Precision, Low Noise, Rail-to-Rail Output, CMOS Operational Amplifier

■ GENERAL DESCRIPTION

The NJU7076/NJU7077 is a high precision Rail-to-Rail output Single/Dual CMOS operational amplifier featuring a low noise of 10nV/√Hz typ., low input offset voltage of 150μV max., low temperature drift of 0.5μV/°C typ. and low bias current of 1pA typ..

The output swing can reach 20 mV from the rails, while driving a 10kΩ load (at 5V operation). The NJU7076/NJU7077 also has a high RF noise immunity which can reduce malfunctions caused by RF noises from mobile phones and others. The combination of these specifications makes the NJU7076/ NJU7077 well-suited for sensor applications such as a temperature sensor, weight sensor and others, high precision current sensing amplifiers and current voltage converters.

■ PACKAGE OUTLINE

NJU7076F (SOT-23-5)

NJU7077R (MSOP8(VSP8))

■ FEATURES

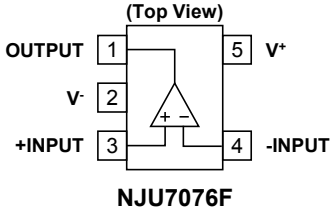
●High Precision	
Low Offset Voltage	150μV max.
Low Offset Voltage Drift	0.5μV/°C typ.
●Low Noise	10nV/√Hz typ.
●Low Input Bias Current	1pA typ.
●Rail-to-Rail Output	
R_L=10kΩ	20mV from Rail typ.
R_L=600Ω	80mV from Rail typ.
●Ground sense	
●RF Noise Immunity	
●Operating Voltage	2.2V to 5.5V
●Unity-Gain Stable	
●Package	SOT-23-5
	MSOP8(VSP8)*

*MEET JEDEC MO-187-DA

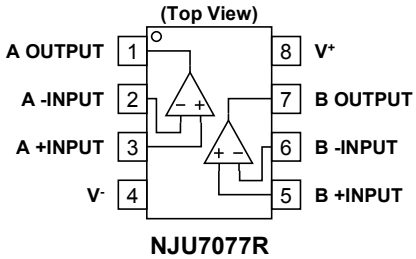
■ APPLICATIONS

- ●Thermocouple / Thermopile Amplifiers
- ●Strain Gauge / Pressure sensor Amplifiers
- ●Load Cell and Bridge Transducer Amplifiers
- ●High Resolution Data Acquisition
- ●Precision Current Sensing
- ●Battery monitoring
- ●Photo-Diode pre amplifier

■ PIN CONFIGURATION



NJU7076F

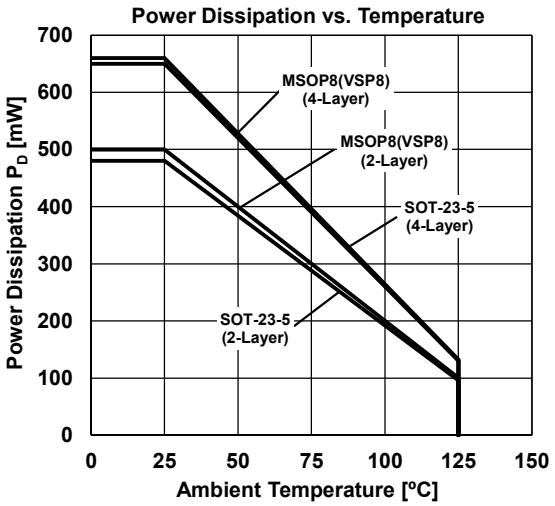


NJU7077R

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

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+- V^-	7 (1)	V
Differential Input Voltage (2)	V_{ID}	±7 (3)	V
Input Voltage	V_{IN}	V^-- 0.3 to V^++ 0.3	V
Power Dissipation (4)		(2-layer / 4-layer)	mW
SOT-23-5	P_D	480 / 650	mW
MSOP8(VSP8)		500 / 660	mW
Operating Temperature Range	T_{opr}	-40 to +125	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C

(1) Supply Voltage is the voltage difference between V^+ and V^-.
(1) Differential voltage is the voltage difference between +INPUT and -INPUT.
(3) For supply voltage less than 7V, the absolute maximum rating is equal to the supply voltage.
(4) 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



■ RECOMMENDED OPERATING CONDITIONS(Ta=25˚C)

