GPS LTD.

GPS-3861C

Insulation Resistance Meter

1.0 to 1000 V DC · 100 kΩ to 10 TΩ · Handler and RS-232

Operating Manual

Issue 1

General Polytronic Systems Ltd · 14 Regent Street, Brent, London NW10 5LG
0800 494 7370 · sales@gpslimited.com · www.gpslimited.com

1 Safety

Read this manual before first use, and use the GPS-3861C only for the measurements it describes. The negative test terminal carries up to 1000 V DC.

Connect and disconnect the device under test only in the discharge state (DSCH). The (−) terminal carries the test voltage, and a charged device can hold a dangerous voltage after a test.

- Stop using the instrument at once and disconnect the power cord if it behaves abnormally; if it makes unusual noise, smells, smokes or flashes; if it becomes hot or gives a shock; if the power cord, switch or socket is damaged; or if anything gets inside it. Contact GPS.
- Connect the instrument to a protective earth through the supplied power cord. If the cord is replaced, make sure its earth is securely connected.
- Do not use the instrument in a flammable or explosive atmosphere, in steam or in dust.
- Do not open the case. There are no user-serviceable parts inside, and the instrument holds charge for some time after it is switched off.
- Do not use an instrument that is damaged or not working properly, and do not try to repair it.
- Do not connect the (−) terminal to the ground terminal.
- Connect polarised devices such as electrolytic capacitors with the correct polarity. After a test, let the device discharge for a few seconds before removing it.
- Do not leave the test terminals short-circuited for long periods: it can damage the instrument.
- Switch the instrument off before connecting or disconnecting the RS-232 or Handler cables.
- Replace the fuse only with a 250 V, 1 A slow-blow fuse, with the power cord unplugged.
- Use the instrument only as this manual describes. Outside these conditions its protection may be impaired.

2 Introduction

The GPS-3861C measures insulation resistance from 100 kΩ to 10 TΩ, with a test voltage set anywhere from 1.0 V to 1000 V DC in 0.1 V steps. Insulation resistance and leakage current are measured and shown together, with the test voltage, on a 3.5 in colour display.

Each test runs through three states: charge, test and discharge. A charge timer of up to 999.9 s lets a capacitive device settle before it is measured, and the residual voltage is discharged quickly afterwards. Six ranges, chosen automatically, held, or set from the comparator limit, give a maximum reading of 9999 at up to 55 readings a second.

For production, the comparator sorts each device as PASS, UPPER or LOWER, and the Handler interface connects the instrument to a PLC or automatic handler. The RS-232 interface accepts SCPI commands for remote control and data capture, and readings can be logged to a USB flash drive.

The GPS-3861C measures the insulation resistance of electronic components, equipment, dielectric materials, and wire and cable.

3 Specification

Accuracy is specified at 23 °C ±5 °C and 65% relative humidity, after an open circuit zero, more than 60 minutes warm-up, and within a one-year calibration interval.

Item	Specification
Measures	Insulation resistance and leakage current, displayed with the test voltage

Item	Specification
Resistance range	100 kΩ to 10 TΩ across six ranges; the span of each range depends on the test voltage, section 16
Accuracy, slow rate	±5% below 1 MΩ · ±1% above 1 MΩ · ±3% above 1 GΩ · ±5% above 10 GΩ · ±10% above 1 TΩ
Test voltage	−1.0 to −1000 V DC (negative output) · set in 0.1 V steps, four digits
Test voltage accuracy	±10% below 10 V · ±1% above 10 V
Maximum charging current	30 mA ±5 mA
Charge timer	0 to 999.9 s · accuracy ±0.5% · counts up or down
Measurement rate	Slow about 3, medium about 25, fast about 55 readings per second
Maximum reading	9999
Range mode	Auto, Hold and Nominal
Zero	Open circuit zero for all ranges in one operation
Comparator	PASS, UPPER and LOWER · beeper off, on good (GD) or on fail (NG)
Trigger	Internal, manual, external and bus (remote)
Display	3.5 in true-colour TFT
Interfaces	Handler · RS-232 with SCPI · USB flash drive port · RS485 and USB-to-RS-232 optional
Other	Contact check · automatic discharge · keypad lock · administrator and user accounts
Power supply	198 to 242 V AC, 50/60 Hz (as marked on the rear panel) · 30 VA maximum · fuse 250 V 1 A slow-blow
Environment	Operating 10 °C to 40 °C, 10% to 80% RH · storage 0 °C to 50 °C, 10% to 90% RH
Dimensions, weight	264 × 107 × 350 mm (W × H × D) · about 5 kg

4 Unpacking and preparation

Check the delivery

Check the instrument for damage, and check the contents against the list in section 18. If anything is damaged or missing, contact GPS.

