Instruction Manual

ΩHMRANGER-LCV

OR-01 Low Compliance Voltage Ohmmeter



Disclaimer

ΩhmRanger-LCV® is a factory-calibrated, accurate low compliance voltage ohmmeter, intended for measuring resistance without subjecting the Device Under Test (DUT) to excess stimulus voltage. It is aimed at both the professional and the enthusiast User. ΩhmRanger-LCV® is not intended to replicate the full functionality of expensive laboratory equipment. Instead, it aims to provide a portable and affordable means of measuring the resistance of delicate components, where this has in the past required engineers to develop their own rigs.

If used in any manner other than that expressly set out in the AltoNovus product documentation, warranties granted by AltoNovus shall be deemed void and AltoNovus shall not be liable for any claims, or damages arising out of product misuse or malfunction.

Although every effort is made to ensure the accuracy of ΩhmRanger-LCV®, no guarantee of accuracy is given or implied, or responsibility accepted for consequential loss. Users may reproduce and store this document for personal use. For wider permission requests, email the publisher, addressed "Attention: Permissions Coordinator," at info@altonovus.com. The name **ΩhmRanger-LCV®** is a Registered Trademark of AltoNovus Limited.

Document Revisions

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Approvals - Release / amendment of this document requires the following approvals:

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1 Preface

1.1 The User

ΩhmRanger-LCV® is not a toy. It is a precision instrument and should be treated accordingly. It is aimed at the professional and enthusiast User community. This Instruction Manual assumes a level of technical expertise on the User's part. ΩhmRanger-LCV® should **not** be used by those without a knowledge of safe working on electronics. This Manual covers the use and operation of ΩhmRanger-LCV®. It does NOT cover calibration or maintenance (beyond battery replacement or routine cleaning), as these are not activities that the User can perform.

1.2 Conventions Used in This Manual

The following style conventions are used in this document:

```
Courier New
SCPI System control inputs and outputs.
```

User input variables

< > Angle brackets surround User-supplied values.

1.3 Explanation of Safety Warnings

CAUTION! Indicates a hazard with a low level of risk which, if not avoided, could result in damage to ΩhmRanger-LCV® and / or minor injury to Users.

1.4 Obtaining Documentation and Information

1.4.1 Internet

The latest version of the documentation and any software updates are available at the following web address: http://www.altonovus.com.

1.4.2 Ordering Documentation

Documentation, User instructions and technical information can be requested by emailing: info@altonovus.com.

1.4.3 Documentation Feedback

We welcome your comments and ideas, which may be incorporated in a ΩhmRanger-LCV® FAQs page. Any comments, requests for clarification, or suggestions for future Versions of this document can be submitted to: info@altonovus.com.

2 ΩhmRanger-LCV®

2.1 Utility and Employment

ΩhmRanger-LCV® is an accurate, affordable, low compliance voltage ohmmeter, for the measurement of resistance of components that cannot be exposed to large stimulus voltages. One example is the delicate Josephson Junction that forms the 'transistor equivalent' of some quantum computers. Previously, engineers have been required to develop their own measurement rigs to test such components.

The ΩhmRanger-LCV® is a solution to this challenge, as it provides accurate measurement from >100M to 10 Ohms, with a stimulus voltage always less than 400mV. It features:

- Low stimulus voltages, selectable between approximately 380mV or approximately 206mV, with on-screen voltage confirmation.
- Stimulus voltage at the output terminal is limited by the maximum current supply of approximately 30mA.
- Readings from >100M to 10 Ohms.
- A 128 x 64 LCD display gives a wealth of information about your Resistance readings.
- A large display shows MΩ, KΩ, and Ω, all on one line.
- Readings every 400mS, built up from 160 samples and averaged to tune out mains noise (both 50 Hz and 60 Hz).
- Fully isolated USB Interface for device control and readings export.
- SNR display to indicate noise level on signal.
- Range Bar movement after every reading to show that ΩhmRanger-LCV® is operating correctly.
- Range Coverage Bar that shows the ranges covered during the measurement.
- User-configurable Auto Power-off timer.
- A small form, with dimensions of 148 x 90 x 30mm, making ΩhmRanger-LCV® highly portable.
- 150 hours of operation on 2 x AA batteries.
- An automatic Power Off timer, and configurable LED backlight, enabling the User to maximise battery life.

Readings are completed approximately every 400mS and the display is updated, with samples collected and averaged out to remove most of the mains noise associated with circuits (50Hz and 60Hz).

