Precision, JFET Input Operational Amplifier

■ FEATURES

●Low Input Offset Voltage	V_{IO}=400μV max.
	V_{IO}=700μV max.
	(Ta= -40°C to +125°C)
●Low Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$=5μV/°C max.
	(Ta= -40°C to +125°C)
●Low Supply Current	Icc=1.3mA /ch typ.
●High Slew Rate	SR=20V/μs typ.
●Wide Bandwidth	ft=7MHz typ.
●Low Noise	en=10nV/√Hz typ. (at f=1kHz)
●Low Input Bias Current	I_B=80pA max. (at Ta=25°C)
●No Phase Reversal	
●RF noise Immunity	
●Guaranteed Temperature	Topr= -40°C to +125°C
●Operating Voltage	Vopr=±4.5V to ±16V
●Package	
NJM8512	MSOP8 (VSP8) meet JEDEC MO-187-DA
	SOP8 JEDEC 150 mil
NJM8513	SSOP14

■GENERAL DESCRIPTION

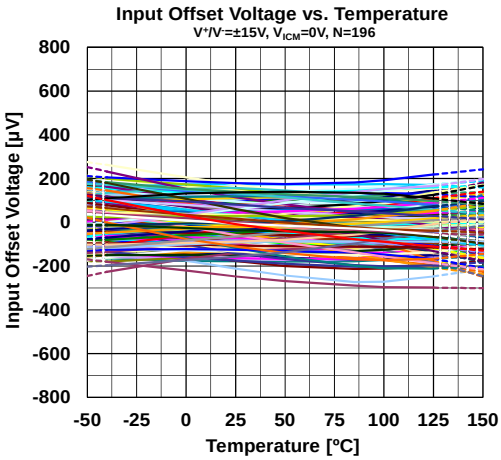
The NJM8512/NJM8513 are Dual/Quad high precision JFET input operational amplifier featuring low offset, low offset drift,low bias current, high slew rate, low noise and wide operating temperature range.

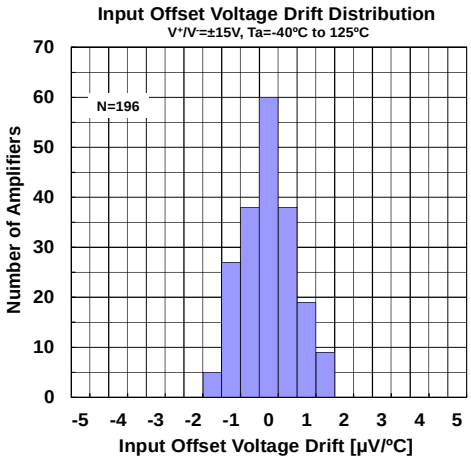
The precision performance, high speed and low noise make the NJM8512/NJM8513 especially suitable for filter and amplification of high speed and small signal in instruments, automated test equipment, sensors and other precision applications.

■APPLICATIONS

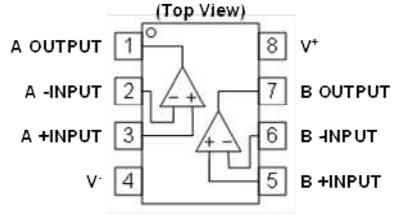
●Current Sensor
●Photodiode Amplification
●Reference Voltage Circuit
●Automatic Test Equipment

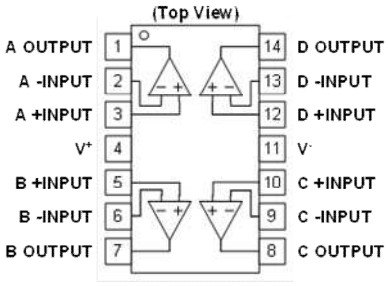
■ ELECTRICAL CHARACTERISTICS





■PIN CONFIGURATION





Pin Function			
Package Outline	MSOP8	SOP8	SSOP14
PART NUMBER	NJM8512AR NJM8512BR	NJM8512AE NJM8512BE	NJM8513AV NJM8513BV

■ ABSOLUTE MAXIMUM RATINGS (Ta=25ºC, unless otherwise noted.)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+/V^-	±18	V
Differential Input Voltage	V_{ID}	±36 (**Note1**)	V
Input Voltage	V_{IN}	V^- - 0.3 to V^+ + 0.3(Note2)	V
Input Current	I_{IN}	±10(Note3)	mA
Power Dissipation MSOP8 (VSP8) SOP8 SSOP14	P_D	(2-layer / 4-layer) 595(Note4) / 805 (Note4) 690 (Note4) / 1000 (Note4) 490 (Note4) / 630 (Note4)	mW
Output Short-Circuit Duration		Infinete(Ta≦25°C) (Note4)	
Operating Temperature Range	T_{opr}	-40 to +125	ºC
Junction Temperature	T_{jmax}	+150	ºC
Storage Temperature Range	T_{stg}	-65 to +150	ºC

(Note1) Differential Input Voltage is the voltage difference between +INPUT and -INPUT.
(Note2) The normal operation will establish when any input is within the Common Mode Input Voltage Range of electrical characteristics.
(Note3) If the input voltage exceeds the supply voltage,the input current must be limited 10 mA or less by using a restriction resistance.
(Note4) 2-layer : EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 2layers, FR-4) mounting.
4-layer : EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 4layers, FR-4) mounting.
See Figure "Fig.1-1 : Power Dissipation Curve" when ambient temperature is over 25°C.

Figure1-A: Power Dissipation Derating Curve

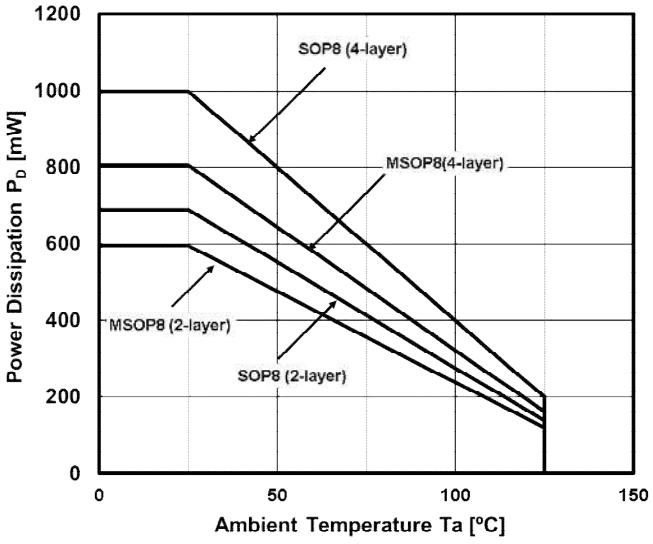
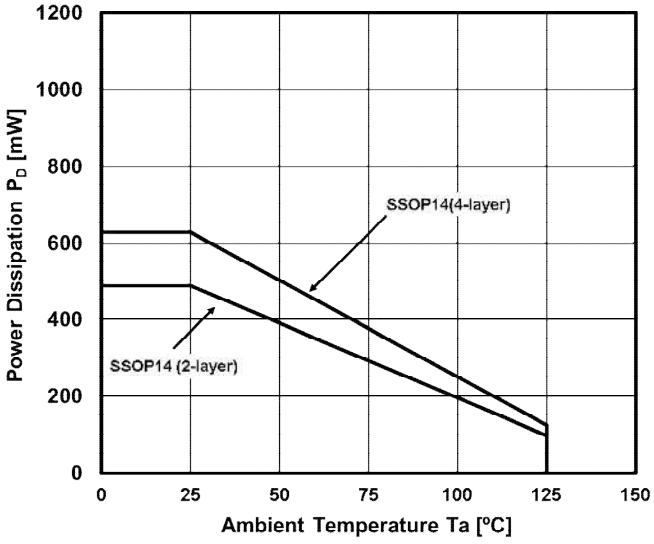


Figure1-B: Power Dissipation Derating Curve



■RECOMMENDED OPERATING VOLTAGE (Ta=25ºC)

PARAMETER	SYMBOL	RATING	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V^+/V^-		±4.5	-	±16	V

