

RCON™

USER MANUAL

Laboratory Device for Testing the
Bulk Electrical Resistivity of Concrete



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Giatec Scientific Inc.

245 Menten Pl #300,
Nepean, ON K2H 9E8

Support@giatec.ca

+1 877-497-6278
www.giatec.ca

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PACKAGE CONTENTS

Part	Qty	Picture
RCON2™ Measurement Device	1X	
Threaded rods with knobs	4X	
Sample Holder Bottom Plate	1X	
Sample Holder Top Plate	1X	
Contact Sponge	2X	
Verification Kit	1X	

Fresh Concrete Probe 1X



Alligator Test Clips 2X



Connection Cables 2X



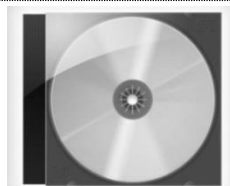
USB Cable 1X



Power Cord 1X



RCON2™ Data Monitor Software 1X



* Please note that the images above are for illustration purposes only and may not be to scale.

WARRANTY

Limited Warranties

Giatic warrants the Product against defects in materials and workmanship under normal use (the “Warranty”) for a period of 12 months from the Delivery Date (the “Warranty Period”), on the condition that the Product has been completely paid for. Unless as otherwise mandated by local law, the Warranty Period does not restart if Customer receives a replacement appliance and/or replacement Software. This Warranty does not apply: (a) to consumable parts, such as batteries, Plexiglas cell units and cables unless damage has occurred due to a defect in materials or workmanship; (b) to cosmetic damage, including but not limited to scratches, dents and broken plastic on ports; (c) to damage caused by accident, abuse, misuse, neglect or failure to properly maintain (to include but not limited to water damage and/or condensation or improper temperatures during storage), or improper installation; (d) to damage caused by electrical disturbances or acts of God, to include but not limited to civil disturbance, war, flood, fire, rodents or insects; (e) where manufacturer’s serial numbers and security labels have been removed from the Product; and (f) to damage caused during shipment (due to Customer’s improper packaging) from Customer to Giatic in the case of Product returns for repair.

Giatic disclaims all other warranties, express or implied, including without limitation implied warranties of merchantability, fitness for a particular purpose, or against hidden or latent defects. Giatic’s responsibility for warranty claims is limited to repair or replacement. Giatic reserves the right to modify this Warranty at any time, at its sole discretion, and with notice to Customer.

Giatic does not warrant that the operation of the Product will be uninterrupted or error-free. Giatic is not responsible for damage arising from failure to follow instructions relating to the Product’s use. This Warranty is voided immediately if repair, modification (to include upgrades, expansions or usage or addition of non-manufacturer parts or accessories),

alteration or other service is attempted other than by Giatec. In this regard, the integrity of the appliance casing (aka the box) should not be violated for any reason, unless expressly authorized by Giatec in writing.

THE WARRANTY SET FORTH IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. GIATEC SCIENTIFIC INC. SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.


** Please refer to the complete Terms and Conditions of Giatec's products for more details.*

** The information contained in this document is subject to change without notice.*

SAFETY INSTRUCTIONS

This chapter contains important safety instructions that the user must follow for operation and storage of Giatec RCON2™. Read the following safety information before any operation to ensure your safety and to keep the instrument in good condition. Keep the user manual in a safe place for future reference.

SAFETY SYMBOLS

In order to ensure the safety of the operator, and increasing the service life of the instruments, pay attention to safety precautions described in this manual. These messages are indicated by a  symbol throughout this user manual.

- | | |
|------------|---|
| WARNING: | Identifies conditions or practices that could result in injury or loss of life. |
| CAUTION: | Identifies conditions or practices that could result in damage to Giatec RCON2™ or to other properties. |
| ATTENTION: | Refer to the User Manual |

GENERAL GUIDELINES

1. Always follow basic safety precautions when using this product to reduce risk of injury from fire or electric shock.
2. Read and understand all instructions in the documentation that comes with Giatec RCON2™.
3. Observe all warnings and instructions marked on the product.

DEVICE HANDLING



CAUTION

Giatec RCON2™ device is a delicate testing instrument. The electronic parts and sample holder are especially sensitive components. Please handle them with care.

- Do not place any heavy objects on RCON2™ Measurement device
- Avoid severe impact or rough handling that might damage the device or the sample holder.
- Do not disassemble RCON2™.
- Install the product in a protected location where no one can step on or trip over the power cord and in a location where the power cord cannot be damaged.

OPERATION



WARNING

- AC Input voltage: 100 ~ 240 V, 50/60Hz.
- Leave at least 100mm (4 in) behind RCON2™ to allow for ventilation.
- Do not perform measurement on or connect the test leads to circuits directly connected to Mains (Live circuit).
- Keep the instrument in a place where the chance of spilling liquids on the device is low.

CLEANING THE INSTRUMENT



ATTENTION

- Unplug this product from wall outlets before cleaning.
- Use a soft cloth dampened in isopropanol alcohol or water.

Do not use chemicals or cleaners containing harsh products such as benzene, toluene, xylene, and acetone.

OPERATION ENVIRONMENT



ATTENTION

- Place the instrument in a well-ventilated area.
- Avoid blocking the fan output at the rear of the instrument.

STORAGE ENVIRONMENT



ATTENTION

- Location: Indoor
- Relative Humidity: 5% to 90%
- Temperature: 0°C to 70°C

INTRODUCTION TO GIATEC RCON2™

Giatic RCON2™ is an advanced tool for measuring the bulk electrical resistivity of concrete. RCON2™ is designed based on the AC impedance spectroscopy technique. It provides a fast and accurate approach for measuring the resistivity of different types of cementitious composites.

The device can be operated as a stand-alone unit for measuring the electrical resistivity. Alternatively, it can be controlled using the Data Monitor software (for PC). This Data Monitor software provides a user-friendly environment to set up and run different test programs. The software provides real-time data visualization (tabulated data and live chart), and provides a convenient way to save the test results.

ELECTRICAL RESISTIVITY OF CONCRETE

Durability of concrete depends largely on the properties of its microstructure such as pore network size and interconnections. A finer pore network with lower connectivity leads to lower permeability. Porous microstructure with a higher degree of interconnections, on the other hand, results in higher permeability and reduced durability in general.

The principal idea behind the electrical resistivity techniques is to quantify the conductive properties of the microstructure of concrete. The electrical resistivity of concrete can be described as the ability of concrete to withstand the transfer of ions when subjected to an electrical field. In other words, resistivity is the inverse of conductivity, which can be attributed to the degree of ionic movement in the pores. In this context, resistivity measurement can be used to assess the size and extent of the interconnectivity of pores. Electrical resistivity measurement provides a non-destructive approach to testing concrete materials, making it suitable for various quality control projects, condition assessment purposes, and research programs. Electrical resistivity is an inherent characteristic of concrete, and is independent of the geometry of the concrete sample.

APPLICATIONS

The electrical resistivity of concrete is well correlated with certain performance characteristics of concrete such as chloride diffusion coefficient, water absorption, and corrosion rate of embedded steel. The technique is also useful both for the characterization of fresh concrete and for the quality control of hardened concrete. The technique can be used to study the corrosion of steel rebar in concrete, the setting time of fresh concrete, and moisture transfer in concrete.

Electrical resistivity can be used as a measure of concrete resistance to chloride penetration. Similar to the Rapid Chloride Permeability (RCP) test, electrical resistivity measurement can be used for evaluating the ionic mobility within the pore solution of concrete. The RCP test was originally developed to quantify the chloride penetrability based on the electric charge that passes through concrete over a specific period of time. Experiments show that there is a good correlation between bulk electrical resistivity and the Rapid Chloride Permeability (RCP) (Table 1).

Table 1: Relationship between bulk electrical resistivity and the RCP test

Chloride Penetration	56-Day Rapid Chloride Permeability Charge Passed (Coulombs)	28-Day Bulk Electrical Resistivity of Saturated Concrete (kΩ.cm)
High	>4,000	<4
Moderate	2,000 to 4,000	4-8
Low	1,000 to 2,000	8-16
Very Low	100 to 1,000	16-190
Negligible	<100	>190

MEASUREMENT CONCEPT

Concrete is a porous composite material, and depending on the moisture content (i.e., degree of the saturation of the pores) it may exhibit conductive or insulated characteristics. For example, a concrete sample might exhibit very high electrical resistance when it is dry, but the same concrete can have much lower resistance in saturated condition. Moreover, concrete has capacitive properties, which means it can hold an electrical charge.

In engineering terminology, the concept of ‘impedance’ should be used to account for the impeding effect of the electrostatic storage of charge in concrete, in addition to the normal resistance of concrete. Impedance, z , is described as a complex quantity that has an imaginary component called reactance, x , and a real component called resistance, r . In other words, the vector summation of these two components would result in an impedance vector, z . Therefore, the electrical impedance z can be also represented by a magnitude (Z) and a phase angle (ϕ) (Fig.1). Both the magnitude and phase angle of such a vector could vary depending on the frequency of the applied current.

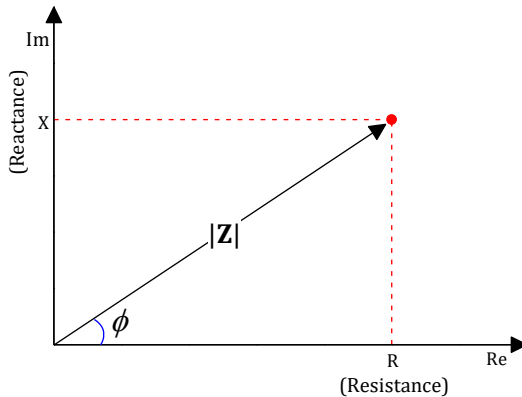


Figure 1. Impedance vector: Real and Imaginary components

BULK ELECTRICAL RESISTIVITY MEASUREMENT CONCEPT

Fig. 2 depicts the general concept behind the measurement of bulk electrical resistivity using Giatec RCON2™.

