

Operation Manual for
SCUI Signal Conditioning Unit



Bartington®
Instruments

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1. About this Manual

This manual provides the information necessary to help customers operate the SCU1 Signal Conditioning Unit from Bartington Instruments. It should be read in conjunction with product brochure [DS2519](#), which can be found on the SCU1 product page on the Bartington Instruments website at: www.bartington.com.

1.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:



WARNING: Indicates a situation in which serious bodily injury or death could result if the warning is ignored.



Caution: Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.



Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

Note: Provides useful supporting information on how to make better use of your purchase.

2. Safe Use



WARNING: These products are not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.



WARNING: The SCU1 is powered by mains electricity. The unit **MUST** be earthed. The centre pin of the IEC inlet on the rear panel is internally connected to all the metal panels of the unit. Use the 3-core connecting cable supplied with the unit to ensure the unit is correctly earthed. Use of an alternative cable may render the unit unsafe.



WARNING: The IEC mains inlet socket must be fitted with two fuses of the type specified in the product brochure.



WARNING: This unit is not sealed against the ingress of water and must only be operated under dry conditions.

3. Compatible Magnetometers

The SCU1 is designed to be compatible with the sensors shown on the Product Compatibility page of the Bartington Instruments website at: www.bartington.com/product-compatibility.html.



Caution: Use of incompatible sensors may cause damage to the SCU1 and/or the sensor.

4. Introduction to the SCU1

4.1. Summary

The SCU1 Signal Conditioning Unit combines the functions of a power supply unit, an analogue signal conditioner and a display unit for use with compatible Bartington Instruments magnetometers.

The unit connects to a single three-axis magnetometer and enables the user to monitor the X, Y and Z magnetic field components via the following outputs:

- unconditioned analogue outputs (signals), direct from the magnetometer
- conditioned analogue signals (the magnetometer signals modified by the SCU1 analogue conditioning)
- digital display meters.

The SCU1 is suitable for use in many situations including:

- where analogue signals from the magnetometer require adjustment to match the input requirements of control electronics or of an analogue to digital (A-to-D) converter system
- as a three-axis magnetic field meter, giving a digital display of the X, Y and Z values from the magnetometer
- where both a digital display and analogue voltage signals are required.

4.2. Functional Description

4.2.1. Power

The SCU1 includes an integral power supply for the attached magnetometer.

4.2.2. Signal Conditioning

The SCU1 applies three stages of analogue processing, converting the unconditioned magnetometer outputs into the conditioned outputs.

- 1. Filtering:** Signals can be filtered (using low and high pass filters) to remove unwanted frequencies.
- 2. Offset:** In the second stage, a DC offset voltage can be added to or subtracted from the magnetometer output signal, producing a DC adjusted output.
- 3. Gain:** Finally, the DC adjusted output signal can be amplified by a variable gain stage, to produce the conditioned output signal.

Offset and gain are controlled independently for the X, Y and Z channels, but the filter settings are common to all three.

The conditioned output signals and the original magnetometer (unconditioned) output signals are available as analogue voltages from the SCU1. In addition, the DC components of each conditioned signal are displayed digitally on display meters.

