

Megger[®]

S1-568, S1-1068

**5 kV, 10 kV High Performance DC
Insulation Resistance Testers**

USER MANUAL



SAFETY WARNINGS

Safety warnings must be observed during use:

- The circuit under test **must** be switched off, de-energised, isolated and checked to be safe before insulation test connections are made. Make sure the circuit is not reenergised whilst the instrument is connected.
- Only Megger supplied test leads rated for this instrument **must** be used.
- Circuit terminals **must not** be touched during an insulation test or when the test LED is flashing to indicate a hazardous condition on the measurement circuit, before suitable grounding of the unit under test is in place in line with safe working practices.
- After completing a test, capacitive circuits **must** be completely discharged before disconnecting the test leads. Capacitive charges can be lethal.
- Tested items **must** be firmly shorted out with a shorting link, after discharge, until required for use. This is to guard against any stored dielectric absorption charge subsequently being released thereby raising the voltage to potentially dangerous levels.
- The voltage indicator and automatic discharge features **must** be regarded as additional safety features and not a substitute for normal safe working practice.
- It is rare, but in certain circumstances, breakdown of the circuit under test may cause the instrument to terminate the test in an uncontrolled manner, possibly causing a loss of display while the circuit remains energised. In this event, the unit must be turned off and the circuit discharged manually.
- Test leads, including crocodile clips, **must** be in good order, clean and with no broken or cracked insulation.
- The instrument **must not** be used if any part of it is damaged.
- Insulation testing in wet conditions might be hazardous. It is recommended that this instrument is not used in these circumstances. If this is unavoidable, the user **must** take all necessary precautions.
- This instrument is not intrinsically safe and **must not** be used in hazardous atmospheres.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

- A test can be started at any time via remote control. Measurement connections must be handled only with the remote control indicator beacon removed from its socket.
- In the event of the instrument failing in remote control mode the test must be stopped manually by pressing the TEST button.
- Switch the instrument OFF, and **disconnect** the mains supply, measurement leads, and all other equipment before opening the case to change the battery. The instrument **must not** be operated with the case open. DANGER! Hazardous voltages are exposed with the mains connected and the case open.
- If performing a two-wire test without guard using the S1-1068, insert the blue safety plug.











BATTERY WARNINGS

- Do not disassemble or modify the battery. The battery contains safety and protection devices which, if damaged, may cause the battery to generate heat, rupture or ignite.
- Never heat the battery in a fire or otherwise.
- Do not pierce or damage the battery in any way
- Do not subject the battery to strong impacts/shocks.
- Do not expose the battery to water, salt water or allow the battery to get wet.
- Never short circuit, reverse polarity or disassemble the battery pack.
- In the event of a battery cell leaking, do not allow the liquid to come into contact with the skin or eyes. If contact has been made, wash the affected area with copious amounts water and seek medical advice.
- Keep cells and batteries out of reach of children
- Seek medical advice if a cell or battery has been swallowed.
- Do not leave a battery on prolonged charge when not in use.
- Retain the original product literature for future reference.

NB: THE INSTRUMENT MUST ONLY BE OPERATED BY SUITABLY TRAINED AND COMPETENT PERSONS

Users of this equipment and/or their employers are reminded that National Health and Safety Legislation requires them to carry out valid risk assessments of all electrical work so as to identify potential sources of electrical danger and risk of electrical injury such as inadvertent short circuits.

Symbols Used on the Instrument

-  Caution: refer to user manual
-  Caution: risk of electric shock
-  Equipment protected throughout by Double Insulation.
-  Line Power / mains
-  Equipment complies with current EU directives.
- N13117**
-  Equipment complies with current “C tick” requirements.
- 
 Do not dispose of in the normal waste stream.
-  Earth
-  Universal Serial Bus (USB)

CAT IV 600 V

Overvoltage category IV (equipment installed at or near the origin of the electrical supply to a building)

600 V refers to the rms phase-to-earth voltage that instruments can withstand to the overvoltage category IV rating.

WEEE Directive

The crossed out wheeled bin symbol on the instrument and on the batteries is a reminder not to dispose of them with general waste at the end of their life.

Megger is registered in the UK as a Producer of Electrical and Electronic equipment. The registration no is; WEE/HE0146QT.

Users of Megger products in the UK may dispose of them at the end of their useful life by contacting B2B Compliance at www.b2bcompliance.org.uk or by telephone on 01691 676124. Users of Megger products in other parts of the EU should contact their local Megger company or distributor.

Battery Disposal

Batteries in this product are classified as Industrial Batteries under the Batteries Directive. Please contact Megger Ltd for instructions on the safe disposal of these batteries.

For disposal of batteries in other parts of the EU contact your local distributor.

Megger is registered in the UK as a producer of batteries. The registration number is BPRN00142.

For Further information see www.megger.com

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General Description

Megger's new utility focused S1 range of Insulation Resistance Testers (IRT) are smaller and lighter than previous models, yet offer advanced features; remote control, improved battery life, rapid charge capability, filter options and extended noise rejection. In addition, all S1 models have USB cable and Bluetooth® interfaces.

The range consists of two models; one 5 kV, one 10 kV. Resistance measurement capability is up to 15 TΩ for the 5 kV models and 35TΩ for the 10 kV model.

A key productivity feature is the ability to operate with a discharged battery when an AC source is connected. An intelligent battery charger ensures the optimum charge rate as a function of battery level, resulting in extended battery life and minimum charge times.

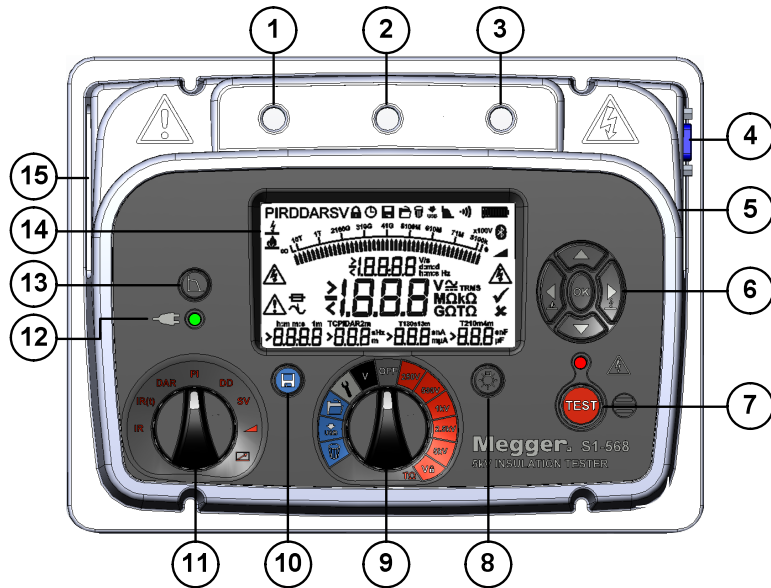
The tough case provides ultimate protection for a portable instrument and a clip-on lead pouch ensures that supplied test leads remain with the instrument at all times. The case lid is removable for improved lead access. Case closed IP rating is IP65. High reliability is built into the dual case design and models are safety rated to CATIV 600 V.

The S1-568 and S1-1068 can be powered from an AC source or by internal rechargeable battery, which provides for 4½ to 6 hours of continuous testing (100 MΩ load), depending on model. A battery level indicator on the LCD display indicates battery capacity. Connecting power to an AC source will automatically charge the battery whether the instrument is switched on or off, except during an insulation test.

