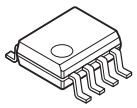
Dual Precision Operational Amplifier

■ FEATURES

●Precision	V_{IO}=60μV max.
	V_{IO}=100μV max. (Ta=-40ºC to +85ºC)
●Low Offset Drift	$\Delta V_{IO}/\Delta T$=0.9μV/ºC max. (Ta=-40ºC to +85ºC)
●Specified for ±15V and ±5V operation	
●CMR	128dB min.
●Low Noise	V_{NI}=80nVrms typ. at f=1 to 100Hz
	en=8nV/√Hz typ. at f=100Hz
●Open Loop Gain	Av=130dB min.
●Guaranteed Temperature	Ta=-40ºC to +85ºC
●Unity Gain Stable	
●Operating Voltage	Vopr=±3V to ±18V
●Unity Gain Frequency	f_T=1.1MHz typ.
●Supply Current	Icc=3.2mA max.
●Package	SOP8

■ PACKAGE OUTLINE



NJM2739E

■ GENERAL DESCRIPTION

The NJM2739 is a high performance operational amplifier featured very low offset voltage and drift.

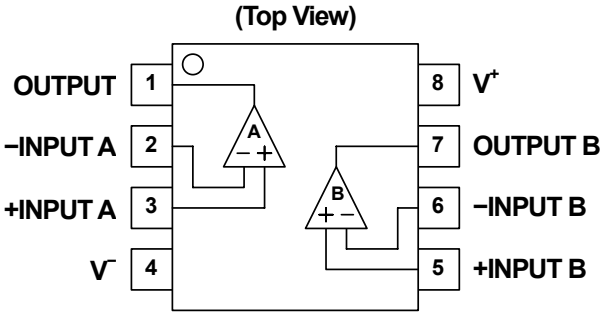
Features are low offset voltage and drift, high common mode rejection, low noise and open loop gain. DC characteristics are100% tested and specified from −40ºC to 85ºC.

The NJM2739 is suitable for high gain circuit amplified small signal and sets required stable behavior over a wide temperature range.

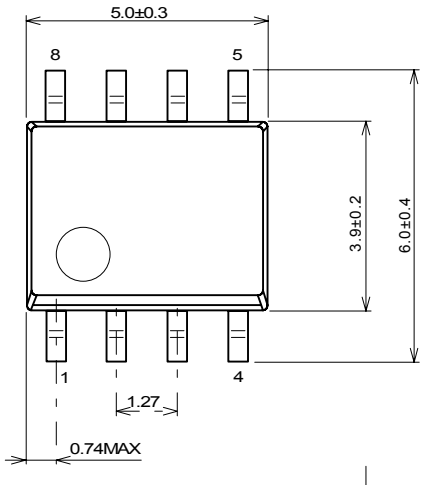
■ APPRICATION

- ●Thermocouple sensor
- ●Bridge Amplifier
- ●Current Sensor
- ●Instrumentation Amplifier
- ●Reference Voltage Circuit

■ PIN CONFIGURATION



■ PACKAGE DESCRIPTION



■ ABSOLUTE MAXIMUM RATING (Ta=25ºC Unless Otherwise Specified)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+/V^-	±20	V
Common Mode Input Voltage Range (Note1)	V_{ICM}	±20	V
Differential Input Voltage Range	V_{ID}	±30	V
Power Dissipation (Note2)	P_D	640	mW
Operating Temperature Range	Topr	-40 to +85	ºC
Storage Temperature Range	Tstg	-50 to +125	ºC

(Note1) For supply voltage less than ±20V, the maximum input voltage is equal to the supply voltage.
(Note2) Mounted on the EIA/JEDEC standard board (114.3×76.2×1.6mm, two layer, FR-4).

■ RECOMMENDED OPERATING VOLTAGE

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V^+/V^-		±3	-	±18	V

■ ELECTRONIC CHARACTERISTICS (V^+/V^-=±15V Ta=+25ºC, V_{CM}=0V unless otherwise specified)

● DC CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage	$V_{IO}1$		-	20	60	µV
	$V_{IO}2$	Ta=-40 to +85ºC	-	20	100	µV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta=-40→+25ºC / Ta=+25ºC→+85ºC	-	0.3	0.9	µV/ºC
Common Mode Input Voltage Range	$V_{ICM}1$		±13	±14	-	V
	$V_{ICM}1$	Ta=-40 to +85ºC	±13	±13.5	-	dB
Common Mode Rejection Ratio	CMR1	V_{CM}=0V→-13V / V_{CM}=0V→+13V	128	135	-	dB
	CMR2	Ta=-40 to +85ºC, VCM=0V→-13V / VCM=0V→+13V	120	130	-	dB
Supply Voltage Rejection Ratio	SVR1	V+/V-=±3V to ±18V	115	125	-	dB
	SVR2	Ta=-40 to +85ºC, V+/V-=±3V to ±18V	110	120	-	dB
Input Bias Current	I_B1		-0.2	1.2	2.8	nA
	I_B2	Ta=-40 to +85ºC	-1.5	1.7	6	nA
Input Bias Current Drift	$\Delta I_B/\Delta T$	Ta=-40→+85ºC	-	8	60	pA/ºC
Input Offset Current	$I_{IO}1$		-	0.3	2.8	nA
	$I_{IO}2$	Ta=-40 to +85ºC	-	0.3	4.5	nA
Input Offset Current Drift	$\Delta I_{IO}/\Delta T$	Ta=-40→+85ºC	-	1.5	72	pA/ºC
Differential Input Impedance	R_{ID}	*1	-	90	-	MΩ
Common-Mode Input Impedance	R_{IC}	*1	-	800	-	GΩ
Voltage Gain	Av1	R_L=2kΩ, Vo= -10V→0V / 0V→+10V / -10V→+10V	130	142	-	dB
	Av2	Ta=-40 to +85ºC, RL=2kΩ, Vo= -10V→0V / 0V→+10V / -10V→+10V	126	136	-	dB
Channel Separation	CS	DC	-	0.01	-	µV/V
Output Characteristics						
Maximum Output Voltage	$V_{OM}1$	R_L=10kΩ	±13.5	±14.0	-	V
	$V_{OM}2$	Ta=-40 to +85ºC, RL=10kΩ	±13.0	±14.0	-	V
	$V_{OM}3$	R_L=2kΩ	±12.5	±13.0	-	V
	$V_{OM}4$	Ta=-40 to +85ºC, RL=2kΩ	±12.0	±13.0	-	V
	$V_{OM}5$	R_L=1kΩ	±12.0	±12.5	-	
Output Resistance	R_O	Open-Loop	-	60	-	Ω
Supply Characteristics						
Supply Current	$I_{CC}1$	A_V=+1, R_L=∞	-	2.6	3.2	mA
	$I_{CC}2$	Ta=-40 to +85ºC, AV=+1, RL=∞	-	2.7	3.4	mA
	$I_{CC}3$	V^+/V^-=±3V, A_V=+1, R_L=∞	-	1.3	1.6	mA
	P_D1	AV=+1, R_L=∞	-	78	96	mW
	P_D1	V^+/V^-=±3V, A_V=+1, R_L=∞	-	81	102	mW

*1 Theoretical value by design

● AC CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency Characteristics						
Unity Gain Frequency	f_T	A_V=+100, R_L=2kΩ, C_L=10pF	-	1.1	-	MHz
Slew Rate	+SR	RISE, A_V=+1, V_{IN}=1Vpp, R_L=2kΩ	0.1	0.3	-	V/μS
	-SR	FALL, A_V=+1, V_{IN}=1Vpp, R_L=2kΩ	0.1	0.3	-	V/μS
Noise Characteristics						
Equivalent Input Noise Voltage	V_{NI}	fo=1Hz to 100Hz	-	80	-	nVrms
Equivalent Input Noise Current	I_{NI}	fo=1Hz to 100Hz	-	3	-	pArms

■ ELECTRONIC CHARACTERISTICS (V^+/V^-=±5V Ta=+25ºC, V_{CM}=0V unless otherwise specified)

