

## HIGH SPEED SINGLE SUPPLY OPERATIONAL AMPLIFIER

### ■FEATURES

- High Slew Rate 10V/μs
- High Bandwidth 3MHz
- High Unity Gain Frequency 3.6MHz
- Input Offset Voltage 5.5mV max.
- Single Supply 3V to 36V
- Operating Temperature Range -40°C to +125°C
- Low input voltage around GND level
- Unity-Gain Stable
- No Phase Reversal
- High EMI Immunity
- Output Short-Circuit Protection
- Operating Current (All amplifiers)
  - NJM3472 4mA
  - NJM3474 8mA
- Package
  - NJM3472 SOP8, SSOP8, MSOP8(VSP8)
  - NJM3474 SOP14, SSOP14

### ■GENERAL DESCRIPTION

The NJM3472/NJM3474 are high speed single supply operational amplifier.

10V/μs slew rate, 3MHz gain bandwidth and 5.5mV max. offset voltage are suitable for inverter current sense application, motor load current sense application and active filter.

As a further feature, operation voltage range from 3V to 36V and operation temperature range from -40 to +125°C are suitable for general-purpose inverters, power supply unit and high performance home appliance. Compared with the TL3472/TL3474, the characteristics of low-power are improved.

### ■APPLICATIONS

- Motor, Inverter Current Sense Application
- Power Supply Application
- Buffer Application Amplifier
- Active filter

### ■PIN CONFIGURATION / PRODUCT INFORMATION

PIN FUNCTION	<p>(Top View)</p> <p>1 A OUTPUT, 2 A -INPUT, 3 A +INPUT, 4 V-, 5 B +INPUT, 6 B -INPUT, 7 B OUTPUT, 8 V+</p>			<p>(Top View)</p> <p>1 A OUTPUT, 2 A -INPUT, 3 A +INPUT, 4 V+, 5 B +INPUT, 6 B -INPUT, 7 B OUTPUT, 8 C OUTPUT, 9 C -INPUT, 10 C +INPUT, 11 V-, 12 D +INPUT, 13 D -INPUT, 14 D OUTPUT</p>		
PACKAGE	<p>SOP8</p>	<p>SSOP8</p>	<p>MSOP8(VSP8)</p>	<p>SOP14</p>	<p>SSOP14</p>	
PART NUMBER	NJM3472G	NJM3472V	NJM3472R	NJM3474G	NJM3474V	

## ■ABSOLUTE MAXIMUM RATINGS (Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	40 <sup>(5)</sup>	V
Differential Input Voltage <sup>(1)</sup>	$V_{ID}$	$\pm 40$ <sup>(2)</sup>	V
Input Voltage <sup>(2)</sup>	$V_{IN}$	$V^- - 0.3$ to $V^- + 40$	V
Output Terminal Input Voltage	$V_O$	$V^- - 0.3$ to $V^+ + 0.3V$	V
Power Dissipation <sup>(3)</sup>	$P_D$	(2-layer / 4-layer)	mW
SOP8		780 / 1200	
SSOP8		510 / 650	
MSOP8(VSP8)		600 / 810	
SOP14		1200 / 1900	
SSOP14		600 / 770	
Output Short-Circuit Duration <sup>(4)</sup>		infinite	
Operating Temperature Range	$T_{opr}$	-40 to +125	°C
Storage Temperature Range	$T_{stg}$	-55 to +150	°C

(1) Differential voltage is the voltage difference between +INPUT and -INPUT.

(2) Input voltage should be allowed to apply to the input terminal independent of the magnitude of  $V^+$ . The normal operation will establish when any input is within the Common Mode Voltage Range of electrical characteristics.

(3) Power dissipation is the power that can be consumed by the IC at Ta=25°C, and is the typical measured value based on JEDEC condition. When using the IC over Ta=25°C subtract the value [mW/°C]=PD/(Tstg(MAX)-25) per temperature.

2-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 2layers, FR-4) mounting

4-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 4layers, FR-4) mounting

(4) Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.

(5) Supply Voltage is the voltage difference between  $V^+$  and  $V^-$ .

Figure1A. Power Dissipation vs. Temperature

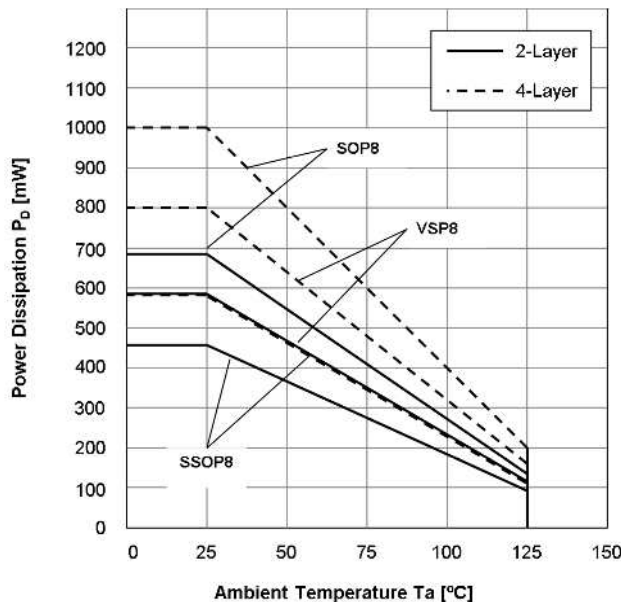
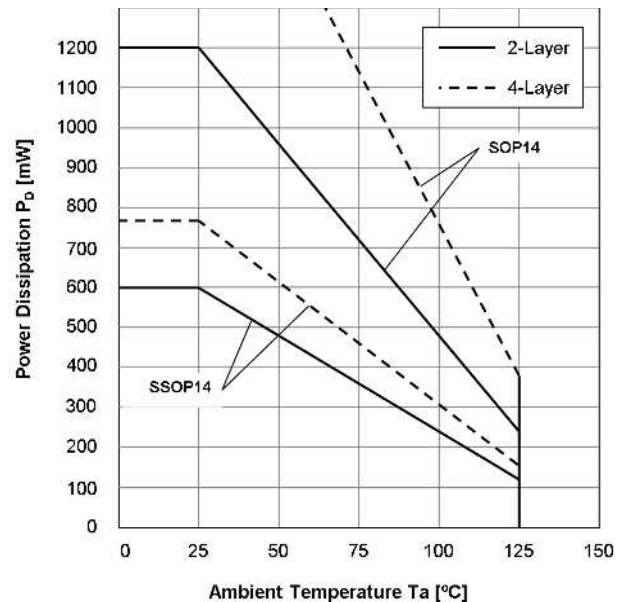


Figure1B. Power Dissipation vs. Temperature



## ■RECOMMENDED OPERATING CONDITIONS (Ta=25°C)

PARAMETER	Supply Voltage	UNIT
Supply Voltage	+3 to +36 (±1.5 to ±18)	V

## ■ELECTRICAL CHARACTERISTICS ( $V^+=+15V$ , $V^-=-15V$ , $V_{CM}=0V$ , $T_a=25^\circ C$ unless otherwise noted)

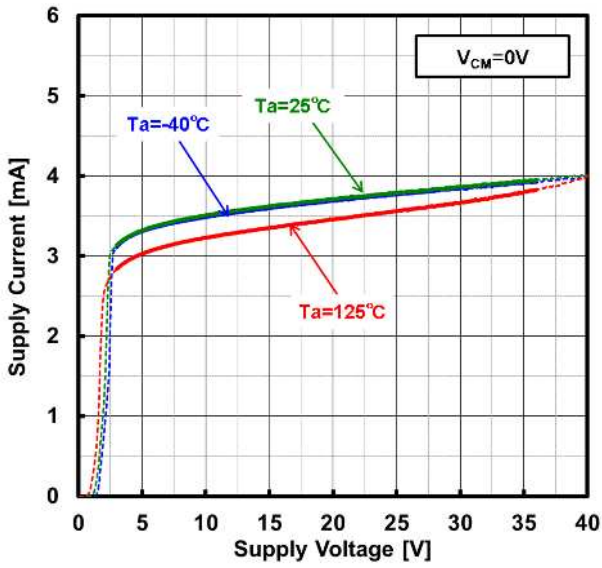
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{IO}$	$R_S=50\Omega$ , $V_{CM}=0V$	-	1	5.5	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a=-40^\circ C\sim+125^\circ C$	-	10	-	$\mu V/^\circ C$
Input Bias Current	$I_B$		-	80	150	nA
Input Offset Current	$I_{IO}$		-	5	75	nA
Open-Loop Voltage Gain	$A_V$	$V_O=\pm 10V$ , $R_L=2k\Omega$ to $0V$	80	95	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=-15V$ to $13.0V$	60	100	-	dB
Common Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 60$ dB	$V^-$	-	$V^+-2.0$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{OH}$	$R_L=10k\Omega$ to $0V$	13.7	14	-	V
		$R_L=2k\Omega$ to $0V$	13.5	13.8	-	
Low-level Output Voltage	$V_{OL}$	$R_L=10k\Omega$ to $0V$	-	-14.8	-14.3	V
		$R_L=2k\Omega$ to $0V$	-	-13.8	-13.5	
Output Source Current	$I_{SOURCE}$	$V_O=0V$ , +Input= $+1V$ , -Input= $0V$	10	35	-	mA
Output Sink Current	$I_{SINK}$	$V_O=0V$ , +Input= $0V$ , -Input= $+1V$	20	60	-	mA
<b>POWER SUPPLY</b>						
Supply Current (All amplifiers) NJM3472 NJM3474	$I_{SUPPLY}$	No Signal, $R_L=\infty$	-	4	5	mA
			-	8	10	
Supply Voltage Rejection Ratio	SVR	$V^+/V^-=\pm 2V$ to $\pm 18V$ , $V_{ICM}=0V$	60	95	-	dB
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $f=100kHz$	-	3	-	MHz
Unity Gain Frequency	$f_T$	$R_L=2k\Omega$ to $0V$	-	3.6	-	MHz
Slew Rate	SR	$G_V=0dB$ , $V_{in}=-10V$ to $+10V$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$	7.5	10	-	V/ $\mu s$
Full Power Bandwidth	FPBW	$G_V=0dB$ , $V_O=20V_{pp}$ , THD=5.0%, $R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	190	-	kHz
Settling Time	$t_s$	$G_V=0dB$ , 10V step To 0.1%	-	1.8	-	$\mu s$
		$G_V=0dB$ , 10V step To 0.01%	-	12	-	
Phase Margin	$\phi_M$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	78	-	deg
		$R_L=2k\Omega$ to $0V$ , $C_L=220pF$	-	68	-	
Gain Margin	$G_M$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	12	-	dB
		$R_L=2k\Omega$ to $0V$ , $C_L=220pF$	-	6	-	
<b>NOISE, THD</b>						
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	48	-	nV/ $\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_V=0dB$ , $f=10kHz$ , $V_O=20V_{pp}$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	0.02	-	%
Channel Separation	CS	$f=1kHz$ , Equivalent Input value	-	120	-	dB

