170°C and will recover the function when the die temperature down to around 150°C.

The ZM866X is available in Green SOT23-5, SOP8, MSOP8 and SOP14 packages. It operates over an ambient temperature range of -40°C to +125°C under single power supplies of 4.5V to 36V or dual power supplies of ±2.25V to ±18V.

Device Information [1]

PART NUMBER	PACKAGE	BODY SIZE(NOM)
ZM8661	SOT23-5	1.60mm × 2.92mm
	SOP8	4.90mm × 3.90mm
ZM8662	SOP8	4.90mm × 3.90mm
	MSOP8	3.00mm×3.00mm
ZM8664	SOP14	8.65mm x 3.90mm

(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.1	2024/03/20	Initial version completed

5 Package/Ordering Information [1]

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking [2]	MSL [3]	Package Qty
ZM8661XF-G	SOT23-5	5	1	-40°C ~125°C	8661	MSL1	Tape and Reel,3000
ZM8661XK-G	SOP8	8	1	-40°C ~125°C	ZM8661	MSL1	Tape and Reel,4000
ZM8662XK-G	SOP8	8	2	-40°C ~125°C	ZM8662	MSL1	Tape and Reel,4000
ZM8662XM-G	MSOP8	8	2	-40°C ~125°C	ZM8662	MSL1	Tape and Reel, 4000
ZM8664XP	SOP14	14	4	-40°C ~125°C	ZM8664	MSL3	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) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

## 6 Pin Configuration and Functions (Top View)

ZM8661

SOT23-5

ZM8661
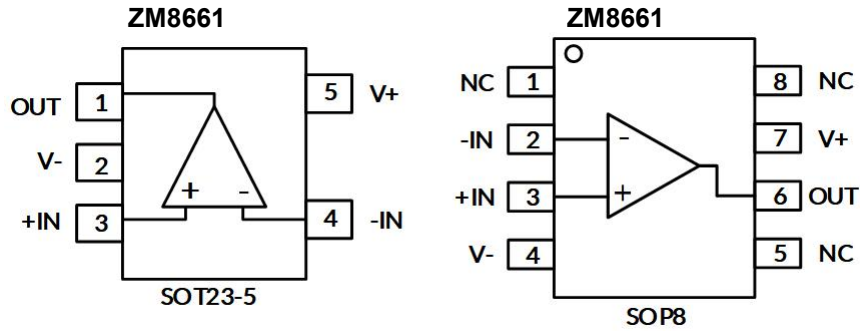
SOP8

Pin Description

NAME	PIN		I/O [1]	DESCRIPTION
	SOT23-5	SOP8		
OUT	1	6	O	Output
V-	2	4	-	Negative (lowest) power supply
+IN	3	3	I	Positive (noninverting) input
-IN	4	2	I	Negative (inverting) input
V+	5	7	-	Positive (highest) power supply
NC [2]	-	1,5,8	-	No internal connection (can be left floating)

(1) I = Input, O = Output.
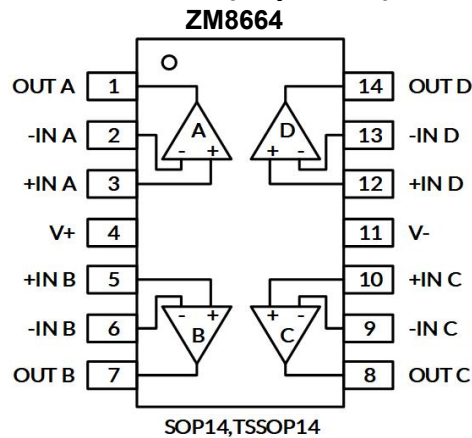(2) There is no internal connection. Typically, GND is the recommended connection to a heat spreading plane.

ZM8662
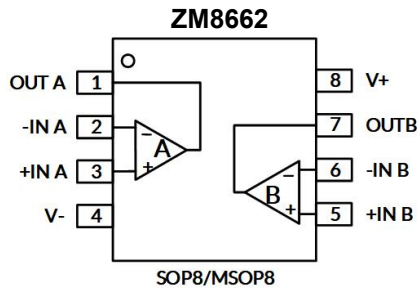
SOP8/MSOP8

Pin Description

NAME	PIN	I/O [1]	DESCRIPTION
	SOP8/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.

