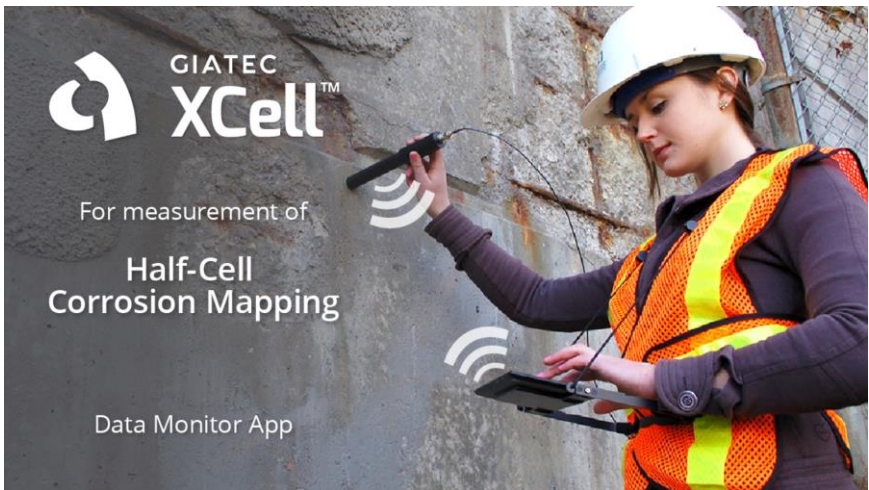




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## USER MANUAL



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# XCell™

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HALF-CELL POTENTIAL MEASUREMENT







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**PACKAGE CONTENTS**

Part	Qty	Photo	Package			
			Lite	Essential	Enhanced	Comprehensive
XCell™ Measuring Probe	1X		✓	✓	✓	✓
Alligator Test Clips	1X		✓	✓	✓	✓
Measurement Cable	1X		✓	✓	✓	✓
Charging Cable	1X		✓	✓	✓	✓
USB Cable	1X		-	-	✓	✓
Contact Sponge	3X		-	✓	✓	✓
Electrode Storage Solution	1X		-	✓	✓	✓

Carrying Case	1X		-	✓	✓	✓
Data Recording App (Smartphone version)	-		✓	✓	-	-
Tablet with hands-free carrying support	1X		-	-	✓	✓
Tablet Charger	1X		-	✓	✓	✓
Data Recording and Analysis Application (Tablet version)	-		-	-	✓	✓
Extension Arm	1X		-	✓	✓	
Verification Kit	1X		-	-	-	✓
Cable Reel (30 m)	1X		-	-	-	✓

\* Please note that the images above are for illustration purpose only and might not be in scale.



## WARRANTY

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### 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 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 Giatic. In this regard, the integrity of the appliance casing (aka the box) should not be violated for any reason, unless expressly authorized by Giatic 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

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This chapter contains important safety instructions that the user must follow for operating and storage of Giatec XCell™. Read the following safety information before any operation to ensure your safety and to keep the instrument in good condition. Keep this 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 XCell™ 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 XCell™.
3. Observe all warnings and instructions marked on the product.

### DEVICE HANDLING



#### CAUTION

---

Giatec XCell™ is a non-destructive testing device. The electronic parts and electrochemical cell are sensitive components. Please handle them with care.

- Do not place any heavy object on the XCell™ probe or the tablet.
- Avoid severe impact or rough handling that leads to damaging XCell™ or the tablet.
- Do not disassemble XCell™.

- Store the product in a protected location (e.g. carrying case) where no one can step on or trip over the connection and USB-charging cables, and in a location where these cables cannot be damaged.

## OPERATION



### WARNING

---

- Device Input: USB only
- Only use the provided USB charging cable for XCell™, and the provided power adapter for the tablet (the latter is applied to the enhanced and comprehensive packages).
- Do not perform measurement at circuits directly connected to Mains (Live circuit).
- Place the instrument in the place where the chance of spilling liquids on the device is negligible.
- The device should be charged at least once every 4 months.

## CLEANING THE INSTRUMENT



### ATTENTION

---

- Disconnect the probe from the cable after testing.
- Do not use chemicals or cleaners containing harsh products such as benzene, toluene, xylene, and acetone.
- Do not submerge the measuring probe

## OPERATION ENVIRONMENT



### ATTENTION

---

- Location: Indoor/outdoor
- Relative Humidity: 20% to 90%
- Temperature: 0°C to 45°C
- Avoid direct sunlight
- Do not submerge the device

## STORAGE ENVIRONMENT



### ATTENTION

---

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

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## INTRODUCTION TO GIATEC XCell™

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Giatic XCell™ is a revolutionary test device for measuring the corrosion activity of the reinforcing steel in concrete. The test procedure has been standardized by different standards including:

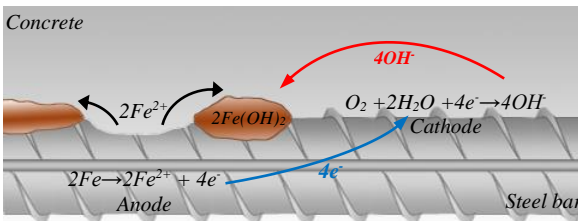
- ASTM C876
- RILEM TC 154
- UNI 10174
- DGZfP B3
- SIA 2006
- BS 1881, Part 201

The device is capable of accurately estimating the electrochemical corrosion potential of uncoated reinforcing steel in field and laboratory conditions.

XCell™ offers an advanced solution for the traditional half-cell potential measurement. The efficiency, accuracy and speed of the half-cell corrosion mapping have substantially increased in Giatic XCell™ by combining the wireless electrode technology with an interactive mobile app. This new device brings enhanced portability, accurate data measurement and easy data management. Moreover, the tablet app offers a powerful post-processing tool and an easy way to share the results with other team members. In this regard, XCell™ can significantly save time, human resources and cost.

### CORROSION OF STEEL IN CONCRETE

The corrosion of steel reinforcement inside concrete can be described as an electrochemical reaction. In this reaction electrons migrate from the anodic zone to the cathodic zone, releasing ferrous ions at the anode and hydroxide ions at the cathode.



**Figure 1.** Corrosion of steel in concrete

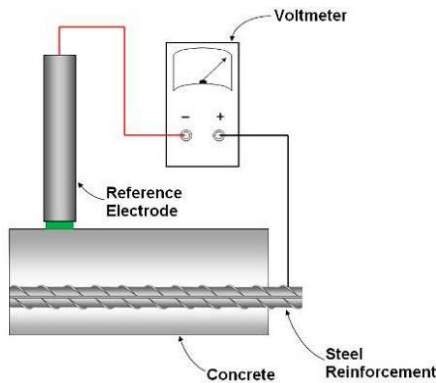
This will eventually lead to a potential difference between the anodic and cathodic areas at the surface of the steel reinforcement.

## HALF-CELL POTENTIAL MEASUREMENT

The purpose of the half-cell potential measurement is to measure the potentials on the surface of concrete in order to predict the potential field.

The potential measurement is used to predict the state of rebar corrosion in concrete. This technique allows for the plotting of a potential contour map of the concrete surface, which can be used to identify the corroding areas and estimate the probability of corrosion (Elsener and Bohni, 1995).

In the half-cell potential measurement, a reference electrode is used to measure the potential values of a specific location on the surface of the concrete with respect to an arbitrary reference point on the reinforcement mesh. The traditional half-cell potential measurement is schematically illustrated below.



**Figure 2.** Half-cell potential measurement

## APPLICATION

XCell™ can be used in either field or laboratory applications to measure the corrosion potential of steel reinforcement in concrete structures. This technique can be utilized for various applications such as:

- Estimation of corrosion potential of uncoated reinforcing steel
- Determine corrosion activity of steel rebar

The measured corrosion potential values are indicative of corrosion probability as presented in Table 1.

**Table 1-** Relationship between the potential values and corrosion probability (adapted from ASTM C876)

Measured Potential (mV/CSE*)	Probability of Steel Corrosion Activity
> -200	Less than 10%
-200 to -350	Uncertain
< -350	More than 90%

\* **Note 1:** CSE= *Copper Sulfate Electrode*

It is noted that half-cell potential measurements can also be affected by testing condition. RILEM TC-154 (2003) reported typical range for half-cell potential measurements in different conditions (see Table 2).