Features

- S1-568 measures up to 15TΩ and S1-1068 up to 35 TΩ
- 8 mA noise rejection plus 4 filter options ensure highest quality resistance measurements
- All models support diagnostic and over voltage tests - PI, DAR, DD, SV and ramp test
- Remote Control (RC) mode via USB cable
- Bluetooth® link for live streaming data to PC and downloading saved results
- Rapid charge Li-ion battery pack
- Operate and charge battery from AC source (except during test)
- Safety rating : CATIV 600 V
- Advanced memory with time/date stamp
- DC and AC voltmeter (30 V to 660 V)
- Large display with backlight
- Download of saved results to PowerDB Lite– USB or Bluetooth®

Instrument Controls and Indicators



1. Positive (+) terminal
2. GUARD terminal
3. Negative (-) terminal
4. 9-pin remote control socket
5. USB device interface
6. Navigation/OK buttons and select burn/breakdown
7. TEST button with associated HV warning lamp
8. Backlight button
9. Range rotary switch
10. Save button
11. Test mode rotary switch
12. LED indicating line power / mains
13. Filter button
14. Display
15. Power socket



	User lock voltage		Delete records
	Timer		Download via USB
	Save		Filter
	Open records		Alarm
	Battery		Breakdown mode
	Ramp test		Burn mode
	Danger HV		Refer to manual
	Fuse		Noise detected
	Bluetooth®		

Preparations for Use

Initial instructions

- Remove instrument, power lead and pouch from the packing box.
- Clip the test lead pouch to the lid.
- Open the lid and familiarise yourself with the layout and position of the IEC 60320 power inlet on the left side of the panel. An isolated USB socket and a 9 pin D-type connector for the remote control indicator beacon are found on the right side of the instrument. Test terminals are located to the rear of the front panel.
- Unpack test leads and place them into the lead pouch.
- Read the product manual, **especially the warnings**.
- A quick reference is provided in the instrument lid.
- Keep the original packaging for re-use.

Power lead and battery charging

- If the power lead supplied is not suitable for your AC connection, do not use an adaptor. Always use a power lead fitted with the correct plug. The ground connection is only connected for EMC filtering purposes and the primary supply is double insulated.
- Do not use an inadequately rated AC lead.
- If using a fused plug, ensure that it is fitted with a 3A fuse.
- Supply voltage: 90 to 265 V rms ac at 50/60 Hz.
- A green LED illuminates when line power/mains is present.
- The battery will charge over its operating temperature range as long as an AC source is connected, except when a test is in progress.

- For optimum battery life, charge the battery after each use. Full charge duration is up to 2½ hours but a first charge time of 3 hours is advised.
- The battery must be charged between 0 °C and 40 °C ambient temperature. If the battery detects a temperature outside this range the battery symbol will flash.

Power lead connection table

Connection	UK/International	USA
Earth/Ground	Yellow/Green	Green
Neutral	Blue	White
Live (Line)	Brown	Black

Functional verification

Simply turning on the instrument at the central rotary switch will initiate a start-up process and the display will respond. If an error is detected 'Err' will be displayed with an associated error number.

Calibration

The S1-568 and S1-1068 are supplied with a calibration certificate. UKAS accredited calibration certificates are available from Megger.

Storage

Instruments should be stored in storerooms which meet the storage temperature and humidity specifications listed in this document.

Operating Instructions

General operation

The S1-568 and S1-1068 insulation resistance testers (IRTs) are primarily controlled by two rotary switches and a TEST button used to start and stop a test (see section entitled, “Instrument Control and Indicators”).

The range rotary switch includes an ‘OFF’ position; the instrument switches on by rotating the switch either clockwise or anticlockwise from this position. A range of test voltages for insulation resistance tests up to 5 kV (S1-568) and 10 kV (S1-1068) are available, including a user selectable voltage range which can be set between 40 V and 5000V or 10000 V depending on the model. The ‘lockable’ test voltage range (V_Ⓛ) can be adjusted within the settings function.

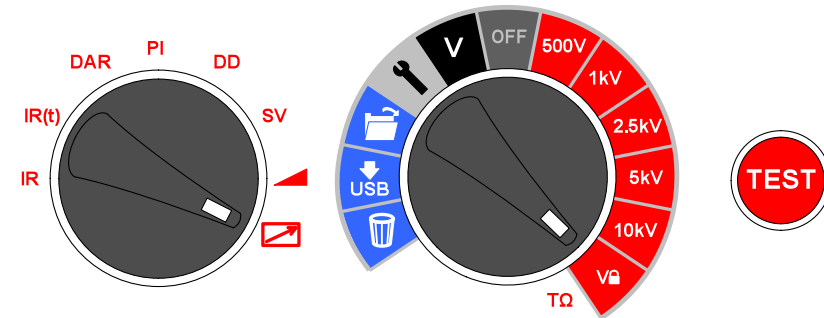
With the central rotary switch pointing at the spanner symbol and mode switch at IR, the settings for lock voltage, low resistance alarm, temperature / humidity and time/date are able to be changed and set.

A light blue coloured section of the rotary switch denotes memory functions; open records, download via USB or Bluetooth® and delete records. A dedicated save button is provided and all models have a backlight button.

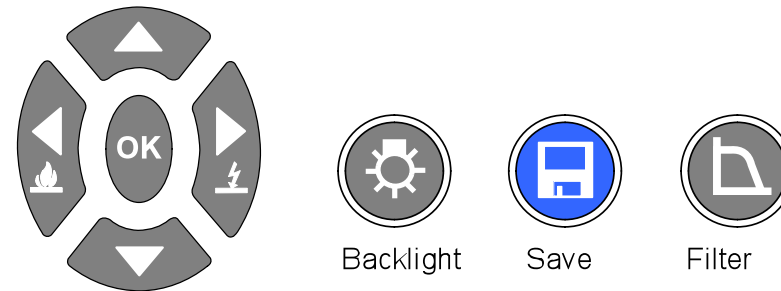
The mode rotary switch controls the insulation test type:

- Basic insulation resistance IR, timed insulation resistance IR(t), Dielectric Absorption Ratio (DAR), Polarisation Index (PI) and Dielectric Discharge (DD).
- Overvoltage tests Step Voltage (SV) and ramp test.
- Remote control mode (☑ + V_Ⓛ) test selection; start and stop of a test and other functions are set by a computer via a USB cable.

A cluster of directional buttons and an OK button are used in settings and memory functions. The up/down arrows also enable the test voltage to be adjusted during IR and IR(t) tests. Prior to the start of an IR or IR(t) test, holding down the left arrow button with a voltage level selected on the central rotary switch will activate burn mode. Burn mode is deactivated if the voltage range or mode is changed or by pressing the right arrow/breakdown button.



Instrument controls are simple to operate. The central rotary switch incorporates the OFF position. The left hand rotary switch selects insulation test type. The TEST button starts and stops a test. Image depicts instrument setup for Remote Control mode.



Four arrow buttons + OK facilitate adjustment and selection of settings, voltages and modes. Breakdown/burn modes are set using the left and right arrow buttons. Backlight, Save and Filter functions are dedicated buttons.

Breakdown vs. burn mode

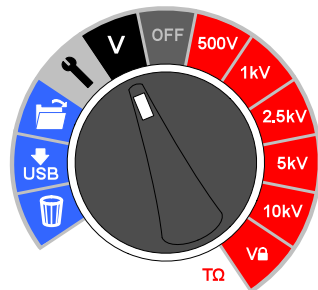
In breakdown mode insulation tests are automatically stopped when a fault causes the applied voltage to drop rapidly. Burn mode IR tests ignore breakdown and continue to test the insulation and are therefore destructive tests. Burn mode is used to purposely create a carbon track in insulation to facilitate fault location.

To enable measurements (IR, IR(t) modes) in very high noise substations, breakdown mode is turned off automatically when noise current exceeds 3.5 mA. Both breakdown and burn icons are switched off and the breakdown detector is disabled. High noise above 3.5 mA can appear to the instrument like a breakdown which would halt an IR/IR(t) test. Burn mode is not affected by the 3.5 mA limit.

To test for high noise select the voltmeter function and read the voltage. A high voltage will indicate a high noise environment.

