Dealer Support Documentation

iCOR Device

The goal of this document is to provide additional guidelines to Giatec's dealers to impower them to act as the first layer of support in a situation where customers are facing some issues with the iCOR device. In this case, the dealer can refer to this document for FAQ's and follow some troubleshooting steps that will either resolve the issue or will provide necessary information for the Giatec Support Team to help solve the issue more efficiently. The dealers are involved in Tier 1 support, the Giatec Support Team will handle cases that escalate to Tier 2 or 3.

Important Note

If required, each client is responsible for getting a copy of the ASTM C876 standard to fully understand how the surface of the concrete must be prepared and how to interpret the results. It is the responsibility of the end user to purchase a copy of the standard, because copyright prevents Giatec from sharing the ASTM C876 document outside the organization. The user manual doesn't cover all the information in the standard, but simply explains how the specific device works.

Tiers Description:

TIER 1 (Dealer): Tier 1 support is the first level of support that can be provided by dealers, resellers, SmartRock Plus partners, sales team, and technical support. It provides simple troubleshooting suggestions that the user can do or try to fix the issue. It also acts as a checklist for information required when the case is escalated to Tier 2.

TIER 2 (Giatec Support): Tier 2 support is provided by technical support at Giatec's main office. It involves accessing some of the user or project information through the backend of Giatec 360 or the support applications. It also requires testing and recreation of more complicated issues.

TIER 3 (Giatec Support): If the root cause of the issue and possible solutions cannot be achieved in Tier 2, the case is escalated to Tier 3 for the product development team to take over. This might involve releasing a patch on the application or a modification on the products' hardware or software.

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Summary

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1. FAQ's

1.1 What is the battery life of the device?

The iCOR battery will last a full day of use, simply make sure it is fully charged the night before. The unit roughly takes 4 hours to charge. The tablet will indicate the level of battery life on the unit at all times. We also recommend having the tablet charged the night before, the tablet will have the limiting battery life in the package (similar to a phone). In addition, it is possible to utilize an external battery pack that can be used to mitigate the battery consumption of the tablet.

1.2 Is it possible to remove the battery from the iCOR unit?

The device is equipped with an embedded battery which is not possible to remove. Under any circumstances, do not open the device.

1.3 What are the limitations of the device?

In general, any feature in the reinforced concrete structure that breaks electrical continuity at the point of measurement will not permit testing, i.e. epoxy coated/galvanized rebar, tensioning ducts sheathing (plastic), asphalt wearing surfaces/waterproofing, fiber reinforced concrete. This is not a limitation of the iCOR but applies to all corrosion detection devices.

Some other aspects of the analyzed structure might affect the readings, such as the presence of voids/ large cracks. As a rule, any nonconductive layer or air layer will block the current from reaching the reinforcement. Another limitation that you may encounter in your region is the temperature measurement range. There is no corrosion activity in the sub 0°C (32°F) temperature as the water inside the concrete becomes ice, it drastically changes the concrete resistivity behavior which would impact the results. Those are not limitations of our equipment but limitations of corrosion rate measurement in general.

1.4 What is the minimum and maximum cover depth for inspection?

A minimum of 10 mm is recommended as the minimum cover depth for inspection. 90 mm is the maximum rebar cover allowable for the iCOR to perform an accurate measurement. Moreover, the equipment will always read the first rebar layer, so if the intent is to read the rebars that are on other layers, it will not read as the current will be drawn toward the first rebar layer only.

When using the corrosion potential, the greater the cover depth, the lower that reading signal gets. Using the half-cell potential on cover depths >90 mm, the interpretation of the results must be carefully made as small differences can represent local corrosion.

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1.5 If a cover depth higher than 90 mm exists, how to proceed?

For cover depths of 7 cm and larger, we would recommend using a longer measurement duration of 20 or 30 seconds. As the cover depth increases, it can become harder and harder to polarize the rebar especially if the concrete is dry. In the event the rebar depth is 10 cm you could still assume 9 cm for the measurement, and this would provide an approximative measurement, but anything deeper would be extremely hard to measure and would increase the error.

1.6 What is the impact of high-density cover layer on the measurements?

When using an overlay, it can create a gap/void between the concrete and the overlay (not a perfect bond). Also, if the resistivity of the overlay is very different from the resistivity of the concrete, this could lead to a misinterpretation of the readings as the bond concrete-overlay consists of a different system (see page 7 of user manual), therefore, the results could be compromised.