Pin Configuration and Functions (Top View)

ZM8664


```
OUT A   1            14   OUT D
-IN A   2    A    D  13   -IN D
+IN A   3       - +  12   +IN D
V+      4            11   V-
+IN B   5            10   +IN C
-IN B   6    B    C   9   -IN C
OUT B   7             8   OUT C
```

SOP14,TSSOP14

Pin Description

NAME	PIN SOP14	I/O (1)	DESCRIPTION
-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
-INC	9	I	Inverting input, channel C
+INC	10	I	Noninverting input, channel C
-IND	13	I	Inverting input, channel D
+IND	12	I	Noninverting input, channel D
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
OUTC	8	O	Output, channel C
OUTD	14	O	Output, channel D
V-	11	-	Negative (lowest) power supply or ground (for single supply operation)
V+	4	-	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-)			40	V
	Signal input pin [2]		(V-) - 0.3	(V+) + 0.3	
	Signal output pin [3]		(V-) - 0.3	(V+) + 0.3	
	Differential input voltage		(V-) - (V+)	(V+) - (V-)	
Current	Signal input pin [2]		-10	10	mA
	Signal output pin [3]		-10	10	mA
	Output short-circuits [4]		Continuous		
θ_{JA}	Package thermal impedance [5]	SOT23-5		230	°C/W
		SOP8		110	
		MSOP8		170	
		SOP14		105	
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 0.3V beyond the supply rails should be current-limited to ±10mA or less.
(4) Short-circuit to ground, one amplifier per package.
(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), JEDEC EIA /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	MAX	UNIT
Supply voltage, V_S= (V+) - (V-)	Single-supply	4.5	36	V
	Dual-supply	±2.25	±18	

7.4 Electrical Characteristics

At T_A = +25°C, Vs= 36V, R_L = 10kΩ, Full [9] = -40°C to +125°C, unless otherwise noted [1]

PARAMETER		CONDITIONS	T_A	ZM866X			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		Full	4.5		36	V
I_Q	Quiescent Current per Amplifier	V_S=5V	25°C		2.0	2.4	mA
			Full			2.6	
		V_S=36V	25°C		2.1	2.5	
			Full			2.7	
PSRR	Power-Supply Rejection Ratio	V_S=4.5V to 36V	25°C	130	150		dB
			Full	120			
INPUT							
Vos	Input Offset Voltage	V_S = 5V, V_{CM} = 2.5V	25°C	-20	±5	20	μV
			Full	-30		30	
		V_S = 36V, V_{CM} = 18V	25°C	-20	±10	20	μV
			Full	-30		30	
Vos Tc	Input Offset Voltage Drift		Full		±0.1		μV/°C
IB	Input Bias Current [4] [5]	V_S = 36V, V_{CM} = 18V	25°C	-2.5	0.3	2.5	nA
			Full	-5		5	
I_{OS}	Input Offset Current [4]	V_S = 36V, V_{CM} = 18V	25°C		0.3		nA
			Full	-5		5	
I_{IN}	Different Input Current	V_S = 36V, V_{ID} = 36V	25°C		1	10	μA
C_{IN}	Input Capacitance	Differential Mode	25°C		5		pF
		Common Mode	25°C		2.5		pF
A_{OL}	Open-loop Voltage Gain	R_{LOAD} = 10kΩ, V_{OUT} = 0.5 V to 35.5 V	25°C	130	150		dB
			Full	120			dB
V_{CM}	Common-Mode Voltage Range		Full	(V-)		(V+)-1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM}=0 to 34.5V	25°C	130	150		dB
			Full	120			
OUTPUT							
	Output Swing from Positive Rail	R_{LOAD} = 100kΩ to V_S/2	25°C		10		mV
		R_{LOAD} = 10kΩ to V_S/2	25°C		95	150	
		R_{LOAD} = 2kΩ to V_S/2	25°C		470		
	Output Swing from Negative Rail	R_{LOAD} = 100kΩ to V_S/2	25°C		6		mV
		R_{LOAD} = 10kΩ to V_S/2	25°C		60	150	
		R_{LOAD} = 2kΩ to V_S/2	25°C		255		
I_{SC}	Short-Circuit Current [6] [7]	Source	25°C	45	60		mA
		Sink	25°C	90	100		
AC Specifications							
SR	Slew Rate [8]	G=1, 10V Step	25°C		15		V/μs
GBW	Gain-Bandwidth Product		25°C		11		MHz
ts	Settling Time,0.1%	G=1, 10V Step	25°C		5		μs
t_{OR}	Overload Recovery Time		25°C		300		ns

PM	Phase Margin	R_L=10kΩ, C_L= 50pF	25°C		60	°
GM	Gain Margin	R_L=10kΩ, C_L= 50pF	25°C		10	dB
NOISE						
En	Input Voltage Noise	V_S = 5V, f = 0.1Hz to 10Hz	25°C		0.2	μVpp
en	Input Voltage Noise Density (4)	f = 0.1kHz	25°C		8	nV/$\sqrt{\text{Hz}}$
		f = 1kHz	25°C		8	
		f = 10kHz	25°C		8	
THD+N	Total Harmonic Distortion and Noise	f = 1kHz, G =1, R_L = 10kΩ, V_{OUT} = 6V_{RMS}			0.0004	%
Thermal Protection						
T_{SHDN}	Thermal Shutdown Temperature				170	°C
ΔT_{SHDN}	Thermal Shutdown Hysteresis				20	

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 $T_{J(MAX)}$, $R_{\theta JA}$, 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) Short circuit test is a momentary test.