**Table 2-** Typical ranges of half-cell potentials of rebar in concrete (adapted from RILEM TC-154, 2003)

Condition	Potential values (mV/CSE*)
Humid, chloride free concrete	-200 to +100
Wet, chloride contaminated concrete	-600 to -400
Water saturated concrete without oxygen	-1000 to -900
Humid, carbonated concrete	-400 to +100
Dry, carbonated concrete	0 to +200
Dry concrete	0 to +200

\* **Note 1:** CSE= *Copper Sulfate Electrode*

## COMPLICATIONS

While half-cell potential measurement is a straightforward procedure, the application of this technique has several complications as ambient condition can influence measurements. These complications can lead to misinterpretation of collected data. The most important parameters that can influence measurements are briefly described below:

**Temperature:** The variation in ambient temperature can affect half-cell potential measurements. The measured values should be corrected for the temperature effects (CEFRACOR, 2007). It is noted that performing the test below freezing point is not recommended.



**Moisture:** Surface moisture has a significant effect on the measured values. Since performing the test may take quite a long time, the change in moisture content of concrete surface can affect the consistency of measurements (RILEM TC-154, 2003). As a rule of thumb, the drier the concrete is, the more positive values will be obtained performing the test.

**Cover Thickness:** A lower concrete cover leads to more negative values in half-cell potential measurements. There is a little research on the effect of cover thickness on the potential measurements; hence there is no straightforward correction procedure (SHRP2, 2013). Therefore, it is recommended to verify the cover thickness for the area being tested in order to avoid misinterpretation of the collected data.

**Concrete Properties:** Concrete properties such as density, permeability, porosity, and electrical resistivity are factors that can affect the half-cell potential measurements. A dense concrete cover reduces the permeability of chloride and oxygen. This will reduce the oxygen concentration. As a result, the half-cell potential values tend to be more negative (Gu and Beaudoin, 1998).

**Availability of Oxygen:** The availability of oxygen gas at the surface of steel rebar can affect the half-cell potential readings. Generally, lower concentration of oxygen at rebar level leads to more negative values on the surface (Gu and Beaudoin 1998, Elsener 2003), which can be mistaken for an active corrosion zone.

## LIMITATIONS

Half-cell potential measurement is a very useful technique in studying the corrosion of existing structures (or elements). However, the test does not provide any information on the kinetics of corrosion (i.e. corrosion rate of steel reinforcement). It is always recommended to interpret Half-cell potential measurements with supplementary data from other tests (i.e. cover thickness measurement, electrical resistivity, and chloride profile).

The presence of large cracks and delaminations can affect half-cell potential readings. In case of pre-stressed steel tendons, the test will not provide any useful information if the tendons are placed in protective tubes. This test is not applicable to concrete structures with epoxy-coated or galvanized steel rebar.

## GENERAL INSTRUCTIONS

---

This section provides general recommendations for a successful half-cell potential measurement.

**Charging the Probe and Data Recording Unit:** It is strongly recommended to charge the measuring probe and data recording unit (smartphone in Essential package, and tablet in Enhanced and Comprehensive packages). Refer to page 10 of this user manual to learn how to charge the probe.

Before performing a half-cell potential measurement, the operator may need to prepare the surface of concrete element.

**Testing Grid:** In order to facilitate the half-cell potential test, it is recommended to mark out the test grid on the surface of the concrete. The user is encouraged to perform the test in a systematic order to efficiently keep track of recordings.

**Pre-moistening the surface:** If the surface of concrete element is too dry, there is a chance that it affects the measurements. In order to avoid this problem, it is recommended to moisten the surface of the concrete element approximately 15-20 minutes before performing the readings.

**Consider the effect of coatings:** The presence of isolating coatings (i.e. sealing epoxy, asphalt layer) on the surface of concrete will make it impossible to perform half-cell potential measurements unless a hole is drilled through this layer. Once the concrete has been reached, the hole needs to be filled with a conductive solution. However, it is still possible to perform the test for thin dispersion coatings (often used in car parking spaces, ceilings). The measurements are often associated with a shift in the potentials.

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## XCell™ OPERATING INSTRUCTIONS

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Giatic XCell™ has two main components:

- 1- Test Probe
- 2- Data Recording Unit

### TEST PROBE

Giatic XCell™ test probe benefits from an advanced maintenance-free reference electrode that measures the corrosion potential. Together with a potentiometer, a temperature sensor, and wireless technology, the probe is capable of measuring and correcting the potential values on the surface of concrete with respect to the reference point and transmitting the measurements to the Data Recording Unit.

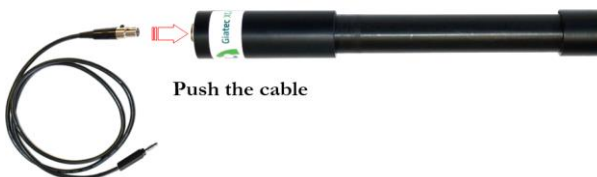
⚠ There is a fixed electrochemical potential difference between the Ag/AgCl electrode and the Cu/CuSO<sub>4</sub> electrode. The XCell™ data recording app accounts for this difference and presents the results in mV/CSE (i.e., Cu/CuSO<sub>4</sub> Electrode, CSE) as per ASTM C876.

⚠ The reference electrode used in the measuring probe has a temperature coefficient of -0.65 mV per °C for the temperature range between 0 to 70 °C. If the temperature compensation mode is selected in the Giatic XCell™ app, the results are modified and presented at 25°C.

⚠ The Giatic XCell™ is equipped with a maintenance-free electrode.

### PROBE SETUP

First, remove the probe cap and wet the contact sponge with water. To turn on the probe, connect the test cable to the probe: gently push the cable end shaft toward the probe socket, until it is locked (as shown below).



**Figure 3.** Probe connection

⚠ The Giatec XCell™ is equipped with a maintenance-free electrode.

⚠ To turn on the probe, connect the test cable to the end of the probe.

⚠ To turn off the probe, disconnect the test cable from the probe. This will increase the battery life.

## CHARGING THE PROBE

The probe is powered by a rechargeable battery embedded inside. In order to charge the probe, connect the charging cable to the probe as shown below. Connect the other end of charging cable (USB end) to any powered USB outlet (i.e.; computer USB port, USB chargers, etc.).



**Figure 4.** Charging probe

In order to check the battery level after charging, connect the probe to the data recording app. While the battery is charging, a charging battery icon will appear on the screen. When the probe is completely charged, a full battery icon will appear on the screen. When this icon appears on the screen, remove the charging cable from the probe.

⚠ The device should be charged at least once every 4 months.

## STORING THE PROBE

It is strongly recommended to turn off the probe after you have finished the test. To turn off the probe, disconnect the test cable from the end of the probe. Push the small button on the socket, and gently pull out the cable.

The sponge on the tip of the probe should be completely wetted with the storage solution and the probe cap should be placed and tightened on the probe head before storing the probe. This practice will significantly increase the lifetime of the electrode.

## DATA RECORDING UNIT SETUP

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Data recording is performed using an interactive app which is installed on a smartphone or a tablet, depending on the package selected.

### LITE/ESSENTIAL PACKAGE

The Lite and Essential package comes with a mobile app that can be installed on an Android-based smartphone (with Bluetooth 4.0 LE capability and Android version 4.3 -or higher- operating system). The app is capable of receiving and saving potential measurements sequentially. The post-processing needs to be conducted in the office by the user.

### ENHANCED/COMPREHENSIVE PACKAGE

The enhanced and comprehensive packages come with an Android-based tablet and Giatec XCell™ post-processing app which is already installed on it. The tablet unit communicates with the probe to receive and store potential and temperature data. It is also capable of processing data and producing colored contour plot maps. All these operations can be easily performed by a single technician or engineer, and can be shared with other team members in real-time.

### FRESH INSTALLATION

In order to install a new version or an upgrade to the data recording app, the user should download the appropriate app (Smartphone version for the Lite/Essential package, or the Tablet version for Enhanced/Comprehensive packages), from Google Play<sup>1</sup>.

The **Lite and Essential Packages** application needs to be installed on a smartphone device. In the Google Play™, search for “Giatec XCell™” smartphone app, press the **Install** button to start installing the app on the device. It should be noted that this version of the app has been developed for smartphones only.