2.2 Theory of Operation

ΩhmRanger-LCV® is powered by 2 x AA batteries (not supplied), generating approximately 3V (but will continue to work down to approximately 2V on the batteries).

Pressing the **Power On** button starts the ΩhmRanger-LCV®. Pressing the **Power On** button *again* powers off the ΩhmRanger-LCV™. Standby current, when powered off, is approximately 10nA.

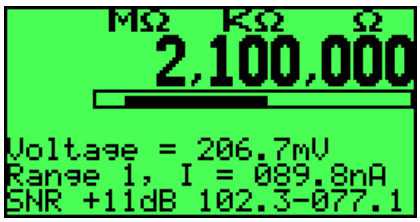
The ΩhmRanger-LCV® is developed from AltoNovus' NanoRanger®, which is an auto-ranging ammeter used to measure low currents, with great accuracy, through decadal ranges. ΩhmRanger-LCV® has an additional, readable voltage source.

The stimulus voltage selected is output on the **Positive** terminal of the ΩhmRanger-LCV® and the resistance to be measured is connected across the terminals. The two voltage outputs that can be selected by the User are approximately 380mV and 206mV. The actual voltage output is displayed on the device screen.

ΩhmRanger-LCV® measures the current coming in through the **Negative** terminal by measuring the voltage across an internal range resistance. The ΩhmRanger-LCV® can measure currents down to 1nA by switching in different range resistances. The device has 9 internal range resistances used to measure current, with a 40mV full scale burden voltage. The maximum current we can measure (together with the associated range resistance) per range is:

Range Number	Internal Range Resistance	Max current @40mV
0	2MΩ	20.00nA
1	200KΩ	200.0nA
2	20KΩ	2.000uA
3	2KΩ	20.00uA
4	200Ω	200.0uA
5	20Ω	2.000mA
6	2Ω	20.00mA
7	0.2Ω	200.0mA
8	0.05Ω	800mA

The resistance is computed by dividing the output voltage by the measured current (R=V/I) before subtracting the range resistance. Factory set calibration compensation is applied to both current and voltage, to give an accurate reading of resistance. i.e. R_TOTAL = R + R_INTERNAL = V/I. In the example shown on the screen below:



R + R_INTERNAL = 0.2067V / 89.8nA (here using Range 1, where the associated Range Resistance is 200KΩ). Therefore:

R + 200KΩ = 2.3MΩ, and

R = 2.3MΩ – 200KΩ = 2.1MΩ

For clarity, the User can see the 3 values above V (206.7mV), I (89.8nA), and the Range (1) on the display in real time, and live, during measurement, as shown above.

Please Note: Although range 8 exists in the ΩhmRanger-LCV®, because the current is limited to approx. 30mA we will never switch up to that range from the 200.0mA range.

2.3 Technical Data

UNIT	PHYSICAL PARAMETERS
Weight (not including batteries)	Approximately 200g
Length x Width x Depth	148 x 90 x 30 mm

Accuracy specifications +/- % of range:

RESISTANCE	ACCURACY
>100MΩ	5%
1-100MΩ	2%
100-1MΩ	1%
<100Ω	2%

- Current consumption **LCD Light on** < 15mA.
- Current consumption **LCD Light off** < 10mA.
- Current consumption **Powered-off** < 10nA.
- Typical operating time on one set of 2 x AA batteries is > 150 hours.

UNIT	OPERATIONAL PARAMETERS
Temperature	0 – 50C
Humidity	10 – 90% non-Condensing

2.4 Compliance

ΩhmRanger-LCV® is certified UKCA, CE and FCC compliant. A supporting Technical File is available to Competent Authorities on request.

2.5 Guide to Product

A - **Positive** Terminal

B - **Negative** Terminal

C - Display Screen

D - On / Off Button

E - Menu Navigation

F - Select Button

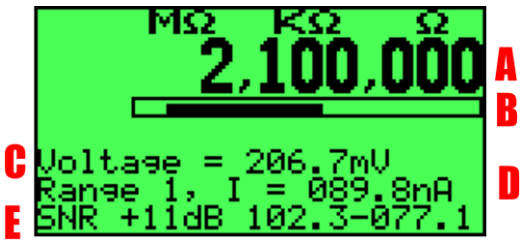
G - Isolated USB Interface

H - Battery Compartment





2.6 Understanding the User Interface



A - The Resistance reading, displayed in MΩ, KΩ and Ω. In the example above, 2.1MΩ.