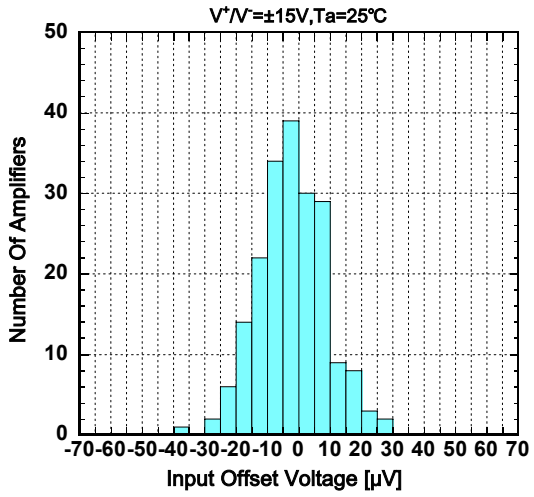
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Characteristics						
Input Offset Voltage	$V_{IO}1$		-	30	70	μV
	$V_{IO}2$	Ta=-40ºC to +85ºC	-	35	110	μV
Common Mode Input Voltage Range	$V_{ICM}1$		±3	±3.9	-	V
	$V_{ICM}1$	Ta=-40ºC to +85ºC	±3	±3.5	-	dB
Common Mode Rejection Ratio	CMR1	V_{CM}=0V→-3V / V_{CM}=0V→+3V	115	125	-	dB
	CMR2	Ta=-40ºC to +85ºC, V_{CM}=0V→-3V / V_{CM}=0V→+3V	105	118	-	dB
Input Bias Current	I_B1		-0.2	0.7	2.0	nA
	I_B2	Ta=-40ºC to +85ºC	-0.2	1.0	6.0	nA
Input Offset Current	$I_{IO}1$		-	0.3	2.8	nA
	$I_{IO}2$	Ta=-40ºC to +85ºC	-	0.3	4.5	nA
Voltage Gain	Av1	R_L=2kΩ, Vo= -3V→0V / 0V→+3V / -3V→+3V	115	130	-	dB
	Av2	Ta=-40ºC to +85ºC, R_L=2kΩ, Vo= -3V→0V / 0V→+3V / -3V→+3V	110	125	-	dB
Channel Separation	CS	DC	-	0.01	-	μV/V
Output Characteristics						
Maximum Output Voltage	$V_{OM}1$	R_L=10kΩ	±3.5	±4.0	-	V
	$V_{OM}2$	Ta=-40ºC to +85ºC, R_L=10kΩ	±3.5	±4.0	-	V
	$V_{OM}3$	R_L=2kΩ	±3.5	±4.0	-	V
	$V_{OM}4$	Ta=-40ºC to +85ºC, R_L=2kΩ	±3.5	±4.0	-	V
Supply Characteristics						
Supply Current	$I_{CC}1$	A_V=+1, R_L=∞	-	1.6	2.0	mA
	$I_{CC}2$	Ta=-40ºC to +85ºC, A_V=+1, RL=∞	-	1.7	2.1	mA

● EXPLANATION OF MEASUREMENT CONDITION

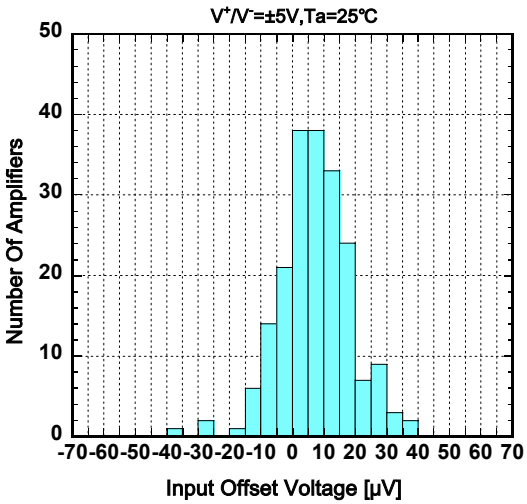
PARAMETER	Explanation
Input Offset Voltage Drift	Input Offset Voltage Drift = $\Delta V_{IO} / \Delta T$ ΔT : Amount of Temperature change. ΔV_{IO} : Amount of Input Offset Voltage.
Common Mode Input Voltage range	A range of input voltage at which the operational amplifier can function.
Common Mode Rejection Ratio	$CMR = 20\log \lvert (\Delta V_{CM} / \Delta V_{IO}) \rvert$ ΔV_{CM} : Amount of Input Voltage. ΔV_{IO} : Amount of Input Offset Voltage.
Supply Voltage Rejection Ratio	$SVR = 20\log \lvert (\Delta V_S / \Delta V_{IO}) \rvert$ ΔV_S : Amount of supply Voltage. ΔV_{IO} : Amount of Input Offset Voltage.
Common Mode Input Impedance	$R_{IC} = \Delta V_{CM} / \Delta I_B$ ΔV_{CM} : Amount of Input Voltage. ΔI_B : Amount of Input bias current.
Voltage Gain	$A_V = 20\log \lvert (\Delta V_O / \Delta V_{IO}) \rvert$ ΔV_O : Amount of output Voltage. ΔV_{IO} : Amount of Input offset Voltage.

■ TYPICAL CHARACTERISTICS

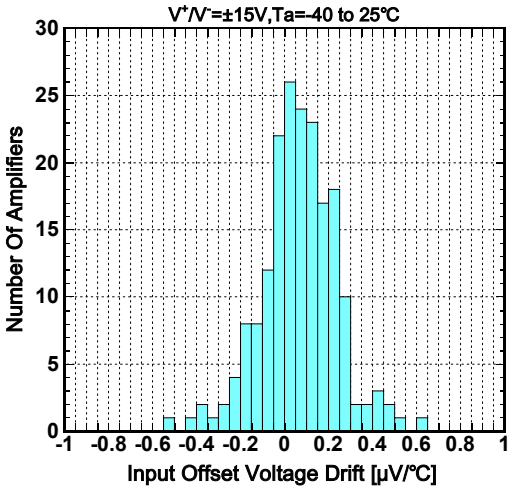
Input Offset Voltage Distribution



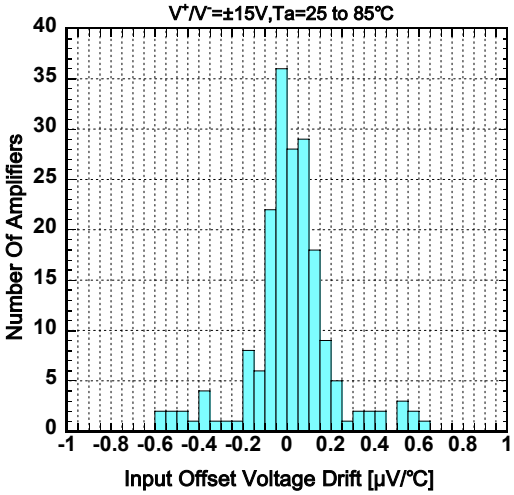
Input Offset Voltage Distribution



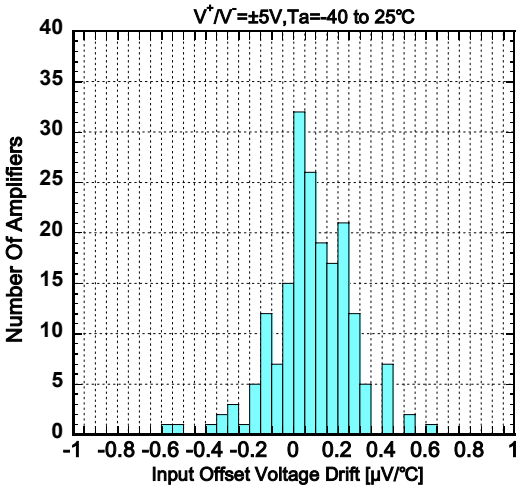
Input Offset Voltage Drift Distribution



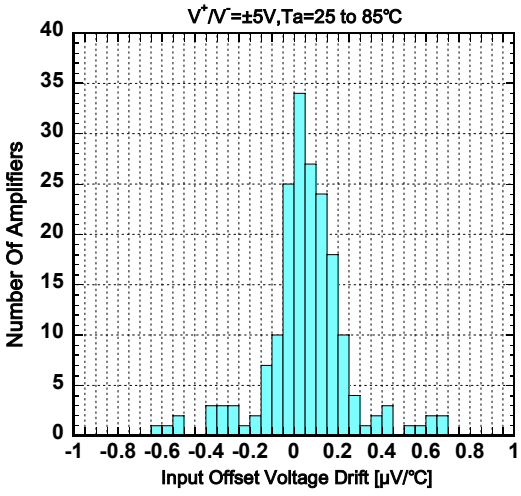
Input Offset Voltage Drift Distribution



Input Offset Voltage Drift Distribution

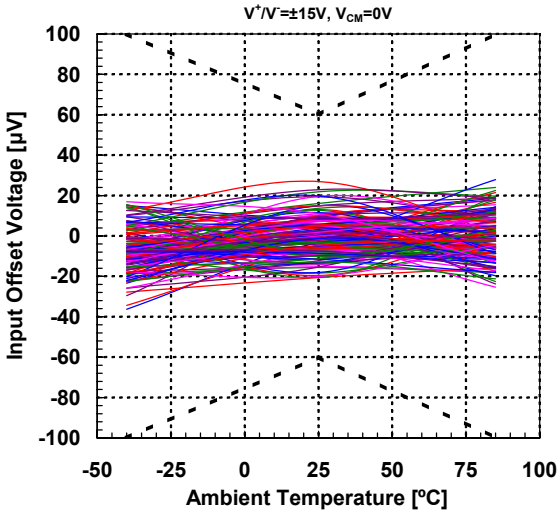


Input Offset Volotage Drift Distribution

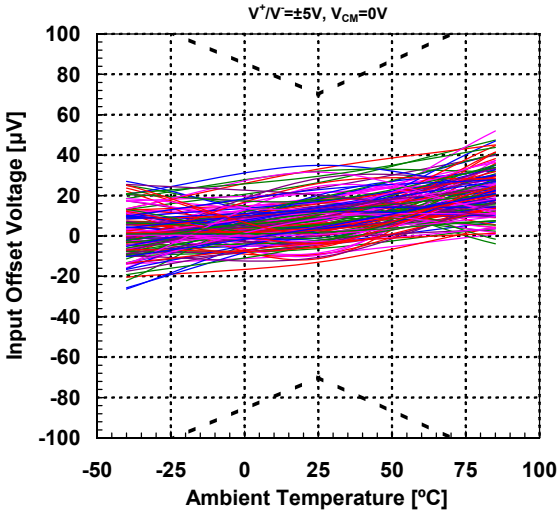


■ TYPICAL CHARACTERISTICS

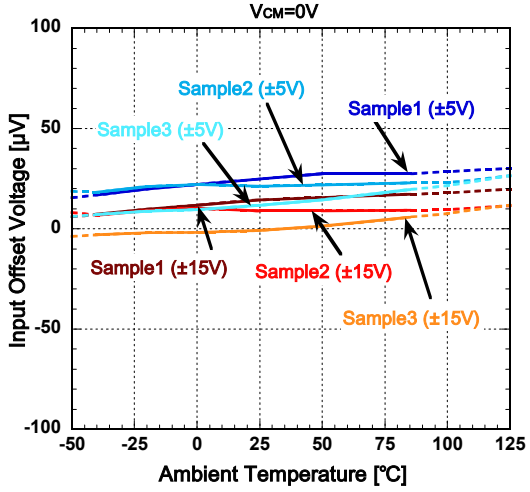
Input Offset Voltage vs. Temperature
V^+/V^-=±15V, V_{CM}=0V



