1000V High Voltage Monitor IC

■FEATURES

● Operation Voltage Range	2.2V to 5.5V
● Common Mode Input Voltage Range	+1000 V (continuous)
● Differential Input Voltage	+1000 V (continuous)
● High Precision Attenuation Rate	±1% (Ta=-40 to +125ºC)
● High Input Resistance	30MΩ
● Enhanced RF noise immunity	
● Package	PMAP11

New Package for Creepage Distance (IEC/EN60664)

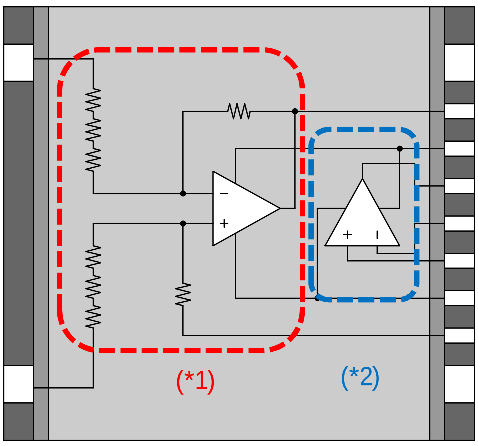
■GENERAL DESCRIPTION

The NJU7890 is a high voltage monitor IC capable of inputting voltages up to 1000V. With our proprietary semiconductor process technology, NJU7890 realizes wide common mode / differential input voltage.

■APPLICATION

● Automotive and Industrial application
Powertrain and Battery management ECU

■BLOCK DIAGRAM

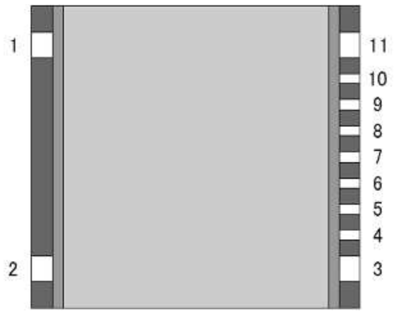


(*1)High Voltage Monitor Block
(*2)OP-Amp Block

■Attenuation Rate Version

Device Name	Input Resistance	Attenuation Version	Gain	Package
NJU7890YPM-A-Z	30MΩ	A	1/205	PMAP11
NJU7890YPM-B-Z	30MΩ	B	1/311	PMAP11

■PIN CONFIGURATION



PIN NO.	SYMBOL
1	-HVIN
2	+HVIN
3	V^-
4	REF
5	V^-
6	+OPIN
7	-OPIN
8	OP OUT
9	V^+
10	OUT
11	V^-

■MARK INFORMATION

NJU7890 YPM A

Part Number
Package
Attenuation Version

■ORDERING INFORMATION

PART NUMBER	PACKAGE OUTLINE	RoHS	Halogen-Free	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJU7890YPM-A	PMAP11	yes	yes	Sn2Bi	90AZ	300	2,000
NJU7890YPM-B	PMAP11	yes	yes	Sn2Bi	90BZ	300	2,000

■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
General Characteristics			
Supply Voltage	V^+-V^-	+7	V
Power Dissipation	P_D	1100(1) / 2000(2)	mW
Junction Temperature Range	Tj	-55 to +150	°C
Strage Temperature Range	Tstg	-55 to +150	°C
High Voltage Monitor Block			
Input Voltage 1	$V_{IN}1$	-1000 to +1000	V
Differential Input Voltage 1	$V_{ID}1$	±1000 (3)	V
Reference Voltage	REF	V^--0.3 to V^+	V
Operational Amplifier Block			
Input Voltage 2	$V_{IN}2$	V^--0.3 to V^+	V
Differential Input Voltage 2	$V_{ID}2$	±7	V

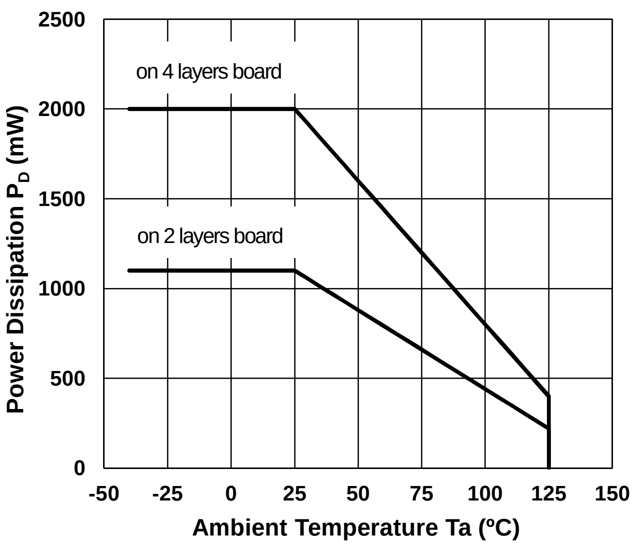
(1) Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JDEC standard, 2Layers FR4)
(2) Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JDEC standard, 4Layers FR4), internal Cu area: 74.2 x 74.2mm
(3) Differential voltage is the voltage difference between +INPUT and –INPUT

■RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V^+-V^-	2.2 to 5.5	V
Reference Voltage	REF	V^- to V^+-0.85	V
Operating Temperature Range	T_{opr}	-40 to +125	°C

■POWER DISSIPATION vs. AMBIENT TEMPERATURE

NJU7890YPM Power Dissipation
(Topr=-40 to +125°C, Tj=150°C)



- Please note that this device is still under the development and therefore the specifications are subject to change.

■ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
General Characteristics (Unless otherwise specified, V^+=5V, V^-=0V, Ta=25ºC)							
Supply Current	I_{SUPPLY}	No signal		-	1.2	1.8	mA
		No signal, Ta=-40 to +125ºC		-	-	1.8	
High Voltage Monitor Block (Unless otherwise specified, V^+=5V, V^-=0V, REF=2.5V, Ta=25ºC)							
Input Resistance	R_{IN}	Ta= -40 to +125°C		30	-	-	MΩ
Attenuation Rate	ATT	Aver		-0.7	1/205	+0.7	V/V
			Ta= -40 to +125°C	-1.0	-	+1.0	
		Bver		-0.7	1/311	+0.7	
			Ta= -40 to +125°C	-1.0	-	+1.0	
Output Offset Voltage	$V_{OS\text{-}RTO}$	-/+HVIN=0V		-	0.04	0.3	mV
		-/+HVIN=0V, Ta= -40 to +125°C		-	-	0.8	
Supply Voltage Rejection Ratio 1	SVR1	V^+=2.2V to 5.5V		70	80	-	dB
Common Mode Rejection Ratio1	CMR1	Aver	V_{ICM}=-/+HVIN=0V to 660V, V^+=5V, V^-=0V, REF=0.5V	85	100	-	dB
		Bver	V_{ICM}=-/+HVIN=0V to 1000V, V^+=5V, V^-=0V, REF=0.5V	85	100	-	
High-level Output Voltage 1	$V_{OH}1$	RL=10kΩ to 2.5V		V^+-0.2	V^+-0.05	-	V
Low-level Output Voltage 1	$V_{OL}1$	RL=10kΩ to 2.5V		-	V^+-0.05	V^++0.2	V

Calculation of output Voltage

$$V_{OUT} = (V_{+HVIN} - V_{-HVIN}) \times ATT + V_{REF} + V_{OS-RTO} + \frac{|5V - V^{+}|}{SVR1} + \frac{|V_{+HVIN}|}{CMR1}$$

(Calculation example)

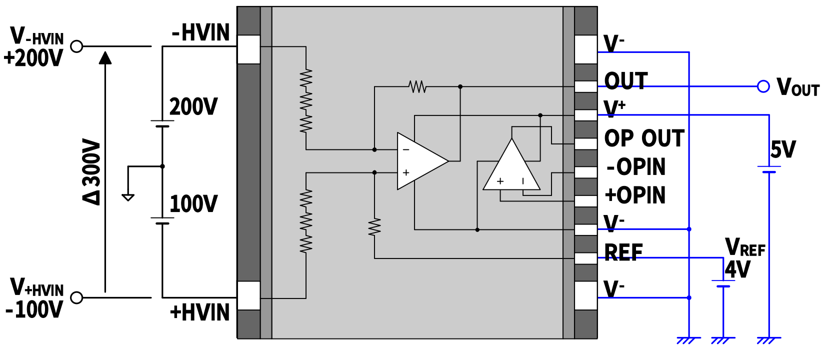
V_{+HVIN} = -100V, V_{-HVIN} = 200V, V_{REF} = 4V, V^{+} = 5.2V, ATT = 1/205±0.7%, V_{OS-RTO} = 0.3mV, SVR1 = 70dB, CMR1 = 85dB

$$V_{OUT} = (-100V - 200V) \times \left(\frac{1}{205} \pm 0.7\%\right) + 4V + 0.3mV + \frac{|-0.2V|}{70dB} + \frac{|-100V|}{85dB}$$

$$V_{OUT} = -300V \times \left(\frac{1}{205} \pm 0.7\%\right) + 4V + 0.3mV + 0.06mV + 5.6mV = 2.553V$$

Without the error component of the calculation example above, the output voltage is 2.537V. The error 0.016 V obtained from the calculation example is 0.016 V × (1 ÷ ATT) = 3.280 V by calculating the input conversion. The error rate obtained from the input conversion value can be calculated as 1.09% from 3.280 V ÷ 300 V. In addition to the above formula, please be aware that there is a VREF error (accuracy influence).

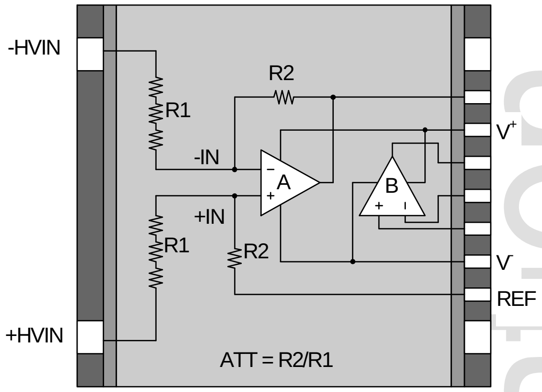
Evaluation circuit example



Please note that this device is still under the development and therefore the specifications are subject to change.

+HVIN input Voltage Range

In order for this IC to operate normally, the positive input terminal voltage (V_{+IN}) of operational amplifier A must be within the common mode input voltage range of operational amplifier A.



Operational amplifier A: common mode input voltage range

$V^{-} \leq V_{+IN} \leq V^{+} - 0.85V$

Therefore, it is necessary to satisfy the following formula expressed by V^{+} / V^{-} (supply voltage), V_{+HVIN} (+HVIN terminal voltage), V_{REF} (REF terminal voltage), ATT (attenuation rate).

Calculation

$$\boxed{V^{-} \leq \frac{1}{1 + ATT^{-1}} \times V_{+HVIN} + \frac{1}{1 + ATT} \times V_{REF} \leq V^{+} - 0.85V}$$

(Calculation example)

V_{REF} = 4 V, V^{+} / V^{-} = 5 V / 0 V, ATT = 1/205

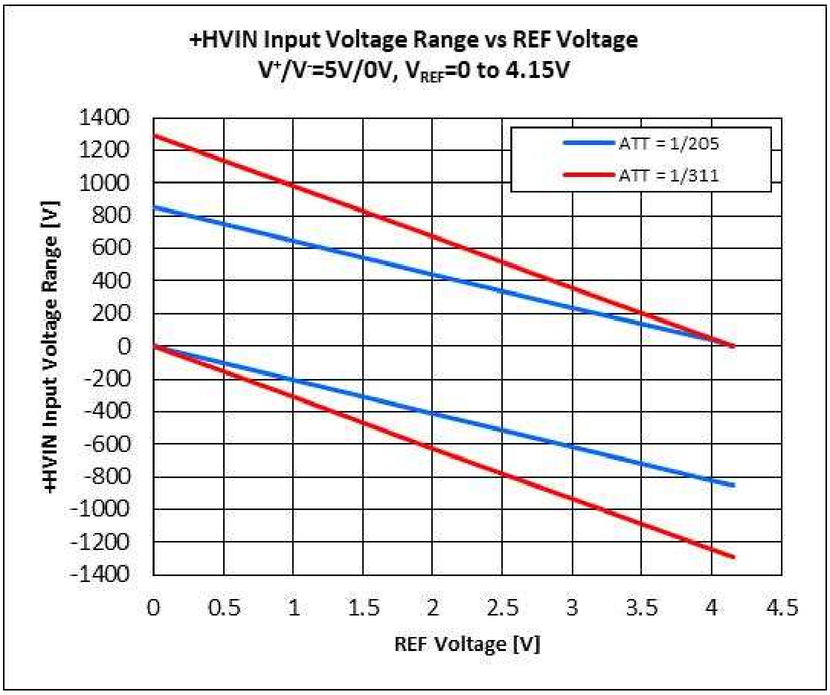
$$0V \leq \frac{1}{1 + 205} \times V_{+HVIN} + \frac{1}{1 + 1/205} \times 4V \leq 5V - 0.85V$$

