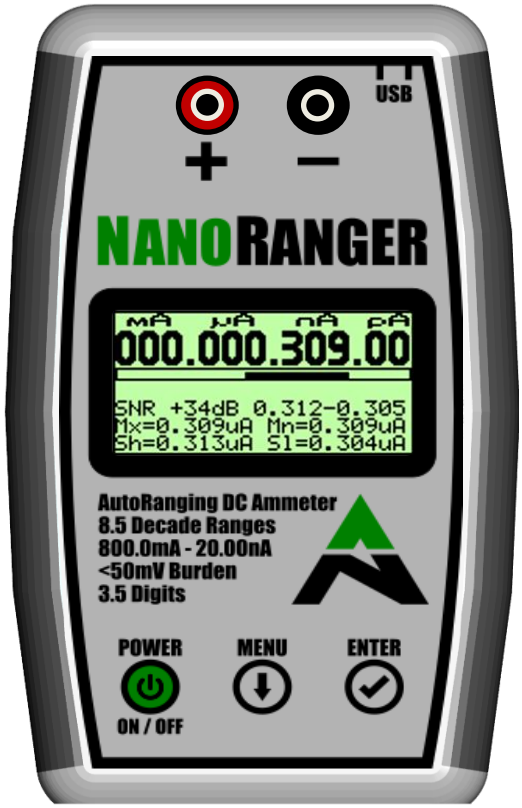
Instruction Manual

NANORANGER

NR-01 Auto-Ranging Direct Current (DC) Ammeter



Disclaimer

NanoRanger is a factory-calibrated, highly accurate ammeter, intended for measuring low levels of current. It is aimed at the hobbyist and professional User. NanoRanger is not intended to replicate the full functionality of bench equipment. Instead, it aims to provide a portable and most affordable means of measuring low current levels, during the development of power-efficient designs. It is not intended to and should NOT be used to measure current levels above 0.8A.

If used in any manner other than that expressly set out in 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 use or malfunction.

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Document Revisions

DATE	VERSION NUMBER	DOCUMENT CHANGES
15 Nov 19	2.2 (Software Release 1.12)	Launch Release
05 Jan 20	2.3 (Software Release 1.12)	Added notes to Section 5
08 Mar 20	2.4 (Software Release 1.12)	Added notes to Section 2
10 Mar 20	2.5 (Software Release 1.12)	Added notes, Sections 2, 4
28 May 20	2.6 (Software Release 1.12)	Added notes to Section 5
14 Nov 20	2.7 (Software Release 1.12)	Added notes to Section 4

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

NAME	ROLE TITLE
Geoff Dean	Managing Director
Steve Thickett	Technical Director

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Preface

1.1 The User

NanoRanger is not a toy. It is a precision instrument and should be treated accordingly. It is aimed at the hobbyist, maker and professional User community. This Manual assumes a level of technical expertise on the User's part. NanoRanger should not be used by those without a knowledge of safe working on electronics. This Manual covers the use and operation of NanoRanger. It does NOT cover calibration or maintenance, 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 NanoRanger and / or minor injury to Users.

1.4 Obtaining Documentation and Information

1.4.1 Internet

The latest version of the documentation is available at the following address: http://www.altonovus.com.

1.4.2 Ordering Documentation

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

1.4.3 Documentation Feedback

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

2 NanoRanger

2.1 Utility and Employment

NanoRanger is an accurate, affordable, auto-ranging DC ammeter for the measurement of very low currents. As people strive for more efficiency from new and existing products, the measurement of current consumption of devices is becoming more critical. Previous solutions to this challenge ranged from very expensive ammeters (thousands of pounds), to cheaper solutions that only have limited manual ranges.

The NanoRanger is a solution to these challenges, as it provides a 3.5-digit, 9 range ammeter that can switch over 8.5 decades (from 800mA to 1nA), with resolutions down to 10pA. It features:

- A 128 x 64mm LCD display, giving a wealth of information about the User's current readings.
- This large 11-digit display shows the User mA, uA, nA, pA, all on one line.
- A SNR display shows how much noise, or AC, is present on the current signal.
- A range bar shows which range the User is in, plus the minimum / maximum range settings.
- Minimum and maximum ranges can be adjusted to limit the auto-ranging, or just to fix it at 1 range.
- An automatic **Power Off** timer, and configurable **LED backlight**, enables the User to maximise battery life.