1.7 Should corrosion rate measurements be performed if the rebar has corroded severely and the diameter has decreased drastically?

In that situation, the concrete itself would demonstrate significant signs of corrosion. If the corrosion process is severe enough to reduce drastically the rebar diameter, its expansion will deteriorate the concrete, and mapped cracks and delamination will appear on the concrete surface. The primary goal of the equipment is to identify corroding rebars that did not yet severely damage the concrete and take actions to prevent further deterioration.

1.8 Are there any recommendations to perform corrosion rate and corrosion potential measurements at the same time?

If it is decided to make a 3 in 1 measurement with the iCOR, when pressing the measurement button, first a half-cell measurement will be taken, followed by both the electrical resistivity and corrosion rate simultaneously. The corrosion rate and electrical resistivity measurement will polarize the reinforcement therefore the half-cell measurement needs to be performed first at a specific location. The iCOR only polarizes the rebar for a short period of time, when the measurements are set to 3, 6 or 10 seconds, however it is always recommended to wait at least 30 minutes before repeating a measurement at the exact same location.

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1.9 How should the surface of the concrete be prepared before a corrosion rate measurement?

It is highly recommended to pre-wet the surface of the concrete before the measurement is taken as described in ASTM C876. The ideal condition to perform a test is in a saturated surface dry (SSD) condition. This is, however, sometimes hard to achieve on site. Ponding the surface before the test is a very good preparation step. If ponding is used, make sure the excess water on the surface dries or gets removed before the test as excess running water between the surface of the concrete and the iCOR electrodes will cause errors in the measurements.

1.10 What is the minimal spacing between the rebars?

There is a limitation to the spacing of the rebar, which is related to the two voltage response electrodes located at the center of the device. If there are two sections of rebar passing through these electrodes, the results will not output correctly. So, the limitation spacing is around 10 cm or 4 in.

1.11 For rebars near the edge of the concrete element, are there any limitations?

As long as the 4 electrodes in the measurement direction make contact with the concrete surface on top of the reinforcement, it will be possible to perform a measurement. For example, in the y-direction (handle direction) the current is passed through the outer two electrodes, and the voltage response is measured by the inner electrodes. This statement also applies to the curve surfaces (e.g : columns).

1.12 What is the benefit of taking half-cell and corrosion rate measurements together?

With the iCOR, it is possible to perform different types of measurements together or independently (refer to user manual for more information). The five types of measurements are:

1 – Corrosion rate (includes concrete resistivity)
2 – Corrosion rate (includes concrete resistivity) and half-cell potential
3 – Half-cell potential
4 – Concrete resistivity
5 – Half Cell potential and concrete resistivity

Half-cell is included in the unit because it is the only standardized corrosion method. It provides a qualitative measurement while the corrosion rate provides a quantitative assessment. The user tends to use both measurements in the earlier test and move away from half-cell because

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the results obtained from corrosion rate can be correlated. The iCOR is capable of measuring corrosion rate and concrete resistivity without a connection to the reinforcement, but requires one for the half-cell test.

1.13 What is the level of accuracy/reliability for the corrosion rate measurements taken with the iCOR?

The equipment is very accurate and reliable. There have been studies on iCOR results regarding its precision compared with mass loss, other devices and half-cell potential. The results are usually in very good agreement and the best part is that no connection to the reinforcement is required. Please see attached documentation.

1.14 The device/user manual states values for corrosion rate. How were those determined?

There is no standard for interpreting corrosion rate values, every device has its own ranking. There is currently an ASTM Work Item put in place to address this exact question.
The corrosion rate measurement for the CEPRA method was obtained through lab testing, field testing, numerical modelling, and electrochemical principles.

1.15 Is it necessary to use a cover meter/rebar locator to identify the rebar location?

Yes, it is necessary to use a rebar detector/ cover meter to localize the rebars before the test. The iCOR must be aligned with the reinforcement. Location of the rebar, cover depth, and size of the reinforcement are all mandatory information that need to be inputted in the iCOR software.

1.16 Is it possible to use the iCOR with another Android tablet other than the one provided by Giatec?

The application has only been tested with the type of Android tablet that Giatec provides with the unit. If you want to use another Android tablet, we cannot guarantee that it will work, and we can only provide minimal support in any case where you are having an issue with the

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application. The application is only compatible with Android tablets. The tablet provided by Giatec also comes with full support for easier measurements onsite.