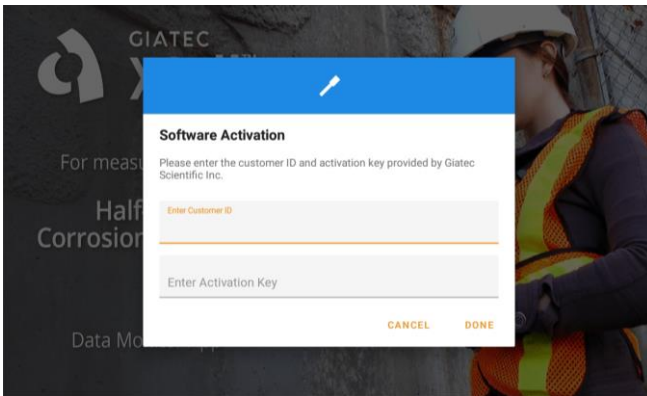
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<sup>1</sup> *Google Play is a trademark of Google Inc.*

The **Enhanced and Comprehensive packages** come with a pre-installed version of the app. However, if the user needs to reinstall the app the following steps should be followed.

**Step 1-** In the search box, search for “Giatec XCell™” tablet app. Press the **Install** button to start downloading and installing the app on the device

**Step 2-** Upon a successful installation, the user will be prompted to enter the customer name and the **9 digit activation** number provided at the time of purchase. User can find the customer name and activation number on the first page of the user manual. Please contact Giatec Scientific Inc. if you have lost the user manual.



**Figure 5.** Device activation after fresh installation  
(Tablet app.)

## ACCESSORIES

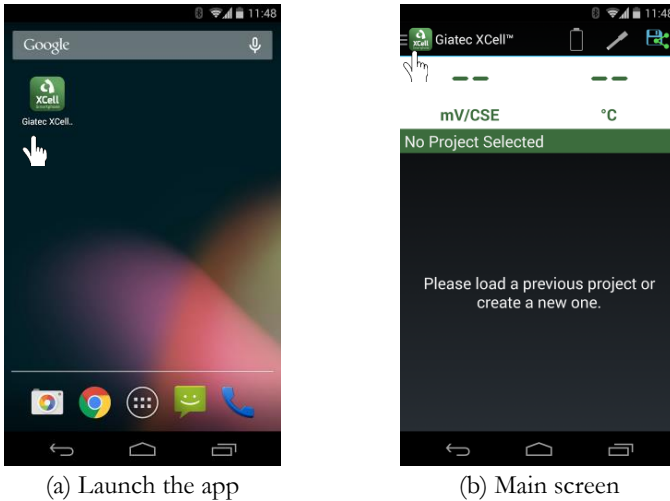
The enhanced and comprehensive packages come with accessories that can be used to improve the efficiency of the measurements and the user experience. The accessories include an extension arm (in both packages), a verification kit and an extension cable reel (in the comprehensive package only).

## XCell™ APP – LITE & ESSENTIAL PACKAGE

The user must launch the mobile app in order for it to communicate with the probe and receive data.

The data receiving unit of the essential package works with Android-based app which can be installed on Android smartphone with Bluetooth 4.0 LE capability and Android version 4.3 – or higher- operating system.

**Step 1-** Open the App: Open the app by clicking on the Giatec XCell™ icon on the home screen:

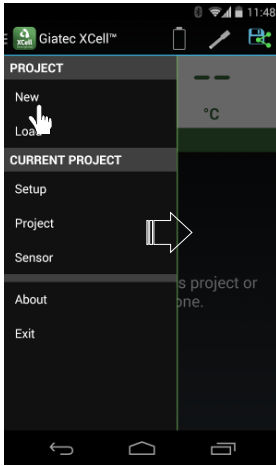


**Figure 6.** Launch the app on Smartphone

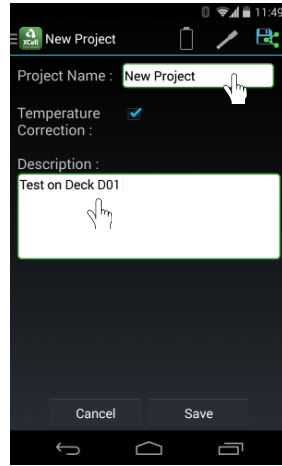
**Step 2-** Click on Giatec XCell™ at the top left corner to start a **New Project**.

In the New Project screen, enter the name and description of the project.

Operator can choose for the readings to be corrected for the effect of temperature. This is selected by default. If user chooses not to take into account the effect of temperature, remove the selection mark. Press **Save** to proceed.



(a) Create a new project

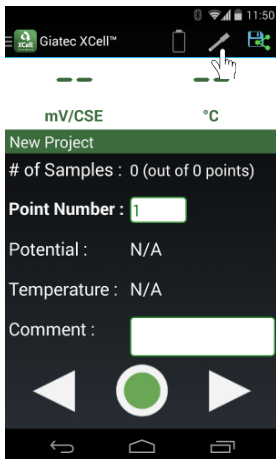


(b) Save new project

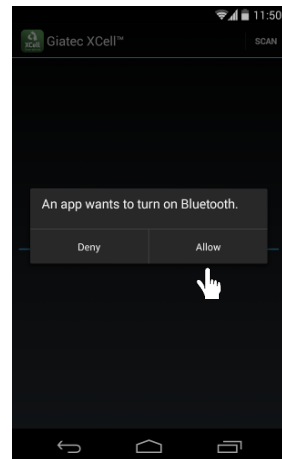
**Figure 7.** New project on Smartphone

**Step 3-** Press the **Probe** icon from the top menu (between the battery level indicator and save icons) to detect the testing probe.

If the Bluetooth device is turned off, a dialogue box will pop up asking for permission to turn on the Bluetooth transmitter of the Smartphone. Press **Allow** to enable the Bluetooth communication.



(a) Turn on Bluetooth communication

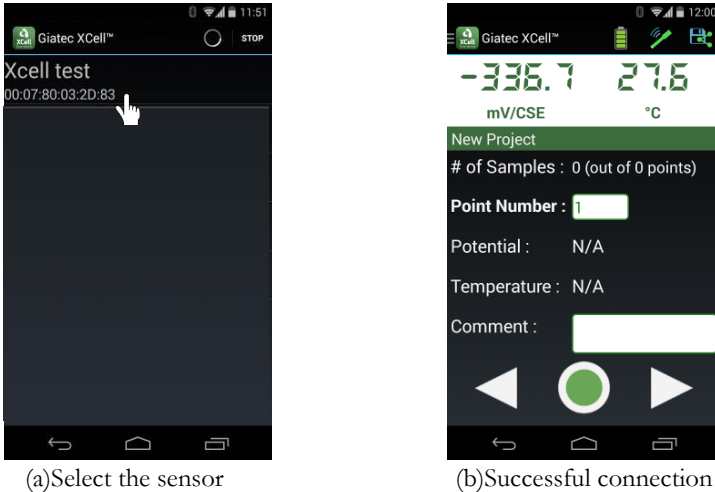


(b) Allow Bluetooth communication

**Figure 8.** Bluetooth communication on Smartphone




**Step 4-** Select the appropriate Giatec XCell™ sensor to get connected to the probe. Following a successful connection, the connect icon changes to green. You will see potential values on the device immediately, as well as temperature and the battery level.

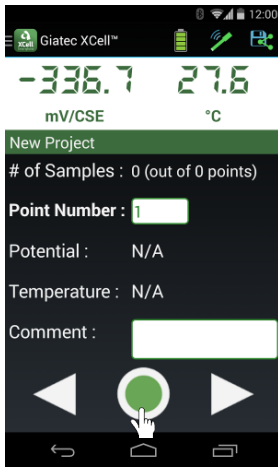


**Figure 9.** Probe connection on Smartphone

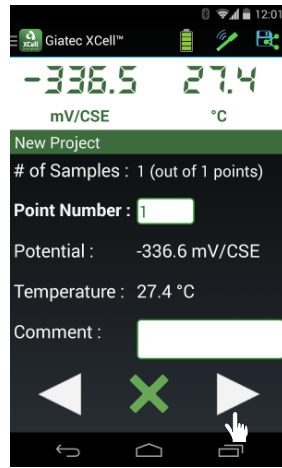
**Step 5-** Move the probe on the pre-defined grid over the surface of concrete. Wait for the potential value to become stable. As soon as the potential value is stable, press the **Green Circle** to save its value.

The user can press **Back** and **Forth** icons in order to move to the previous or next grid point.