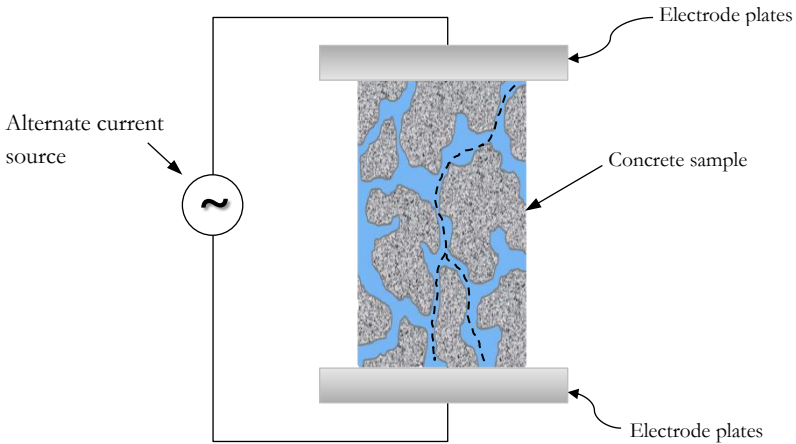


Figure 2. Schematic view of the pore structure and ionic movement through interconnections in bulk electrical resistivity measurement concept

The hardened concrete specimen is placed between two parallel electrode plates. These plates connect to an alternate current source. The source is capable of applying alternate current (I) with different frequencies. The potential drop (V) between the two electrode plates is measured by the device. The impedance, **Z**, can then be calculated from the measured voltage and applied current values:

$$Z = \frac{V}{I} \tag{Eq. 1}$$

The alternate current is generated by a sinusoidal signal. The current scale may vary from 10 μA to 1 mA depending on the impedance value. The phase of the impedance can be calculated as the difference between the phase of the applied current and measured voltage.

Electrical resistivity is related to the Impedance as described in Eq. 2:

$$\rho = kZ \tag{Eq. 2}$$

where k is the geometry factor and ρ is the electrical resistivity of concrete. For a cylindrical-shape specimen the bulk electrical resistivity of concrete can be calculated as described in Eq. 3:

$$\rho = \frac{A}{L}Z \tag{Eq. 3}$$

The shape factor k is taken as A/L , where A is the cross sectional area of the concrete specimen, and L is the height of concrete sample.

ELECTRICAL RESISTIVITY MEASUREMENT OF FRESH CONCRETE

The RCON2™ also allows for monitoring of the electrical resistance in fresh concrete using the provided probe. The two electrodes of the fresh concrete probe are inserted into the fresh concrete specimen and are connected to the device for real-time measurement of concrete resistivity.

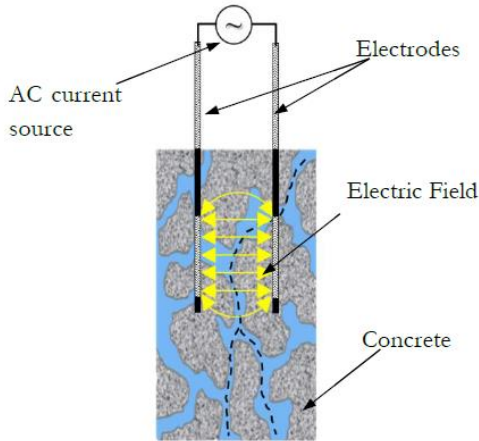


Figure 3. Fresh electrical resistivity measurement concept

A practical approach to determine the geometry factor for fresh concrete resistivity measurement is to use a solution with a known electrical

resistivity value. Fill the same geometry (for example a cylindrical mold) with this solution, and measure the electrical resistance. The geometry factor can be calculated dividing the resistivity by resistance value (refer to Eq. 2) Alternatively, one can calculate the geometry factor by solving the governing differential equation for the specific geometry.

DEVICE OVERVIEW

Giatic RCON2™ has two main components: A measuring device (Figs. 4 and 5), and a sample holder. (Figs. 6 and 7). The measuring device can be used as stand-alone equipment to perform the tests. It can also be connected to a personal computer (PC) using the USB connection port. The Data Monitor software provided in the package controls the device and can be used to record the test data. In this section, the key functions of these components are described.

Measuring Device

The front panel of the measuring device includes input terminals, the display, the main power key and the control keypad. The sample holder plates are connected to the measuring device using the cables included in the package.

Front Panel

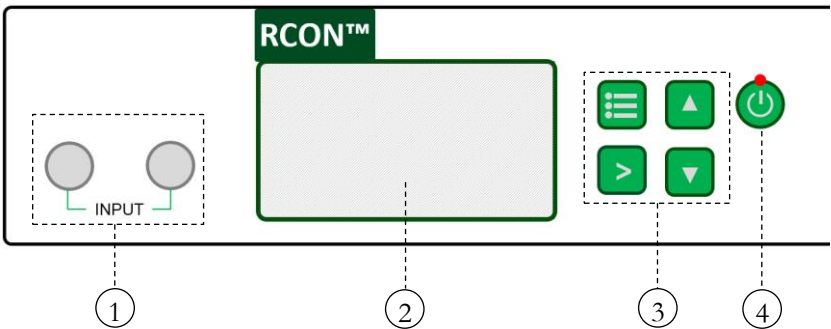


Figure 4. RCON2™ device front panel description

1. Current Input Terminals
2. Display
3. Control Keypad
4. Main Power Key

Back Panel

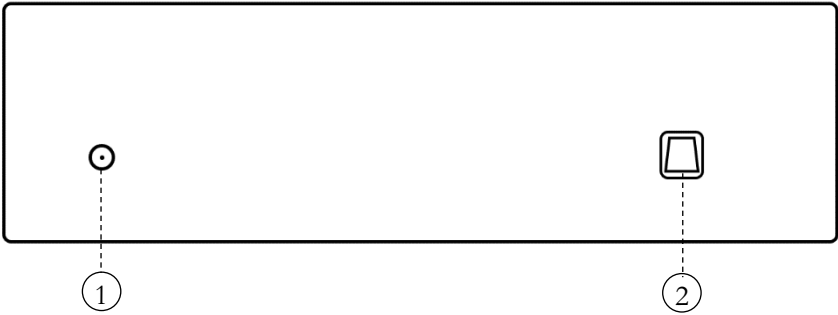


Figure 5. RCON2™ device back panel description

1. Power Inlet
2. USB Communication Cable Port

Hardened Concrete Sample holder

The sample holder provides a flexible setup to place and test concrete samples of different sizes and shapes.

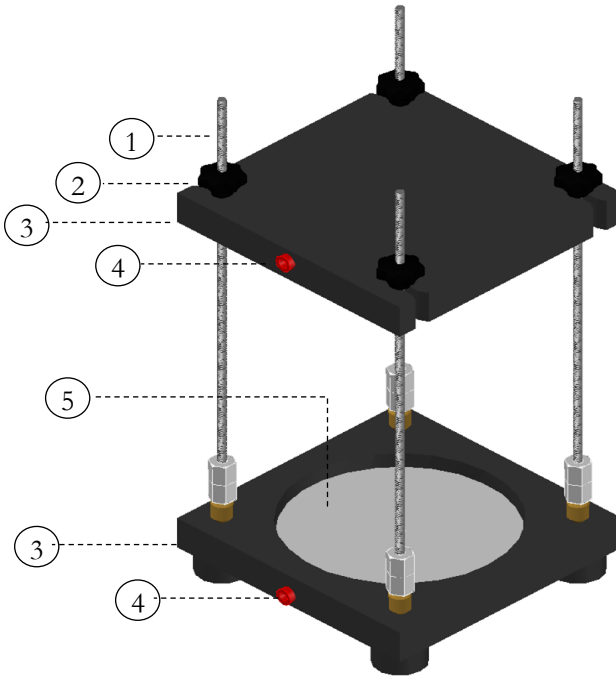


Figure 6. Hardened concrete sample holder description

The assembled RCON2™ sample holder

1. Threaded rod vertical supports
2. Star grip knob
3. Sample holder plates (top and bottom)
4. Electrical terminal (top and bottom)
5. Electrode plate with sponge covering

Fresh Concrete Sample Holder

The fresh concrete spacer assembly is specifically designed to facilitate the measurement of the electrical resistance of fresh concrete. The spacer can easily be mounted on a standard 75 mm, 100 mm and 150 mm cylinder.

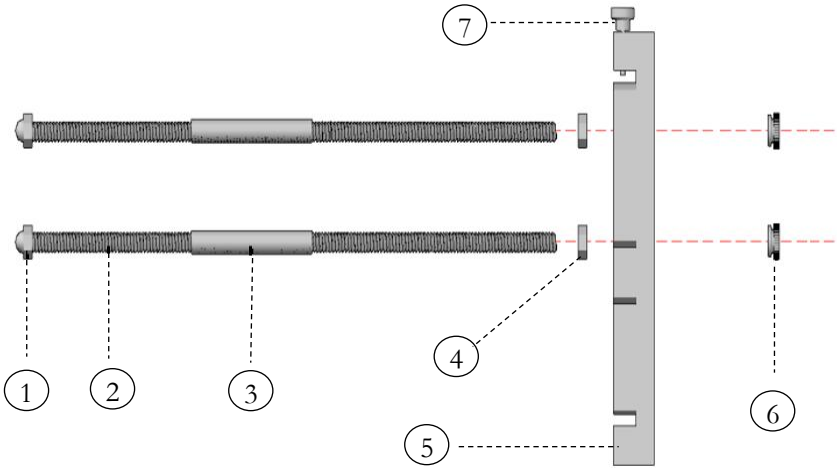


Figure 7. Fresh concrete sample holder

1. Plastic nuts
2. Steel rods
3. Rubber insulator
4. Plastic nuts
5. Electrode spacer
6. Steel nuts
7. Tightening knob

TEST SETUP

To start using RCON2™, the user has to set up the concrete sample in the sample holder. RCON2™ sample holder provides a convenient approach to setting up concrete samples of different sizes and shapes

HARDENED CONCRETE

Step 1: Place the bottom plate on a stable surface such as a test table. Using water, moisten both of the sponges provided in the package. Place one sponge over the bottom plate, and the other sponge over the top plate.

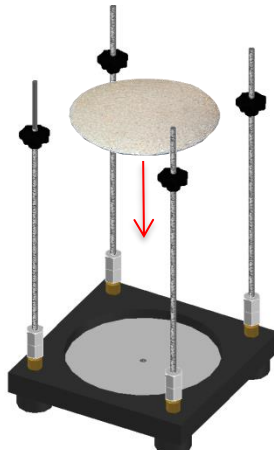


Figure 8. Place the moist sponge over the bottom plate

Step 2: Place the concrete sample on the sponge.