1.17 Can I install the iCOR application on multiple Android devices?

Yes, it must be a Android Tablet version 8.0 and higher, compatible with wireless 4.0 LTE connectivity. Note that projects cannot be shared or transferred to another tablet.

1.18 Does the iCOR requires a connection to the reinforcement during the test?

Only when the device is used to measure corrosion potential (HCP). If the device is used for corrosion rate and electrical resistivity assessment only, the connection to the reinforcement is not necessary.

1.19 Does the half-cell electrode need to be calibrated?

A verification probe is available upon purchasing any iCOR package. It is recommended to verify the device using the reference electrode before conducting corrosion potential mapping. The half-cell doesn't require calibration, but must be maintained in good condition in order to pass the verification.

1.20 Can the device develop corrosion mapping for non-flat surfaces?

Yes, corrosion maps can be developed for a non-flat surface, the tablet application creates a grid which represents plan surface. In the case of non-flat testing surfaces, for example a column, the measurements taken on the circumference are represented as a surface. The user creates a grid with desired dimension and spacing and measurements can be taken at any location within that grid.

However, in the presence of a non-plan surface, it is important to ensure that all the four electrodes in the measurement direction selected for electrical resistivity and corrosion rate be in contact with the concrete surface.

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1.21 How to wet the surface?

The best condition is saturated surface dry (SSD). This condition can be achieved by wetting the surface with a water spray, water hose, sprinkler, pounding the surface, etc. Wet the surface as much as possible and let it dry for 15-20 minutes before the measurement is taken, making sure there is no running water on the surface of the concrete.

1.22 Measuring in cold weather?

When performing measurements in cold weather, the results for both corrosion rate and half-cell potential will indicate low corrosion, high resistivity, and low corrosion potential. This is because in low temperatures the corrosion process is greatly reduced and the water inside the concrete could be in the form of ice instead of liquid. In this scenario, it is best to perform the readings when the ambient temperature is warmer.

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2. Tier Support

2.1 Device does not pass verification – Corrosion Rate

Description:
The unit does not pass the verification on the corrosion rate method

Possible Causes:

- *Disk is broken/damaged*
- *Client is using wet sponges to perform verification*
- *Client is not pressing down the device while performing verification*
- *Client is using wrong X and Y on the verification disk*
- *Poor connection between the unit and the verification kit*
- *Electrodes are dirty*
- *Device is not working/damaged*

Troubleshooting		
#	**Questions/ Steps**	**Comments**
1	User should be using latest version of the tablet application.	Some functionalities of the device are only accessible using the latest version. Ask the client to check Google Play store/ App store to download the latest available update.
2	Are the electrodes positioned properly on the verification disk?	If the electrodes are not touching the correct pad, it will not pass verification. The Y direction is represented by the handle direction.
3	Verification without sponges?	Make sure to remove the sponges during the verification.
4	Is the device pressed down for the verification?	Press on the unit during the verification to ensure contact between the unit and the verification disk.
5	Ask to clean the verification disk and the electrodes.	This procedure can be done using alcohol wipes.
6	Perform a real corrosion rate measurement on the verification disk.	Get screenshots of the voltage vs. time figure for both X and Y direction.
7	How often the device is used and when did it start to fail verification?	If the results on site are working great this might be related to the verification disk. Additional test will be proposed by support.
If none of the above steps worked, please proceed below to escalate the issue to Tier 2 (Giatec Support Team)		
14	What is the device's Serial Number?	Provide serial number to Giatec Support Team.
15	Contact: support@giatec.ca	Make sure to include all the information given by the client in the previous steps.

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2.2 Error 1

Description:
When performing the test, the device shows Error 1 message in corrosion rate measurement

Possible Causes:

- Non-conductive layer between the electrode and the reinforcement (epoxy, paint…)
- Electrode not aligned with the reinforcement
- No rebar below the iCOR within the distance of 90 mm.
- Very large delamination, spalling and cracking below the iCOR
- Concrete surface is too dry
- Water running between the electrodes
- Presence of stray current
- Issue with the unit

Additional Comments:
An Error 1 typically indicates that the current cannot reach the reinforcement and typically displays a flat line in the figure.

