Low Noise, Low Offset Voltage Drift Rail-to-Rail Output CMOS Operational Amplifier

FEATURES (V_{DD}=5V, V_{SS}=0V, Ta=25°C)

- ●Low Noise 15nV/√Hz
- ●Low Offset Voltage Drift 0.7μV/°C typ.
- ●Offset Voltage 4mV max.
- ●Rail-to-Rail Output
  - R_L=10kΩ 50mV from rail
  - R_L=600Ω 140mV from rail
- ●Gain Bandwidth Product 2.1MHz
- ●Slew Rate 0.8V/μs
- ●Supply Current 260μA/ch
- ●Supply Voltage 1.8V to 5.5V
- ●Thin and Ultra Small Package ESON8-U1 2.0 x 2.0 x 0.4 mm
- ●RF noise Immunity
- ●Ground sense
- ●Unity-Gain Stable
- ●Package
  - NJU7056 SOT-23-5, SC-88A
  - NJU7057 MSOP8 (TVSP8)*, ESON8-U1
    *meet JEDEC MO-187-DA / thin type
  - NJU7058 SSOP14

APPLICATIONS

- ●Battery-powered instruments
- ●Current sensor amplifiers
- ●Audio pre/mic. amplifiers
- ●Power line monitoring
- ●current to Voltage converter

DESCRIPTION

The NJU7056/NJU7057/NJU7058 are Single/Dual/Quad rail-to-rail output CMOS operational amplifiers. Low noise of 15nV/√Hz and low offset drift of 0.7μV/°C typ. make them suitable for several sensor amplifiers and preamplifiers.

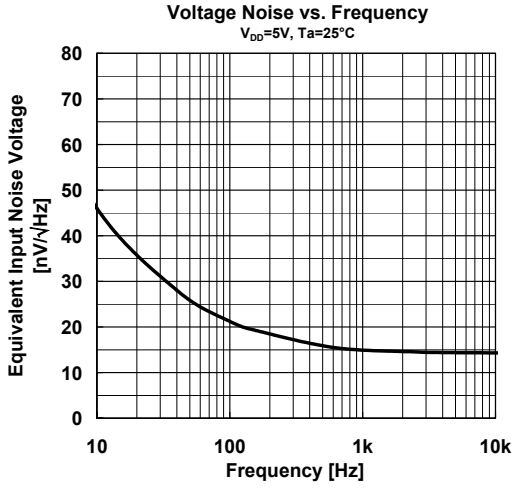
NJU7056/NJU7057/NJU7058 operate from 1.8V to 5.5V supply voltage. They are optimized for 2-cell battery systems and 1-cell li-ion battery systems. The NJU7056/NJU7057/NJU7068 have high-impedance inputs with ground sense, rail-to-rail output that swings within 50mV from rail with 10kΩ load at 1.8V supply, 2.1MHz Gain bandwidth and 0.8V/μs Slew rate. These characteristics make them excellent performance for general-purpose applications.

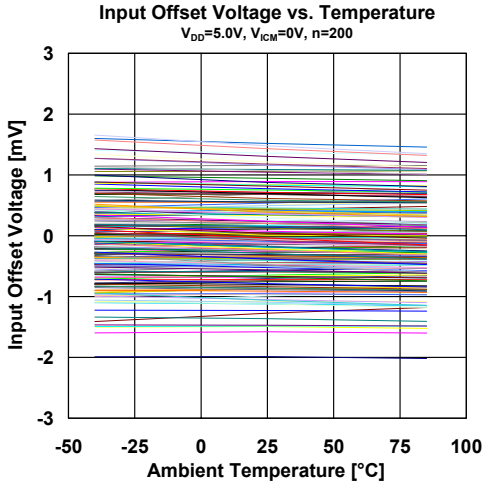
The NJU7056 is available in 5-pin SC-88A and SOT-23 package. NJU7057 is available in 8-pin MSOP (TVSP): meet JEDEC MO-187-DA / thin type package and ESON that is thin and 2mm square small package. NJU7058 is available in 14-pin SSOP package.

RELATED PRODUCTS

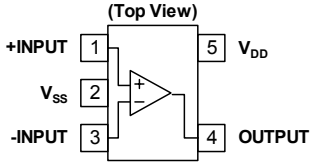
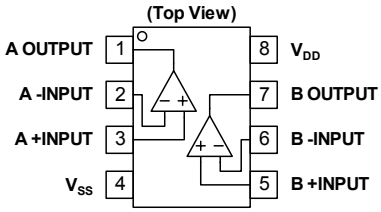
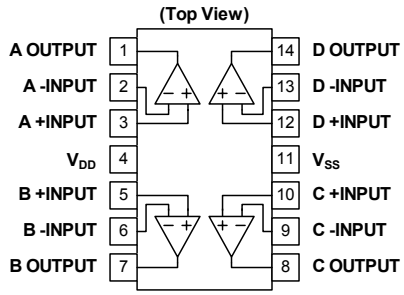
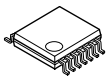
Features	Single	Dual	Quad
13μA/ch, Rail-to-rail Output (Low power type)	NJU7026	NJU7027	NJU7028
9V/μs, 5MHz, Rail-to-rail I/O (High slew rate type)	NJU7046	NJU7047	NJU7048

