

LOW NOISE AMPLIFIER SA SERIES

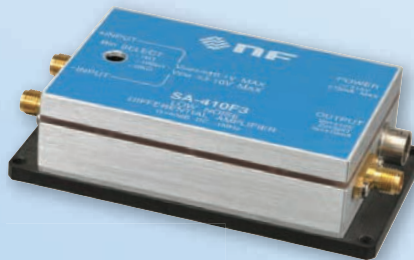
*Accurate and ultra low noise measurements of very small signals
Achieve one of the highest level of low noise amplification*



Current Amplifier

SA-600 series

Voltage Amplifier



SA-400 series

Differential input



SA-200 series

Single-ended input

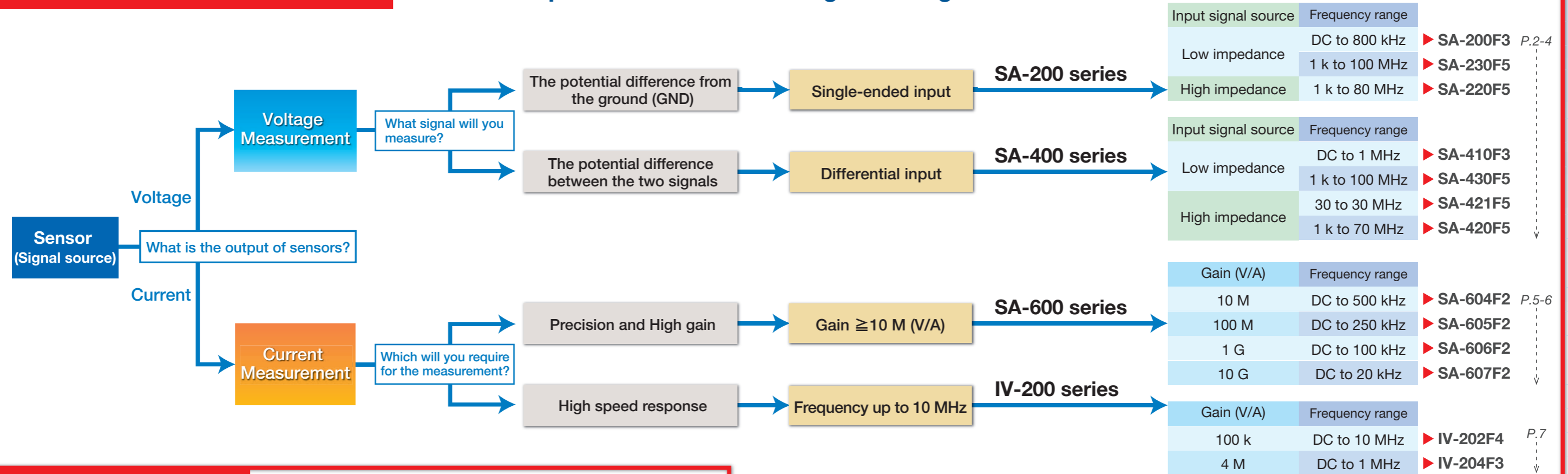
NF Low Noise Amplifier Line-up that Performs High Quality Amplification of Small Signals.

Special Website

Competitive Comparison data showing our low noise performance is available on our website. NF also offers custom-designed amplifiers in addition to the line up in this brochure.

Selection Chart

Select the optimum model according to the signal of the sensor.



Best Combination

Low Noise DC Power Supply LP series

LP series enable the optimal performance of SA series amplifiers

Highly stable DC power supply with extremely low output noise voltage, thorough noise resistance, and ultra low noise design. The SA series meets severe low noise demand by using LP power supply.

• The data on this brochure is measured using the LP series.



LP5394

- Output Noise: 10 μ Vrms or lower (typ.) (10 Hz to 20 MHz bandwidth)
- Output Voltage Stability: ± 10 ppm/ $^{\circ}$ C (typ.)
- Output Voltage: 0 to ± 15 V
- Output Current: 0.1 A max.
- Precisely adjusts the output voltage using the 10-turn potentiometer
- 1/4-rack size for easy integration into multi-channel rack systems
- Input voltage 100, 120, 220 and 240 V AC (selector switch) ± 10 %
However, 250 V AC or lower



LP5393

- Output Noise: 10 μ Vrms or lower (typ.) (10 Hz to 20 MHz bandwidth)
- Output Voltage Stability: ± 20 ppm/ $^{\circ}$ C (typ.)
- Output Voltage: ± 12 V to ± 15 V
- Output Current: 0.1 A max.
- 1/4-rack size
- Input voltage 100, 120, 220 and 240 V AC (selector switch) ± 10 %
However, 250 V AC or lower



Low Noise Voltage Amplifier SA-200 series / SA-400 series

Our SA-200 series / SA-400 series preamplifiers for detection of sub micro-Volt signals achieve ultra low noise levels that were previously not possible.

