

# PROGRAMMABLE CURRENT AMPLIFIER

CA5350

Supports a Variety of Small Current Measurements, Using Various Optical Sensors (PD, APD, PMT)

## Applications

- ▶ Photodetection with PMTs and Photodiodes
- ▶ Scanning Tunneling Microscopy
- ▶ Spectroscopy
- ▶ Quantum Electronics
- ▶ Semiconductors
- ▶ MEMS
- And more...



<b>High Gain</b>	$10^4$ V/A to $10^{10}$ V/A (7 ranges, x10 increments), $10^{11}$ V/A maximum
<b>Broad Bandwidth</b>	DC to 500 kHz ( $10^6$ V/A), DC to 70 kHz ( $10^9$ V/A)
<b>Fast Response</b>	0.7 $\mu$ s ( $10^6$ V/A)
<b>Low Noise</b>	2.5 fA/ $\sqrt{\text{Hz}}$ ( $10^{10}$ V/A, at 55 Hz)
<b>Current Suppression</b>	$\pm 8$ nA to $\pm 800$ $\mu$ A (6 ranges)

# With its unique circuitry, high gain and broad bandwidth, as well as stable operation with additional input capacitance.

The CA5350 programmable current amplifier is a variable gain type, current-input, voltage-output amplifier. Gain can be set from  $10^4$  V/A to a maximum of  $10^{11}$  V/A. In addition, the included current suppression function enables the canceling of the dark current that cannot be avoided with photoelectric conversion elements such as photodiodes.

BNC connectors are used for input and output, so special cables or an external power supply are not required. The various settings, including gain, are easy to perform using the dial and keys on the front panel, and the set values are displayed on the screen.

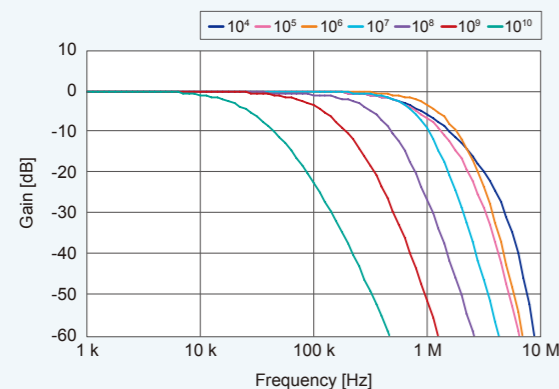
Since the GPIB and USB interfaces make remote control also possible, gain and other settings can be performed from a personal computer, making it easy to configure an automatic measurement system.

With its performance, functions and operability, this programmable current amplifier supports the current amplification of signals from a variety of current output sensors.

## High Gain and Broad Bandwidth

The CA5350 realizes unprecedented high gain and broad bandwidth support from DC to 14 kHz at  $10^{10}$  V/A, and from DC to 70 kHz at  $10^9$  V/A. In addition, it also supports high-speed signals from DC to 500 kHz at  $10^6$  V/A or less.

Gain-frequency characteristics



## Variable Gain $10^4$ to $10^{11}$ V/A

Gain can be set in seven ranges of  $10^4$ ,  $10^5$ ,  $10^6$ ,  $10^7$ ,  $10^8$ ,  $10^9$ ,  $10^{10}$  (V/A), in x10 increments.

This enables the optimal gain setting to match the current and sensor values that vary depending on the measurement conditions.

In addition, if an output amplifier gain of x10 is used, a maximum gain setting of  $10^{11}$  V/A is possible.

## Fast Response and Stable Operation

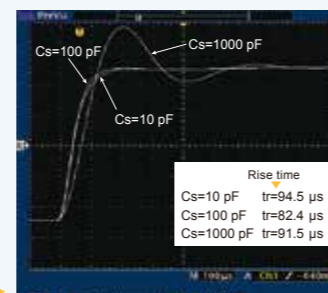
The fast response of 0.7  $\mu$ s at  $10^6$  V/A gain enables support for fast pulse response signal processing in optical systems. Our unique circuit design technology enables stable operations even with the capacitance of the connecting cables and sensors, eliminating any concerns about oscillation.

In addition, overshoot and ringing do not occur even for pulse responses.

By achieving both fast response and broad bandwidth, as well as stable operation even with additional capacitance on the input side, the CA5350 supports a variety of sensor types.