TYPICAL CHARACTERISTICS



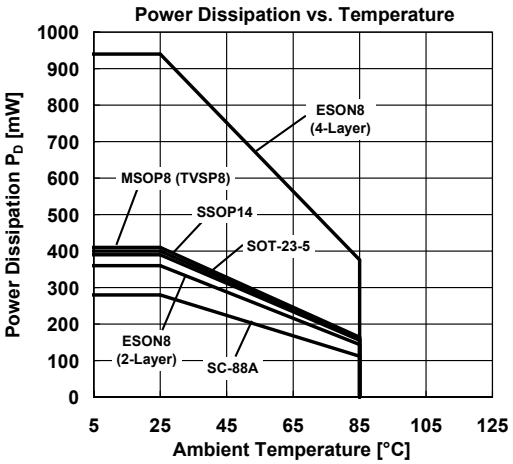


PIN CONFIGURATION / PRODUCT INFORMATION

Pin Function				
Package	 SC-88A	 SOT-23-5	 MSOP8 (TVSP8)	 ESON8-U1	 SSOP14
Product Name	**NJU7056F3**	**NJU77056F**	**NJU7057RB1**	**NJU7057KU1**	**NJU7058V**

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	7	V
Input Voltage	V_{ICM}	V_{SS} - 0.3 to V_{DD} + 0.3	V
Differential Input Voltage (1)	V_{ID}	±7 (2)	V
Power Dissipation (3)	P_D	(2-layer)	mW
SOT-23-5		390	
SC-88A		280	
MSOP8 (TVSP8)		410	
ESON8		360(2-layer) / 940(4-layer)	
SSOP14		400	
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C



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

■ RECOMMENDED OPERATING CONDITIONS (Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}		1.8	-	5.5	V

■ ELECTRICAL CHARACTERISTICS (V_{DD}=5V, V_{SS}=0V, Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Input Offset Voltage	V_{IO}	V_{ICM}= 0V	-	0.8	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta = -40°C to 85°C	-	0.7	-	μV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Voltage Gain	A_V	R_L=10kΩ to 2.5V	70	90	-	dB
Common-Mode Rejection Ratio	CMR	V_{ICM}=0V to 4.1V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=1.8V to 5.5V	70	90	-	dB
Common-Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	4.1	V
Maximum Output Voltage1	V_{OH1}	R_L=10kΩ to 2.5V	4.9	4.95	-	V
	V_{OL1}		-	0.05	0.1	
Maximum Output Voltage2	V_{OH2}	R_L=10kΩ to 0V	4.9	4.95	-	
	V_{OL2}		-	0.02	0.05	
Maximum Output Voltage3	V_{OH3}	Isource=2mA	4.8	4.85	-	
	V_{OL3}	Isink=2mA	-	0.15	0.2	
Supply Current (All Amplifiers)						
NJU7056	I_{DD}	No Signal	-	0.26	0.42	mA
NJU7057		No Signal	-	0.52	0.84	
NJU7058		No Signal	-	1.1	1.7	
AC CHARACTERISTICS						
Slew Rate (4)	SR	G_V=0dB, R_L=10kΩ to 2.5V, C_L=20pF, Vin=3Vpp (1V to 4V)	-	0.8	-	V/μs
Gain Bandwidth Product	GBW	R_L=10kΩ to 2.5V, C_L=20pF, f=100kHz	-	2.1	-	MHz
Phase Margin	φ_M	R_L=10kΩ to 2.5V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=10kΩ to 2.5V, C_L=20pF	-	10	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	15	-	nV/√Hz
Total Harmonic Distortion + Noise	THD+N	G_V=6dB, Vo=4Vpp, f=1kHz	-	0.002	-	%
Channel Separation	CS	f=1kHz, NJU7057/NJU7058	-	120	-	dB

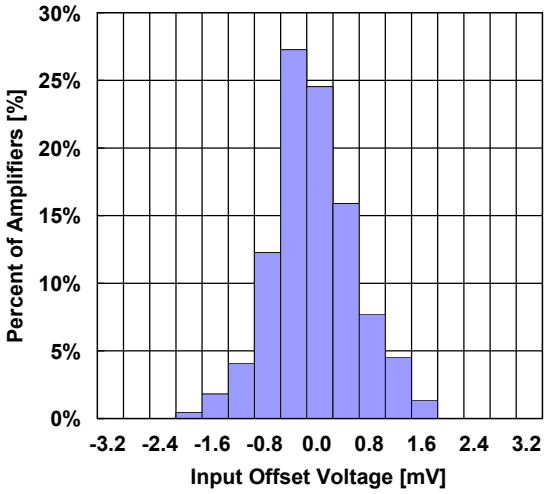
■ ELECTRICAL CHARACTERISTICS (V_{DD}=1.8V, V_{SS}=0V, Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Input Offset Voltage	V_{IO}	V_{ICM}= 0V	-	0.8	4	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta = -40°C to 85°C	-	0.8	-	µV/°C
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Voltage Gain	A_V	R_L=10kΩ to 0.9V	65	90	-	dB
Common-Mode Rejection Ratio	CMR	V_{ICM}=0V to 0.9V	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	V_{DD}=1.8V to 5.5V	70	90	-	dB
Common-Mode Input Voltage Range	V_{ICM}	CMR≥65dB	0	-	0.9	V
Maximum Output Voltage1	V_{OH1}	R_L=10kΩ to 0.9V	1.7	1.75	-	V
	V_{OL1}		-	0.05	0.1	
Maximum Output Voltage2	V_{OH2}	R_L=10kΩ to 0V	1.7	1.75	-	
	V_{OL2}		-	0.02	0.05	
Maximum Output Voltage3	V_{OH3}	Isource=1mA	1.5	1.55	-	
	V_{OL3}	Isink=1mA	-	0.25	0.3	
Supply Current (All Amplifiers)						
NJU7056	I_{DD}	No Signal	-	0.22	0.38	mA
NJU7057		No Signal	-	0.44	0.76	
NJU7058		No Signal	-	0.9	1.5	
AC CHARACTERISTICS						
Slew Rate (4)	SR	G_V=0dB, R_L=10kΩ to 0.9V, C_L=20pF, Vin=0.5Vpp (0.3V to 0.8V)	-	0.6	-	V/µs
Gain Bandwidth Product	GBW	R_L=10kΩ to 0.9V, C_L=20pF, f=100kHz	-	1.7	-	MHz
Phase Margin	φ_M	R_L=10kΩ to 0.9V, C_L=20pF	-	80	-	deg
Gain Margin	G_M	R_L=10kΩ to 0.9V, C_L=20pF	-	13	-	dB
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	18	-	nV/√Hz
Total Harmonic Distortion + Noise	THD+N	G_V=6dB, Vo=1Vpp, f=1kHz	-	0.005	-	%
Channel Separation	CS	f=1kHz, NJU7057/NJU7058	-	110	-	dB