Figure 9. Place the concrete sample over the sponge

Step 3: Place the top plate over the concrete and fasten the knobs. Make sure the sample is in vertical position, and that the top and bottom plates are parallel.

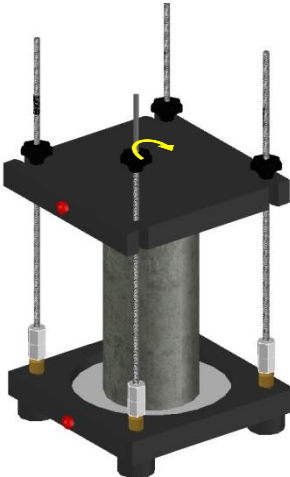


Figure 10. Place the top plate and turn the knobs to fasten the sample

Step 4: Connect the sample holder to the measurement device using the provided cables. One cable should be connected to the top plate, and the other one should be connected to the bottom plate.

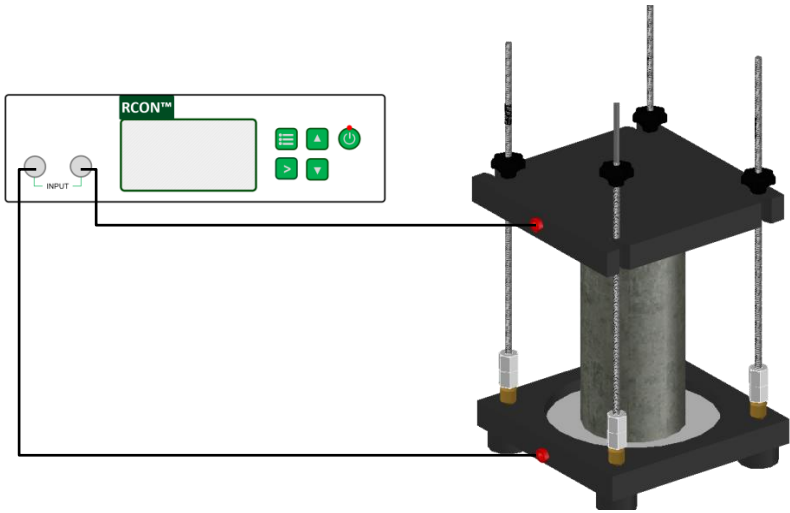


Figure 11. RCON2™ connection to the hardened concrete sample holder

FRESH CONCRETE

Step 1: Prepare the concrete cylindrical mold and spacer assembly.

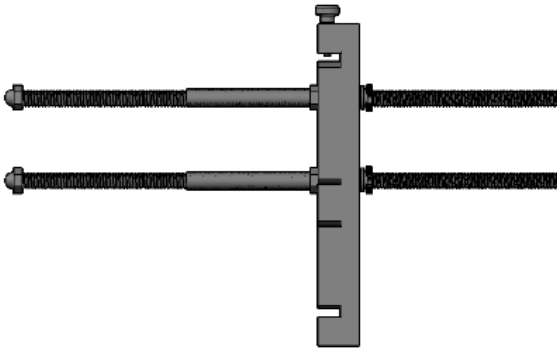


Figure 12. Spacer assembly

Step 2: Fill the cylinder with fresh concrete; if you are using the electrode spacer, leave at least 20 mm of empty space at the top of the mold, so that the spacer can easily fit in.

Step 3: Carefully insert the spacer assembly into the concrete sample. Push the electrodes completely through until the mold's wall are placed into the provided grooves on the spacer. Tighten the knob to keep the electrode spacer assembly stable.

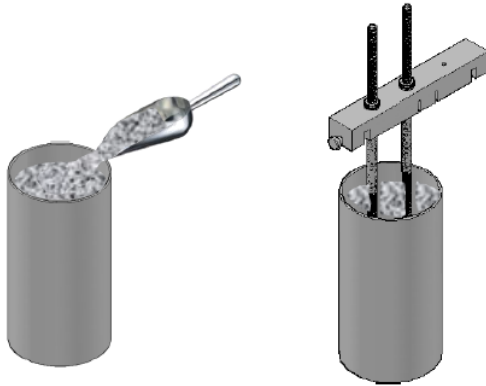


Figure 13. Fresh concrete sample preparation

Step 4: Connect the sample holder to the measurement device using the provided cables. Each cable should be connected to one electrode (metal rod) using the alligator clips.

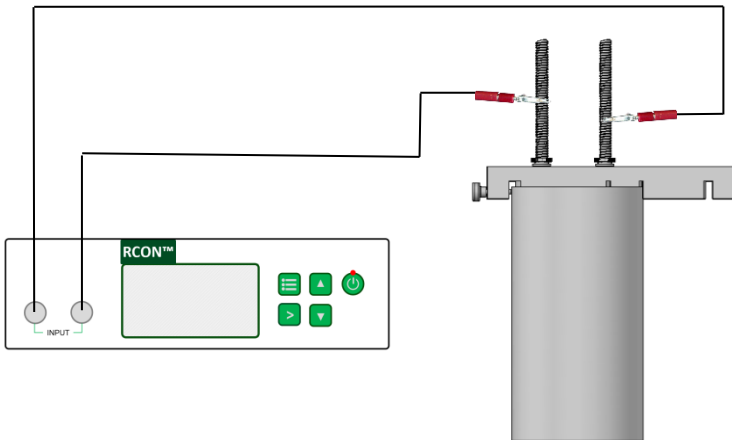


Figure 14. RCON2™ connection to the fresh concrete sample holder

DEVICE OPERATION

RCON2™ can either be used as a stand-alone unit, or it can be controlled using a computer. The former approach is a quick and simple way to start the test, while the latter approach provides more testing options, data logging, and data visualization.



Before turning on the device, make sure that the sample holder is appropriately connected to the device

STAND-ALONE OPERATION

The main power switch of RCON2™ is located on the front panel of the device. Press and hold the power key to turn on the device. The LED light on the power key as well as the device display will turn on. After a few seconds, the measurements will appear on the device display. The default frequency of the device is set to 1 kHz.



Figure 15. Test Parameters on the LCD display

Main Menu

The system setup can be changed by pressing the **Menu** key from the front panel. The menu options will then appear on the LCD display. Using the **Up** and **Down** keys on the front panel, the user can access these options.

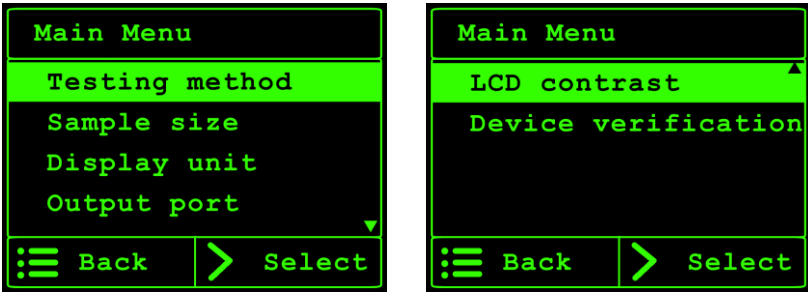



Figure 16. Main Menu on the device display

Testing Method

Two different testing methods are available. RCON2™ can be used to measure the electrical resistance (Impedance) or resistivity. For resistivity measurement, the user needs to select the type and size of the test sample. Use the Up and Down keys to select the test method, and press Select  key. Note that the testing method for fresh state concrete, using only the device display, should be selected for "impedance" since the dimension of the sample (geometry factor) cannot be implemented for the resistivity calculation. To directly calculate the concrete resistivity of fresh concrete the PC software should be used (Refer to Page 25).

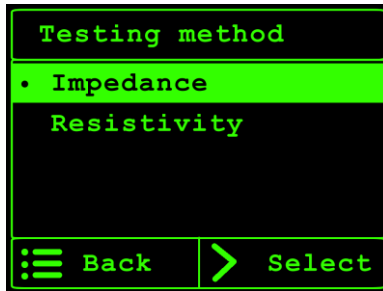


Figure 17. Testing Methods

Sample Size

The user has to select the sample shape and size in order to get the measurement results in Resistivity mode. Three different sample types/sizes are available: concrete cylinders (4"x8" and 6"x12") and 100 mm cube specimen.

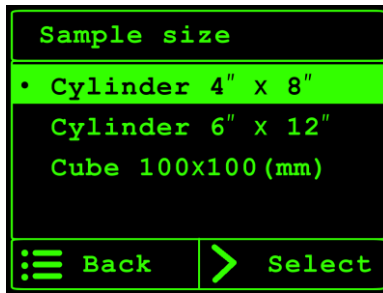


Figure 18. Sample Size/Type

Display Unit

The user can select one of the two available units for the measurement. Test results can be displayed in as Ω .m or k Ω .cm.



Figure 19. Measurement units

Output Port

RCON2™ can communicate with a computer through the USB port.

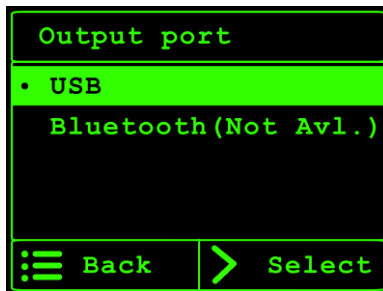


Figure 20. Output port

Screen Contrast

In order to adjust the contrast of the device display, use the Up key to increase the contrast or the Down key to reduce the contrast.



Figure 21. Screen contrast on the LCD display

Device Verification

The verification kit is a useful accessory unit that can be used to ensure the appropriate functionality of the RCON2™ system. In order to verify the device, select the verification option in the Main Menu and follow the instructions. For more information, please refer to the Device Verification section of this manual.

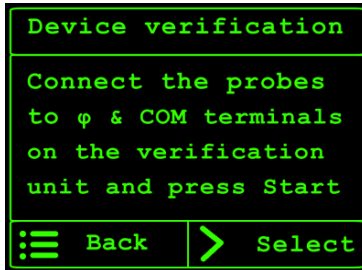


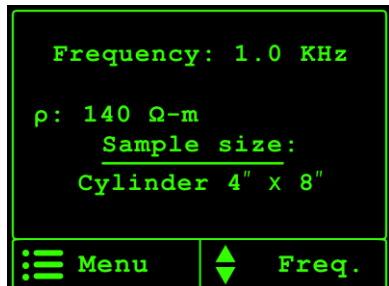
Figure 22. Device verification on the LCD display

Perform the Test

The test results are displayed on the device in real time. Depending on the test method, the user will see impedance/resistivity values on the screen.