 User can add comments related to the specific grid point. These comments will be saved along with the potential and temperature values.




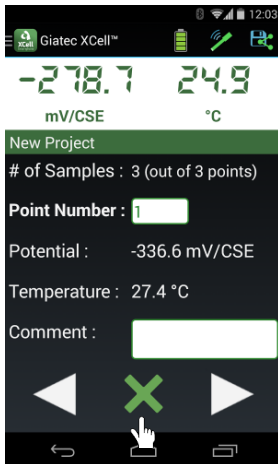
(a) Save potential values



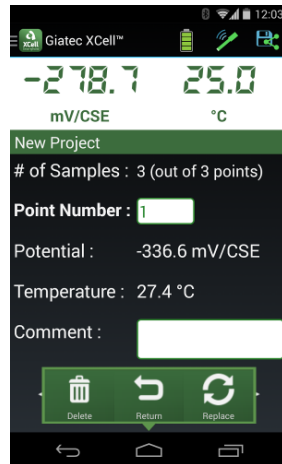
(b) Move to the next grid point

**Figure 10.** Measurement potential value on Smartphone

 The user can delete or modify the temperature and potential values of previously tested points. Select the point for which you want to delete or repeat testing, and click on the **Green X** as indicated. A box will appear at the bottom of the screen. The user can delete the values of the point by selecting **Delete** button, or replace the value with new readings by selecting the **Replace** icon. If the user does not want to make any change, select **Return** to go back to data recording mode.



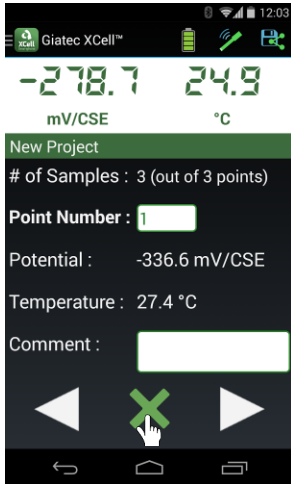
(a) Delete or Replace potential values



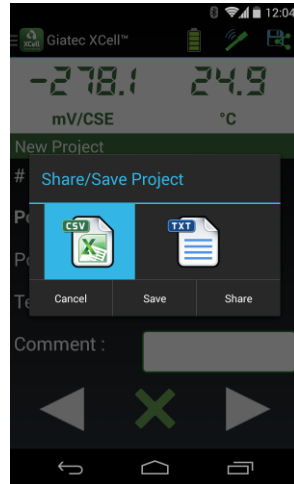
(b) Choose to Delete/Replace potential values

**Figure 11.** Delete/replace potential value on Smartphone

**Step 6-** The user can **Save** or **Share** the project data by clicking on the Share/Save button on the top right corner of the screen.



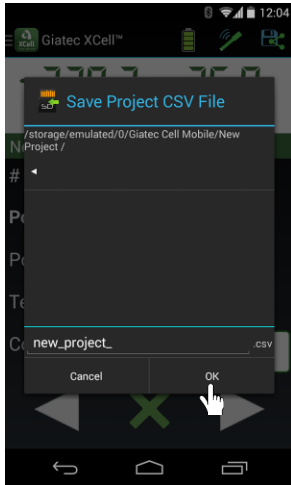
(a)Click on Save/Share Button



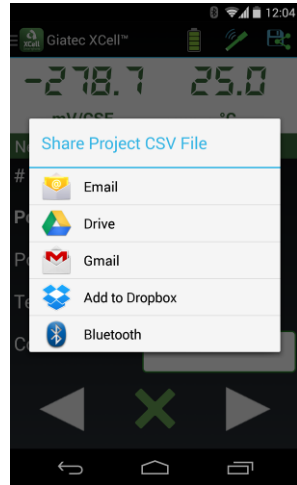
(b)Select the output format

**Figure 12.** Save/Share project on Smartphone

**!** If you want to save your project, select the appropriate output format (spreadsheet format CSV or plain text format TXT) and click on **Save** button. A dialog box will appear asking for the location of the output file. If you want to share the output file with other team members, select the output file format, and click on the **Share** button. From the dialog box, select the method of sharing (email, Bluetooth, etc.) and follow the instructions.




(a) Enter saving location



(b) Select sharing method

**Figure 13.** Save/Share method on Smartphone

 When the test is finished, disconnect the Bluetooth connection on the data recording unit. This can be done by clicking on the probe icon on the App. This will save the battery life of the probe.

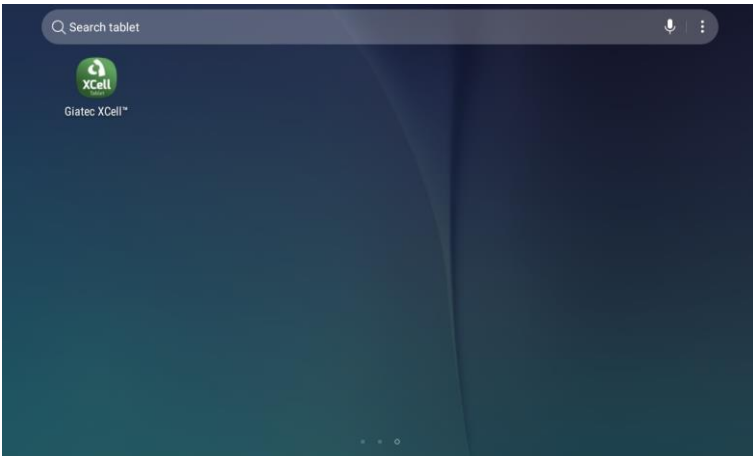
## XCell™ App – ENHANCED & COMPREHENSIVE PACKAGES

The Enhanced and Comprehensive packages come with an Android-based tablet.



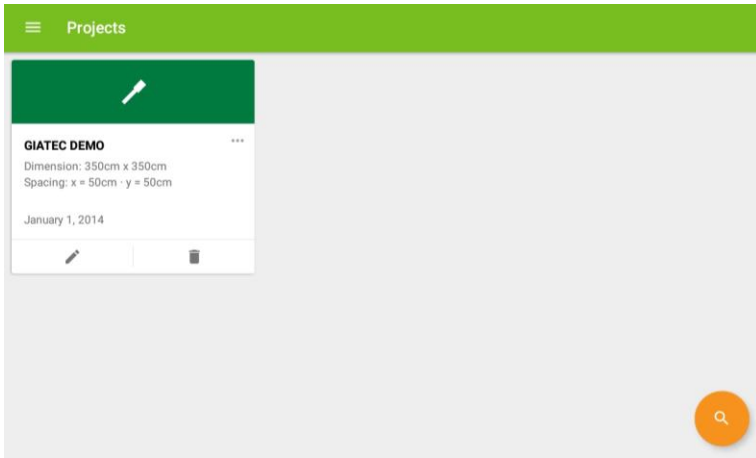
**Figure 14.** Welcome screen of Giatec XCell™ software on tablet

The tablet comes pre-installed with the Giatec XCell™ Data recording and processing app. The app can be launched by clicking on the Giatec XCell™ icon on the home screen.



**Figure 15.** Start a New Project


The main page of the XCELL™ application shows active projects (Figure 16); by default, there is a demonstration project available, select a project to collect or view data points.



**Figure 16.** Launching the software

## NEW PROJECT

### Step 1: Create New Project

On the top left corner of the home screen select  in order to access the main menu. From the main menu, click on **New** to define a new project or **Bin** to retrieve a previously created project.

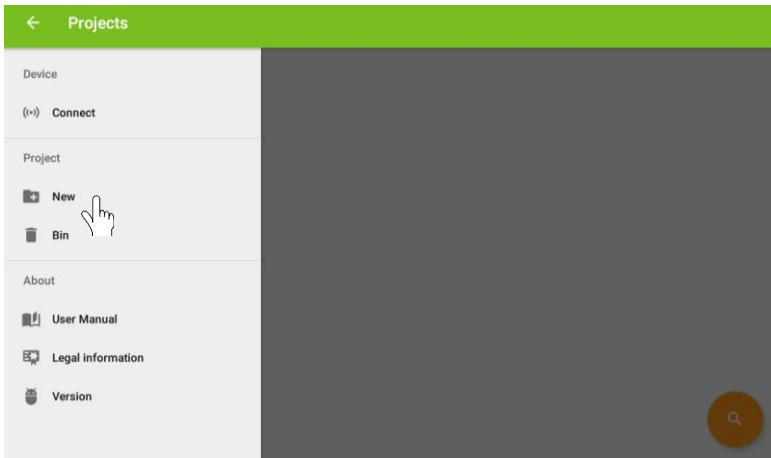


Figure 17. Main menu

## Step 2: Project Description

Enter the **name** of the project and select the temperature correction and off-grid sampling options. Assign a picture to the project, using the image or photo icon on the top right corner of the page (Figure 18). Press **Next**.