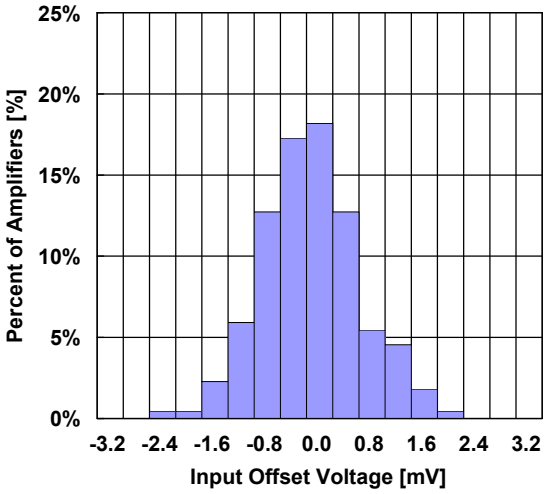
(4) Slew rate is defined by the lower value of the rise or fall.

■ TYPICAL CHARACTERISTICS

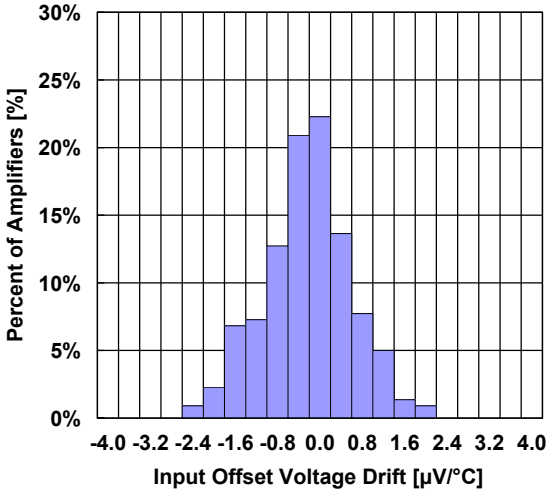
Input Offset Voltage Distribution
V_{DD}=5.0V, V_{ICM}=0V, Ta=25°C, n=200



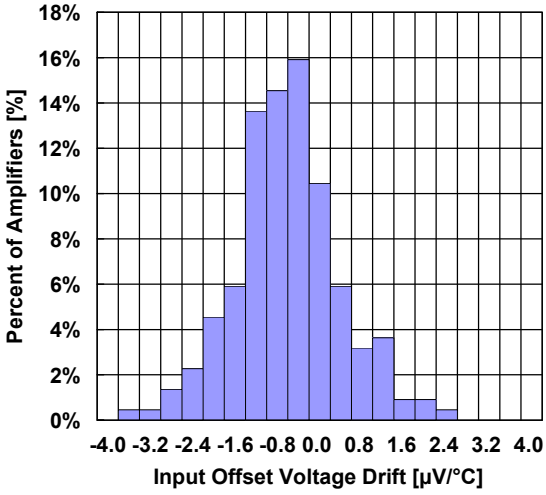
Input Offset Voltage Distribution
V_{DD}=1.8V, V_{ICM}=0V, Ta=25°C, n=200



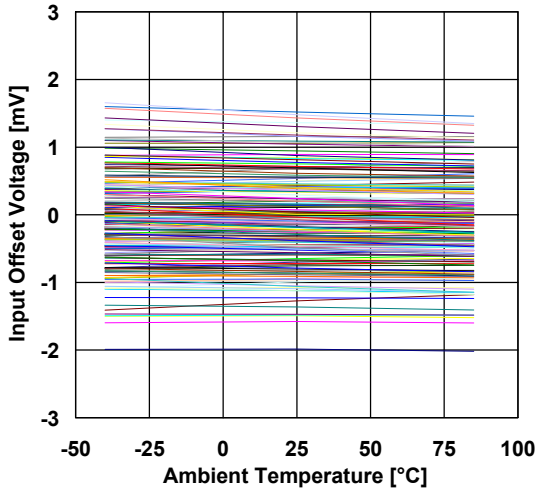
Input Offset Voltage Drift Distribution
V_{DD}=5.0V, V_{ICM}=0V, n=200



