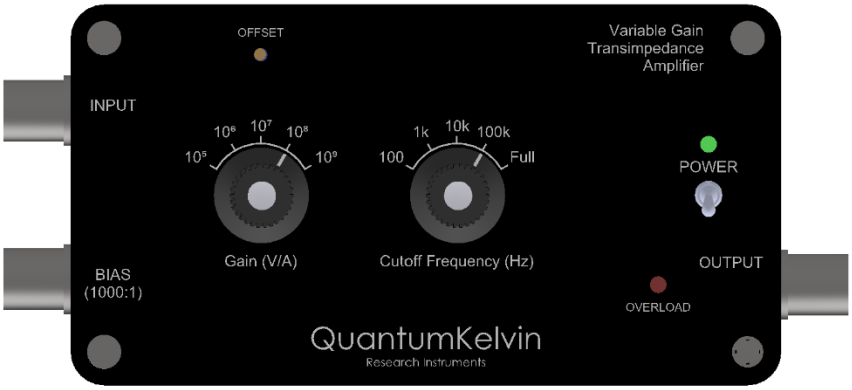
QK-CA-100
Variable Gain Current Amplifier



QK
Precision
Research Instruments

QK-CA-100 transimpedance amplifier is engineered for ultra-low input voltage and current noise, making it ideal for high-precision measurement applications, including semiconductor characterization, quantum device testing, and optical experiments.

Unlike conventional commercial amplifiers, the QK-CA-100 operates using standard USB power adapters while maintaining complete electrical isolation between the power source and the measurement circuitry. This architecture fundamentally eliminates power-related noise and prevents ground loop interference.

Its compatibility with portable USB power bank also enables mobile operation. For instance, with a 10,000 mAh power bank, the amplifier can run continuously for up to 15 days without recharging.

To achieve battery-grade noise performance even with USB power, the amplifier integrates dual-stage linear voltage regulators and multiple high-frequency cutoff filters to suppress switching noise completely.

In addition, a second-order low-pass filter is applied at the output stage to effectively attenuate out-of-band noise, ensuring clean measurement signals within the desired frequency range.

Features.

- Ideal for semiconductors, quantum device characterizations and optical experiments.
- No need for specialized or lab-grade power supplies.
- Prevents ground loops and blocks noise from power source.
- Enables mobile operation with USB power bank.
- 15 days of continuous operation with a 10,000 mAh power bank.
- Completely suppress switching noise from USB power.
- Achieves battery-grade noise performance.

Specifications

Gain(V/A)	10^5	10^6	10^7	10^8	10^9
Input Current Noise	407 fA/Hz$^{1/2}$	129 fA/Hz$^{1/2}$	41 fA/Hz$^{1/2}$	13.5 fA/Hz$^{1/2}$	5.7 fA/Hz$^{1/2}$
Bandwidth (open input)	>500 kHz	160 kHz	25 kHz	3.7 kHz	250 Hz
2nd order Low Pass Fiter	100 Hz, 1 kHz, 10 kHz, 100 kHz and Full Bandwidth				
Input Voltage Noise	~ 4 nV/Hz$^{1/2}$ @ 1 kHz				
Accuracy	Gain ±1 %, flatness 0.1 dB				
Input Voltage drift	±0.3 μV/°C				
Input Bias Current	±1 pA				
Power	Stand USB power adapters or USB power bank				
Output Impedance	50 ohms				
Output Voltage Range	±6 V				
External Bias Input Port	Dedicated port Available (via 1000:1 divider)				
Dimensions (W x D x H)	127 mmx 68 mm x 22 mm				

* All specifications listed in the table represent typical values.

Warranty and Technical Support

This product includes a standard 2-year warranty that covers troubleshooting, repairs, and technical assistance. Optional extended maintenance services are available for up to 5 years at a minimal additional cost. These services may include circuit modifications upon user request, providing enhanced long-term reliability and system flexibility.

1. Device Description

The QK-CA-100 current amplifier is designed to minimize input voltage and current noise, making it suitable for high-precision measurements in electronic device characterization and optical experiments. Unlike conventional commercial amplifiers, this product is designed to be powered by a universal USB power supply, and through complete electrical isolation between the input power and measurement circuits, it fundamentally prevents the introduction of power-side noise and the possibility of ground loop formation.