Power

The GPS-3861C runs from 198 to 242 V AC, 50/60 Hz, as marked on the rear panel, and draws up to 30 VA. Use the supplied power cord, connected to an earthed socket.

Where to use it

Operate the instrument at 10 °C to 40 °C and 10% to 80% relative humidity, away from dust and condensation. For the specified accuracy, keep it at 18 °C to 28 °C. Keep the ventilation fan on the rear panel clear.

The handle

The handle has four positions: carrying, two viewing angles, and removed. To move it, hold both sides, pull them gently outwards until the handle turns freely, and turn it to the new position. To remove it, pull both sides outwards until it comes free.

5 The instrument

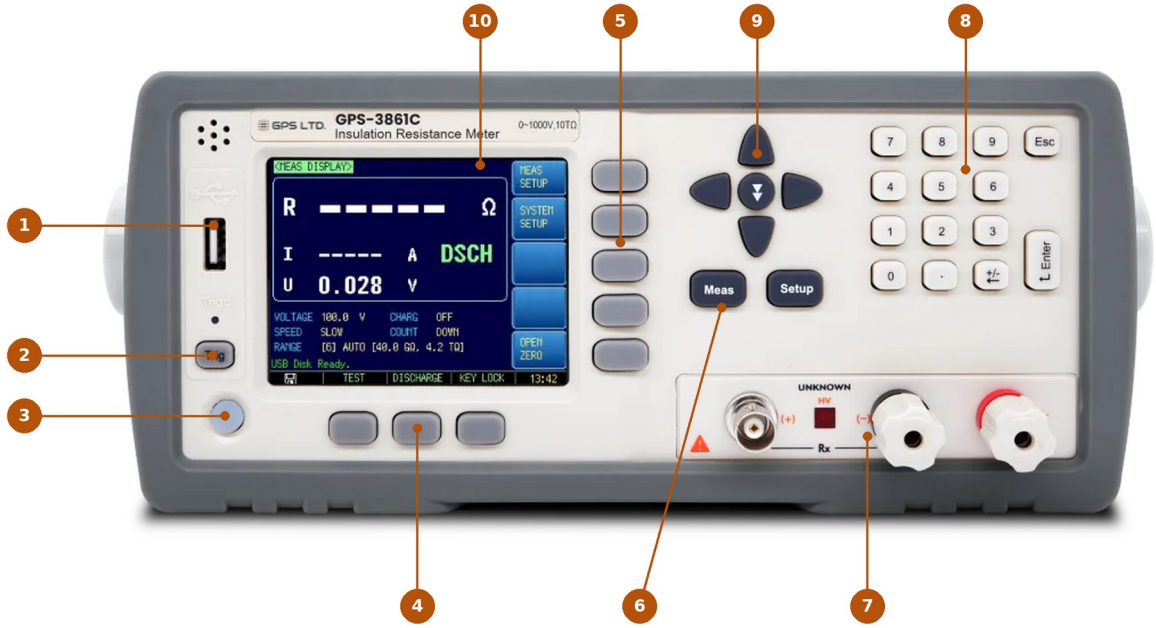


Figure 1 The front panel

	Item	Description
1	USB port	For a USB flash drive, to log readings, section 13
2	Trig	Manual trigger key
3	Power	Touch power button, section 6
4	System soft keys	The three keys under the display: save to USB, TEST, DISCHARGE, KEY LOCK and similar, as labelled on the bottom line of the display
5	Function soft keys	The five keys beside the display. Their functions are shown on the display next to them
6	Meas and Setup	Open the measurement page and the setup page
7	Test terminals (UNKNOWN)	(+) positive terminal, the current sampling input · (−) negative terminal, the test voltage output · ground terminal, for a guard or shield, section 7
8	Numeric keypad	Enter values
9	Cursor keys	Move between the fields on the display
10	Display	3.5 in colour display, section 8