Pulse response characteristics

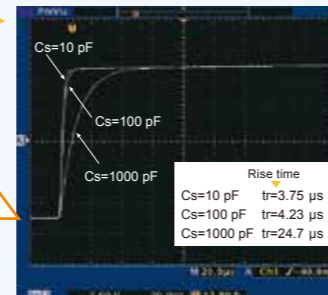
Gain:  $10^9$  V/A  
Cs: Input-ground capacitance



Conventional current amplifiers

X-axis: 100  $\mu$ s/div. Y-axis: 2 V/div.

CA5350



Ringing and overshoot hardly occur.

X-axis: 20  $\mu$ s/div. Y-axis: 2 V/div.

## Current Suppression

For photoelectric conversion elements such as photodiodes and photo transistors, in the absence of incident light, a weak current called a dark current will flow.

In a current amplifier with high gain, a small DC current input becomes a large voltage when output, and the amplifier is saturated and measurement becomes impossible.

The built-in suppression current source is adjustable to cancel the input of such dark current.

The current suppression setting can be selected in six ranges from  $\pm 8$  nA to  $\pm 800$   $\mu$ A.

In addition, the auto-suppression function can be used to automatically set the range and current value required to suppress the dark current.

Current suppression setting screen



## Low Noise

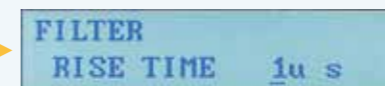
Built-in filters and DC power supply

The CA5350 achieves an ultra-low noise with an input-referred noise of 2.5 fA/ $\sqrt{\text{Hz}}$  (at  $10^{10}$  V/A, 55 Hz).

In addition, in order to remove noise components and to improve the signal-to-noise ratio (SN ratio), the built-in filter can be set to a response speed in the range of 1  $\mu$ s to 300 ms to optimize the SN ratio and response speed depending on the application.

And furthermore, in our pursuit of the low noise operation that is essential to the amplification of a weak current, we have adopted a low noise DC power supply in the power supply section using our own unique technology.

Filter response speed (rise time) setting screen



## Built-in System Features

Interfaces, input and output terminals

The standard-equipped USB and GPIB interfaces support remote control and integration of the CA5350 into an automatic measurement system.

Since input and output terminals are provided on both the front and rear panels, you can choose the terminals depending on how you are connecting to sensors or other equipment.

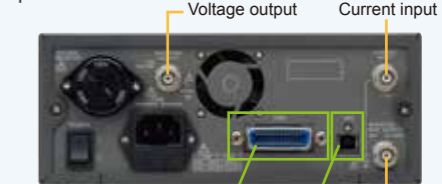
In addition, the half-rack size makes the integration of multiple units easy.

Front panel



Current input Bias output Voltage output

Rear panel



Voltage output Current input GPIB USB Bias output

For system measurements that combine a variety of measurements.



The CA5350 programmable current amplifier can be combined with various other devices such as a lock-in amplifier, digital oscilloscope, and data acquisition system to support system measurements.

\*Note: Optional single-unit and double-unit rack mount brackets are available.



## Applications

- Beam position monitoring for storage rings and synchrotrons
- I-V characteristic measurement of organic thin film devices
- Gate leakage current measurement of devices such as field-effect transistors (FET) and insulated-gate bipolar transistors (IGBT)
- Detection of tunneling current of scanning tunneling microscopes (STM)
- Detection of conductive probe current for atomic force microscope (AFM) current measurement
- As a preamplifier for a lock-in amplifier

Depend on sensors and applications — Supporting research with a variety of functions

- Bias power supply  $-8$  V to  $+8$  V  
Bias power supply for applying a bias voltage to a variety of sensors
- Display backlight brightness setting  
3-level setting, including OFF  
Enables use in light-sensitive experiments.
- Setting memory: 10 sets

■ Input section

Input form	DC coupled unbalanced input
Input connector	Insulating type BNC receptacle. Either front panel/rear panel input connector can be used
Non-destructive maximum input current	±30 mA