Users can employ a USB power supply connected to AC power (100V~240V), and when necessary, can operate in a completely AC power-isolated state using a USB power bank. Testing was performed on external noise intrusion for both operating methods, and it was confirmed that there is no significant difference in noise performance under typical experimental conditions.

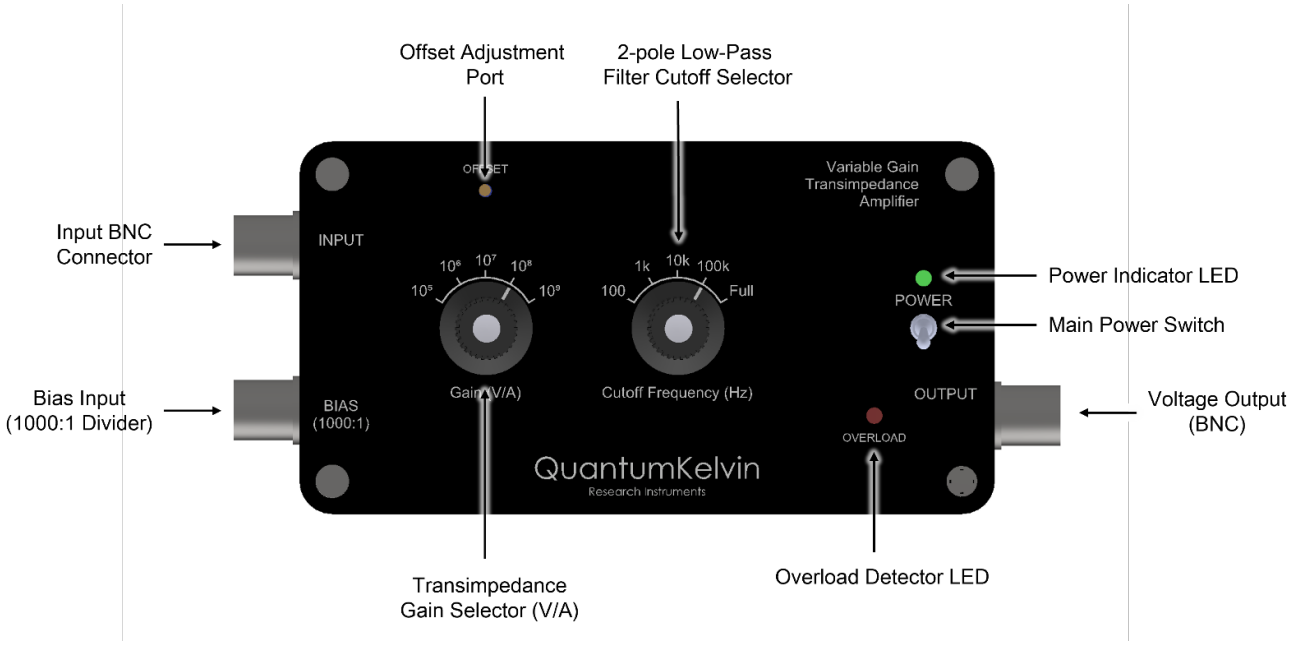


Figure 1. QK-CA-100 variable gain transimpedance amplifier front panel detail.

- Offset Adjustment

  To adjust the offset voltage of the input terminal, connect a precision voltmeter (e.g., Keysight 34465A, Keithley DMM6500, etc.) to the input terminal, then use an insulated trimmer adjustment driver to adjust the input voltage to exactly 0 V.

- Current-to-Voltage Conversion Gain Setting

  Use Transimpedance Gain Selector to select current-to-voltage conversion gains. The selectable gains are 10^5, 10^6, 10^7, 10^8, and 10^9 V/A.

- Overload Indicator

  When the result of multiplying the input current by the current-to-voltage conversion gain exceeds +5 V or falls below -5 V, the Overload LED illuminates to warn that the input current has exceeded the allowable

range. The maximum output voltage range is approximately +5.5 V to -5.5 V. For example, when the current-to-voltage conversion gain is 10^7 V/A, the Overload LED will turn on when the input current exceeds $+5\times10^{-7}$ A or falls below -5×10^{-7} A. In such cases, the conversion gain must be reduced to maintain the output within the allowable range.