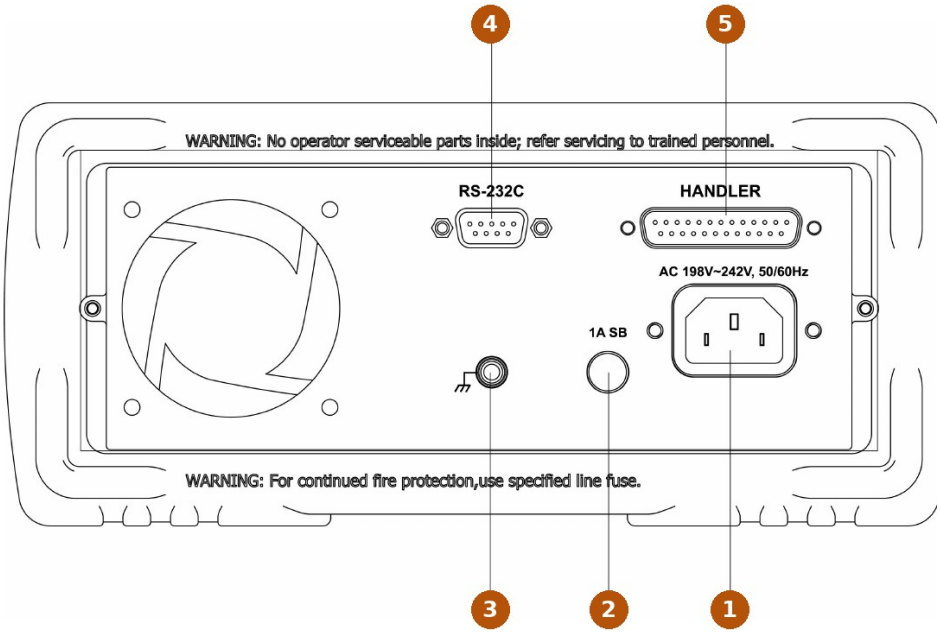


Figure 2 The rear panel

	Item	Description
1	Mains inlet	Power cord socket. Supply 198 to 242 V AC, 50/60 Hz
2	Fuse holder	Fuse 250 V, 1 A slow-blow (marked 1A SB), section 17
3	Ground terminal	Chassis ground
4	RS-232C	9-pin serial interface, section 15
5	HANDLER	25-pin interface for a PLC or automatic handler, section 14

6 Switching on

The power button is at the bottom left of the front panel. The instrument uses a soft start:

- To switch on, press the power button. When the power light turns green, release it.
- To switch off, press the power button. When the power light turns orange, release it.

The instrument starts in the discharge state, DSCH. Let it warm up for at least 30 minutes before measuring. The specified accuracy assumes more than 60 minutes.

7 Connecting the device under test

The three terminals are (+), the current sampling input; (−), the test voltage output; and the ground terminal, used as a guard. Connect the device only in the discharge state.

Devices with a shield or guard terminal

For devices with a shield or a shielding enclosure, such as a standard high-resistance box, connect the two ends of the resistance to (+) and (−) and the shield to the ground terminal (Figure 3). A shielding enclosure must not be connected to (+) or (−).