Impedance mode



Resistivity mode

Figure 23. Test results

The default frequency of the measurements is set to 1.0 kHz. The user can increase or decrease the signal frequency using the Up and Down keys on the front panel.

DATA MONITOR SOFTWARE OPERATION

Click on the RCON2™ Data Monitor icon on the desktop to launch the software. Alternatively, you can open the software from **Programs** in the Windows **Start Menu**.



You should first install Data Monitor Software on your computer. Please refer to the Installing Data Monitor Software section of the user manual.

The device should be connected to the PC with the USB cable and turned on before launching the Data Monitor software.

The software is only compatible with English computer set-up

Turn off sleeping setting for continuous monitoring

The RCON2™ Data Monitor home window will appear on the screen. If the device is not connected to the PC, or if the device has not been turned on, a message box will appear on the screen. The user is asked to turn on the device and check the connection cable. Click on the refresh button to connect to the device. Once it is connected, the menu strip box at the top of this form will be enabled.

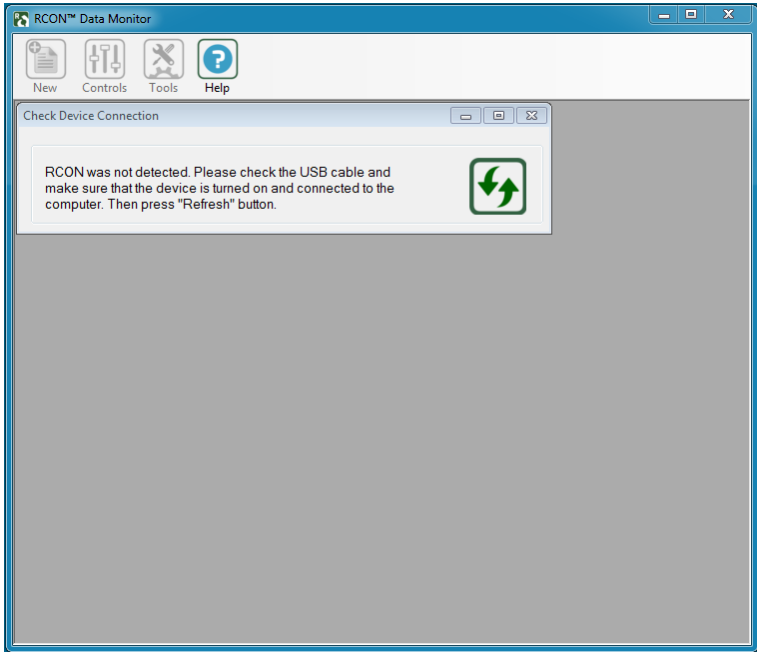


Figure 24. Data Monitor home screen

The Fixed Frequency method is the default test method in the Data Monitor software. When the software is launched, the Fixed Frequency form will appear inside the main form. However, the user can simply change the test method by clicking on the **New** button, and selecting the Sweep Frequency test method.

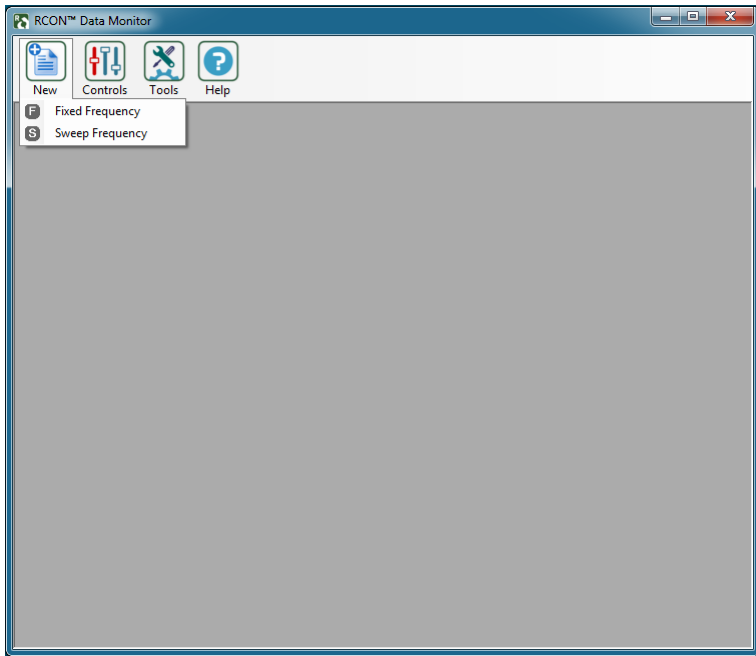


Figure 25. Select the test method

Fixed Frequency Measurement Mode

The Fixed Frequency Form has two main parts. The left side of the form is dedicated to the control keys and the test setting options. The right side of the form is designed to display the real-time measurements, as well as the tabulated data (when the data logger is running).

When the form is loaded, the real-time values of the impedance and phase are displayed on the top right side of the screen.

The user can select the frequency of the alternate current from the frequency drop-down list. The available frequency range is 10 Hz to 10 kHz. When the user changes the frequency, the measurements will be updated.

For data logging, the user can select the sampling intervals. Intervals can be as short as 5 seconds and as long as 30 minutes.

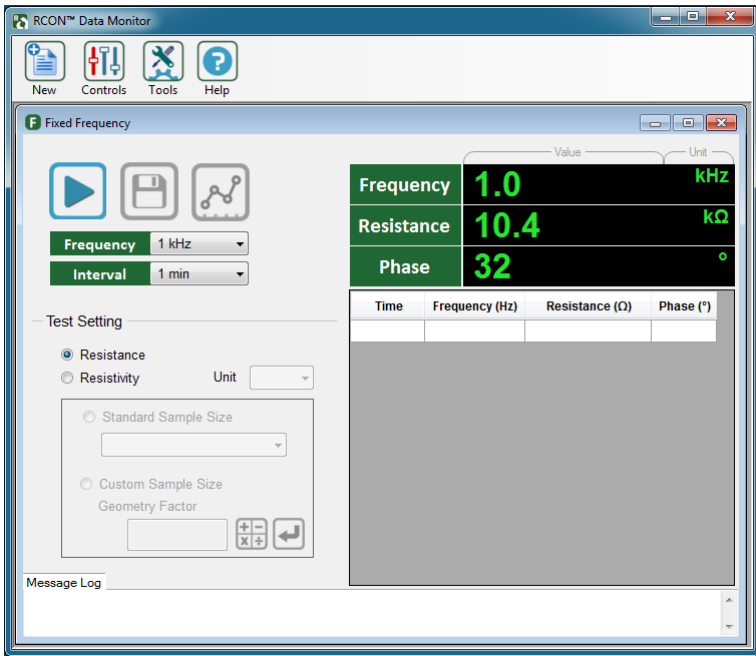


Figure 26. Fixed Frequency

Test Setting

Test results can be displayed in Impedance format, or Resistivity format. The user can also select to display the resistivity measurement in the following two units: Ω.m, and kΩ.cm.

In the case of a resistivity measurement, the user should select the sample type and size. If the test sample dimensions do not exist in the drop-down list, the user has the option to enter the appropriate geometry factor. A geometry factor calculator is available to help the user calculate the geometry factor.

The phase value is not displayed when the test setting is set to resistivity measurement.

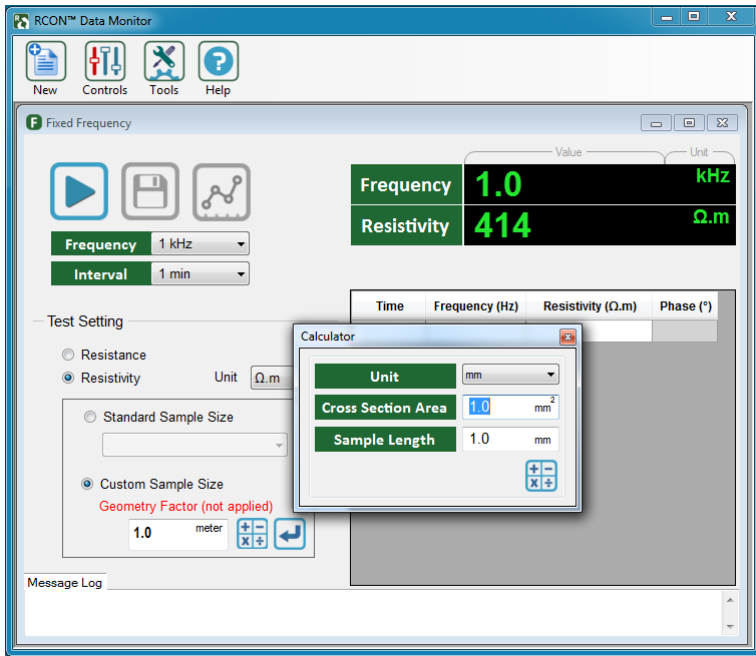


Figure 27. Fixed Frequency Measurement Mode

Control Keys

On the top left corner of the form, the user can find the control keys. The control keys can be used to start/stop a test (i.e., logging the measurements), display the test results in real-time chart, and save the test results.

Icon Name	Default	Enabled	When
Start		-	Default
Save			When the test is successfully completed or after pressing Stop
Chart			After the first two sets of data are logged
Stop	-		After pressing Start

Alternatively, the user can use the control keys under the Controls menu item to proceed with the test.

Real-Time Chart

The measurements can be displayed in real-time chart format by clicking on the chart icon in the control keys panel.