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

(9) Specified by characterization only.

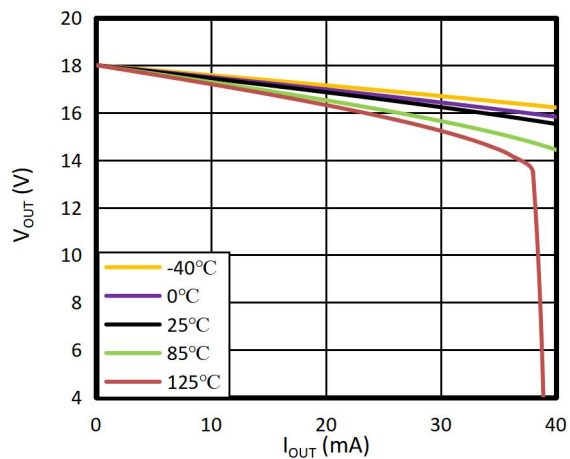## 7.5 Typical Characteristics

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.

At T_A = +25°C, V_S = ±18V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.
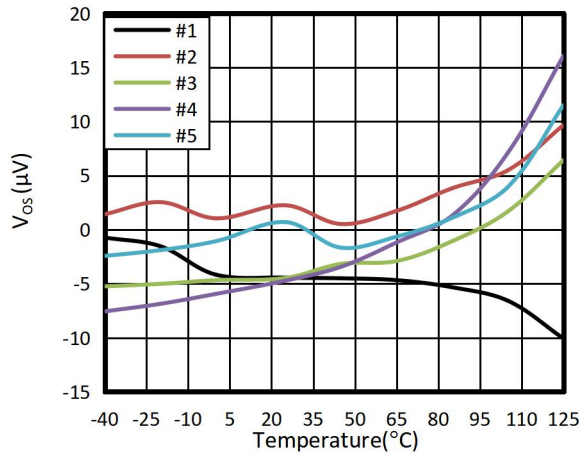
Figure 1.V_{OS} at 36V V_S, 18V V_{CM} vs Temperature
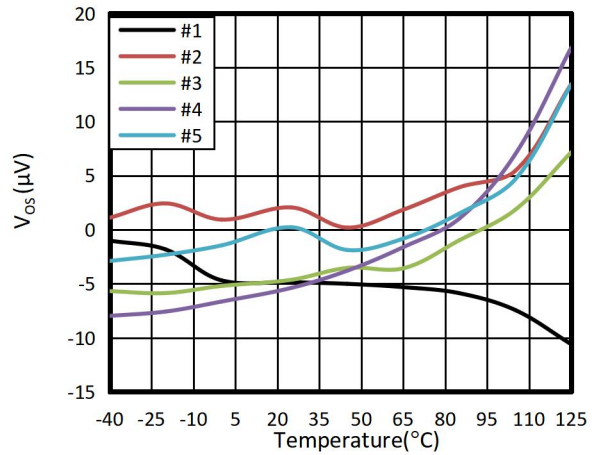

Figure 2.V_{OS} at 5V V_S, 2.5V V_{CM} vs Temperature
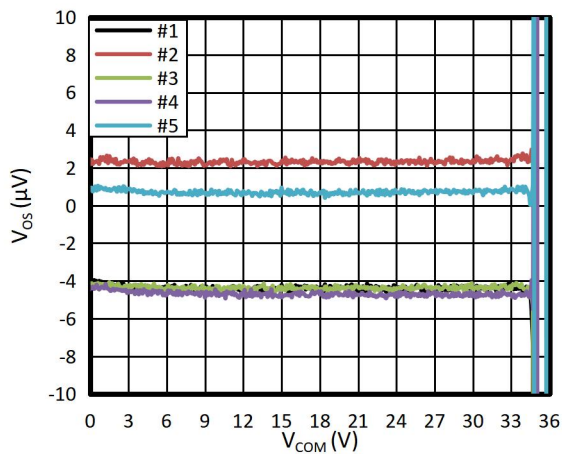
Figure 3. Offset Voltage vs Common Mode Voltage
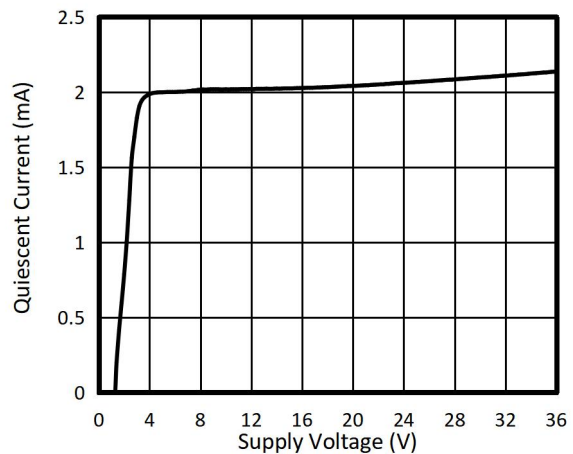
Figure 4. Quiescent Current vs Supply Voltage
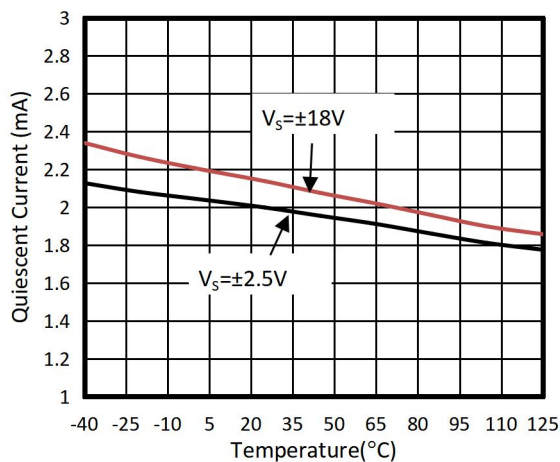
Figure 5. Quiescent Current vs Temperature