Voltmeter

A voltmeter is incorporated in the instrument and measures AC/DC voltage from 30 V to 660 V. Frequency (Hz) is measured and displayed for AC voltages.



The voltmeter function can be checked by removing all leads from the instrument, starting any test and confirming that the voltage shows on the display.

The voltmeter is a useful aid as it automatically indicates a voltage prior to a test if there is induced voltage present and after stopping a test when residual voltage is displayed until the insulation is discharged. If the voltage is above 50 V at the start of

an insulation test, a voltage is displayed on the analogue and digital readouts to alert the user.

Positive and negative terminals are used for the voltmeter function; do not connect the GUARD terminal when in voltmeter (V) mode.

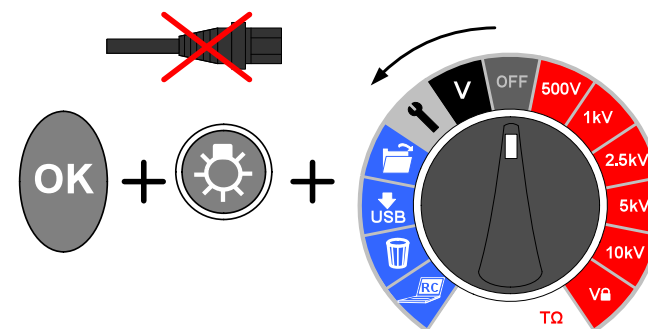
In *exceptionally high electrical noise environments* a lock-out activates when induced currents exceed the capability of the instrument to remain within specified accuracies. The voltmeter reports the voltage across the internal discharge resistor, i.e. the actual voltage across the positive and negative terminals.

During a test, the voltage during discharge of a reactive load will be displayed in addition to warning symbols. Non reactive loads will discharge too rapidly to show the voltage drop.

In the unlikely event of a fault during a test or during the discharge process, the user is advised to check for the flashing high voltage warning symbol on the display and a flashing red LED on the instrument panel. After the warning symbols and LED no longer flash, switch off the instrument before disconnection.

Reset Default Settings

Remove AC source, press OK, backlight buttons and switch main rotary switch from OFF to setting icon.

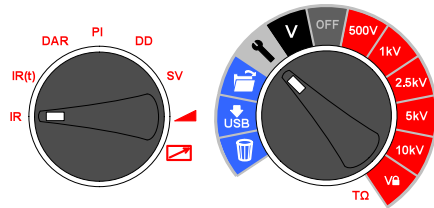


Instrument Control

Initial setup

It is important to setup the Real Time Clock (RTC) on S1-568 and S1-1068 to ensure that records saved in the instrument are time/date stamped correctly. The RTC has a separate battery to maintain settings even when the primary battery is removed.

To set the clock and date, select the settings function (spanner) on the central rotary switch and turn the mode rotary switch to IR. Navigate using the left/right arrows to where the time and date is displayed.



Set the time using the up and down arrows. Change the hours and minutes then press OK to save.



Select the day/month format required, i.e. d:m for day:month or m:d for month:day and press the right arrow button, then set the date and press OK to save.



A tick on the left of the display indicates that a setting is saved, a cross is displayed during adjustment indicates that it is not set. Exit settings by changing the central rotary switch to a different position.

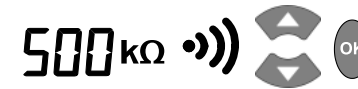
Lock Voltage

The user selectable 'lock' voltage range is set by adjusting the displayed voltage using the up and down arrow buttons. When the desired voltage is displayed it is saved by pressing the OK

button. The setting does not change even if the instrument is switched off.

Alarm setting

A low resistance alarm can be set to sound when the resistance of an insulator reaches this limit. The default alarm setting is 500 k Ω and *inactive* (x is displayed on the right of the display). Set range and mode switches to the settings and IR positions respectively. Press the right arrow button once. The low resistance alarm can be set at the default value by simply pressing the OK button, or changed to a different alarm resistance level using the up/down arrow buttons and save it by pressing OK.

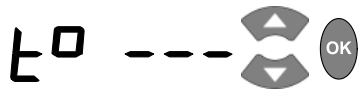


Recording temperature, humidity

The S1-568 and S1-1068 are able to record insulation temperature and humidity measured by *independent* sensors. If you do not wish to record either temperature or humidity do not change the default setting or reset it if it was previously set. If temperature entry is enabled the humidity entry can be selected.

Move the central rotary switch to point to settings and press the right/left arrow buttons until 't° ---' is displayed. The default setting is no temperature record. This can be changed by pressing up or down arrows to select either °F or °C temperature entry. Pressing OK will confirm the settings. If humidity is to be recorded it is necessary to set the temperature and humidity before pressing OK to save them with a test result. Humidity will either be set "On") or not set ("---").

When prompted for temperature or temperature and humidity they can be entered using the up - down arrows. Temperature is entered in 1 degree steps, humidity is entered in 1% steps. The up and down arrows adjust the selected value, the OK button accepts the displayed value and advances to entering humidity if temperature is currently being entered.



Temperature and humidity setting and is entered as follows:



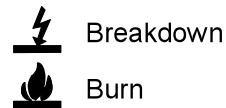
Temperature and relative humidity are entered together:

1. At the **t°** --- prompt change the setting even if it shows the setting you require
2. Set **t°** to setting you require, it will flash, then press left arrow key again, do *not* press OK.
3. Enter **rH** setting **On** and press OK to confirm both temperature and relative humidity readings will be recorded.

It is not possible to enter only a relative humidity reading as it is meaningless without temperature.

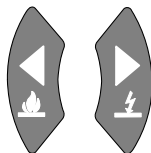
Breakdown / burn mode – in IR & IR(t) test modes

The insulation resistance 'IR' test operates in either 'Breakdown' or 'Burn' mode.



Default mode is *breakdown*.

Left and right arrow buttons toggle between burn and breakdown mode when a voltage range is selected. In the breakdown mode the breakdown icon will be indicated.



In breakdown mode the test will automatically terminate on detection of a breakdown to prevent damage to the insulation.

Burn mode disables the normal breakdown detection and test voltage continues after breakdown of the insulation. This enables the location of a failure to be detected but it is a destructive test.

Due to the potential damage that could occur, the unit produces two long beeps when starting a test with burn mode activated.

Running an insulation test

Before testing any reactive load ensure that the insulation is fully discharged.

The required resistance test is selected on the test mode rotary switch at the bottom left of the instrument keypad. The test voltage is selected using the preconfigured voltage ranges on the central rotary switch or the V_{set} user settable/lockable voltage range.


It is possible to adjust the test voltage using the up and down arrow buttons, either before or during an IR and IR(t) test. Once a test has begun, it is advisable to only adjust the voltage in the first 10s of the test to prevent interference with the capacitive and absorptive currents in the insulator.

A test is started by pressing and holding down the TEST button for approximately 3 seconds. A timer will be displayed to indicate elapsed time during the test. The test is stopped by pressing the TEST button. As soon as the test is stopped a discharge of the insulator is automatically initiated and the display indicates a voltage if present on the insulator.




Do not disconnect instrument leads or clamps until the LED and display warnings are switched off indicating that the unit under test is discharged! Significant current can be stored in reactive loads which act as capacitors or inductors, which can be lethal.

The display shows the final resistance result, capacitance, test current and time constant (TC) in addition to test duration.

On all S1 models the result can be saved by pressing the dedicated save () button after a resistance test is complete. The save icon will appear momentarily to confirm the data is saved. If a full test curve is required the user must select logging by pressing the save button *before starting the test*. In this case, data will be logged every 5 seconds for the duration of a resistance test. It is not possible to log voltages in voltmeter mode.

If temperature entry has been activated a prompt will appear for the user to enter a temperature reading after IR and IR(t) insulation tests. If relative humidity has been activated the user should enter a humidity reading. DAR, PI, SV, Ramp and DD tests will *not* prompt for temperature or humidity input.