5. SCU1 Inputs, Outputs and Controls

5.1. Back Panel Connections and Controls

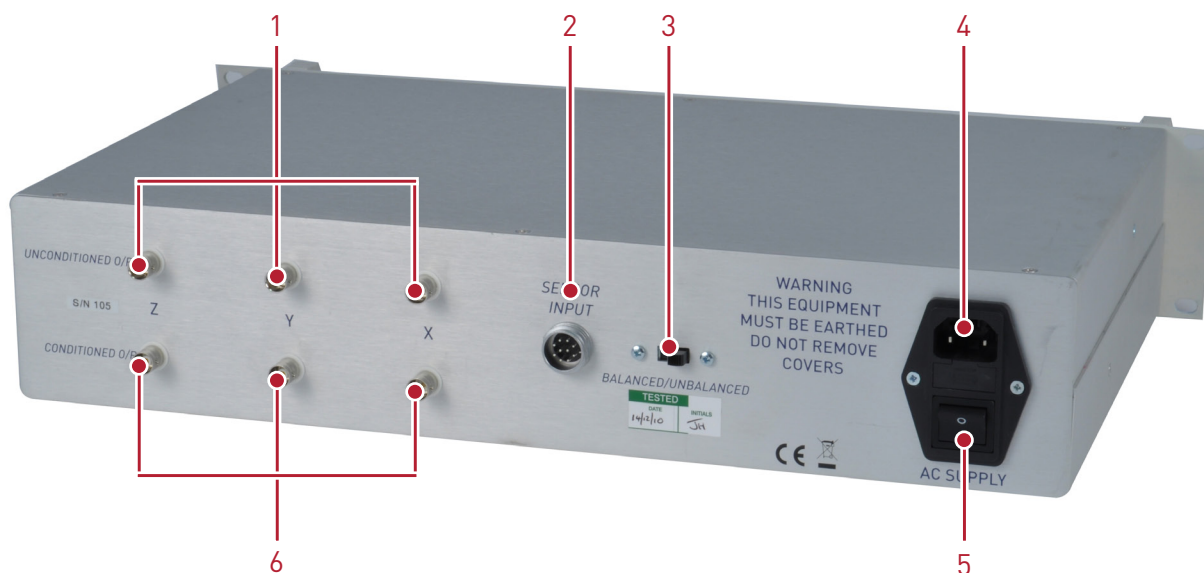


Figure 1. Back panel connections and controls.

Key to Figure 1

1. **Unconditioned Outputs.** These three BNC connectors provide buffered versions of the X, Y and Z output signals from the magnetometer. Signals are only valid when the SCU1 is switched ON. They are not affected by any of the other SCU1 controls.
2. **Magnetometer Socket.** This multi-pin socket is for the connection of the magnetometer cable.
3. **Magnetometer Output Type Selector Switch.** The SCU1 can be used with magnetometers that have unbalanced (single-ended) outputs or balanced (differential) output signals. This switch sets the SCU1 to operate in unbalanced or balanced mode.



Caution: This switch must be set to match your magnetometer output type (see [Magnetometer Output Type Selection](#)).

4. **IEC Mains Socket (Electrical Supply Input).** The unit requires an AC mains supply as specified in the product brochure via this IEC inlet socket.



WARNING: The socket includes a removable fuse carrier. The correct fuse types must be fitted. Refer to the product brochure for fuse details.

5. **ON/OFF Switch.** The IEC inlet socket includes this ON(1)/OFF(0) switch, to control power to the unit.

- 6. Conditioned Outputs.** These three BNC connectors carry the conditioned analogue output voltages. The conditioned outputs are the magnetometer X, Y and Z signals after they have been modified by the filter, gain and offset controls.

5.2. Front Panel Displays and Controls

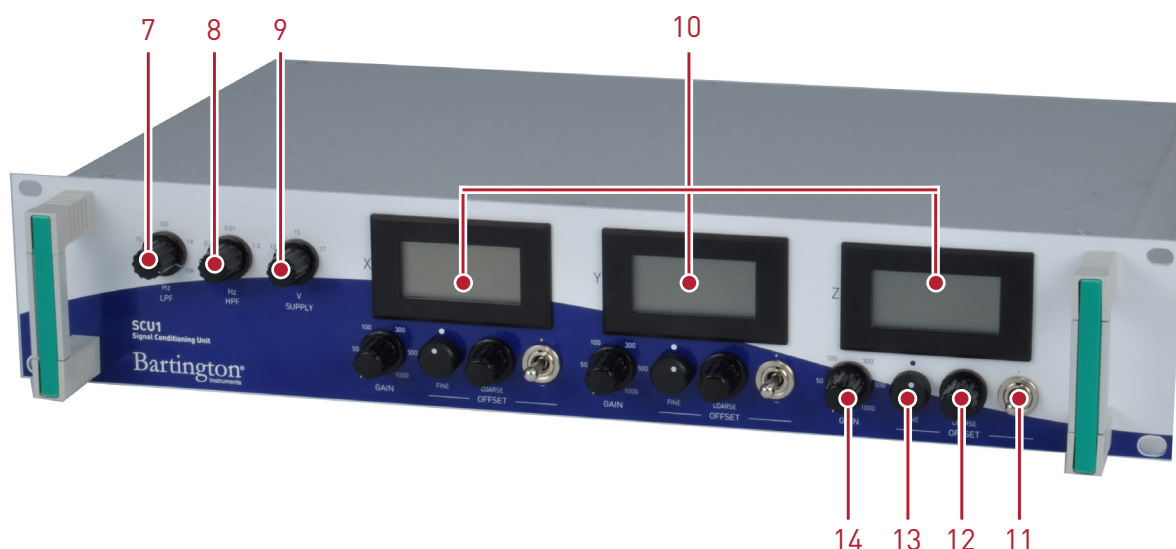


Figure 2. Front panel displays and controls.