Figure 6. V_{OUT} vs I_{OUT}, Source

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 = ±18V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.
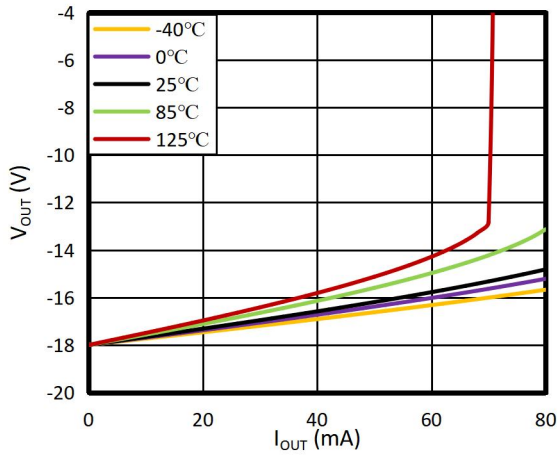
Figure 7. V_{OUT} vs I_{OUT}, Sink
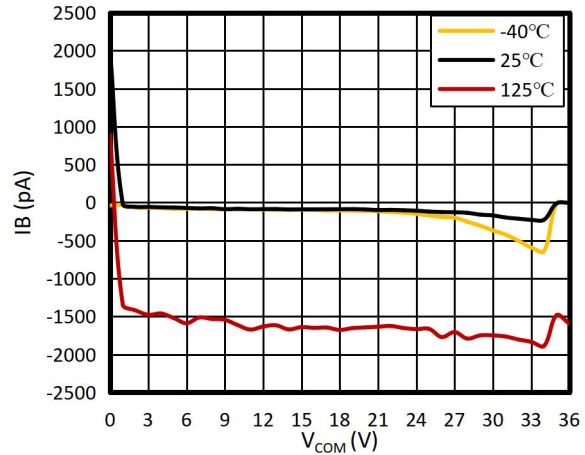
Figure 8. IB vs V_{COM}
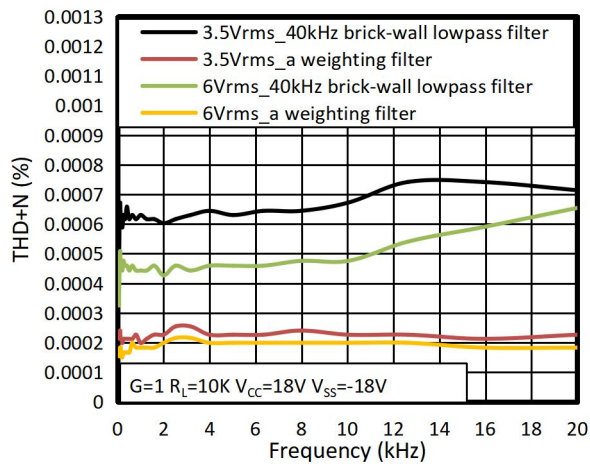
Figure 9. THD+N VS Frequency
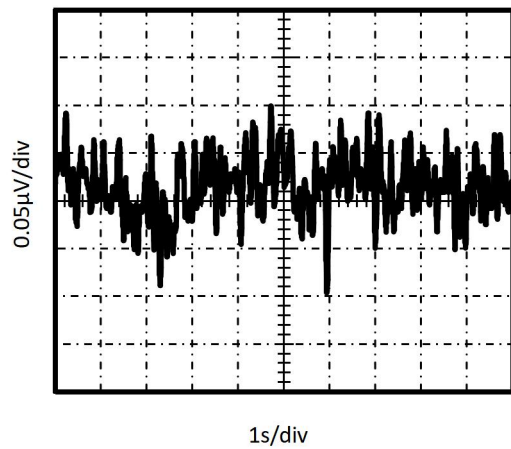
Figure 10. 0.1Hz to 10Hz Input Voltage Noise
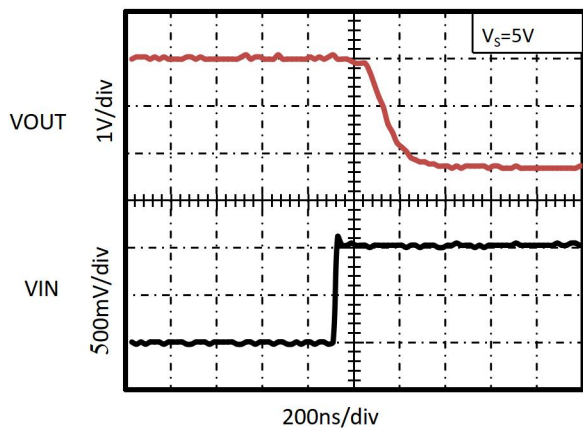
Figure 11. Positive Overload Recovery
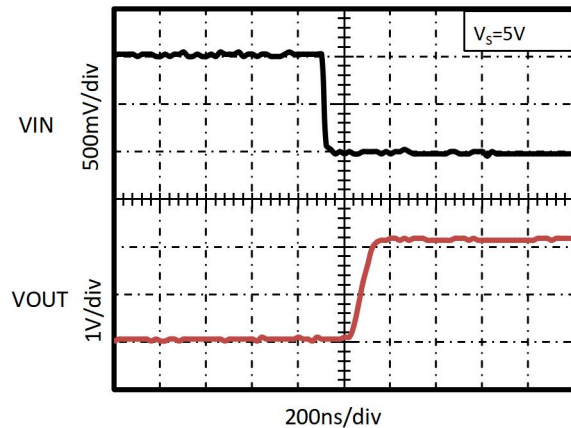
Figure 12. Negative Overload Recovery