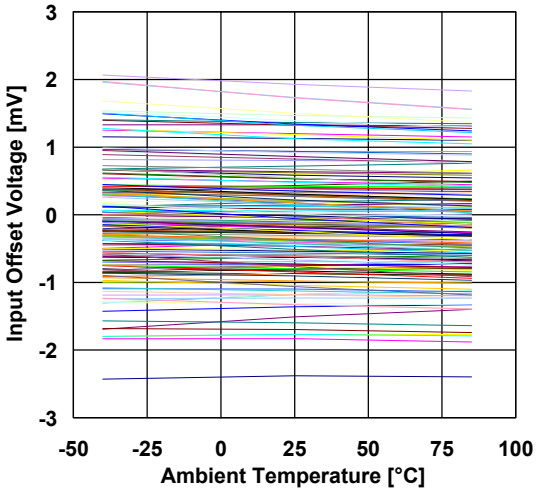
Input Offset Voltage Drift Distribution
V_{DD}=1.8V, V_{ICM}=0V, n=200



Input Offset Voltage vs. Temperature
V_{DD}=5.0V, V_{ICM}=0V, n=200

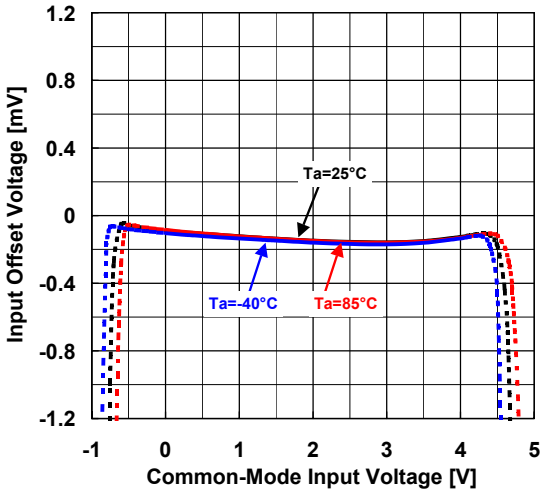


Input Offset Voltage vs. Temperature
V_{DD}=1.8V, V_{ICM}=0V, n=200

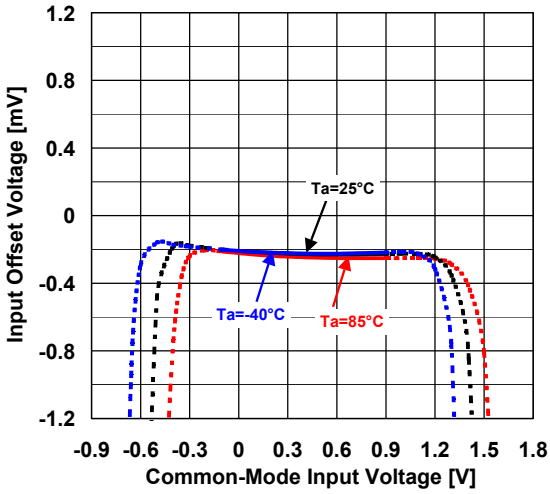


■ TYPICAL CHARACTERISTICS

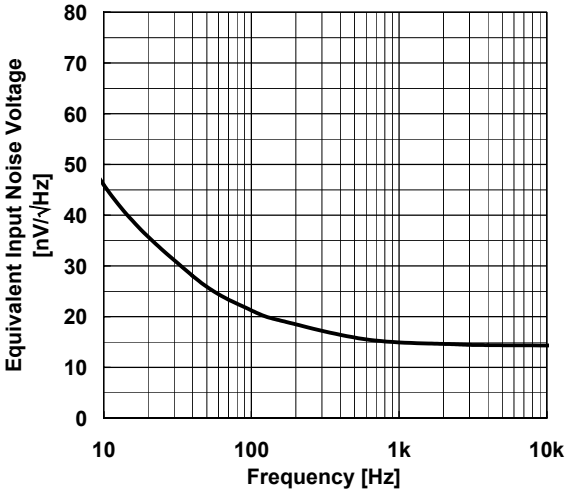
Input Offset Voltage vs. Common-Mode Input Voltage
V_{DD}=5V



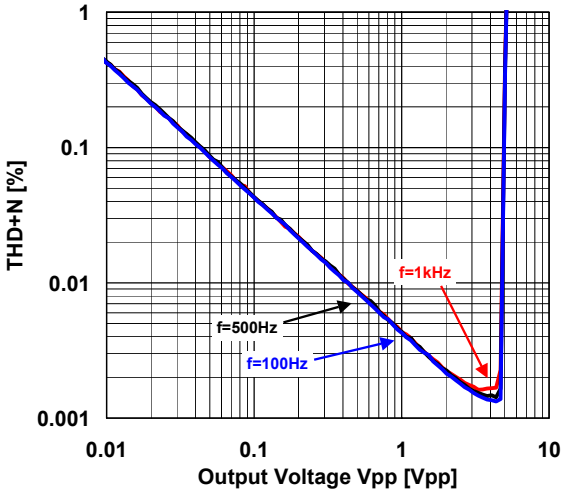
Input Offset Voltage vs. Common-Mode Input Voltage
V_{DD}=1.8V