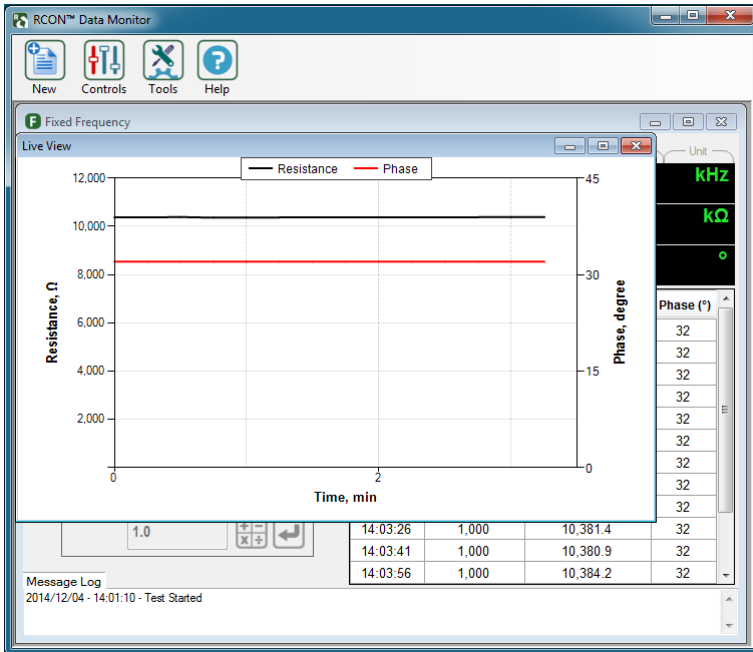


Figure 28. Live view of the test results

Message Log

A message log box located at the bottom of the form will log any errors that might have occurred during the test. The user can scroll the box to view multiple messages.

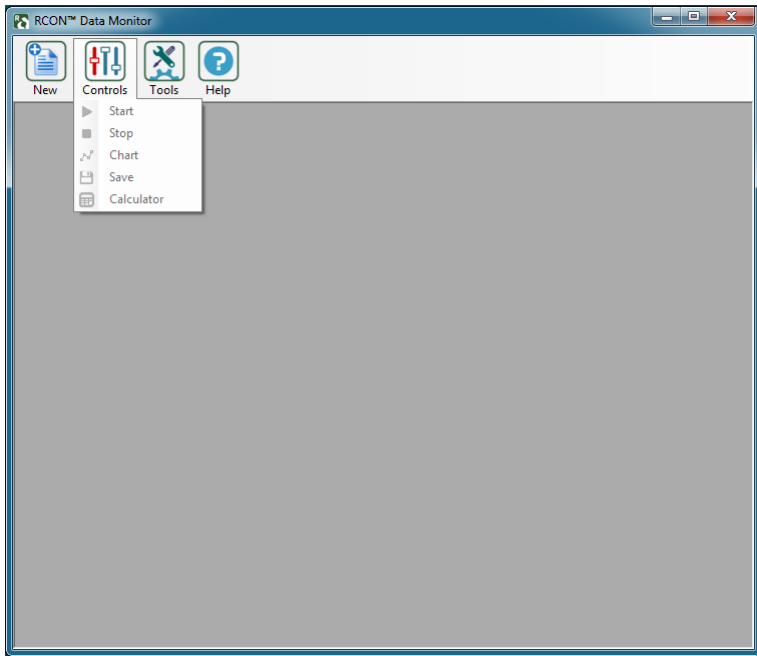


Figure 29. Control keys panel

Sweep Frequency Measurement Mode

The Sweep Frequency measurement mode provides a convenient approach to perform the measurements in a particular frequency range. The user can perform the test in the following three frequency ranges:

- Wide band 1 Hz to 10 kHz
- Normal band 10 Hz to 10 kHz
- Narrow band 100 Hz to 10 kHz

The data logging interval can be selected from the interval drop-down menu.

FIRMWARE UPGRADE

If there is any update for the firmware of the RCON2™ device, the firmware upgrade files will be sent directly to the customers. These files will be used to upgrade the firmware of the device. You can access the firmware upgrade from the Tools menu item.

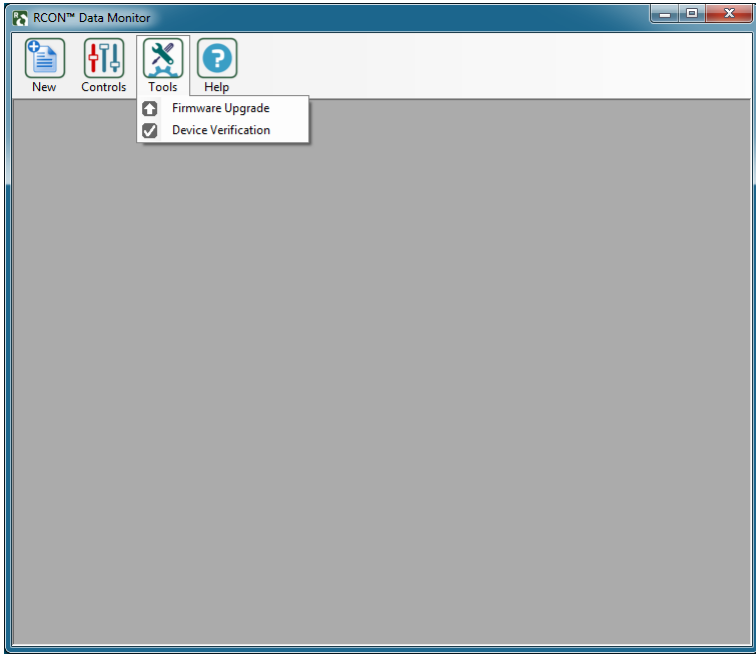



Figure 30. Firmware Upgrade

The user has to turn on the device in the Firmware upgrade mode. To do so, hold the Up key  and press the power switch on the front panel.

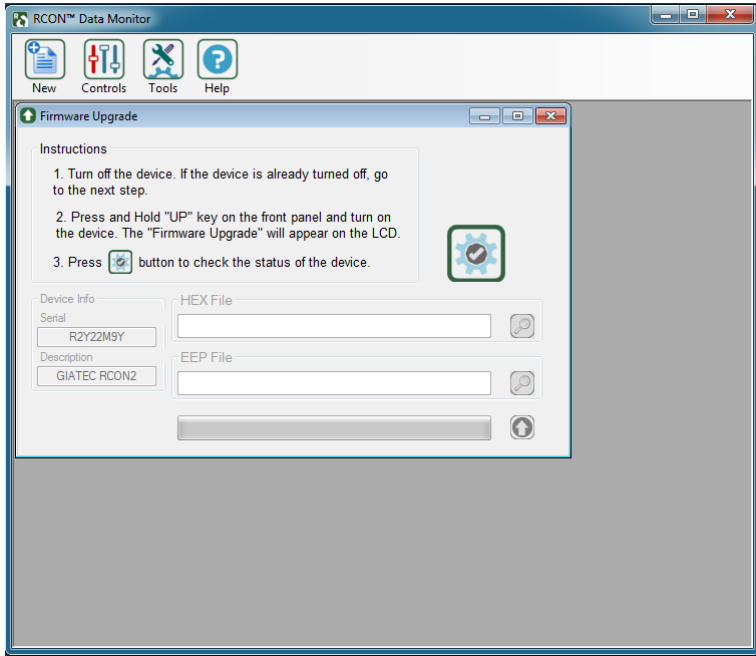


Figure 31. Firmware Upgrade

If the device is not in the correct mode, the user is asked to follow the instructions and try again. Click on the Verify button to check the status of the device. If the device is appropriately set to **Firmware Upgrade** mode, the following screen will appear.

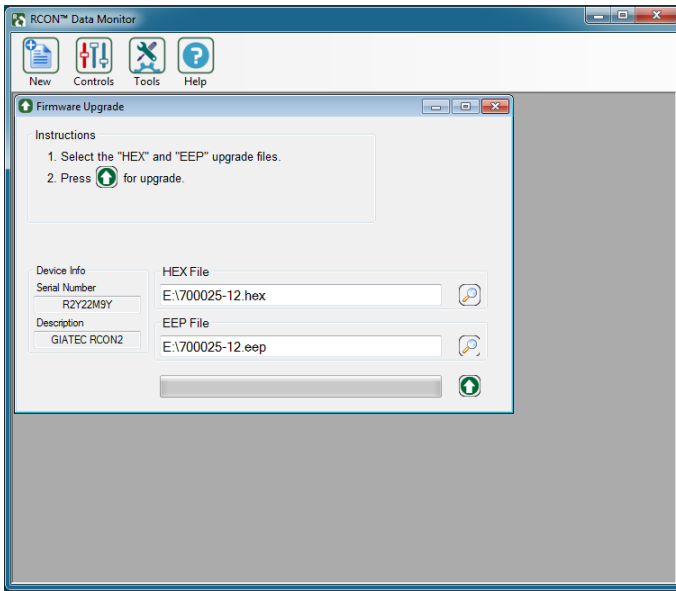


Figure 32. Select Upgrade files

Select the appropriate .Hex and .Eep files provided by Giatec Scientific Inc. Click on the Upgrade button to start the upgrade. Upon successful completion, the following screen will appear and the device will return to the test mode:

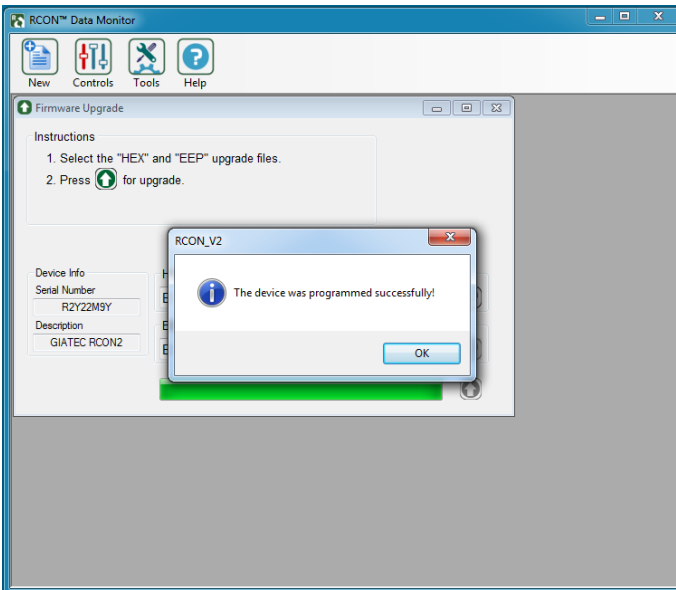


Figure 33. Firmware Upgrade

DEVICE VERIFICATION

A verification kit is provided with RCON2™ that can be used to ensure the appropriate functionality of the device. The verification kit contains various electrical circuits that emulate specific impedance and phase angles within the operating frequency range of the device.