## ■ELECTRICAL CHARACTERISTICS ( $V^+=+5V$ , $V^-=0V$ , $V_{CM}=2.5V$ , $T_a=25^\circ C$ unless otherwise noted)

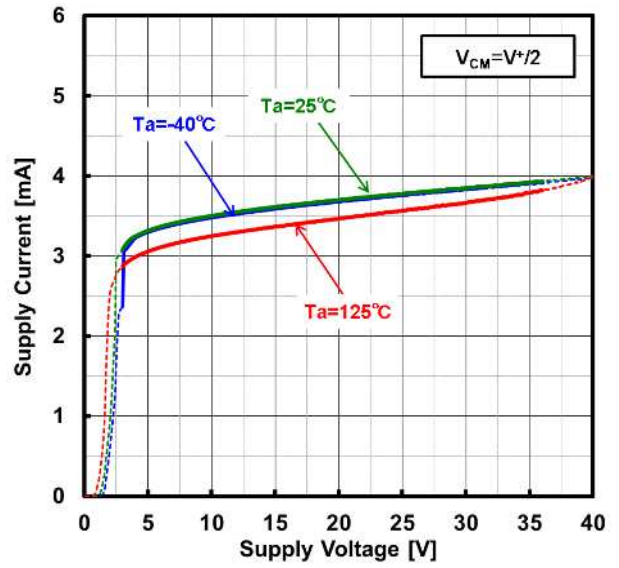
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{IO}$	$R_S=50\Omega$ , $V_{CM}=0V$ , $V_o=V^+/2$	-	1	5.5	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a=-40^\circ C \sim +125^\circ C$	-	10	-	$\mu V/^\circ C$
Input Bias Current	$I_B$	$V_{CM}=V^+/2$ , $V_o=V^+/2$	-	80	150	nA
Input Offset Current	$I_{IO}$	$V_{CM}=V^+/2$ , $V_o=V^+/2$	-	5	75	nA
Open-Loop Voltage Gain	$A_V$	$V_o=1.5V$ to $3.5V$ , $R_L=2k\Omega$ to $V^+/2$	80	95	-	dB
Common Mode Rejection Ratio	CMR	$V_{CM}=0V$ to $3V$	60	90	-	dB
Common Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 60$ dB	$V^-$	-	$V^+-2.0$	V
<b>OUTPUT CHARACTERISTICS</b>						
High-level Output Voltage	$V_{OH}$	$R_L=2k\Omega$ to $0V$	3.7	4	-	V
Low-level Output Voltage	$V_{OL}$	$R_L=2k\Omega$ to $0V$	-	0.1	0.3	V
Output Source Current	$I_{SOURCE}$	$V_o=0V$	10	28	-	mA
Output Sink Current	$I_{SINK}$	$V_o=5V$	20	60	-	mA
<b>POWER SUPPLY</b>						
Supply Current (All amplifiers) NJM3472 NJM3474	$I_{SUPPLY}$	No Signal, $R_L=\infty$	- -	3.3 6.6	4.5 9	mA mA
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$R_L=2k\Omega$ to $0V$ , $f=100kHz$	-	3	-	MHz
Unity Gain Frequency	$f_T$	$R_L=2k\Omega$ to $0V$	-	3.2	-	MHz
Slew Rate	SR	$G_V=0dB$ , $V_{in}=+2V$ to $+3V$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$ ,	5	7	-	V/ $\mu s$
Phase Margin	$\phi_M$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	64	-	deg
Gain Margin	$G_M$	$R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	13	-	dB
<b>NOISE, THD</b>						
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	48	-	nV/ $\sqrt{Hz}$
Total Harmonic Distortion + Noise	THD+N	$G_V=6dB$ , $f=1kHz$ , $V_o=2V_{pp}$ , $R_L=2k\Omega$ to $0V$ , $C_L=20pF$	-	0.01	-	%
Channel Separation	CS	$f=1kHz$ , Equivalent Input value	-	120	-	dB

■ ELECTRICAL CHARACTERISTICS

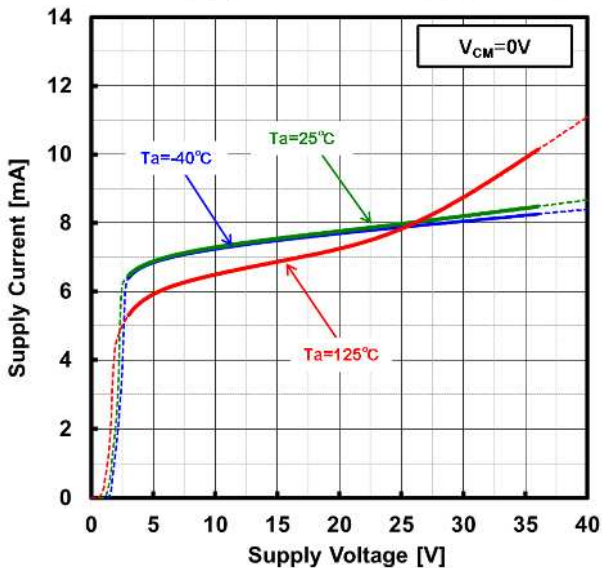
NJM3472 : Supply Current vs. Supply Voltage



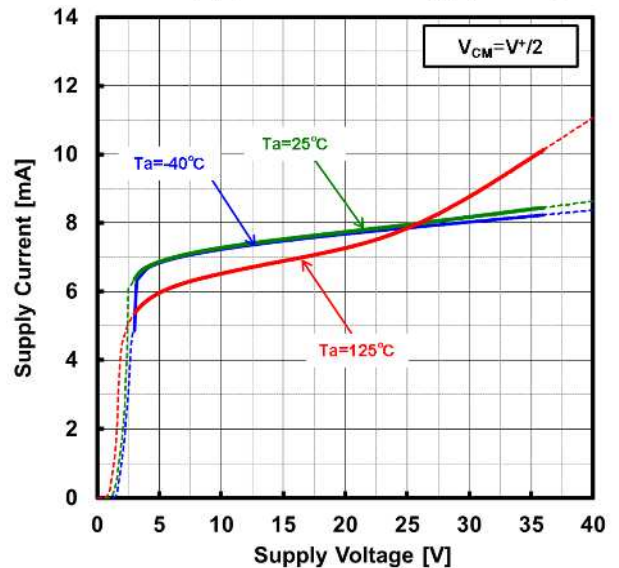
NJM3472 : Supply Current vs. Supply Voltage



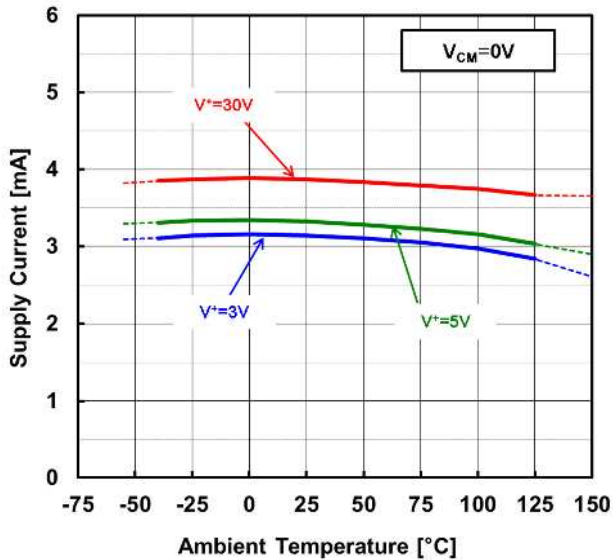
NJM3474 : Supply Current vs. Supply Voltage