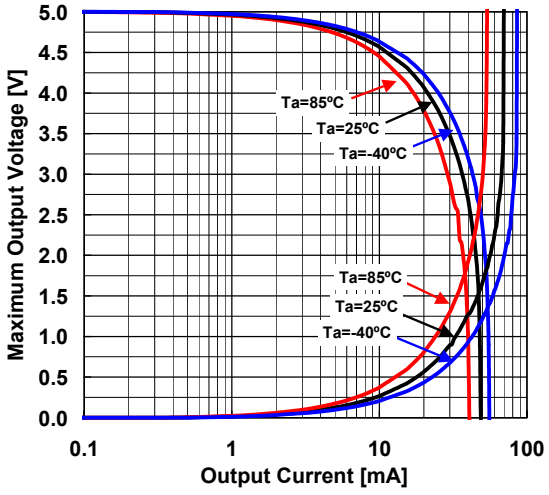
Voltage Noise vs. Frequency
V_{DD}=5V, Ta=25°C



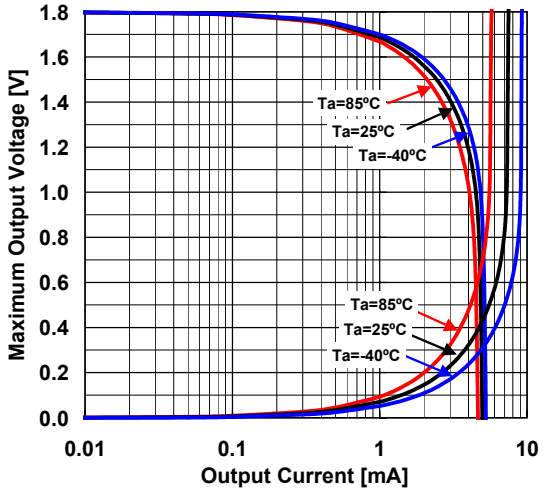
THD+N vs. Output Voltage
V_{DD}=5V, Gv=6V, Ta=25°C



Maximum Output Voltage vs. Output Current
V_{DD}=5V, V_{ICM}=2.5V

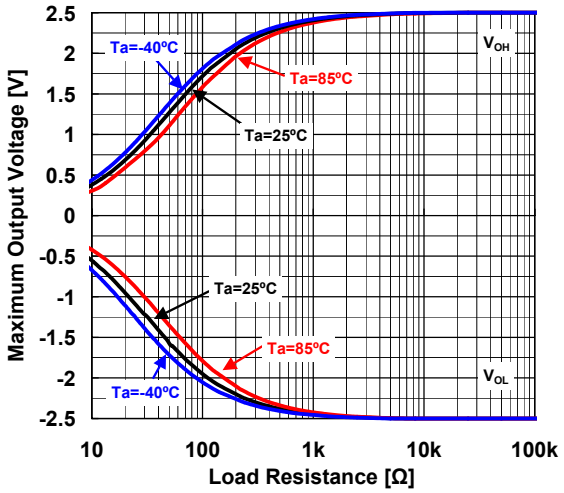


Maximum Output Voltage vs. Output Current
V_{DD}=1.8V, V_{ICM}=0.9V

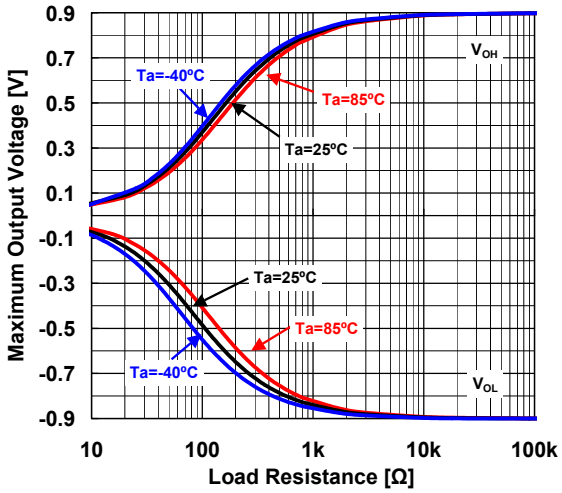


■ TYPICAL CHARACTERISTICS

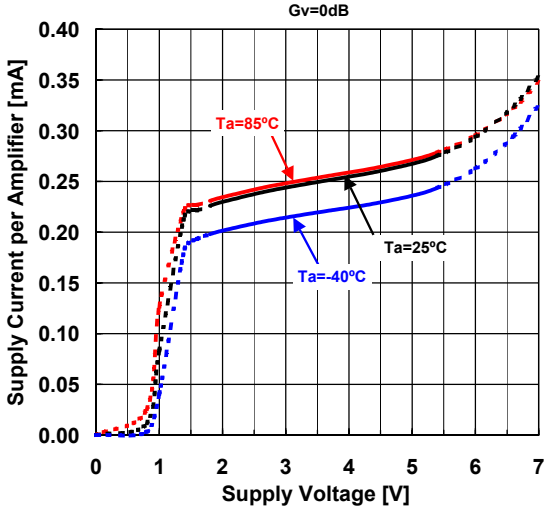
Maximum Output Voltage vs. Load Resistance
V_{DD}/V_{SS}=±2.5V