Display backlight is activated by pressing the () button. The backlight button can be pressed a second time to deactivate the backlight. Automatic deactivation will occur after a pre-set timeout period if not deactivated manually.

Filter button and settings

All S1 models have a dedicated filter button which can be set before or after starting an IR test .



The filter has four settings; 10 s, 30 s, 100s, 200s. It is also possible to turn off the hardware filter to speed up the response when there is no noise present. If a one minute spot test is to be performed a suitable filter would be 10 s or possibly 30 s

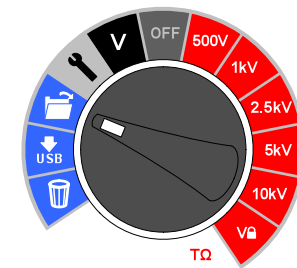
activated towards the end of the test. Setting a longer filter would be meaningless because the test only lasts 60 s. The S1 range memorises all results in the current test to be able to give an instantaneous meaningful filtered reading of results as long as the duration of test is longer than the filter length.

Memory functions, downloading and remote control

All S1 models have advanced storage, recall and download functions to facilitate documentation of insulation tests. Download is enabled via a USB cable or Bluetooth® connection.

Recall results

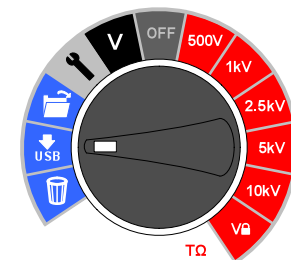
Setting the central rotary switch to 'open folder' position enables the user to recall saved results beginning with the most recent result. Up and down arrow buttons enable the user to scroll through results based on a sequential four digit index. Left and right arrow buttons scroll through a single result showing all saved test data including time/date. Where logging has been enabled, only the final result is displayed on screen. The full result can be viewed by downloading to PowerDB/PowerDB Lite.



In saved results, the test mode is identified by the icon or abbreviation of each test on the display. In addition, the open folder icon is displayed to indicate recall memory mode.

Download results

Downloading data function is selected by switching to the 'download via USB' icon on the central rotary switch. Before starting a download a USB PC-to-device cable must be connected between a PC and the USB port on the instrument, or alternatively a Bluetooth® connection setup to a suitably enabled PC or similar device.



PowerDB Pro, Advanced and Lite are Megger's asset and data management software packages with integrated forms for the S1 range of instruments. Ensure that the applicable version of PowerDB is loaded and running on the PC, then select the appropriate S1 by model number.

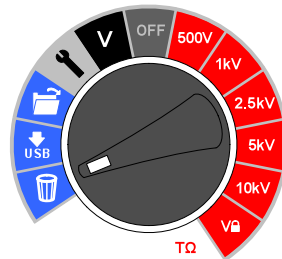
Check the product CD provided with the instrument for a folder named, "Megger USB." If this folder exists, use it when starting PowerDB for the first time to find the S1 driver, if not allow the operating system to search the internet for the driver.

When using the USB cable, check the serial port allocation on Device Manager, and enter the serial port allocated when starting PowerDB.

PowerDB offers instructions specific to the S1 range regarding the download procedure. When results are downloaded the IRT can be disconnected from the PC/Bluetooth® device after the application releases the port.

Deleting results

There are two delete functions; delete a single result and delete all results. Select the bin icon on the central rotary switch. The first record indicated contains the result of the last test performed. Up/down arrows navigate through records and the OK button is used to select delete where the 'X' changes to a tick and the on screen bin icon flashes. A subsequent press of the OK button activates the deletion.



Real-time output during insulation tests

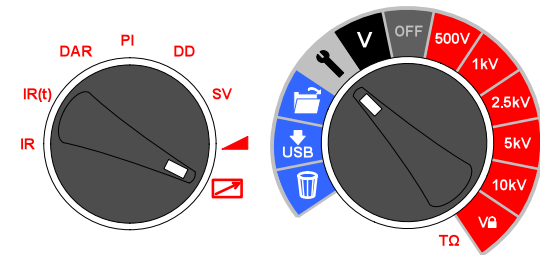
PowerDB can be used to record real time data output from the S1 range. Voltage, current and resistance data is sent at a rate 1 Hz from the IRT and displayed in real time on a graph, e.g. a plot of current (µA) versus voltage (kV) for the ramp test.

Before running a test where a real time output is required, attach a PC running PowerDB Pro, PowerDB Advanced or PowerDB Lite via a USB cable or Bluetooth® link.

Start the application and activate real time data capture in the form of choice. As soon as the test is started real time data output will begin. When the test is complete ensure that the form is saved in PowerDB Pro/Advanced/Lite.

Bluetooth® interface activation

The Bluetooth® interface is set with the main rotary switch pointing to setting and the mode switch pointing at the remote control icon.



To connect a PC or other intelligent device, enable the Bluetooth® on the S1 and the PC. Let the PC find the S1, its serial number will be part of the identifier and default passcode for connection is '0000'. Create a connection to the S1 and check the link works by connecting directly to the S1. It is also possible to check the Bluetooth® link using a terminal emulator.

PowerDB Lite running on a PC can be used to connect to the S1 units via Bluetooth®. Port allocations can be found in Windows Device Manager.

Battery indicator

The battery symbol on the LCD display contains four pairs of segments. The battery is monitored continuously when the instrument is turned on. The charge remaining in the battery is indicated by segment pairs as follows:

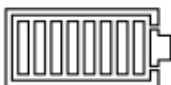
Fully charged battery



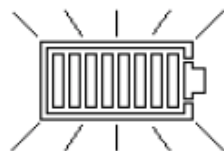
50% charged battery



Tests cannot be started, insufficient charge



Symbol flashes when there is not enough charge for a test and the instrument will turn itself off.



When mains power is present the indicator shows the battery is being charged by animating the segments of the bar graph.

A blinking full battery icon indicates that the battery is prevented from charging due to the temperature being out of the allowable charge temperature range, 0 °C to 40 °C, or that the battery has failed.

On screen error reporting

Should an error be detected during the operation of the S1 instrument, an error code is reported preceded by 'Err' with the 'read handbook warning'.

Error codes are given in the following table.

'Err' code	Fault
2	Output voltage over limit
3	FIFO (memory) overflow
4	HV board mismatch with control board setup
5	Battery low error
6	Control board detected inter-board communication failure
7	Test button stuck
8	Measurement board i2c failed
9	Measurement board detected inter-board communication failure
10	Isolation supply feedback fault
11	Instrument attempted auto power off but failed

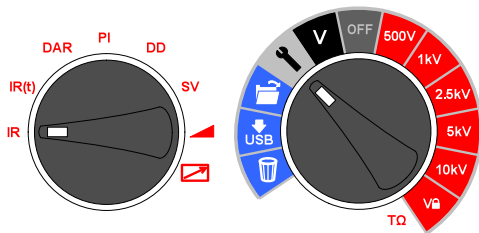
If an error occurs do not attempt to repair the instrument. Obtain a repair number from Megger Instruments Limited, carefully pack in a suitable box and send the faulty instrument to the nearest Megger Approved Service Centre, if possible noting the error that was reported.

Measurement Modes

'Spot' IR test

The spot insulation resistance test (IR) is selected on the test mode rotary switch. Select the IR setting and then the required test voltage using the preconfigured voltage ranges on the central rotary switch or the V_{lock} user settable/lockable voltage range. All preconfigured voltage ranges, but not V_{lock} , are adjustable using up and down arrow buttons before and during the test, but their use should be limited to the first 10 seconds of IR or IR(t) test. Press and hold TEST for up to three seconds to start the test.

To set the user defined lock voltage V_{lock} , turn the central rotary switch to settings and the mode switch to IR. The preset voltage will flash and can be changed using the up/down buttons. When the required maximum voltage is displayed, press the OK button to save the setting. This setting will remain until it is reset.