- The software automatically corrects corrosion potential values for temperature variation. If you do not want the values to be corrected, **Turn Off** the temperature correction feature.
- The off-grid sampling feature enables the user to add data points which are not on the generated grid nodes. The user can select any location on the grid and assign the measured values by double-clicking on the test grid working area screen. However, the operator can **Turn Off** the off-grid sampling feature.

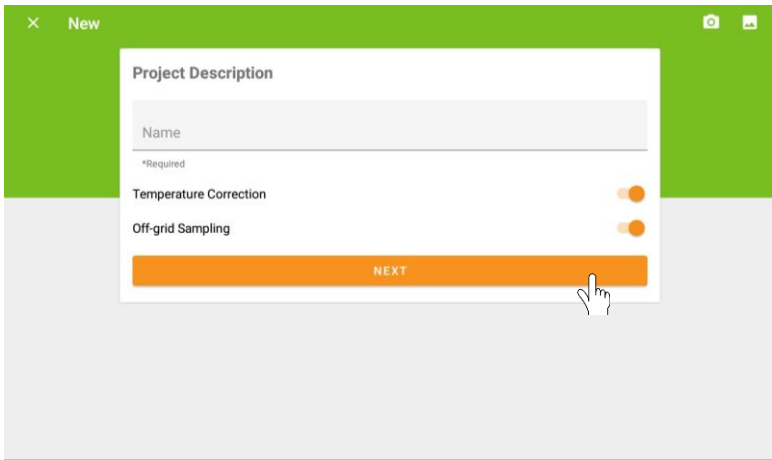


Figure 18. New project description

### Step 3: Units

Define the system of units for dimensions and temperature, (Figure 19). Press **Next**.

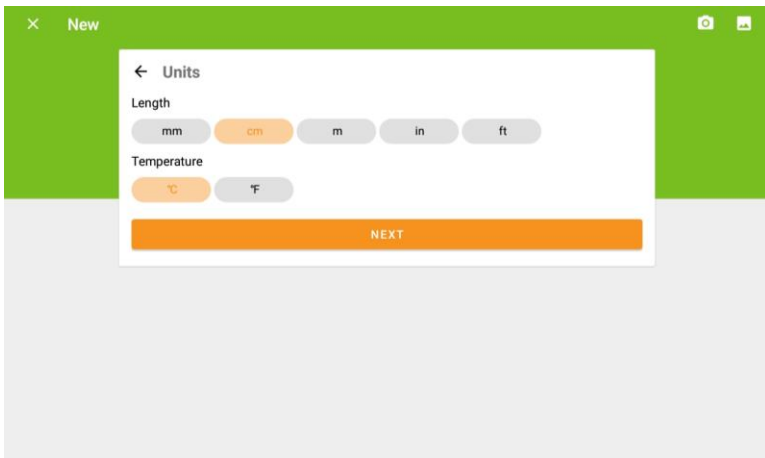


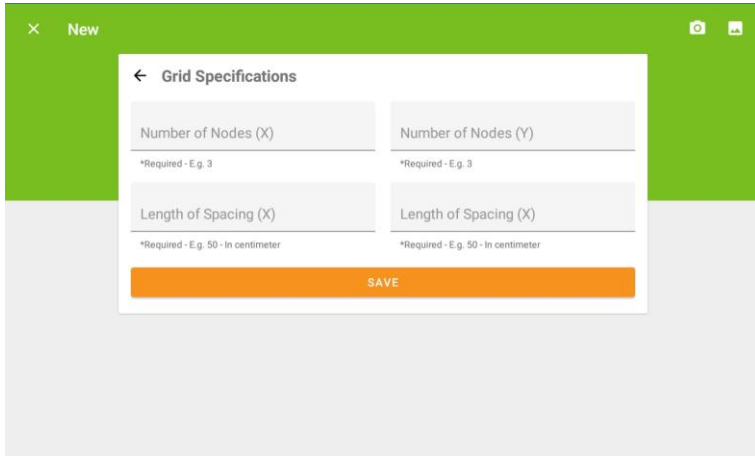
Figure 19. Units

### Step 4: Grid Specifications

The grid visually represents the number of rebar and the spacing between each in both the vertical and horizontal direction. Specify the **number of nodes** (number of rebar) on the test grid in the X and Y directions and the





**length of spacing** between the nodes. Press **Save**, the application will bring you back to the main page showing your new active project.



**Figure 20.** Grid specifications

### Step 5: Edit project

To **edit** a project, select  below the project description. To **delete** the project from the active project page, select . It is not possible to fully delete a project, project will be sent to the **Bin** where they are archived, at any time a project can be reactivated (Figure 17).

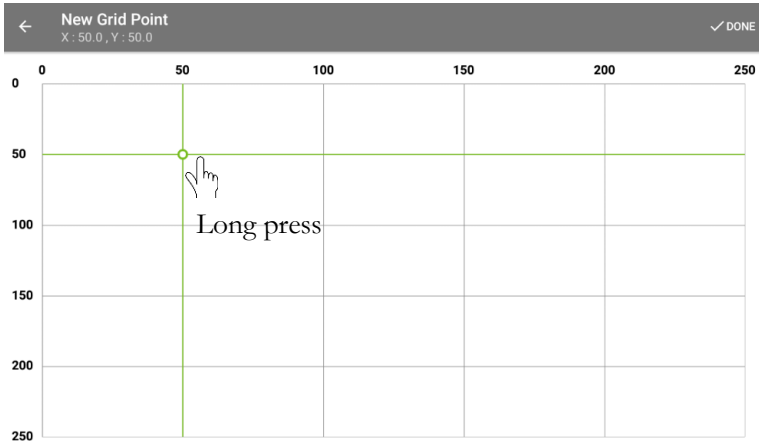
It is possible to edit the grid size and spacings; location of points will be adjusted taking in consideration point (0,0) remains the same.

## GRID

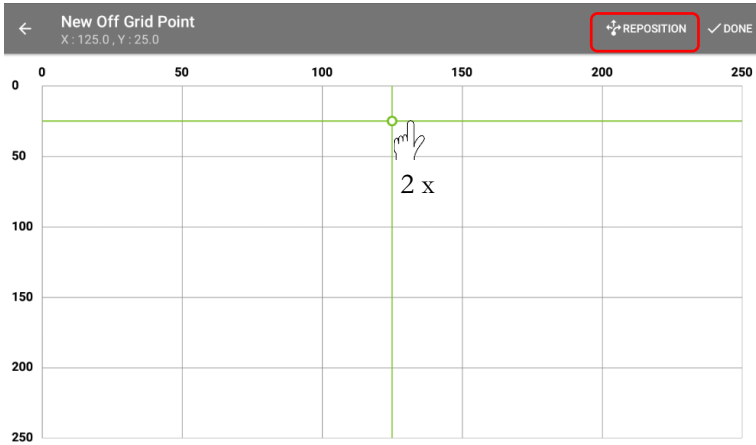
Select a project from the main active project page (Figure 16); this will generate the test grid (Figure 21). Long press on an intersection to select a point (Figure 22a). To select an off-grid point, double click at any location on the grid (Figure 22b). A window will open where you will be asked to specify the X and Y intersection. A selected point can be repositioned using the **Reposition** option on the top right corner. Once the point is selected, press **Done** on the top right corner of the screen to make a measurement.



Figure 21. Test grid




(a) Select grid point



(b) Select off-grid point

**Figure 22.** Select point for measurement

On the top left corner of the grid screen, select  in order to access the **project menu**. From the project menu the user can generate contour maps, view a summary of the data, and share the project information.

## CONNECTION

### **Step 1: Turn on device**

In order to use the XCELL™, the device (unit) must be paired with the tablet via Bluetooth. Turn on the XCELL™ by inserting the test cable to the probe (Figure 3).

### **Step 2: Connect**

From the main menu or the project menu, select **Connect**. If the Bluetooth connectivity is off, the user will be asked to give permission to turn on the Bluetooth communication on the device.