B - A small, oscillating Range Bar shows which range is currently in use. An upper, longer Range Coverage Bar shows any movement across the ranges during the reading (in this example, none). The box surrounding shows the operating range.

C - The Voltage being applied by ΩhmRanger-LCV® at the **Positive** terminal, in this case 206.7mV, to measure the resistance.

D - The active Range and the observed Current.

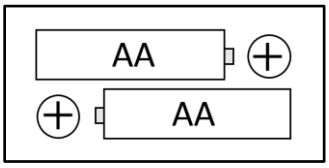
E - The Signal to Noise Ratio (SNR). The SNR indicates how much noise, variation, and AC components are in the signal, followed by Maximum and Minimum Current samples during the reading. Higher resistances (lower currents) are more susceptible to noise. In this example currents ranged from 102.2nA down to 77.1nA. At these current levels mains pickup in the test leads are the biggest source of noise.

2.7 Device Set-Up



2.7.1 Fitting 2 x AA Batteries

1. Remove battery compartment cover, by applying gentle pressure to the finger pad.
2. Ensure clean contacts on batteries.
3. Insert new batteries, observing polarity instructions in battery compartment:



4. Replace battery compartment cover.

Note: 2 x AA alkaline batteries should give more than 150 hours of continuous operation. Treat and dispose of all batteries in accordance with manufacturer's instructions.

2.7.2 Removing the Protective Film



If desired, remove the protective film from the front of ΩhmRanger-LCV®. Peel carefully from below the **Positive** and **Negative** terminals. ΩhmRanger-LCV® will still function normally if the User chooses to leave the film in place.

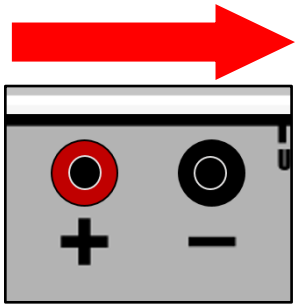
2.7.3 Attach Feet (if desired)

ΩhmRanger-LCV® is supplied with 4 rubber feet, for Users requiring added stability. Attach these with due regard to the areas that will experience pressure during normal use; i.e. the Keypad buttons and Terminals. Attaching the Feet as shown below will improve the stability of ΩhmRanger-LCV® during use.



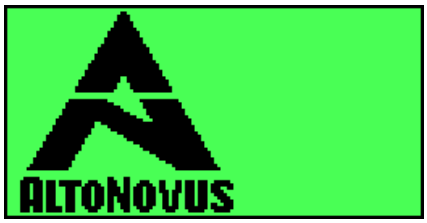
2.7.4 Connecting User Probes

Using User Probes (not supplied), Connect the Resistance to be measured between the **Positive** (RED) and **Negative** (BLACK) terminals of the ΩhmRanger-LCV®. Leads should be industry standard, uninsulated, 4mm banana plug type. As short a lead as practicable (0.3M) will help minimise noise during measurement.

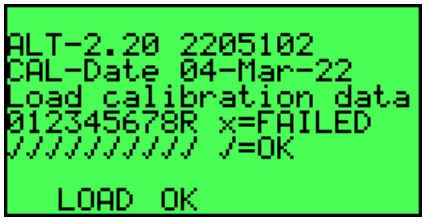


2.7.5 Controls

Firstly, ensure batteries are fitted in accordance with 2.7.1 (above). Three buttons control the operation of the ΩhmRanger-LCV®; **Power**, **Menu**, and **Select**. Pressing the **Power** button will start the ΩhmRanger-LCV®. Two start-up screens will display, whilst loading the code. The first screen shows the AltoNovus logo:

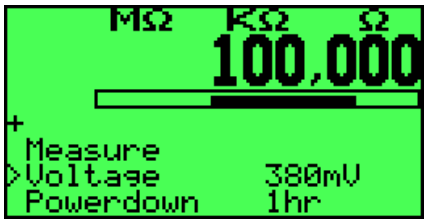


Then a second screen, shown below, will appear briefly, with the serial number of the ΩhmRanger-LCV® (here 2205102), the software release (here ALT-2.20), calibration date and calibration load status. Taking measurements can then commence (See Section 4).