Readings are completed approximately every 300mS, with samples collected every 170uS and averaged out over 200mS to remove most of the mains noise associated with circuits (50Hz and 60Hz).

An averaging mode, restricted to measurements within a single range, allows the User to run the sampling for however long the User chooses. When finished, it reports the average current, time, and total charge in mAh or smaller. This enables the User to use it to measure the charge of specific events; e.g. a device coming out of **Standby** to make a radio transmission.

2.2 Theory of Operation

NanoRanger is powered by 2 x AA batteries (not supplied), generating approximately 3V. This is fed into a buck-boost power converter to produce 3.3V that powers the system. NanoRanger will continue to work down to approximately 2V on the batteries.

Pressing the **Power On** button starts the NanoRanger. Pressing the **Power On** button *again* powers off the NanoRanger. Standby current, when powered off, is approximately 10nA.

The current to be measured is connected through the Positive and Negative terminals of the NanoRanger. Current *must* flow from the Positive terminal to the Negative terminal.

A switch bank selects the appropriate load resistor to put across the terminals. The current flowing through the terminals generates a voltage across the resistor. If the voltage increases beyond 45mV, then the load resistor is switched to a higher current resistor and the readings are restarted.

The voltage across the load resistor is amplified by a x50 amplifier and filter, before entering an Analogue to Digital Converter (ADC).

The ADC is 12-bit, which then oversamples and automatically averages to produce a 16-bit result. Samples are taken approximately every 170uS. These are then built up over a period of 200mS to average out and eliminate most mains-based noise (50 and 60Hz). Factory set calibration compensation is applied to the result, to give an accurate reading. The reading is displayed on the LCD, which takes approximately 60mS to update. A new reading is then started.

A range produces readings up to approximately 2500. If the reading is below 150, then the range is switched down before starting the next reading. If the reading is above 2150 at any time, then the range switches up immediately and the reading is restarted.

Fast up-range switching is needed when a device under test comes out of standby mode. The NanoRanger can switch up a range in less than 30uS and change from the lowest to the highest range in approximately 200uS.

Down-range switching is initiated after a reading has been completed and when the reading is below the down-range threshold. This is so that the User achieves a complete reading if the current is switching quickly between ranges (fast up, slow down).

The minimum and maximum range settings can be adjusted so that no range switching down or up will occur (necessary, for example, for the Measure Average function).

2.3 Technical Data

UNIT	PHYSICAL PARAMETERS
Weight (incl batteries)	Approximately 200g
Length x Width x Depth	148 x 90 x 30 mm

Accuracy specifications +/- % of range:

RANGE	RESOLUTION	BURDEN VOLTAGE	RESISTANCE	ACCURACY
20.00nA	10pA	< 0.05V	2M	< 1%
200.0nA	100pA	< 0.05V	200K	< 0.5%
2.000uA	1nA	< 0.05V	20K	< 0.3%
20.00uA	10nA	< 0.05V	2K	< 0.3%
200.0uA	100nA	< 0.05V	200R	< 0.3%
2.000mA	1uA	< 0.05V	20R	< 0.3%

20.00mA	10uA	< 0.05V	2R	< 0.3%
200.0mA	100uA	< 0.05V	0R2	< 0.3%
800mA	1mA	< 0.05V	0R05	< 0.5%

- Burden voltage is for full 2500 fixed range. Range switching occurs at around 0.045V.
- 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

NanoRanger is certified CE and FCC compliant. A supporting Technical File is available to Competent Authorities.