$$-820V \leq V_{+HVIN} \leq 34.9V$$

(Characteristics example)

The figure below shows an example of characteristics when the attenuation rate is set to 1/205 and 1/311.

The range indicated by the arrow is the input voltage range of the $+H_{VIN}$.



■ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operational Amplifier Block (Unless otherwise specified, V^+=5V, V^-=0V, Ta=25ºC)						
Input Offset Voltage 2	$V_{IO}2$		-	0.04	0.3	mV
		Ta= -40 to +125°C	-	-	0.8	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	Ta=-40 to +125ºC	-	0.5	-	µV/ºC
Input Bias Current	I_B	-/+ OPIN	-	1	-	pA
Input Offset Current	I_{IO}	-/+ OPIN	-	1	-	pA
Open-Loop Voltage Gain	A_V	RL≧10kΩ to 2.5V, OP OUT=2.5V±2V	100	130	-	dB
		RL≧10kΩ to 2.5V, OP OUT=2.5V±2V, Ta=-40 to +125ºC	100	-	-	
High-level Output Voltage 2	$V_{OH}2$	RL=10kΩ to 2.5V	4.95	4.98	-	V
		RL=10kΩ to 2.5V, Ta=-40 to +125ºC	4.95	-	-	
Low-level Output Voltage 2	$V_{OL}2$	RL=10kΩ to 2.5V	-	0.02	0.05	V
		RL=10kΩ to 2.5V, Ta=-40 to +125ºC	-	-	0.05	
High-level Output Voltage 3	$V_{OH}3$	RL=600kΩ to 2.5V	4.85	4.92	-	V
		RL=600kΩ to 2.5V, Ta=-40 to +125ºC	4.85	-	-	
Low-level Output Voltage 3	$V_{OL}3$	RL=600Ω to 2.5V	-	0.08	0.15	V
		RL=600Ω to 2.5V, Ta=-40 to +125ºC	-	-	0.20	
Output Current	I_{OUT}	V_{OH}≧4.85V, V_{OL}≦0.15V	2	3	-	mA
		V_{OH}≧4.85V, V_{OL}≦0.15V, Ta=-40 to +125ºC	2	-	-	
Common Mode Rejection Ratio 2	CMR2	V_{ICM}=-/+OPIN=0 to 4V	70	90	-	dB
		V_{ICM}=-/+OPIN=0 to 4V, Ta=-40 to +125ºC	70	-	-	
Common Mode Input Voltage Range	V_{ICM}	CMR≧70dB , -/+OPIN	0	-	4	V
		CMR≧70dB, -/+OPIN, Ta=-40 to +125ºC	0	-	4	
Supply Voltage Rejection Ratio 2	SVR2	V^+=2.2V to 5.5V	70	90	-	dB
		V^+=2.2V to 5.5V, Ta=-40 to +125ºC	70	-	-	
Gain Bandwidth Product	GBW	GV=40dB, RF=100kΩ, RL=10kΩ to 2.5V, CL=20pF, f=100kHz	-	1.3	-	MHz
Phase Margin	ϕ_M	GV=40dB, RF=100kΩ, RL=10kΩ to 2.5V, CL=20pF	-	60	-	deg
Gain Margin	G_M	GV=40dB, RF=100kΩ, RL=10kΩ to 2.5V, CL=20pF	-	12	-	dB
Slew Rate	SR	GV=0dB, RL=10kΩ to 2.5V, CL=20pF,VIN=3V_{PP},	-	0.5	-	V/µs