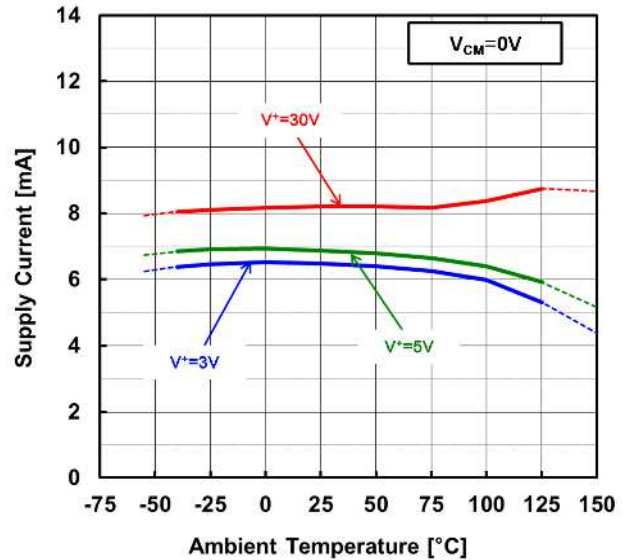
NJM3474 : Supply Current vs. Supply Voltage



NJM3472 : Supply Current vs. Temperature

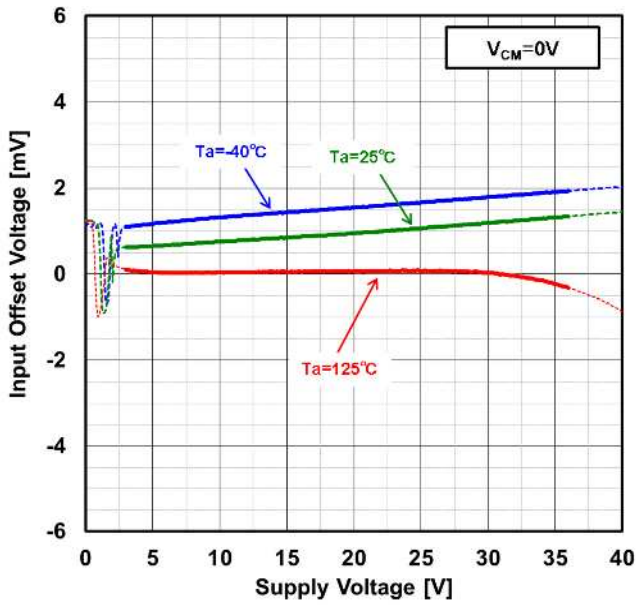


NJM3474 : Supply Current vs. Temperature

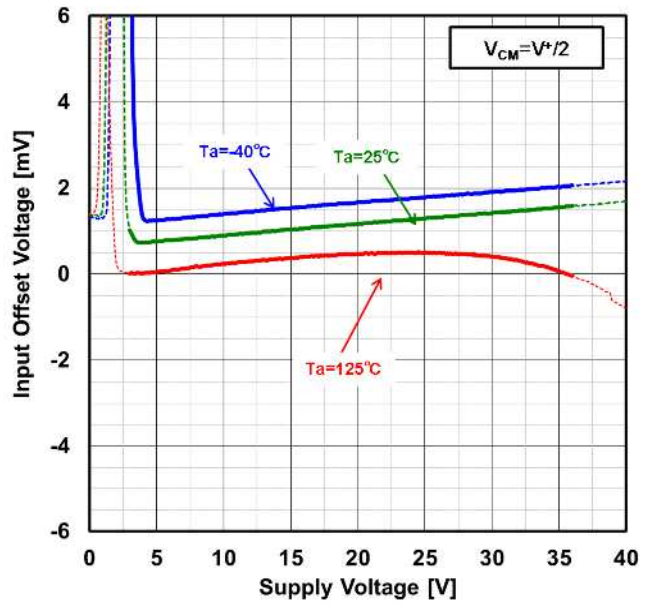


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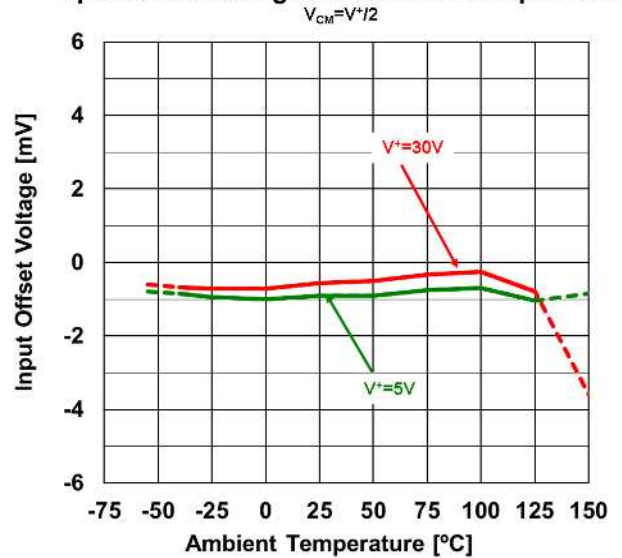
Input Offset Voltage vs. Supply Voltage



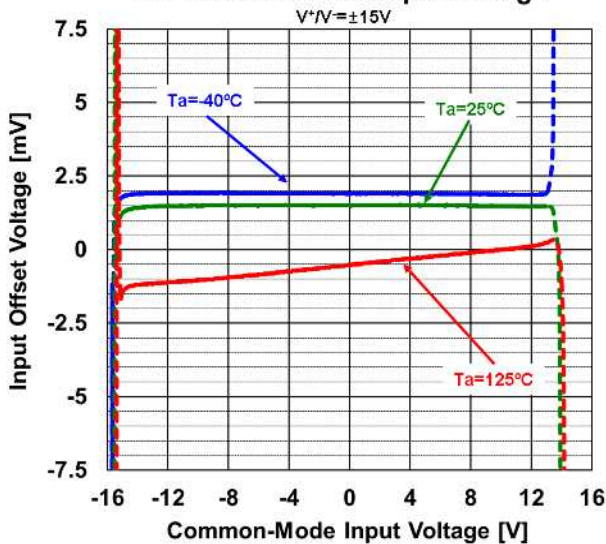
Input Offset Voltage vs. Supply Voltage



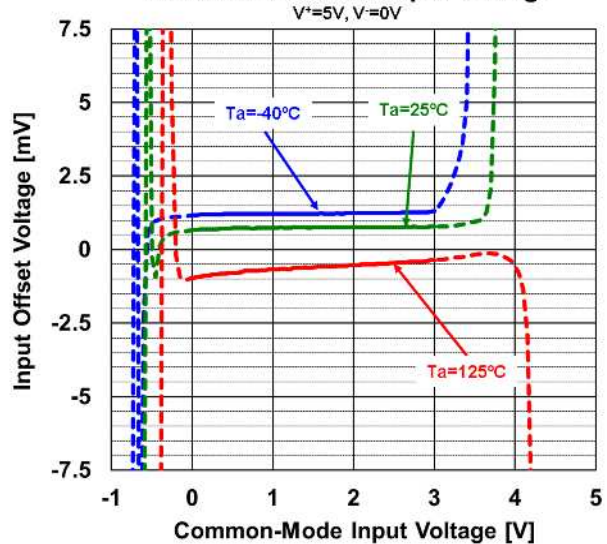
Input Offset Voltage vs. Ambient Temperature



Input Offset Voltage vs. Common-Mode Input Voltage

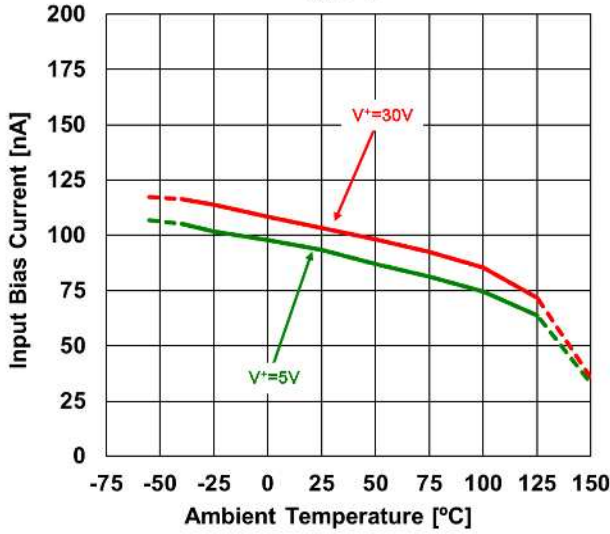


Input Offset Voltage vs. Common-Mode Input Voltage

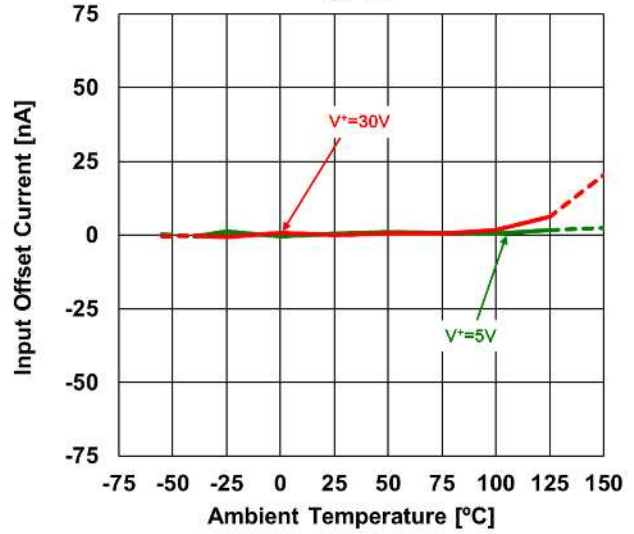


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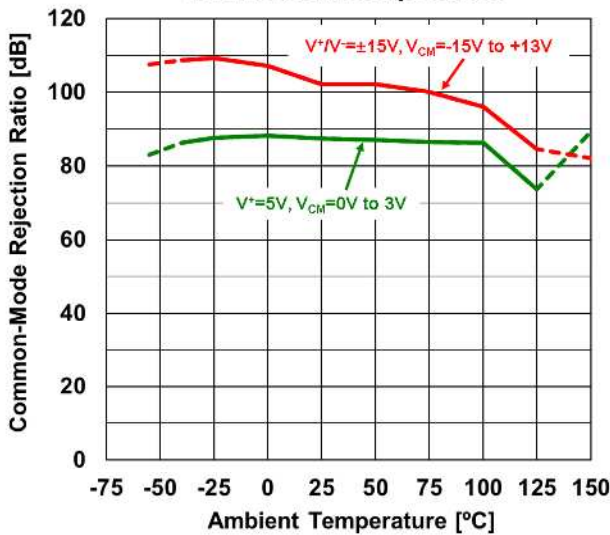
Input Bias Current vs. Ambient Temperature  
 $V_{CM} = V^*/2$