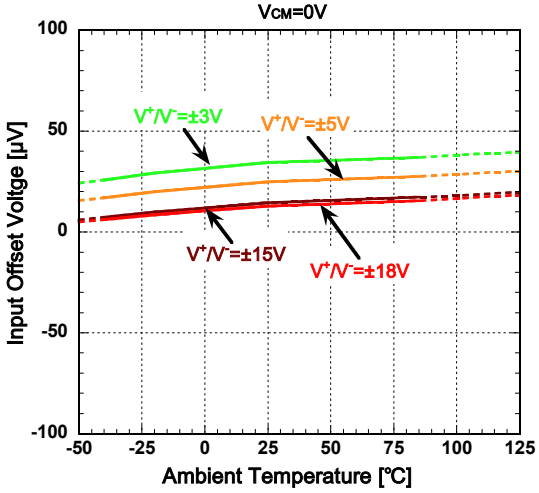
Input Offset Voltage vs. Temperature
V^+/V^-=±5V, V_{CM}=0V



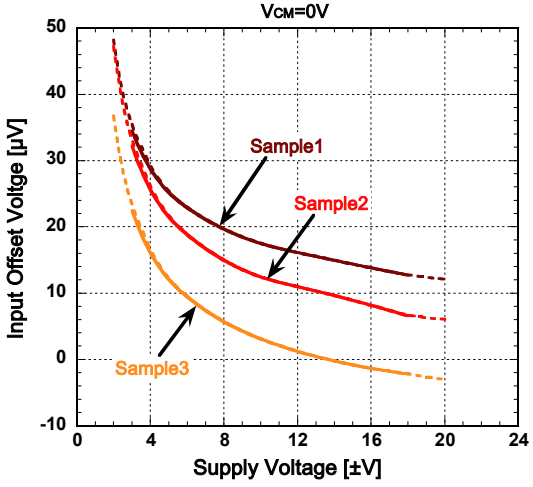
Input Offset Voltage vs. Temperature
(Supply Voltage)
V_{CM}=0V



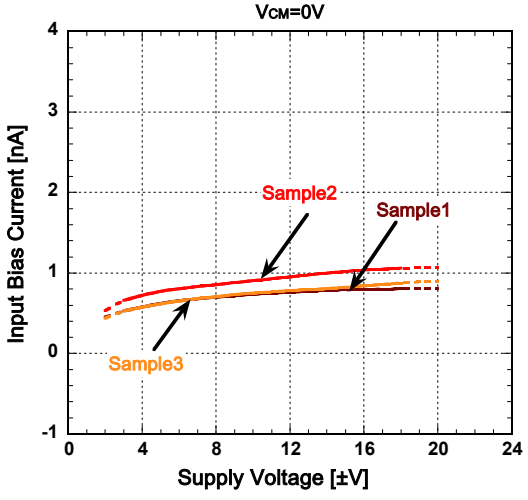
Input Offset Voltage vs. Temperature
(Supply Voltage)
V_{CM}=0V



Input Offset Voltage vs. Supply Voltage
V_{CM}=0V

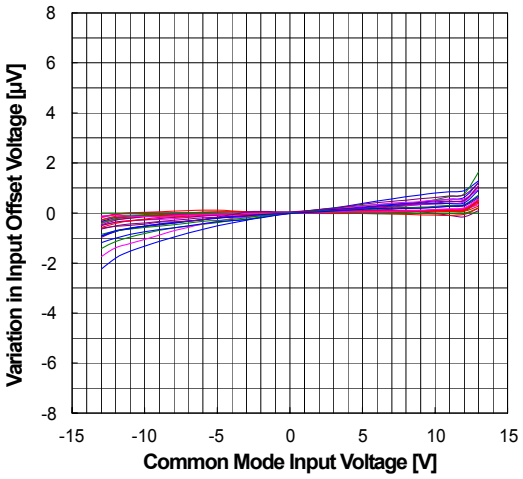


Input Bias Curent vs. Supply Voltage
V_{CM}=0V

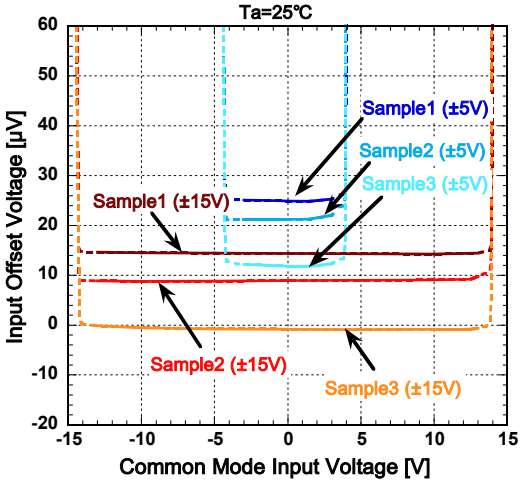


■ TYPICAL CHARACTERISTICS

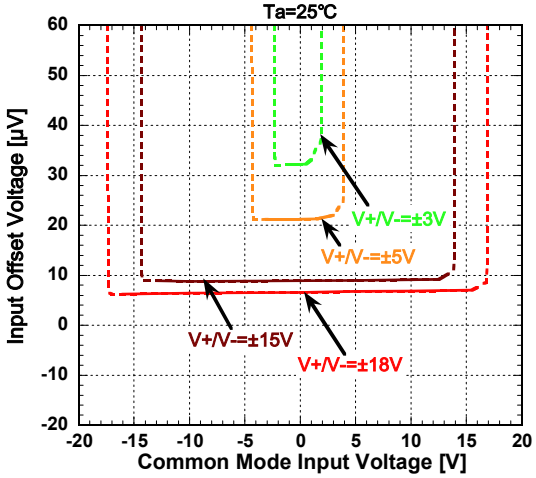
Variation in Input Offset Voltage
vs. Common Mode Input Voltage



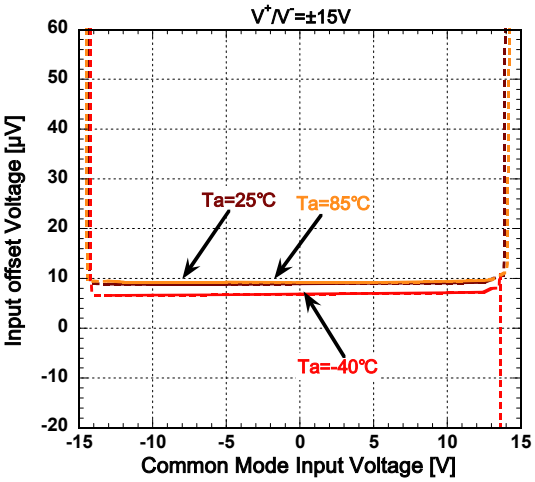
Input Offset Voltage
vs. Common Mode Input Voltage
(Supply Voltage)
Ta=25℃



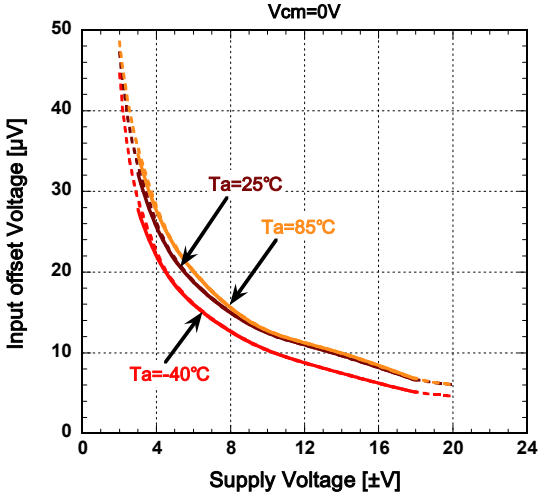
Input Offset Voltage vs. Common Mode Input Voltage
(Supply Voltage)
Ta=25℃



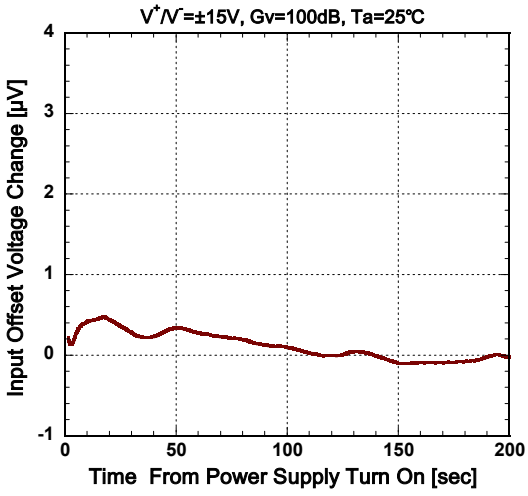
Input Offset Voltage vs. Common Mode Input Voltage
(Temperature)
V^+/V^-=±15V