2.5 Guide to Product

A - Positive Terminal

B - Negative Terminal

C - Display Screen

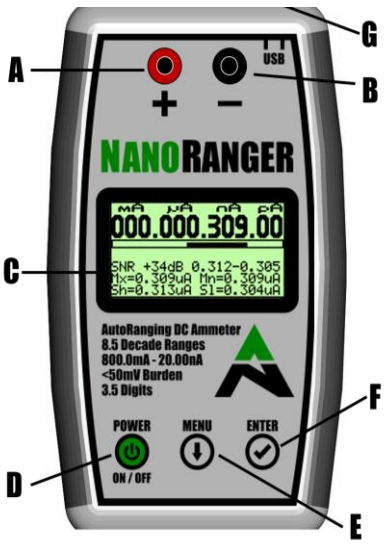
D - On / Off Button

E - Menu Navigation

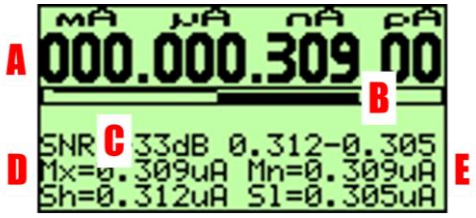
F - Select Button

G - Isolated USB Interface

H - Battery Compartment



2.6 Understanding the User Interface



A - The current reading, displayed in mA, uA, nA, and pA. In this example, 0.309uA.

B - The small, lower Range Bar shows which ranges are in use. The upper, longer Range Coverage Bar shows movement across the ranges during the reading. The box surrounding both shows what range constraint has been input via the menu. In this example, none.

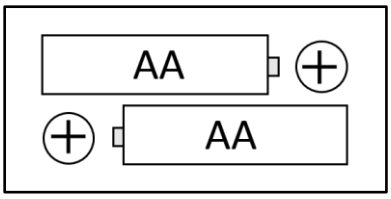
C - The Signal to Noise Ratio (SNR). The SNR indicates how much (Min and Max) noise, variation, and AC components are in the signal, followed by Maximum and Minimum samples during the reading.

D - Maximum (Mx) and **E** – Minimum (Mn). The Mx and Mn Readings are the largest and smallest that have occurred since measurement started. Below that, the maximum (Sh) and minimum (Sl) samples are shown, from which the Readings are derived.

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 will give in excess of 150 hours of continuous operation. Treat and dispose of all batteries in accordance with manufacturer's instructions.

2.7.2 Removing the Protective Film

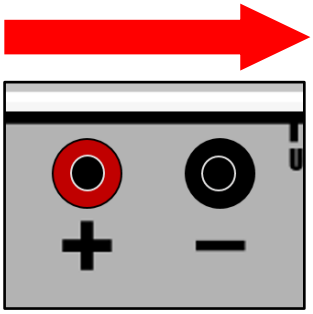
If desired, remove the protective film from the front of the NanoRanger unit.
Peel carefully from below the Positive and Negative terminals.
NanoRanger will still function normally if the User chooses to leave the film in place.

2.7.3 Attach Feet (if desired)

NanoRanger 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 NanoRanger during use.

2.7.4 Connecting User Probes

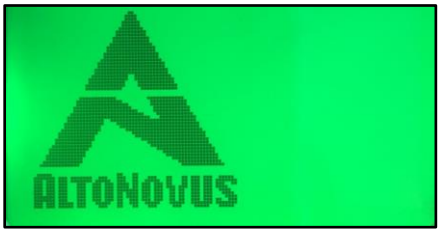
Using User Probes (not supplied), connect the Positive terminal (RED) to the higher voltage side of the current to be measured. Connect the Negative terminal (BLACK) to the lower voltage side of the current to be measured. Current *must* flow from Positive to Negative, for the NanoRanger to function. Leads should be industry standard, uninsulated, 4mm banana plug type. As short a lead as practicable (0.3M) will help minimise noise during low current measurement.



2.7.5 Controls

Firstly, ensure batteries are fitted in accordance with 2.7.1 (above). Three buttons control the operation of the NanoRanger; **Power**, **Menu**, and **Select**. Pressing the **Power** button will start the NanoRanger. Two start-up screens will display whilst loading the code:

One with the AltoNovus logo:



The second with battery voltage*, software release (here ALT-1.11), NanoRanger serial number (here 1933200), calibration date and load status. Measurement can then commence (See Section 4).