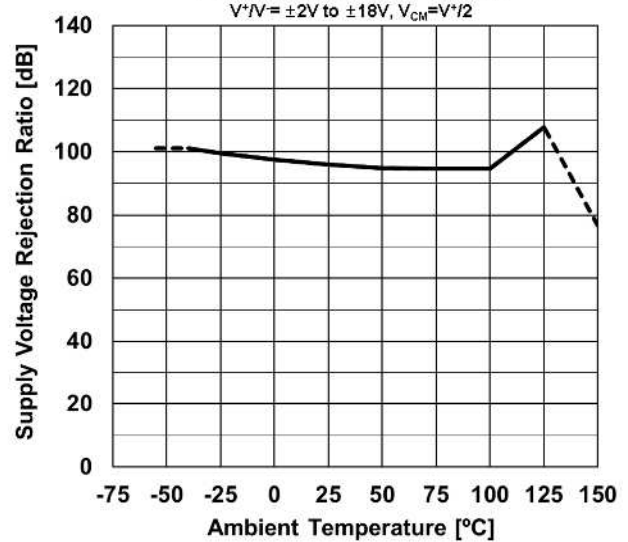
Input Offset Current vs. Ambient Temperature  
 $V_{CM} = V^*/2$



Common-Mode Rejection Ratio vs. Ambient Temperature

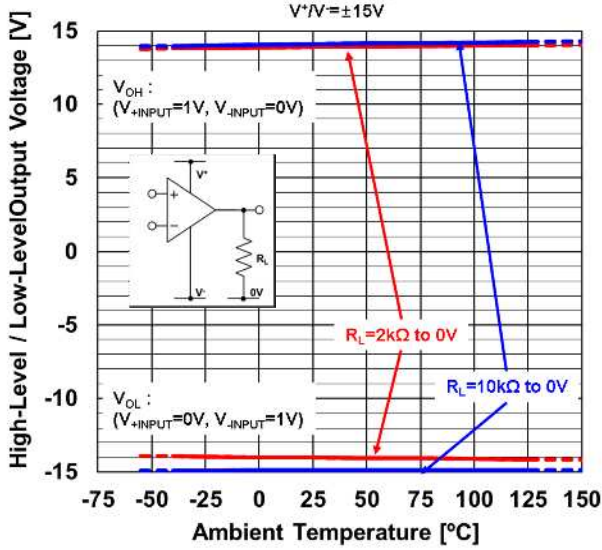


Supply Voltage Rejection Ratio vs. Ambient Temperature  
 $V^*/V = \pm 2V$  to  $\pm 18V$ ,  $V_{CM} = V^*/2$

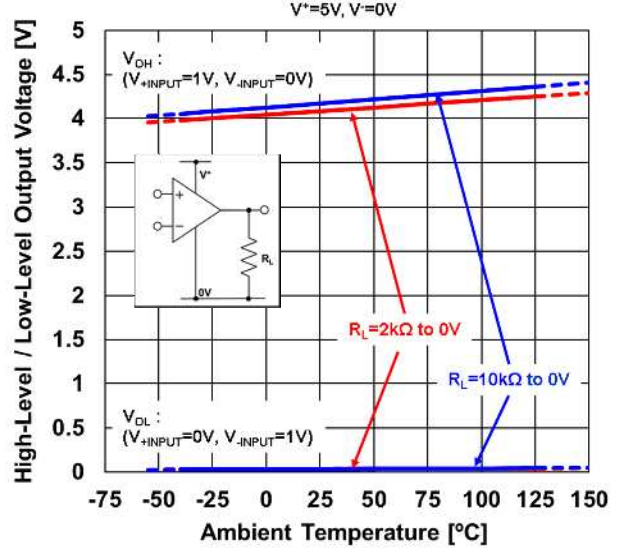


## ELECTRICAL CHARACTERISTICS

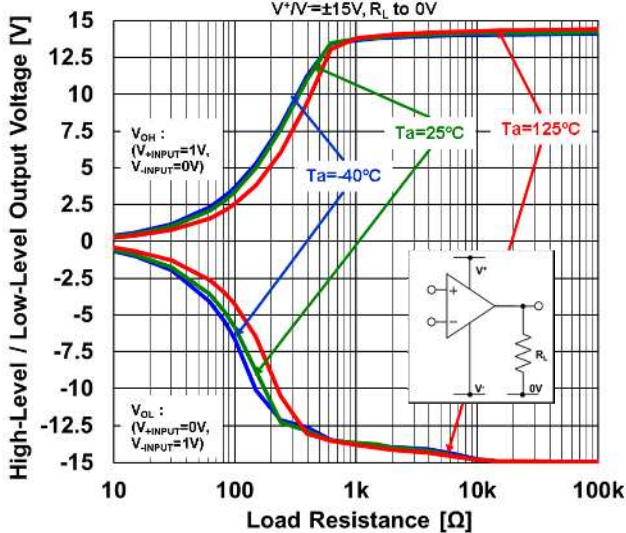
High-Level / Low-Level Output Voltage vs. Ambient Temperature



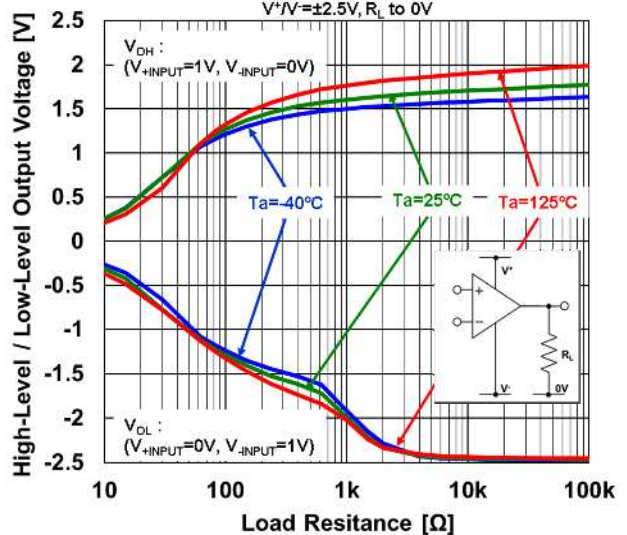
High-Level / Low-Level Output Voltage vs. Ambient Temperature



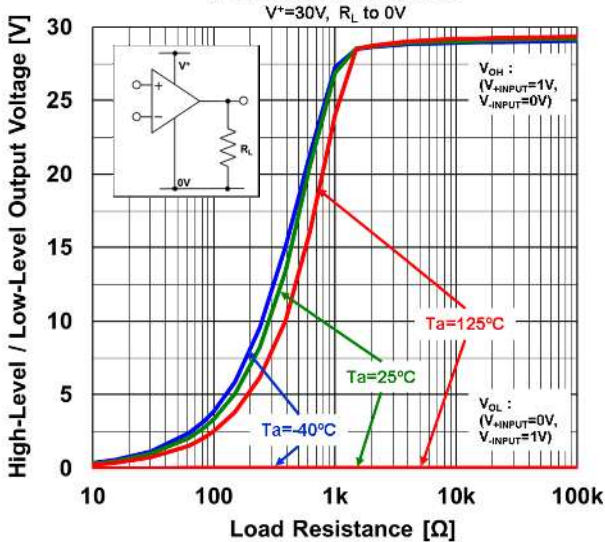
High-Level / Low-Level Output Voltage vs. Load Resistance