PARAMETER	Value	UNIT
Supply Voltage	+2.2 to +5.5 (±1.1 to ±2.75)	V

■ **ELECTRICAL CHARACTERISTICS**(V^+=5V, V^-=0V, V_{COM}=V^+/2, Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Supply Current(All Amplifiers)						
NJU7076	I_{SUPPLY}	No Signal, R_L=OPEN	-	0.6	0.9	mA
		No Signal, R_L=OPEN, Ta = -40°C to 125°C	-	-	0.9	mA
NJU7077		No Signal, R_L=OPEN	-	1.2	1.8	mA
		No Signal, R_L=OPEN, Ta = -40°C to 125°C	-	-	1.8	mA
Input Offset Voltage	V_{IO}		-	20	150	μV
		Ta=-40°C to 125°C	-	-	400	μV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta=-40°C to 125°C (5)	-	0.5	5	μV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open-Loop Voltage Gain	A_V	Vo=0.5V to 4.5V, R_L=10kΩ to 2.5V	100	130	-	dB
		Vo=0.5V to 4.5V, R_L=10kΩ to 2.5V, Ta= -40°C to 125°C	100	-	-	dB
Common-Mode Rejection Ratio	CMR	V_{ICM}=0V to 4V	70	90	-	dB
		V_{ICM}=0V to 4V, Ta= -40°C to 125°C	70	-	-	dB
Supply Voltage Rejection Ratio	SVR	V^+=2.2V to 5.5V	70	90	-	dB
		V^+=2.2V to 5.5V, Ta= -40°C to 125°C	70	-	-	dB
High-level Output Voltage	V_{OH}	R_L=10kΩ to 2.5V	4.95	4.98	-	V
		R_L=10kΩ to 2.5V, Ta= -40°C to 125°C	4.95	-	-	V
		R_L=600Ω to 2.5V	4.85	4.92	-	V
		R_L=600Ω to 2.5V, Ta= -40°C to 125°C	4.85	-	-	V
		I_{SOURCE}=2mA	4.9	4.96	-	V
		I_{SOURCE} =2mA, Ta= -40°C to 125°C	4.85	-	-	V
Low-level Output Voltage	V_{OL}	R_L=10kΩ to 2.5V	-	0.02	0.05	V
		R_L=10kΩ to 2.5V, Ta= -40°C to 125°C	-	-	0.05	V
		R_L=600Ω to 2.5V	-	0.08	0.15	V
		R_L=600Ω to 2.5V, Ta= -40°C to 125°C	-	-	0.2	V
		I_{SINK}=2mA	-	0.04	0.1	V
		I_{SINK}=2mA, Ta= -40°C to 125°C	-	-	0.15	V
Common-Mode Input Voltage Range	V_{ICM}	CMR≥70dB	0	-	4	V
		CMR≥70dB, Ta= -40°C to 125°C	0	-	4	V
AC CHARACTERISTICS						
Gain Bandwidth Product	GBW	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 2.5V, C_L=20pF, f=100kHz	-	1.3	-	MHz
Phase Margin	Φ_m	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 2.5V, C_L=20pF	-	60	-	deg
Gain Margin	G_m	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 2.5V, C_L=20pF	-	12	-	dB
Equivalent Input Noise Voltage	e_n	f=1kHz	-	10	-	nV/√Hz
Slew Rate	SR	G_V=0dB, R_L=10kΩ to 2.5V, C_L=20pF, V_{IN}=3V_{PP}	-	0.5	-	V/μs
Total Harmonic Distortion + Noise	THD+N	G_V=20dB, R_L=10kΩ to 2.5V, f=1kHz, V_O=3V_{PP}	-	0.01	-	%
Channel Separation	CS	f=1kHz, NJU7077 only	-	140	-	dB

(5) Guaranteed by two points of Temperature -40°C and +125°C

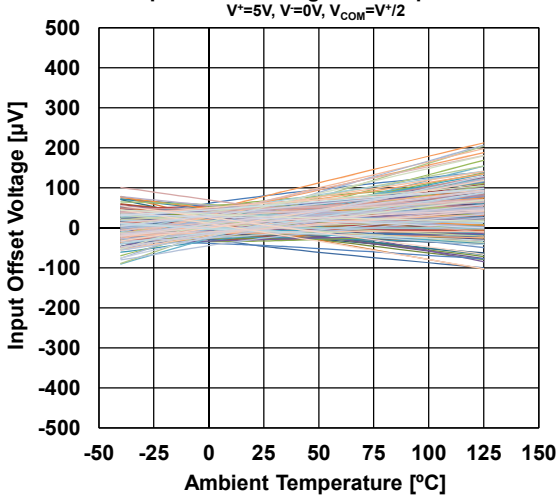
■ **ELECTRICAL CHARACTERISTICS**(V^+=2.2V, V^-=0V, V_{COM}=V^+/2, Ta=25˚C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Supply Current(All Amplifiers)						
NJU7076	I_{SUPPLY}	No Signal, R_L=OPEN	-	0.55	0.82	mA
		No Signal, R_L=OPEN, Ta = -40°C to 125°C	-	-	0.82	mA
NJU7077		No Signal, R_L=OPEN	-	1	1.5	mA
		No Signal, R_L=OPEN, Ta = -40°C to 125°C	-	-	1.5	mA
Input Offset Voltage	V_{IO}		-	60	250	μV
		Ta= -40°C to 125°C	-	-	400	μV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta= -40°C to 125°C (5)	-	0.6	5	μV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Open-Loop Voltage Gain	A_V	Vo=0.6V to 1.6V, R_L=10kΩ to 1.1V	100	130	-	dB
		Vo=0.6V to 1.6V, R_L=10kΩ to 1.1V, Ta= -40°C to 125°C	100	-	-	dB
Common-Mode Rejection Ratio	CMR	V_{ICM}=0V to 1.2V	70	90	-	dB
		V_{ICM}=0V to 1.2V, Ta= -40°C to 125°C	70	-	-	dB
High-level Output Voltage	V_{OH}	R_L=10kΩ to 1.1V	2.15	2.18	-	V
		R_L=10kΩ to 1.1V, Ta= -40°C to 125°C	2.15	-	-	V
		R_L=600Ω to 1.1V	2.1	2.14	-	V
		R_L=600Ω to 1.1V, Ta= -40°C to 125°C	2.05	-	-	V
		I_{SOURCE}=2mA	2.05	2.13	-	V
		I_{SOURCE}=2mA, Ta= -40°C to 125°C	2	-	-	V
Low-level Output Voltage	V_{OL}	R_L=10kΩ to 1.1V	-	0.02	0.05	V
		R_L=10kΩ to 1.1V, Ta= -40°C to 125°C	-	-	0.05	V
		R_L=600Ω to 1.1V	-	0.06	0.1	V
		R_L=600Ω to 1.1V, Ta= -40°C to 125°C	-	-	0.15	V
		I_{SINK}=2mA	-	0.07	0.15	V
		I_{SINK}=2mA, Ta= -40°C to 125°C	-	-	0.2	V
Common-Mode Input Voltage Range	V_{ICM}	CMR≥70dB	0	-	1.2	V
		CMR≥70dB, Ta= -40°C to 125°C	0	-	1.2	V
AC CHARACTERISTICS						
Gain Bandwidth Product	GBW	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 1.1V, C_L=20pF, f=100kHz	-	1.2	-	MHz
Phase Margin	Φ_m	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 1.1V, C_L=20pF	-	60	-	deg
Gain Margin	G_m	G_V=40dB, R_F=100kΩ, R_L=10kΩ to 1.1V, C_L=20pF	-	12	-	dB
Equivalent Input Noise Voltage	e_n	f=1kHz	-	10	-	nV/√Hz
Slew Rate	SR	G_V=0dB, R_L=10kΩ to 1.1V, C_L=20pF, V_{IN}=1V_{PP}	-	0.5	-	V/μs
Total Harmonic Distortion + Noise	THD+N	G_V=20dB, R_L=10kΩ to 1.1V, f=1kHz, V_O=1V_{PP}	-	0.01	-	%
Channel Separation	CS	f=1kHz, NJU7077 only	-	140	-	dB