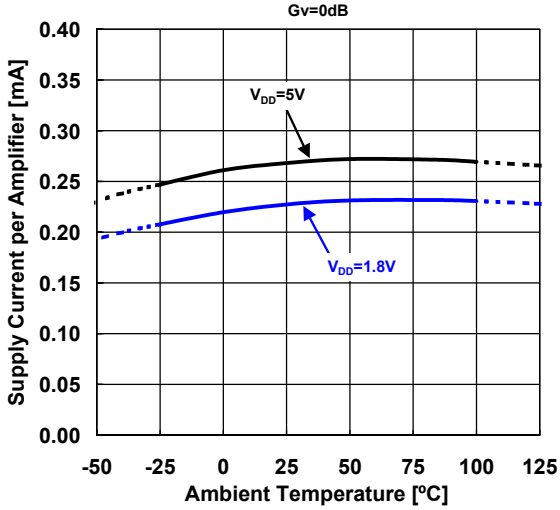
Maximum Output Voltage vs. Load Resistance
V_{DD}/V_{SS}=±0.9V



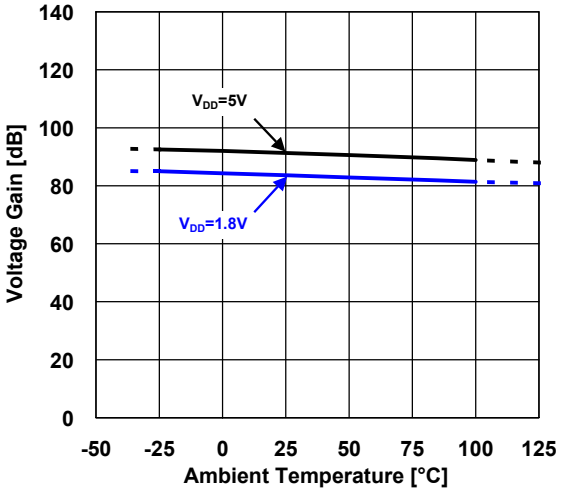
Supply Current per Amplifier vs. Supply Voltage
Gv=0dB



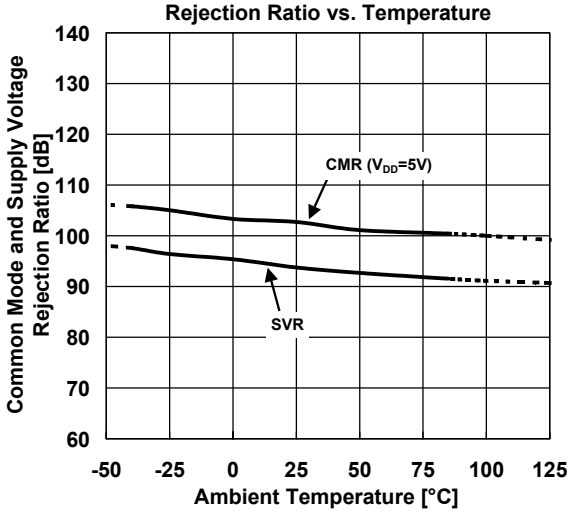
Supply Current per Amplifier vs. Temperature
Gv=0dB



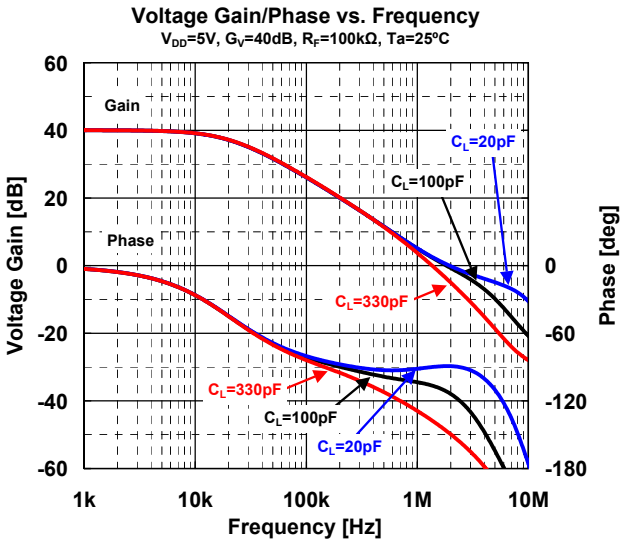
Voltage Gain vs. Temperature
V_{OUT}=0.5V to V_{DD}-0.5, R_L=10KΩ

