

AMS220

Voltage Controlled Current Source with Active Common Mode Rejection



Features

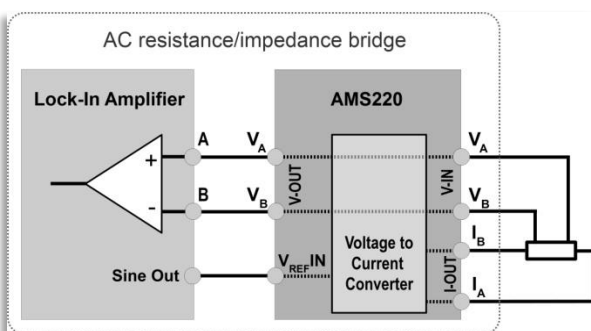
- ❑ Patented common mode rejection technology (U.S. #9,285,809, March 2016)
- ❑ Output current up to ± 50 mA
- ❑ Voltage-to-current conversion ranges from $1 \mu\text{A/V}$ to 10 mA/V
- ❑ ± 5 V control voltage input range
- ❑ Low-noise, all analog design
- ❑ Optimized for use with lock-in amplifiers

... for lock-in amplifier users performing very-low resistance measurements in the most demanding conditions

Targeted applications

- ❑ “Open architecture” AC resistance bridge when used with a lock-in amplifier
 - ✓ Very low resistance measurements *) down to mK temperatures, e.g.
 - Superconductivity research
 - Hall resistance measurements
 - ✓ Simultaneous resistance and Hall resistance measurements (with two lock-in amplifiers)
 - ✓ Higher harmonic detection (e.g. 2ω , 3ω) in resistance measurements
 - ✓ Thermometry/calorimetry
 - ✓ Mutual inductance measurements
- ❑ AC and DC electrical measurements with DAQ devices
- ❑ Replacement for floating current sources in resistance measurements

*) The use of the preamplifier AMS560 (Gain=1000) is recommended for measurements of micro- and nanovolt signals.



The AMS220 voltage controlled current source with active common mode rejection

...brings a unique possibility for researchers to perform low-level electrical measurements requiring precise current excitation at negligible level of common mode voltage. The AMS220 is preferentially designed for low resistance measurements using a lock-in amplifier. When using the AMS220 in combination with a high sensitivity lock-in amplifier, measurements of very low resistances (less than $1 \text{ m}\Omega$) become a routine even in the most demanding conditions (e.g. temperatures below 500 mK). Just specific combination of the lock-in technique (which enables very-low voltage measurements also in the background of significant disturbance signals, if common mode signal *at measuring frequency* is sufficiently low) and the unique, patented, architecture of the AMS220 (which ensures active rejection of common mode signals) opens new experimental possibilities, especially for researchers working in the field of superconductivity and electrical transport phenomena. Alternatively, the AMS220 can be also used in combination with DAQ devices in many types of DC or AC electrical measurements, where well defined current excitation of D.U.T. is required.

Building an “open architecture” AC resistance bridge

Connection of the AMS220 in the configuration replacing an AC resistance (impedance) bridge is schematically shown in the figure on the left. The functionality of the AC resistance bridge is obtained simply by interconnecting the reference voltage output (Sine Out) and voltage sensing inputs of a lock-in amplifier with the corresponding input and outputs of the AMS220, while the tested resistance is connected to the AMS220. The excitation current provided by the AMS220 is then proportional to the reference voltage provided by the lock-in amplifier and the selected voltage-to-current conversion factor of the AMS220.

Elimination of common mode errors in low-level resistance measurements

Benefits of the patented common mode voltage rejection technology of the AMS220 can be illustrated by the following example.

At measuring the test resistor of 0.1 mΩ resistance by use of the 10 mA_{RMS} current, the voltage across the test resistor is 0.1 mΩ x 10 mA_{RMS} = 1 μV_{RMS}. However, if one of the current leads is connected to the signal ground of the experimental setup and resistance of the corresponding current path is 20 Ω, for example, then the signals at the inputs of the used (grounded) voltage-sensing instrument will contain an AC component of 20 Ω x 10 mA_{RMS} = 200 mV_{RMS}. (Note that 200 mV_{RMS} is very much greater than the sensed voltage of 1 μV_{RMS} across the test resistor). The corresponding common mode voltage, defined as the average value of voltage potential at sensing inputs with respect to the signal ground will be 200.0005 mV_{RMS}. Considering an industry standard lock-in amplifier with common mode rejection (CMR) of ≈100 dB (i.e. with suppression of common mode voltage 10⁵ times, approximately), an estimated common mode error will be 200 mV_{RMS}/10⁵ = 2 μV_{RMS}. The result provided by the lock-in amplifier is always a sum of the voltage difference of the signals applied to its voltage-sensing inputs (1 μV_{RMS}) and common mode error (2 μV_{RMS}). Thus, the result provided by the lock-in amplifier in this case will be 3 μV_{RMS} instead of 1 μV_{RMS}! So, in this example, the “artificial” result is even 3-times greater than the real value!

If the AMS220 is used to excite the test resistance, the active common mode rejection circuit will suppress the common mode voltage typically to the level of few microvolts or less. Based on this fact it can be estimated that the common mode error for

instruments having the CMR = 100 dB (or greater) will not exceed tens of picovolts. Taking into account sensitivity limitations of industry standard lock-in amplifiers, it can be concluded that resistance measurements utilizing AMS220 are not affected by common mode errors. Note that the AMS220 is the only current source on the market possessing the (patented) active common mode rejection capability. However, where desired, the AMS220 can be used also with disabled active common mode rejection functionality, as a standard current source.

Related products

For especially sensitive applications, where sensed voltage on the measured resistance is extremely small, preamplifiers AMS560 and AMS540 are recommended to be used with the AMS220 current source. The preamplifiers are powered directly by the AMS220.

AMS560 preamplifier (Gain=1000) is intended for use to perform very low resistance measurements (with excitation currents greater than ≈50 μA). It can be also favourably used to perform sensitive measurements with DAQ devices not having millivolt ranges. Frequency range of the AMS560 is from DC to 200 Hz, thus covering the whole frequency range of the AMS220 operating in the active common mode rejection regime (ACTIVE CMR – ENABLED).

AMS540 preamplifier (Gain=100) is dedicated for use in applications requiring high input impedance of a voltage-sensing instrument (with a bias current of the inputs not exceeding tens of picoamperes). It can be also favourably used to perform sensitive measurements with DAQ devices not having millivolt ranges. The frequency range of the AMS 540 is from DC to 20 kHz.

Basic specifications	
Ranges of voltage-to-current conversion	0.001, 0.01, 0.1, 1, 10 [mA/V]
Control voltage input range	3.6 V _{RMS} / ±5 V _{DC}
Maximum AC _{RMS} /DC output current	36 mA _{RMS} / ±50 mA _{DC}
Targeted frequency range	DC - 200 Hz @ACTIVE CMR – ENABLED
	DC - 20 kHz (2 kHz for 1μA/V range) @ACTIVE CMR – DISABLED
Power	12 V (AC) / 0.6 A

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Specifications and descriptions provided in this document are subject to change without notice.