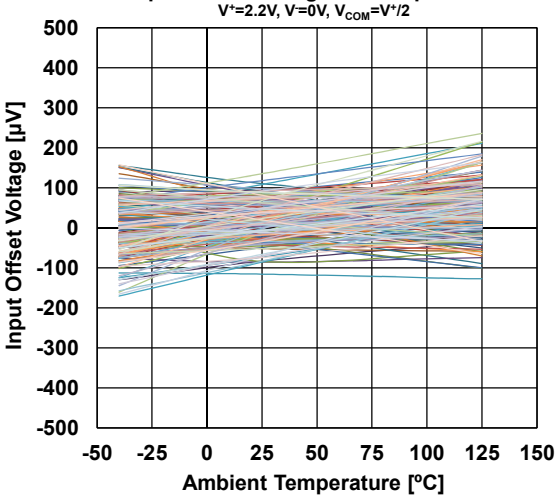
(5) Guaranteed by two points of Temperature -40˚C and +125˚C

■ TYPICAL CHARACTERISTICS

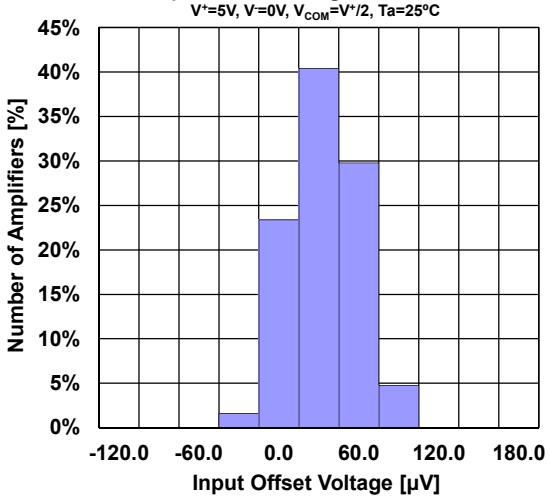
Input Offset Voltage vs. Temperature
V^+=5V, V^-=0V, V_{COM}=V^+/2



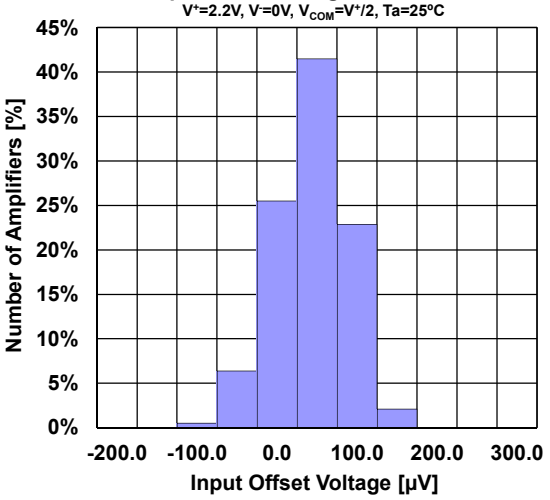
Input Offset Voltage vs. Temperature
V^+=2.2V, V^-=0V, V_{COM}=V^+/2



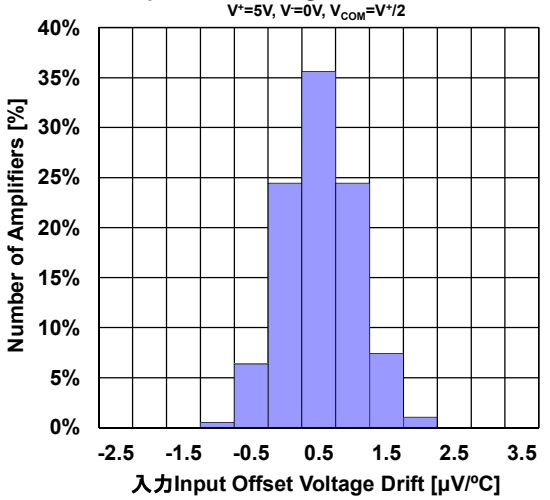
Input Offset Voltage Distribution
V^+=5V, V^-=0V, V_{COM}=V^+/2, Ta=25ºC



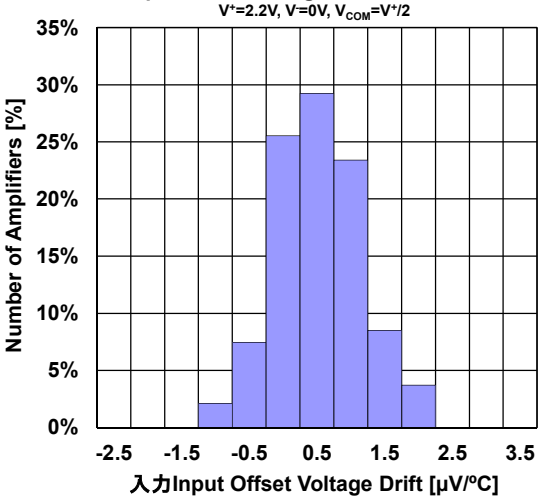
Input Offset Voltage Distribution
V^+=2.2V, V^-=0V, V_{COM}=V^+/2, Ta=25ºC