Figure 23. Connecting tablet to the device

**Step 3: Scan**

A list of available devices will then appear on the screen. In the search results, select the **Connect** button beside the XCELL™ for pairing. This will pair the device to the tablet. If the XCELL™ is turned on but doesn't show on the connect page, select the big green scanning circle on the bottom right corner of the page to refresh.

It will take a few seconds for the tablet to be paired with the unit; a connecting window will be shown during this period.

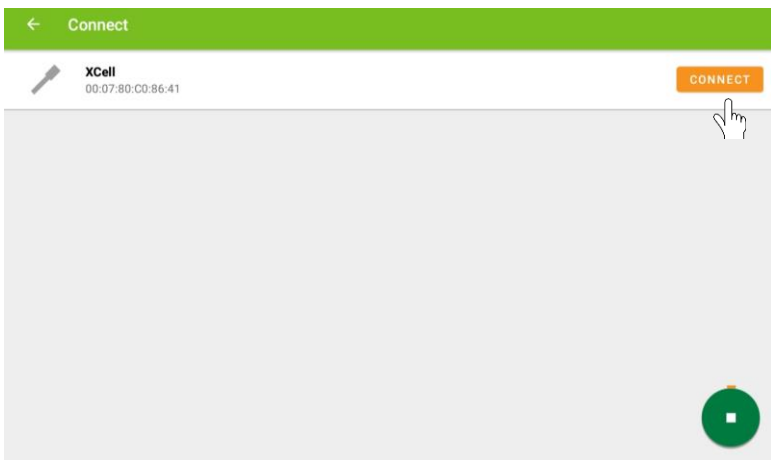




Figure 24. Select the appropriate device from the list

### **Step 4: Device connected**

When the tablet is connected to the device, the  on the toolbar indicates that the device and tablet are paired and ready for testing. The battery indicator  will also turn on showing the charging level of the battery in the XCELL™ device.



**Figure 25.** Device connected

## **MEASUREMENT**

### **Step 1: Position the XCELL™**

In order to conduct the measurements on a specific location on the grid, move the Giatec XCELL™ device to the corresponding grid point on the concrete surface. Select the corresponding grid point (or off-grid point) on the tablet screen and press **Done**. This will direct the user to the measurement page.

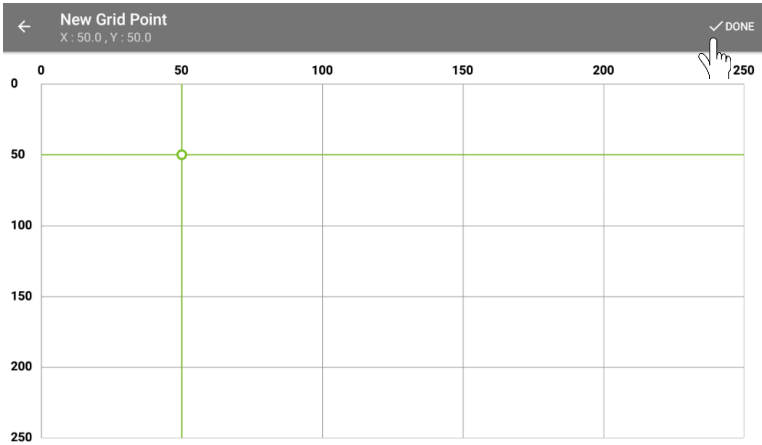


Figure 26. Selecting a point for measurement

### Step 2: Making a measurement

The measurement page will show the live half-cell potential and temperature measurement. Once the values stabilize select **Measure** at the bottom of the page (Figure 27). The taken measurements will then be shown in the result box, with the colour indicator (Figure 28).

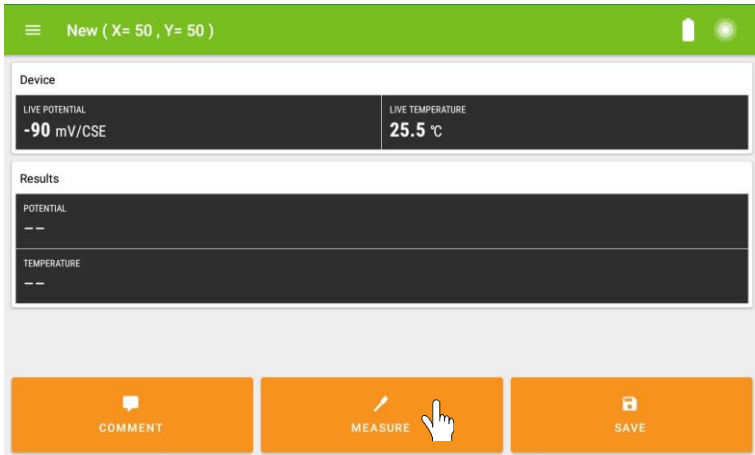


Figure 27. Measurement page

### Step 3: Saving a measurement

If you are satisfied with the measurement, select **Save**. The measurement will be saved, and the application will bring you back to the grid page and in order to take a new measurement. If you are not satisfied with the measurement, leave the unit on the concrete are press **Measurement** until the data is satisfactory to be saved.



Figure 28. Save measurement

After pressing the store button, the recorded data will be assigned to the grid point. Tested grid points are indicated with red bullets on the screen and off grid points are shown in blue.

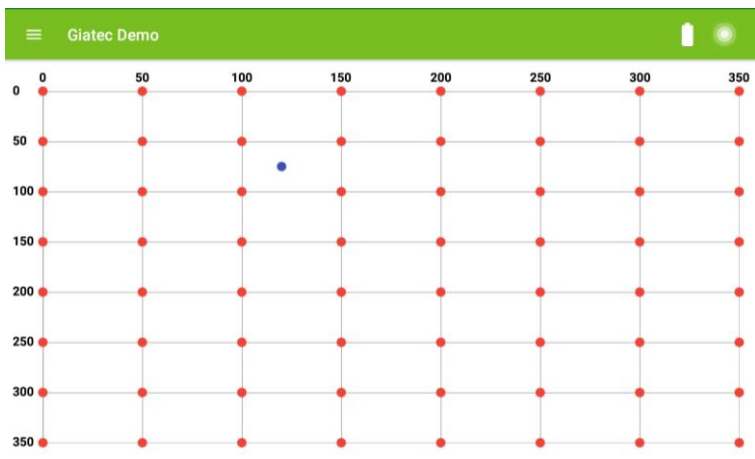


Figure 29. Test points

#### Step 4: Edit a measurement

The user can re-test any previously tested location. To do so, simply move the probe to the location you want to re-test.

On the tablet screen, press and hold the corresponding grid point where the measurement was previously taken. Select the **Edit** option on the top right of the screen. If you want to replace the old values with these new measurements, press **Measure** and **Save** a new measurement. The user can delete previously saved data by pressing **Delete**.



**Figure 30.** Replacing/Discard/Delete a measurement

**!** When the test is finished, disconnect the Bluetooth connection on the data recording unit. This can be done by selecting **Disconnect** from the main menu or by disconnecting the connection cable from the probe. This will save the battery life of the unit.

#### DATA PROCESS AND CONTOUR PLOTS

Each measurement will be identified by a color code indicating the probability of the steel corrosion activity, going from green to red as the probability increases (see table 3).



**Table 3-** Half-cell potential color code

Color Code	Potential Value (mV/CSE)	Probability of Steel Corrosion Activity
Green	> -200	Less than 10%
Yellow	-200 to -350	Uncertain
Red	< -350	More than 90%

To access all the data points in a tabulated format, select the **summary** option from the project side menu (Figure 23). Select the column header to organize the data in ascending or descending order.

Axis (x, y)	Corrosion Potential (mV/CSE)	Temperature	Comment
0,350	-507	25°C	--
50,350	-341	25°C	--
100,350	-265	25°C	--
150,350	-61	25°C	--
200,350	-88	25°C	--
250,350	-61	25°C	--
300,350	-215	25°C	--
350,350	-315	25°C	--
0,300	-550	25°C	--
50,300	-331	25°C	--
100,300	-332	25°C	--

**Figure 31.** Summary

Once the measurements are completed, visualize the results through the contour map. Select the **Contour map** option in the project menu. The user can zoom in/out and pan over the generated contour plot to review the details.