Seven models are available to match differing requirements for frequency range, input form, and input impedance. SA series amplifiers are suitable as head amplifiers for sensors of various types, and they are ideal for enhancing sensitivity of analyzers or measuring instruments.



NEW PRODUCTS SA-410F3

Compared to the previous model (SA-400F3), the frequency characteristics and the harmonic distortion ratio are improved, and the current consumption is reduced.

- Electromagnetic sensor for MRI systems
- High speed temperature sensor
- High precision strain gauge sensor
- Superconducting SQUID sensor for micro-magnetic detection
- High-temperature superconducting Josephson device for microwave detection
- Superconducting device in quantum computers

Applications

- **Low Noise**
Adopted our proprietary circuit applying negative feedback technology. Input equivalent noise voltage 0.25 nV $\sqrt{}$ /Hz, noise figure 0.6 dB (input impedance 50 Ω) <SA-230F5>
- **Wideband**
From low-frequency including DC <SA-200F3 / SA-410F3> to high-frequency / high-speed signal of 100 MHz <SA-230F5 / SA-430F5>, covering a wide frequency range.
- **Input form matched to the signal source**
Single-ended input, single-ended FET input, differential input, differential FET input

Low Noise Voltage Amplifier

SA-200 Series

SPECIFICATIONS

Single-ended Input

DC to 800 kHz



SA-200F3
LOW NOISE AMPLIFIER

1 kHz to 80 MHz



SA-220F5
LOW NOISE FET AMPLIFIER

1 kHz to 100 MHz



SA-230F5
LOW NOISE AMPLIFIER

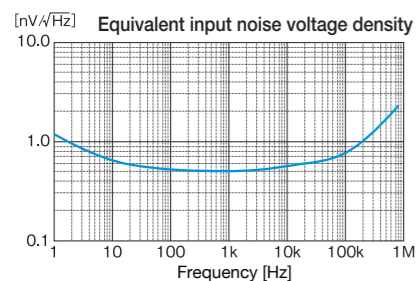
| INPUT SECTION | | | |
|---|--|---|---|
| Input form | DC coupling, unbalanced single-ended input | AC coupling, unbalanced single-ended input | AC coupling, unbalanced single-ended input |
| Input impedance | 1 k / 10 k / 100 kΩ ±5 % (DC) // 150 pF typ. | 1 MΩ ±5 % (5 kHz) // 57 pF typ. | 50 Ω ±5 % (100 kHz) |
| Maximum Input Voltage (Non-destructive) | ±0.5 V | ±1.0 V | ±1.0 V |
| CMRR(Equivalent input) | - | - | - |
| Equivalent input noise voltage density (Input terminal short circuit) | 0.7 nV/√Hz or less (1 kHz) 0.5 nV/√Hz typ. (1 kHz) | 0.7 nV/√Hz or less (100 kHz) 0.5 nV/√Hz typ. (10 kHz to 1 MHz) | 0.35 nV/√Hz or less (100 kHz) 0.25 nV/√Hz typ. (10 kHz to 1 MHz) |
| Equivalent input noise current density | 2.2 pA/√Hz typ. (10 kHz) | 200 fA/√Hz typ. (100 kHz) | 5.0 pA/√Hz typ. (100 kHz) |
| Noise figure (50Ω system) | - | - | 0.7 dB or less, 0.6 dB typ. (10 MHz) 1.0 dB or less, 0.8 dB typ. (100 MHz) |
| OUTPUT SECTION | | | |
| Maximum output voltage | ±10 V/1 kΩ (1 kHz) | 2.0 V _{p-p} /50 Ω (1 kHz to 20 MHz) | 1.8 V _{p-p} /50 Ω (1 kHz to 20 MHz) |
| Output impedance | 50 Ω ±5 % (DC) | 50 Ω ±5 % (100 kHz) | 50 Ω ±5 % (100 kHz) |
| AMPLIFIER SECTION | | | |
| Voltage gain | 40±0.5 dB/1 MΩ (1 kHz) | 46 ±0.5 dB/50 Ω (1 MHz) | 46 ±0.5 dB/50 Ω (20 MHz) |
| Voltage gain frequency characteristic | DC to 800 kHz : +0.5 dB, -3 dB typ. | 1 kHz to 80 MHz : +0.5 dB, -3 dB | 1 kHz to 100 MHz : +0.5 dB, -3 dB |
| Total harmonic distortion | 0.009 % typ. (1 kHz, ±10 V) | - | - |
| Intercept Point | - | - | +30 dBm typ. (68 MHz) |
| GENERAL | | | |
| Power Supply | Through feed-through capacitor | Through feed-through capacitor | Through feed-through capacitor |
| Operating supply voltage range | ±15 V ±5 % | ±15 V ±5% | ±15 V ±5 % |
| Consumption current (no signal) | ±50 mA or less | +65 mA typ. +75 mA or less -10 mA typ. -15 mA or less | +55 mA or less |
| Operating temperature ranges | 0°C to 40°C | 0°C to 40°C | 0°C to 40°C |
| Storage temperature and humidity ranges | -10°C to 50°C 10 % RH to 80 % RH (non-condensation) | -10°C to 50°C 10 % RH to 80 % RH (non-condensation) | -10°C to 50°C 10 % RH to 80 % RH (non-condensation) |
| Dimensions (without protrusions and bottom plate) | 68(W)×43(D)×17.6(H) mm | 68(W)×43(D)×28(H) mm | 68(W)×43(D)×17.6(H) mm |
| Weight | Approx. 90 g | Approx. 130 g | Approx. 90 g |
| Accessory | Instruction manual, bottom plate | Instruction manual, bottom plate | Instruction manual, bottom plate |