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 = ±18V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.
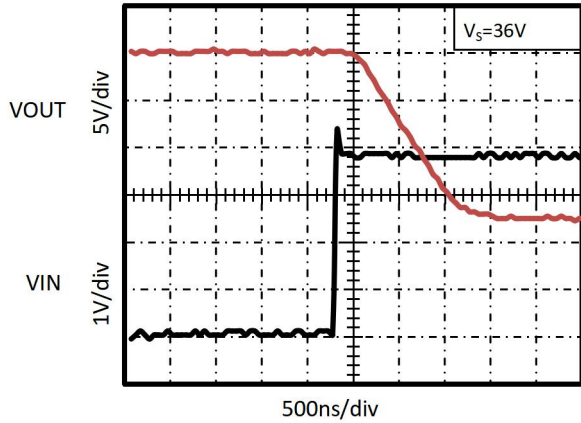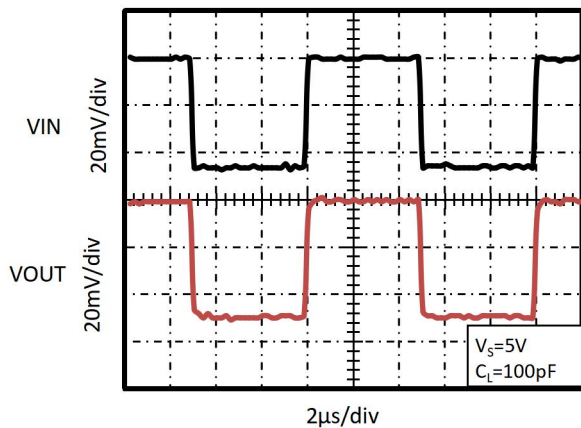