2.8 ΩhmRanger-LCV® Menu Structure

ΩhmRanger-LCV® has several features accessible through the **Menu**. Press the **Menu** button to exit measuring and enter the **Menu**. The screen below will appear:



Selecting **Measure** will take the User back to measuring mode. Pressing the **Menu** button will scroll through the menu options. The **Menu** options are *currently*:

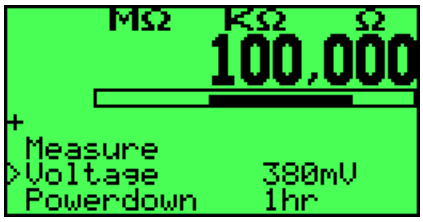
- Measure
- Voltage
- Powerdown
- LCD Light
- 4 Beep Read
- Details

These **Menu** options *may* change in the future. ΩhmRanger-LCV® software updates are available from time to time. Register for notifications at info@altonovus.com.

2.8.1 Measure

The Measure feature performs a measurement, as described in Section 4.

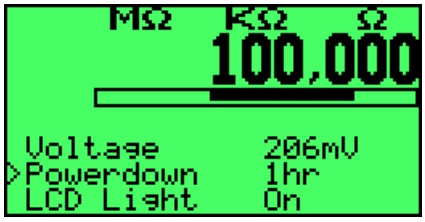
2.8.2 Voltage



This feature allows the User to specify the stimulus voltage that will be applied by ΩhmRanger-LCV® to the Device Under Test (DUT). There are 2 options, approximately 380mV (the default setting), or 206 mV.

Configuration is saved to Non-Volatile memory and restored on **Power Up**.

2.8.3 Powerdown



This feature enables the automatic **Power Off** timer. The timer starts at the most recent interaction with ΩhmRanger-LCV® (the last key press). The timer options are: Off, 30mins, 1hr (Default), 2hrs, 4hrs, and 8hrs.

Configuration is saved to Non-Volatile memory and restored on **Power Up**.

2.8.4 LCD Light



This feature enables / disables the LCD backlight. Disabling the backlight will extend battery life.

Configuration is saved to Non-Volatile memory and restored on **Power Up**.

2.8.5 4 Beep Read

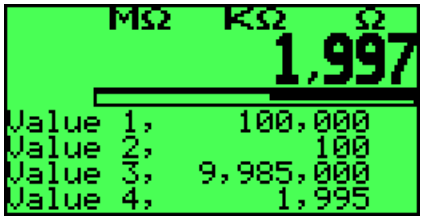


The 4 Beep Read function is intended to enable Users to ignore fluctuating resistance measurements and to save readings only when a stable resistance value is detected.

This mode of operation also gives an audio cue to notify Users who may need to keep the Device Under Test (DUT) under close observation during the measurement process.

To begin the process, ΩhmRanger-LCV® takes a measurement and stores the value (as the first in the sequence). With the second and subsequent measurements, ΩhmRanger-LCV® checks the new value against the value stored for the first. If the new value **is** within the selected stability tolerance (either 1%, 2%, 5%, or 10%) then ΩhmRanger-LCV® increases the count.

If the new value **is not** within the set tolerance, then this measurement replaces the previous value and is stored as the new 'first' in the sequence (and the count is reset). If the count reaches 5 (i.e. 5 sequential values are within tolerance) then the reading is stored and a beep sounds. If nothing is connected (400MΩ), any values captured are not counted as readings and the count restarts. This process repeats until all 4 slots for stored readings are filled. The slots for stored readings can be cleared by pressing the ENTER button.

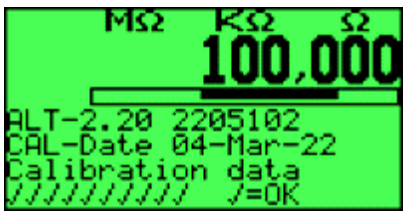


Configuration is saved to Non-Volatile memory and restored on **Power Up**.

2.8.6 Details



Under this Menu option, the User can find information about the ΩhmRanger-LCV®'s Software version, Serial number, Calibration date and Calibration status, as shown below:



2.8.7 Exiting the Menu and Clearing Readings

Select **Measure** to exit the **Menu** and return to the Measure screen. While on the Measure screen, pressing the **Select** key will clear the Reading from ΩhmRanger-LCV®.