Key to Figure 2

- 7. Low Pass Filter (LPF) Control.** The SCU1 applies low pass filtering to the magnetometer output signals. This control sets the -3dB point frequency for the LPF.
- Note:** The LPF cannot be completely disabled.
- 8. High Pass Filter (HPF) Control.** The SCU1 can apply high pass filtering to the magnetometer output signals. This control sets the -3dB point frequency for the HPF.
- 9. Magnetometer Supply Voltage Control.** This control sets the voltage that the SCU1 supplies to the magnetometer connector power pins. This enables the user to vary the voltage to compensate for cable voltage loss, ensuring the required voltage is present at the magnetometer. See [Magnetometer Supply Voltage](#) for guidance on matching voltage to cable length.
- 10. Display Panel Meters.** The conditioned output voltages for the three channels are displayed numerically on these 3½ digit meters. The meters display in volts and should only be used for low frequency signals. See [Display Panel Meters](#) for full details on how to use the meters.

11. Offset Switches (one for each channel). These 3-position switches control the polarity of the offset DC voltages applied to the magnetometer output signals (see Table 1 below). There is an individual switch for each of the X, Y and Z channels.

Switch Position	Polarity	Function
Centre	OFF	No offset
Up	+	Offset voltage is added
Down	-	Offset voltage is subtracted

Table 1. Offset switch functions.

12. Offset Coarse Controls (one for each channel).

13. Offset Fine Controls (one for each channel). These rotary controls set the offset DC voltages applied to each of the X, Y and Z channels. For guidance on use of the offset controls see [Offset Controls](#).

14. Gain Controls (one for each channel). These controls set the gain (amplification) that is applied to each of the X, Y and Z channels.

Note: The effect of the gain control is dependent on the offset voltage. See [Gain Controls](#) for guidance on use of the gain and offset facilities.

6. Installing the SCU1

6.1. Location of the Equipment

6.1.1. Environmental Precautions



WARNING: This equipment is powered by mains electricity. It should not be used in wet or damp locations, where water may enter the unit and create a safety hazard.

Refer to the product brochure for maximum environmental ratings for the SCU1.



Caution: Exceeding the maximum environmental ratings may cause irreparable damage to the equipment.

6.1.2. Mounting

The SCU1 can be used:

- free-standing, on a bench-top, or
- mounted in a 19" rack, using the integral side brackets.

6.1.3. Orientation

The SCU1 can be orientated horizontally or vertically.

6.1.4. Temperature

To minimise temperature induced drift effects, position the SCU1:

- in a constant ambient temperature
- out of direct sunlight.

6.1.5. Proximity to Other Equipment

The SCU1 contains no high frequency electronics likely to cause emissions which could cause interference with other equipment. The unit is unlikely to be affected by interference from other equipment in the normal operating environment.

Note: The sensors used with this unit, being designed to measure magnetic fields, are susceptible to electromagnetic interference. Avoid operation close to high frequency sources of radiation. Interference is indicated by instability in the reading when the sensor is maintained in a fixed position.

6.2. Connecting the Equipment

Connect the equipment using the following sequence:

1. Connect the magnetometer to the SCU1 magnetometer socket. Ensure the connector pins are correctly aligned with those in the socket. The locking ring should be hand-tightened only.
2. If your system will use the SCU1 analogue outputs, connect the conditioned and/or unconditioned BNC outputs to your external equipment, as required.
3. Ensure the IEC socket mains switch (Figure 1, item 5) is OFF (position 0). Connect your mains supply cable to the IEC socket. The unit will operate with a mains supply in the range specified in the product brochure. Range selection is automatic within the unit.

6.3. Initial Settings

6.3.1. Magnetometer Supply Voltage

Before switching the equipment ON, set the appropriate voltage for your magnetometer, using the front panel control (Figure 2, item 9).

For all Mag648 and Mag-03RC magnetometers, use the 12V setting.

For Mag-03MC, MS and IE magnetometers, the voltage setting should be used to compensate for any voltage loss in the magnetometer cable. Refer to individual sensor brochures to select the correct setting for your cable length (see the Mag-03 product brochure DS0013, available from the Bartington Instruments website, for recommended cable types).

6.3.2. Magnetometer Output Type Selection

Before switching on the equipment, set the magnetometer output type selector switch (Figure 1, item 3) to the correct position for your magnetometer: see Table 2. See individual sensor data sheets for those not mentioned in this table.