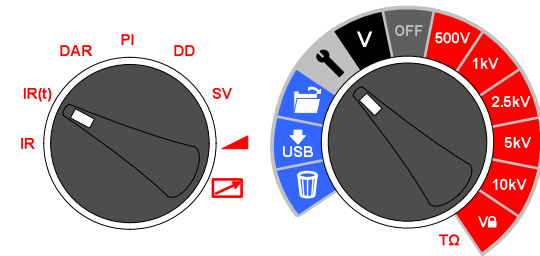
Whenever V_{lock} is selected the set voltage is shown on the display. The voltage lock is useful when, for example, testing insulation of XLPE cables that should not be tested above 5000 V. The lock function will ensure it does not exceed the V_{lock} voltage within the stated output voltage accuracy.

On test completion, insulation capacitance (C) and Time Constant (TC) associated with it is calculated and displayed.

$$\text{Time Constant (TC)} = R_{\text{insulation}} \times C_{\text{insulation}}$$

Timed IR test

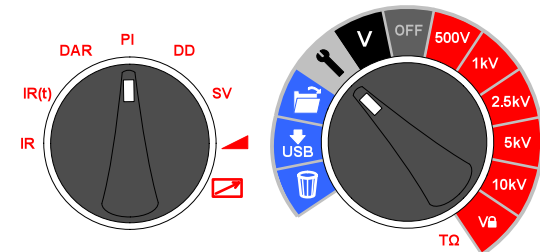
A timed test IR(t) will automatically terminate an insulation test after a preset time. Default timer is set to 1 minute and is adjustable within the settings function. This is a useful feature which saves the user watching the display for the full duration of the test and the possibility of missing the 1 minute reading.



Turn the central rotary switch to the settings position. Select IR(t) on the test mode rotary switch. The default time of 1:00 minute will flash prompting the user to select a new time using the up/down arrow buttons. Press OK to set test duration and turn central rotary switch to desired test voltage. Press and hold TEST to start the test.

DAR and PI Insulation Tests

DAR and PI tests are measurements of resistance over time expressed as a ratio of resistance at time t2 divided by resistance at time t1. The assumption is that insulation temperature does not vary widely over the duration of the test so the resulting DAR and/or PI value are temperature independent. Testing should be done at or below 40 °C, 104 °F for this assumption to hold.



DAR and PI timers t1 and t2 are set when DAR or PI is selected on the test mode rotary switch with the central rotary switch in the settings position. Timer t1 is set first followed by t2. Up and down arrow buttons are used to change the t1 and t2 default values and OK confirms each setting.

DAR and PI insulation test voltages are selected on the central rotary switch by simply aligning the switch opposite to the required insulation test voltage. Press and hold TEST to start a DAR/PI test.

DAR is defined as the ratio of insulation resistance at 1 minute divided by insulation resistance at 30 seconds, although a 1 minute, 15 second DAR is also popular:

$$DAR = IR_{60s} / IR_{30s}$$

Insulation Condition	DAR result
Poor	< 1
Acceptable	1 – 1.4
Excellent	1.4 – 1.6

IEEE standard 43-2000, Recommended Practice for Testing Insulation Resistance for Rotating Machines, defines PI as the ratio of insulation resistance at 10 minutes divided by insulation resistance at 1 minute:

$$PI = IR_{10min} / IR_{1min}$$

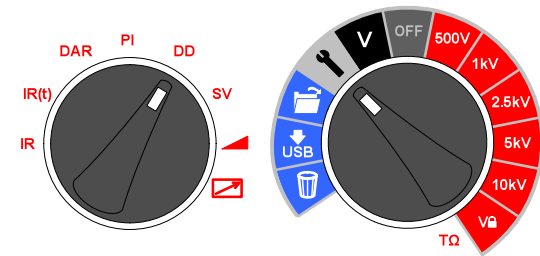
If $IR_{1min} > 5000 \text{ M}\Omega$ the PI may or *may* not be an indication of insulation condition and is therefore not recommended by IEEE std. 43.

Insulation Condition	PI result
Poor	< 1
Questionable	1 - 2
Acceptable	2 - 4
Good	> 4

PI results > 1.5 are regarded as acceptable by IEC60085:- 01:1984 for thermal class rating A, and PI results > 2.0 for thermal class ratings B, F and H.

Dielectric Discharge test

The Dielectric Discharge (DD) or *reabsorption current* test operates during the discharge of the dielectric under test. Originally developed by EDF, France's power utility company, it is a diagnostic insulation test that allows ageing, deterioration, and voids in the insulation to be assessed. The result is dependent on the discharge characteristic which tests the internal condition of the insulation and is largely independent of surface contamination.



The insulator must be charged until the only remaining component of current is leakage current. On discharge the capacitive component of the discharge current decays from a high value with a relatively short time constant of a few seconds. The released reabsorption current decays from a lower value with but has relatively long time constant of up to several minutes.

The DD timer (t1) defaults to 30 minutes of charge, which is generally sufficient time for full absorption to take place in an insulation material. The default test voltage is set to 500 V so the primary rotary switch must be set at 500 V. The discharge timer (t2) defaults to 1 minute. Timer settings t1 and t2 are adjustable.

DD should be selected on the test mode rotary switch and settings on the central rotary switch.

The 'DD' test requires the instrument to measure the discharge current 1 minute after the removal of the test voltage. On completion of the test, the instrument uses the current, the test voltage and calculated capacitance to produce a figure of merit indicating the quality of the insulation.

$$DD = I_{1min}/(V \times C)$$

where I_{1min} is the discharge current in mA one minute after removal of the test voltage V in Volts and C is the capacitance in Farads.

Homogenous insulation will have a DD value of 0, while good multi-layer insulation will have a value up to 2. The following table is a guide to DD test results:

Insulation Condition	DD result
Bad	> 7
Poor	4 - 7
Questionable	2 - 4
Good	< 2
Homogenous	0

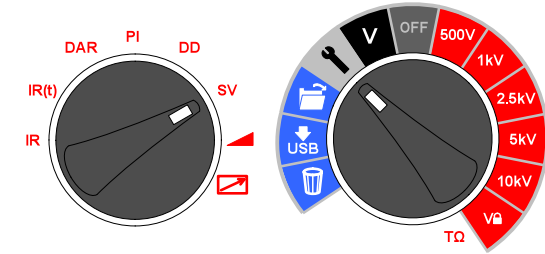
Step Voltage Test

The SV test is a controlled overvoltage test that can be applied to stator and rotor windings on synchronous and asynchronous AC motors and the armature and field windings on DC motors. It is advisable to perform a PI test before an SV test to determine if the insulation is suitable for overvoltage testing. If a PI test was performed to verify the winding's suitability for overvoltage testing, the winding must be completely discharged before an overvoltage test is performed.

The SV test is based on the principle that an ideal insulator will produce identical readings at all voltages, while an insulator which is being over stressed, will show lower insulation values at higher voltages.

The SV test is selected using SV mode switch position and any voltage range including $V_{\hat{}}$ range setting. If no custom SV test has been setup then a standard five step test will be performed where each step is $1/5^{\text{th}}$ of the test voltage.

A custom SV can be created with up to 10 steps. To activate this test press the right arrow from within the timer setup for the standard 5-step SV test. Rotary switch selection indicated:



For a regular 5 step SV test, resistance readings for the first four 'steps' are displayed under consecutive time designators '1m' to '4m'. The 5 minute reading is displayed by the main display.