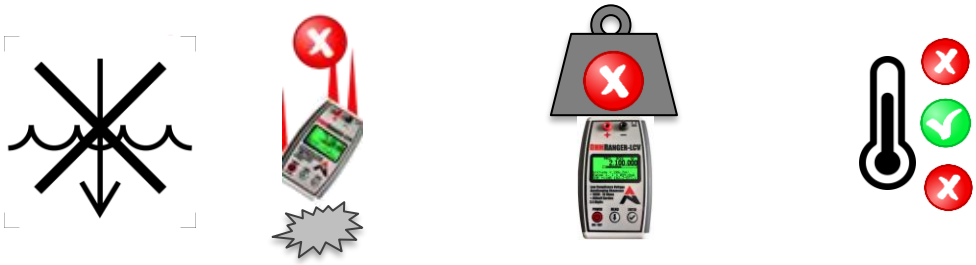
3 Safety

CAUTION! Please use ΩhmRanger-LCV® only as described in this Instruction Manual and the complementary Quick Start Guide, which is included with every device.

3.1 Using ΩhmRanger-LCV® Safely

3.1.1 Environmental Conditions:

- ΩhmRanger-LCV® is ***not*** intrinsically hazardous. Users should take the same care when using ΩhmRanger-LCV®, as they would with any other device for measuring resistance.
- ΩhmRanger-LCV® should ***not*** be connected to leads (USB, probe) greater than **3M** in length.
- ΩhmRanger-LCV® should ***not*** be exposed to:
  - Excess moisture, condensing humidity, liquid, or excessive dust
  - Shock
  - Excess Load
  - Heavy weights
  - Pressure to the screen area
  - Extremes of temperature (accuracy will be impacted)



3.1.2 Technical Life Span:

- ΩhmRanger-LCV® is guaranteed for a period of 2 years from the date of purchase.
- Periodic (every 1 year) recalibration is recommended to ensure continuing maximum accuracy (see Section 7.3 'Recalibration'), though no great diminution of accuracy with time is anticipated.

3.1.3 General Safety Information:

- Users should continue to observe usual safe working practices when using ΩhmRanger-LCV®.
- ΩhmRanger-LCV® is intended to be used in a controlled environment.
- ΩhmRanger-LCV® does ***not*** incorporate overcurrent protection.
- ΩhmRanger-LCV® uses a flame-retardant enclosure (Hammond 1553 series), Fire Class UL 94 HB.
- ΩhmRanger-LCV® meets UKCA, CE and FCC standards for radiated emissions and susceptibility to emissions.

3.1.4 Product Limitations and Restrictions:

- ΩhmRanger-LCV® is a cost-effective means of obtaining accurate readings of resistance, with a low compliance voltage. However, whilst every care is taken to ensure accuracy, no guarantee of accuracy is given or implied.

3.1.5 Installation Safety Information:

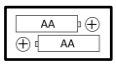
- ΩhmRanger-LCV® is delivered ready for use. With temperature and humidity variation in transit, Users should allow the device to acclimatise to the operating environment before use.

3.1.6 Maintenance Safety Information:

- ΩhmRanger-LCV® is ***not*** User-serviceable, or User-repairable. If ΩhmRanger-LCV® should fail to operate satisfactorily during its warranty period, please contact AltoNovus through the website to arrange for repair or replacement.

3.2 Guide to Graphical Symbols

3.2.1 Explanation of Graphics on the Packaging and Product

SYMBOL	MEANING
	Waste of Electrical and Electronic Equipment (WEEE) recycling. Dispose of electronics correctly.
	Mark of compliance with United Kingdom legislation and regulations.
	Mark of compliance with European Union legislation and regulations.
	Mark of compliance with Federal Communications Commission requirements.
	Battery polarity indicator. The User's serial number is also on this label, is found inside the battery compartment.

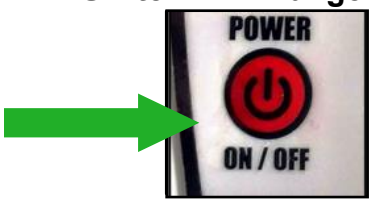
3.2.2 Explanation of Graphics in this Instruction Manual

SYMBOL	MEANING
	Do not immerse in, or expose to, liquid or dust.
	Avoid extremes of temperature.
	Precision electronic instrument. Do not drop.
	Do not subject to heavy weights or excess pressure, particularly in the screen area.
	No User-serviceable parts. Do not open unit.
	Only use a clean, dry cloth to clean unit.