Figure 13. Positive Overload Recovery
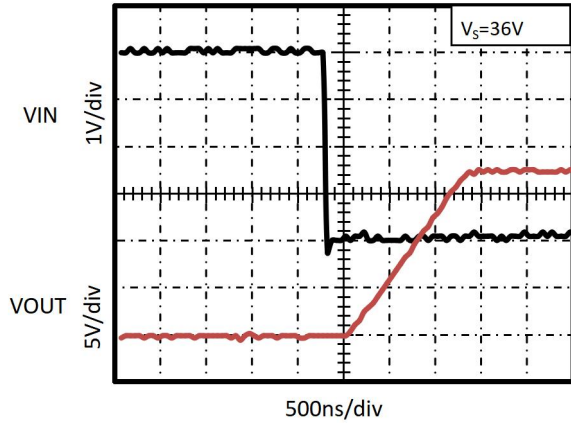
Figure 14. Negative Overload Recovery
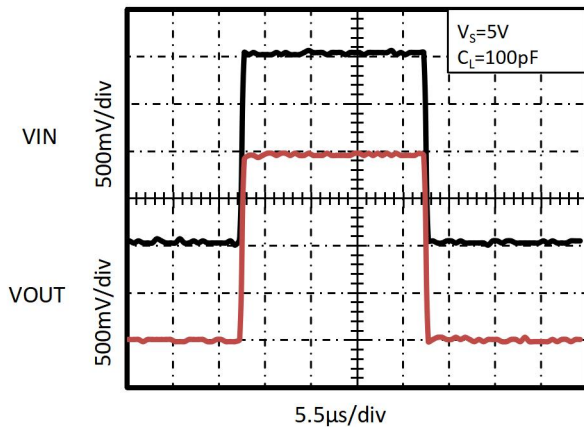
Figure 15. Large Signal Step Response
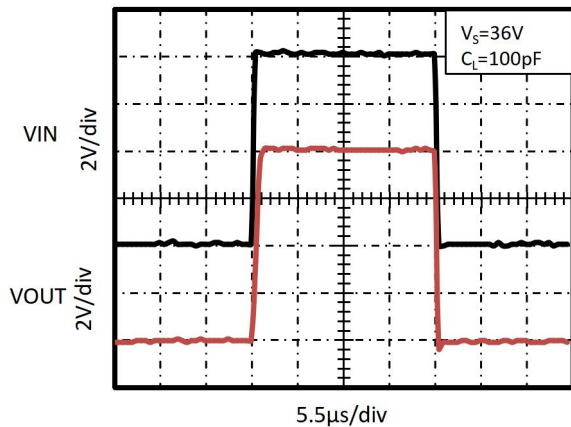
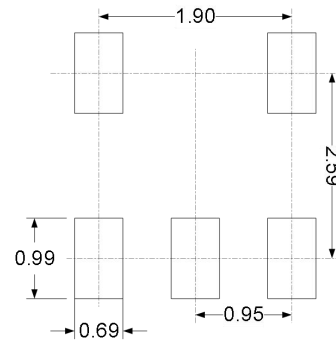Figure 16. Large Signal Step Response
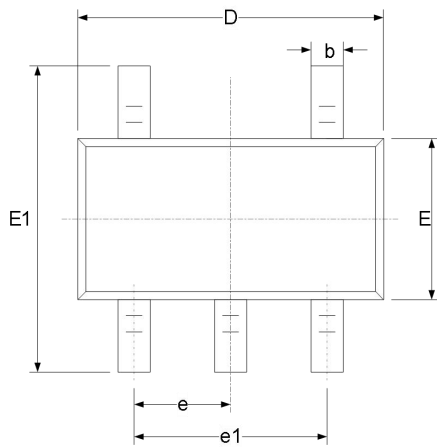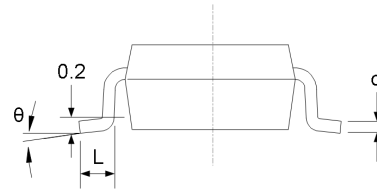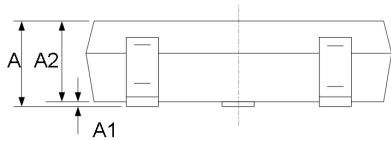

Figure 17. Small Signal Step Response
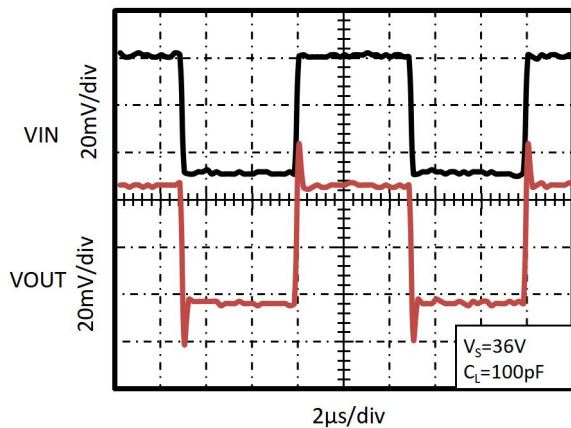
Figure 18. Small Signal Step Response

8 Pacakge Outline Dimensions
SOT23-5 [3]

RECOMMENDED LAND PATTERN (Unit: mm)

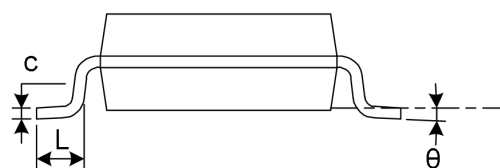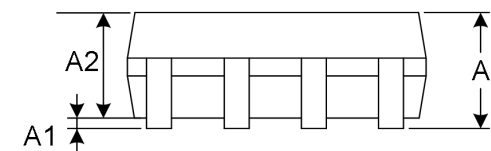| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D [1]	2.820	3.020	0.111	0.119
E [1]	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) [2]		0.037(BSC) [2]	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
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. This drawing is subject to change without notice.