* Note: the most accurate indication of remaining battery life will be at device **Powerdown**.

2.8 NanoRanger Menu Structure

NanoRanger has several features accessible through the **Menu**. Press the **Menu** button to exit measuring and enter the menu mode. The screen below will appear:

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

- Measure.

- Range Maximum.
- Range Minimum.
- Measure Average.
- Advanced.

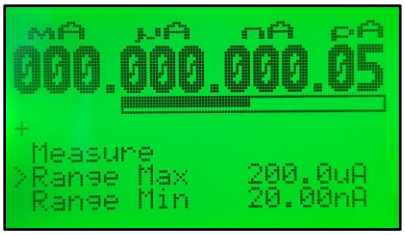
These **Menu** options *may* change in the future. NanoRanger software updates will be available from time to time. Register for notifications at info@altonovus.com.

2.8.1 Measure

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

2.8.2 Range Max

This feature sets the maximum range to move up to. Press the **Select** button to scroll through the ranges.

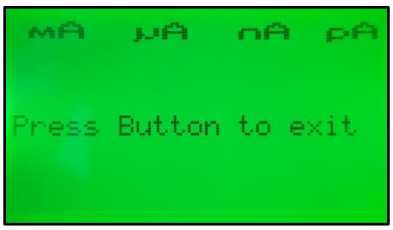


2.8.3 Range Min

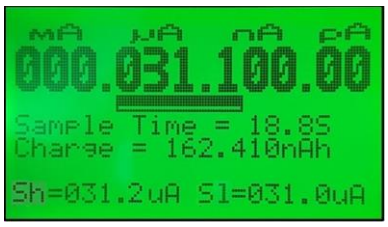
This feature sets the minimum range to move down to. Press the **Select** button to scroll through the ranges.

2.8.4 Measure Average (within a Single Range)

This feature calculates an average current over a longer period. The display is not updated until the **Select** button is pressed to stop the average reading:



The following screen will then be displayed:



- The average current is shown over the period. In this case, 31.1uA.
- The sample time is shown in multiples of 200mS. In this case, 18.8 seconds.
- The total charge for the period is shown. In this case, 162.410nAh.
- The maximum (Sh) and minimum (Sl) 200mS samples in the period are shown.

When taking an average reading, the range should *not* be allowed to change, as this will affect the results. Ensure that the minimum and maximum ranges are set to **fix the range to the single range** that will cover the largest current expected.

2.8.5 Advanced Menu

Configuration in this menu is saved to Non-Volatile memory and restored on **Power up**. This feature gives two options:

- **Powerdown** that enables the automatic **Power Off** timer. Timer starts at the last key press. Options are; Off, 30mins, 1hr (Default), 2hrs, 4hrs, and 8hrs.
- **LCD Light** that enables / disables the LCD backlight.

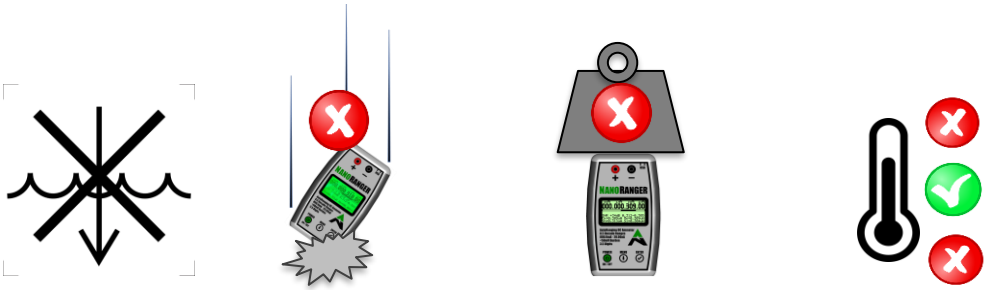
3 Safety

CAUTION! NanoRanger is designed to measure low levels of current. Do ***not*** expose to excess load. Excess load can result in component failure.