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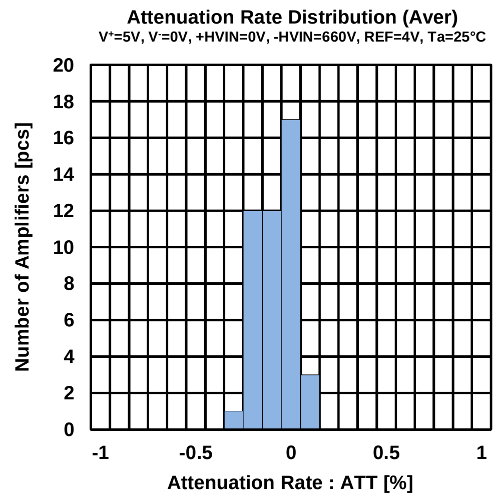
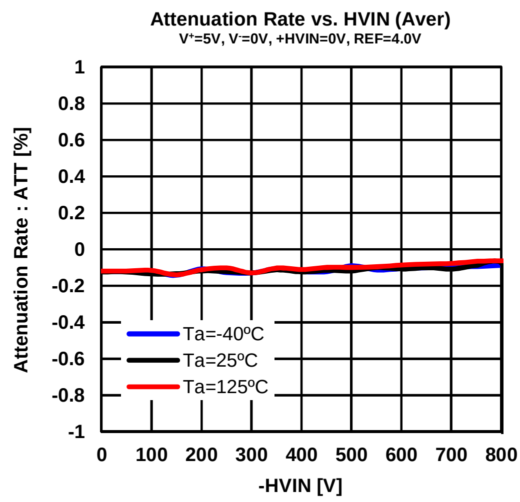
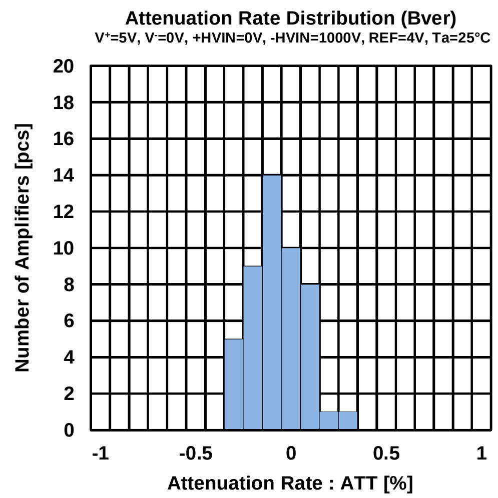
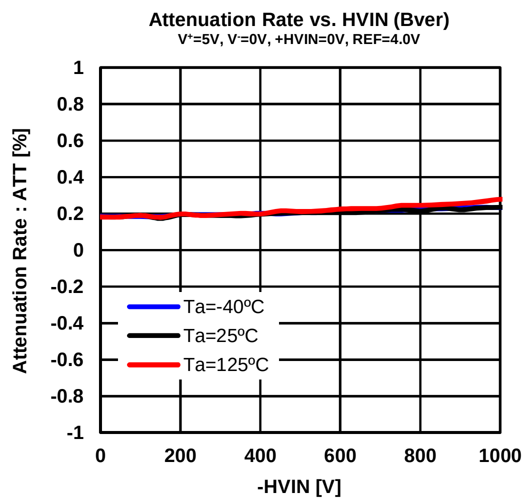
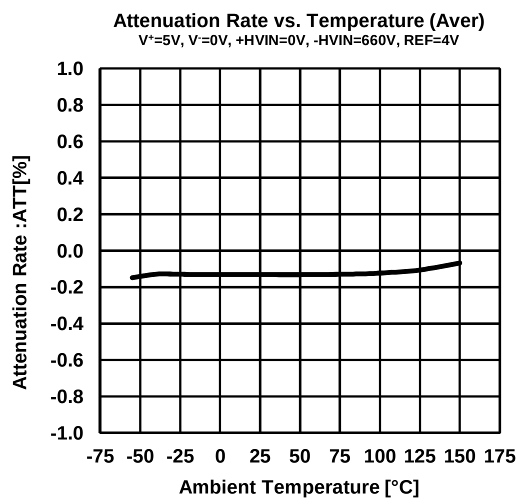
■TYPICAL CHARACTERISTICS (High Voltage Monitor Block)

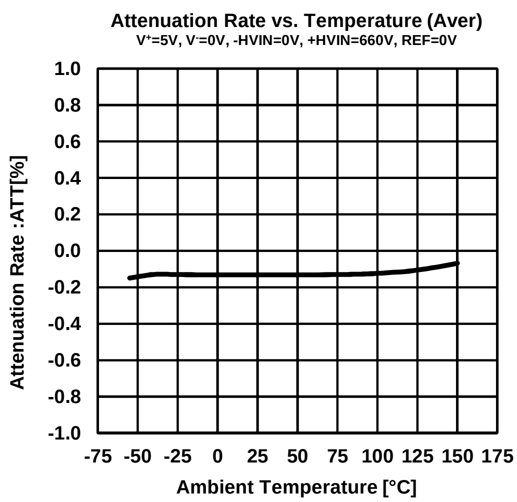






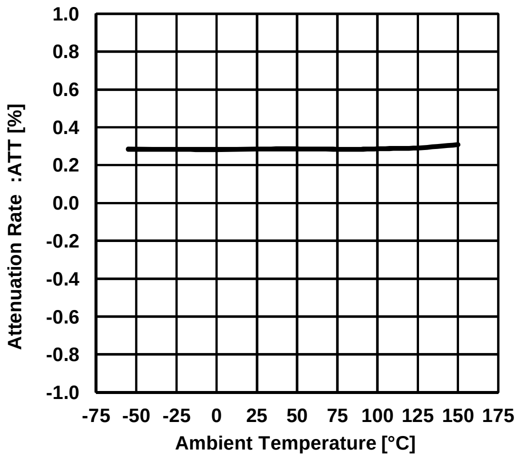




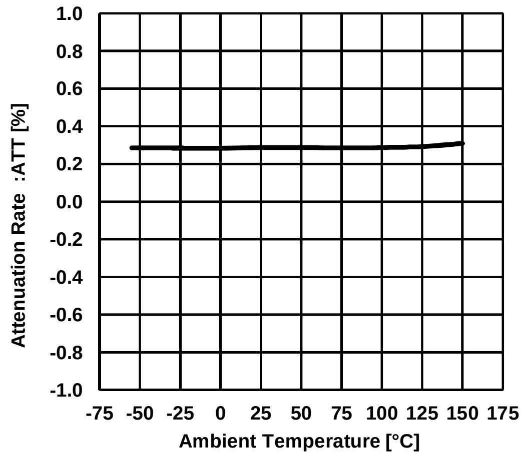


■TYPICAL CHARACTERISTICS (High Voltage Monitor Block)

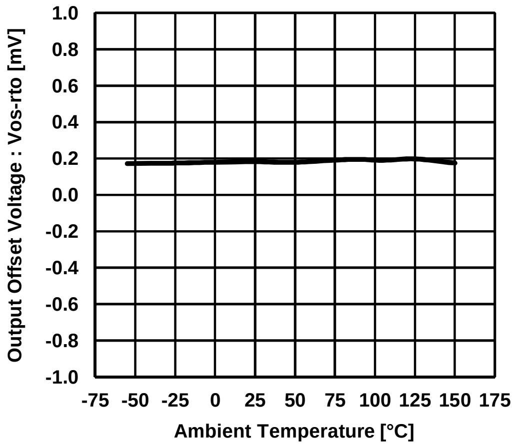
Attenuation Rate vs. Temperature (Bver)
V^+=5V, V^-=0V, +HVIN=0V, -HVIN=1000V, REF=4V