* Supply voltage ±15 V (SA-230F5: +15 V), temperature 23°C ±5°C

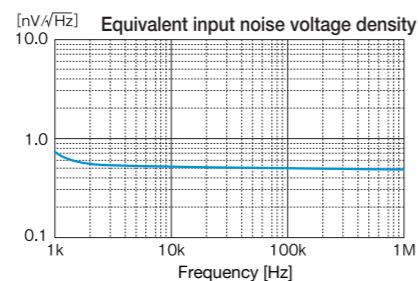
● Recommended power supply: Low Noise DC Power Supply LP series
Use a dedicated cable for power supply from LP series. See back cover.

CHARACTERISTICS

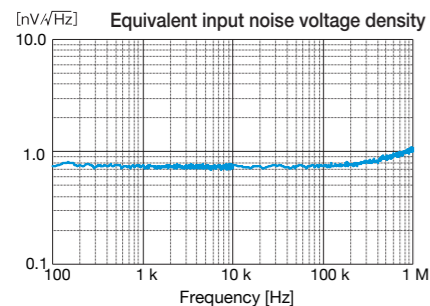
SA-200F3



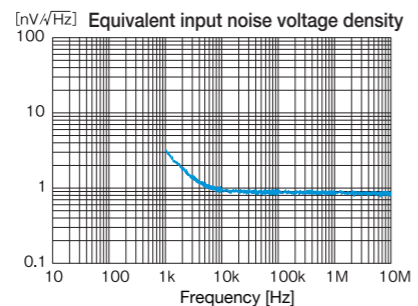
SA-220F5



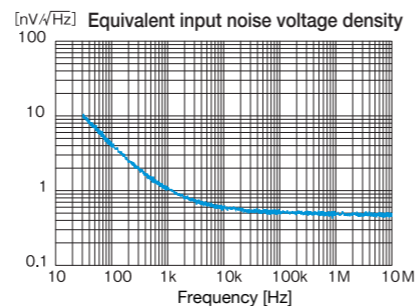
SA-410F3



SA-420F5



SA-421F5



SA-400 Series

Differential Input

DC to 1 MHz



SA-410F3
LOW NOISE DIFFERENTIAL AMPLIFIER

1 kHz to 70 MHz



SA-420F5
LOW NOISE DIFFERENTIAL FET AMPLIFIER

30 Hz to 30 MHz



SA-421F5
LOW NOISE DIFFERENTIAL FET AMPLIFIER

1 kHz to 100 MHz

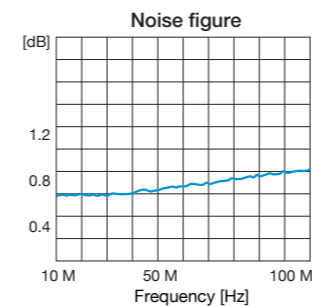


SA-430F5
LOW NOISE DIFFERENTIAL AMPLIFIER

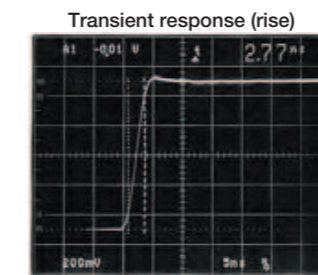
| INPUT SECTION | | | |
|---|---|---|---|
| DC coupling, balanced differential input | AC coupling, balanced differential input | AC coupling, balanced differential input | AC coupling, balanced differential input |
| 1 k/10 k/100 kΩ ±5 % // 100 pF typ. | 1 MΩ ±5 % (1 kHz) // 15 pF typ. | 1 MΩ ±5 % (1 kHz) // 85 pF typ. | 50 Ω ±5 % (100 kHz) |
| Differential input : ±1 V Common-mode input : ±15 V | Differential input : ±10 V DC or 4 V _{p-p} AC Common-mode input : ±10 V DC or 6 V _{p-p} AC | Differential input : ±10 V DC or 4 V _{p-p} AC Common-mode input : ±10 V DC or 6 V _{p-p} AC | ±2.0 V (Differential input / Common-mode input) |
| 110 dB or more (55 Hz) 80 dB typ. (100 kHz) | 55 dB or more (1 kHz to 10 MHz) | 46 dB or more (1 kHz to 10 MHz) | 80 dB or more (100 kHz), 90 dB typ. (100 kHz) 80 dB typ. (10 MHz) |
| 0.75 nV/√Hz typ. (1 kHz) | 1.2 nV/√Hz or less (100 kHz) 0.9 nV/√Hz typ. (100 kHz to 10 MHz) | 0.7 nV/√Hz or less (100 kHz) 0.5 nV/√Hz typ. (100 kHz to 10 MHz) | 0.45 nV/√Hz or less (100 kHz) 0.35 nV/√Hz typ. (10 kHz to 1 MHz) |
| 4.5 pA/√Hz typ. (10 kHz) | 100 fA/√Hz typ. (1 kHz) | 100 fA/√Hz typ. (100 Hz) | 7.0 pA/√Hz typ. (100 kHz) |
