

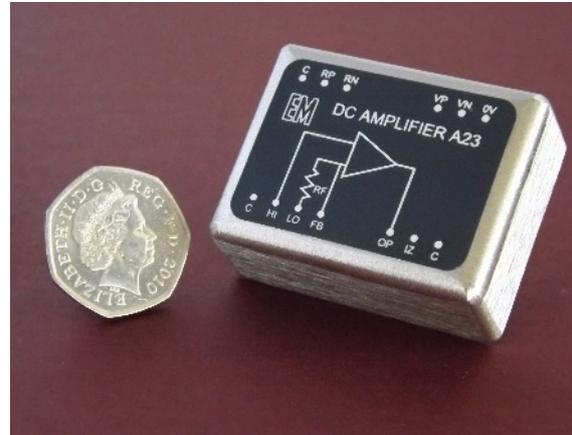
EM ELECTRONICS

DC NANOVOLT AMPLIFIER MODEL A23

The EM DC amplifier model A23 is a very low noise amplifier module, for sensitive DC measurements, data collection and systems, and is ideal for very sensitive temperature measurement using thermocouples. The noise level of the A23 is equivalent to a perfect resistor of about 25 ohms, thus giving sub nanovolt sensitivity with a response time constant of a few seconds. When used with normal type thermocouples for temperature measurement, sensitivities of around 20 micro Kelvin can be achieved. The input voltage drift is very low and is compatible with voltage sensitivities of around 1 nanovolt. The A23 has many other features desirable in a measurement amplifier. The very high loop voltage gain of around 100T, or 280dB, means that high overall gain may be used, controlled precisely by feedback resistors, thus ensuring good linearity, with the accuracy defined by the feedback resistors used. Despite the high gain, the model A23 is stable with 100% feedback, thus allowing feedback capacitors to be used to filter the output.

The input signal level can be up to plus or minus 2 milli-volts and the output can be up to plus and minus 3 volts.

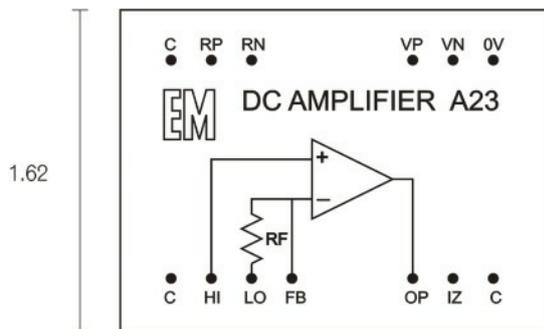
The response time of the A23 is fast, and the loop gain is reduced to unity at about 10 kHz, thus



ensuring good response times, even at relatively high gain settings.

The power supply requirement is low, being about 1.5 milli-amp quiescent with power supplies of plus and minus 6 volts, making it ideal for multi-channel measurement systems.

The A23 is designed to be mounted on a printed circuit board, using a 0.1" grid, with 13 pin connections on a dual in line rectangle 1.6" X 1.2", and is built into a heavy gauge mumetal case which gives it very good magnetic, electrostatic and thermal immunity from interference.



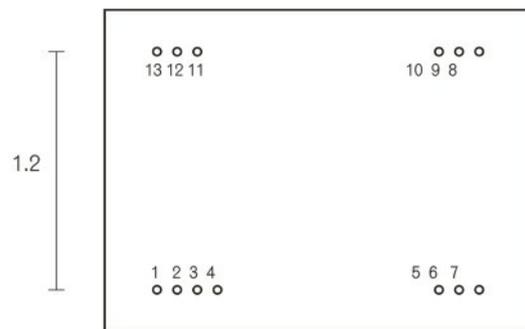
1.62

2.12

0.75

0.025

All Dimensions in Inches



1.2

0.1

1.6

A23 CONNECTIONS (Viewed from Top)

- 1 Case
- 2 Input High
- 3 Input Low
- 4 Feedback
- 5 Output
- 6 Current Zero
- 7 Case
- 8 Power Supply 0v
- 9 Power Supply Negative
- 10 Power Supply Positive
- 11 Internal Supply Negative
- 12 Internal Supply Positive
- 13 Case

ULTRA LOW LEVEL DC MEASUREMENTS

SPECIFICATION

DC NANOVOLT AMPLIFIER MODEL A23

Noise

Equivalent noise resistance less than 25 ohms. Peak to peak noise voltage depends on bandwidth selected e.g. rise time constant 1 second, peak to peak noise voltage is approximately 1.3 nano-volts with the rms. equivalent being about 300 pico-volts.

Offset Voltage

This is adjustable to zero by introducing a current into the feedback terminal. The internal feedback resistor is 1 ohm and so an offset current of plus and minus 100 nano-amps will give a voltage offset in the range of plus and minus 100 nano-volts.