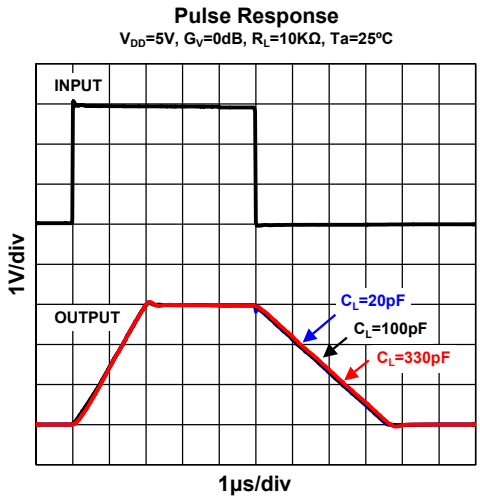


Common Mode and Supply Voltage Rejection Ratio vs. Temperature

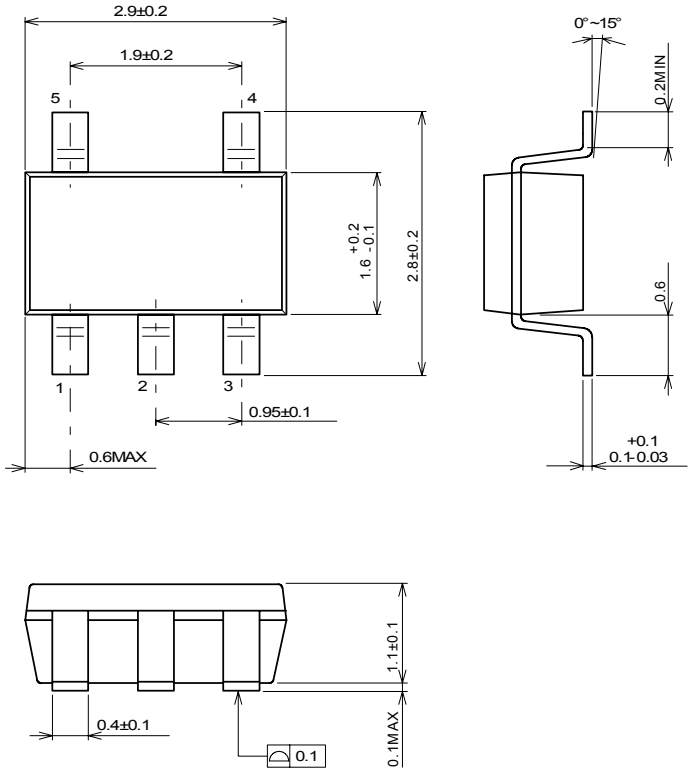


■ TYPICAL CHARACTERISTICS





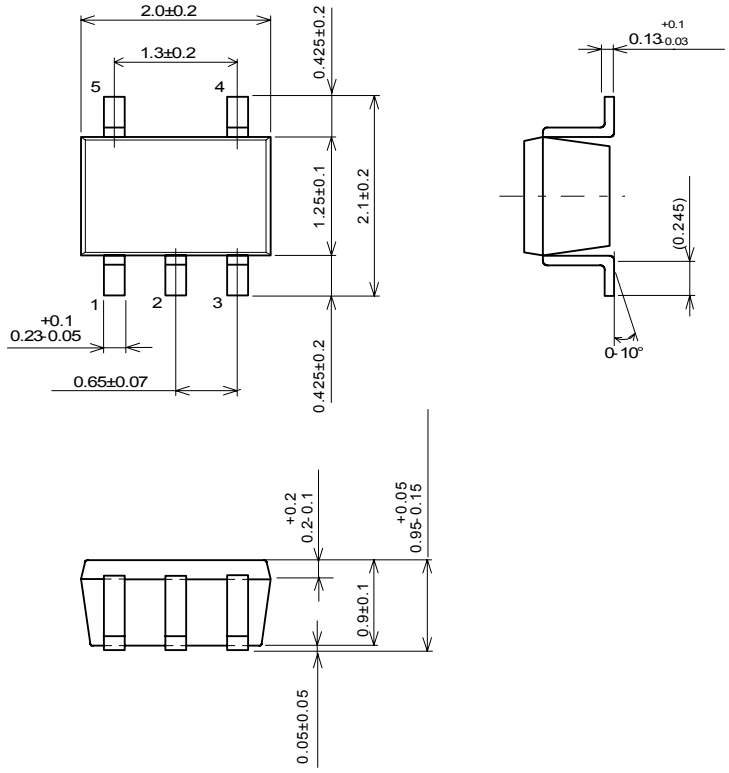
■ PACKAGE DIMENSIONS



Unit: mm

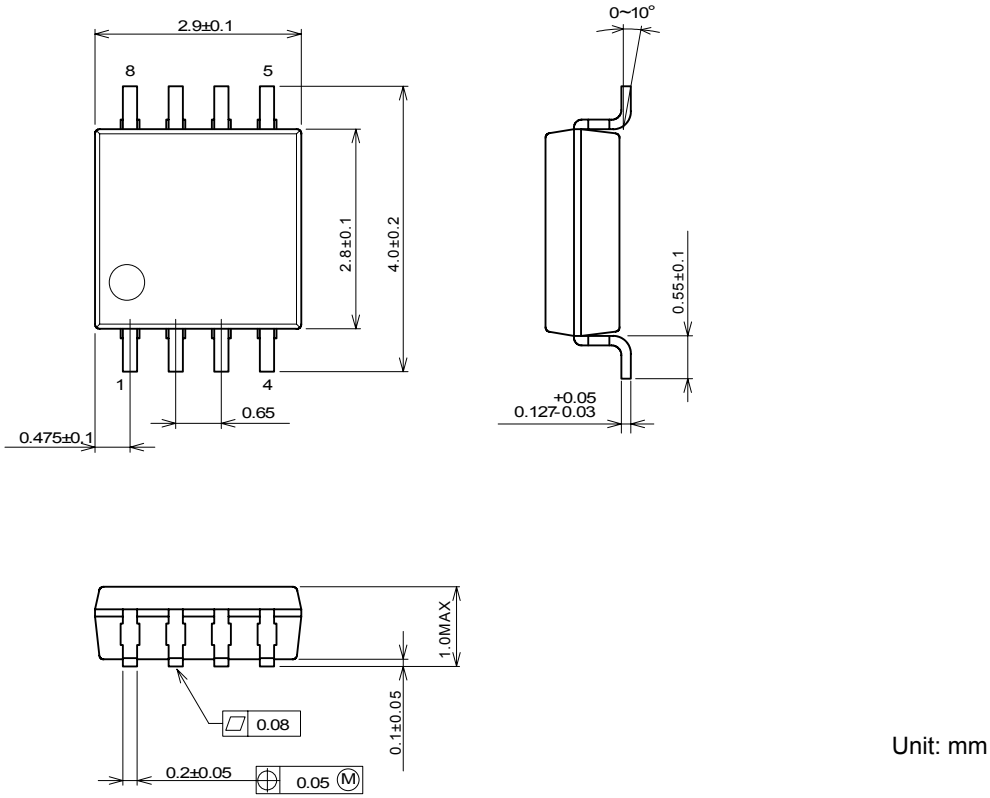
SOT-23-5 Package

■ PACKAGE DIMENSIONS



Unit: mm