| - | - | - | 1.25 dB or less, 1.10 dB typ. (10 MHz) 1.75 dB or less, 1.40 dB typ. (100 MHz) |
| OUTPUT SECTION | | | |
| ±10 V/1 kΩ (1 kHz) | 2.0 V _{p-p} /50 Ω (1 kHz to 20 MHz) | 2.0 V _{p-p} /50 Ω (100 Hz to 20 MHz) | 2.0 V _{p-p} /50 Ω (1 kHz to 20 MHz) |
| 50 Ω ±5 % (100 Hz) | 50 Ω ±5 % (100 kHz) | 50 Ω ±5 % (100 kHz) | 50 Ω ±5 % (100 kHz) |
| AMPLIFIER SECTION | | | |
| 40 ±0.2 dB/1 MΩ (1 kHz) | 46 ±0.5 dB/50 Ω (1 MHz) | 46 ±0.5 dB/50 Ω (1 MHz) | 46 ±0.5 dB/50 Ω (100 kHz) |
| DC to 1 MHz : +0.5 dB, -3 dB | 1 kHz to 70 MHz : +0.5 dB, -3 dB | 30 Hz to 30 MHz : +0.5 dB, -3 dB | 1 kHz to 100 MHz : +0.5 dB, -3 dB |
| 0.004 % typ. (1 kHz, ±10 V) | - | - | - |
| - | - | - | +28 dBm typ. (68 MHz) |
| GENERAL | | | |
| HR10-7R-4P(73)connector (Hirose Electric) | Through feed-through capacitor | Through feed-through capacitor | Through feed-through capacitor |
| ±15 V ±1 V | ±15 V ±5 % | ±15 V ±5 % | ±15 V ±5 % |
| ±45 mA typ. ±75 mA or less (Max. output, load: 1 kΩ) | +54 mA typ. +70 mA or less -25 mA typ. -40 mA or less | +74 mA typ. +90 mA or less -64 mA typ. -80 mA or less | +55 mA typ. +65 mA or less -30 mA typ. -45 mA or less |
| 0 °C to 40 °C | +5 °C to +35 °C | +5 °C to +35 °C | 0 °C to +40 °C |
| -10 °C to 50 °C 5 % RH to 95 % RH (non-condensation) | -10 °C to 50 °C 5 % RH to 95 % RH (non-condensation) | -10 °C to 50 °C 5 % RH to 95 % RH (non-condensation) | -10 °C to 50 °C 10 % RH to 80 % RH (non-condensation) |
| 76(W)×50(D)×21.1(H) mm | 68(W)×43(D)×28(H) mm | 68(W)×43(D)×28(H) mm | 68(W)×43(D)×28(H) mm |
| Approx. 105 g (without accessory) | Approx. 100 g | Approx. 100 g | Approx. 130 g |
| Instruction manual, bottom plate SMA short plug | Instruction manual, bottom plate SMA short plug | Instruction manual, bottom plate SMA short plug | Instruction manual, bottom plate SMA short plug |

OPTION PA-001-2985 : SMA short plug (for SA-200 series and SA-400 series)
PA-001-2986 : SMA to BNC adapter (for all SA series)