Troubleshooting		
#	**Questions/ Steps**	**Comments**
1	User should be using latest version of the tablet application.	Some functionalities of the device are only accessible using the latest version. Ask the client to check Google Play store/ App store to download the latest available update.
2	Does the device pass corrosion rate verification?	If yes, continue troubleshooting on step 3. If the unit doesn't pass verification, refer to Section 2.1.
3	Is this happening on every point or simply a couple of points?	If this issue is only happening on for a few points, move the unit to make sure it's aligned with the reinforcement. This would indicate that the polarization is not possible at specific locations due to possible cut in the rebar or any voids or non-conductive layer between the reinforcement and the unit at specific locations. If this is consistent for all points on this project proceed to Step 4.
4	Is there any cover layer on the concrete surface?	Could be epoxy coating, asphalt, some paints, etc., those layers must be removed as they block the current from entering the concrete.
5	Are the electrodes aligned with the rebars?	Make sure that the rebar location was identified using third-party equipment. The electrode must be aligned on top of the reinforcement location. The Y direction is indicated by the handle location.
6	Increase the measurement duration to 30 seconds.	Increase the measurement time.

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7	What is the condition of the concrete? Is the concrete wet?	Make sure the concrete was wetted prior to the test. If an error 1 is displayed, the unit might display a value of concrete resistivity. If the resistivity values are very high >2000 Ω.m this would indicate that your concrete is too dry.
8	Can you see water running on the surface of the concrete?	Running water between the electrodes will cause a short circuit. Wait for the concrete surface to dry before performing another test.
9	Are there any considerable cracks, spalling or delamination on the surface?	This prevents the current from flowing through the concrete. If considerable deterioration is visible on the concrete surface, corrosion rate assessment is most likely already too late, and repair is most likely the preferable option.
10	Is there any source of stray current near the rebar?	Stray current will affect the readings
11	General project information.	Providing this information will help Tier 2: What is the rebar size? What type of concrete? What is the cover depth? What type of structure? How old is the concrete? What is the environment?
12	Ask the client to send a screen shot of the results of the measurements.	This information will help Tier 2.
If none of the above steps worked, please proceed below to escalate the issue to Tier 2 (Giatec Support Team)		
13	What is the device's Serial Number?	Provide serial number to Giatec SupportTeam.
14	Contact: support@giatec.ca	Make sure to include all the information given by the client in the previous steps.

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2.3 Error2

Description:
When performing the test, the device shows Error 2 message.

Possible Causes:

- *Not enough data points to fit the curve*
- *Error in calculations*
- *Movement of the unit during the measurement*
- *Too many continuous measurements*

Additional Comments:
The rebar is getting polarized, but the fitted curve cannot be completed. It will display a certain amount of voltage measurements over time but won't be able to output a result.

Troubleshooting		
#	**Questions/ Steps**	**Comments**
1	User should be using latest version of the tablet application.	Some functionalities of the device are only accessible using the latest version. Ask the client to check Google Play store/ App store to download the latest available update.
2	Does the device pass corrosion rate verification?	If yes, continue troubleshooting on step 3. If the unit doesn't pass verification, refer to Section 2.1.
3	Number of continuous measurements at the same location?	If the customer tried to do multiple measurements on the same point in a short period of time, wait at least 30 minutes to let the rebar depolarize.
4	Increase the measurement duration to 30 seconds.	Increase the measurement time for longer polarization.
5	Is the concrete very dry?	If concrete is very dry, it is hard for the current to travel through. Make sure the concrete is wetted prior to testing.
6	What is the cover depth and the rebar diameter?	Error in calculation could be attributed to the wrong rebar size and cover depth input.
7	Is the user maintaining the unit still when performing the test?	Removing pressure or displacing the unit could cause incomplete measurements. The Y direction represents the handle direction.
8	General project information.	Providing this information will help Tier 2: What is the rebar size? What type of concrete? What is the cover depth? What type of structure?

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		How old is the concrete? What is the environment?
9	Ask the client to send a screen shot of the results of the measurements.	This information will help Tier 2.
If none of the above steps worked, please proceed below to escalate the issue to Tier 2 (Giatec Support Team)		
10	What is the device's Serial Number?	Provide serial number to Giatec Support Team.
11	Contact: support@giatec.ca	Make sure to include all the information and screenshot given by the client in the previous steps.