This is easily achieved by connecting a 1 Megohm potentiometer across the internal supply, pins 11 and 12 and connecting a 100 M-ohm resistor from the wiper to the feedback connection, pin 4.

The temperature coefficient of offset voltage is typically 1 nV per deg C.

The initial, unbalanced offset voltage is typically plus or minus 50 nV.

Offset Current

This is adjustable to zero, in a similar manner to the offset voltage adjustment, but using a 10 Megohm resistor to pin 6. The temperature coefficient of offset current is typically 2 pA per degree C.

The initial, unbalanced offset current is typically plus or minus 100 pA.

Source Resistance

The A23 closely follows the Johnson noise characteristic from its equivalent noise resistance up to about 2 Kohm. Between 25 ohms and 2Kohm source resistance, the total noise is very little more than the noise from the source alone, i.e. the noise increases by about 10dB per decade. At source resistance above about 10K, the overall noise increases above the source noise by about 10dB per decade, giving an overall increase of noise of about 20dB per decade. At source resistance below 25 ohms, the noise voltage is constant down to zero ohms. 25 ohms is the amplifier equivalent noise resistance (enr).

Input Resistance

Greater than 1 Megohms, 1 second after an input step function, increasing with time to over 1 Gohm, with a set gain of 1,000.

Gain and Bandwidth

Open loop voltage gain 100T or 280dB. This gain is reduced to unity at 10KHz, at a rate of 30dB per decade. The amplifier is stable with 100% feedback. If a gain of 1000 is set by feedback components, the frequency at which the loop gain is reduced to unity is about 100Hz.

Input Level

The A23 will operate with input levels up to plus or minus 2mV.

Output Level

The A23 will provide an output level up to +/- 3 volts at DC and will deliver +/- 2 mA.

The output is limited at low gain settings by the maximum current which can be drawn from the amplifier.

The minimum gain for maximum output is 1500.

The A23 is normally used at higher gain settings in order to make the best use of its' noise performance and not be limited by the noise of the following device.

Feedback Components

There is an internal feedback resistor connected to the feedback terminal and internal ground, of 1 ohm +/- 0.5%, with a t.c. of 15ppm/degree C.

The gain is set by connecting an external resistor from 'Output' to 'Feedback'.

The value of this resistor is:

$R_{fb} = (\text{gain required} - 1) \text{ ohms.}$

Gain required = 1000, $R_{fb} = 999 \text{ ohms.}$

Connections

All connections to the A23 are made by printed circuit board pins, which are configured on a 0.1" grid, on a rectangle 1.6" X 1.2". The pcb mounting pin holes should be 1 mm diameter.

Power Supply

The A23 operates from supplies of +/- 5.5 volts to +/- 12 volts at 1.5 mA quiescent. Nominal Supply +/- 6 volts.

Dimensions

Length 2.12" (53.8mm)

Width 1.62" (41.1mm)

Height above board 0.75" (19mm)

Printed Circuit Board Pin Length 0.22" (5.5mm)

Connection Pin Size 0.025" (0.64mm) square.

Weight

5.2 ounces (149 gm)

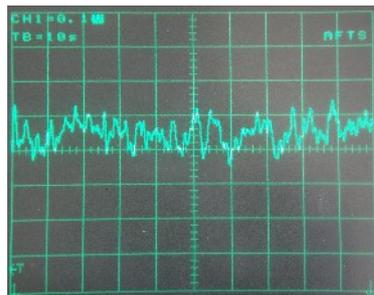
Note

A test pc board is available for mounting the A23, which includes a passive output filter and has the following facilities.

Voltage and current offset controls, powered from the internal regulated A23 supplies. Pins for input, direct and filtered outputs, power supply, and feedback connections.

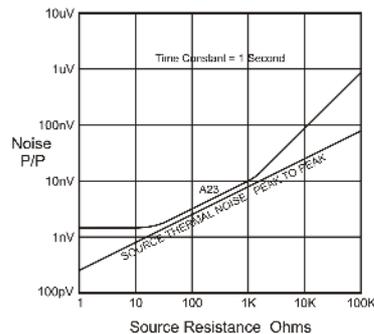
Board Size 3.5" (89mm) x 3" (76mm)

A23 Noise

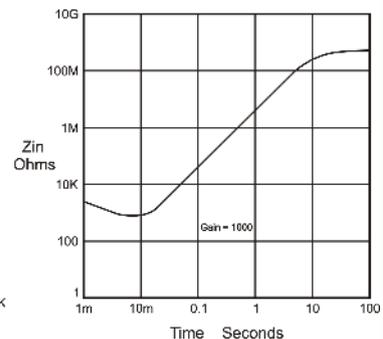


X = 10 Seconds per Div Y = 1nV per div

NOISE CHARACTERISTIC



INPUT IMPEDANCE CHARACTERISTIC



This data sheet is dated 18/04/2016 and is subject to change without prior notification