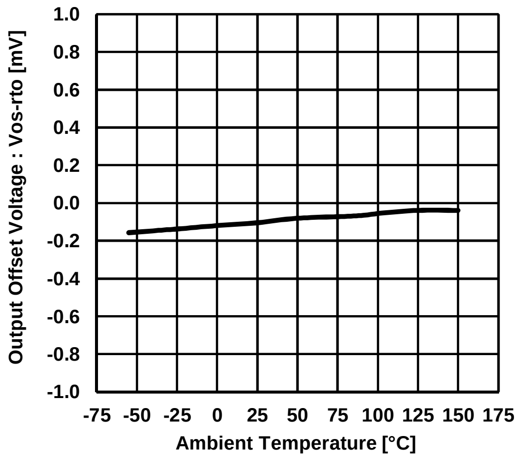
Attenuation Rate vs. Temperature (Bver)
V^+=5V, V^-=0V, -HVIN=0V, +HVIN=1000V, REF=0V



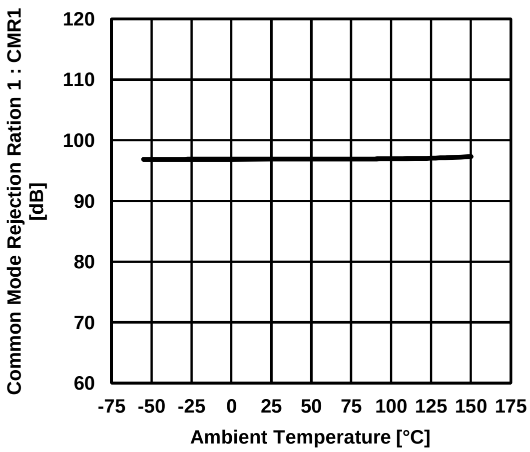
Output Offset Voltage vs. Temperature (Aver)
V^+=5V, V^-=0V, +HVIN=0V, -HVIN=0V, REF=2.5V



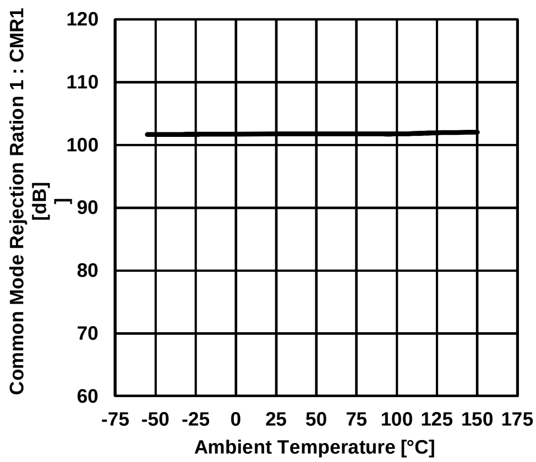
Output Offset Voltage vs. Temperature (Bver)
V^+=5V, V^-=0V, +HVIN=0V, -HVIN=0V, REF=2.5V



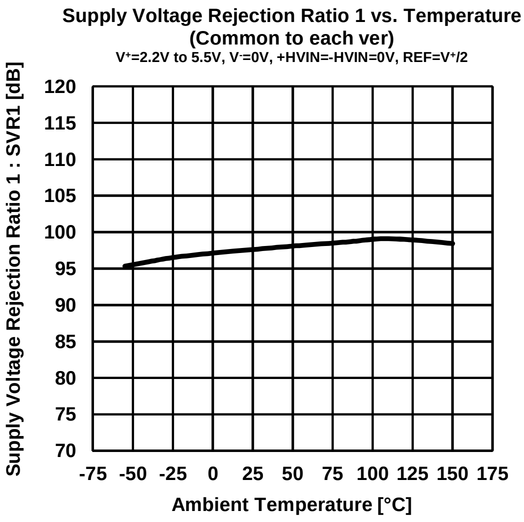
Common Mode Rejection Ration 1 vs. Temperature (Aver)
V^+=5V, V^-=REF=0V, +HVIN=-HVIN=0V to 660V

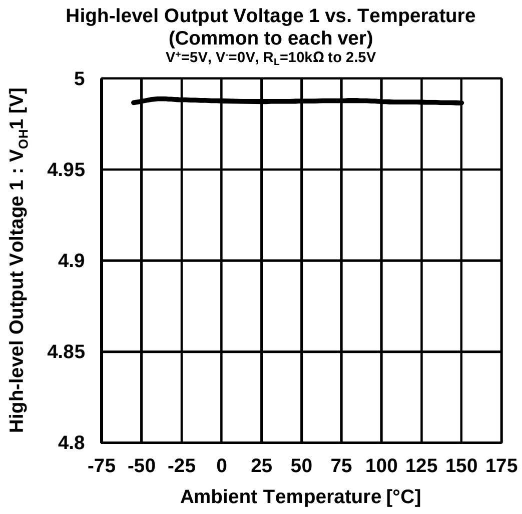


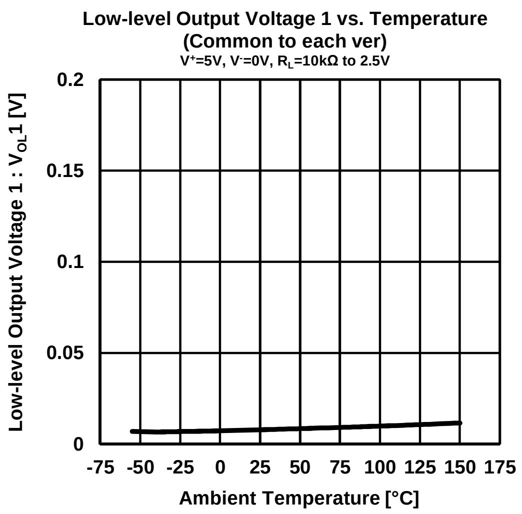
Common Mode Rejection Ration 1vs. Temperature (Bver)
V^+=5V, V^-=REF=0V, +HVIN=-HVIN=0V to 1000V