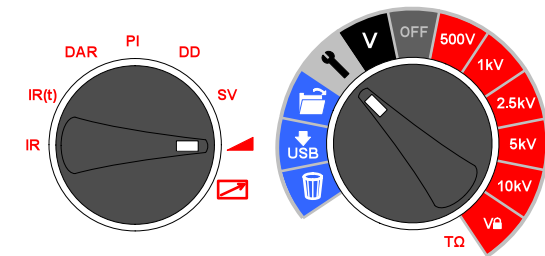
The standard SV test duration can be adjusted if desired from the 5 minute default value using the up/down arrows and OK to save the setting. If the default 5 minute test duration is changed by the user the four readings will not show the respective '1m' to '4m' indicators. The step timer will always be set to total test time divided by the number of steps selected by the user. Too short a step time may result in incorrect readings and too long a step time may over stress a motor.

The reference standard for step voltage testing is IEEE 95-2002.

Ramp voltage test

The ramp voltage test is an overvoltage test similar to the SV test but with many very small steps. The slow continuous voltage ramp is less likely to result in unpredictable damage to the insulation than the rapid step increases employed in SV test.

The typical voltage ramp (dV/dt) is 1 kV/min which is the default for S1 range. This value is user adjustable from the settings function with the mode rotary



switch set to ramp. Up and down buttons are used to adjust dV/dt to the required rate and OK confirms the setting. Press and hold TEST to start.


The test will ramp the voltage until it reaches the selected test voltage unless a breakdown or sudden fall in voltage is detected. The result displayed after the test is the final insulation resistance, voltage and current. If the result is saved a complete curve of current (μA) and voltage (kV) is recorded and can be read into PowerDB, PowerDB Lite or converted to a spreadsheet so that the current vs. voltage curves can be compared to published curves in IEEE 95-2002.

Remote control mode

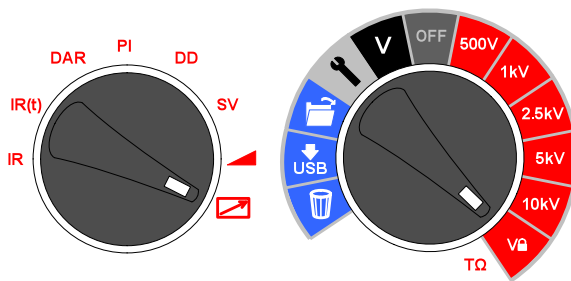
Remote control of the S1 range is possible on all models via USB cable only and the Bluetooth® link is disabled.

The remote control indicator must be attached to the right side of the instrument.

Coloured lights in the dongle indicate remote control status. When the indicator is lit green it means that remote control is activated and when red that the instrument is not in remote control mode.

Remote control mode is activated with the test mode switch pointed at the remote control icon  and the main rotary switch pointed at V_{Ω} .

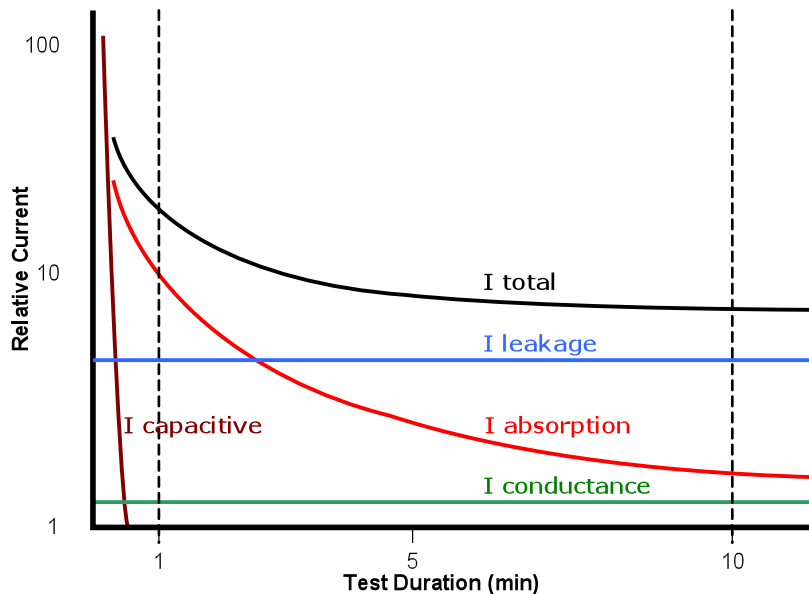
All manual test modes can be setup, tests started and stopped remotely.



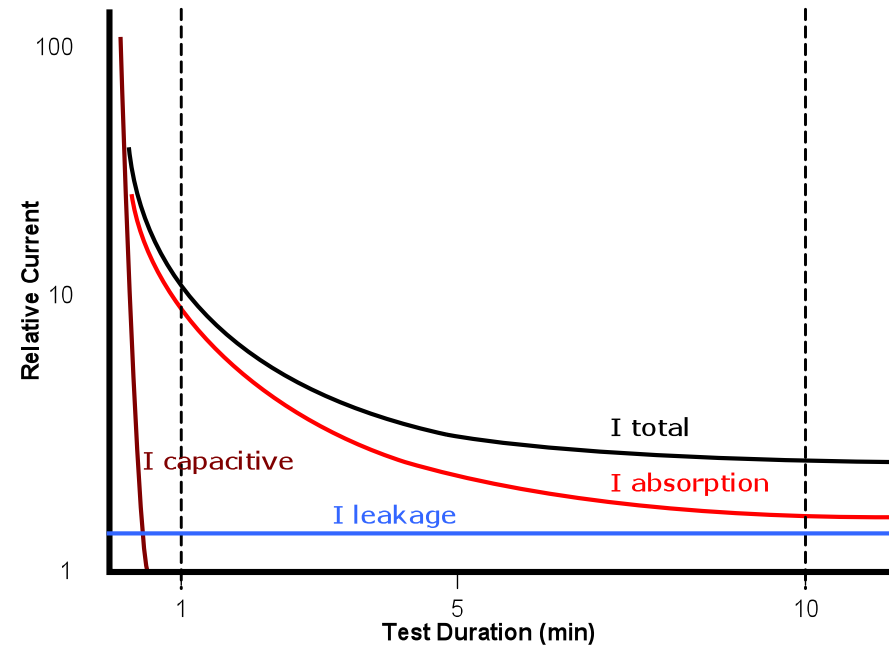
Measurement Techniques

Understanding Measurement Currents

Insulation resistance is defined as the dc test voltage divided by the total current flowing in an insulator. The total current has four components; capacitive current, absorption current, conductance current and leakage current. If a generator has wet or contaminated windings conductance current will be present.



In the case of dry insulation conductance current may be negligible, and the leakage current may be low, in which case the absorption current will dominate the total current measured.



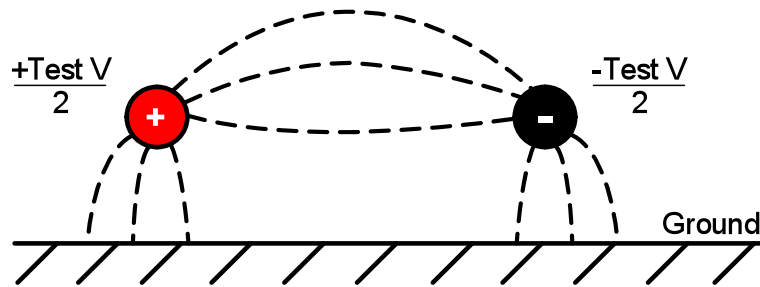
Insulation measurements above 100 GΩ

Measurements up to 100 GΩ can be made without any special precautions, assuming that the test leads are reasonably clean and dry. The guard lead can be used to remove the effects of surface leakage if necessary. When measuring resistances above 100 GΩ, the test leads should not be allowed to touch each other, or any other object since this will introduce leakage paths. Sharp points at the test lead connections should also be avoided since this will encourage corona discharge.