- Bandwidth Setting

  The output voltage is delivered through a 2nd-order low-pass filter, and Figure 2 shows the frequency response characteristics of this filter. The selectable cutoff frequencies are 100 Hz, 1 kHz, 10 kHz, and 100 kHz, with an attenuation slope of –40 dB/decade in the filter's transition band. To bypass the filter, set the rotary switch to the "Full" position. In this case, the output signal is passed without filtering, and the bandwidth varies according to the current-to-voltage conversion gain (Gain). For example, when the conversion gain is set to 10^5 V/A, the bandwidth is approximately 500 kHz or higher. To optimize the signal-to-noise ratio (SNR), it is recommended to limit bandwidth beyond what is necessary and select the lowest possible cutoff frequency.

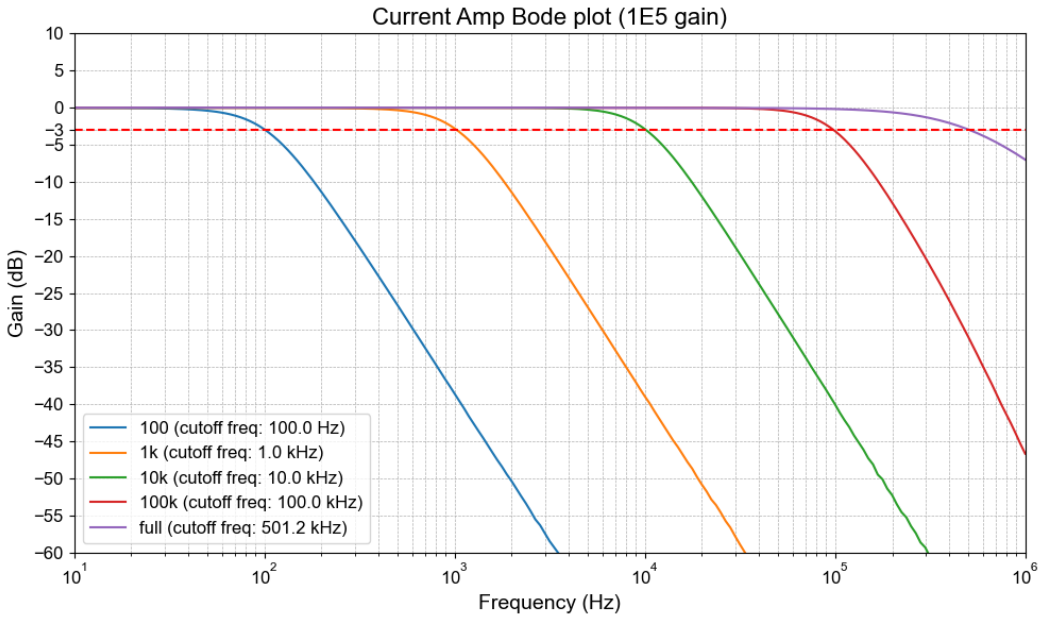


Figure 2. Frequency characteristics of the 2nd-order low-pass filter.

- External Input Bias Setting

  When voltage is applied to the BIAS input terminal, bias voltage is applied to the input terminal of the current amplifier. The voltage actually applied to the input terminal is approximately 1/1000 of the externally applied BIAS voltage. This enables fine potential adjustment and can be utilized for various applications such as constant current device measurements.

- Power Supply

  Supply power to the device using the included standard USB charger. If necessary, power can also be supplied using a portable mobile battery. However, some low-quality USB chargers may generate excessive electrical noise, which can affect measurement signals. Therefore, it is recommended to use a reliable quality USB power supply.

2. Device Characteristics

Figure 3 shows the measured bandwidth characteristics when the bandwidth setting filter is set to "Full Bandwidth" and the current-to-voltage conversion gain is set to 10^5, 10^6, 10^7, 10^8, and 10^9 V/A. In actual use, the bandwidth may decrease when input capacitance increases due to the influence of coaxial cables or external circuits connected to the current input terminal. Particularly when input capacitance exceeds several nF, it is recommended to measure and verify the actual bandwidth in the operating environment before use.