To ensure appropriate functionality of the measurement system, verify the device with the verification kit. The verification procedure may be repeated as required. If the device does not pass the verification procedure, the device should be returned to Giatec for hardware calibration. The hardware calibration is also advised to be conducted once per year to ensure the appropriate functionality and accuracy of the measurements.

The verification process can be performed using any of the following two procedures:

a) Quick verification

Connect the verification kit to RCON2™ device using the following instructions: Connect to the COM port on the verification kit to the right port on RCON2™ front panel. Using the other cable, connect the φ port or any resistance ports to the left port on the front panel. The accuracy of the resistance and phase measurements can be verified at different frequency ranges (using the data provided in Table 2).

Table 2. Quick verification: Acceptable measurement range

Test Port	Test Frequency Hz	Acceptable Measurement Range k Ω		Acceptable Phase Range Degree	
		Min	Max	Min	Max
R-C	10	12.7	13.8	0	3
R-C	100	12.7	13.8	1	6
R-C	1,000	10.1	11.0	30	36
R-C	3,000	5.1	5.8	52	58
R-C	10,000	2.0	2.2	45	51

Quick verification procedure is implemented in the firmware of the device. The verification of the device can be performed from the main menu option on the front panel of the device. Alternatively, you can verify the device by using the Data Monitor software.

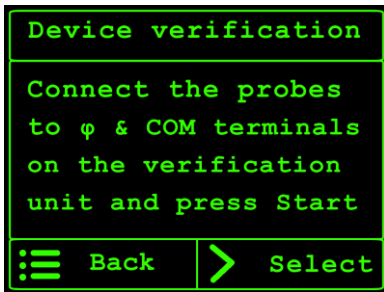
Using the Front Panel

From the main menu, go to the **Device verification** option and press the Select key.

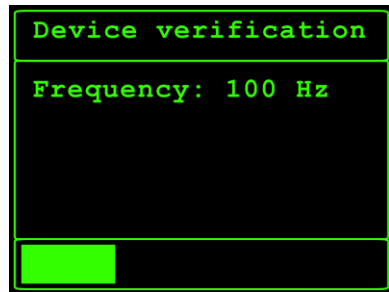


Figure 34. Select Device Verification

The user will be asked to connect the probes to the corresponding ports on the verification unit.




Select Device Verification



Verification in progress

Figure 35. Verification Process

Press the start key  to initiate the verification process. Once the verification process is completed, the results will be displayed on the LCD screen:



Verification Failed

Verification Passed

Figure 36. Verification Results

Using Data Monitor Software

The user can also verify the accuracy of the device using the Data Monitor software by connecting the device to the verification kit.

Once connected, click on the start key to start the verification of the device.

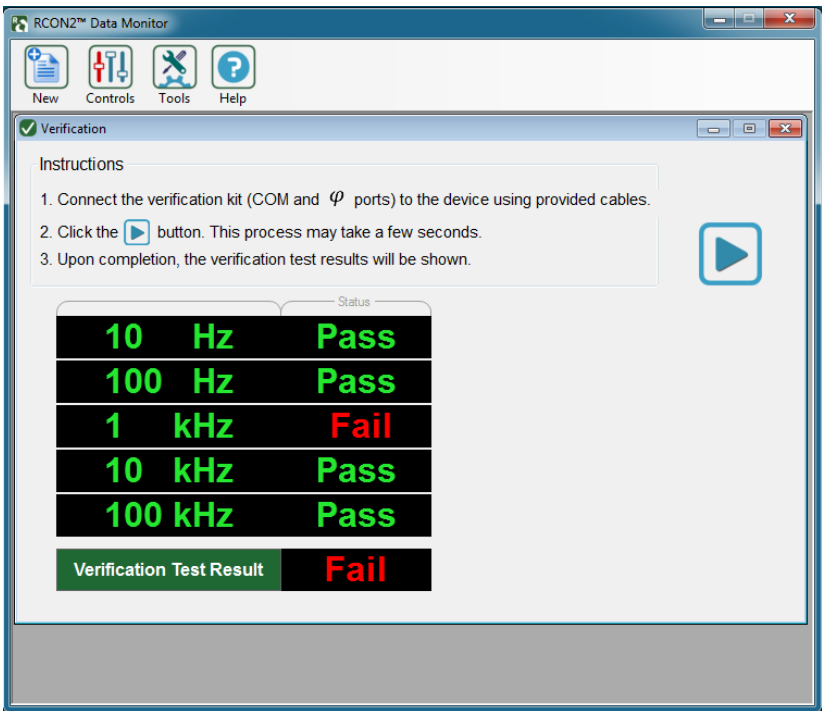


Figure 37. Device Verification

The device will automatically perform the verification at different frequency ranges. For each frequency range, if the verification test is passed, a **Pass** message will appear on the screen. If the verification test fails, a **Fail** message will appear on the screen.

b) Comprehensive verification

Comprehensive verification process can be used to examine the accuracy of resistance and phase measurements for different resistance ranges and current frequencies.

Connect the verification kit to the device using the following instructions: Using the banana clip cables, connect the COM port of the verification kit to the right port on the device. For each resistance range, connect the corresponding channel on the verification kit to the left port on the RCON2™ device.

The acceptable values for resistance and phase measurements are summarized in Table 3. If the device does not pass the verification test, contact Giatec technical support team.

Table 3. Comprehensive verification: Acceptable measurement range

Test Port	Test Frequency	Acceptable Measurement Rang kΩ		Acceptable Phase Range Degree	
		Min	Max	Min	Max
COM - 12Ω	10Hz, 100Hz, 1KHz, 10KHz,	11.5	12.5	0	3
COM - 120Ω	10Hz, 100Hz, 1KHz, 10KHz,	115	125	0	3
COM - 1.2kΩ	10Hz, 100Hz, 1KHz, 10KHz,	1.15K	1.25K	0	3
COM - 12kΩ	10Hz, 100Hz, 1KHz, 10KHz,	11.5K	12.5K	0	3
COM - 120kΩ	10Hz, 100Hz, 1KHz, 10KHz	115K	125K	0	3

INSTALLING DATA MONITOR SOFTWARE

RCON2™ Data Monitor software can be used to control the device, perform the tests, and log the test data on your computer. In order to be able to use the RCON2™ Data Monitor, you have to install the software on your PC. You should also connect the measuring device to the PC using the USB cable provided.

DEVICE DRIVER

When you connect the RCON2™ device to your computer for the first time, Microsoft Windows will automatically install the required driver if your computer has access to internet. A pop-up message will appear on the lower right corner of the screen (Windows taskbar).

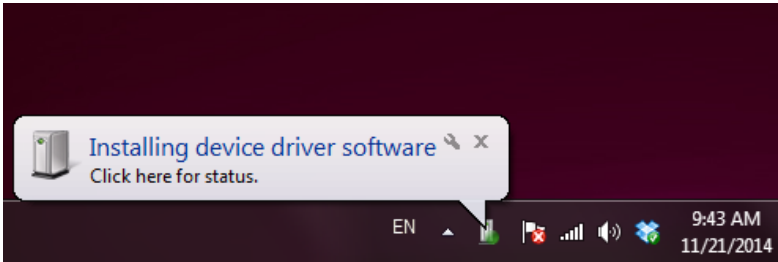


Figure 38. Installing the device driver

When the installation has successfully completed, a message will appear confirming the installation:

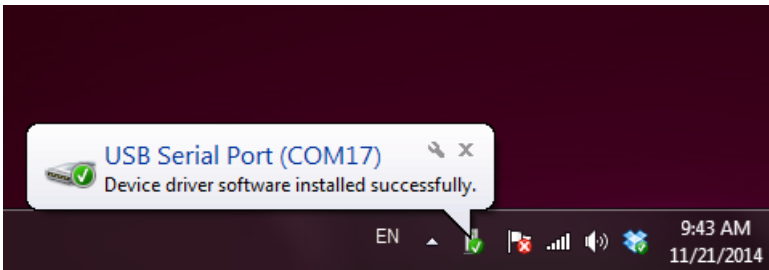


Figure 39. USB Serial Port successfully installed on the computer

If your computer is running an older version of Windows (i.e., XP or 2000), or if your computer does not have internet access, you have to install the driver manually. The driver file is located on the RCON2™ Data Monitor CD. In order to install, or update a previously unsuccessful installation, go

to the **Device Manager**. In Windows, you can access **Device Manager** under **System** in the **Control Panel**.

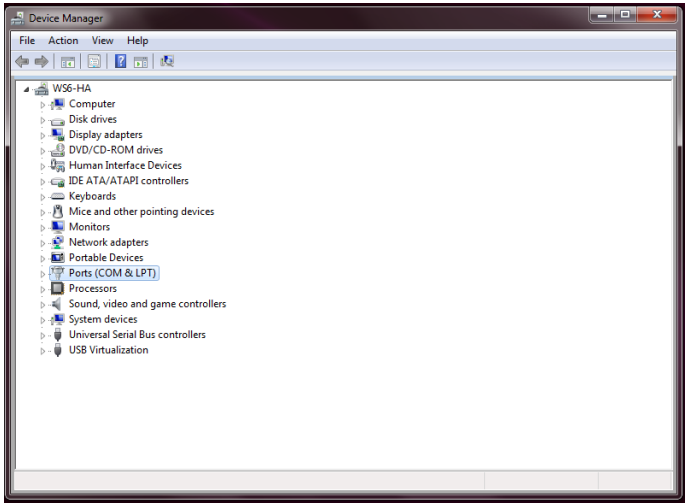


Figure 40. Device Manager window

Right click on the **USB Serial Port**, and select **Update Driver Software**.