Input Offset Voltage Drift Distribution
V^+=5V, V^-=0V, V_{COM}=V^+/2

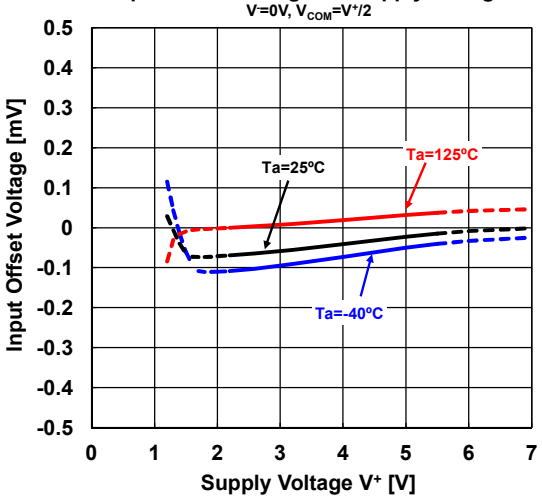


Input Offset Voltage Drift Distribution
V^+=2.2V, V^-=0V, V_{COM}=V^+/2

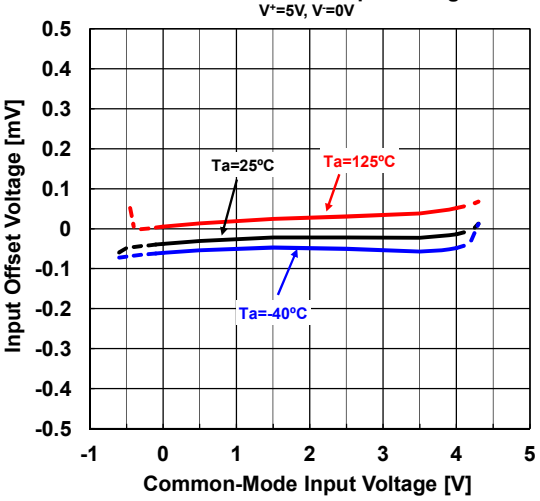


■ TYPICAL CHARACTERISTICS

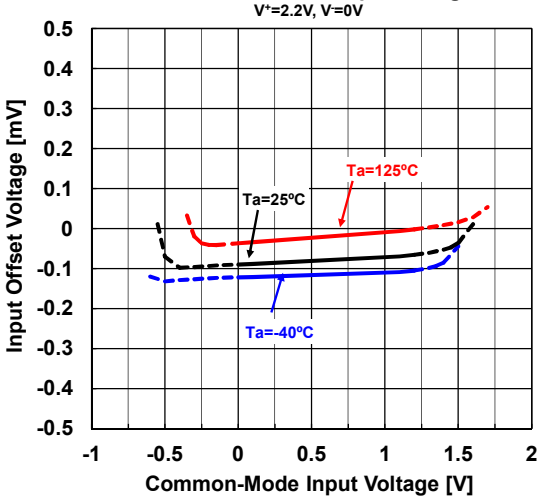
Input Offset Voltage vs. Supply Voltage
V⁻=0V, V_{COM}=V⁺/2



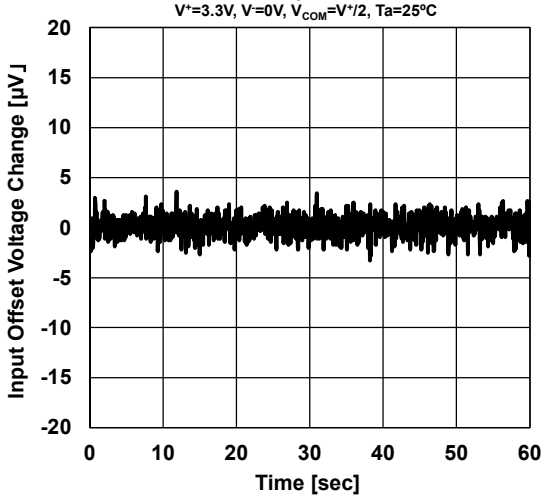
Input Offset Voltage
vs. Common-Mode Input Voltage
V⁺=5V, V⁻=0V



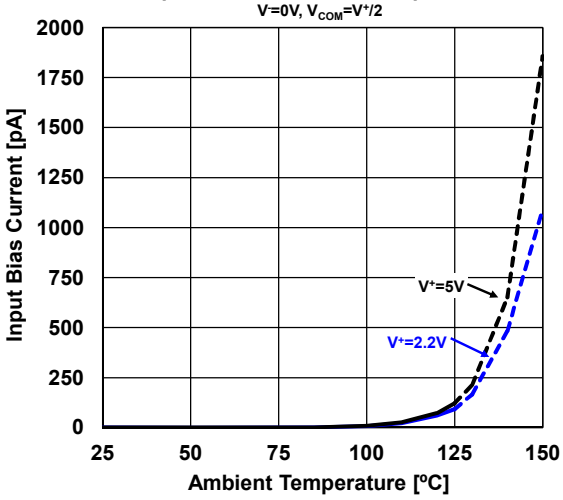
Input Offset Voltage
vs. Common-Mode Input Voltage
V⁺=2.2V, V⁻=0V



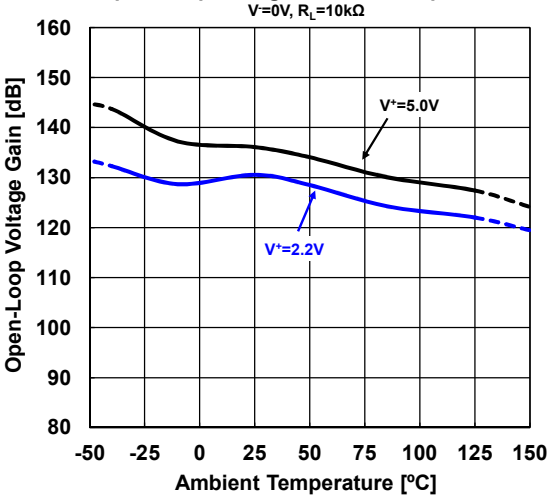
Warm-Up Vio Drift
V⁺=3.3V, V⁻=0V, V_{COM}=V⁺/2, Ta=25ºC