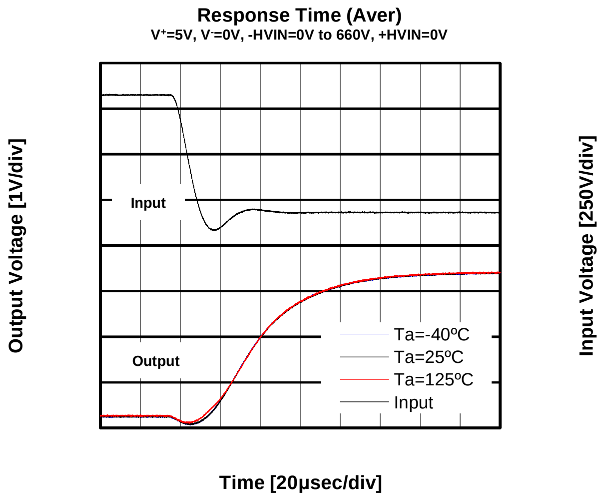
■TYPICAL CHARACTERISTICS (High Voltage Monitor Block)

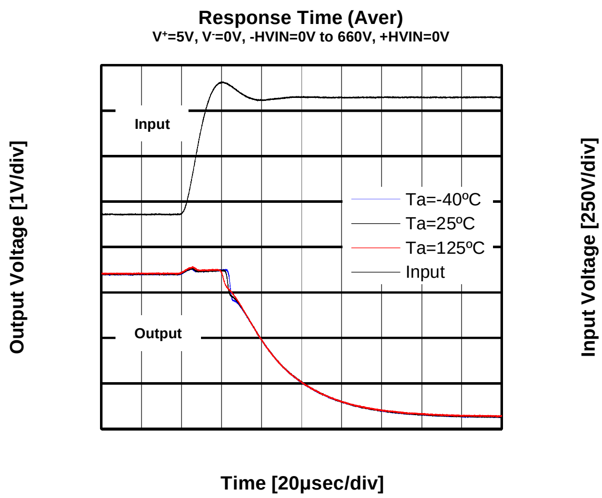


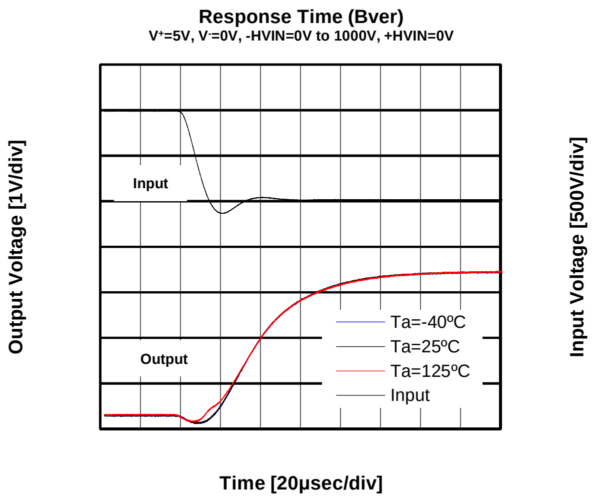


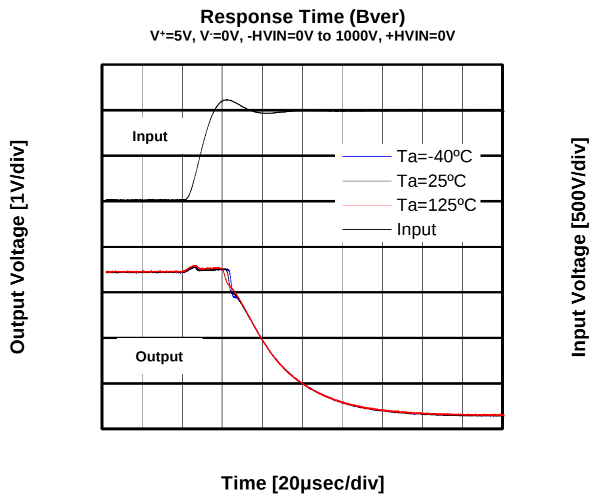


■TYPICAL CHARACTERISTICS (High Voltage Monitor Block)



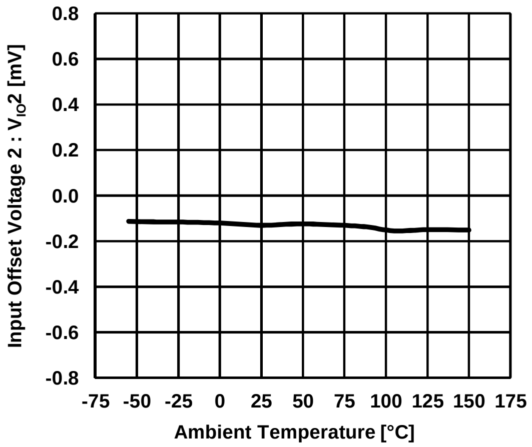




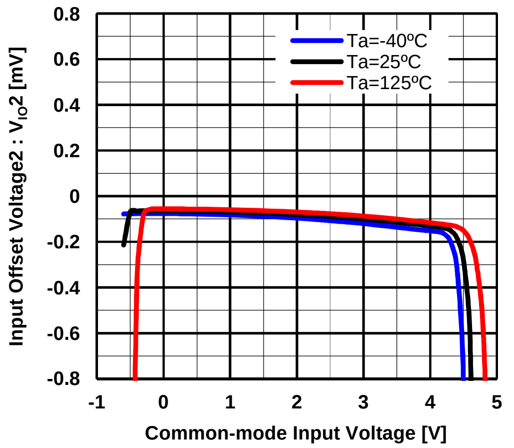


■TYPICAL CHARACTERISTICS (Operational Amplifier Block)

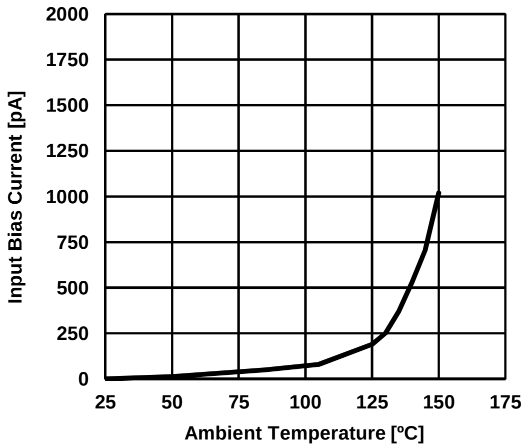
Input Offset Voltage 2 vs. Temperature
V+=5V, V-=0V