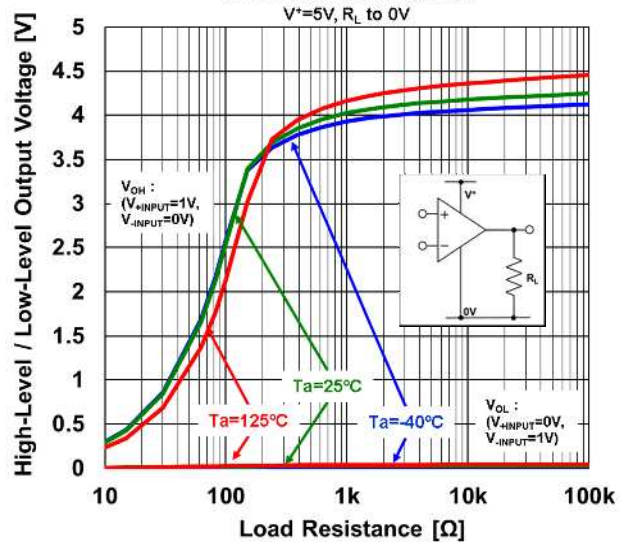
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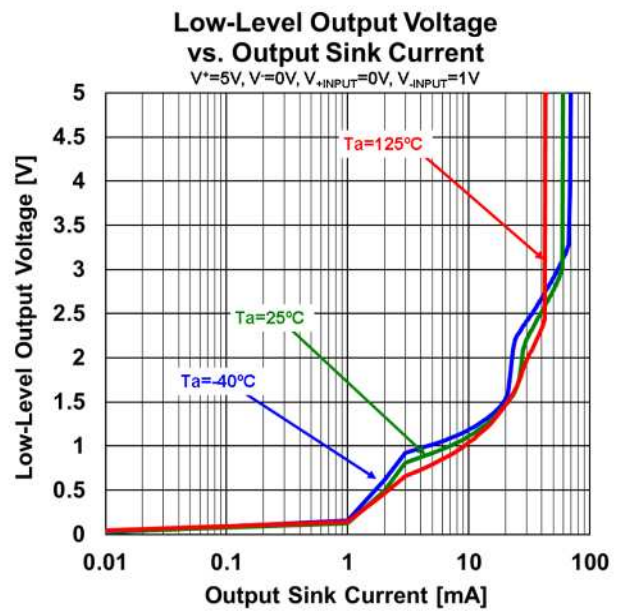
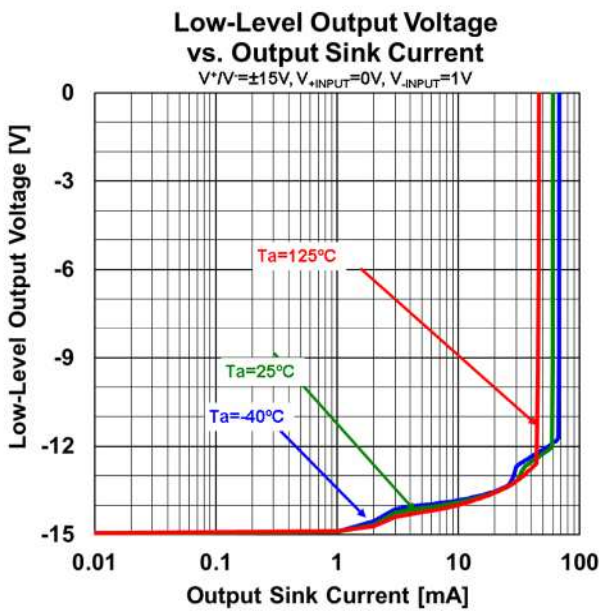
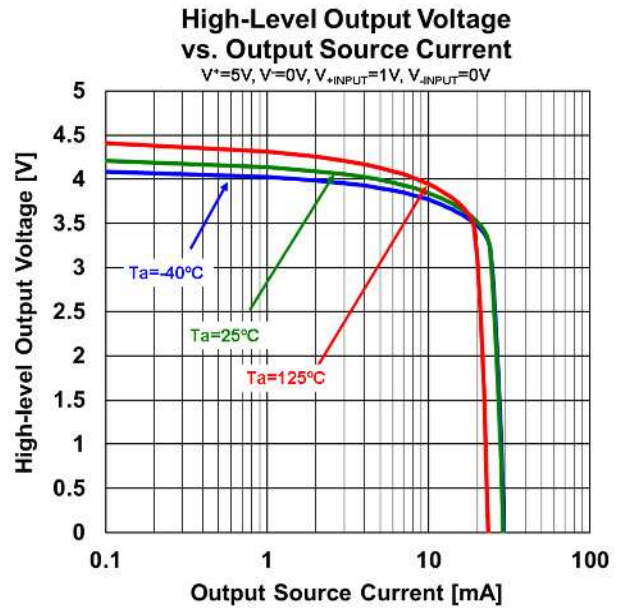
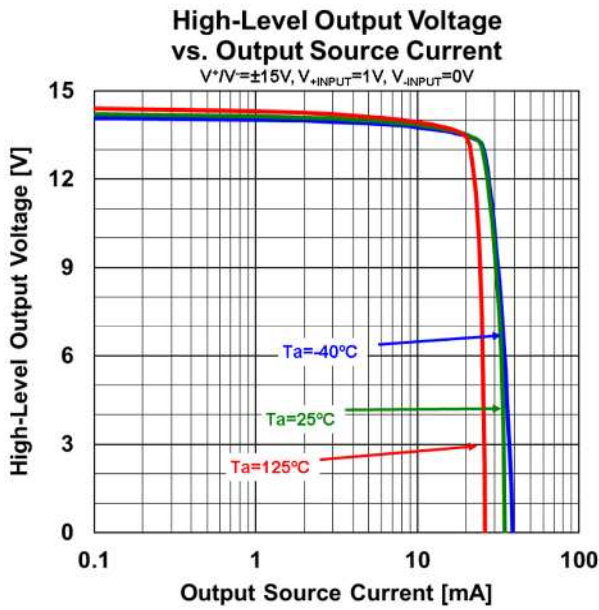


High-Level / Low-Level Output Voltage vs. Load Resistance





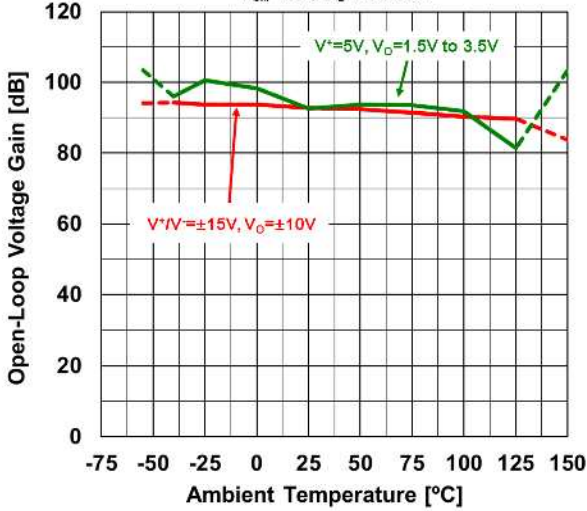
■ ELECTRICAL CHARACTERISTICS



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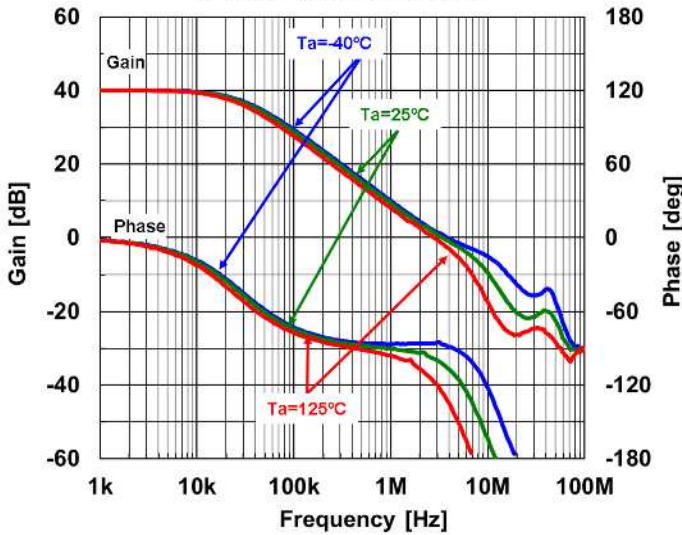
Open-Loop Voltage Gain vs. Ambient Temperature

$V_{CM}=V^*/2$ ,  $R_L=2k\Omega$  to  $0V$



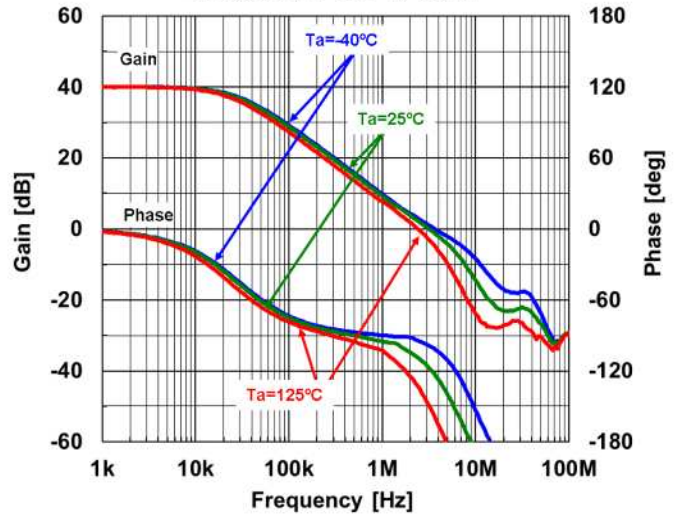
40dB Voltage Gain / Phase vs. Frequency

$V^*/V=\pm 15V$ ,  $G_v=40dB$ ,  $R_F=100k\Omega$ ,  $R_S=1k\Omega$ ,  $R_L=2k\Omega$  to  $0V$ ,  $C_L=20pF$ ,  $V_{IN}=-30dBm$