■ ELECTRICAL CHARACTERISTICS (V^+/V^-=±15V, Ta=25°C, V_{ICM}=0V, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage						
NJM8512Bx / NJM8513Bx	$V_{IO}1$		-	80	400	µV
	$V_{IO}2$	Ta = -40ºC to 125ºC	-	-	700	µV
NJM8512Ax / NJM8513Ax	$V_{IO}1$		-	80	800	µV
	$V_{IO}2$	Ta = -40ºC to 125ºC	-	-	1400	µV
Input Offset Voltage Drift						
NJM8512Bx / NJM8513Bx	ΔVio/ΔT	Ta = -40ºC to 125ºC	-	0.8	5	µV/ºC
NJM8512Ax / NJM8513Ax	ΔVio/ΔT	Ta = -40ºC to 125ºC	-	1	9	µV/ºC
Input Bias Current	I_B1		-	25	80	pA
	I_B2	Ta = -40ºC to 125ºC	-	-	35	nA
Input Offset Current	$I_{IO}1$		-	6	75	pA
	$I_{IO}2$	Ta = -40ºC to 125ºC	-	-	2	nA
Common Mode Input Voltage Range	$V_{ICM}1$	CMR ≧ 86dB	-12.5	-	+12.5	V
	$V_{ICM}2$	CMR ≧ 80dB, Ta = -40ºC to 125ºC	-12.5	-	+12.5	V
Common Mode Rejection Ratio	CMR1	V_{CM}=-12.5V to +12.5V	86	108	-	dB
	CMR2	V_{CM}=-12.5V to +12.5V, Ta = -40ºC to 125ºC	80	-	-	dB
	CMR3	V_{CM}=-10V to +10V	100	120	-	dB
Voltage Gain	A_V1	R_L=2kΩ, V_O=-13.5V to +13.5V	90	100	-	dB
	A_V2	R_L=2kΩ, V_O=-13.5V to +13.5V, Ta = -40ºC to 125ºC	82	-	-	dB
	A_V3	R_L=10kΩ, V_O=-13.5V to +13.5V	98	106	-	dB
Input capacitance	C_{IN}		-	10	-	pF
Channel Separation	CS	DC	-	125	-	dB
Output Characteristics						
Maximum Output Voltage	$V_{OH}1$	R_L=10kΩ, Ta = -40ºC to 125ºC	+14.0	+14.2	-	V
	$V_{OL}1$	R_L=10kΩ, Ta = -40ºC to 125ºC	-	-14.9	-14.6	V
	$V_{OH}2$	R_L=2kΩ, Ta = -40ºC to 125ºC	+13.8	+14.1	-	V
	$V_{OL}2$	R_L=2kΩ, Ta = -40ºC to 125ºC	-	-14.8	-14.4	V
	$V_{OH}31$	R_L=600Ω	+13.5	+13.9	-	V
	$V_{OH}32$	R_L=600Ω, Ta = -40ºC to 125ºC	+11.4	-	-	V
	$V_{OL}41$	R_L=600Ω	-	-14.3	-13.8	V
	$V_{OL}42$	R_L=600Ω, Ta = -40ºC to 125ºC	-	-	-12.1	V
Supply Characteristics						
Supply Current (ALL Amps) : NJM8512	$I_{CC}1$	G_V=+1, R_L=∞	-	2.6	3.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta = -40ºC to 125ºC	-	-	3.3	mA
Supply Current (ALL Amps) : NJM8513	$I_{CC}1$	G_V=+1, R_L=∞	-	5.2	6.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta = -40ºC to 125ºC	-	-	6.6	mA
Supply Voltage Rejection Ratio	SVR1	V^+/V^- = ±4.5V to ±16V	86	110	-	dB
	SVR2	V^+/V^- = ±4.5V to ±16V, Ta = -40ºC to 125ºC	80	-	-	dB
Dynamic Performance						
Unity Gain Frequency	fT	G_V=+100, R_L=2kΩ, C_L=10pF	-	7	-	MHz
Slew Rate	+SR	RISE, G_V=+1, V_{IN}=2Vpp, R_L=2kΩ	-	20	-	V/µs
	-SR	FALL, G_V=+1, V_{IN}=2Vpp, R_L=2kΩ	-	20	-	V/µs
Settling Time	ts1	To 0.1%, 0V to 10V step, Gv=+1	-	0.7	-	µs
	ts2	To 0.01%, 0V to 10V step, Gv=+1	-	1.0	-	µs
Phase Margin	Φ_M		-	70	-	deg
Total Harmonic Distortion	THD	fo=1kHz, G_V=+1, R_L=2kΩ	-	0.0004	-	%
Noise Performance						
Input Voltage Noise Density	V_{NI}	fo=0.1Hz to 10Hz	-	0.9	-	µVpp
	en1	fo=10Hz	-	20	-	nV/√Hz
	en2	fo=100Hz	-	11	-	nV/√Hz
	en3	fo=1kHz	-	10	-	nV/√Hz
	en4	fo=10kHz	-	9	-	nV/√Hz

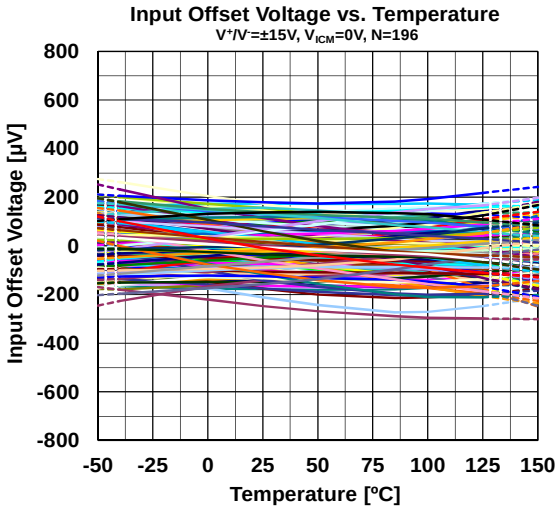
(Note) Measurement is to be conducted in pulse testing.

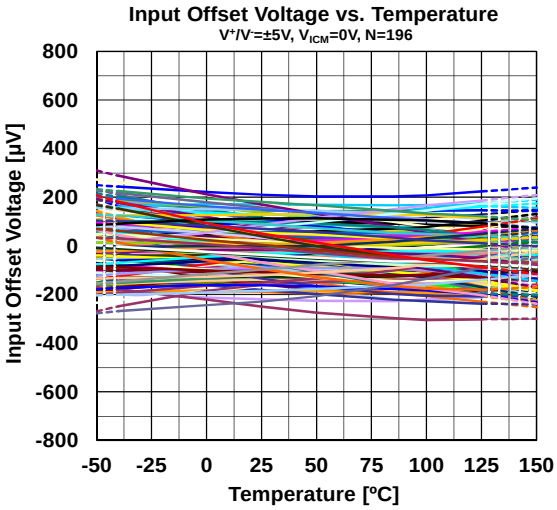
■ELECTRICAL CHARACTERISTICS (V^+/V^-=±5V, Ta=25°C, V_{ICM}=0V, unless otherwise noted.)