Magnetometer	Output Type
Mag-03MS	Unbalanced
Mag-03MC	Unbalanced
Mag-03IE	Unbalanced
Mag-03RC	Balanced
Mag648	Balanced

Table 2. Magnetometer output types.

7. Using the SCU1

7.1. Output Scaling

7.1.1. Converting Output Voltage to Magnetic Units

The conditioned output voltage at the output connectors is displayed on the panel meters and can be converted into magnetic field strength units (e.g. Tesla). The conversion will depend on the range of your magnetometer, analogue output voltage, and scale factor of your magnetometer.

Scale factor = range / analogue output of magnetometer. For example:

- a magnetometer with a range of 250 μ T and an analogue output of ± 10 V has a scale factor of 25
- a magnetometer with a range of 60 μ T and an analogue output of ± 3 V has a scale factor of 20.

To convert voltage to field strength:

1. Divide the output voltage by the gain control setting, then
2. Multiply by the scale factor for your magnetometer.

For example, if the display for the X axis shows 6.5V when connected to a magnetometer with a range of 250 μ T and an analogue output of ± 10 V, with SCU1 gain = 50, this indicates an X axis field of:

$$(6.5/50) \times (250/10) = 3.25\mu\text{T}$$

7.2. Over-range Condition

The SCU1 conditioned output and display meter readings are only accurate when in the range -10V to +10V. Readings beyond -10 to +10V are considered over-range as they will not be to the specification accuracy.

Note: Use the offset and gain controls, as described in [Using the SCU1 Controls](#), to ensure the conditioned outputs do not go over-range.

7.3. Switching ON and OFF



Caution: Connect the magnetometer before switching on the SCU1, as connecting a live cable to the magnetometer may cause damage. Similarly, switch off the SCU1 before disconnecting the magnetometer.



Caution: The SCU1 should be switched on and off using the IEC socket switch (Figure 1, item 4) ("0" = OFF, "1" = ON).

Note: For best results, after switching ON, leave the SCU1 for 10 minutes for the internal temperature to stabilise, before performing any measurements.

7.4. Using the SCU1 Controls

7.4.1. Offset Controls

The offset controls apply a DC offset value to the magnetometer output voltage, to generate a DC adjusted signal voltage. This resulting voltage will be amplified by the gain controls, to form the final SCU1 conditioned output signal.

The offset voltage range limits are -10 to +10V.

The offset control includes a coarse adjust, to set an approximate level, and a fine adjust to achieve the exact offset level desired. A polarity switch selects whether the offset is added to or subtracted from the magnetometer output, or set to OFF (zero offset).

Offset is generally used where an AC magnetic field being investigated is superimposed on a background static (DC) field. The DC signal can be eliminated from the SCU1 conditioned output by applying offset. The conditioned output will then contain only the AC signal, which can be investigated at high resolution by using gain (amplification).

Example: to remove the background DC field from the X channel:

1. Set the X channel gain to 1, and the HPF to DC.
2. Set the X channel offset polarity switch to the centre position (no offset).
3. If the X channel meter shows a + reading, set the offset polarity to -; if meter shows -, set offset polarity to +.
4. Adjust the offset controls until the meter reading decreases to zero.

7.4.2. Gain Controls

The gain controls apply amplification to the DC adjusted signals from the offset stage, to generate the SCU1 conditioned analogue outputs.

Gain is a simple multiplication of the signal, so a gain of 300 will, for example, convert a 1mV signal into a 300mV signal at the output. Gain can be set to 1, 50, 100, 300, 500 or 1000, independently for the three channels.

Note: Excessive gain will result in the SCU1 output becoming over-range. When applying gain, start with gain = 1 and increment the control until you find the maximum setting that does not cause the over-range condition.

Note: Both AC and DC components of the adjusted magnetometer signals are amplified by the gain. If a signal contains a large DC component, gain may cause the output to go over-range. To prevent this, the DC component can be removed using the offset controls.

In general, gain is used to improve measurement resolution of small signals, usually when studying AC fields or very slow changes to a background DC field. In these situations, any DC signal present would normally be removed by using offset. This allows the level of gain to be set as high as possible, without the output becoming over-range.

7.4.3. Low Pass Filter (LPF)

The LPF attenuates high frequencies above the -3dB setting, reducing their amplitude in the SCU1 conditioned outputs. The LPF is intended to be used for removal of unwanted frequencies present in the magnetic field being measured.