Input Offset Voltage vs. Supply Voltage
(Temperature)
Vcm=0V

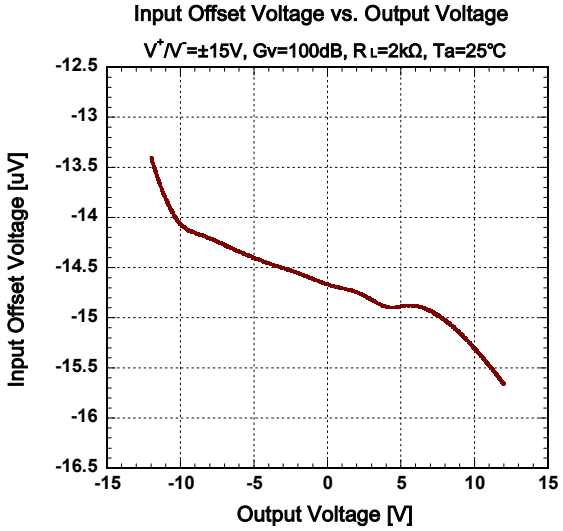


Warm Up Input Offset Voltage Drift
V^+/V^-=±15V, Gv=100dB, Ta=25℃

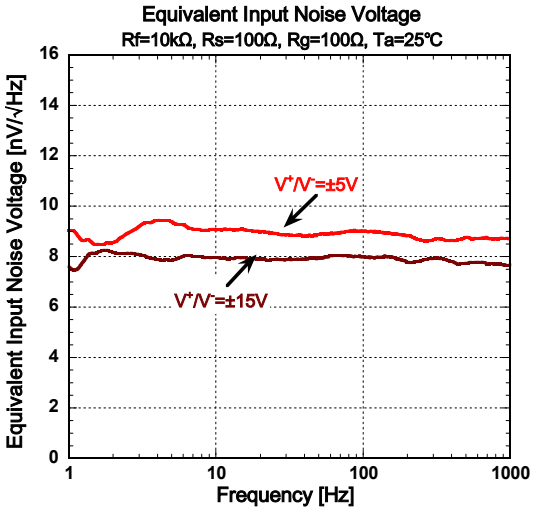


■ TYPICAL CHARACTERISTICS

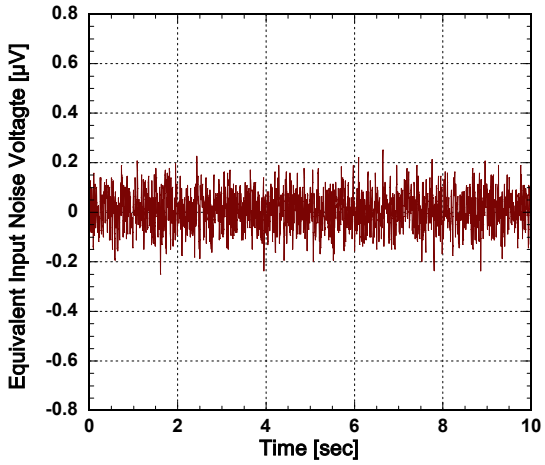
Input Offset Voltage vs. Output Voltage



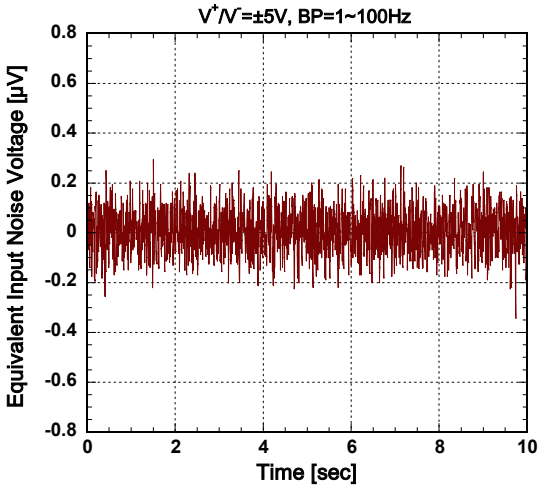
Equivalent Input Noise Voltage



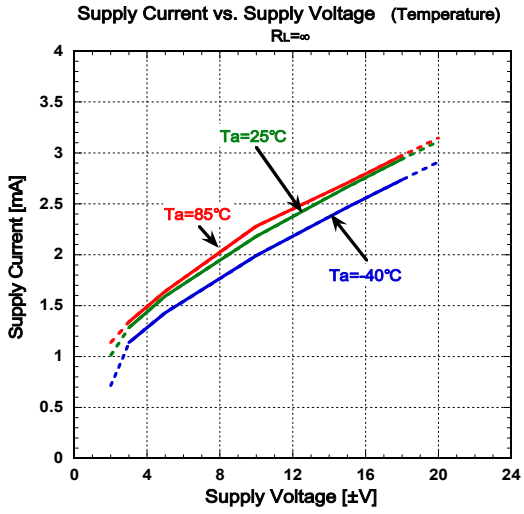
Equivalent Input Noise Voltage



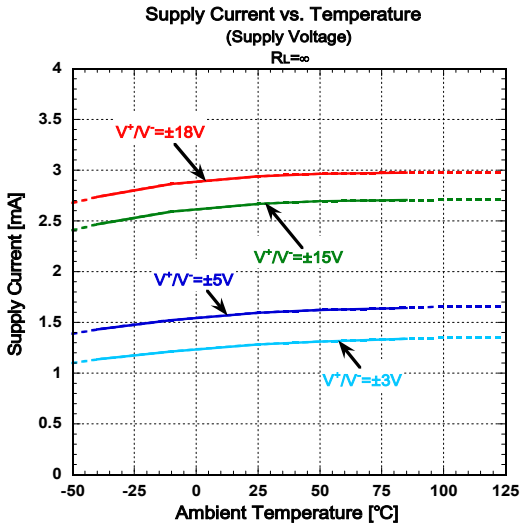
Equivalent Input Noise Voltage



Supply Current vs. Supply Voltage (Temperature)

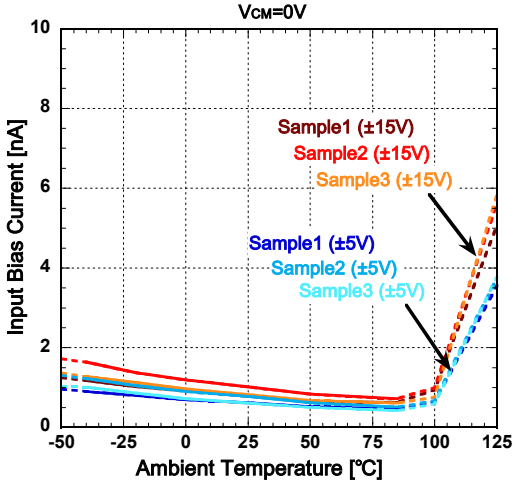


Supply Current vs. Temperature (Supply Voltage)

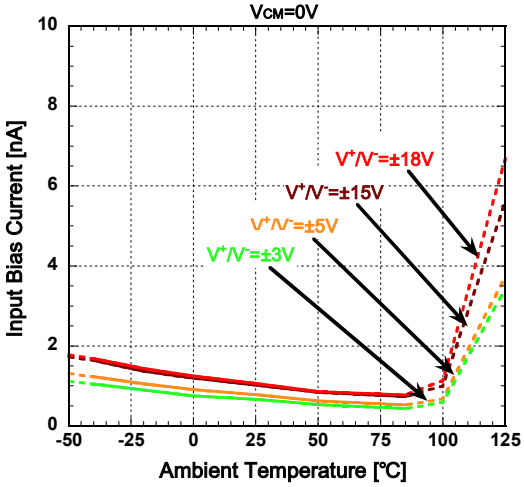


■ TYPICAL CHARACTERISTICS

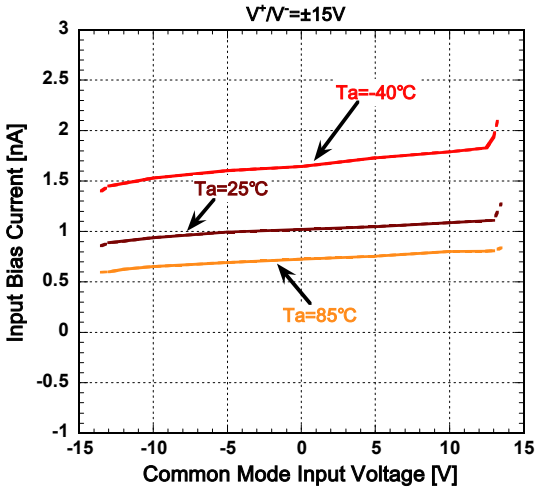
Input Bias Current vs. Temperature
(Supply Voltage)
VCM=0V