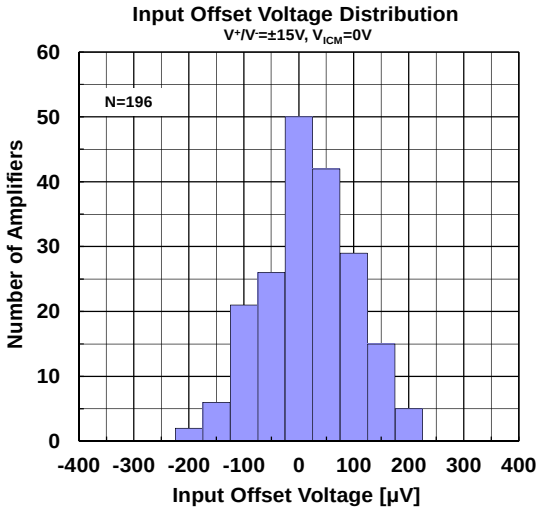
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage						
NJM8512Bx / NJM8513Bx	$V_{IO}1$		-	80	400	μV
	$V_{IO}2$	Ta = -40°C to 125°C	-	-	700	μV
NJM8512Ax / NJM8513Ax	$V_{IO}1$		-	80	800	μV
	$V_{IO}2$	Ta = -40°C to 125°C	-	-	1400	μV
Input Offset Voltage Drift						
NJM8512Bx / NJM8513Bx	ΔVio/ΔT	Ta = -40°C to 125°C	-	0.8	5	μV/°C
NJM8512Ax / NJM8513Ax	ΔVio/ΔT	Ta = -40°C to 125°C	-	1	9	μV/°C
Input Bias Current	I_B1		-	21	75	pA
	I_B2	Ta = -40°C to 125°C	-	-	31	nA
Input Offset Current	$I_{IO}1$		-	5	50	pA
	$I_{IO}2$	Ta = -40°C to 125°C	-	-	2	nA
Common Mode Input Voltage Range	$V_{ICM}1$	CMR ≧ 86dB	-2	-	+2.5	V
	$V_{ICM}2$	CMR ≧ 80dB, Ta = -40°C to 125°C	-2	-	+2.5	V
Common Mode Rejection Ratio	CMR1	V_{CM}=-2V to +2.5V	86	108	-	dB
	CMR2	V_{CM}=-2V to +2.5V, Ta = -40°C to 125°C	80	-	-	dB
	CMR3	V_{CM}=-1V to +2V	92	113	-	dB
Voltage Gain	A_V1	R_L=2kΩ, V_O=-3V to +3V	85	93	-	dB
	A_V2	R_L=2kΩ, V_O=-3V to +3V, Ta = -40°C to 125°C	80	-	-	dB
	A_V3	RL=10kΩ, V_O=-3V to +3V	90	100	-	dB
Input capacitance	C_{IN}		-	10	-	pF
Channel Separation	CS	DC	-	125	-	dB
Output Characteristics						
Maximum Output Voltage	$V_{OH}1$	R_L=10kΩ, Ta = -40°C to 125°C	+4.1	+4.3	-	V
	$V_{OL}1$	R_L=10kΩ, Ta = -40°C to 125°C	-	-4.9	-4.7	V
	$V_{OH}2$	R_L=2kΩ, Ta = -40°C to 125°C	+3.9	+4.2	-	V
	$V_{OL}2$	R_L=2kΩ, Ta = -40°C to 125°C	-	-4.9	-4.5	V
	$V_{OH}31$	R_L=600Ω	+3.7	+4.1	-	V
	$V_{OH}32$	R_L=600Ω, Ta = -40°C to 125°C	+3.6	-	-	V
	$V_{OL}41$	R_L=600Ω	-	-4.8	-4.3	V
	$V_{OL}42$	R_L=600Ω, Ta = -40°C to 125°C	-	-	-4.2	V
Supply Characteristics						
Supply Current (ALL Amps) : NJM8512	$I_{CC}1$	G_V=+1, R_L=∞	-	2.0	3.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta = -40°C to 125°C	-	-	3.3	mA
Supply Current (ALL Amps) : NJM8513	$I_{CC}1$	G_V=+1, R_L=∞	-	4.0	6.0	mA
	$I_{CC}2$	G_V=+1, R_L=∞, Ta = -40°C to 125°C	-	-	6.6	mA
Dynamic Performance						
Unity Gain Frequency	fT	G_V=+100, R_L=2kΩ, C_L=10pF	-	7	-	MHz
Slew Rate	+SR	RISE, G_V=+1, V_{IN}=2Vpp, R_L=2kΩ	-	18	-	V/μs
	-SR	FALL, G_V=+1, V_{IN}=2Vpp, R_L=2kΩ	-	18	-	V/μs
Settling Time	ts1	To 0.1%, 0V to 4V step, Gv=+1	-	0.5	-	μs
Phase Margin	Φ_M		-	65	-	deg
Total Harmonic Distortion	THD	fo=1kHz, G_V=+1, R_L=2kΩ	-	0.0005	-	%
Noise Performance						
Input Voltage Noise Density	V_{NI}	fo=0.1Hz to 10Hz	-	0.9	-	μVpp
	en1	fo=10Hz	-	20	-	nV/√Hz
	en2	fo=100Hz	-	11	-	nV/√Hz
	en3	fo=1kHz	-	10	-	nV/√Hz
	en4	fo=10kHz	-	9	-	nV/√Hz

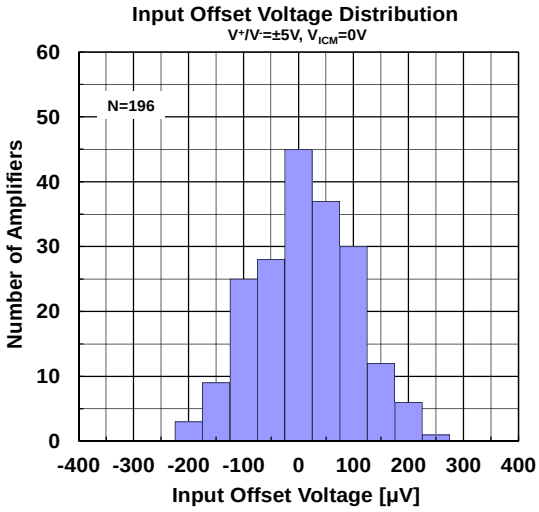
(Note) Measurement is to be conducted in pulse testing.

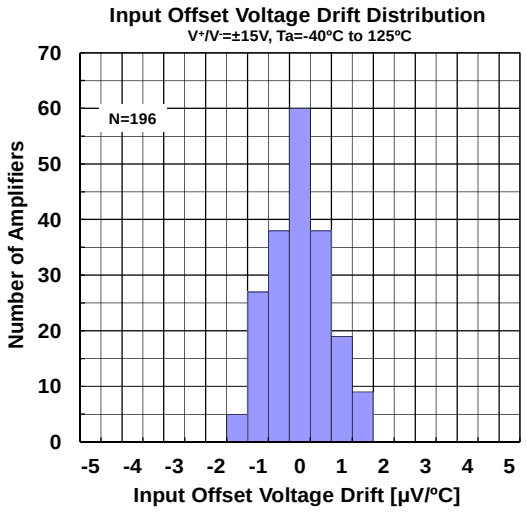
■ ELECTRICAL CHARACTERISTICS

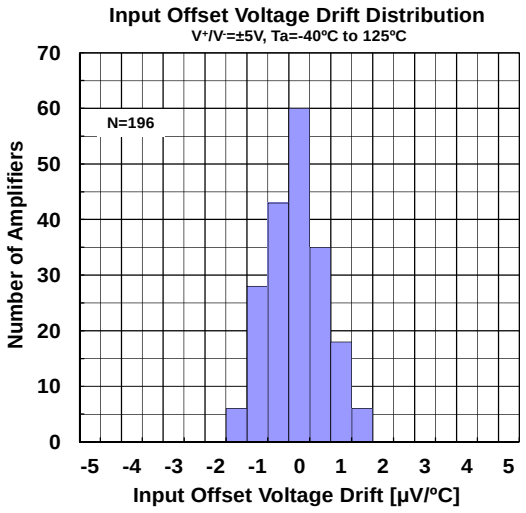






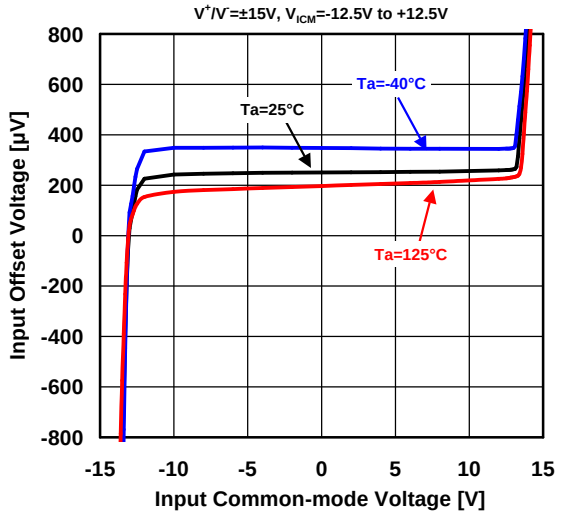






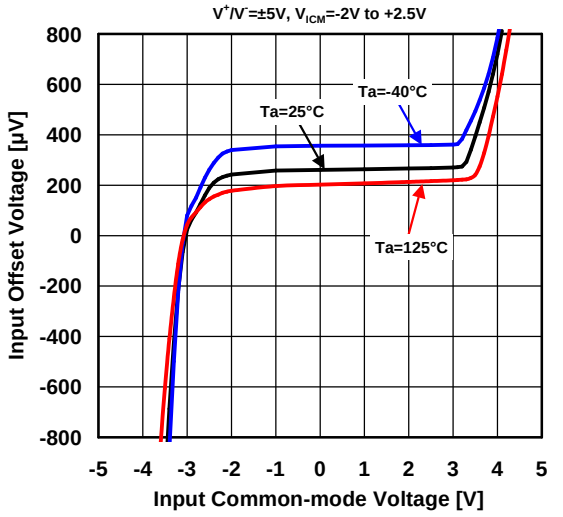
Input Offset Voltage vs. Common-mode Voltage