Input Bias Current vs. Temperature
V⁻=0V, V_{COM}=V⁺/2

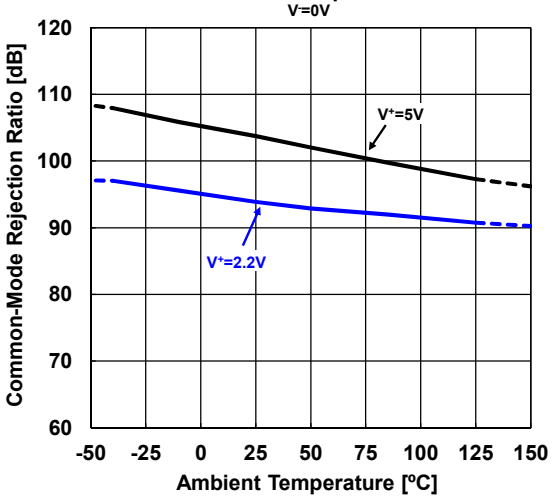


Open-Loop Voltage Gain vs. Temperature
V⁻=0V, R_L=10kΩ

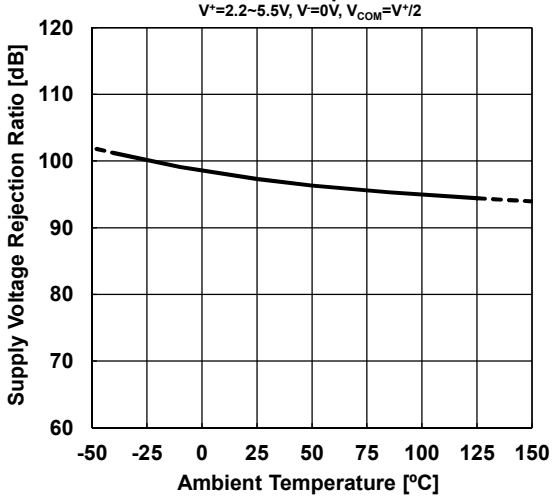


■ TYPICAL CHARACTERISTICS

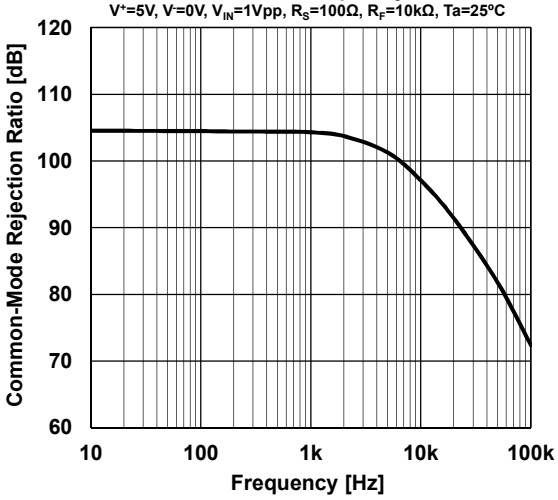
CMR vs. Temperature
V⁻=0V



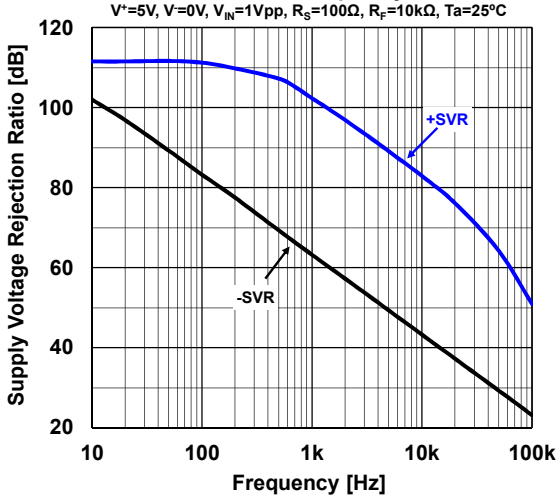
SVR vs. Temperature
V⁺=2.2~5.5V, V⁻=0V, V_{COM}=V⁺/2



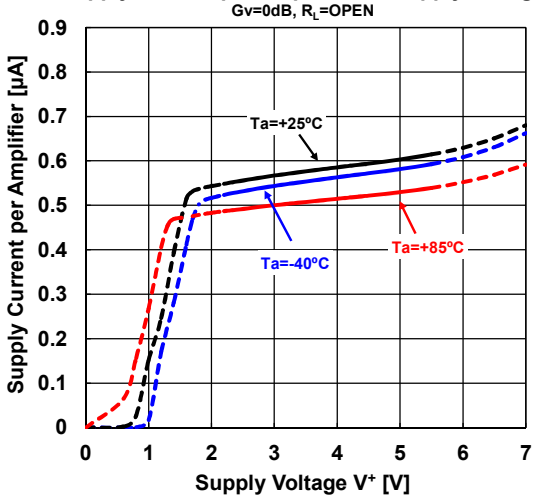
CMR vs. Frequency
V⁺=5V, V⁻=0V, V_{IN}=1Vpp, R_S=100Ω, R_F=10kΩ, Ta=25ºC



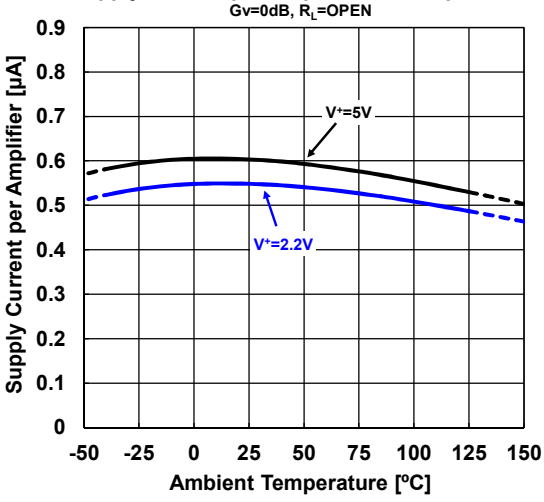
SVR vs. Frequency
V⁺=5V, V⁻=0V, V_{IN}=1Vpp, R_S=100Ω, R_F=10kΩ, Ta=25ºC



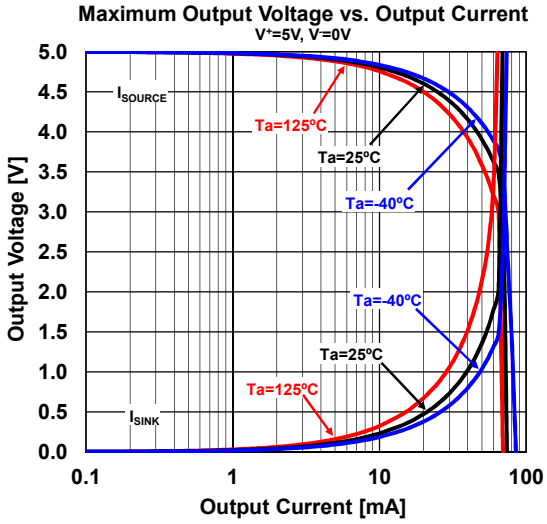
Supply Current per Amplifier vs. Supply Voltage
Gv=0dB, R_L=OPEN