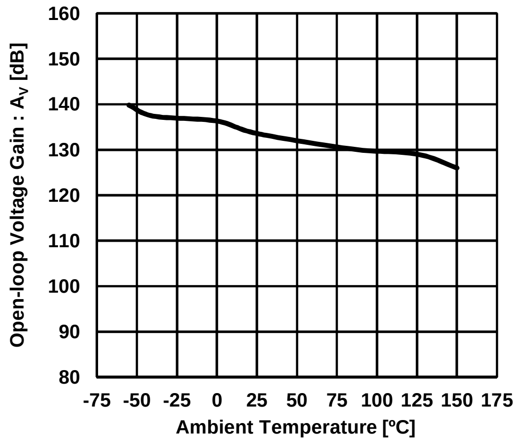
Input Offset Voltage 2vs. Common-mode Input Voltage
V+=5V, V-=0V



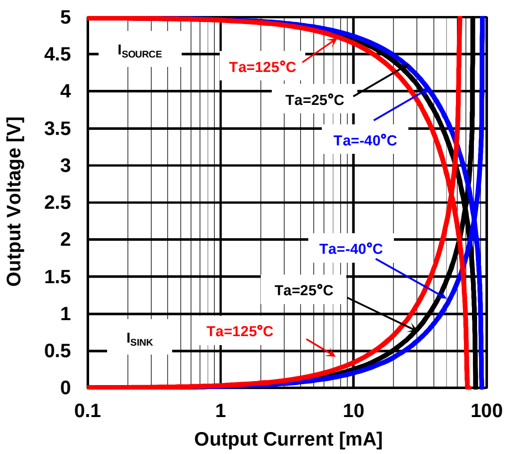
Input Bias Current vs. Temperature
V+=5V, V-=0V



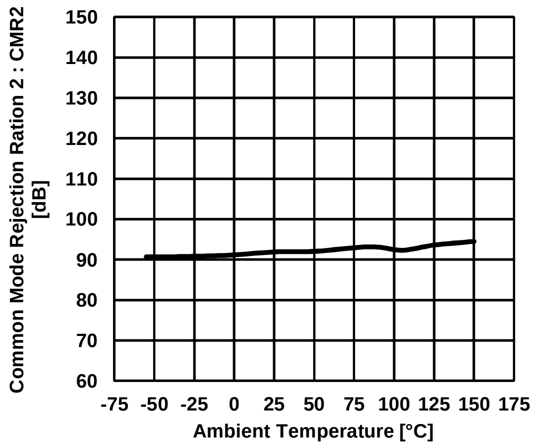
Open-loop Voltage Gain vs. Temperature
V+=5V, V-=0V, R_L=10kΩ



Maxmum Output Voltage vs. Output Current
V+=5V, V-=0V,

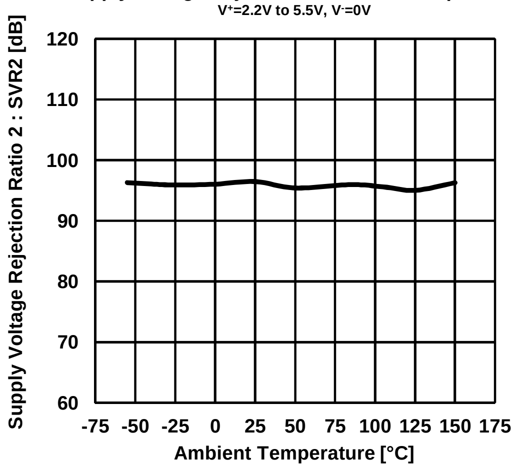


Common Mode Rejection Ration 2 vs. Temperature
V+=5V, V-=0V, +OPIN=0V to 4V

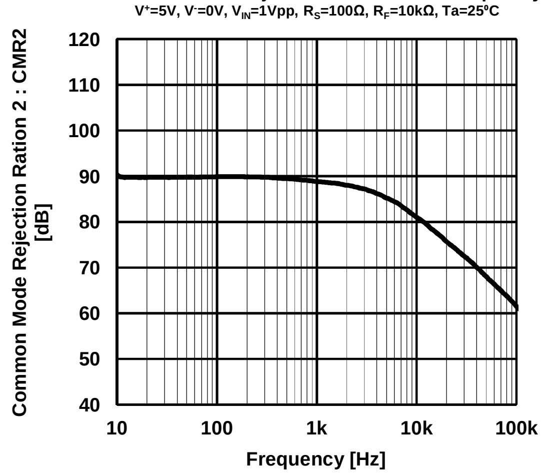


■TYPICAL CHARACTERISTICS (Operational Amplifier Block)

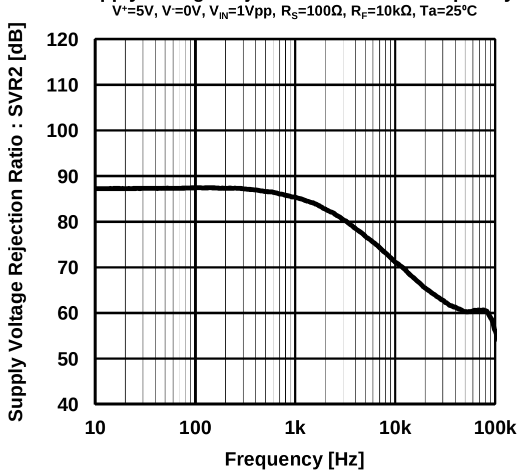
Supply Voltage Rejection Ratio 2 vs. Temperature
V^{+}=2.2V to 5.5V, V^{-}=0V