SOP8 [3]
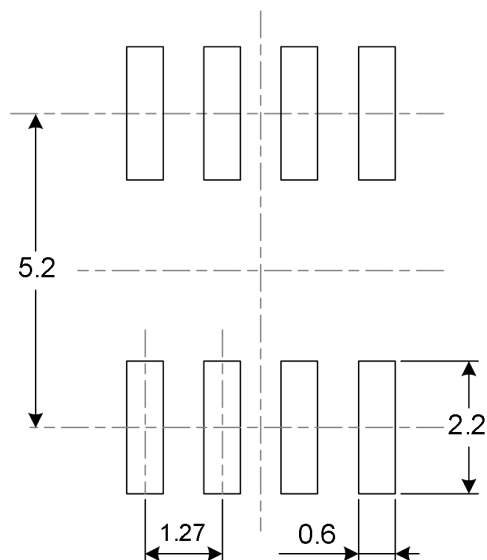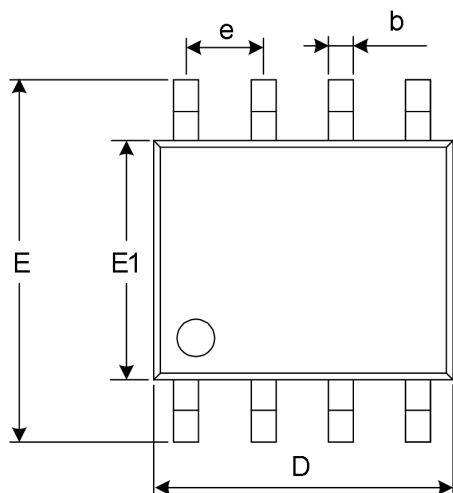
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D [1]	4.800	5.000	0.189	0.197
e	1.270(BSC) [2]		0.050(BSC) [2]	
E	5.800	6.200	0.228	0.244
E1 [1]	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
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. This drawing is subject to change without notice.

MSOP8 [3]

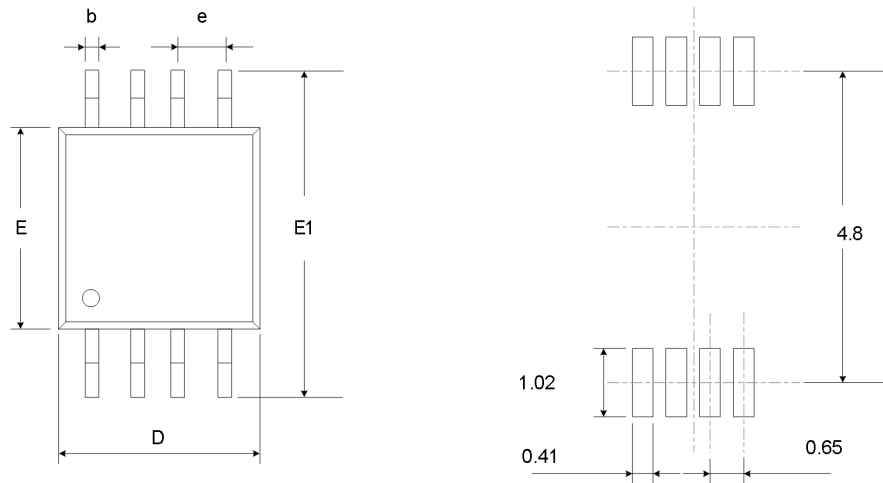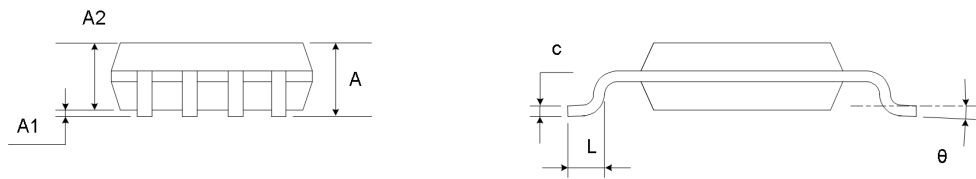

RECOMMENDED LAND PATTERN (Unit: mm)