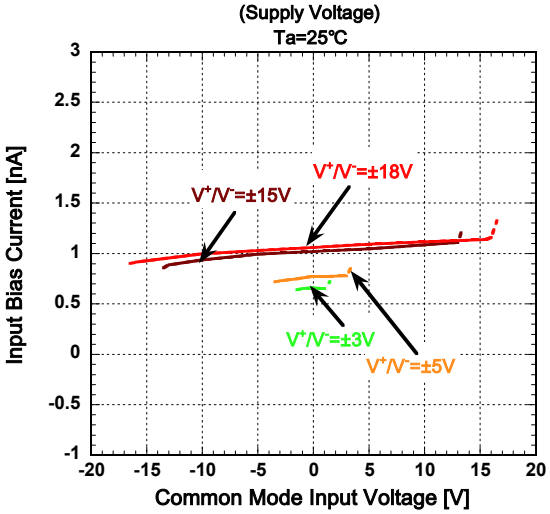
Input Bias Current vs. Temperature
(Supply Voltage)
VCM=0V



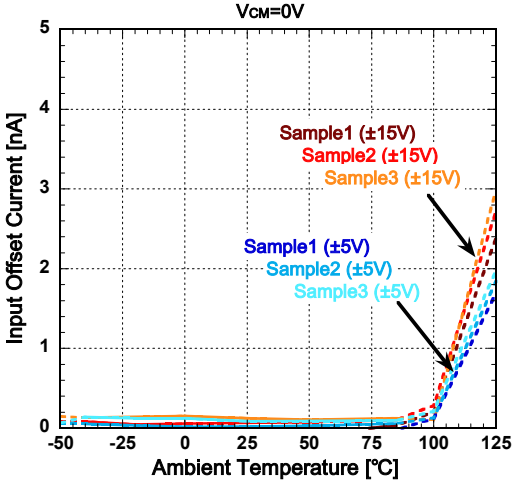
Input Bias Current vs. Common Mode Input Voltage
(Temperature)
V+/V-=±15V



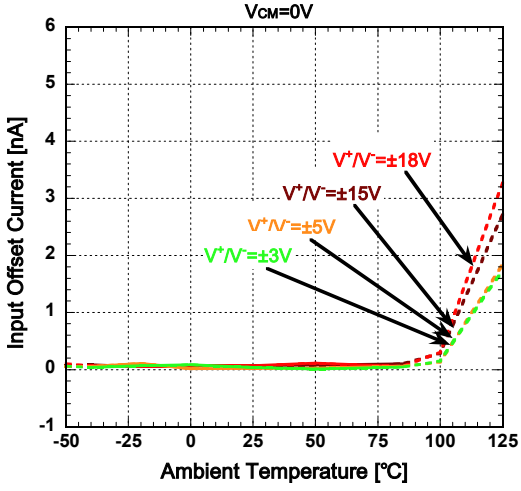
Input Bias Current vs. Common Mode Input Voltage
(Supply Voltage)
Ta=25°C



Input Offset Current vs. Temperature
(Supply Voltage)
VCM=0V

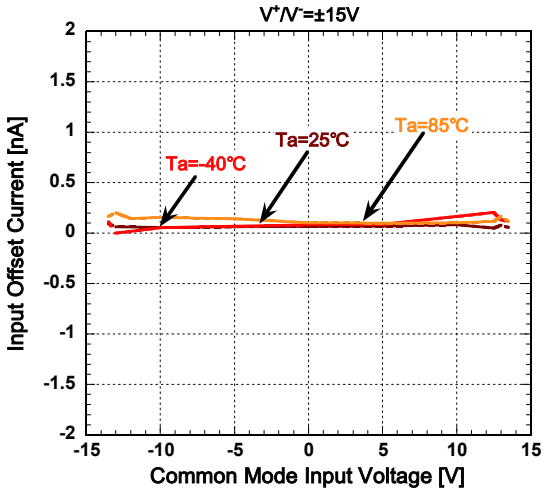


Input Offset Current vs. Temperature
(Supply Voltage)
VCM=0V

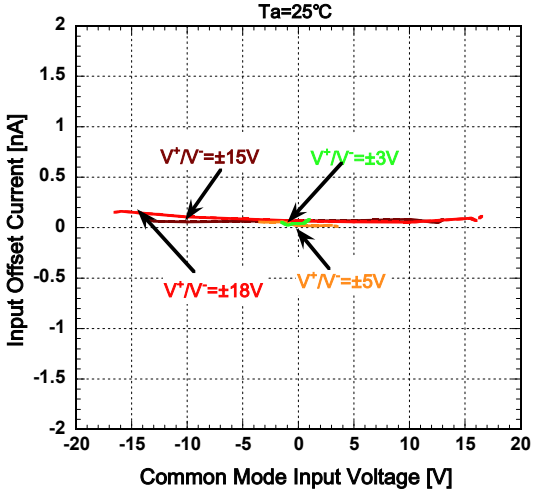


■ TYPICAL CHARACTERISTICS

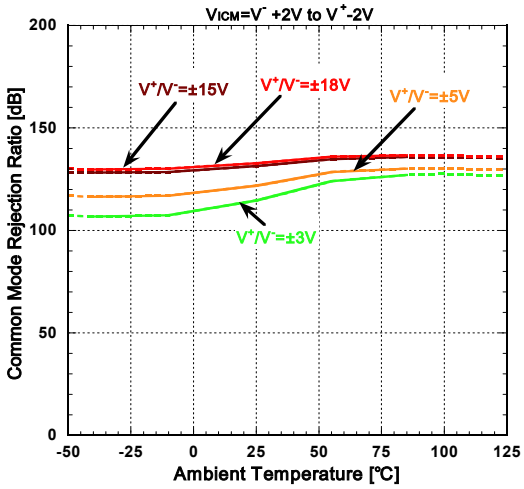
Input Offset Current vs. Common Mode Input Voltage
(Temperature)



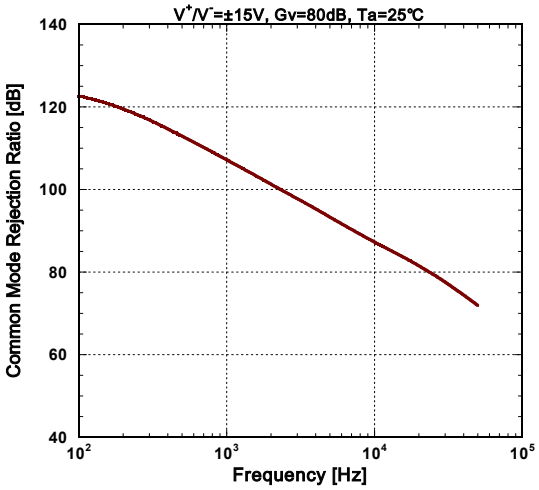
Input Offset Current vs. Common Mode Input Voltage
(Supply Voltage)
Ta=25℃



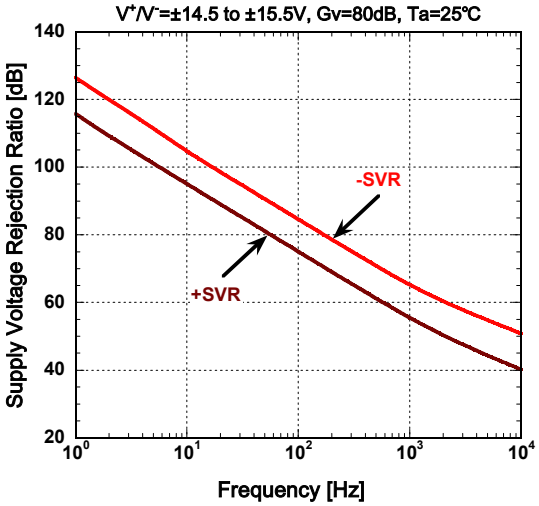
Common Mode Rejection Ratio vs. Temperature
(Supply Voltage)
VICM=V- +2V to V+-2V



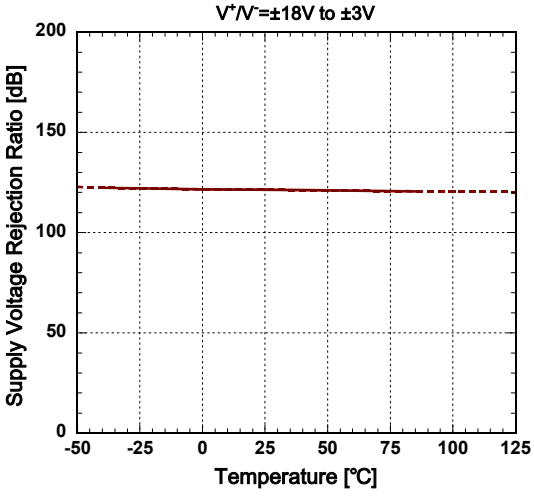
Common Mode Rejection Ratio vs. Frequency
V+/V-=±15V, Gv=80dB, Ta=25℃



Supply Voltage Rejection Ratio vs. Frequency
V+/V-=±14.5 to ±15.5V, Gv=80dB, Ta=25℃