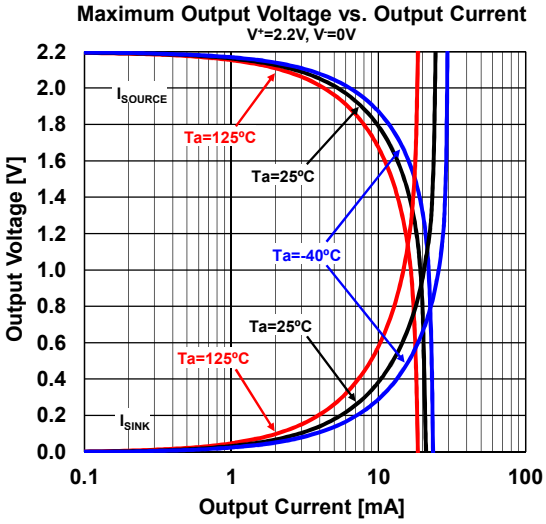


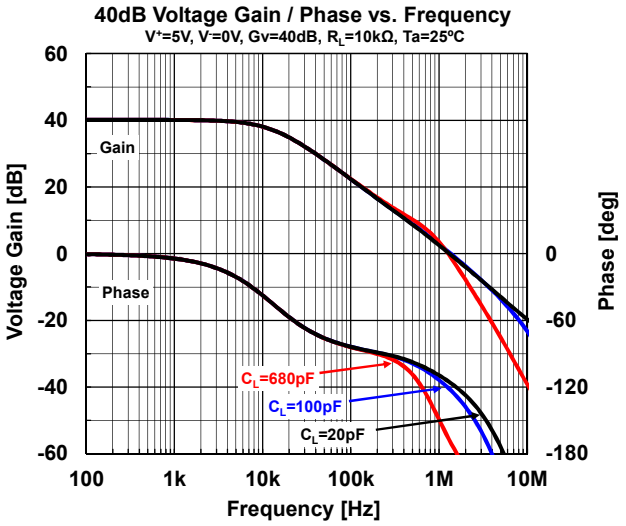
Supply Current per Amplifier vs. Temperature
Gv=0dB, R_L=OPEN