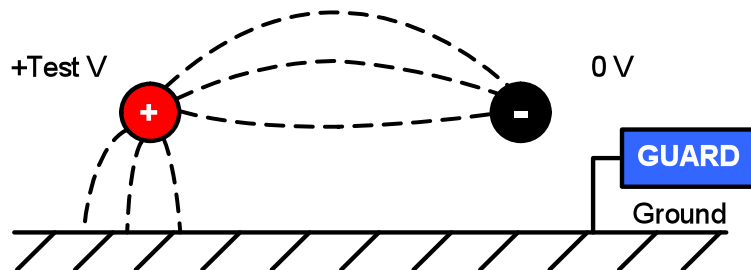
The output is isolated, and so will float relative to ground such that the positive terminal is at plus half of the test voltage, and the

negative terminal is at minus half of the test voltage with respect to ground.

Leakages therefore occur between the positive terminal and ground, between the negative terminal and ground, and directly between the positive and negative terminals. These leakages have a significant effect and can occur through air.



If the guard lead is grounded, and since the negative terminal is at the same voltage as the guard terminal, the leakage into the negative terminal will be considerably reduced. This will improve accuracy because the current flowing into the negative terminal is measured by the instrument and used to calculate resistance. This technique is only permissible if the item under test is isolated from ground. In this context *isolated* means insulated by a resistance of at least 5 MΩ for the positive terminal, or at least 10



kΩ for the negative terminal.

Conversely, if the positive terminal is grounded, then the negative terminal will be at a voltage equal to the test voltage relative to

ground, which will result in an increase in leakage current, and worsening of measurement accuracy.

When making measurements above 100 GΩ therefore, the user should ground the Guard lead where possible otherwise parallel leakage paths may occur.

Alternatively, screened leads are available as an optional accessory from Megger. When using a screened lead the screen is plugged into the Guard terminal, diverting any leakage currents. This considerably improves measurements made with a floating output, where the leads might touch each other or another object other than the test piece.

Terminals

There are three test terminals marked +, - and GUARD. These terminals are designed to accept only genuine Megger test leads. Shutters across the terminals prevent accidental ingress of dirt and other objects. Test lead plugs interlock with the shutters and are released by rotating the test lead plug by a quarter turn.

The GUARD terminal, as explained below, is only used in cases where surface leakage currents need to be eliminated. Most measurements use just the + and - terminals. The instrument's internal voltage generator drives the + terminal with respect to the - terminal, current being measured in the - terminal.

GUARD terminal, screened leads

For basic insulation tests and where there is *little possibility of surface leakage affecting the measurement* it is unnecessary to use the guard terminal, i.e. if the insulator is clean and there are unlikely to be any adverse current paths.

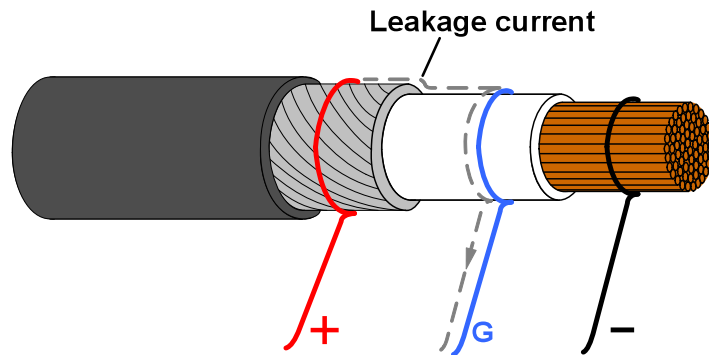
However in cable testing for example, there may be surface leakage paths across the insulation between the bare cable and the external sheathing due to the presence of moisture or dirt. Where it is required to remove the effect of this leakage, particularly at high

testing voltages, a bare wire may be bound tightly around the insulation and connected via the third test lead to the guard terminal 'G'.

The guard terminal is at the same potential as the negative terminal. Since the leakage resistance is effectively in parallel with the resistance to be measured, the use of the guard causes the current flowing through surface leakage to be diverted from the measuring circuit. The instrument therefore reads the leakage of the insulator, ignoring leakage across its surface.

The display will show a warning and fuse terminal symbol if the internal guard terminal fuse has blown. The instrument must be switched off to clear the message before further testing is permitted. The fuse must be replaced by an authorised repairer. The instrument may be used in the meantime if the guard terminal not used. Refer to notes regarding measurements above 100 GΩ above.

currents are an issue. The screen connects to GUARD and prevents induced currents in the lead.



This diagram illustrates GUARD terminal used to prevent surface leakage on cable insulation from affecting a high resistance measurement.

Screened leads are available for the complete range of insulation testers. They are useful in HV switchyards where induced

Preventive Maintenance

Cleaning

Disconnect the instrument and wipe it with a clean cloth *slightly* dampened with soapy water or Isopropyl alcohol (IPA). Care should be taken near the terminals, IEC power and USB sockets.

Care of the instrument

The instrument should always be handled with care and not dropped. Always ensure that the instrument is secured when being transported to prevent mechanical shock.

Leads

Leads are silicone insulated and perform well in all weather conditions. Always keep the leads in the clip-on lead pouch supplied with the instrument.

Regular inspection of leads is recommended to ensure they are not damaged in any way. Damaged leads could affect insulation resistance readings and are a safety hazard.

Battery Care

The battery should be charged on a routine basis at an absolute minimum of once a year. However more regular charging, i.e. once per quarter is preferable.

Never attempt to charge the battery below 0 °C or above +40 °C. The battery is charged by connecting line power at the instrument IEC power socket.

Store the instrument in a cool, dry location to improve battery life. Storage temperatures below freezing should be avoided.

Replacing the battery

Read and fully understand the warnings on the Li-ion battery in the Safety Warnings section of this document.

Switch the instrument OFF, and disconnect the mains supply, measurement leads, and all other equipment before opening the case to change the battery. The instrument must not be operated with the case open. **DANGER!** Hazardous voltages are exposed with the mains connected and the case open.

The battery pack contains Lithium-ion cells and should be replaced when it no longer holds a charge. A new battery is available as a spare part from Megger. **Genuine Megger battery packs must be used. Failure to use genuine parts may affect product safety performance and will invalidate your warranty.**

Replacement involves removal of four screws from the bottom of the instrument after which the base can be lifted away from the front panel and internal moulded assembly. Care should be taken to keep the front panel and moulding assembly together. The battery pack is housed within a grey moulded cover secured by four screws.

S1-568, S1-1068 battery replacement instructions:

1. Remove the lid and invert the lower case resting the front panel on a soft surface so as not to damage the keypad.
2. Remove the four case fixing screws and lift off case bottom.
3. Carefully unclip the battery cable connector leading from the main printed circuit board to the battery and remove the cables from recesses designed to hold them in place.
4. Remove the four screws and lift off the battery cover.
5. Remove the used battery and replace with a genuine spare battery ordered from Megger, ensuring correct orientation of cable exit.
6. Route the battery cables via the recesses and clip the battery connector to the printed circuit board battery receptacle **ensuring correct orientation.**

7. Replace the battery cover and secure with the four screws.
8. Ensure the alignment of the instrument panel and high voltage moulding, then replace the lower case and secure with the retaining screws.
9. Check and verify instrument operation.