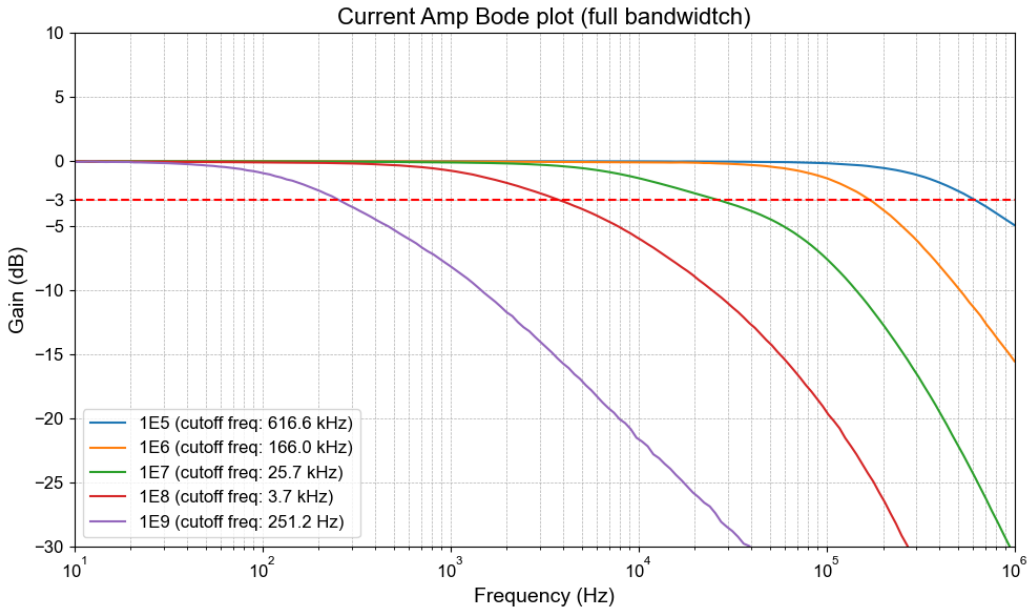


Figure 3. Bandwidth measurement results according to current-to-voltage conversion gain.

Figure 4 shows the measurement results of input bias voltage changes over time when the current-to-voltage conversion gain is set to 10^5 V/A. Since input bias voltage may fluctuate with temperature, the ambient temperature was maintained at 22 °C during this measurement. The temperature drift of input bias voltage is typically ±0.3 μV/°C, which represents a very stable level under normal operating conditions. This value represents typical characteristics, and while there may be some variation between individual devices, most cases exhibit smaller drift characteristics than this.

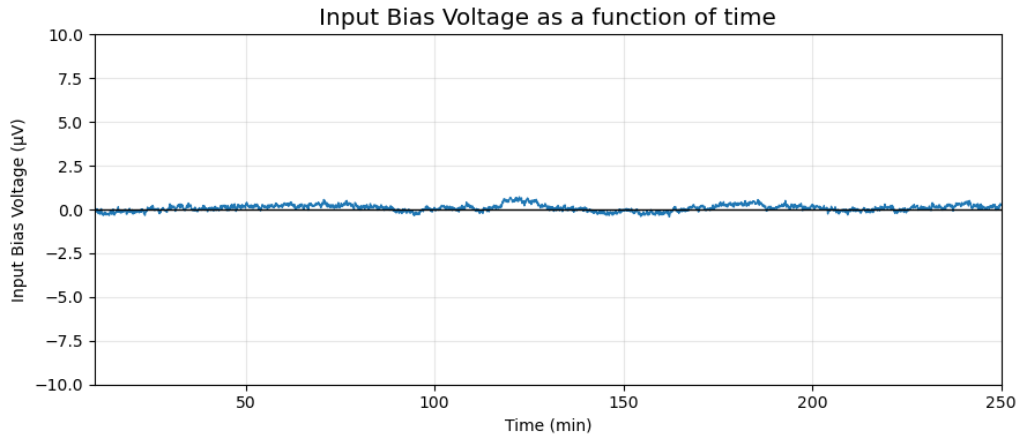


Figure 4. Input bias voltage changes over time.

3. Precautions

- All current-to-voltage converters are structurally very sensitive to static electricity. In particular, when high static electricity is applied to the input terminal, internal circuits may be damaged and cause malfunction. Therefore, users must take anti-static measures when handling the device and always protect the input terminal from static electricity. For example, when installing or connecting the device, it is recommended to wear an ESD wrist strap and work in an environment equipped with anti-static mats.
- For power supply, it is preferable to use the dedicated USB power supply included with the device. If it is unavoidable to use a different power supply, a reliable quality product must be used.
- If mechanical shock is applied to the product, internal components may be damaged and cause malfunction, so care must be taken to avoid shock during handling.

4. Product Configuration

QK-CA-100 Transimpedance Amplifier 1 ea.

USB power adaptor and cable 1 ea. each.

5. Service Inquiry

support@quantum-kelvin.com