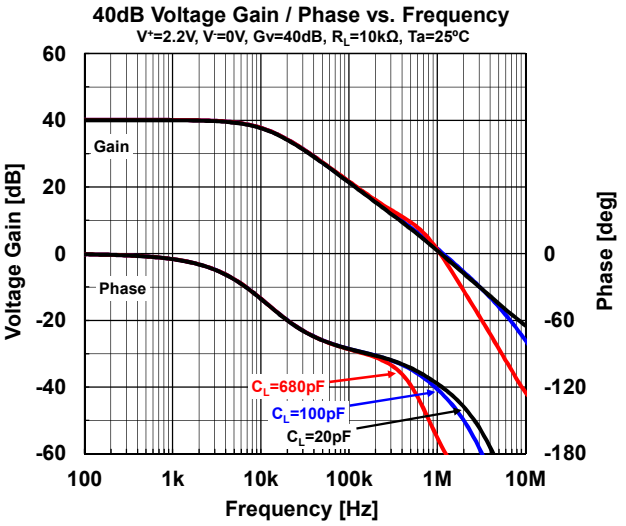


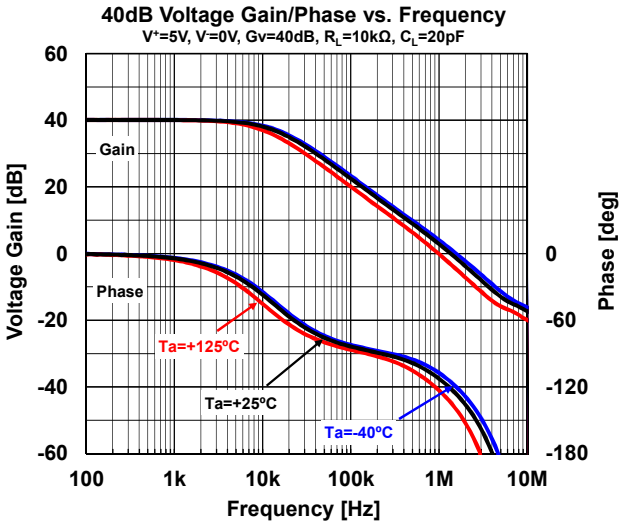
■ TYPICAL CHARACTERISTICS

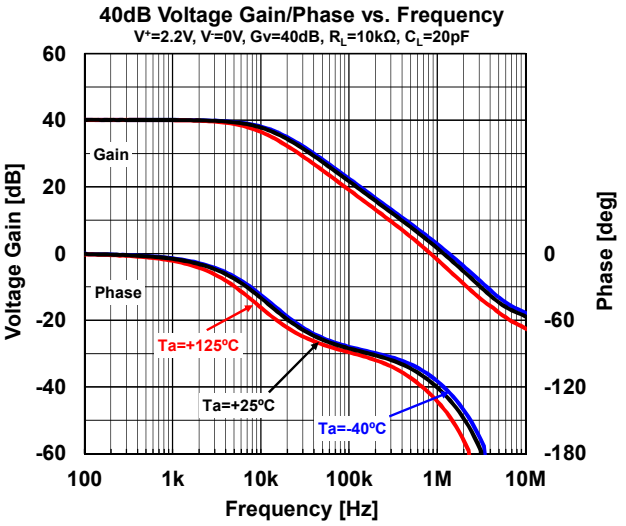






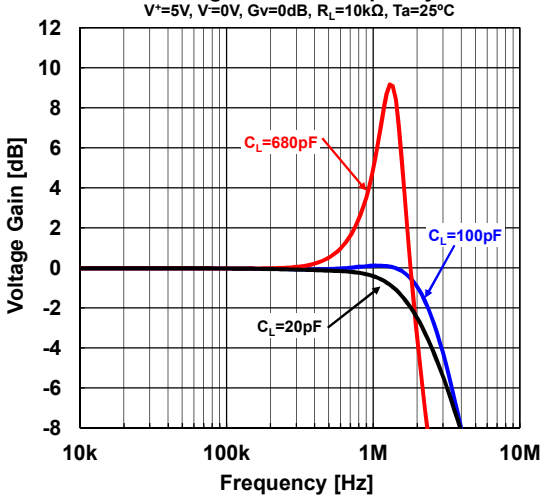




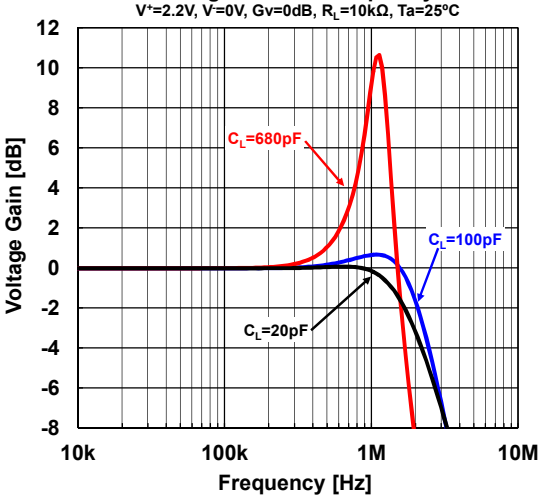


■ TYPICAL CHARACTERISTICS

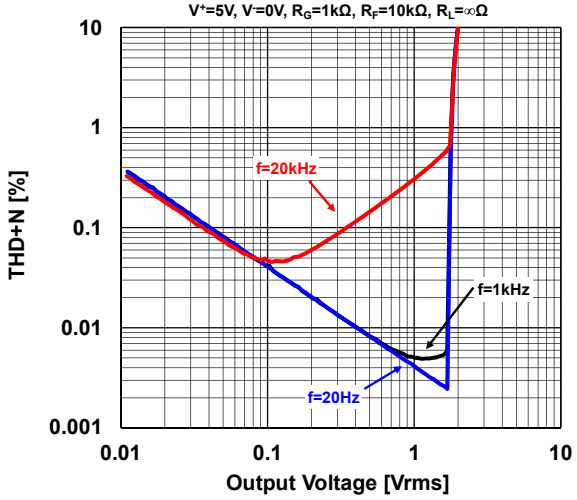
Voltage Gain vs. Frequency
V⁺=5V, V⁻=0V, Gv=0dB, R_L=10kΩ, Ta=25°C



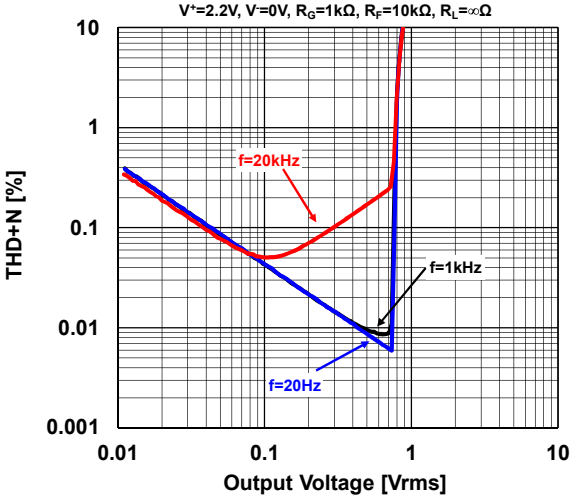
Voltage Gain vs. Frequency
V⁺=2.2V, V⁻=0V, Gv=0dB, R_L=10kΩ, Ta=25°C



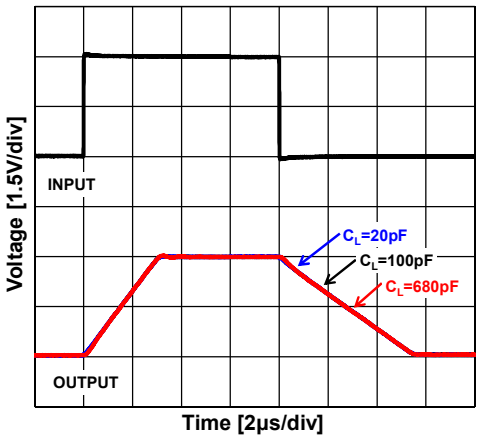
THD+N vs. Output Voltage
V⁺=5V, V⁻=0V, R_G=1kΩ, R_F=10kΩ, R_L=∞Ω



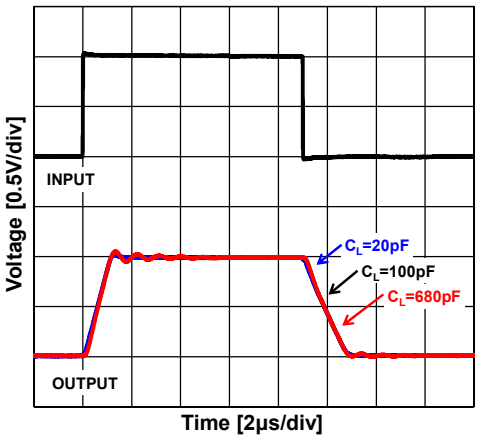
THD+N vs. Output Voltage
V⁺=2.2V, V⁻=0V, R_G=1kΩ, R_F=10kΩ, R_L=∞Ω



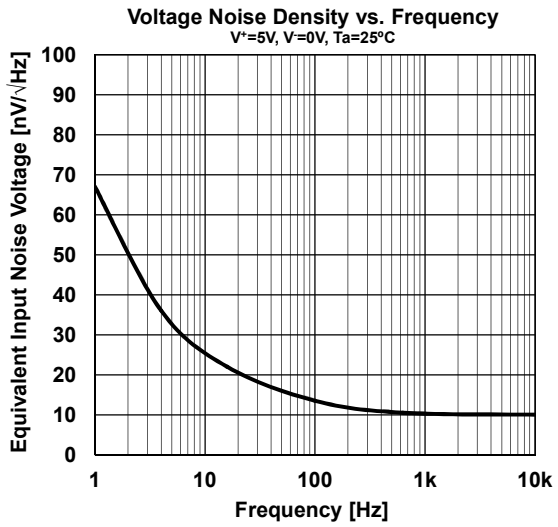
Pulse Response
V⁺=5V, V⁻=0V, R_L=10kΩ, Gv=0dB, Ta=25°C