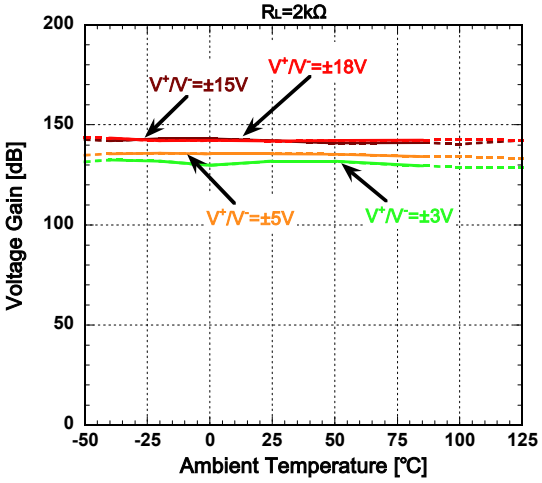


Supply Voltage Rejection Ratio vs. Temperature
V+/V-=±18V to ±3V

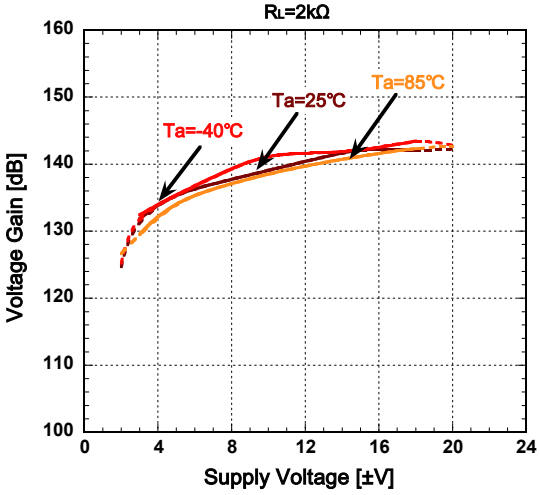


■ TYPICAL CHARACTERISTICS

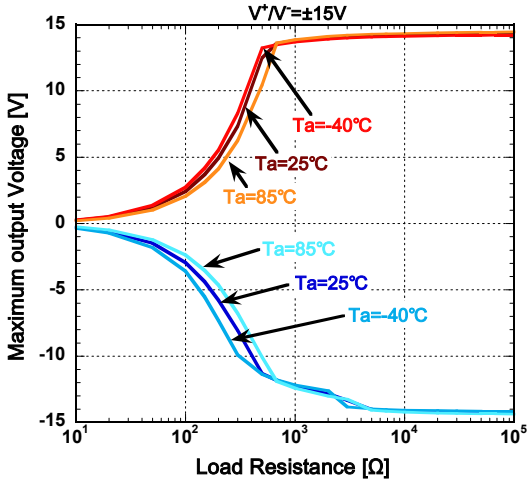
Voltage Gain vs. Temperature
(Supply Voltage)
RL=2kΩ



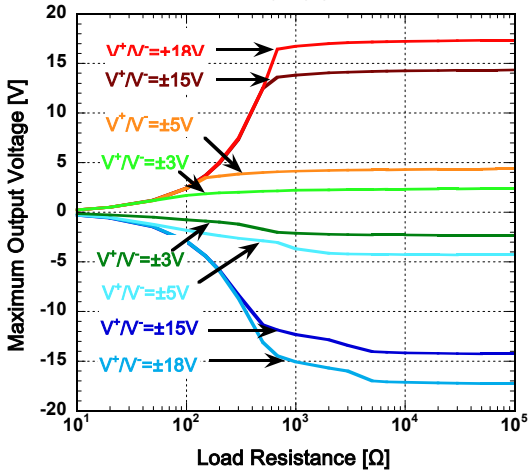
Voltage Gain vs. Supply Voltage
(Temperature)
RL=2kΩ



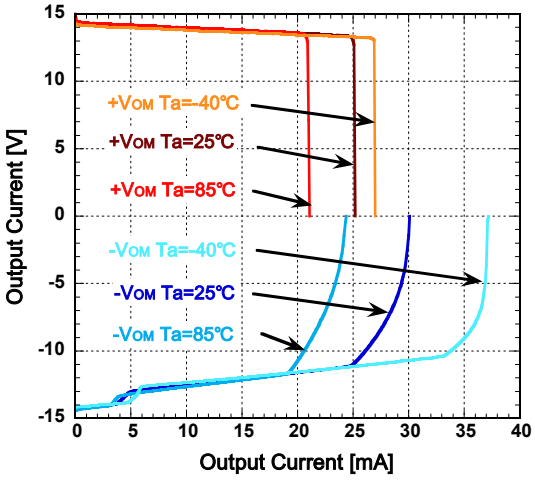
Maximum Output Voltage vs. Load Resistance
(Temperature)
V+/V-=±15V



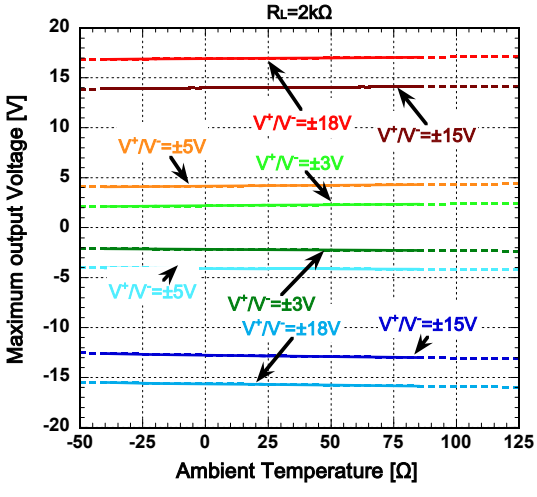
Maximum Output Voltage vs. Load Resistance
(Supply Voltage)
Ta=25℃



Output Voltage vs. Output Current
V+/V-=±15V



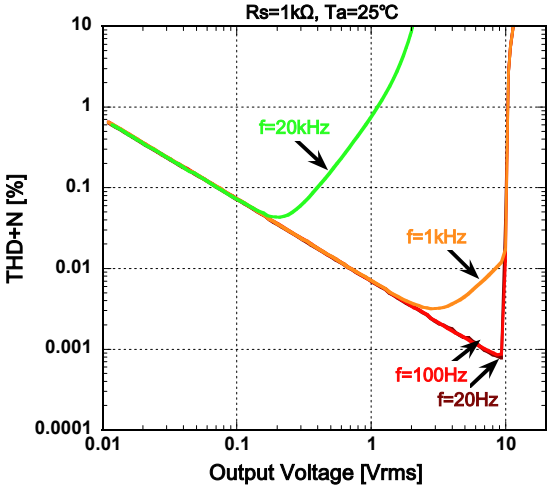
Maximum output Voltage vs. Temperature
(Supply Voltage)
RL=2kΩ



■ TYPICAL CHARACTERISTICS

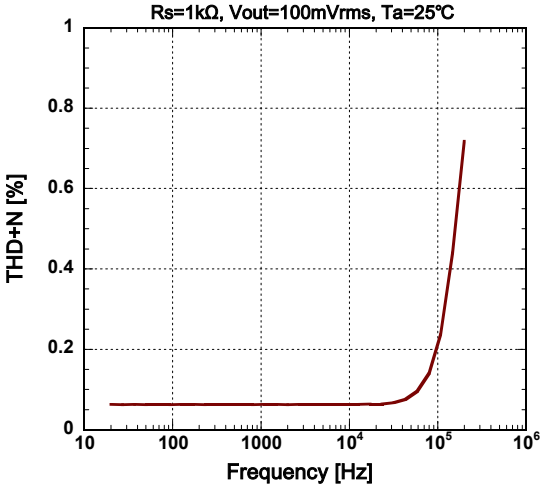
THD+N vs. Output Voltage

V+/V-=±15V, Gv=20dB, RF=10kΩ, Rs=1kΩ, Ta=25℃



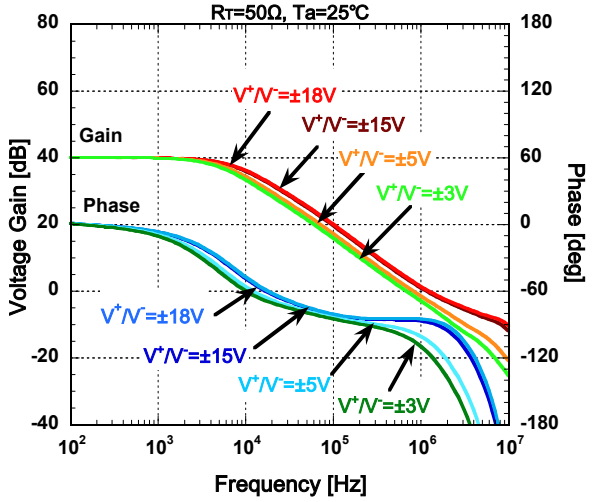
THD+N vs. Frequency

V+/V-=±15V, Gv=20dB, RF=10kΩ, Rs=1kΩ, Vout=100mVrms, Ta=25℃



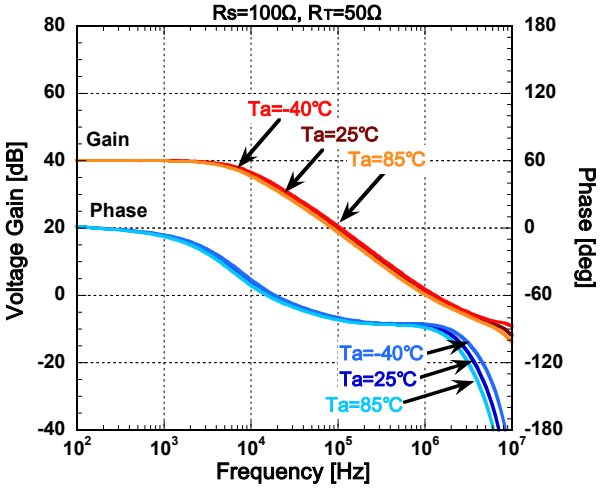
40dB Gain/Phase vs. Frequency (Supply Voltage)