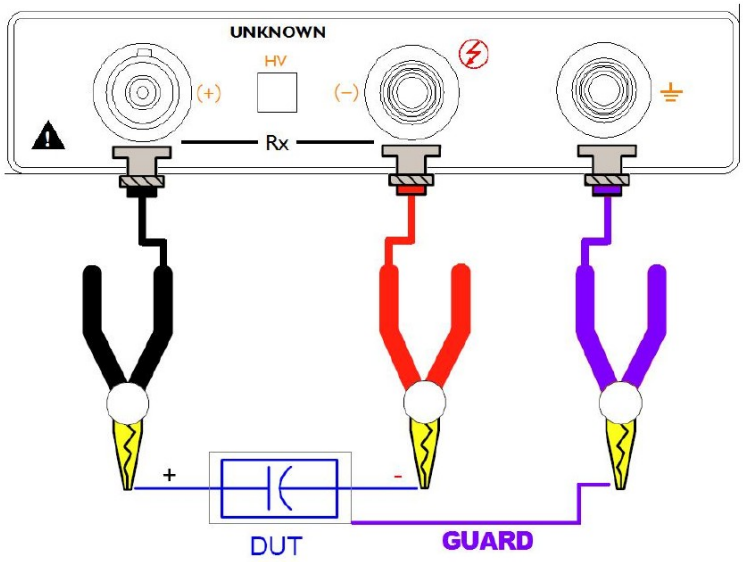


Figure 3 Device with a guard: (+), (–) and the ground terminal

Polarised devices

Connect the positive side of a polarised device, such as a capacitor, to (+) and the negative side to (–) (Figure 4).

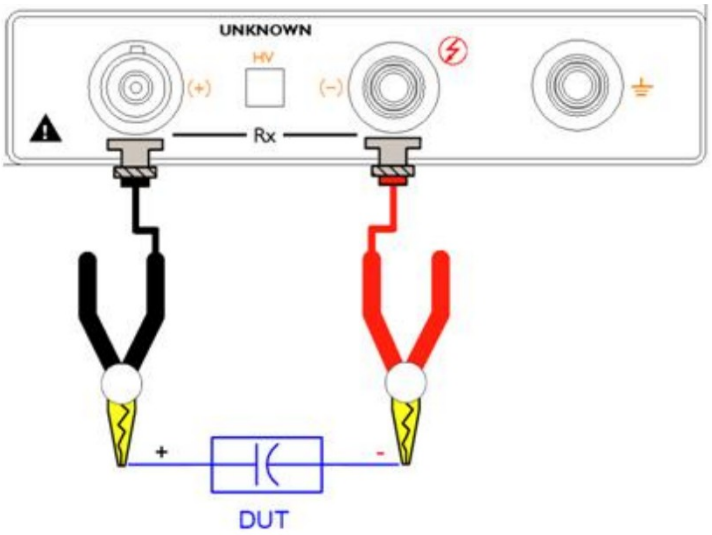


Figure 4 Polarised device: positive to (+), negative to (–)

Cable, wire and materials

Devices and materials with no polarity and no shield, such as wire and cable, need no special connection: connect them between (+) and (–) (Figure 5). Do not connect the ground terminal for a cable or a capacitor.

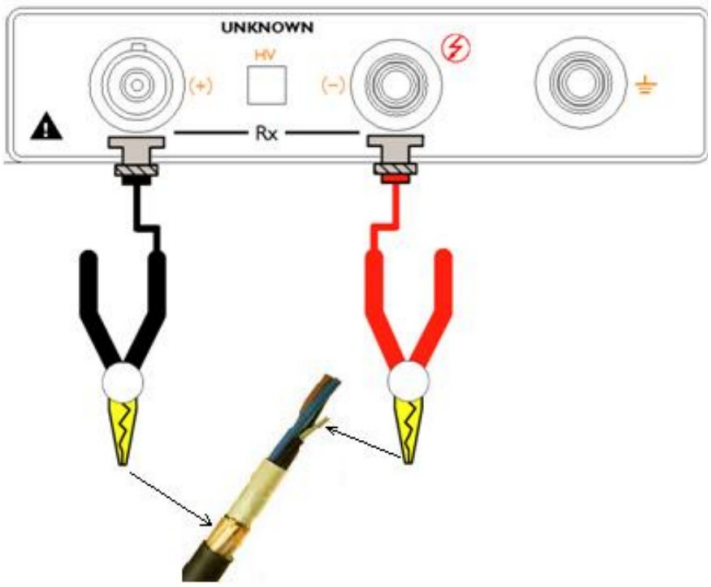


Figure 5 Cable: between (+) and (–)

The (–) terminal carries the test voltage. Make every connection in the discharge state, and connect polarised devices the right way round.

The instrument discharges the device internally. For stable readings, keep the room within the temperature and humidity limits in section 4.

8 The measurement display

In the discharge state, press Meas to open the measurement display (Figure 6). It shows the results, the state of the test and the sorting result, and the five settings used most often.