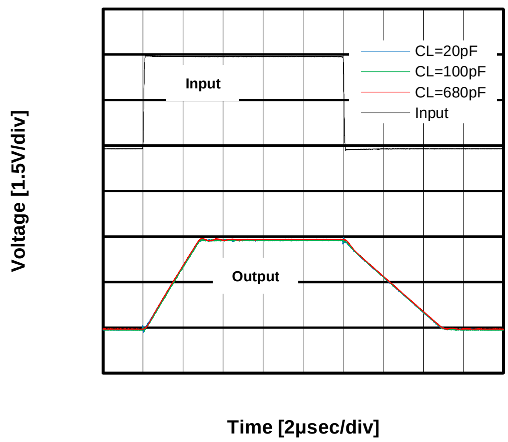
Common Mode Rejection Ration 2 vs. Frequency
V^{+}=5V, V^{-}=0V, V_{IN}=1Vpp, R_S=100Ω, R_F=10kΩ, Ta=25ºC



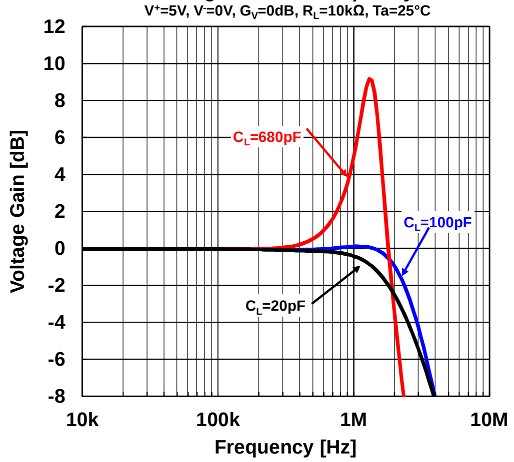
Supply Voltage Rejection Ratio 2 vs. Frequency
V^{+}=5V, V^{-}=0V, V_{IN}=1Vpp, R_S=100Ω, R_F=10kΩ, Ta=25ºC



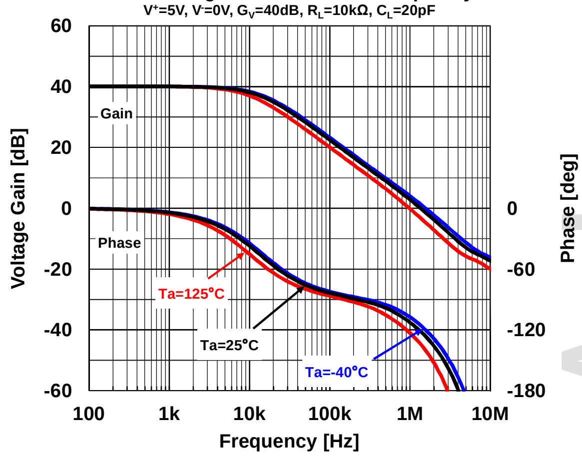
Slew Rate
V^{+}=5V, V^{-}=0V, R_L=10kΩ, G_V=0dB, Ta=25°C



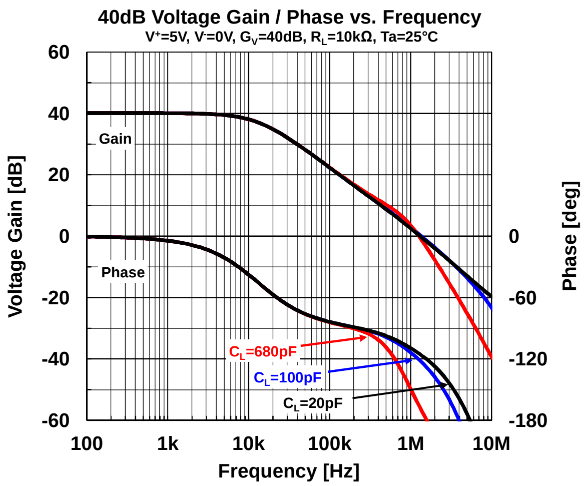
Voltage Gain vs. Frequency
V^{+}=5V, V^{-}=0V, G_V=0dB, R_L=10kΩ, Ta=25°C



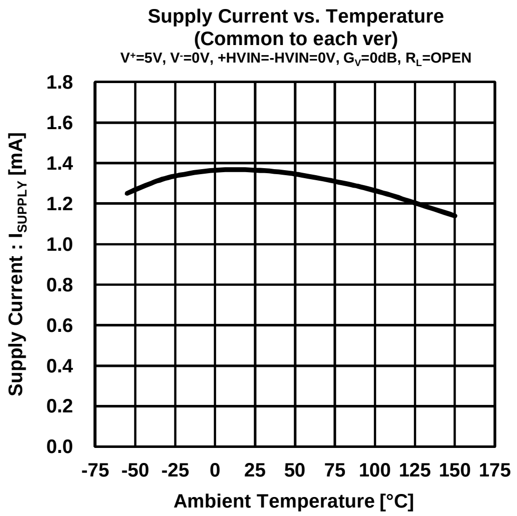
40dB Voltage Gain/Phase vs. Frequency
V^{+}=5V, V^{-}=0V, G_V=40dB, R_L=10kΩ, C_L=20pF



■TYPICAL CHARACTERISTICS (Operational Amplifier Block)



■TYPICAL CHARACTERISTICS (General Characteristics)



[CAUTION]

1. New JRC strives to produce reliable and high quality semiconductors. New JRC's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of New JRC's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures

2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.
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3. To ensure the highest levels of reliability, New JRC products must always be properly handled.
   The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.

4. New JRC offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact New JRC's Sale's Office if you are uncertain about the products listed in this catalog.

5. Special care is required in designing devices, machinery or equipment which demands high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.

6. The products listed in the catalog may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.

   Aerospace Equipment
   Equipment Used in the Deep sea
   Power Generator Control Equipment (Nuclear, Steam, Hydraulic)
   Life Maintenance Medical Equipment
   Fire Alarm/Intruder Detector
   Vehicle Control Equipment (airplane, railroad, ship, etc.)
   Various Safety devices

7. New JRC's products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this catalog. Failure to employ New JRC products in the proper applications can lead to deterioration, destruction or failure of the products. New JRC shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of its products. Products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.

8. Warning for handling Gallium and Arsenic(GaAs) Products (Applying to GaAs MMIC, Photo Reflector). This Product uses Gallium(Ga) and Arsenic(As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burns, destroy, or process chemically to make them as gas or power. When the product is disposed, please follow the related regulation and do not mix this with general industrial waste or household waste.

9. The product specifications and descriptions listed in this catalog are subject to change at any time, without notice.