V^+/V^-=±15V, V_{ICM}=-12.5V to +12.5V

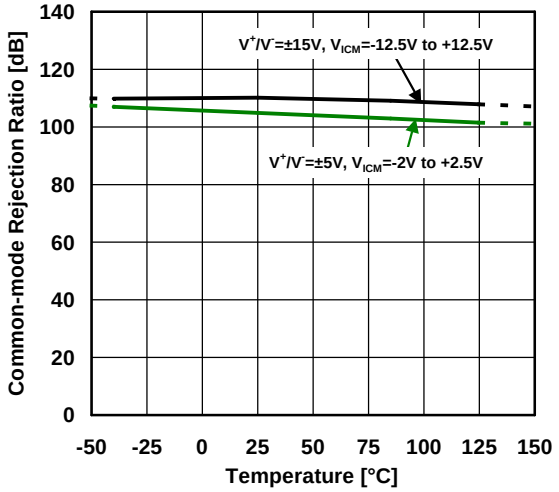


Input Offset Voltage vs. Common-mode Voltage

V^+/V^-=±15V, V_{ICM}=-2V to +2.5V

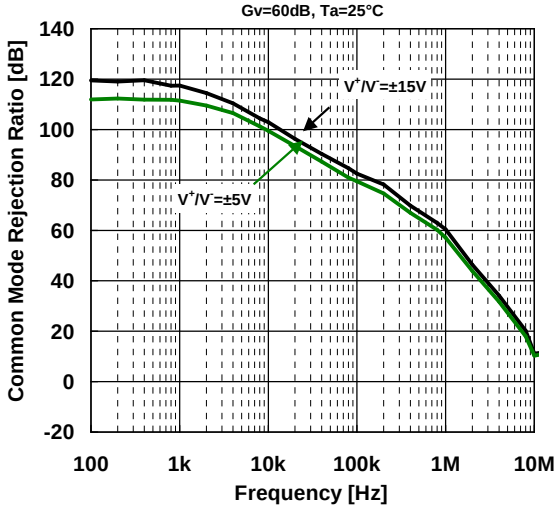


Common-mode Rejection Ratio vs. Temperature



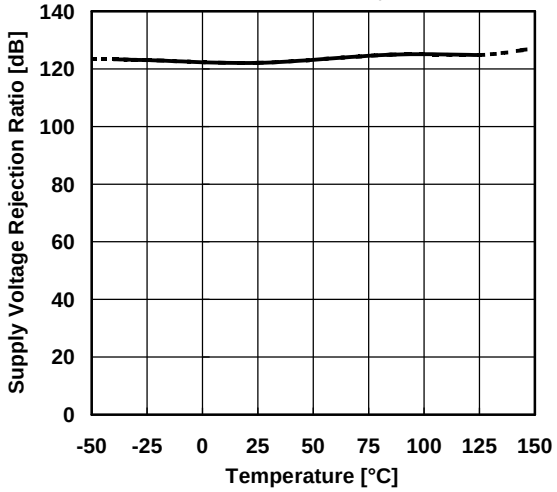
CMR vs. Frequency

Gv=60dB, Ta=25°C



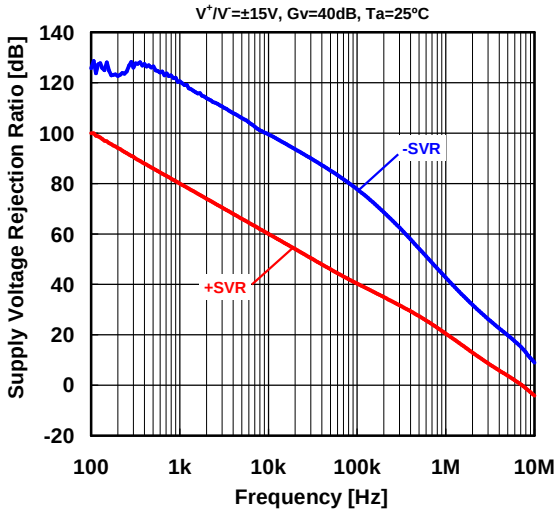
Supply Voltage Rejection Ratio vs. Temperature

V^+/V^-=±4.5V to ±16V, V_{ICM}=0V



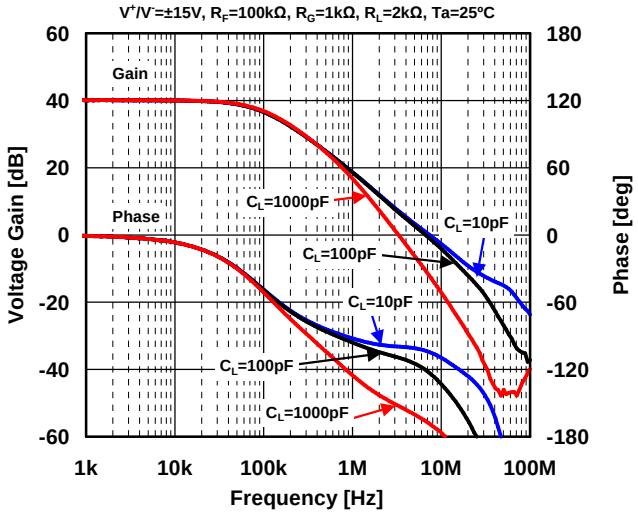
Supply Voltage Rejection Ratio vs. Frequency