Gain setting (V/A)	Rated maximum input current		Input impedance (Supplementary value)	Equivalent input current noise density*1 (Supplementary value)
	Output amplifier gain setting ×1	×10		
10 G	±1 nA	±100 pA	30 kΩ (@100 Hz)	2.5 fA/√Hz (@55 Hz)
1 G	±10 nA	±1 nA	10 kΩ (@1 kHz)	6 fA/√Hz (@200 Hz)
100 M	±100 nA	±10 nA	3 kΩ (@1 kHz)	15 fA/√Hz (@200 Hz)
10 M	±1 μA	±100 nA	1 kΩ (@1 kHz)	45 fA/√Hz (@1 kHz)
1 M	±10 μA	±1 μA	400 Ω (@1 kHz)	150 fA/√Hz (@1 kHz)
100 k	±100 μA	±10 μA	300 Ω (@1 kHz)	750 fA/√Hz (@1 kHz)
10 k	±1 mA	±100 μA	10 Ω (@1 kHz)	6 pA/√Hz (@1 kHz)

\*Note 1: Input open, Front input, Filter 300 μs (10G V/A) or 30 μs (1G V/A to 10kV/A), no source capacitance

■ Current suppression section

Range	6 ranges (8 nA, 80 nA, 800 nA, 8 μA, 80 μA, 800 μA) or OFF	
Setting range	8 nA range	-8.000 nA to +8.000 nA resolution 1 pA
	80 nA range	-80.00 nA to +80.00 nA resolution 10 pA
	800 nA range	-800.0 nA to +800.0 nA resolution 100 pA
	8 μA range	-8.000 μA to +8.000 μA resolution 1 nA
	80 μA range	-80.00 μA to +80.00 μA resolution 10 nA
	800 μA range	-800.0 μA to +800.0 μA resolution 100 nA
Setting accuracy (Supplementary value)	8 nA range	± (  3.0% of setting   + 0.15% of range)
	80 nA range	± (  1.5% of setting   + 0.15% of range)
	800 nA range	± (  0.8% of setting   + 0.15% of range)
	8μA range -800μA range	± (  0.6% of setting   + 0.15% of range)

\*Note: Auto suppression: Function for automatically selecting and setting the current value and current suppression range required for cancelling the input current.

■ Amplification section

Gain and accuracy (DC)		
Gain Setting (V/A)	Output amplifier gain setting ×1	Output amplifier gain setting ×10
10 G	1×10 <sup>10</sup> ±1.0%	1×10 <sup>11</sup> ±1.0%
1 G	1×10 <sup>9</sup> ±1.0%	1×10 <sup>10</sup> ±1.0%
100 M	1×10 <sup>8</sup> ±0.5%	1×10 <sup>9</sup> ±0.5%
10 M	1×10 <sup>7</sup> ±0.3%	1×10 <sup>8</sup> ±0.3%
1 M	1×10 <sup>6</sup> ±0.25%	1×10 <sup>7</sup> ±0.25%
100 k	1×10 <sup>5</sup> ±0.25%	1×10 <sup>6</sup> ±0.25%
10 k	1×10 <sup>4</sup> ±0.25%	1×10 <sup>5</sup> ±0.25%

Frequency characteristics (Conditions: Filter OFF, Output amplifier gain ×1, no source capacitance)

Gain setting (V/A)	within +0.5 dB / -3 dB	Response speed*2 (Supplementary value)	Reference frequency
10 G	DC to 14 kHz	25 μs	10 Hz
1 G	DC to 70 kHz	5 μs	
100 M	DC to 175 kHz	2 μs	
10 M	DC to 350 kHz	1 μs	
1 M	DC to 500 kHz	0.7 μs	
100 k			
10 k			

Output amplifier gain		×1 or ×10 Gain after current-voltage conversion
Filter	Setting range	Response speed (rise time) 1 μs ~ 300 ms, 1-3 sequence or OFF
	Setting accuracy	Less than ±20% of the setting time (10%-90% rise time) (supplementary value)
	Filter characteristics	Low-pass filter (LPF), phase-linear type
	Attenuation slope	12 dB/oct
I/O polarity		Inverted (Once current starts flowing in the input connector, output will have minus potential)

\*Note 2: Response speed is the rise time (10%~90%) of square output response waveform.