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2.4 Device does not pass verification – Half-Cell

Description:
The unit does not pass verification on Half-Cell mode

Possible Causes:

- *Half-cell electrode is dry*
- *Half-cell verification probe is problematic/dry*
- *Half-cell is disconnected inside the unit (over rotation)*
- *Half-cell cable is broken*

Additional Comments:
This issue is mostly likely related to a dried-out electrode. If the device is stored for a long period of time without the wetting the sponges on the verification probe and inner electrode, the electrodes could dry.

Troubleshooting		
#	**Questions/ Steps**	**Comments**
1	User should be using latest version of the tablet application.	Some functionalities of the device are only accessible using the latest version. Ask the client to check Google Play store/ App store to download the latest available update.
2	Setup for the verification according to the user manual?	If not properly conducted, the device could fail verification.
3	Verification with both sponges wet.	Sponges from the inner electrode and verification probe should be wet and connected during the verification test.
4	Ask to perform real measurements using the verification set up and send the screenshots of the results.	More info in Appendix A1. If the result is “Out of Range” proceed to Step 6. If the unit displays some values, proceed to step 5.
5	Ask to wet the sponges of the verification probe and iCOR electrode using the storage solution, close the tap and leave them for 2-3 days.	If the issue is a dried electrode, performing this procedure may revive the electrode. Repeat verification, and Step 4. If the unit still doesn’t pass verification proceed to Step 6.
If none of the above steps worked, please proceed below to escalate the issue to Tier 2 (Giatec Support Team)		
6	What is the device’s Serial Number?	Provide serial number to Giatec Support Team.
7	Contact: support@giatec.ca	Make sure to include all the information and screenshot given by the client in the previous steps.

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2.5 Electrodes not moving

Description:
Electrodes are jammed/stuck and are not moving

Possible Causes:

- *Corrosion on the springs*
- *Corrosion between the electrodes and the unit*
- *Other physical problem*

Additional Comments:
This issue is caused by corrosion on the shafts or electrodes. Could be related to mishandling of the device / storing the device wet for a long period.

Troubleshooting		
#	**Questions/ Steps**	**Comments**
1	Is it possible to visualize any sign of corrosion on the electrodes?	If yes, the shaft must be cleaned following Step 2. If not, proceed to Step 3 to grease the shafts.
2	Use a brush to physically remove the salts at the bottom of the electrode.	If dirt or any material is found on the electrodes, removing those could release the electrodes movement.
3	Use a non-conductive rust removal spray (e.g. CRC). Can be found in any hardware store.	Apply the spray on the corrosion location and let it act according to the spray's specification.
4	Try to rotate the spring on the electrode which might be stuck.	Carefully rotating the spring, this could release the movement. Do not make a hard movement or apply too much force.
6	Ask if the electrodes are stuck when trying to push or they have a constant resistance the more it is pushed.	Do not pull on the electrode.
7	Ask to send pictures/video demonstrating the issue.	Focus on the bottom of the device. Also, on the location of the electrodes/shafts.
If none of the above steps worked, please proceed below to escalate the issue to Tier 2 (Giatec Support Team)		
8	What is the device's Serial Number?	Provide serial number to Giatec Support Team.
9	Contact: support@giatec.ca	Make sure to include all the information and screenshot given by the client in the previous steps.

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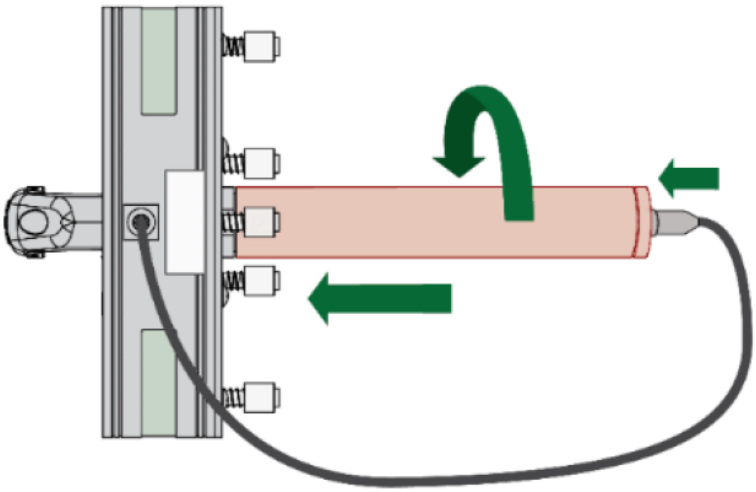
Appendix