The LPF -3dB frequencies settings are 1, 10, 100, 1000 and 10000Hz.

The LPF cannot be completely disabled. If LPF is not required, use the 10000Hz setting to ensure the maximum signal bandwidth is available.

7.4.4. High Pass Filter (HPF)

The HPF implements AC coupling of the magnetometer input signals, attenuating low frequency signals below the HPF -3dB setting. The HPF is intended for the removal of DC and very slowly changing signals.

The HPF -3dB frequencies settings are 0.01Hz, 1Hz, and OFF.

Use OFF when HPF (AC coupling) is not required.

Note: When using the 0.01Hz setting, allow sufficient time (up to 1 minute) for the filter to settle. Momentary selection of the 1Hz setting will shorten the settling time.

Note: The offset control can be used at the same time as using high pass filtering, but it is not normally required. It is recommended that the offset control be switched to the OFF position when using the HPF.

7.5. Using the SCU1 Outputs and Displays

7.5.1. Unconditioned and Conditioned Outputs

The SCU1 analogue outputs should be used when both the AC and DC content of the signals need to be measured (e.g. with an oscilloscope, meter or an A-to-D system) or when a voltage output is required for connection, for example, to a feedback or control system.

Note: The **unconditioned** outputs should be used if access to the direct analogue output signals from the magnetometer is required.

Note: The **conditioned** outputs should be used to access the magnetometer output signals after the application of filtering, offset and gain by the SCU1.

Consult the product brochure for maximum load.

To convert the analogue voltage level into units of magnetic field at the magnetometer, refer to [Converting Output Voltage to Magnetic Units](#).

7.5.2. Display Panel Meters

The panel meters give a continuous digital display of the conditioned output voltage.

The meter readings are in volts. To convert the analogue voltage level into units of magnetic field at the magnetometer, refer to [Converting Output Voltage to Magnetic Units](#).

Note: The meters are updated at 3 readings per second and hence will only indicate the DC component (strictly, frequencies below 1Hz) present in the conditioned output voltage.

8. Troubleshooting

The SCU1 is unlikely to suffer any defects in normal use: no internal components are serviceable. The most likely causes of failure, and their solutions, are detailed in the following table.

In the event of any apparent malfunction beyond those described in the table below, please email service@bartington.com, or telephone the Bartington Instruments service team on +44 (0)1993 706565.

Fault	Possible cause	Solution
Panel meters are off	Power fault	Check SCU1 is connected to a mains supply.
		Check the ON/OFF switch position.
		Check the fuse in the IEC socket (see Fuses).
Conditioned output shows an unexpected DC level, or is “stuck” at a large + or - value	High pass filter, offset or gain control settings could be affecting the signal	Ensure that the HPF is set to 0 (OFF).
		Check that the relevant offset control is OFF.
		If offset must be used, check the polarity is correct.
		Ensure the signal is not over-range due to excessive gain.
		Ensure you account for any gain applied in your conversion of voltage to magnetic units.
AC signals are distorted or clipped	Gain is too high	Switch to a lower gain setting.
Magnetometer is unusually hot	Power supply voltage is too high	Lower the voltage supply to the magnetometer.

9. Care and Maintenance

The SCU1 requires no routine maintenance. The only user serviceable parts are the fuses in the IEC mains inlet socket.

9.1. Fuses

To change a blown fuse, ensure the mains supply is disconnected, then extract the fuse block from the IEC socket with a blunt tool (e.g. flat-bladed screwdriver). Extract and replace the blown fuse. Replace the fuse block.



WARNING: Fuses fitted must be of the type specified in the product brochure.

9.2. Calibration

Return the SCU1 to Bartington Instruments for calibration at the recommended intervals. Refer to the Calibration Certificate for further details.

9.3. Cleaning



WARNING: Disconnect the electrical supply before performing any cleaning operation.

Periodic cleaning is not normally required.

If the system becomes soiled and cleaning is necessary:

1. Use a damp cloth to clean the outer surfaces.
2. Use an air duster to blow debris from the connectors.



WARNING: Ensure water does not enter the system. The system must be completely dry before the electrical supply is reconnected.



Caution: Never use chemicals, such as solvents, when cleaning the SCU1.



Caution: Take particular care when cleaning around electrical connections. Bent or damaged pins may cause the magnetometer to malfunction.

10. End of Life Disposal



This product (electrical and electronic equipment) should not be placed in municipal waste.
Check local regulations for disposal of electronic products.

Notes



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