Gv=40dB, RF=10kΩ, Rs=100Ω, RT=50Ω, Ta=25℃



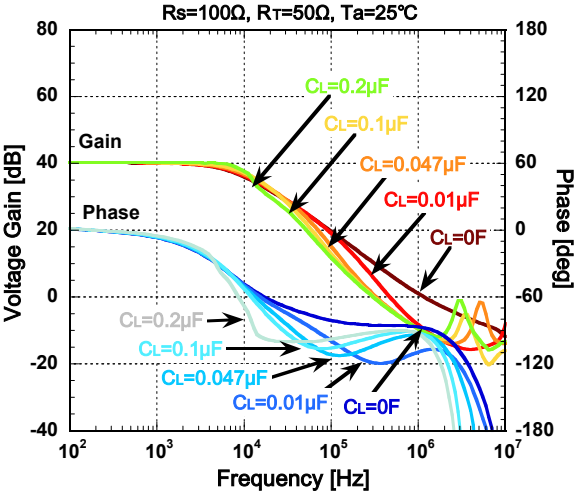
40dB Gain/Phase vs. Frequency (Temperature)

V+/V-=±15V, Gv=40dB, RF=10kΩ, Rs=100Ω, RT=50Ω



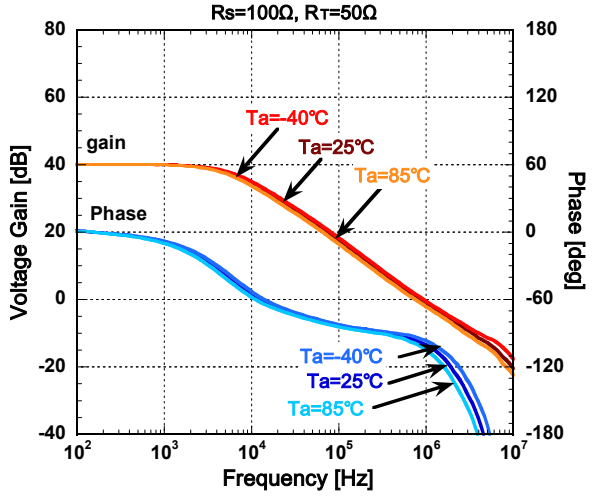
40dB Gain/Phase vs. Frequency (Load Capacitance)

V+/V-=±15V, Gv=40dB, RF=10kΩ, Rs=100Ω, RT=50Ω, Ta=25℃



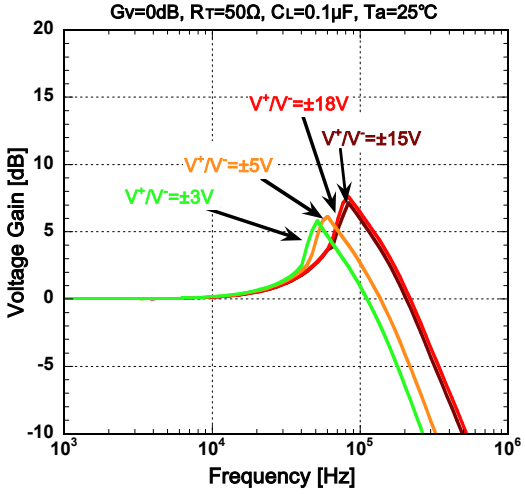
40dB Gain/Phase vs. Frequency (Temperature)

V+/V-=±5V, Gv=40dB, RF=10kΩ, Rs=100Ω, RT=50Ω

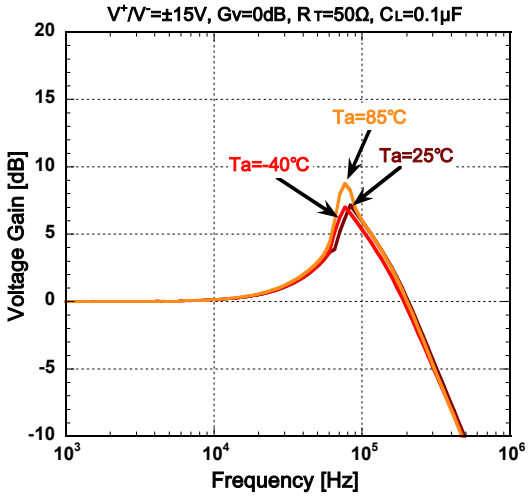


■ TYPICAL CHARACTERISTICS

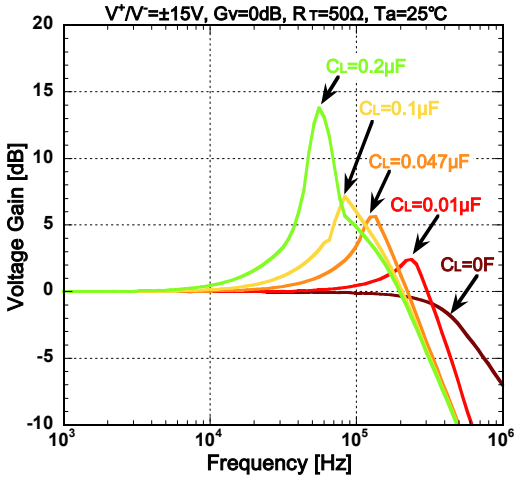
V.F. Peak (Supply Voltage)
Gv=0dB, RT=50Ω, CL=0.1μF, Ta=25℃



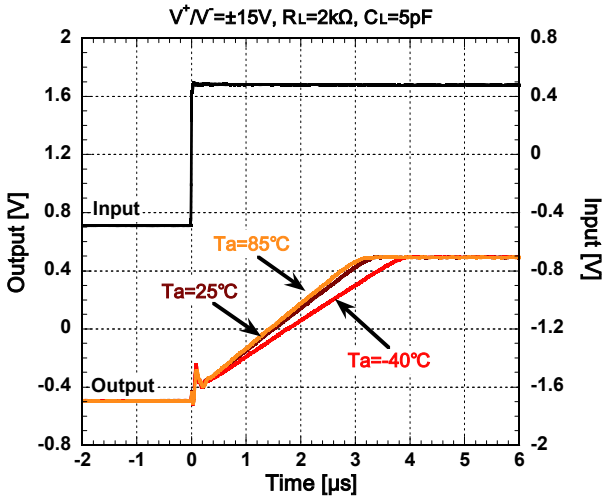
V.F.Peak (Temperature)
V+/V-=±15V, Gv=0dB, RT=50Ω, CL=0.1μF



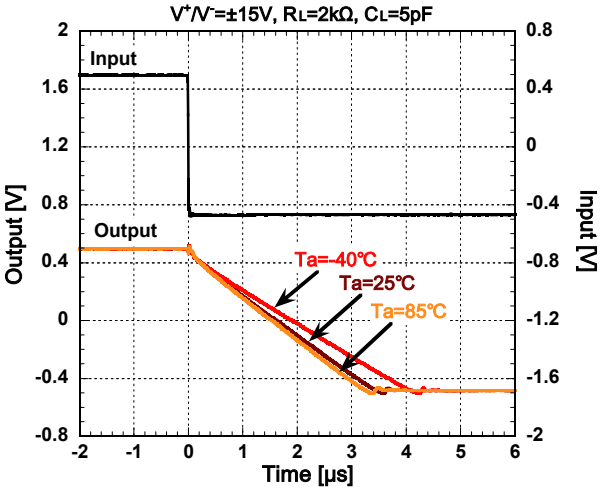
V.F.Peak (Load Capacitance)
V+/V-=±15V, Gv=0dB, RT=50Ω, Ta=25℃



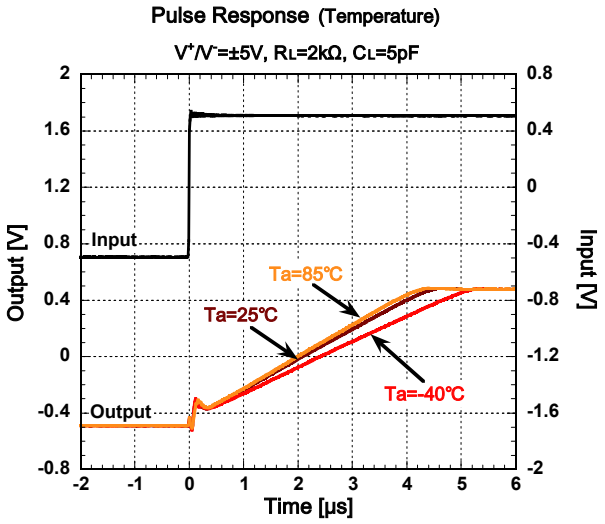
Pulse Response (Temperature)
V+/V-=±15V, RL=2kΩ, CL=5pF