4 Taking Manual Readings

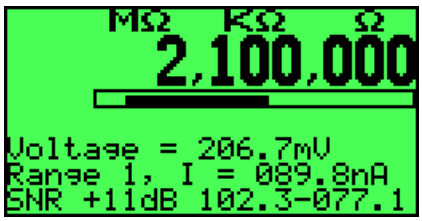
The following section explains how to take readings.

4.1 Switch ΩhmRanger-LCV® ON



Fit the batteries and connect User-supplied probes in accordance with the instructions at Section 2 above. Pressing the **Power** button will start the ΩhmRanger-LCV®.

Following **Power Up**, ΩhmRanger-LCV® will take a Reading approximately every 400mS, built up from 160 samples and averaged to tune out mains noise (both 50 Hz and 60 Hz) and to give an accurate Average over the period. By the time processing and displaying this information on the LCD is completed, the ΩhmRanger-LCV® takes about 2.5 Readings per second.



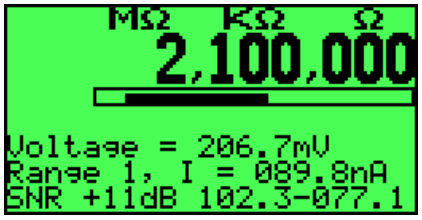
Looking at the screen above, the User can see that ΩhmRanger-LCV® displays the resistance in MΩ, KΩ and Ω, in this case, 2.1MΩ.

4.2 Automatic Range-Switching

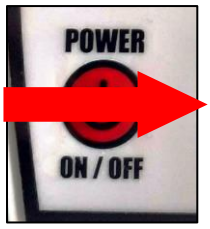
ΩhmRanger-LCV® is a variant of the NanoRanger®, which is an auto-ranging ammeter used to measure very low currents through decadal ranges. ΩhmRanger-LCV® measures the current coming in via the negative terminal, by measuring the voltage across an internal range resistance. ΩhmRanger-LCV® can measure currents as low as 1nA, by switching in different range resistances.

4.3 The Signal to Noise Ratio (SNR)

The **SNR** indicates how much noise, variation, and AC components are in the signal (higher resistances (lower currents) are more susceptible to noise). Also shown are the largest and the smallest samples that occurred whilst the ΩhmRanger-LCV® was building up the reading. Here for example, the largest sample is 102.3nA and the smallest is 77.1nA. Should the minimum sample hit **0** then the reading may be invalid, due to missing data. If this happens, the **SNR** will change to a negative contrast.



4.4 Switching ΩhmRanger-LCV® OFF



Press the **Power** button again, once readings are complete, to return ΩhmRanger-LCV® to Standby mode. Failing this, the automatic **Power Off Timer** will do so, according to the timeframe that the User has specified via the Menu.

5 Getting Connected - taking PC-Controlled Readings & SCPI Commands

To connect ΩhmRanger-LCV® to your computer, the User will require a **terminal programme** to log data. A useful programme is **RealTerm**.

- When you plug your ΩhmRanger-LCV® in, it should install the device driver for the FT230X. This should then be seen by your system as a **COM port.**
- **Right click** on the **Windows icon**, select **Device Manager**, then select **Ports (COM & LPT)**. The User should then see the **COM port with the port number** (e.g. USB Serial Port (COM3)).
- **Plug and Unplug** the ΩhmRanger-LCV®, to check it is operating through the appropriate **COM port**.
- Select the correct **COM port** in the **terminal programme.**
- Please note that the **port** may appear as **\VCPn port** under the port selection in **RealTerm**.

While ΩhmRanger-LCV® is USB *enabled*, the chip it uses converts output to Rs232. Set the baud rate to 57K6 on the port.

ΩhmRanger-LCV® is SCPI *compatible*, but with limited functionality. Hence, it is *not SCPI compliant* and cannot process commands whilst performing measurements. When entering SCPI commands, indicated by `Courier New` font, only the portions with capital letters MUST be entered; the remainder can be left out. The commands below can be entered through the USB interface, via a COM port on a simple terminal programme. Commands / responses are terminated with a Line Feed.

5.1 SCPI Mandated Commands:

`*CLS` This command clears the event registers and queues.
`*ESE` This command sets bits in the Status Enable Register of the Standard Event Register.
`*ESE?` This command queries bits in the Status Enable Register of the Standard Event Register.
`*ESR` This command reads and clears the contents of the Standard Event Status Register.
`*IDN?` This command retrieves the identification string of the device:

AltoNovus, ΩhmRanger-LCV,nnnnnnn,yyyy
Where nnnnnnn = serial number
yyyy = software version

`*OPC` This command sets the operation complete (OPC) bit after all pending commands have been executed.
`*OPC?` This command queries the OPC bit.
`*RST` This command resets the device settings to their default values.