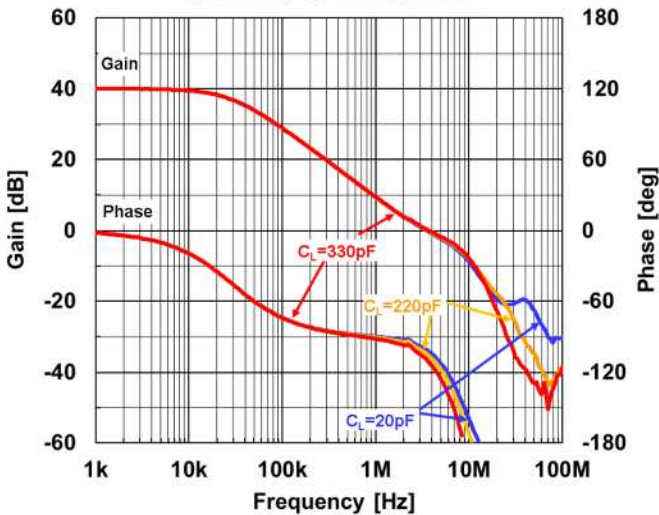
40dB Voltage Gain / Phase vs. Frequency

$V^*=5V$ ,  $V=0V$ ,  $G_v=40dB$ ,  $R_F=100k\Omega$ ,  $R_S=1k\Omega$ ,  $R_L=2k\Omega$  to  $0V$ ,  $C_L=20pF$ ,  $V_{IN}=-30dBm$



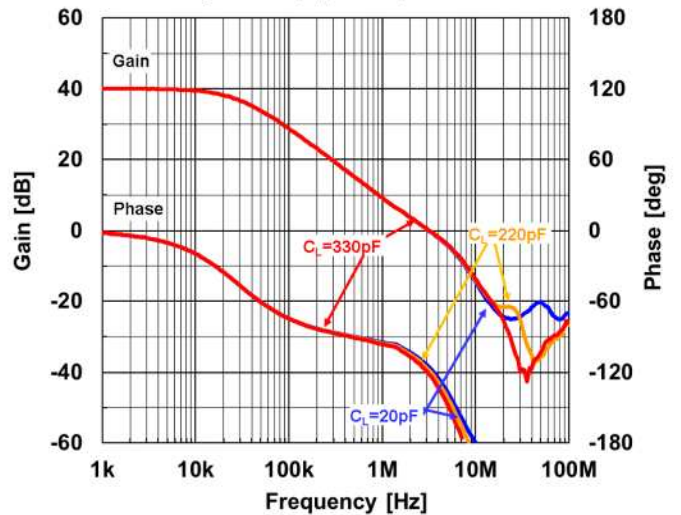
40dB Voltage Gain / Phase vs. Frequency

$V^*/V=\pm 15V$ ,  $G_v=40dB$ ,  $R_F=100k\Omega$ ,  $R_S=1k\Omega$ ,  $R_L=2k\Omega$  to  $0V$ ,  $V_{IN}=-30dBm$ ,  $T_a=25^\circ C$



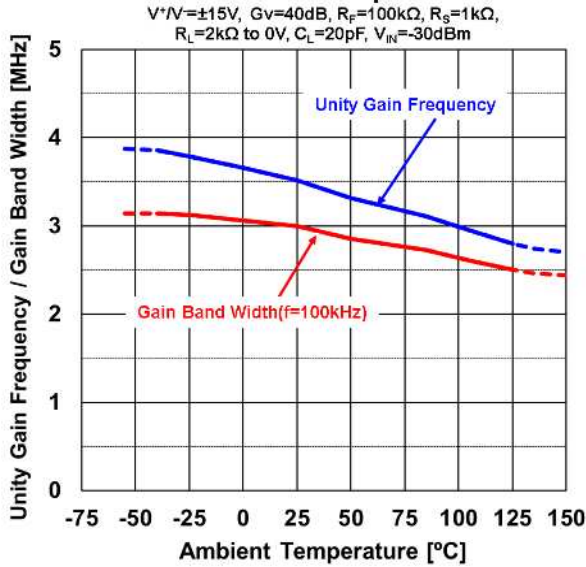
40dB Voltage Gain / Phase vs. Frequency

$V^*=5V$ ,  $V=0V$ ,  $G_v=40dB$ ,  $R_F=100k\Omega$ ,  $R_S=1k\Omega$ ,  $R_L=2k\Omega$  to  $0V$ ,  $V_{IN}=-30dBm$ ,  $T_a=25^\circ C$

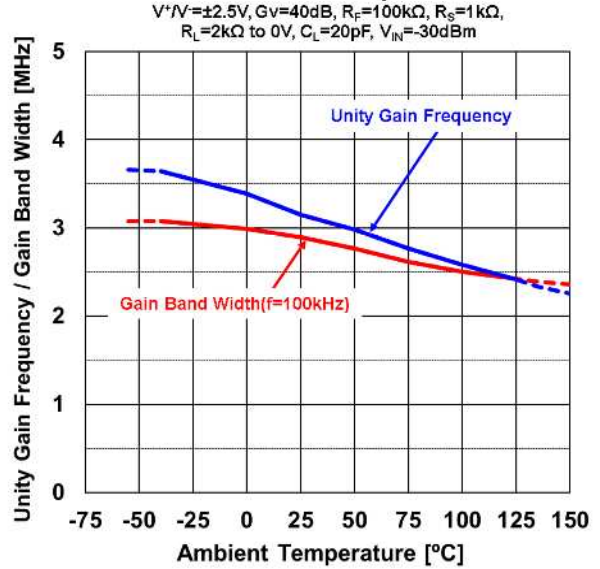


■ ELECTRICAL CHARACTERISTICS

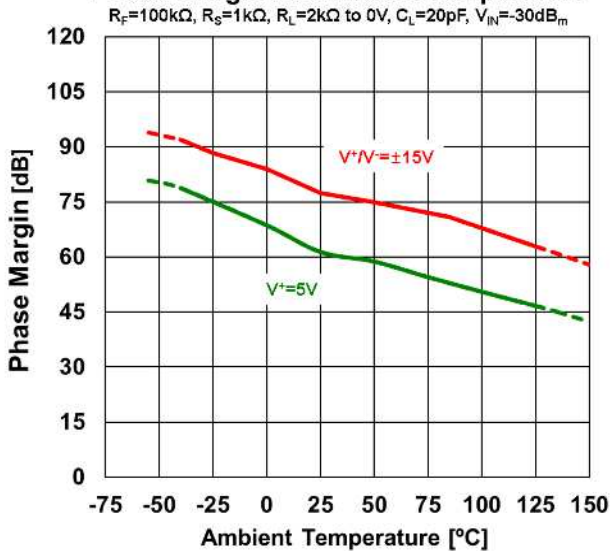
Unity Gain Frequency / Gain Band Width vs. Ambient Temperature



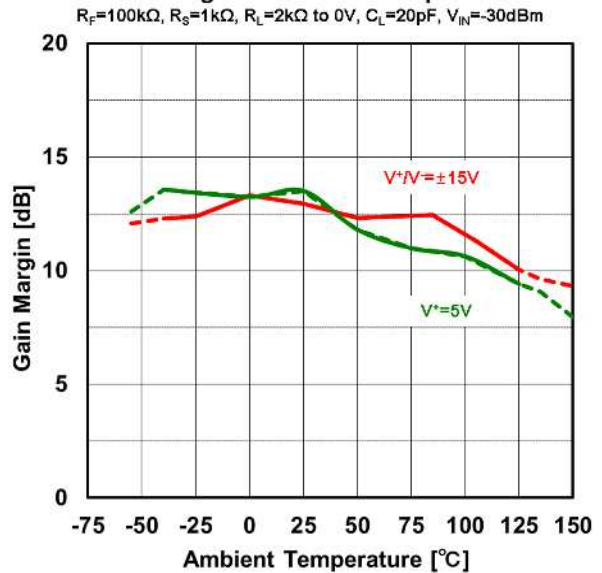
Unity Gain Frequency / Gain Band Width vs. Ambient Temperature