SA-230F5

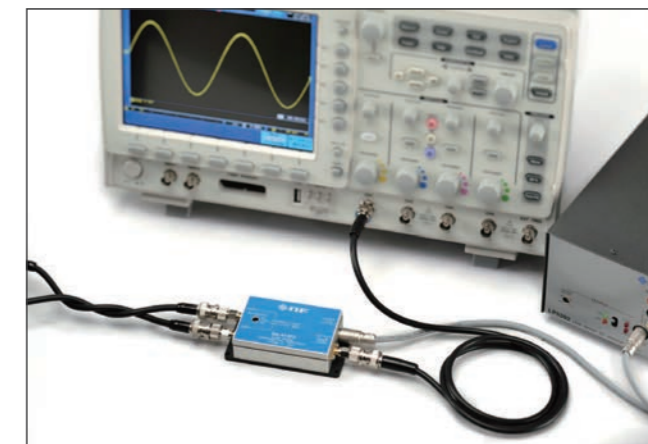
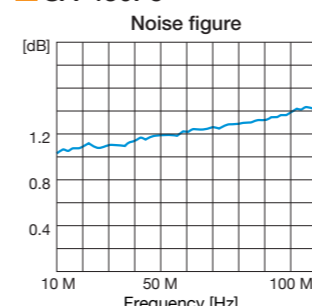


SA-230F5



Low overshoot response of SA-200 series and SA-400 series are equivalent to SA-230F5.

SA-430F5





SA-600 series preamplifiers for detection of sub nano-Amp. signals achieve high gain and wide bandwidth that were previously not possible. Four models are available to match differing requirements for gain and frequency range. SA series amplifiers are suitable as head amplifiers for sensors of various types, and they are ideal for enhancing sensitivity of analyzers or measuring instruments.

Applications

- Photomultiplier tube, photodiode and other photodetectors
- Monitor of particle accelerator beam
- Scanning tunneling microscope
- Ion detector
- Other current output sensors

Both high gain and wideband have been achieved up to 10 G(V/A)

Four models are available with gains of 10 M / 100 M / 1 G / 10 G (V / A).

Stable with capacitance of sensor and connection cable.

SA-600 series operates stably against input capacitance such as sensor's and connection cable's parallel capacitance. The overshoot and the ringing rarely occur for pulse response.

Low Noise

Not only high gain and wideband, the SA-600 series also achieves a low noise of fA/√Hz (10⁻¹⁵) order. The SA-600 series adopts SMA connectors for input and output with excellent shielding effectiveness.

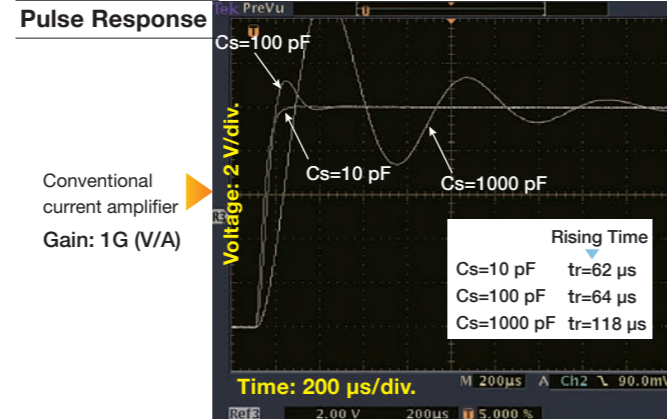
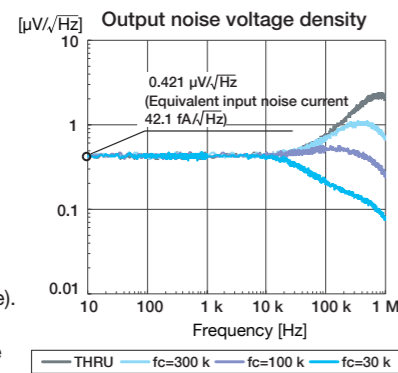
LPF Output

The SA is equipped with a low pass filter to reduce high frequency noise. The high frequency noise can be reduced by selecting its frequency.



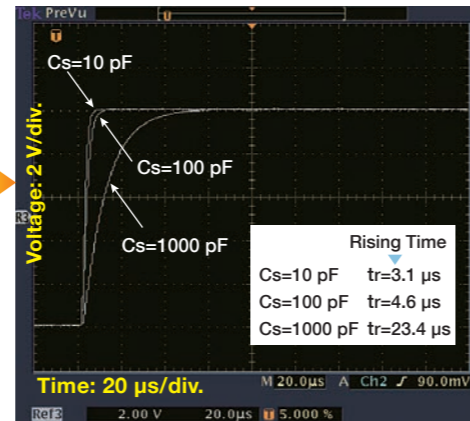
SA-604F2 (10 M V/A)

Cut-off frequency is selectable by the switch on the panel (4 selectable). The graph on the right shows the output voltage noise.