Technical Specification

Electrical specifications

AC Voltage

input range: 90-264 V rms 47 – 63 Hz

Battery: 11.1 V, 5.2 Ah meets IEC 62133:2003

Battery life

S1-586: 6 hours (typical) continuous testing at 5 kV with a 100 MΩ load

S1-1068: 4.5 hours (typical) continuous testing at 10 kV with a 100 MΩ load

30 min. chg: 1 hour operation at 5 kV, 100 MΩ

Test voltages: 1000 V, 2500 V, 5000 V, 10000 V, V_U

Lock test: 40 V to 1 kV in 10 V steps, 1 kV to 5 kV in 25 V steps, 5 kV to 10 kV in 25 V steps

Test voltage

accuracy: +4%, -0%, ±10 V nominal test voltage at 1GΩ load (0 °C to 30 °C)

Resistance range: 10 kΩ to 15 TΩ (5 kV)
10 kΩ to 35 TΩ (10 kV)

Accuracy (23 °C):

S1-568 **5000 V** **2500 V** **1000 V** **500 V** **250 V**

±5% to 1 TΩ 500 GΩ 200 GΩ 100 GΩ 50 GΩ

±20% to 10 TΩ 5 TΩ 2 TΩ 1 TΩ 500 GΩ

S1-1068 **10000 V** **5000 V** **2500 V** **1000 V** **500 V** **250 V**

±5% to 2 TΩ 1 TΩ 500 GΩ 200 GΩ 100 GΩ 50 GΩ

±20% to 20 TΩ 10 TΩ 5 TΩ 2 TΩ 1 TΩ 500GΩ

Guard : 2% error guarding 500 kΩ leakage, 100 MΩ load

Display range analogue: 100 kΩ to 10 TΩ

Display range digital: 10 kΩ to 35 TΩ

Short circuit current: 6 mA nominal

Charge current: 2 mA

Insulation alarm: 100 kΩ to 10 GΩ

Capacitor chg bat pwr: < 2.5 s/μF to 5 kV , < 5 s/μF to 10 kV

Capacitor chg AC pwr: < 1.5 s/μF to 5 kV , < 2.7 s/μF to 10 kV

Capacitor discharge: 5 kV to 50 V: < 120 ms/ μF
10 kV to 50 V: < 250 ms/ μF

Capacitance range: 10 nF to 50 μF ≤ 5kV
(> 500 V) 10 nF to 25 μF > 5 kV

Capacitance accuracy(23 °C): ±10% ±5 nF

Current measurement range: 0.01 nA to 6 mA

Current measurement accuracy: ±5% ±0.2 nA at all voltages (23 °C)

Noise rejection: 8 mA

Software filtering: 4 filter settings: 10 s, 30 s, 100 s, 200 s

Voltmeter range: 30 V to 660 V ac or dc, 50/60 Hz
Voltmeter accuracy: $\pm 3\%$, ± 3 V
Frequency range: 45 Hz – 65 Hz
Timer range: 99 m 59 s, 15 s minimum setting
Memory capacity: 11 hrs logging @ 5 sec intervals
Test regimes: IR, IR(t), DAR, PI, SV, DD, ramp test
Interfaces: USB type B (device), Bluetooth®
Real time output: reading (V, I, R) at a rate of 1 Hz
Remote control: Remote control via USB cable only
(requires RC indicator dongle to be in position)

Environmental Conditions

Altitude: 3000 m (5 kV, 10 kV)
Operating temp.: -20 °C to 50 °C
Storage temp.: -25 °C to 65 °C
Humidity: 90% RH non-condensing at 40 °C
Ingress protection: IP65 (lid closed), IP40 (lid open)

General Specifications

Safety: Meets the requirements of IEC 61010-1, CATIV 600 V
(5 kV, 10 kV)
EMC: Meets the requirements of IEC61326-1
Dimensions: L 315 mm x W 285 mm x H 181 mm
Weight: 4.5 kg (5 kV, 10 kV)

Repair and Warranty

If the protection of an instrument has been impaired it should not be used, but sent for repair by suitably trained and qualified personnel. The protection is likely to be impaired if, for example, the instrument shows visible damage, fails to perform the intended measurements, has been subjected to prolonged storage under unfavourable conditions, or has been exposed to severe transport stresses.

New instruments are covered by a two year warranty from the date of purchase by the user, the second year being conditional on registration of the product on www.megger.com. You will need to log in, or first register and then login to register your product. The second year warranty covers faults, but not recalibration of the instrument which is only warranted for one year. Any unauthorised prior repair or adjustment will automatically invalidate the warranty.

These products contain no repairable parts, with the exception of the user replaceable battery, and if defective should be returned to your supplier in original packaging or packed so that it is protected from damage during transit. *Damage in transit is not covered by this warranty and replacement/repair is chargeable.*

Calibration, Service and Spare Parts

For service requirements for Megger Instruments contact:

Megger Instruments Limited Archcliffe Road Dover Kent CT17 9EN England. Tel: +44 (0) 1304 502 243 Fax: +44 (0) 1304 207 342	Megger Valley Forge Corporate Centre 2621 Van Buren Avenue Norristown PA 19403 U.S.A. Tel: +1 610 676 8579 Fax: +1 610 676 8625
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Megger operate fully traceable calibration and repair facilities, ensuring your instrument continues to provide the high standard of performance and workmanship you expect. These facilities are complemented by a worldwide network of approved repair and calibration companies to offer excellent in-service care for your Megger products.

Returning product to Megger UK & USA service centres

1. When an instrument requires recalibration, or in the event of a repair being necessary, a Returns Authorisation (RA) number must first be obtained from one of the addresses shown above. You will be asked to provide the following information to enable the Megger Service Department to prepare in advance for receipt of your instrument, and to provide the best possible service to you.
 - Model, e.g. S1-568.
 - Serial number, to be found on the underside of the case or on the calibration certificate.
 - Reason for return, e.g. calibration required, or repair.
 - Details of the fault if the instrument is to be repaired.
2. Make a note of the RA number. A returns label can be emailed or faxed to you if you wish.
3. Pack the instrument in the original packing box to prevent damage in transit.
4. Ensure the returns label is attached, or that the RA number is clearly marked on the outside of the package and on any correspondence, before sending the instrument, freight paid, to Megger. Copies of the original purchase invoice and packing note should be sent simultaneously by airmail to expedite clearance through customs. In the case of instruments requiring repair outside the warranty period, an immediate quotation can be provided when obtaining the RA number.
5. You may track progress of your return online at www.megger.com

Approved Service Centres

A list of Approved Service Centres may be obtained from the UK address above, or by contacting Megger on ukrepairs@megger.com, and giving details of your location.

Accessories, equipment and spares

Included accessories (S1-568, S1-1068)	Part Number
User guide CD	
Power lead	
3 m leadset x 3, medium insulated clips	1002-531
Shielded USB cable	
PowerDB Lite software CD	
Remote control indicator dongle	
S1-1068 only:	
3 m leadset x 3, large insulated clips	1002-534
Optional accessories	
<i>HV test lead sets</i>	
3m leadset x 3, medium insulated clips	6220-820
10m leadset x 3, medium insulated clips	1000-441
15m leadset x 3, medium insulated clips	1000-442
3m leadset x 3, large insulated clips	6220-811
10m leadset x 3, large insulated clips	1000-443
15m leadset x 3, large insulated clips	1000-432
3m leadset x 3, bare clips	8101-181
8m leadset x 3, bare clips	8101-182
15m leadset x 3, bare clips	8101-183
<i>Screened HV test lead sets</i>	
3 m, 5 kV screened un-insulated small clips	6220-835
15 m, 5 kV screened un-insulated small clips	6311-080
3 m, 10 kV screened un-insulated small clips	6220-834
10 m, 10 kV screened un-insulated small clips	6220-861
15 m, 10 kV screened un-insulated small clips	6220-833

	Part Number
Screened HV test lead sets	
3 m, 5 kV screened un-insulated small clips	6220-835
15 m, 5 kV screened un-insulated small clips	6311-080
3 m, 10 kV screened un-insulated small clips	6220-834
10 m, 10 kV screened un-insulated small clips	6220-861
15 m, 10 kV screened un-insulated small clips	6220-833
Other	
CB101, 5 kV Calibration box	6311-077
Calibration certificate - CB101	1000-113
UKAS calibration certificate CB101	1000-047
Fused test probe and clip leadset 1002-913	1002-913
Control circuit test leadset	6220-822
Spares:	
Spare Li-ion battery pack	1002-552
Spare remote control indicator beacon	1003-228

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This instrument is manufactured in the United Kingdom.

The company reserves the right to change the specification or design without prior notice.

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Part No. S1568_S11068_UG_EN_V01 0513
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