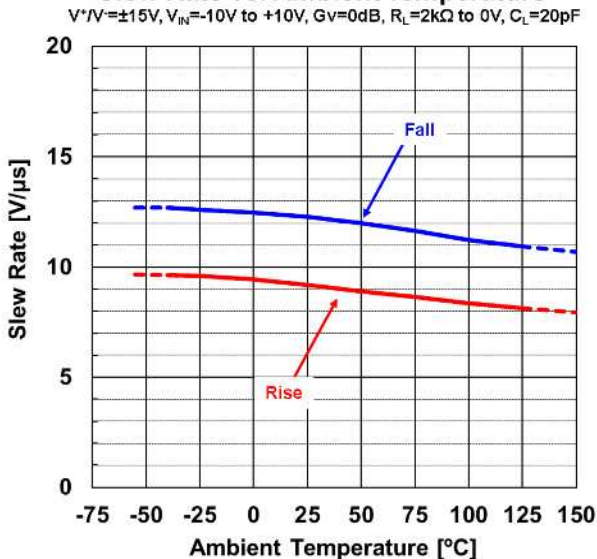
Phase Margin vs. Ambient Temperature



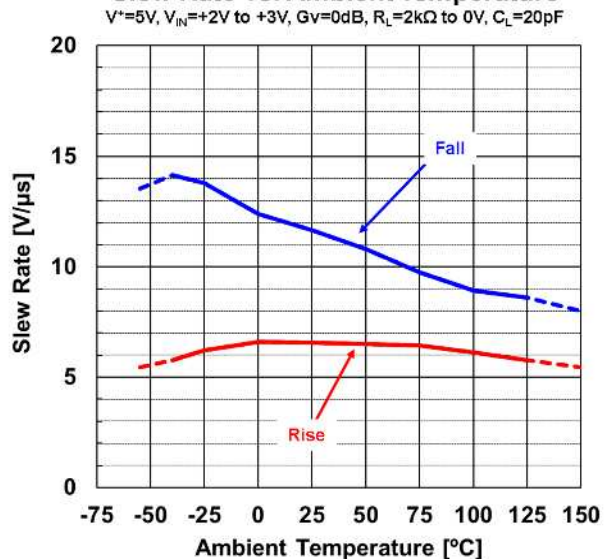
Gain Margin vs. Ambient Temperature



Slew Rate vs. Ambient Temperature



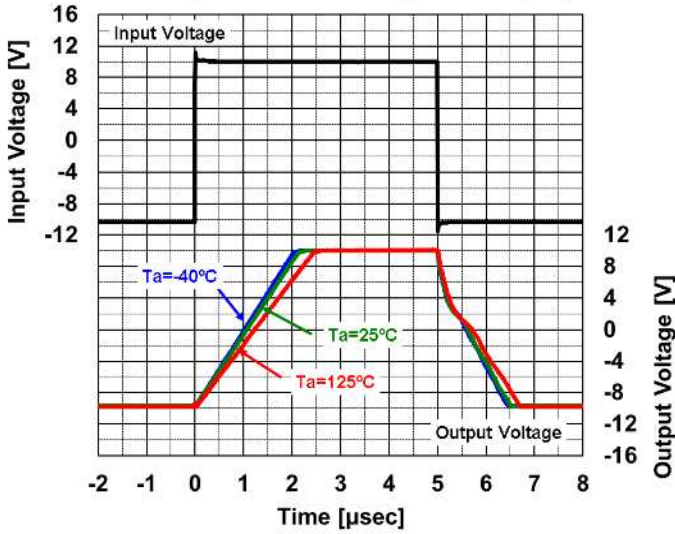
Slew Rate vs. Ambient Temperature



■ ELECTRICAL CHARACTERISTICS

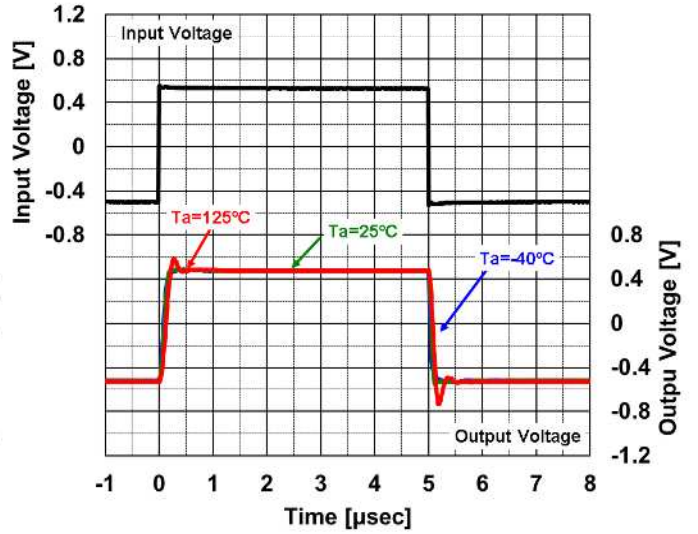
**Pulse Response**

$V^+V^-=\pm 15V, V_{IN}=-10$  to  $+10V, G_v=0dB, R_L=2k\Omega$  to  $0V, C_L=20pF$



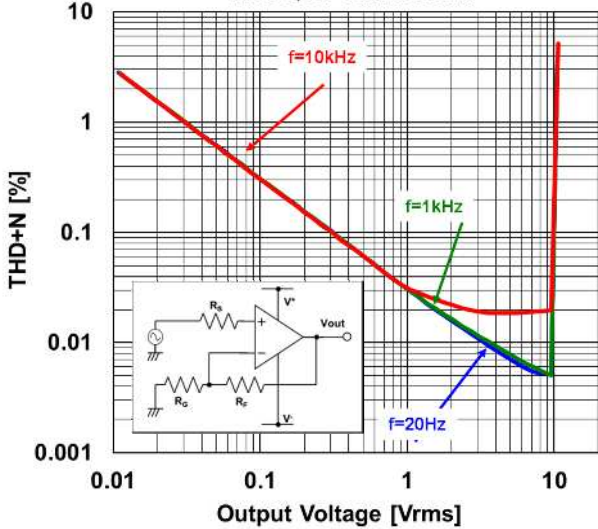
**Pulse Response**

$V^+=5V, V^-=0V, V_{IN}=-0.5$  to  $+0.5V, G_v=0dB, R_L=2k\Omega$  to  $0V, C_L=20pF$



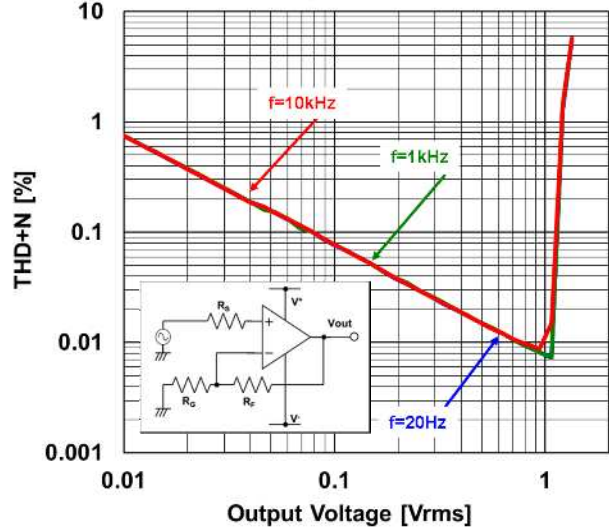
**THD + N vs. Output Voltage**

$V^+V^-=\pm 15V, G_v=20dB, R_G=200\Omega, R_F=2k\Omega, R_S=10k\Omega, Ta=25^\circ C, BW=10Hz$  to  $500kHz$



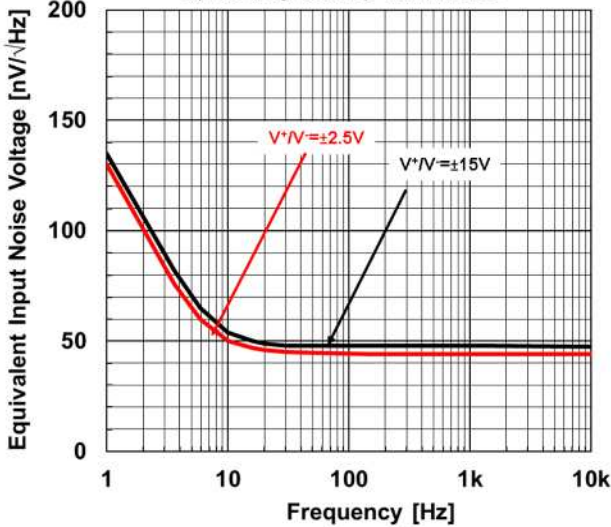
**THD + N vs. Output Voltage**

$V^+V^-=\pm 2.5V, G_v=6dB, R_G=1k\Omega, R_F=1k\Omega, R_S=10k\Omega, Ta=25^\circ C, BW=10Hz$  to  $500kHz$