Conventional current amplifier
Gain: 1G (V/A)

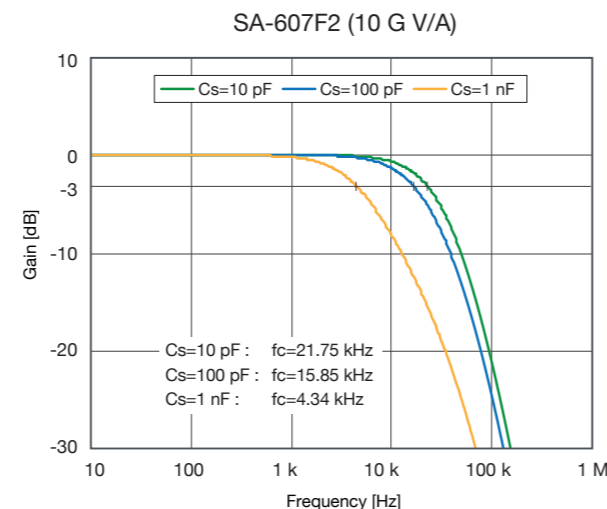
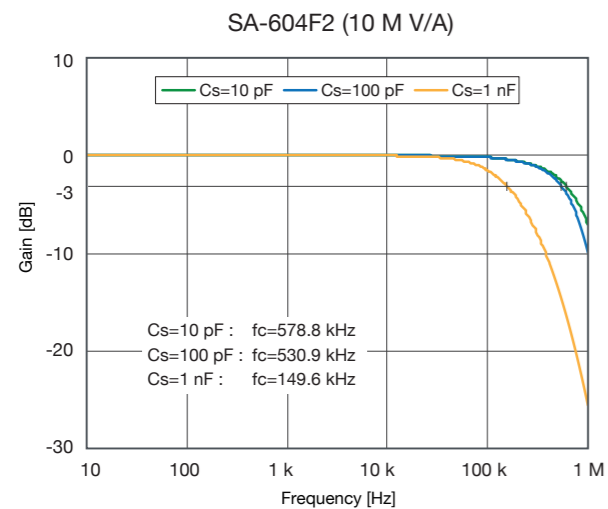
SA-606F2
Gain: 1G (V/A)



Cs : Input - GND capacitance

CHARACTERISTICS

Frequency Response



SPECIFICATIONS

DC to 500 kHz
10 M (V/A)



SA-604F2

DC to 250 kHz
100 M (V/A)



SA-605F2

DC to 100 kHz
1 G (V/A)



SA-606F2

DC to 20 kHz
10 G (V/A)