Figure 32. Generating contour map

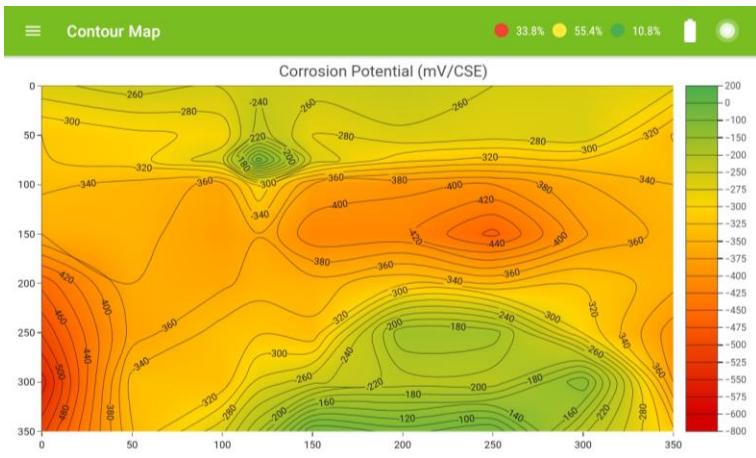



Figure 33. Half-cell contour map

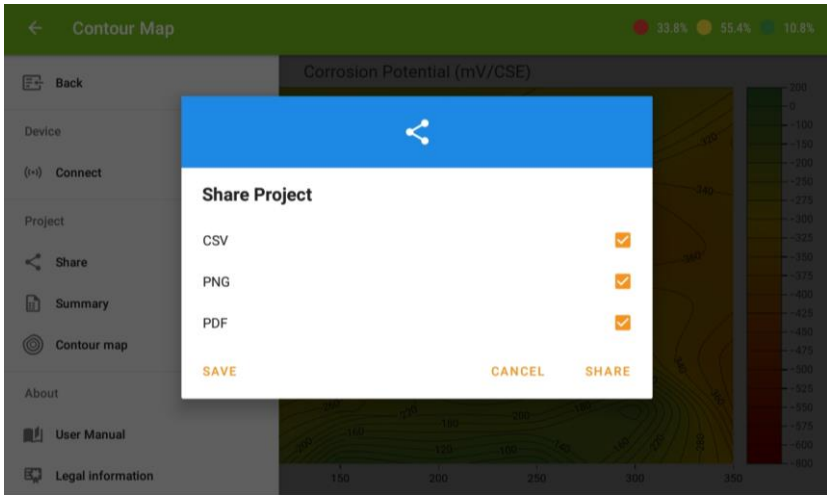
 **NOTES**

The contour mapping tool is available to help the user visualize the results. The XCELL™ application has some limitations in regard to the contour map customization since it is not designed as a sophisticated contour mapping tool.

 The application calculates the area (in % of total test area) corresponding to the three main categories specified in Table 3 of this manual.

## DATA EXPORTING AND SHARING

By selecting the share option from the project menu, the data can be exported and shared in a spreadsheet format (CSV), image format (PNG), and/or PDF format.



**Figure 34.** Share/save project

To save the project, select the appropriate file format and press on the **Save** button. A dialog box will appear asking to define a location for the file. Enter a location where you want to save the file.

To share the data, select the appropriate file format (Figure 34) and press the **Share** button. Specify the preferred shared method (Email, Google Drive, Dropbox, Bluetooth etc.) If you are using email, make sure you have previously login into your email account on the tablet.

**HALF-CELL POTENTIAL TEST**

Report Prepared at August 11, 2016 9:40 AM

**DESCRIPTION**

Project Name:	Gatec
Date Created:	January 01, 2014 7:59 AM
Potential Unit:	mV/CSE
Length Unit:	m
Temperature Unit:	°C
Temperature Correction:	On
Number of Nodes (X):	8
Node Spacing (X):	50
Number of Nodes (Y):	8
Node Spacing (Y):	50

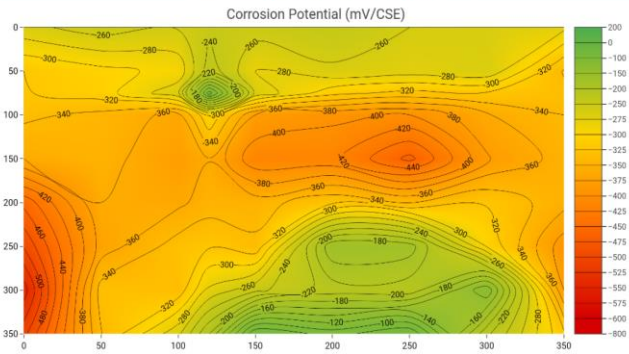


**SUMMARY**

Measurement Range:	Area(%)
< -350 mV	37.5
-350 mV to -200 mV	53.1
> -200 mV	9.4

(a) Project description in the PDF report

**CORROSION POTENTIAL TEST CONTOUR MAP**



(b) Contour map in the pdf report

**HALF-CELL TEST RESULTS – RAW DATA**

X	Y	Potential (mV/CSE)	Temperature (°C)
0	350	-507.0	25.0
50	350	-341.0	25.0
100	350	-265.0	25.0
150	350	-60.9	25.0
200	350	-88.4	25.0
250	350	-60.9	25.0
300	350	-215.0	25.0
350	350	-315.0	25.0
0	300	-550.0	25.0
50	300	-331.0	25.0
100	300	-332.0	25.0
150	300	-246.0	25.0
200	300	-211.0	25.0
250	300	-213.0	25.0
300	300	-124.4	25.0
350	300	-380.0	25.0
0	250	-498.0	25.0
50	250	-372.0	25.0
100	250	-330.0	25.0

(c) Raw data in the PDF report

**Figure 35.** Typical PDF Report in XCell™ app

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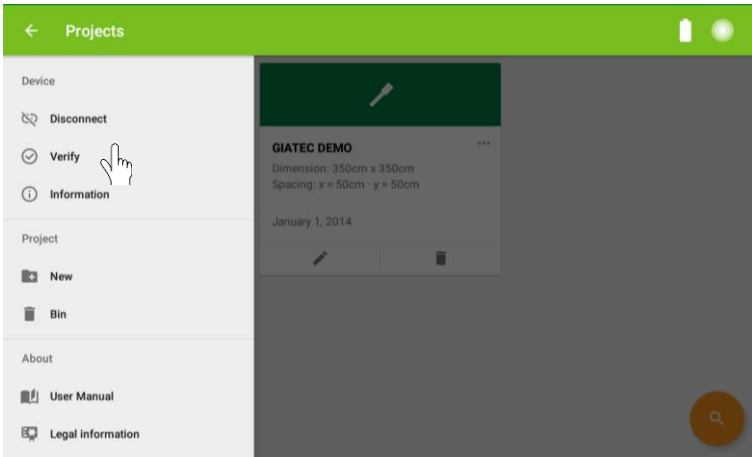
## VERIFICATION

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It is strongly recommended to verify the accuracy of the measuring probe prior to any field or laboratory test using the verification kit (only included in the comprehensive package). The verification kit consists of a very accurate reference electrode. To perform verification of the probe, follow these instructions:

**Step 1-** Connect the tablet to the probe (refer to the instructions on page 25).

**Step 2-** Access the verification in the Main Menu, through **Verify**.

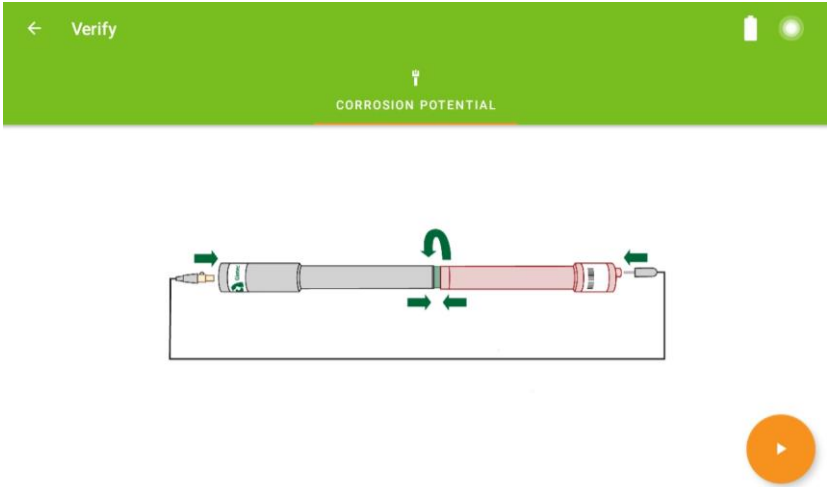


**Figure 36.** Verification option in the main menu

**Step 3-** Connect unit to verification kit

The half-cell verification kit consists of a very accurate reference electrode (i.e. red probe). Open the cap of the red verification electrode and the half-cell potential measurement electrode. Make sure that the green contact sponge is wet and that the white surface inside the verification probe behind the sponge is moist.