Figure 6 The measurement display

Field	What it shows
R	Insulation resistance
I	Leakage current
U	Voltage at the terminals
State	The state of the test, for example DSCH in the discharge state

Field	What it shows
VOLTAGE	The test voltage setting
CHARG	The charge time, or OFF
SPEED	Measurement rate
COUNT	Charge timer direction
RANGE	Range number, range mode, and the span of resistance the range covers at the present voltage
Status line	Messages, for example USB Disk Ready
Side soft keys	MEAS SETUP, SYSTEM SETUP and OPEN ZERO on this page
Bottom soft keys	Save to USB (disk symbol), TEST, DISCHARGE and KEY LOCK, with the clock at the right

Voltage, speed, range, charge time and timer direction can be set on this page or on the setup page. Select a field with the cursor keys, then choose with the soft keys or type a value on the keypad.

9 Setting a measurement

Test voltage

1. Press Meas or Setup.
2. Select the VOLTAGE field with the cursor keys.
3. Press a soft key for 50, 100, 250, 500 or 1000 V, or type any voltage from 1.0 to 1000 V on the keypad.

Measurement rate

Slow (about 3 readings a second) for measuring by hand; medium (about 25) or fast (about 55) for automatic testing with a PLC. The rate can be changed in the discharge or the test state.

1. Select the SPEED field.
2. Press SLOW, MEDIUM or FAST.

Range

The right range is needed for the specified accuracy. The span of each range at each voltage is given in section 16.

Mode	How it works	Use it for
Auto	The instrument chooses the best range for the value it measures	General use. Slower than a held range
Hold	Measures on a fixed range	The fastest testing, and leakage current measurement
Nominal	The instrument chooses the best range from the comparator lower limit	Sorting. Works only with the comparator on; with it off, the instrument uses auto

1. Select the RANGE field.
2. Press AUTO, HOLD or NOMINAL. With HOLD, INCR+ and DECR− step the range up and down.

Some devices, such as polypropylene film capacitors, may not range correctly on auto. This is normal: use a held range. For leakage current, a held range is recommended.

Charge time

The charge time lets a capacitive device charge before the reading is taken, up to 999.9 s.

1. Select the CHARG field.
2. Press OFF, or a soft key for 10, 30, 60 or 120 s, or type a time on the keypad.

Charge timer direction

1. Select the timer (COUNT) field.
2. Press UP to count up from zero, or DOWN to count down to zero.

Open circuit zero

For accurate high-resistance readings, run an open circuit zero with the test leads connected and open, before measuring.

1. Connect the test leads, with nothing between them.
2. Press OPEN ZERO beside the display.
3. Press ENTER to zero all ranges, or CANCEL to return to the discharge state without zeroing. A successful zero is stored in memory.

10 Measurement setup

In the discharge state, press Setup. The setup page holds all the measurement settings: the five in section 9, and the ones below.

Contact check

For capacitive devices above 100 pF, such as capacitors and cables, the contact check tells whether the device is properly connected, so a poor contact is not taken for a high resistance. It adds no test time. With the check on, the display shows OPEN if no capacitance is found in the test state. Set the field to ON or OFF.

Trigger

Mode	How a measurement starts
INT	Internal: the instrument measures continuously
MAN	Manual: one measurement each time Trig is pressed
EXT	External: one measurement on each trigger edge at the Handler interface, section 14
BUS	Bus: one measurement on each trigger command over RS-232. Available only with the comparator on

In external trigger, the trigger edge field sets RISING or FALLING edge.

Delay

In the external trigger modes, the delay holds off the test voltage for a set time after the trigger, so the station can settle. Type a delay from 1 ms to 60 s on the keypad.

Comparator, limits and beeper

With the comparator on, each reading is compared with the limits:

Reading	Result	Display
Between the lower and upper limits	Good	PASS

Reading	Result	Display
Below the lower limit	Not good	LOWER
Above the upper limit	Not good	UPPER

1. Set the COMPARATOR field to ON.
2. Select the upper or lower limit field and type the value on the keypad. The upper limit can be turned off.
3. Set the BEEP field to OFF, GD (beep on a good result) or NG (beep on a fail). The beeper works only with the comparator on.

Automatic discharge

With automatic discharge ON, the instrument takes one reading in the test state and then returns to the discharge state by itself.