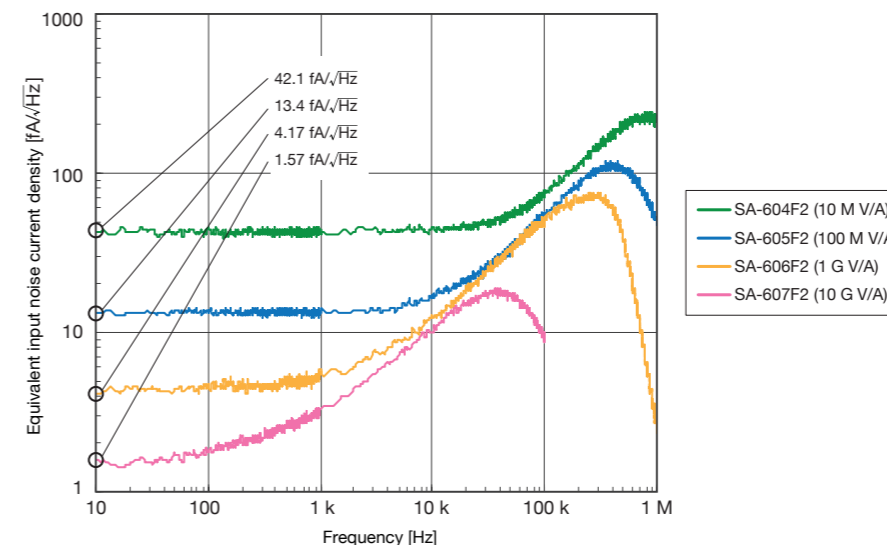


SA-607F2

| INPUT SECTION | | DC to 500 kHz 10 M (V/A) | DC to 250 kHz 100 M (V/A) | DC to 100 kHz 1 G (V/A) | DC to 20 kHz 10 G (V/A) |
|--|--|--|---|--|--|
| Input form | DC coupling, unbalanced single-ended input, SMA connector | | | | |
| Maximum input current *1 | ±1 μA | ±100 nA | ±10 nA | ±1 nA | |
| Input impedance *1 | 1 kΩ (typ.) | 3 kΩ (typ.) | 10 kΩ (typ.) | 30 kΩ (typ.) | |
| Recommended signal source resistance | 1 MΩ or more | 10 MΩ or more | 100 MΩ or more | 1 GΩ or more | |
| Input bias current *2 | ±1pA (typ.) | | | | |
| Equivalent input current noise density *3 | 45 fA/√Hz (typ.) | 15 fA/√Hz (typ.) | 6 fA/√Hz (typ.) | 2.5 fA/√Hz (typ.) | |
| OUTPUT SECTION | | | | | |
| Output form | DC coupling, unbalanced single-ended input, SMA connector | | | | |
| Maximum output voltage *1 | ±10 V | | | | |
| Maximum output current *1 | ±5 mA | | | | |
| Output impedance *1 | 50 Ω | | | | |
| Output offset voltage *4 | ±3 mV | | ±5 mV | ±15 mV | |
| Output offset voltage adjustment range | ±15 mV (typ.) adjusting with a potentiometer | | | | ±20 mV (typ.) adjusting with a potentiometer |
| AMPLIFIER SECTION | | | | | |
| Gain *5 | 1×10 ⁷ (10 M) V/A ±1% | 1×10 ⁸ (100 M) V/A ±1% | 1×10 ⁹ (1G) V/A ±1% | 1×10 ¹⁰ (10G) V/A ±1% | |
| Output gain flatness (within ±0.5 dB)*6 *7 | DC to 50 kHz | DC to 25 kHz | DC to 10 kHz | DC to 2 kHz | |
| +0.5dB Frequency response (Cs=10pF)*8 | DC to 500 kHz | DC to 250 kHz | DC to 100 kHz | DC to 20 kHz | |
| I/O polarity | Non-inverting | | | | |
| LPF output (Cut-off frequency setting) | 30 kHz / 100 kHz / 300 kHz / THRU, selectable with a switch | 10 kHz / 30 kHz / 100 kHz / THRU, selectable with a switch | 3 kHz / 10 kHz / 30 kHz / THRU selectable with a switch | 1 kHz / 3 kHz / 10 kHz / THRU selectable with a switch | |
| GENERAL | | | | | |
| Power supply connector | HR10-7R-4P (73) connector (Hirose Electric) | | | | |
| Operating power supply voltage | ±15 V ±1 V | | | | |
| Current consumption (no signal) | ±40 mA or less, ±37 mA (typ.) | | | ±40 mA or less, ±32mA (typ.) | |
| Performance guarantee temperature range | 23°C ±5°C | | | | |
| Temperature and humidity range | Operation : 0°C to 40°C, 5 % RH to 85 % RH (non-condensation) Storage : -10°C to 50°C, 5 % RH to 95 % RH (non-condensation) | | | | |
| External dimensions | 76(W)×50(D)×21.1(H) mm (without protrusions and bottom plate) | | | | |
| Weight | Approx. 135 g | | | | |
| RoHS | Directive 2011/65/EU | | | | |
| EMC | EN 61326-1: 2013 | | | | |
| Accessory | Instruction manual, bottom plate, SMA open plug, BNC to SMA adapter x2 | | | | |

*1 Nominal values when f = 1 kHz, when f = 100 Hz for SA-607F2 *2 The input bias current approximately doubles as the temperature increases by +7 °C
*3 Measured with a Keysight 89410A equivalent when f = 1 kHz, when f = 100 Hz for SA-607F2 *4 Input is opened. *5 Measured with DC
*6 When the cut-off frequency is set at THRU. *7 Reference frequency: f = 10 Hz, f = 1 Hz for SA-607F2 *8 "Cs" is an input parallel capacitance between input and GND
● Recommended power supply: Low Noise DC Power Supply LP series (Use a dedicated cable for power supply from LP series. See back cover.)

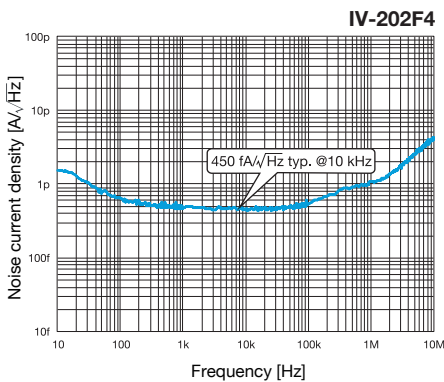
Equivalent input noise current density





The IV-200 series is compact current to voltage converter. It realizes wide bandwidth and low noise characteristics.