*SRE This command sets or clears the bits of the Service Request Enable Register.
*SRE? This command queries the bits of the Service Request Enable Register.
*STB? This command collects the status byte of the device.
*WAI This command postpones the execution of subsequent commands, until all previous overlapped commands are finished (Not Used).

5.2 SCPI Required Commands:

SYSTem:ERRor[:NEXT]? This command returns the oldest unread error message from the event log and removes it from the log.
SYSTem:ERRor:COUNt? This command returns the number of errors in the event log.
SYSTem:VERSion? This command queries the present SCPI version.
STATus:QUEStionable[:EVENt]? This command reads the Questionable Event Register.
STATus:QUEStionable:ENABle This command sets the contents of the Questionable Event Register.
STATus:QUEStionable:ENABle? This command reads the contents of the Questionable Event Register.
STATus:PRESet This command resets all bits in the status model.

5.3 Device Commands (Routine Use)

The commands below are used to control the functionality of the ΩhmRanger-LCV®. When a ΩhmRanger-LCV® is powered up, it is controlled via the front panel buttons. In this mode, it will output its measurement through the USB in the form below. All resistances are in units of Ohms:

+2.1E+06<CR><LF>

This will be output continuously. In the example above, it is **2.1MOhm**.

To enable the device to be controlled via SCPI, a ***RST** command must be issued. This will stop all output and the operation of the device until it receives commands telling it what to do.

5.3.1 Save (*SAV) and Recall (*RCL)

*SAV This command will save all the changes the User has made into flash memory, so that they can be recalled later.
*RCL This command will retrieve the saved changes made. When entering SCPI mode with ***RST** the device will be in its default state.

5.3.2 Power OFF (SYSTem:POWer)

SYSTem:POWer This command will turn the ΩhmRanger-LCV® OFF, similar to the power button on the front panel.

5.3.3 LCD Backlight (CONFigure:LED)

`CONFigure:LED` **<0,1>** This command will turn the LCD backlight LED **On** or **Off**. 0 = off, 1= On. For example:

`CONFigure:LED 0` This command turns the backlight LED **Off**.

`CONFigure:LED?` This command returns the backlight LED status. For example:

```
CONFigure:LED?
1
```

5.3.4 Powerdown Settings (CONFigure:POWerdown)

`CONFigure:POWerdown` **<0..5>** This command sets the timer to automatically **Powerdown**. Any command received through the USB interface will restart the timer. The options are:

0 = Off
1 = 30 minutes
2 = 1 hour
3 = 2 hours
4 = 4 hours
5 = 8 hours

`CONFigure:POWerdown?` This command will return the current **Powerdown** timer setting.

5.3.5 Reading (READ?, MEASure?, INITiate)

`READ?` This command initiates a reading. It is the same as `MEASure?` and `INITiate`. For example:

+2.1E+06<CR><LF>

Measurement is **2.1MOhm**.

5.3.6 Triggering (TRIGger:COUnt)

`TRIGger:COUnt` This command sets the number of triggers for a measurement. Each measurement takes 400mS. Setting a trigger count of **5** and the issuing a `READ?` command will result in **5** measurements being taken. When not in SCPI mode, the trigger count is essentially set to *infinite*, with measurements being taken continuously.

`TRIGger:COUnt?` This displays the number of triggers.

5.3.7 4 Beep reading (CONfigure:BUZzer)

`CONFigure:BUZzer` **<0..4>** This command sets the tolerance for the 4 beep reading mode of the ΩhmRanger-LCV™. There are **4** ranges, as detailed below.

0 = Off
1 = 1%
2 = 2%
3 = 5%
4 = 10%

`CONFigure:BUZzer?` This displays the setting value.

5.3.8 Voltage (CONfigure:VOLtage)

`CONFigure:VOLtage` **<0..3>** This command sets the voltage output for the ΩhmRanger-LCV®. There are **4** ranges, as detailed below. However, options 2 & 3 should not be used, as they are for calibration purposes only.

0 = 380mV
1 = 206mV
2 = 48mV
3 = 43mV

`CONFigure:VOLtage?` This displays the setting value.