■ Output section

Output form	DC coupled unbalanced output
Output connector	Front and rear panel, insulated type BNC receptacle Same signal is output from the front and the rear connectors.
Maximum output voltage	±10 V (When no load)
Maximum output current	±10 mA, Total current of front and rear connectors.
Output impedance	50 Ω (Supplementary value)
Output offset voltage	Less than ±30 mV (When amplifier gain is 10 G V/A) Less than ±20 mV (When amplifier gain is 10 k to 1 G V/A) (Input open, Current suppression OFF, and Output amplifier gain ×1)

■ DC voltage bias output section

Output form	DC coupled unbalanced output
Output connector	Front and rear panel, insulated type BNC receptacle Same signal is output from the front and the rear connectors.
Setting range	-8.000 V to +8.000 V, resolution 0.001 V
Setting accuracy	± ( 1.0% of setting  +20 mV) (When no load)
Maximum output current	±2 mA, Total current of front and rear connectors
Output impedance	50 Ω (Supplementary value)

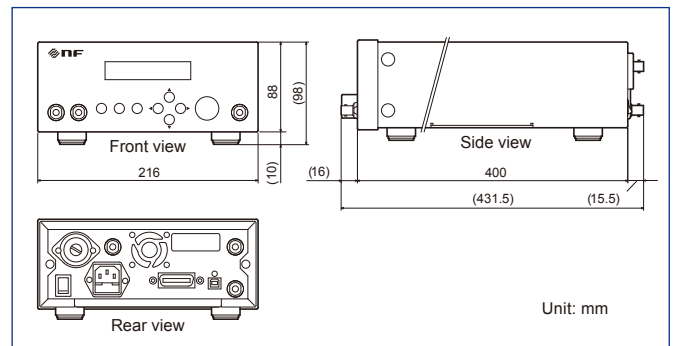
\*Note: DC bias will output voltage with inverted polarity.

Example: When +1.000V is set, -1.000V will be output in the DC bias voltage output BNC connector.

■ General information

Display device	20 characters × 2 lines Black and white LCD Backlight brightness can be set on 3 stages including OFF	
Memory for saving the setting	10 sets (including 1 set reserved for factory default settings)	
I/O grounding	Signal grounding of Input (CURRENT INPUT), Output (INVERTING OUTPUT), and bias output (INVERTING BIAS OUTPUT) are insulated from the enclosure. Their signal grounding is common. Maximum withstanding voltage between signal grounding and enclosure is 42Vpk (DC+ACpeak).	
External control	GPIB: IEEE488.1 USB: USB 1.1 full speed, device class CDC *Note: USB driver can be downloaded from our website.	
Power supply Voltage	AC100V / 120V / 220V / 240V ±10% However, 250V or less 50Hz/60Hz ±2Hz, Power consumption: 40VA or less Overvoltage category: II	
Temperature and humidity	Performance guarantee	23°C ± 5°C, 5% to 85% RH (Absolute humidity: 1 to 25 g/m <sup>3</sup> , non-condensing)
	Operation	0°C to +40°C, 5% to 85% RH (Absolute humidity: 1 to 25 g/m <sup>3</sup> , non-condensing)
	Storage	-10°C to +50°C, 5% to 95% RH (Absolute humidity: 1 to 29 g/m <sup>3</sup> , non-condensing)
Pollution Degree	2 (indoor use)	
Warm-up time	30 minutes	
Safety regulation	EN 61010-1: 2010, EN 61010-2-030: 2010	
EMC	EN 61326-1: 2013 (Group 1, Class A), EN 61326-2-1: 2013 EN 61000-3-2: 2006 + A1: 2009 + A2: 2009 EN 61000-3-3: 2008	
RoHS directive	Directive 2011/65/EU	
External dimensions	216 (W) × 88 (H) × 400 (D) mm (Not including protuberances)	
Weight	Approx. 5.0 kg (Not including accessories)	
Accessories	Power cord: 1, fuse: 1, instruction manual: 1	

■ Dimensions



\*Note: The contents of this catalog are current as of November 6th, 2024.

- Product appearance and specifications are subject to change without notice.
- Before purchase, contact us to confirm the latest specifications, price and delivery date.

Option

- Rack-mount kit (Single-unit, inch)
- Rack-mount kit (Double-unit, inch)
- Rack-mount kit (Single-unit, metric)
- Rack-mount kit (Double-unit, metric)

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