V^+/V^-=±15V, Gv=40dB, Ta=25°C



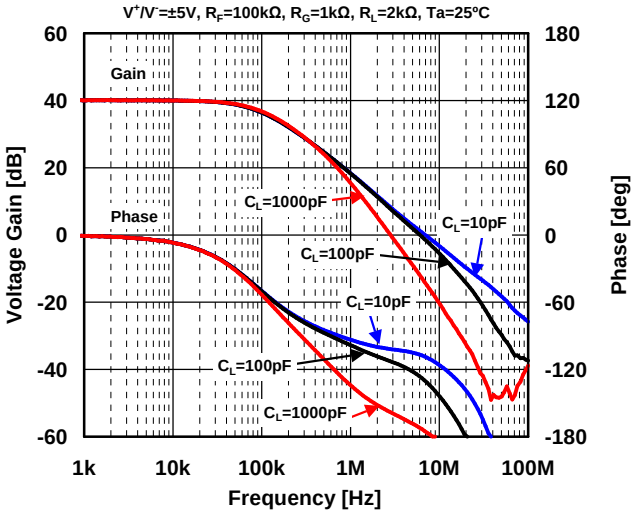
Gain/Phase vs. Frequency

V^+/V^-=±15V, R_F=100kΩ, R_G=1kΩ, R_L=2kΩ, Ta=25°C



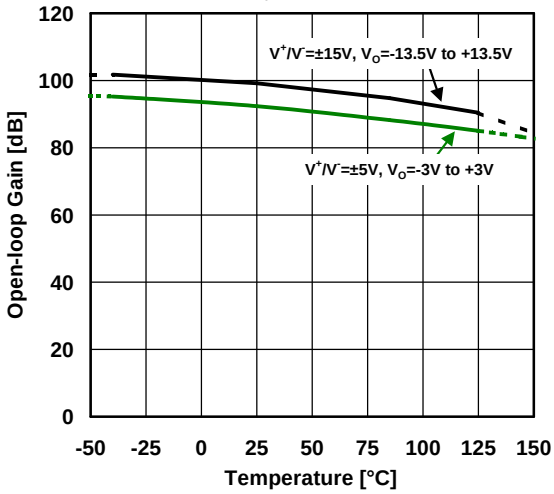
Gain/Phase vs. Frequency

V^+/V^-=±5V, R_F=100kΩ, R_G=1kΩ, R_L=2kΩ, Ta=25°C



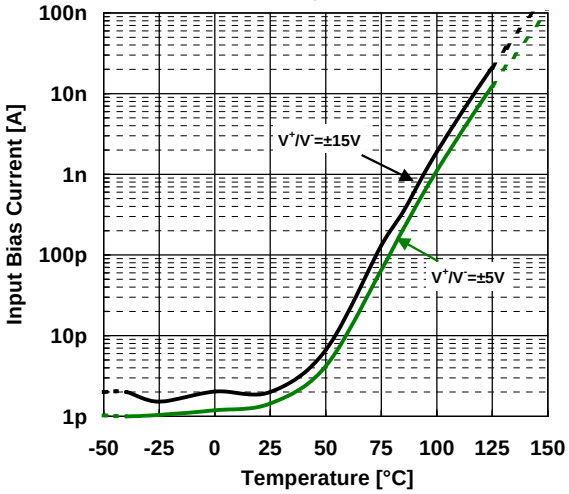
Open-loop Gain vs. Temperature

V_{ICM}=0V, R_L=2kΩ



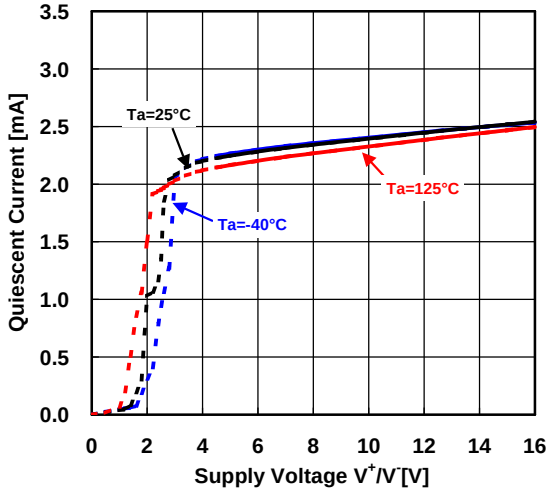
Input Bias Current vs. Temperature

V_{ICM}=0V



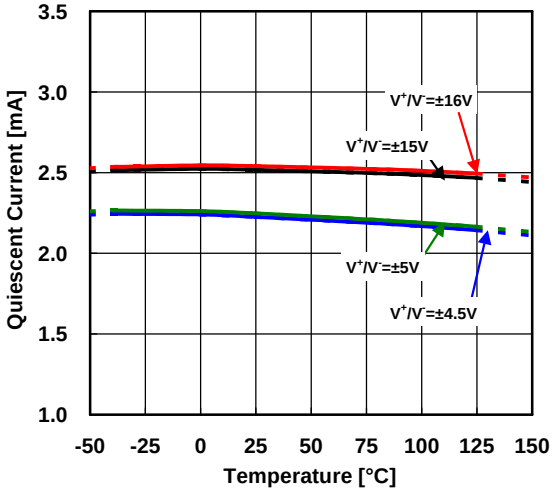
Quiescent Current vs. Supply Voltage

Gv=0dB, V_{ICM}=0V



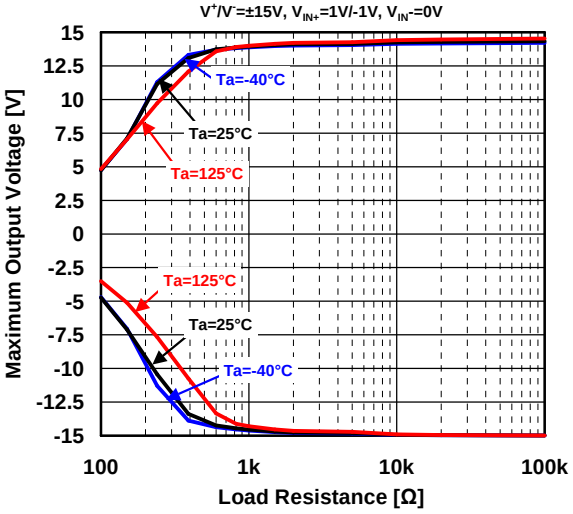
Quiescent Current vs. Temperature

G_V=0dB, V_{ICM}=0V



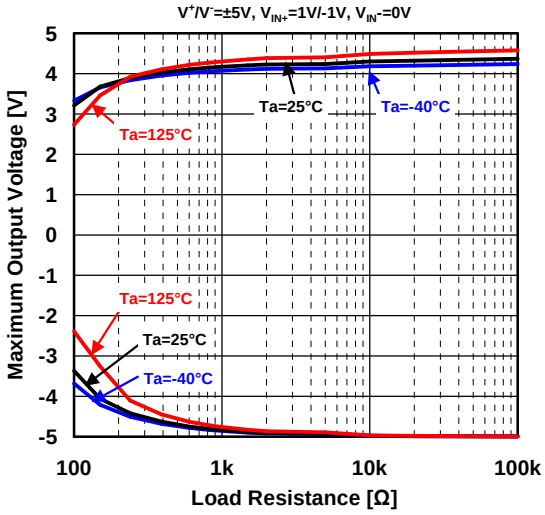
Maximum Output Voltage vs. Load Resistance

V^+/V^-=±15V, V_{IN+}=1V/-1V, V_{IN-}=0V



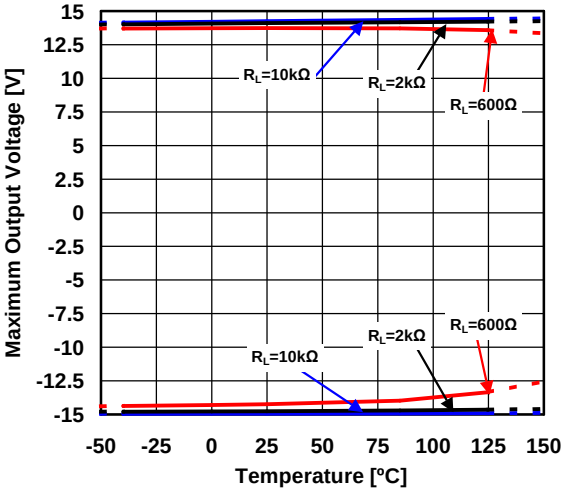
Maximum Output Voltage vs. Load Resistance

V^+/V^-=±5V, V_{IN+}=1V/-1V, V_{IN-}=0V



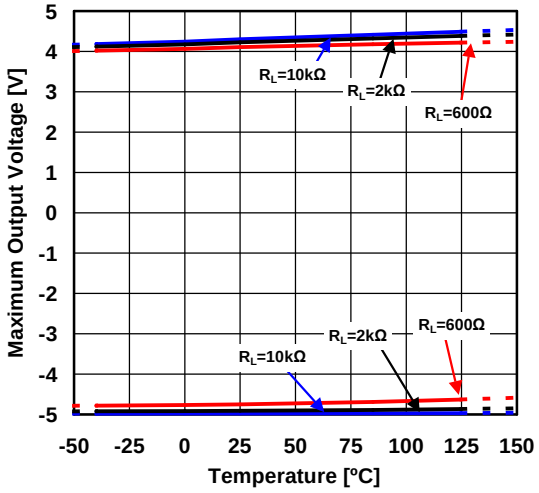
Maximum Output Voltage vs. Temperature

V^+/V^-=±15V, V_{IN+}=1V/-1V, V_{IN-}=0V



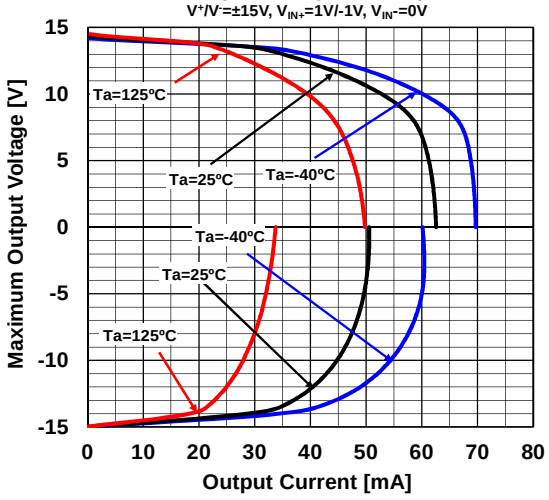
Maximum Output Voltage vs. Temperature

V^+/V^-=±5V, V_{IN+}=1V/-1V, V_{IN-}=0V



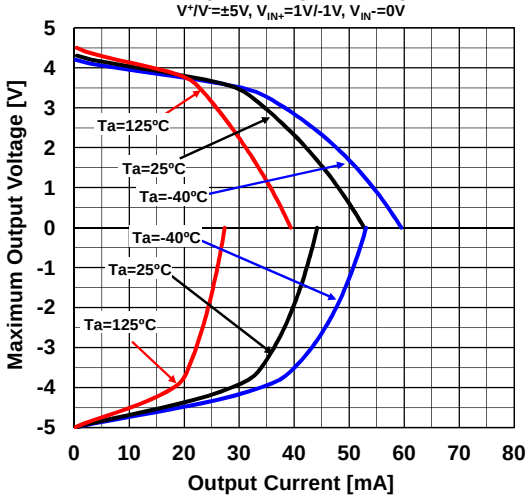
Maximum Output Voltage vs. Output Current

V^+/V^-=±15V, V_{IN+}=1V/-1V, V_{IN-}=0V



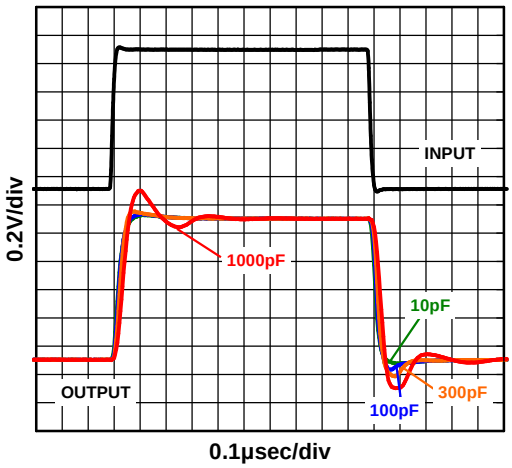
Maximum Output Voltage vs. Output Current