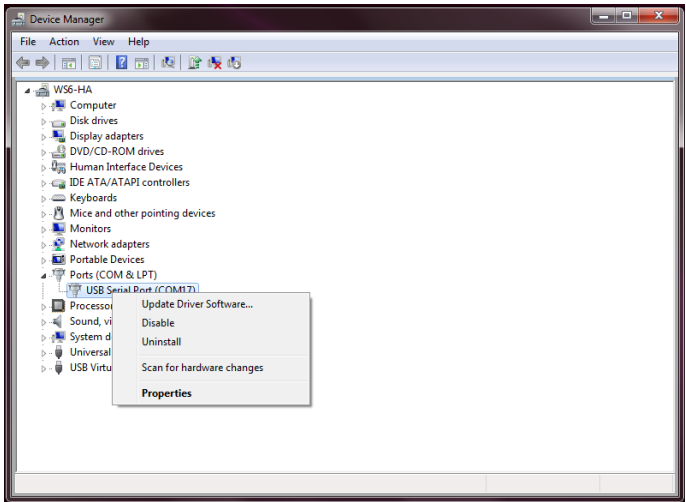


Figure 41. Update Driver Software

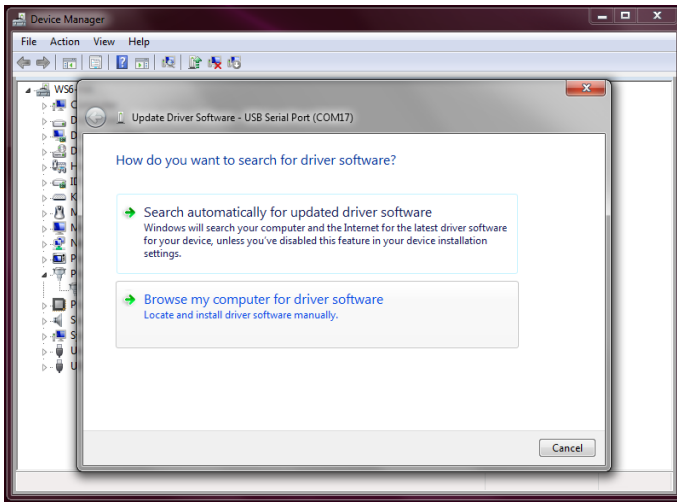


Figure 42. Select Browse my computer

Select the Driver provided on the software CD and click on Next to install the driver.

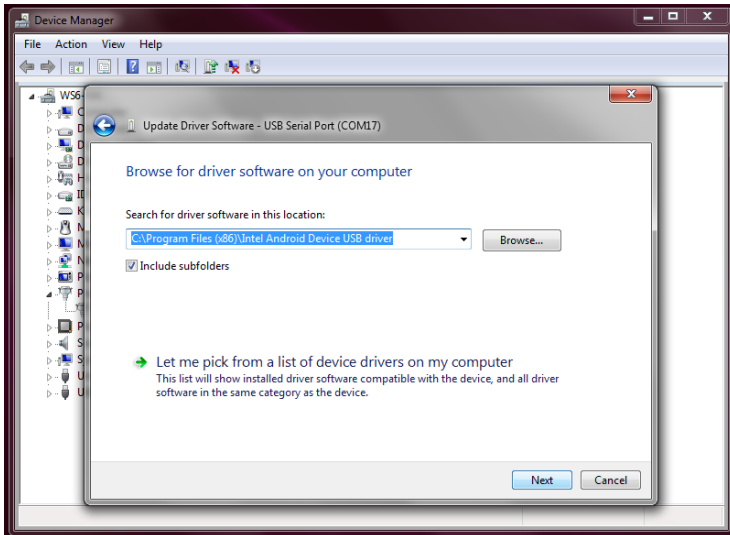


Figure 43. Select the driver file and browse for the file on the CD

INSTALLING DATA MONITOR SOFTWARE

Insert the RCON2 Data Monitor software CD in your computer’s CD-ROM drive. The Setup file is an autorun application. If the autorun did not start automatically, you can start the setup by clicking on the setup file in the installation CD.

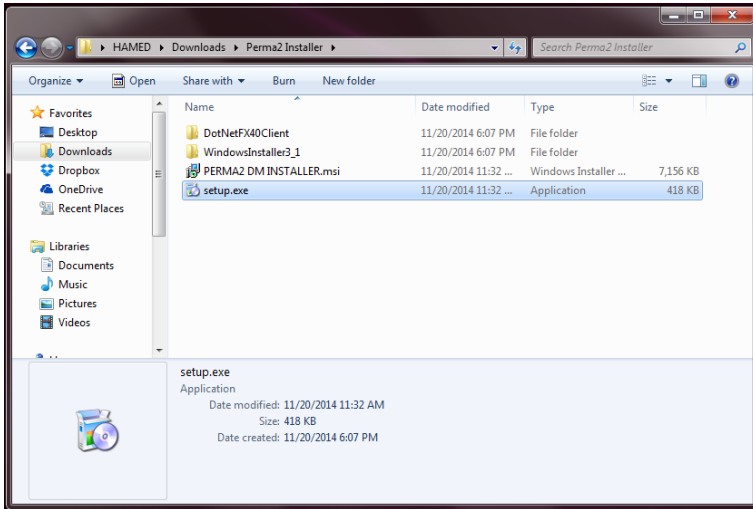


Figure 44. Click on Setup to start installing the RCON2 Data Monitor

The setup wizard will guide you through the rest of the installation. Follow the instructions on your screen to install the software. This process may be different depending on the version of your operating system (Windows XP, 2000, 7 or 8). Following a successful installation, an RCON2™ Data Monitor icon will be created on your desktop. Click on this icon to run the software.

MAINTENANCE

Repairs and servicing not covered in this manual should only be performed by qualified personnel. Periodically wipe the case with a damp cloth. Do not use abrasives or solvents.

SERVICE

If RCON2™ does not start, check the power supply cord to see if it is connected properly. If RCON2™ still does not work properly, review this manual to make sure you are operating it correctly.

If RCON2™ malfunctions, first try to check its functionality using the verification kit. If that fails, call our technical support line number provided on the back of this manual. Only after consulting with our technical support department, pack the device securely in its original shipping container and forward it to the nearest service center. Please include a description of the malfunction.

REPLACEMENTS

When servicing RCON2™, use only the replacement parts specified. The USB communication cable is intended to be used only by RCON2™ device and connecting it to other instruments will damage the cable. To order replacement parts contact Giatec Scientific Inc. using the contact information provided on the back of the manual or on the back of the device.

RCON2™ TECHNICAL SPECIFICATIONS

ACCURACY

Resistance Range	Frequency spectrum	Phase measurement	Impedance accuracy	Phase accuracy
1 to 100 Ω				
100 to 1 kΩ	1Hz ~ 30kHz	0~180°	±2% ±2digit	5% ±3digit
1 to 10 kΩ				
10 to 100 kΩ				
100 kΩ ~1 MΩ	1Hz ~ 10kHz			

MEASUREMENT TIME

Frequency	Sampling time	Reading time (minimum)
1 Hz ~ 4 Hz	5 seconds	10 seconds
5 Hz ~ 30 KHz	1 second	2 seconds

OPERATING CONDITIONS

Operating temperature	15 ~ 45 °C
Operating humidity	30 ~ 80%
Storage temperature	0 ~ 60 °C
Operating voltage/current	100 ~ 250 V 50 ~ 60 Hz
Dimensions of RCON2™	200 x 230 x 70 mm

TERMS AND CONDITIONS OF SALE ("SALE AGREEMENT")

Please read this Sale Agreement before using the Giatec Scientific Inc. (“Giatec”) product (the “Product”). By finalizing Your purchase order, You, the purchaser of the Product, and, if applicable, any end user (“End User”) on whose behalf You are making this purchase for (You and the End User are hereafter collectively referred to as “Customer”; Customer and Giatec are hereafter together referred to as “Parties”) agree to be bound by and accept the terms and conditions provided below. If You and/or the End User, as the case may be, disagree with these terms and conditions, do not finalize Your order, or if the order has been placed, return the Product immediately upon receipt without using it.

Payment; Purchase Price and Associated Charges. Payment must be made at the time of order unless otherwise agreed to by the Parties. Customer will pay the total purchase price plus shipping and handling, if any, as specified on the emailed invoice. Customer is also responsible for all taxes related to this purchase and to the import of the Product, if applicable, to include but not limited to all sales taxes, value-added taxes, import taxes/customs/duties and any other similar taxes imposed by any governmental entity.

Title; Risk of Loss. Title to the Product passes to Customer when the Product is paid for in full. However, Giatec bears all responsibility for loss of or damage to the Product during initial shipment after purchase and until Product is received by Customer, unless Customer selects its own mode of shipping. In repair cases, risk of loss is borne by Customer for return of the Product, but by Giatec following repair and upon return to Customer.

Limited Warranties. Giatec warrants the Product against defects in materials and workmanship under normal use (the “Warranty”) for a period of 12 months (#) from the Delivery Date (the “Warranty Period”), on the condition that the Product has been completely paid for. Unless as otherwise mandated by local law, the Warranty Period does not restart if

Customer receives a replacement appliance and/or replacement Software. This Warranty does not apply: (a) to consumable parts, such as batteries, Plexiglas cell units and cables unless damage has occurred due to a defect in materials or workmanship; (b) to cosmetic damage, including but not limited to scratches, dents and broken plastic on ports; (c) to damage caused by accident, abuse, misuse, neglect or failure to properly maintain (to include but not limited to water damage and/or condensation or improper temperatures during storage), or improper installation; (d) to damage caused by electrical disturbances or acts of God, to include but not limited to civil disturbance, war, flood, fire, rodents or insects; (e) where manufacturer's serial numbers and security labels have been removed from the Product; and (f) to damage caused during shipment (due to Customer's improper packaging) from Customer to Giatec in the case of Product returns for repair.

Giatec disclaims all other warranties, express or implied, including without limitation implied warranties of merchantability, fitness for a particular purpose, or against hidden or latent defects. Giatec's responsibility for warranty claims is limited to repair or replacement. Giatec reserves the right to modify this Warranty at any time, at its sole discretion, and with notice to Customer.

Giatec does not warrant that the operation of the Product will be uninterrupted or error-free. Giatec is not responsible for damage arising from failure to follow instructions relating to the Product's use. This Warranty is voided immediately if repair, modification (to include upgrades, expansions or usage or addition of non-manufacturer parts or accessories), alteration or other service is attempted other than by Giatec. In this regard, the integrity of the appliance casing (aka the box) should not be violated for any reason, unless expressly authorized by Giatec in writing.