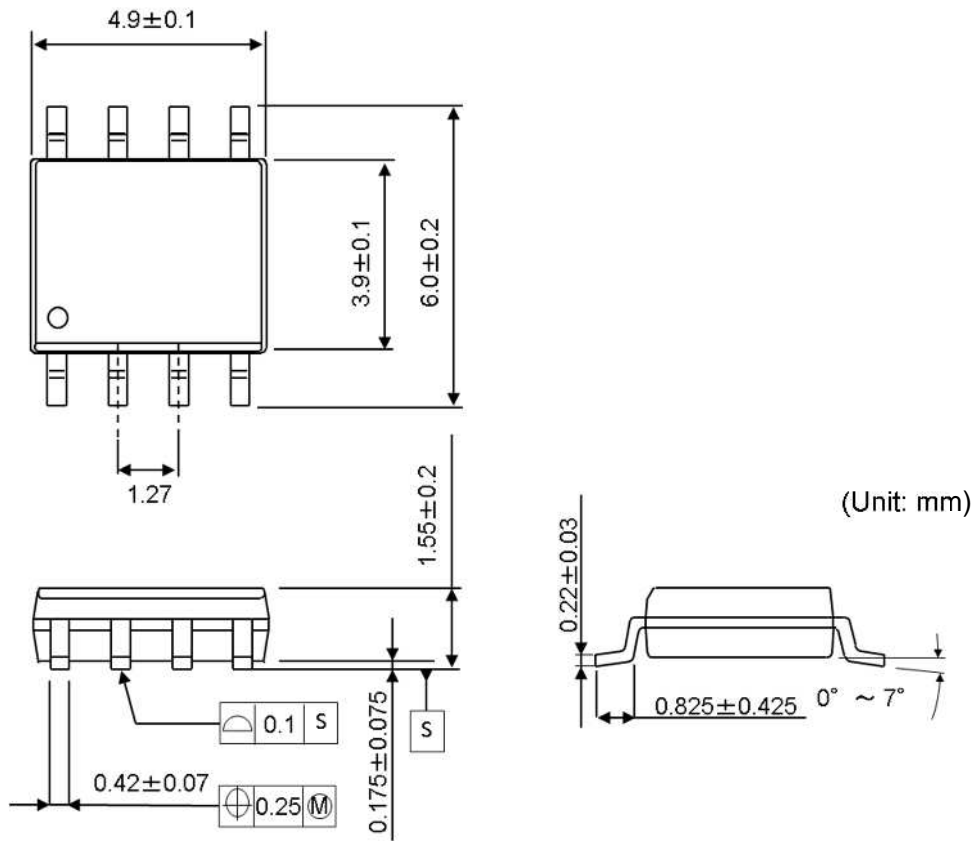


**Voltage Noise Deisity vs. Frequency**

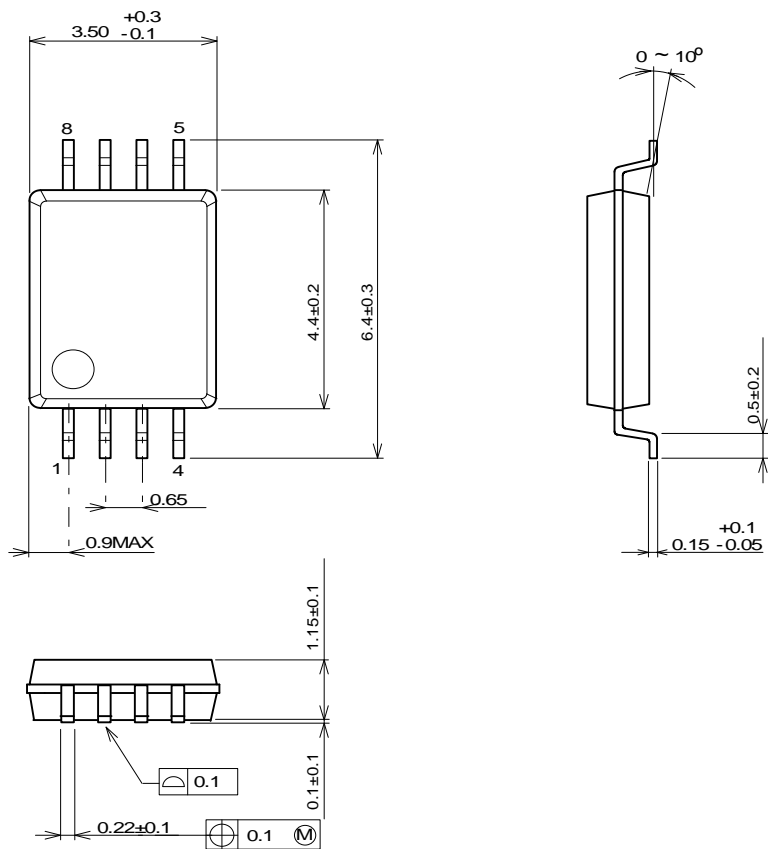
$G_v=40dB, R_S=100\Omega, R_F=10k\Omega, Ta=25^\circ C$



■ PACKAGE DIMENSIONS

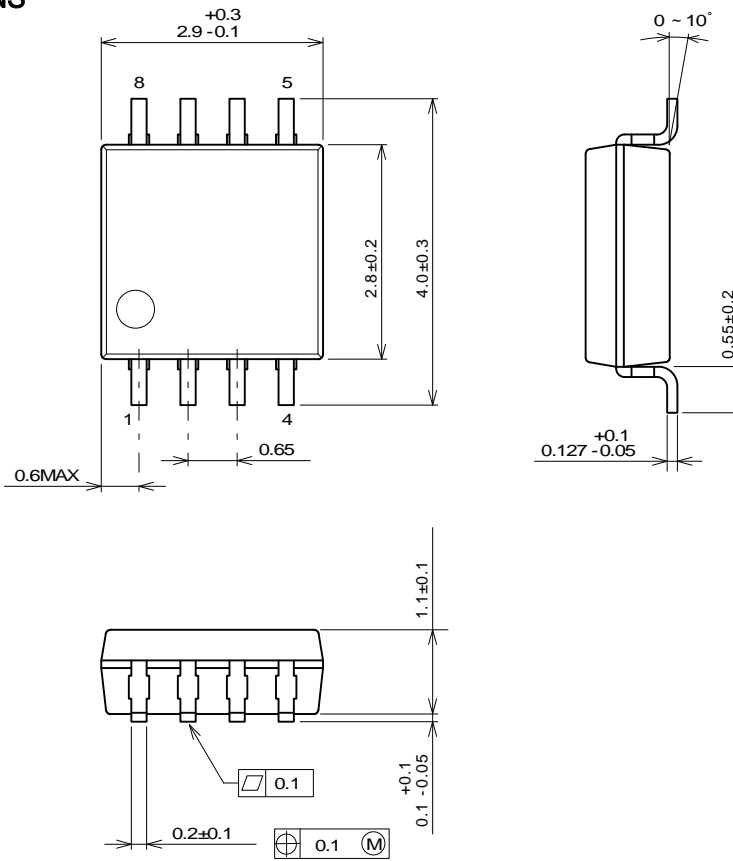


SOP8 Package



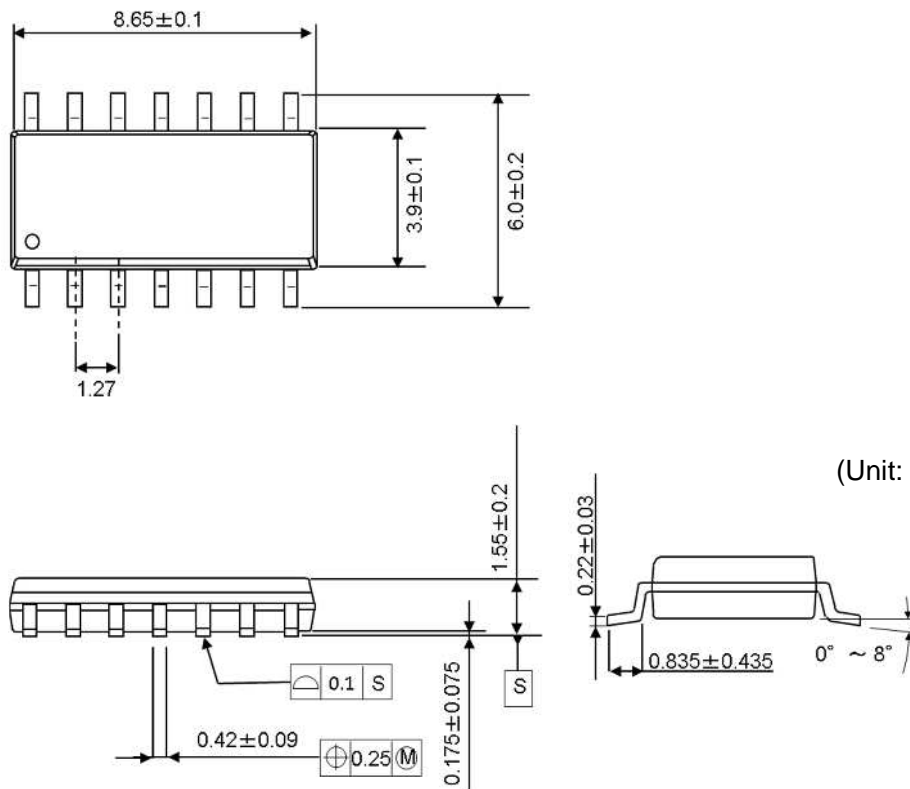
SSOP8 Package

## PACKAGE DIMENSIONS



(Unit: mm)

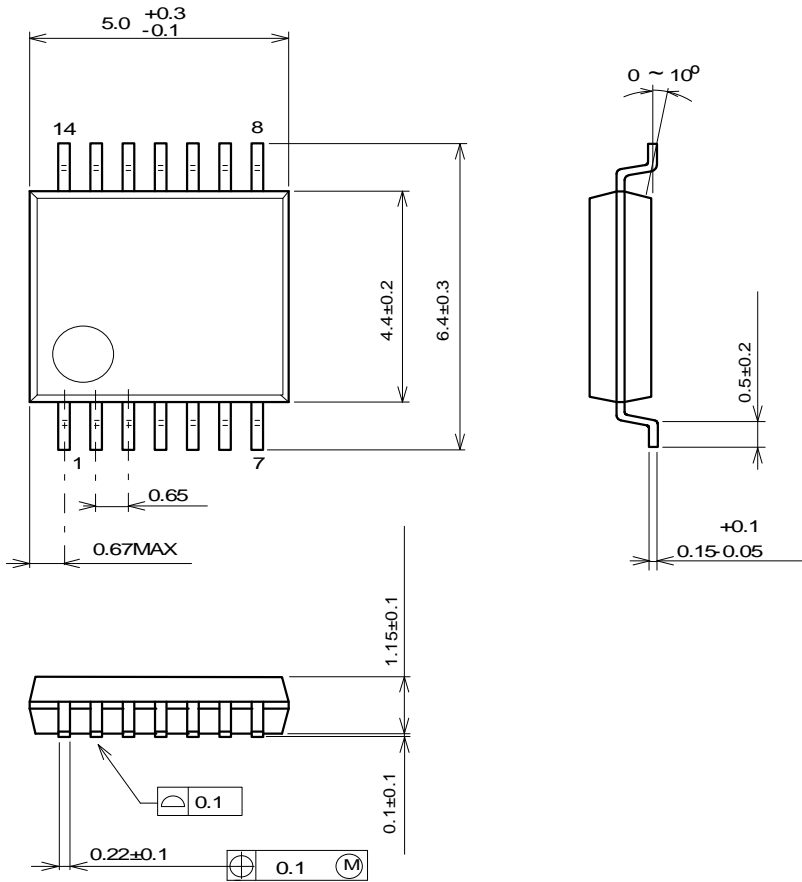
**MSOP8 (VSP8) JEDEC MO-187-DA / thin type Package**



(Unit: mm)

**SOP14 Package**

■PACKAGE DIMENSIONS



(Unit: mm)

SSOP14 Package

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