3.1 Using NanoRanger Safely

3.1.1 Environmental Conditions:

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



3.1.2 Technical Life Span:

- NanoRanger 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').

3.1.3 General Safety Information:

- Users should continue to observe usual safe working practices when using NanoRanger.
- NanoRanger is intended to be used in a controlled environment, to measure levels of current within its operating range (<800mA).
- If in doubt, Users should check current levels with another instrument before employing NanoRanger to obtain higher accuracy readings. NanoRanger does ***not*** incorporate overcurrent protection, as this would inhibit accuracy at low current levels.
- NanoRanger uses a flame-retardant enclosure (Hammond 1553 series), Fire Class UL 94 HB.

- NanoRanger meets CE and FCC standards for radiated emissions and susceptibility to emissions.

3.1.4 Product Limitations and Restrictions:

- NanoRanger is a cost-effective means of obtaining highly accurate readings of current. However, while every care is taken to ensure accuracy, no guarantee of accuracy is given or implied.

3.1.5 Installation Safety Information:

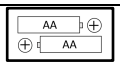
- NanoRanger is delivered ready for use. With temperature variation in transit, Users should allow the device to acclimatise to the operating environment before use.

3.1.6 Maintenance Safety Information:

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

3.2 Guide to Graphical Symbols

3.2.1 Explanation of Safety Information on the Packaging and Product

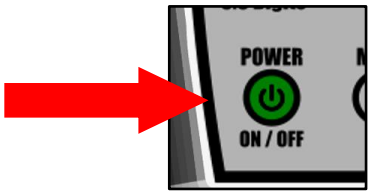
SYMBOL	MEANING
	Waste of Electrical and Electronic Equipment (WEEE) recycling. Dispose of electronics correctly.
	Mark of compliance with European Union legislation and regulations.
	Mark of compliance with Federal Communications Commission requirements.
	Battery polarity indicator. The User's serial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

3.2.2 Explanation of Graphical Symbols in this Instruction Manual

SYMBOL	MEANING
	Do not immerse in, or expose to, liquid.
	Avoid extremes of temperature.
	Precision electronic instrument. Do not drop.
	Do not subject to heavy weights or excess pressure.
	No User-serviceable parts. Do not open unit.
<=1.0A >1.0A	Do not exceed maximum load.
	Only use a clean, dry cloth to clean unit.

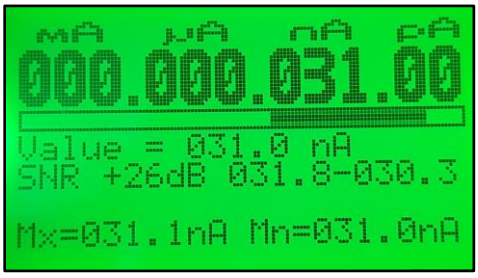
4 Taking Manual Readings

4.1 Switch NanoRanger 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 NanoRanger.

Following start-up, NanoRanger will take 1073 samples to build up a reading over 200mS. This is undertaken to eliminate mains noise at both 50Hz and 60Hz and to give an accurate average over the period. By the time processing and displaying this information on the LCD is completed, the NanoRanger averages about 3 readings per second.



Looking at the screen above, the User can see that it displays the current in mA, uA, nA, and pA. In this example, 31.0nA.

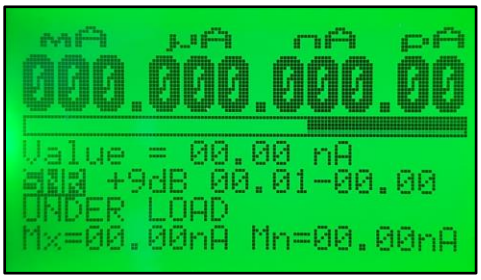
4.2 Automatic Range-Switching

The range switches up (to a higher range) in approximately 30uS. When the current rises above 2150 in whatever range the User is in, then the reading is immediately aborted, and the range increased. This cycle is repeated until the range covers the input current. **Note:** *If the maximum range is set, the range will not automatically increase.*

CAUTION! Care must be taken, as the burden voltage will increase and may result in damage, if excessive voltages are encountered across the input terminals.