11 Running a test

A test moves through three states: discharge, charge and test.

1. Connect the device under test in the discharge state (DSCH), section 7.
2. Press CHARGE. The test voltage is applied and the charge timer starts. With the charge time set to 0 there is no charge state.
3. When the charge time ends, the instrument enters the test state and measures. Press TEST at any time to go straight to the test state.
4. Read the resistance and leakage current, and the sorting result if the comparator is on.
5. Press DISCHARGE to remove the test voltage and discharge the device, then disconnect it.

Wait until the instrument is back in the discharge state before touching the device under test or the leads.

12 System configuration

In the discharge state, press Meas or Setup, then SYSTEM. Settings on this page are saved automatically and loaded at the next switch-on.

Language

Select the LANGUAGE field and choose ENGLISH.

Date and time

The instrument has a 24-hour clock. Select the date or time field and use the soft keys to step the year, month, day, hour, minute and second.

Accounts and password

Account	Access
Administrator	All functions except the service page. Settings are saved to memory five seconds after they are made, and loaded at the next switch-on
User	All functions except the service and file pages. Changes are not saved: the administrator's settings return at the next switch-on

From the account field, the administrator can set a numeric password of up to nine digits, or delete it. If you forget the password, contact GPS.

Communication

Setting	Choices
Baud rate	1200 (for a converter with optocoupler isolation), 9600, 38400, 57600, 115200 (recommended)
Command protocol	SCPI, or Modbus (RTU)
Station number	00 (broadcast) to 15. Needed for Modbus, and usable for addressing several instruments with SCPI
Instruction handshake	OFF (recommended) or ON. With ON, each command is echoed to the host before the reply. SCPI only
Result sending	FETCH: the host asks for results · AUTO: results are sent after every test. SCPI only

The system information page shows the instrument details and has no settings.

13 Logging to a USB flash drive

Insert a USB flash drive in the front panel port; the status line shows USB Disk Ready. Press Setup, then the USB storage soft key.

1. Select a file slot, File 0 to File 9.
2. Press CREATE FILE, type a name on the on-screen keyboard and press OK. Files are saved in CSV format.

Trigger mode	When readings are saved
Internal	At the interval set in the save-period field, while in the test state
External or bus	Each time a trigger is received in the test state
Any	When the save-to-USB soft key (disk symbol) is pressed on the measurement display

14 Handler interface

The 25-pin Handler interface on the rear panel outputs the sorting result and the end of test signal, and accepts trigger, charge, discharge and keypad lock inputs. It works in external trigger mode.

Pin	Signal	Function
1	/EOC	End of test (busy) signal
2	/NG	Comparator fail output
3	/GD	Comparator pass output
4	/OPEN	Open circuit signal, low when an open circuit is found. /NG and /GD are reset to high
5	/KNG	Comparator relay, fail contact: closes to /COM
6	/COM	Comparator relay common
7	/KGD	Comparator relay, pass contact: closes to /COM
12	DISCH	Input: discharge (acts in the test state)
13	CHARG	Input: charge or test (acts in the discharge state)
24	TRIG	Input: trigger (external trigger only)
25	KLOCK	Input: keypad lock

Pin	Signal	Function
16	EX-GND	External supply 0 V
17	EX-VCC	External supply positive

All outputs and inputs are active low.

Supply and ratings

The interface needs an external supply connected to EX-VCC and EX-GND. Without one, only the comparator relay contacts work.

Item	Rating
External supply	+3.3 to 24 V DC
Outputs	Open collector with built-in pull-up resistor · optocoupler isolated · maximum voltage: the supply voltage · maximum current 50 mA
Inputs	Optocoupler isolated

- Do not exceed the supply rating, and wire the interface with the instrument switched off.
- If an output drives a relay coil, fit a flyback diode across the coil.

Foot switch

CHARG and DISCH can also be used for a foot switch: connect the switch between CHARG or DISCH and ground, with the external supply connected to EX-VCC.

15 Remote control over RS-232

The RS-232 interface controls every function of the instrument using SCPI commands.