CHARACTERISTICS



SPECIFICATIONS

| | IV-202F4 | IV-204F3 |
|---|--|--|
| INPUT SECTION | | |
| Input form | DC coupling, unbalanced single ended input | |
| Maximum input current | ±100 μA | ±2.5 μA |
| Input Impedance | 30 Ω or less | 1.2 kΩ or less |
| Recommended signal source impedance | 25 kΩ or more, 20 pF or less | 1 MΩ or more, 50 pF or less |
| Input bias current | 5 pA typ. | |
| Equivalent input noise current density | 600 fA/√Hz or less 450 fA/√Hz typ. (at 10 kHz, input opened) | 90 fA/√Hz or less 70 fA/√Hz typ. (at 1 kHz, input opened) |
| OUTPUT SECTION | | |
| Output form | DC coupling, unbalanced single ended output, SMB connector (male) | |
| Phase between input and output | Inverting | |
| Maximum output voltage | ±10 V | |
| Maximum output current | ±5 mA | |
| Output Impedance | 50 Ω ±10 % | |
| Output offset voltage | ±10 mV (Input opened) | |
| AMPLIFIER SECTION | | |
| Gain | 1×10 ⁵ V/A ±5 % | 4×10 ⁶ V/A ±5 % |
| Frequency bandwidth | DC to 10 MHz (Based on 10 kHz, +1 to -3 dB) | DC to 1 MHz (Based on 10 kHz, +1 to -3 dB) |
| GENERAL | | |
| Power supply connector | DF11-4DP-2DS(52) (4 pins, male) Hirose Electric | |
| Operating supply voltage range | ±15 V ±1 V | |
| Consumption current | ±40 mA or less, ±25 mA typ. (no signal) | |
| Adjuster for frequency response | Adjustable frequency response, If large input parallel capacitance is connected. | |
| Performance guarantee temperature range | 23°C ±5°C | |
| Temperature and humidity ranges | Operating: 0°C to 40°C, 10 % RH to 90 % RH Storage: -10°C to 60°C, 10% RH to 80% RH | |
| External dimensions | 80(W)×15(D)×21(H) mm (without protrusions) | |
| Weight | Approx. 25 g | |
| RoHS | Directive 2011/65/EU | |
| Accessory | Instruction manual, Power supply cable (DF11-4DS-2C connector (4 pins, female), Hirose Electric) | |

Ordering Information

| Model | Description |
|----------|--------------------------------------|
| SA-200F3 | Low Noise Amplifier |
| SA-220F5 | Low Noise FET Amplifier |
| SA-230F5 | Low Noise Amplifier |
| SA-410F3 | Low Noise Differential Amplifier |
| SA-420F5 | Low Noise Differential FET Amplifier |
| SA-421F5 | Low Noise Differential FET Amplifier |
| SA-430F5 | Low Noise Differential Amplifier |
| SA-604F2 | Wideband Current Amplifier |
| SA-605F2 | Wideband Current Amplifier |
| SA-606F2 | Wideband Current Amplifier |
| SA-607F2 | Wideband Current Amplifier |

Option

| | |
|-------------|---|
| PA-001-2985 | SMA Short Plug (for SA-200 series, SA-400 series) |
| PA-001-2986 | SMA to BNC Adapter (for all SA series) |

*Note: The contents of this catalog are current as of July 10, 2017.
 • Product appearance and specifications are subject to change without notice.
 • Before purchase, contact us to confirm the latest specifications, price and delivery date.

| Model | Description |
|----------|--------------------------|
| IV-202F4 | Transimpedance Amplifier |
| IV-204F3 | Transimpedance Amplifier |

Option

| | |
|-------------|---|
| PA-001-3017 | SMB to BNC Adapter |
| PA-001-3018 | Power Supply Cable (for general-purpose power supply) |

| Model | Description |
|--------|---------------------------|
| LP5393 | Low Noise DC Power Supply |
| LP5394 | Low Noise DC Power Supply |

Option

| | |
|-------------|---|
| PA-001-2590 | BNC Adapter * |
| PA-001-2591 | Binding Post Adapter * |
| PA-001-2372 | Output Cable A (for SA-600 series, SA-410F3) |
| PA-001-2373 | Output Cable B (for SA-200 series, SA-400 series) Except SA-230F5 and SA-410F3 |
| PA-001-2374 | Output Cable C (for SA-230F5) |
| PA-001-3029 | Output Cable D (for IV-200 series) |
| PA-001-2642 | Rack Mount Kit (EIA, for 4 units) |
| PA-001-2643 | Rack Mount Kit (JIS, for 4 units) |

* Output Cable A is required for the connection with this main unit

NF Corporation

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