The range switches down when the completed reading is below 150. This is achieved so swiftly that range switching does not occur going down ranges, but the User will see that the range has changed because of a low value. For example, on powering up, the User will see the range bar move down over 2 seconds to the bottom range, when nothing is plugged into the NanoRanger.

The **Value** is displayed in a 4-digit format that also tells the User which range is in operation: e.g. 200.0nA.

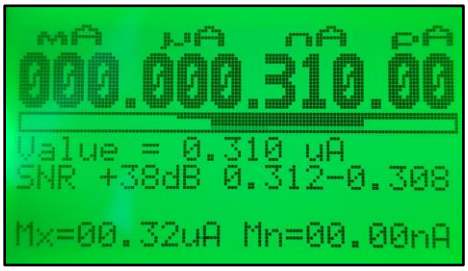


UNDER LOAD indicates that the threshold has been reached at which NanoRanger would usually switch down to the range below. Users might see **UNDER LOAD** displayed where a lower limit to ranging has been set. **UNDER LOAD** will also display when NanoRanger is in **Power On** mode, but nothing is connected to it.

4.3 Setting the Range Limit

Via the **Menu**, it is possible to define the range across which NanoRanger will operate. The range bar underneath the digits shows which ranges are currently in use, moving left and right to confirm the range. The range bar oscillates vertically after each reading to show how fast readings are occurring and to provide visual confirmation that the device is functioning properly.

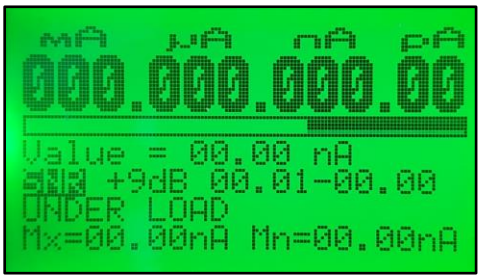
The rectangle around the range bar shows how far the range *can* move. In this example, it can cover all possible ranges, but it is configurable with the **Mx** (maximum) and **Mn** (minimum) range functions and so the User can fix and limit the range. **This is needed for accurate use of the Measure Average function**.



4.4 The Signal to Noise Ratio (SNR)

The **SNR** indicates how much noise, variation, and AC components are in the signal. It shows the maximum and minimum samples that occurred whilst the NanoRanger was building up the reading. For example, largest sample 31.8nA and smallest 30.3nA. In this case, the current is constant. The explanation for *noise* is mains power at 50Hz being picked up by the test leads. When the minimum sample hits **0** then the reading may be invalid, due to missing data.

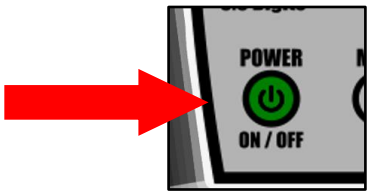
If this happens, the **SNR** will change to a negative contrast, as shown in the **Power-Up** screen below:



4.5 Maximum and Minimum Readings (Mx & Mn)

The **Mx** and **Mn** readings are the maximum and minimum readings that have occurred since the User started measuring; e.g. maximum 31.1nA and minimum 31.0nA. These values will be reset on exiting the measuring function.

4.6 Power Off



Press the **POWER** button again, once readings are complete, to return NanoRanger to **Standby** mode. Failing this, the **Power Saver** will do so, according to the timeframe that the User has specified.

5 Getting Connected: Taking PC-Controlled Readings & SCPI Commands

To connect NanoRanger to your computer, you will require a **terminal programme** to log data. A useful programme is **RealTerm**.

- When you plug your NanoRanger 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 your **Windows icon**, select **Device Manager**, then select **Ports (COM & LPT)**. You should then see the **COM port with the port number** (e.g. USB Serial Port (COM3)).
- **Plug and Unplug** your NanoRanger, to check that you are 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 NanoRanger is USB *enabled*, the chip it uses converts output to Rs232. Set the baud rate to 57K6 on the port.