Connection

Use a straight-through 9-pin cable, not a null-modem cable. The instrument uses three lines:

Signal	Pin
Transmit (TXD)	2
Receive (RXD)	3
Ground	5

With a home-made three-wire cable on a computer's own port, pins 4 and 6, and 7 and 8, may need to be linked at the computer end. Switch the instrument off before connecting or disconnecting the cable.

Settings

Setting	Value
Baud rate	As set on the system page, section 12
Data bits	8
Parity	None
Stop bits	1
Flow control	None (software handshake optional)

Commands and replies are ASCII. End each command with a line feed (NL). When the instrument detects the RS-232 connection it communicates at the set baud rate and locks the keypad. The full command reference is available from GPS.

If the computer receives nothing

- Check that the instruction handshake setting matches the host software.
- Check the cable and its connections.
- Check the port number, the format and the baud rate in the host software.
- If the instrument is still processing the previous command, try again.

16 Accuracy and measurement ranges

The six ranges cover different spans at different test voltages. The table gives them at eleven typical voltages; the units are Ω, with k = 10^3, M = 10^6, G = 10^9 and T = 10^{12}.

Voltage	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
1 V	Not specified	1M – 10M	10M – 100M	100M – 1G	1G – 10G	10G – 100G
10 V	100k – 1M	1M – 10M	10M – 100M	100M – 1G	1G – 10G	10G – 100G
25 V	250k – 2.5M	2.5M – 25M	25M – 250M	250M – 2.5G	2.5G – 25G	25G – 250G
50 V	500k – 5M	5M – 50M	50M – 500M	500M – 5G	5G – 50G	50G – 500G
75 V	750k – 7.5M	7.5M – 75M	75M – 750M	750M – 7.5G	7.5G – 75G	75G – 750G
100 V	1M – 10M	10M – 100M	100M – 1G	1G – 10G	10G – 100G	100G – 1T
125 V	2.5M – 12.5M	12.5M – 125M	125M – 1.25G	1.25G – 12.5G	12.5G – 125G	125G – 1.25T
250 V	5M – 25M	25M – 250M	250M – 2.5G	2.5G – 25G	25G – 250G	250G – 2.5T
500 V	10M – 50M	50M – 500M	500M – 5G	5G – 50G	50G – 500G	500G – 5T
750 V	10M – 75M	75M – 750M	750M – 7.5G	7.5G – 75G	75G – 750G	750G – 7.5T
1000 V	10M – 100M	100M – 1G	1G – 10G	10G – 100G	100G – 1T	1T – 10T

Resistance	Accuracy, slow rate
Below 1 MΩ	±5%
Above 1 MΩ	±1%
Above 1 GΩ	±3%
Above 10 GΩ	±5%
Above 1 TΩ	±10%

Conditions: 23 °C ±5 °C, 65% relative humidity, open circuit zero run, more than 60 minutes warm-up, one-year calibration interval. Test voltage accuracy is ±10% below 10 V and ±1% above.

To keep the specified accuracy, have the instrument recalibrated by GPS or an authorised agent every year.

17 Care and maintenance

Cleaning

Unplug the power cord before cleaning. Clean the case with a dry cloth, or one slightly dampened with water. Do not use solvents such as alcohol or petrol, and do not try to clean the inside of the instrument.

Replacing the fuse

1. Switch off and unplug the power cord.
2. Open the fuse holder on the rear panel.
3. Fit a 250 V, 1 A slow-blow fuse of the same shape and rating. A spare is supplied. A different fuse, or a short circuit, can damage the instrument.

If the fuse blows again, do not fit another: contact GPS.

18 Supplied with the instrument

- GPS-3861C insulation resistance meter
- Test cable
- RS-232 communication cable
- Power cord
- Spare fuse, 250 V 1 A slow-blow
- This manual and a calibration certificate

Model	Description	Part number
GPS-3861C	Insulation resistance meter, 1.0 to 1000 V DC, 100 kΩ to 10 TΩ	621745

RS485 and USB-to-RS-232 interfaces are available to order.

19 Warranty and service

One year from the date of purchase, subject to product registration with GPS at www.gpslimited.com/register-product. The warranty does not cover the fuse, or damage from misuse, neglect, contamination, accident, abnormal operating conditions or unauthorised modification.

For service, calibration or technical support, contact GPS at sales@gpslimited.com or 0800 494 7370, quoting the model, part number and serial number.