V^+/V^-=±5V, V_{IN+}=1V/-1V, V_{IN-}=0V



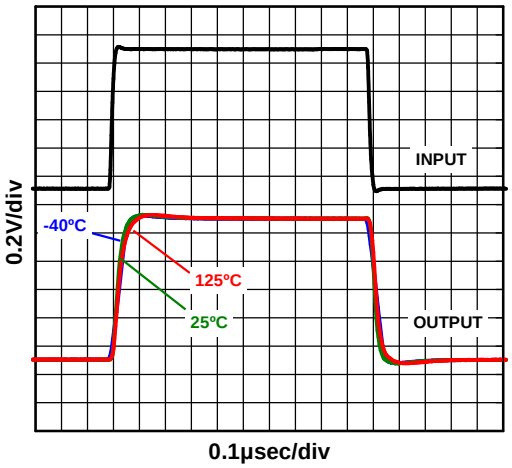
Small-Signal Step Response (Road Capacitance)

V^+/V^-=±15V, Gv=0dB, V_{IN}=1V_{PP}, R_L=2kΩ, Ta=25°C



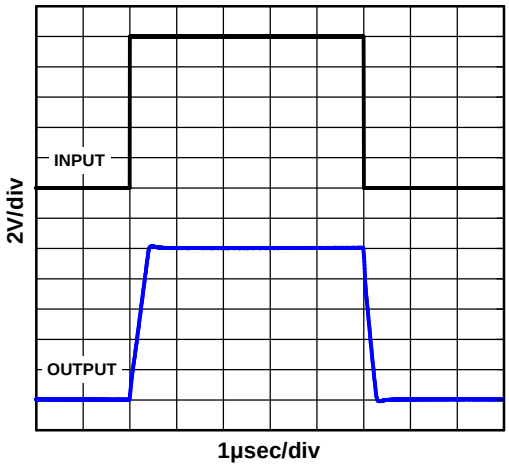
Small-Signal Step Response (Temperature)

V^+/V^-=±15V, Gv=0dB, V_{IN}=1V_{PP}, R_L=2kΩ, C_L=10pF



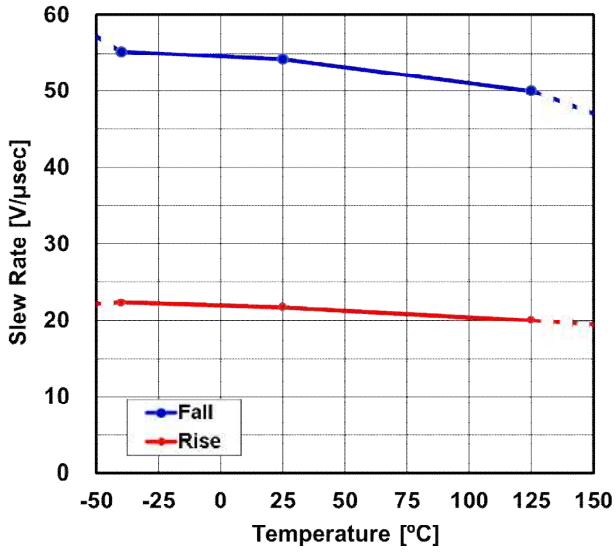
Large Signal Step Response

V^+/V^-=±15V, Gv=0dB, V_{IN}=10Vpp, R_L=2kΩ



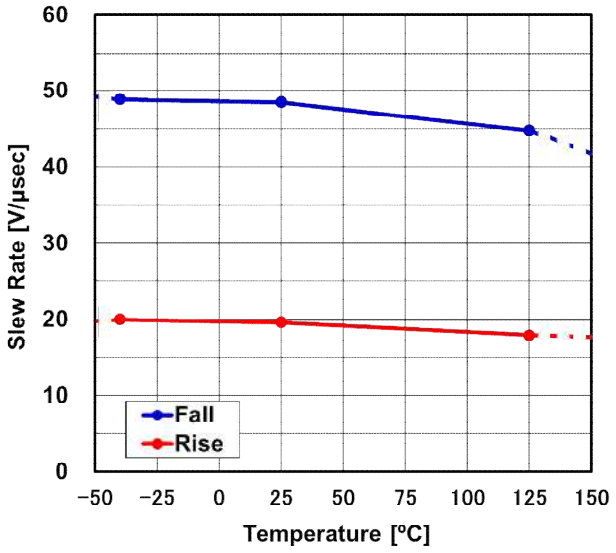
Slew Rate vs. Temperature

V^+/V^- = ±15V, V_{IN}=2V_{PP}, f=100kHz, Gv=0dB, C_L=10pF, R_L=2kΩ



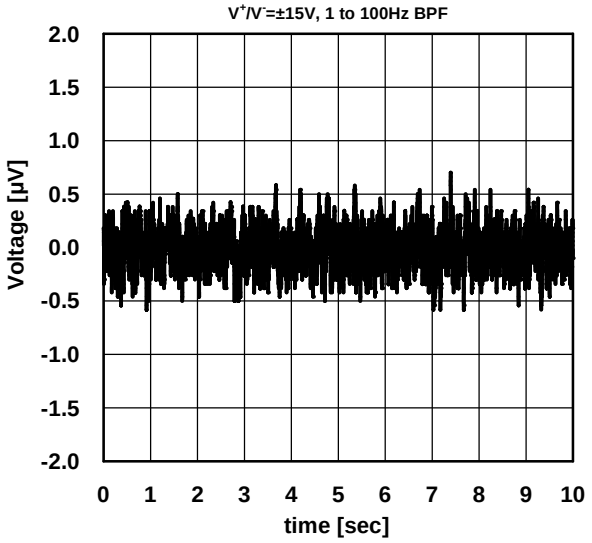
Slew Rate vs. Temperature

V^+/V^- = ±5V, V_{IN}=2V_{PP}, f=100kHz, Gv=0dB, C_L=10pF, R_L=2kΩ



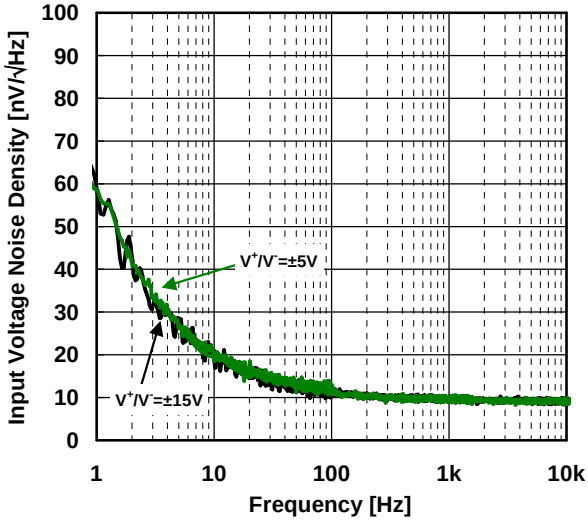
1Hz to 100Hz Input Voltage Noise

V^+/V^-=±15V, 1 to 100Hz BPF



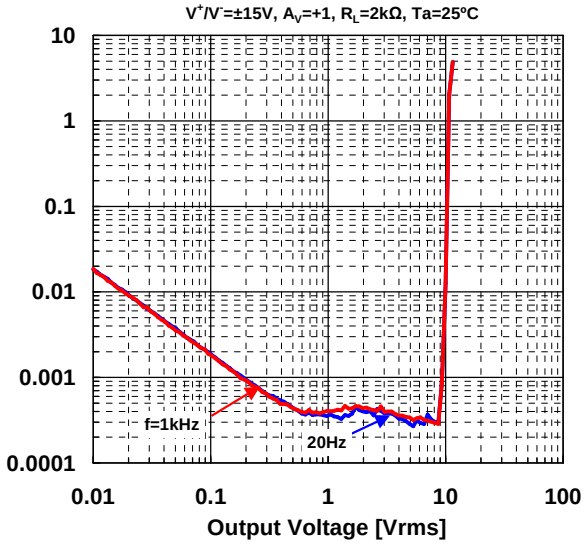
Input Voltage Noise Density vs. Frequency