NanoRanger 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,NanoRanger,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:

The commands below are used to control the functionality of the NanoRanger. When a NanoRanger 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 currents are in units of Amperes and all power measurements in units of Ampere Hours:

+6.4E-10<CR><LF>

This will be output continuously. In the example above, it is **0.64nA**.
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 at a later time.
`*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 NanoRanger 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 Range Settings (`CONFigure:RANge`)

`CONFigure:RANge` **<0..8>** This command sets the range of the NanoRanger. There are **9** ranges, as detailed below. Do Not subject the NanoRanger to currents above the selected range, as this may damage the device:

0 = 20.00nA
1 = 200.0nA
2 = 2.000uA
3 = 20.00uA
4 = 200.0uA
5 = 2.000mA
6 = 20.00mA
7 = 200.0mA
8 = 800mA

`CONFigure:RANge?` This command returns the current range setting of the NanoRanger, as well as the maximum and the minimum ranges. For example:

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

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

`CONFigure:RANge:MAXimum?` This command returns the current maximum range setting of the NanoRanger.

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

`CONFigure:RANge:MINimum?` This command returns the current minimum range setting of the NanoRanger.

5.3.6 Samples (`CONFigure:SAMples`)

`CONFigure:SAMples` **<0,1>** This command enables/disables the sending of sample information with the main current measurement. **0** = off, **1**= On.

The sample information will be added to the main measurement with maximum sample during the measurement first, and minimum sample during the measurement last. For example:

+6.4E-10,+2.71E-09,+0<CR><LF>

Measurement **0.64nA**, maximum sample **2.71nA**, minimum sample **0**.

`CONFigure:SAMples?` This command returns the sample sending status.

5.3.7 Reset Readings (`CONFigure:CURRent`)

`CONFigure:CURRent` This command resets the currently held minimum/maximum measurement values and the minimum/maximum sample values.

5.3.8 Max/Min 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**.

5.3.9 Max/min 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**.

5.3.10 Reading (`READ?`, `MEASure?`, `INITiate`)

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

+3.1E-06<CR><LF>

Measurement is **3.1uA**.

5.3.11 Triggering (`TRIGger:COUnt`)

`TRIGger:COUnt` This command sets the number of triggers for a measurement. Each measurement takes 200mS. 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. When used with the `MEASure:AVERage` command, it sets the time for measurement in units of 200mS, 5 counts per second.

5.3.12 Average Power Measurement (`MEASure:AVERage?`)

`MEASure:AVERage?` This command measures the average power over a period of time. The time is set by the `TRIGger:COUnt` above. After the measuring has finished, the average power in Ah (Ampere Hours) is displayed. When using this command, the range should be fixed to cover the maximum current encountered. Any range changes will affect the result and make it inaccurate. For example:

. `TRIGger:COUnt 20` Sets trigger for 4 seconds
`CONFigure:RANge 6` Sets the range to 20.00mA
`MEASure:AVERage?` Starts the averaging measurement
After 4 seconds
+1.111E-06
1.111uAh. The average current can be worked out as 1mA over the 4 second period.

6 Storage, Transportation and Disposal

6.1 Storage:

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

6.2 Packaging and Transportation:

- Batteries should be removed prior to commercial transportation.
- Ensure NanoRanger is well insulated against shocks during transportation.

6.3 Disposal

6.3.1 Disposal of Electronic Components:

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

6.3.2 Disposal of Packaging Waste:

- A high proportion of NanoRanger's packaging is recyclable. Recycle where possible.

6.3.3 Disposal of Batteries:

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

7 Maintenance

CAUTION! NanoRanger has no User-serviceable parts. Users should ***not*** attempt maintenance beyond routine battery replacement and surface cleaning (as necessary).

7.1 Replacing the Batteries:

- NanoRanger 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 NanoRanger 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 NanoRanger is calibrated shortly before its dispatch to the User and should remain highly accurate over time (12+ months). However, a recalibration service is available. Please visit www.altonovus.com for details.