Technical Support. Giatec will provide technical support to Customer in accordance with the then-current support policy in effect and in accordance with the Warranty provided herein, unless full payment for the purchase of the Product is not received. Giatec will respond to Customer support problems by phone or by email inquiry. If a support problem cannot be

rectified via phone or email, Customer will be provided with return instructions.

Customer agrees and understands that it may be necessary for Giatec to collect, process and use Customer data to perform the support and repair obligations identified herein. This may include the necessity to transfer data to affiliate third parties that are contracted with Giatec to assist in meeting these obligations. In doing so, Giatec will (i) protect and keep confidential such information, (ii) not use such information for reasons other those discussed above, and (iii) not sell, distribute or pass on such information to any third party.

Repair. Customer should carefully inspect the Product upon its delivery. Customer should maintain all original packaging upon receiving the Product until the Product has been installed and is found to be in proper working order.

If the Product arrives to Customer (the date of arrival is referred to herein as the “Delivery Date”) damaged or defective at initial delivery, Customer must notify Giatec Technical Support within 30 days from the Delivery Date of the condition of the Product and obtain return instructions if needed. Product must then be returned immediately to Giatec for repair or replacement at Giatec’s discretion. Giatec will then arrange for delivery of temporary or permanent replacement Product. Customer is responsible for properly packing the return shipment of the Product. Giatec will arrange for shipping and insurance.

If Customer fails to notify Giatec within 30 days of the Delivery Date, (i) the Refund Policy below will not apply, (ii) Customer will bear the cost of returning the Product for repair, and (iii) damaged Product will not be accepted.

If during the Warranty Period (as described herein) but following the initial 30 day period the Product is not working properly, Customer must contact Giatec Technical Support to confirm the problem and obtain return

instructions if needed. Customer will pay shipping and insurance costs when returning the Product for repair.

If the Product is returned for repair or replacement at any time following purchase by Customer and Giatec discovers that the Warranty is inapplicable due to the reasons provided above (see the “Limited Warranties” section hereof), the Product will not be repaired and will be returned to Customer at Customer’s expense, unless Customer authorizes and pays for repair. Whether Customer authorizes repair or not, Giatec reserves the right to charge a “No Fault Found” fee where the Product is found not to be defective due to any fault of Giatec.

Any Giatec reseller or distributor involved in the purchase of the Product is not authorized to make any modification, extension, or addition to the Limited Warranties provided by Giatec herein, although any such reseller or distributor may provide its own warranty in addition to the warranty coverage provided by Giatec.

Refund Policy and Product Return. On a case-by-case basis, Giatec reserves the right to authorize a full refund of any Product purchase made where a refund is requested within 30 days of the Delivery Date. In such cases where a refund is approved, End User will return the Product to Giatec if the End User made such order itself. If the Product was ordered by a distributor or reseller, such distributor or reseller will coordinate with Giatec for the return of the Product. In either case, Customer is responsible for shipping and insurance charges and any damage to the Product which takes place en route to Giatec. Giatec reserves the right to charge a nominal re-stock fee for any such returns.

Limitation of Liability. Giatec is not liable under any other agreement between End User and a Giatec reseller or distributor for the provision of support (to include but not limited to an extended warranty or any support, service or repair agreement).

If found to have breached this Sale Agreement, Giatec is not liable for any amount above the aggregate dollar amount paid by Customer for the

purchase of the Product under this Sale Agreement. Except as provided in the Warranty and to the extent permitted by law, Giatec is not responsible for indirect, special, incidental or consequential damages resulting from any breach of this Sale Agreement, including but not limited to loss of use; loss of revenue; loss of actual or anticipated profits (including loss of profits on contracts); loss of the use of money; loss of anticipated savings; loss of business; loss of opportunity; loss of goodwill; loss of reputation; loss of, damage to or corruption of data or software programs; or any indirect or consequential loss or damage howsoever caused including the replacement of equipment and property, any costs of recovering, programming, or reproducing any program or data stored or used with the Product and any failure to maintain the confidentiality of data stored on the product. The foregoing limitation shall not apply to death or personal injury claims, or any statutory liability for intentional and gross negligent acts and/or omissions.

Not For Resale. The Product may not be purchased for resale purposes by Customer unless Customer is a legal and authorized reseller of Giatec products.

High Risk Uses. Customer will not purchase the Product for usage in connection with any high risk or strict liability activity (including, without limitation, air travel, space travel, firefighting, police operations, vehicle operations, power plant operations or power generation applications, transport management systems, military operations, rescue operations, hospital and medical operations or the like) whereby such usage could cause or contribute to damage to property or injury to persons.

Software License. The Product is and contains, the intellectual property of Giatec, and is protected by Canadian, U.S. and international copyright, patent, trade secret laws and international treaties. This Agreement is not intended to grant, and shall in no way be construed to grant, to Customer any rights in the intellectual property of Giatec, including the intellectual property in the Products. The Customer shall obtain a non-exclusive license to use the software contained in the Product (the “Software”) only in accordance with the terms of the Software License Agreement, attached

hereto as Exhibit A, and the Customer shall agree with its terms prior to installing the Software. Customer acknowledges that the Software is the intellectual property of Giatec and respects Giatec's rights as the intellectual property rights holder. Customer may not and customer agrees not to, or to enable others to, copy, decompile, reverse engineer, disassemble, attempt to derive the source code of, decrypt, modify, or create derivative works of the Software or any part thereof (except as and only to the extent any foregoing restriction is prohibited by applicable law). Any attempt to do so is a violation of the rights of Giatec. By virtue of this Sale Agreement, Customer acquires only the right to use the Software as contained in the Product and does not acquire any rights of ownership. All rights, title and interest in the Software shall at times remain the property of Giatec.

Product Disposal/Recycling. Giatec is unable to dispose of or recycle the Product following use. End User may dispose of or recycle the Product or arrange for the same through the Giatec distributor or reseller which made the Product sale. Any disposal or recycling of the Product must be done in accordance with local government directives.

Export. Customer must comply with all export laws and restrictions and regulations of Canada. Furthermore, Customer will not export, or allow the export or re-export of the Product in violation of any such restrictions, laws or regulations. Additionally, Customer agrees to comply with the above and represents and warrants that it is not located in, under the control of, or a resident of any restricted country.

Entire Agreement. This Sale Agreement constitutes the entire understanding of the Parties as to the subject matter hereof and supersedes all prior offers, agreements, arrangements, negotiations and understanding, written or oral between the parties relating to that subject matter.

Severability; Assignment. If any provision of this Sale Agreement is held to be unenforceable for any reason, the legality or enforceability of the remaining terms shall not be affected or impaired. The failure of Giatec to act with respect to a breach of this Sale Agreement by Customer or others does not constitute a waiver and shall not limit Giatec's rights with respect

to such breach or any subsequent breaches. Giatec expressly reserves the right to assign this Sale Agreement and to delegate any of its obligations hereunder. Customer may not assign, delegate or otherwise transfer (whether by operation of law or otherwise) this Sale Agreement or any of Customer rights or obligations hereunder without the prior written consent of Giatec. Giatec may assign the provision of repair services to third parties.

Governing Law; Dispute Resolution. All disputes arising out of or in connection with this Sale Agreement shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the said Rules. The place of arbitration shall be Ottawa, Ontario, Canada. The language of the arbitration shall be English. For the purposes of this arbitration, this Sale Agreement shall be governed by and construed under Ontario law as such law applies to agreements between Ontario residents entered into and to be performed within Ontario, Canada. The decision of the arbitrators shall be binding upon the parties hereto, and the expense of the arbitration (including without limitation the award of attorneys' fees to the prevailing party) shall be paid as the arbitrators determine. The decision of the arbitrators shall be executory, and judgment thereon may be entered by any court of competent jurisdiction.

Any non-English language translation of this Sale Agreement is done for local requirements and in the event of a dispute between the English and any non-English versions, the English version of this Sale Agreement shall govern.

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Limited Warranty

Giatec warrants the physical compact disk(s) on which the Software is distributed to be free from defects in materials and workmanship and that the Software will function in substantial accordance to the specifications for a period of one (1) year from the date of shipment of the Software to Customer. General and specific limitations on this warranty are described in Giatec's "Warranty" statement, and are incorporated by reference. THE WARRANTIES DESCRIBED HEREIN AND/OR ACCOMPANYING PRODUCTS ARE IN LIEU OF ALL OTHER WARRANTIES OR CONDITIONS AND, SAVE AS OTHERWISE PROVIDED HEREIN, GIATEC MAKES AND THERE ARE NO OTHER WARRANTIES OR CONDITIONS OR REPRESENTATIONS OF ANY KIND WHETHER EXPRESSED OR IMPLIED, AND GIATEC EXPRESSLY DISCLAIMS THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND THOSE ARISING BY STATUTE OR OTHERWISE IN LAW OR FROM A COURSE OF DEALING OR USAGE OF TRADE. GIATEC DOES NOT REPRESENT OR WARRANT THAT THE PRODUCTS WILL MEET ANY OR ALL OF ANY ORGANIZATION'S PARTICULAR REQUIREMENTS, THAT THE OPERATION OF THE PRODUCTS WILL BE ERROR FREE OR UNINTERRUPTED. Any written or oral information or advice given by Giatec distributors, agents or employees will in no way increase the scope of this warranty.

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This Agreement constitutes the entire agreement between you and Giatec and supersedes any prior agreement concerning the Software. Giatec is not bound by any provision of any purchase order or any other type of correspondence (written or verbal). Should any court of competent jurisdiction find any provision in this Agreement to be illegal, unenforceable, invalid, or to be overreaching, in whole or in part and for any reason, such illegal, unenforceable, invalid or overreaching provisions or part thereof shall be stricken from this Agreement, and such provision shall not affect the legality, enforceability, or validity of the remainder of this Agreement. This Agreement is governed by the laws of the Province of Ontario and any disputes or claims arising hereunder shall be under the exclusive jurisdiction of the courts situated in the City of Ottawa, Province of Ontario.

GIATEC SCIENTIFIC INC.
245 MENTEN PLACE, SUITE 300,
OTTAWA, ON, K2H 9E8, CANADA

PHONE: +1 (613) 240-7451
FAX: +1 (613) 280-1544
SUPPORT@GIATECSCIENTIFIC.COM
WWW.GIATEC.CA