Gv=40dB, R_G=100Ω, R_L=10kΩ, Ta=25°C



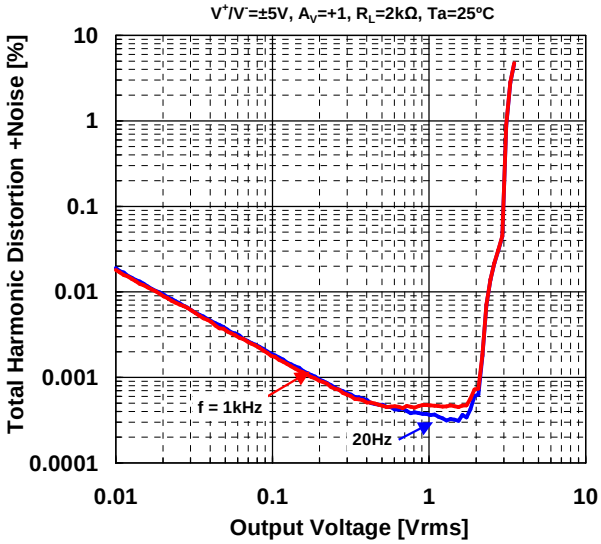
THD + Noise vs. Output Voltage

V^+/V^-=±15V, A_V=+1, R_L=2kΩ, Ta=25°C



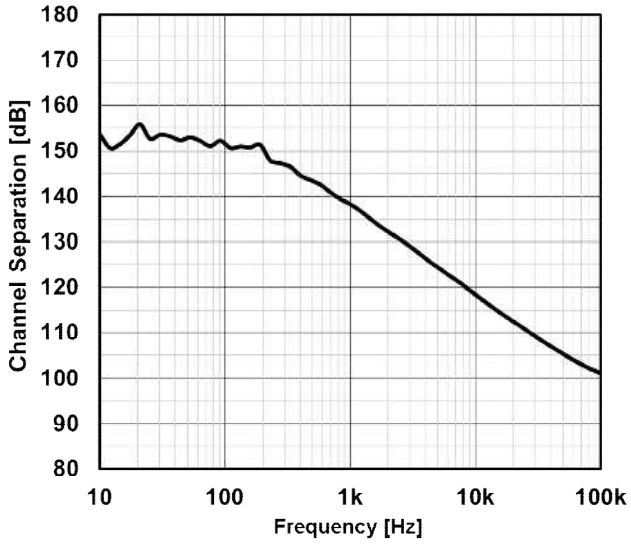
THD + Noise vs. Output Voltage

V^+/V^-=±5V, A_V=+1, R_L=2kΩ, Ta=25°C



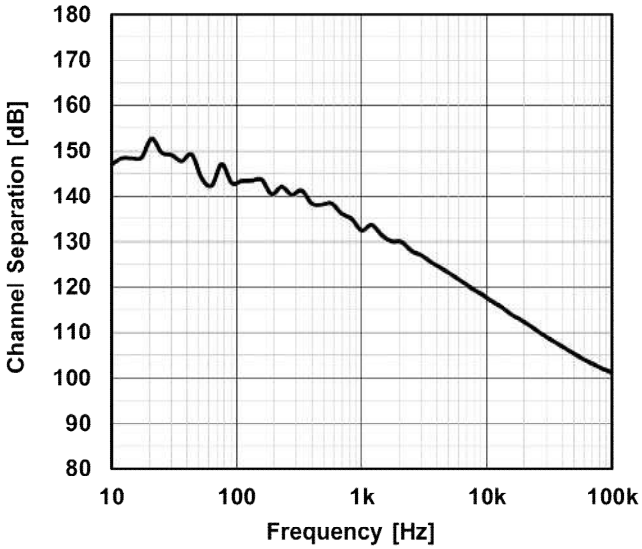
Channel Separation vs. Frequency

V^+/V^-=±15V, R_F=100kΩ, R_S=1kΩ, Ta=25°C,
R_L=2kΩ to 0V, Vo=5Vrms



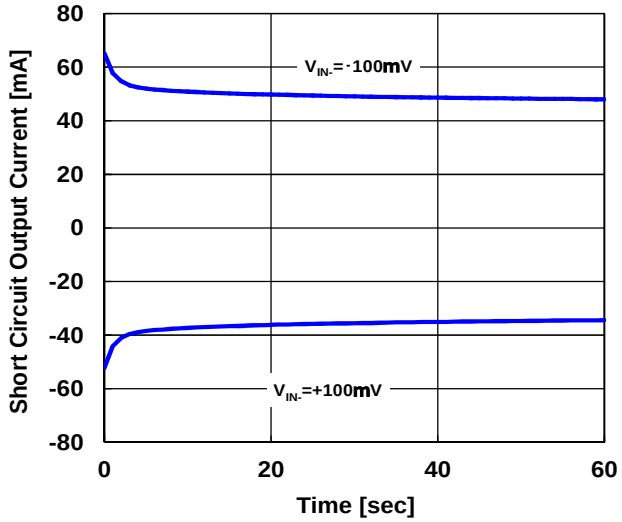
Channel Separation vs. Frequency

V^+/V^-=±5V, R_F=100kΩ, R_S=1kΩ, Ta=25°C,