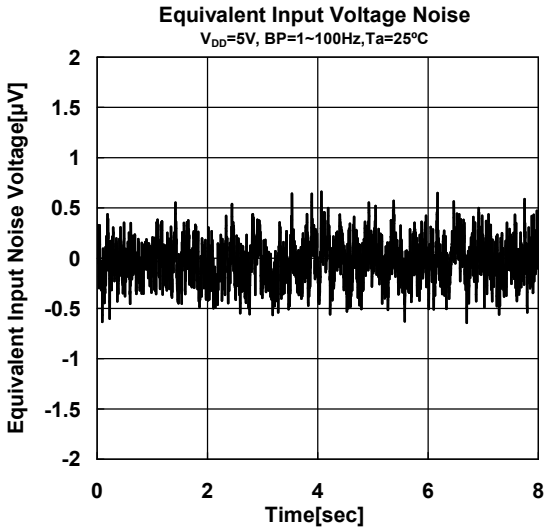


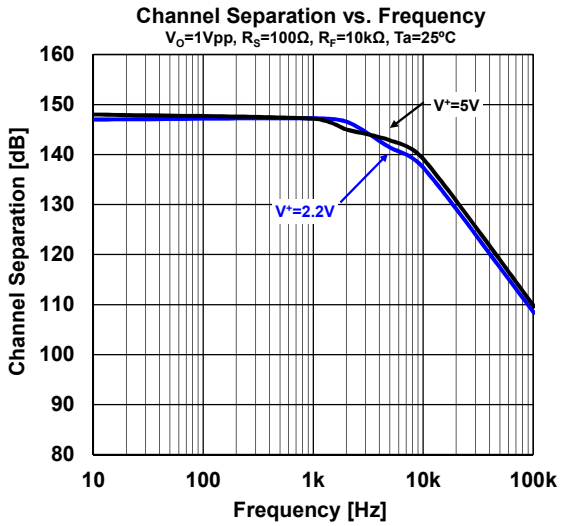
Pulse Response
V⁺=2.2V, V⁻=0V, R_L=10kΩ, Gv=0dB, Ta=25°C



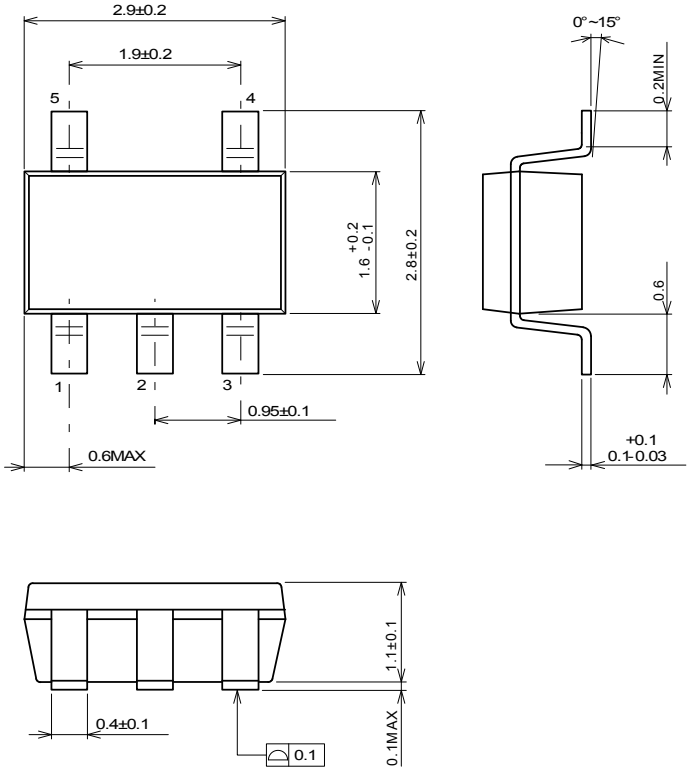
■ TYPICAL CHARACTERISTICS





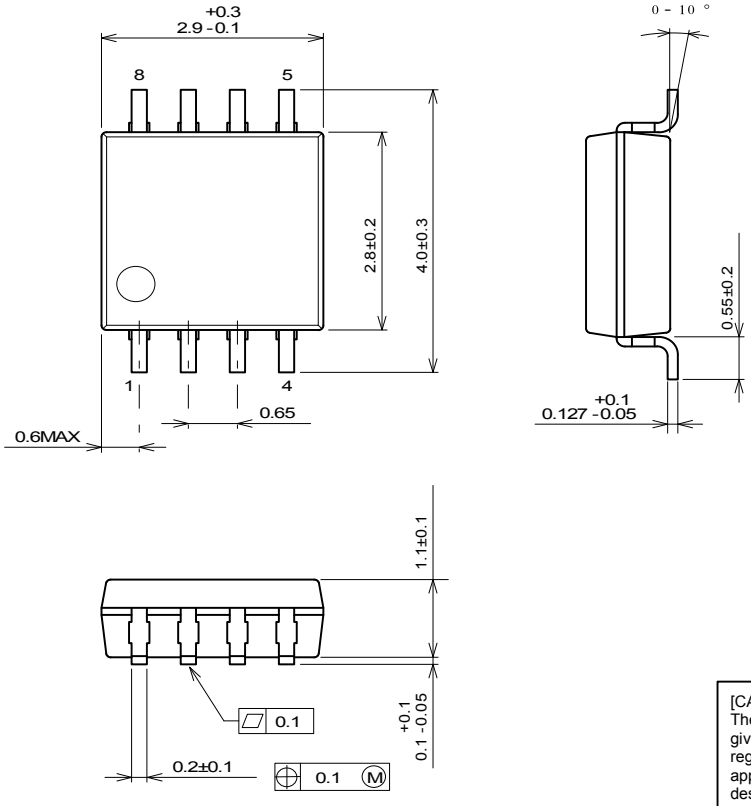


■PACKAGE DIMENSIONS



Unit: mm

SOT-23-5 Package



Unit: mm

MSOP8(VSP8)* Package
***MEET JEDEC MO-187-DA**

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