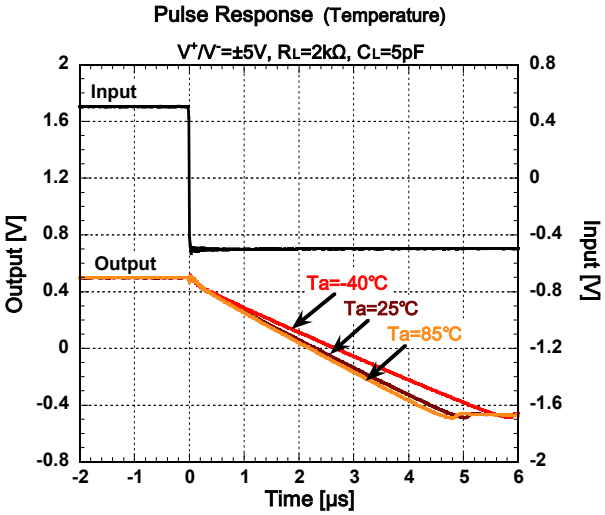


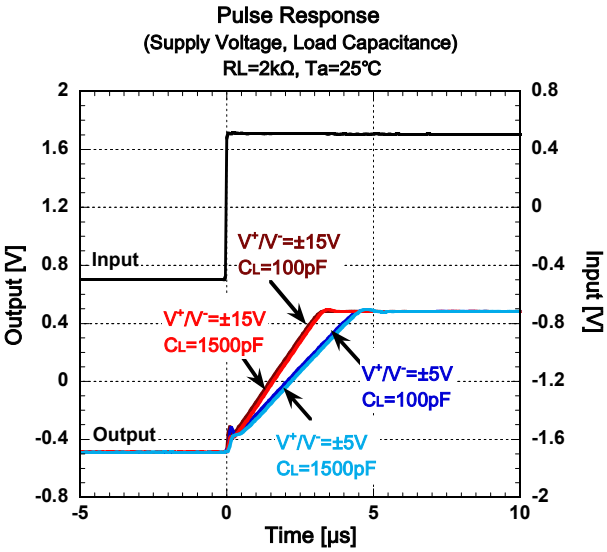
Pulse Response (Temperature)
V+/V-=±15V, RL=2kΩ, CL=5pF

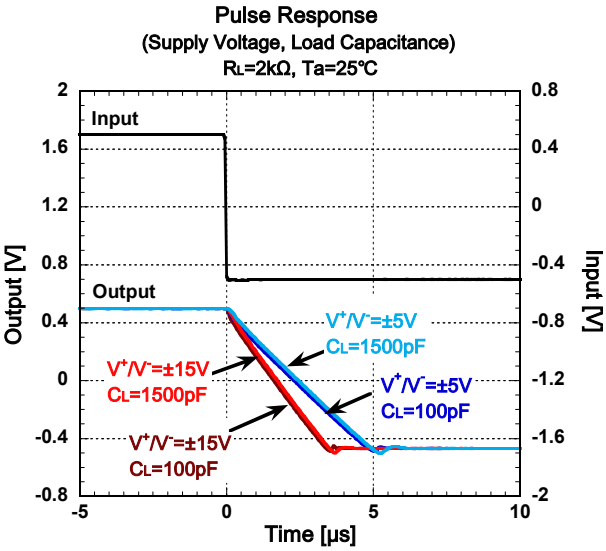


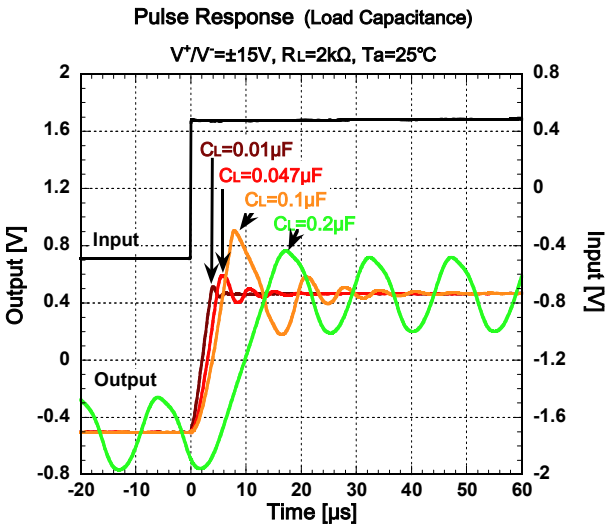
■ TYPICAL CHARACTERISTICS

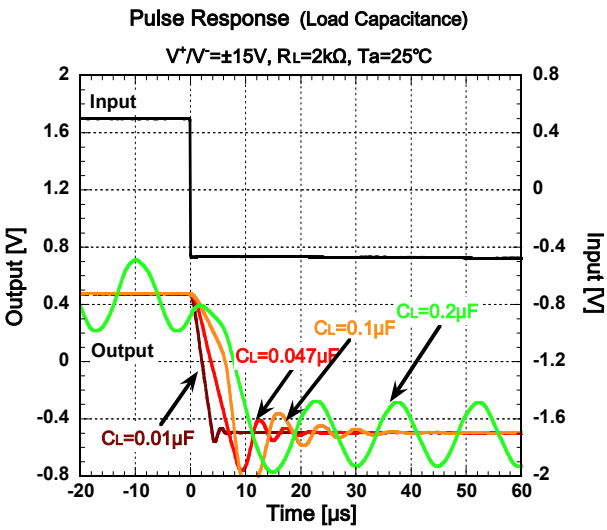




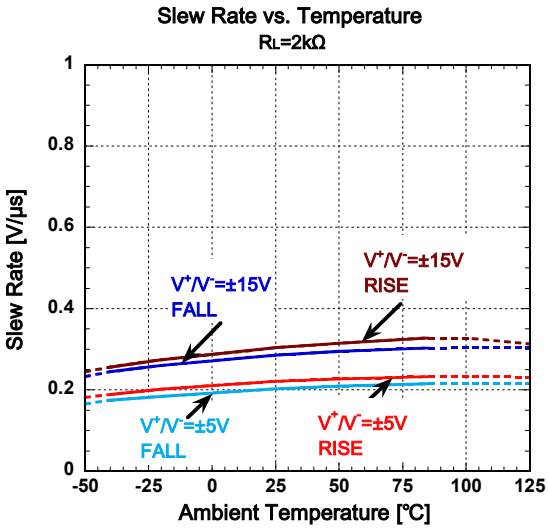


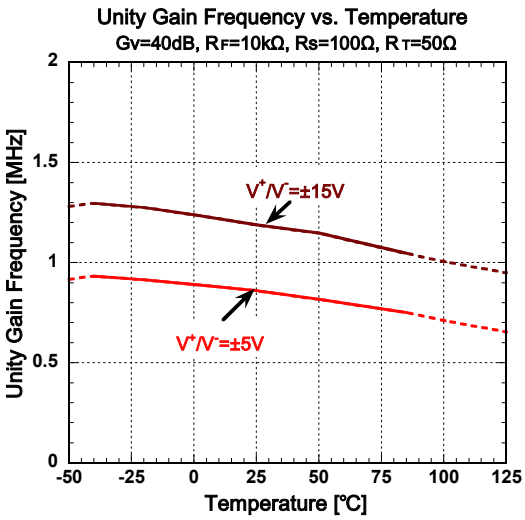






■ TYPICAL CHARACTERISTICS





■ Application Information

●Power Supply Bypassing

The NJM2739 is a high precision operational amplifier featuring low offset voltage, high voltage gain, high CMR, high SVR and so on. To maximize such a high performance with stable operation, the NJM2739 should be operated by clean and low impedance supply voltage. So, the bypass capacitor should be connected to the NJM2739's both power supply terminals (V+ and V-) as shown in Fig.1. The bypass capacitors should be placed as close as possible to IC package

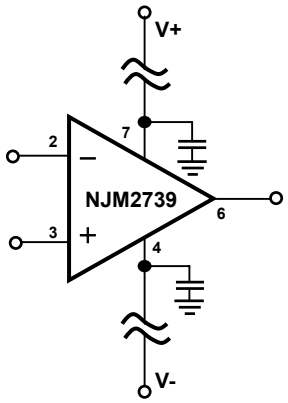


Fig.1 Power Supply Bypassing Circuit

●Thermoelectric Effect

The NJM2739 is a high precision operational amplifier featuring low offset voltage and low offset voltage thermal drift. To achieve such a high performance, take care about thermoelectric effect possibly occurs on each input terminal of the NJM2739. Generally, if there are thermal mismatches at the junction of different types of metals, the thermoelectric voltage (Seebeck effect) occurs at the junction. The thermoelectric voltages possibly occur at the junction of PCB metal patterns and NJM2739's each input terminal metal. If there is thermal mismatch in-between NJM2739's each input terminal metal, the thermoelectric voltages generated on each input terminal possibly have different voltage each. This voltage difference causes offset voltage and offset voltage thermal drift of the NJM2739. To minimize this voltage difference, the thermal mismatch in-between NJM2739's each input terminal and PCB metal should be minimized.

●Differential Amplifier

Differential amplifier (see below Fig.2) is used in high accuracy circuit to improve common mode rejection ratio (CMR).

A matching between the ratio R1/R2 = R3/R4 and R1=R3 makes the high CMR.

For example, acceptable error range to obtain CMR of 130dB or more is about 0.1ppm.

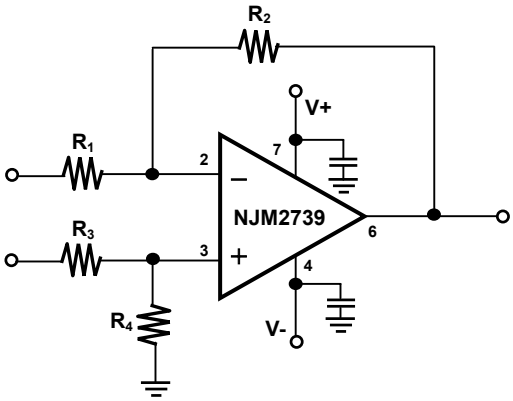


Fig.2 Differential Amplifier

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