5.4 Device Commands for Advanced Use only (not normally required)

5.4.1 Range Settings (`CONFigure:RANge`)

`CONFigure:RANge` **<0..8>** This command sets the range resistance of the ΩhmRanger-LCV®. There are **9** ranges, as detailed below.

0 = 2M
1 = 200K
2 = 20K
3 = 2K
4 = 200R
5 = 20R
6 = 2R
7 = 200mR
8 = 50mR

CONFigure:RANge? This command returns the resistance range setting of the ΩhmRanger-LCV®, as well as the maximum and the minimum ranges. For example:

CONFigure:RANge? **7,8,7**
Resistance range is **7**, maximum range is **8**, minimum range is **7**.

CONFigure:RANge:MAXimum **<0..8>** This command sets the maximum range of the ΩhmRanger-LCV®. On Powerup, or *RST the maximum range will be **8**.

CONFigure:RANge:MAXimum? This command returns the current maximum range setting of the ΩhmRanger-LCV®.

CONFigure:RANge:MINimum **<0..8>** This command sets the minimum range of the ΩhmRanger-LCV®. On Powerup, or *RST the maximum range will be **0**.

CONFigure:RANge:MINimum? This command returns the current minimum range setting of the ΩhmRanger-LCV®.

5.4.2 Reset Readings (CONFigure:CURRent)

CONFigure:CURRent This command resets the currently held minimum/maximum measurement values and the minimum/maximum sample values. This command also resets the Measurement's running Average current calculation and time count.

5.4.3 Maximum/Minimum Current (MEASure:CURRent:Maximum?)

MEASure:CURRent:MAXimum? This command displays the maximum and minimum current readings since Powerup, or issues the CONFigure:CURRent command. For example:

+3.1E-06,+2.71E-09<CR><LF>

Maximum measurement **3.1uA**, minimum measurement **2.71nA**.

5.4.4 Maximum/Minimum current samples (MEASure:SAMples:Maximum?)

MEASure:SAMples:MAXimum? This command displays the maximum and minimum samples taken since Powerup, or issues the CONFigure:CURRent command. For example:

+3.1E-06,+2.71E-09<CR><LF>

Maximum sample **3.1uA**, minimum sample **2.71nA**.

6 Storage, Transportation and Disposal

Instructions for storage, transportation, and safe disposal of ΩhmRanger-LCV® follow.

6.1 Storage

- AltoNovus recommends that the User removes the batteries from ΩhmRanger-LCV® prior to any prolonged period of storage.
- Avoid storing ΩhmRanger-LCV® in areas of high humidity.

6.2 Packaging and Transportation

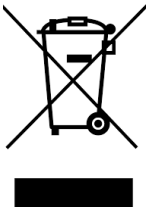
- Batteries should be removed from ΩhmRanger-LCV® prior to commercial transportation.
- Ensure ΩhmRanger-LCV® is well insulated against shocks during transportation.

6.3 Disposal

Disposal instructions follow.

6.3.1 Disposal of Electronic Components

- ΩhmRanger-LCV® should be disposed of safely, in accordance with local regulations for electronic products.
- ΩhmRanger-LCV® can be returned to the manufacturer for safe recycling and disposal.



6.3.2 Disposal of Packaging Waste

- A high proportion of ΩhmRanger-LCV®'s packaging is recyclable. Please recycle where possible.

6.3.3 Disposal of Batteries

- Please dispose of batteries in accordance with local regulations and manufacturer's instructions.

7 Maintenance

CAUTION! ΩhmRanger-LCV® has no User-serviceable parts. Users should ***not*** attempt maintenance other than routine battery replacement and surface cleaning (as necessary).

7.1 Replacing the Batteries

- ΩhmRanger-LCV® uses 2 x AA batteries, which should give over 150 hours of normal operation, before requiring replacement. To replace the batteries, follow the instructions at Section 2.7.1. Batteries should be stored and disposed of in accordance with manufacturer's instructions.

7.2 Cleaning

- Should ΩhmRanger-LCV® need its surface cleaning, only use a soft, dry cloth and avoid the application of excessive pressure, particularly in the area of the screen.

7.3 Recalibration

- Each ΩhmRanger-LCV® is factory calibrated shortly before its despatch to the User and should remain highly accurate over time (12+ months). However, a recalibration service is available. Please contact AltoNovus at info@altonovus.com for details.

DOCUMENT ENDS