R_L=2kΩ to 0V, Vo=1Vrms



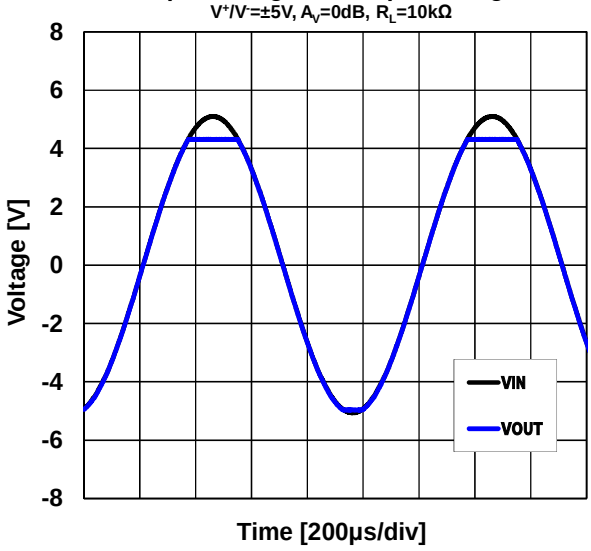
Short Circuit Output Current

V^+/V^-=±15V, V_{IN+}=0V, V_O=0V, Ta=25°C



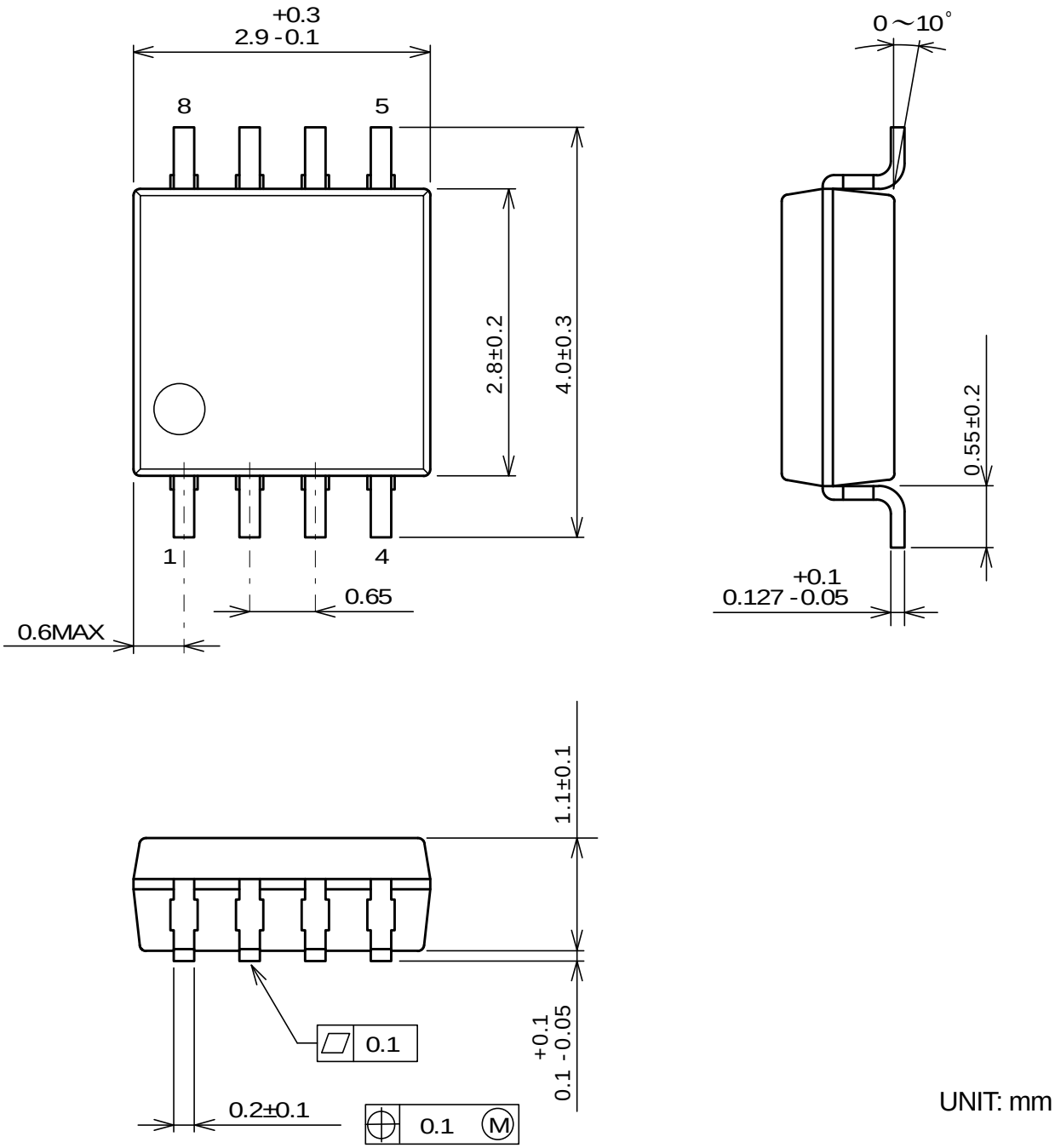
Input Voltage vs. Output Voltage

V^+/V^-=±5V, A_V=0dB, R_L=10kΩ



■PACKAGE DIMENSIONS

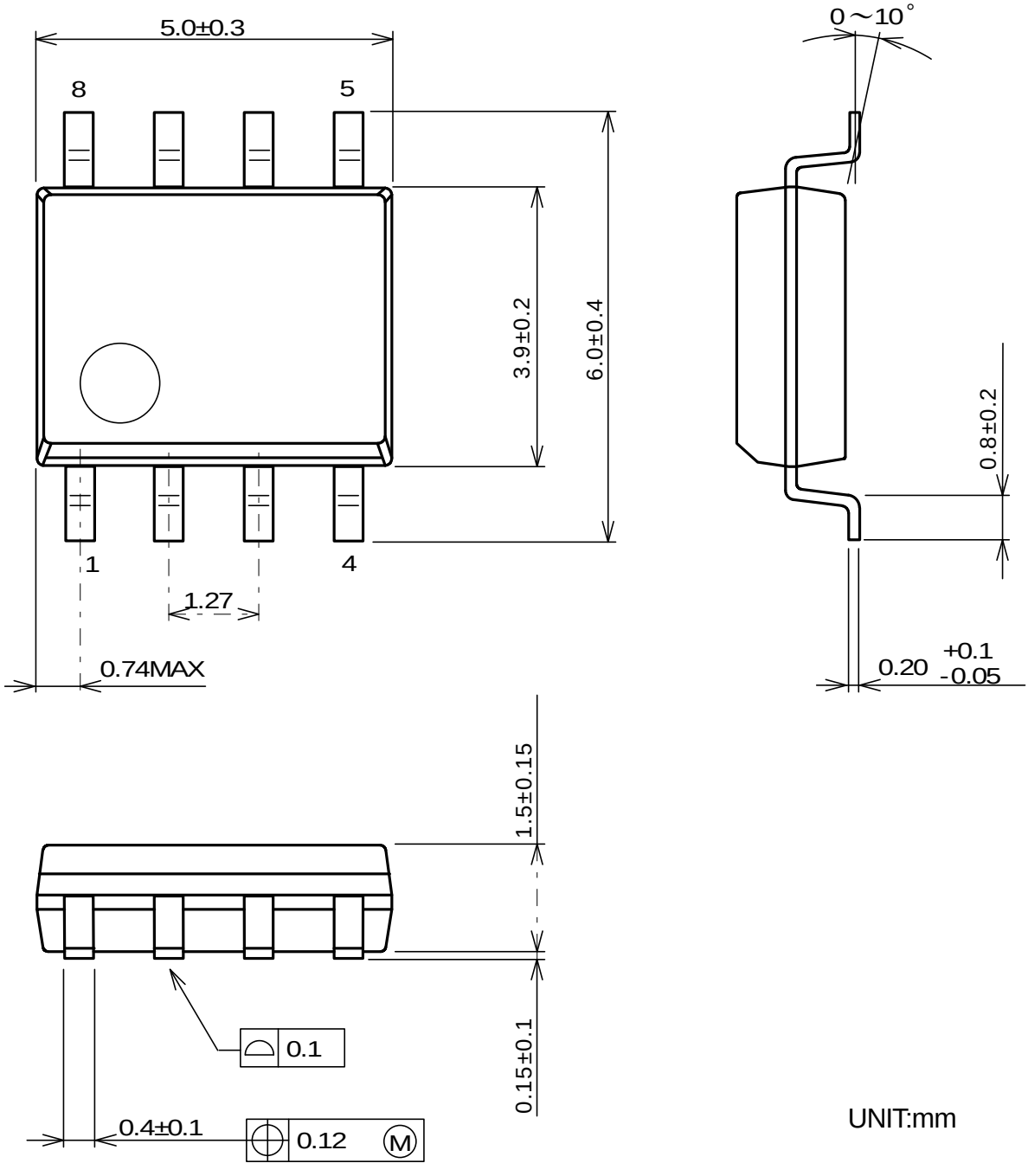
MSOP8(VSP8)



UNIT: mm

■PACKAGE DIMENSIONS

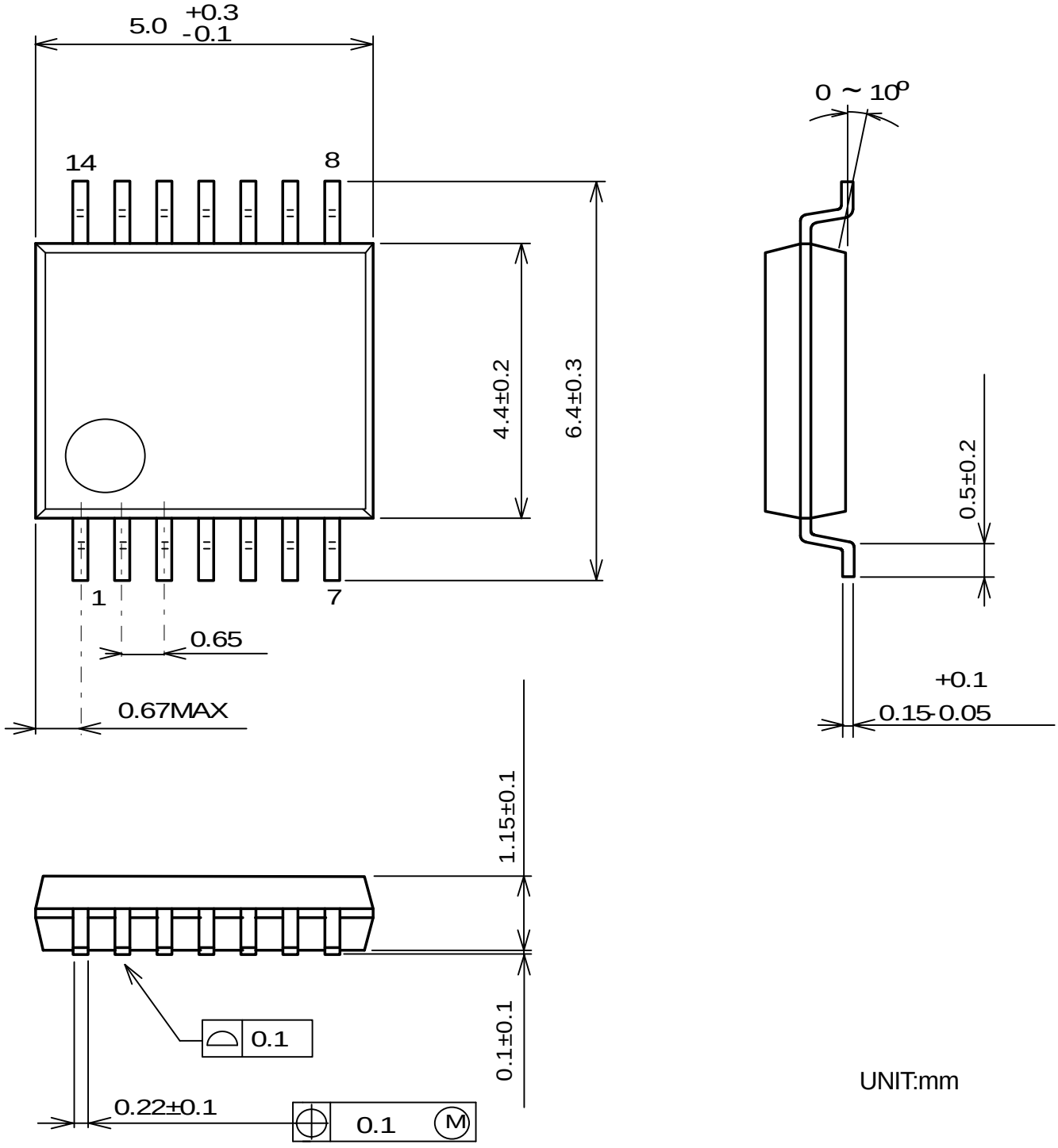
SOP8 JEDEC 150 mil



UNIT:mm

■PACKAGE DIMENSIONS

SSOP14



UNIT:mm

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