Twist the verification kit onto the top of the half-cell measurement electrode, then connect the cable from the half-cell connection terminal to the end of the verification electrode (i.e. red probe) by pushing the banana jack into the socket as shown in figure 37. Make sure there is enough contact between the sponges of the verification and half-cell electrodes.

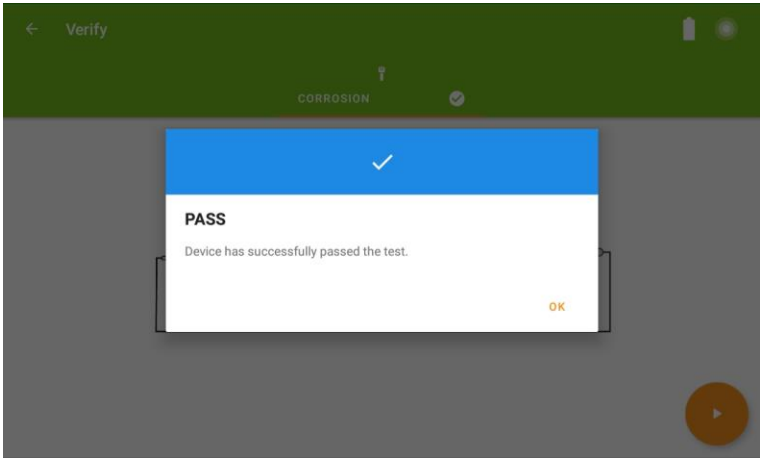


**Figure 37.** Verification set-up

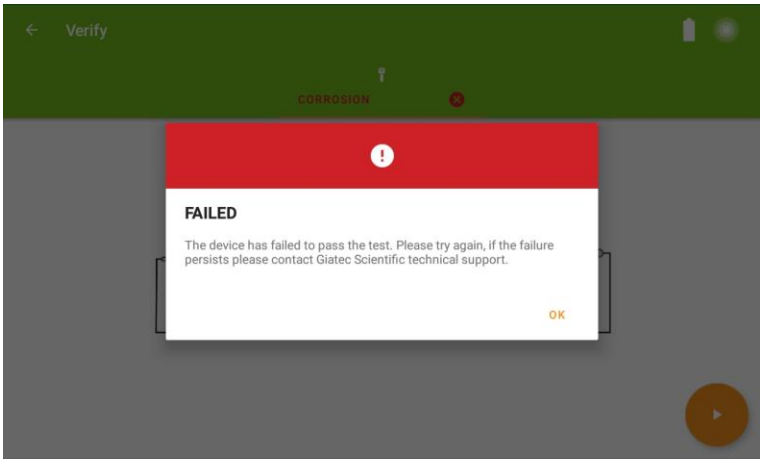
#### **Step 4-** Make verification

Press the **Start** button on the bottom right corner of the screen.

It will take a couple of seconds to perform the test. The results will be displayed as a “Pass” or “Failed” message. If the verification fails, please contact our technical support team using the information on the back of this user manual.



(a) Verification PASS



(b) Verification FAILED

**Figure 38.** Verification status

## MAINTENANCE

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

The sponge on the tip of the probe should be completely wetted with the storage solution and the probe cap should be placed and tightened on the probe head before storing the probe. This practice will significantly increase the lifetime of the electrode. This practice should also be applied to half-cell verification electrode.

The device should be charged at least once every 4 months in order to maintain

### SERVICE

If the XCell™ probe does not connect with the mobile app; check the cable to see if it is connected properly. If XCell™ still does not work properly; review this user manual to make sure you are operating it correctly.

If XCell™ malfunctions, first try to check its functionality using the verification kit. If that fails, call our technical support number provided on the back of this manual. If, after consulting with our technical support department, return is required, the instructions for packaging and returning the device will be provided.

### REPLACEMENTS

For Giatec XCell™, use only the replacement part specified. The USB cable is intended to be used only by XCell™ device and connecting it to other instruments might damage the cable. To order replacement parts call Giatec Scientific Inc. using the number provided on the back of the user manual or on the test probe.

For the latest updates, please refer to the Giatec website at [www.giatec.ca](http://www.giatec.ca)



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## XCell™ TECHNICAL SPECIFICATIONS

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### GENERAL

Type	Value
Voltage Measurement Range	+250 mV to -750 mV
Measurement Resolution	0.1 mV
Sampling Rate	1 sec
Input Impedance	>10 MΩ
Temperature Measurement Range	0 ~ 50 °C
Temperature Measurement Resolution	0.5 °C
Communication Protocol	Bluetooth V4.0 LE
Probe Weight	250 gr

### OPERATING CONDITIONS

Type	Value
Operating temperature	0 ~ 45 °C
Operating humidity	20 ~ 90%
Storage temperature	0 ~ 70°C
Storage humidity	5 ~ 90%
Dimensions of XCell™ Probe	32 mm x 260 mm (D x L)

## REFERENCES

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- [1] Gu, P. and Beaudoin, J.J. 1998. “Obtaining effective half-cell potential measurement in reinforced concrete structure”, Institute for research in construction, NRC, 1-4.
- [2] ASTM C876. 1999. “Standard test method for half-cell potentials of uncoated reinforcing steel in concrete”, Annual Book of ASTM Standards, Vol.14.02.
- [3] RILEM TC 154-EMC. 2003. “Half-cell potential measurements-Potential mapping on reinforced”, Concrete Structures, Materials and Structures. 36, 461-471.
- [4] Elsener, B., Andrade, C., Gulikers, J., Polder, R., & Raupach, M. (2003). Half-cell potential measurements—Potential mapping on reinforced concrete structures. Materials and Structures, 36(7), 461-471.
- [5] Elsener, B., and Böhni, H. (1995). Condition evaluation of reinforced concrete bridges—The benefits of potential mapping. Proc. 6th Int. conf. Structural Faults Repair, London, 47-52.
- [6] Strategic Highway Research Program. (2013). “Nondestructive Testing to Identify Concrete Bridge Deck Deterioration”, Transportation Research Board, Washington D.C.
- [7] CEFRACOR (2007). “Recommendations for the verification of reference electrodes-PCRA 005”. Committee for Cathodic Protection and Associated Coatings.

## **TERMS AND CONDITIONS OF SALE ("SALE AGREEMENT")**

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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 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.



**EXHIBIT A: END USER SOFTWARE LICENSE**

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**IMPORTANT**

**PLEASE READ THE TERMS AND CONDITIONS OF THIS SOFTWARE LICENSE AGREEMENT CAREFULLY BEFORE AGREEING TO INSTALL THE SOFTWARE. THIS IS A LEGAL AGREEMENT BETWEEN GIATEC AND THE END USER (“CUSTOMER”).**

**GIATEC IS WILLING TO LICENSE THE SOFTWARE WITH WHICH THIS AGREEMENT IS PROVIDED (“THE SOFTWARE”) TO THE CUSTOMER UTILIZING THE SOFTWARE ONLY ON THE CONDITION THAT THE CUSTOMER, ACTING THROUGH YOU, THE CUSTOMER’S AUTHORIZED AGENT, ACCEPT ALL OF THE TERMS OF THIS AGREEMENT.**

**BY CLICKING ON THE “I ACCEPT THE TERMS IN THE LICENSE AGREEMENT” RADIO BUTTON BELOW, YOU, ON BEHALF OF CUSTOMER, AGREE TO, AND ARE LEGALLY BOUND BY, THE TERMS AND CONDITIONS OF THIS AGREEMENT.**

**IF YOU DO NOT AGREE WITH, AND DO NOT WISH TO BE LEGALLY BOUND BY, THE TERMS AND CONDITIONS OF THIS AGREEMENT DO NOT CLICK ON THE “I ACCEPT THE TERMS IN THE LICENSE AGREEMENT” RADIO BUTTON AND THE INSTALLATION PROCESS WILL STOP.**

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