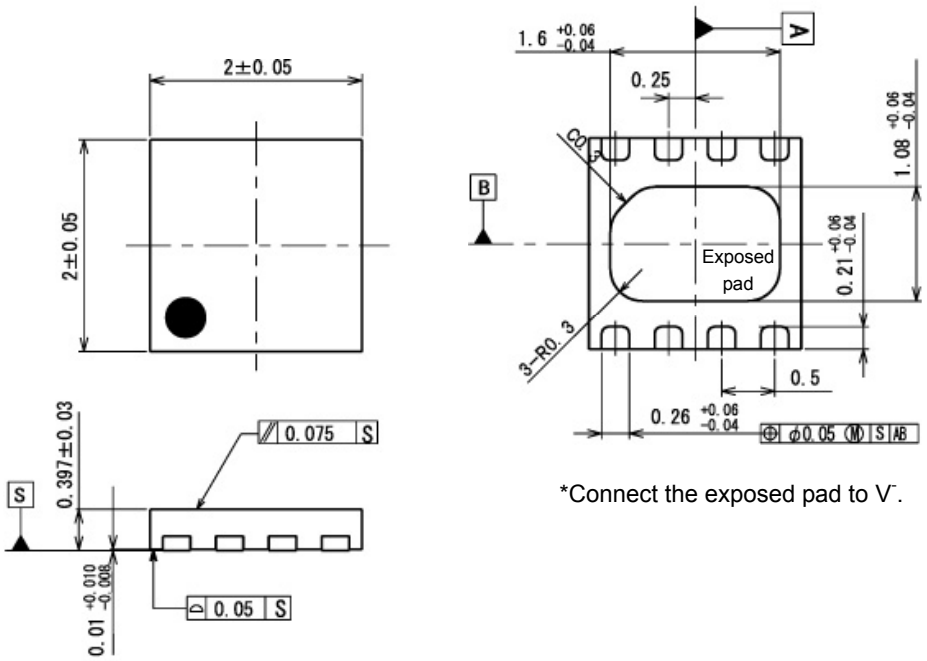
SC88A Package



Unit: mm

MSOP (TVSP8) meet JEDEC MO-187-DA / thin type Package

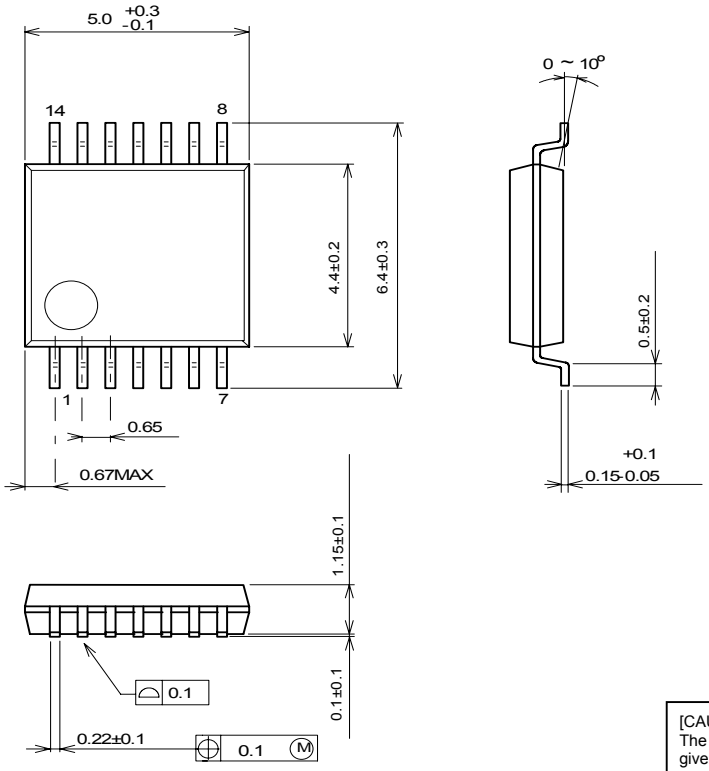
■ PACKAGE DIMENSIONS



*Connect the exposed pad to V-.

Unit: mm

ESON8-U1 Package



Unit: mm

SSOP14 Package

[CAUTION]
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