A.1 Life status of the Half-Cell Electrode

If the iCOR is not passing verification in half-cell mode, it is possible to inspect the electrode's condition:

- Set the iCOR in the half-cell verification setup
- Perform a real measurement using the below:



Verification setup for half-cell potential

The goal is to determine the condition of the electrodes, whether it is too dry, too wet or might not be working. This can be diagnosed by comparing the reading between electrodes (electrode in the iCOR and the one in the red probe). If the result obtained with the verification setup is close to -110mV, the electrodes should be in good shape and the device should be passing verification. Results more positive than roughly -90mV indicates that there is a dried electrode, which is the cause of the verification failure. First try the troubleshooting step outlined in Step 5 of Section 2.4.

If the electrode was dry for a long time, it is probable that it won't be able to pass the half-cell verification. Giatec support team will most likely propose one or two of the following options:

- Sending the device to our laboratory to replace the half-cell electrode.
- Take into consideration that the measurements are lower by a certain amount and take this error into consideration during analysis. Giatec Team can guide the end user through this process.

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A.2 Cleaning the device

Always after a session of tests, we recommend cleaning the device using alcohol wipes. This will ensure that the unit stays clear of dirt that could lead to any corrosion damage.

To clean using the alcohol wipes wipe all surrounding areas of the iCOR device, especially the shafts and electrodes. On those, make sure that they are clear of any contaminants or job-site residue. Also, to clean the shafts, simply pass the wipe around the shafts as demonstrated in the schematic below:

Representation of cleaning the iCOR shafts

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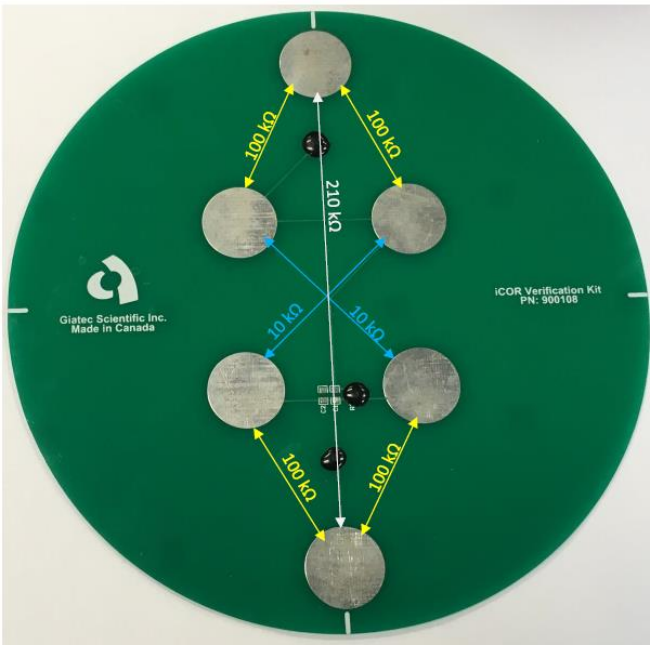
A.3 Continuity check on verification disk

To verify the accuracy of the verification disk, measure the resistance between electrode pads (metallic circles) on the green disk. To do so, use a voltmeter and set it to resistance (ohms) measurement, then place one probe on one electrode and the other probe on another electrode.

The resistance measurement between an outer and an inner electrode should be 100kΩ. The resistance between the two inner electrodes should be 10kΩ. Finally, the resistance between the two outer electrodes should be 210kΩ ± 1kΩ. The measurements are illustrated in the figure below.



Schematic demonstration of the continuity on the verification disk

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A.5 iCOR training videos

1. Components (1 min)

https://www.youtube.com/watch?v=DlpQDrxT9xI

2. Walkthrough (4 min)

https://www.youtube.com/watch?v=iLrkuLtZ2FE&t=114s

3. App Software (7 min)

https://www.youtube.com/watch?v=3YutfIdb6eY

4. Half-Cell Test (1 min)

https://www.youtube.com/watch?v=gHOwsK5UOwU

5. Device Storage (1 min)

https://www.youtube.com/watch?v=bFHtmW1GpS

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