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.
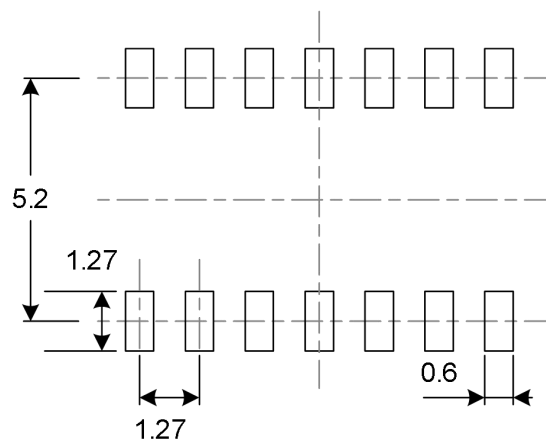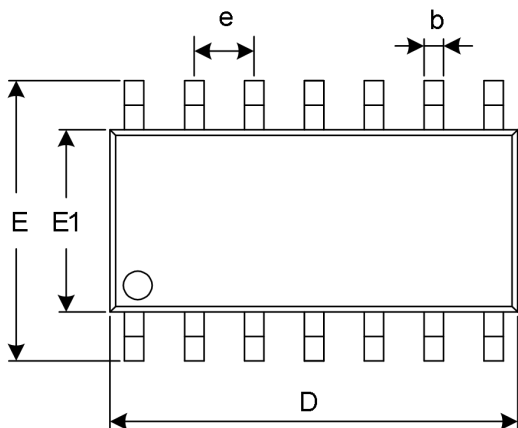
SOP14 [3]

RECOMMENDED LAND PATTERN (Unit: mm)

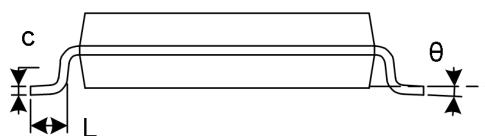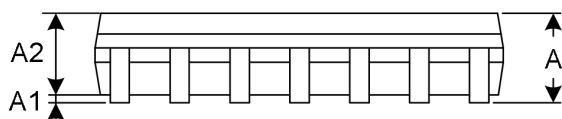| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D [1]	8.450	8.850	0.333	0.348
e	1.270(BSC) [2]		0.050(BSC) [2]	
E	5.800	6.200	0.228	0.244
E1 [1]	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
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. This drawing is subject to change without notice.

9 Tape and Reel Information

REEL DIMENSIONS   TAPE DIMENSION
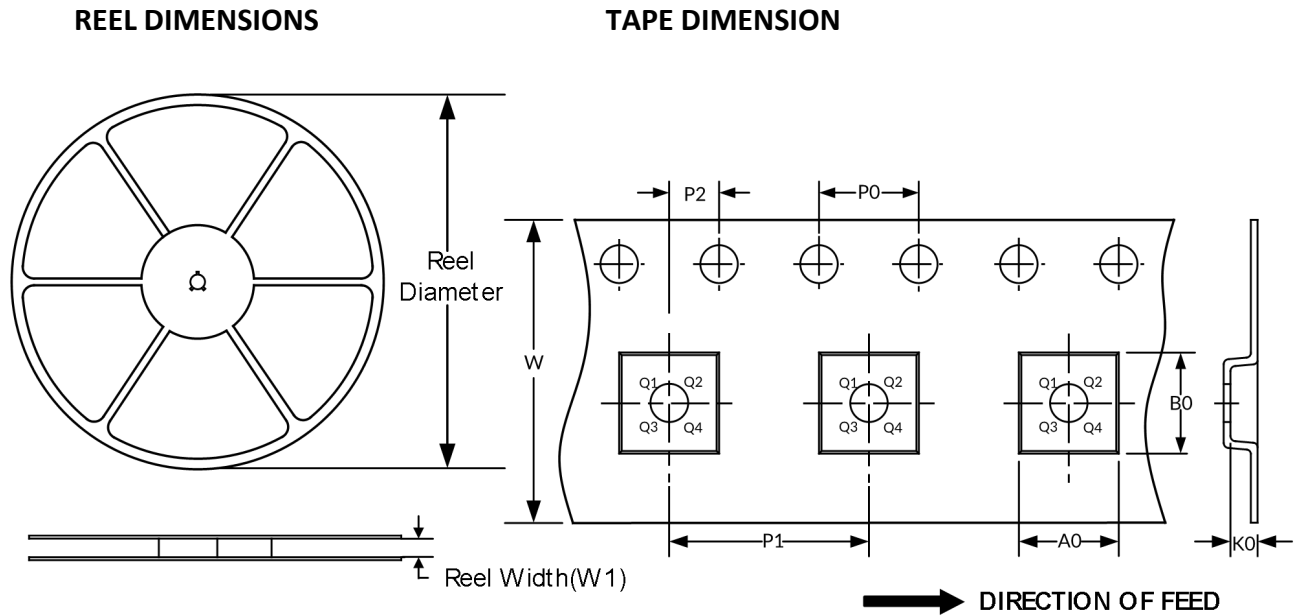
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOT23-5	7''	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOP8	13''	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP8	13''	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOP14	13''	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	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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