SOP Title: **solarZero Hub Installation – For Delta Hybrid Inverter**

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1. PURPOSE

This document provides all solarcity installation partners and employees with guidelines and instructions for the installation of the solarZero hub for residential solarZero systems with a Delta Hybrid Inverter.

2. SCOPE

This document applies to solarZero Hub installations that will communicate with a Delta Hybrid Inverter and covers the electrical installation and commissioning of the solarZero Hub. For further instructions and scenarios not covered in this document refer to the carbonTRACK installation manual and videos available online. Note that references to 'CarbonTRACK' and 'solarZero Hub' refer to the same device.

3. GENERAL GUIDELINES

- Always follow solarcity's Code of Conduct while on site.
- Follow NZ Health & Safety laws and regulations, your company's and/or solarcity's H&S Policy.

4. INSTALLATION

- Complete the accreditation process and obtain an installer login via the online training portal.
- Familiarise yourself with this SOP, the installation manual, and the wiring schematic available at www.solarcity.co.nz/installerportal
- If using a diagnostic dongle, ensure that you have downloaded the carbonTRACK diagnostic app to your android smartphone or laptop
- Installation and Commissioning support is available from CarbonTrack Mon-Fri 10:30am – 7pm NZ time on **0800 005 647** extension 3

4.1 Essential equipment

- Internet access to the https://solarzero.solarcity.co.nz website via a smartphone, tablet or laptop
- Electrical Tools: Multimeter, Load tester (e.g. hair dryer), Phase rotation meter
- Other Tools: Drill, Hole saw
- Deep mounting block with blank plate, conduit, MCB, suitably sized Isolator for relay bypass
- Antenna upgrade and 10m extension cable

4.2 Optional items

- Diagnostic dongle

4.3 solarZero Hub configurations

The solarZero Hub installation kit consists of

- 1 x solarZero Hub unit
- 2 x 60A current transformers

The standard installation will include a CT measuring the total site energy consumption, a CT measuring the hot water circuit, and relay control of the hot water cylinder.

The hub is paired wirelessly via Zigbee to the Delta Hybrid Inverter so they can exchange information. The hub sends the inverter the mains consumption reading every second so that the inverter can either charge to capture exported solar, or discharge to meet the site loads. The hub also collects the solar production and battery state of charge readings from the inverter which are then shown on the customer's monitoring dashboard or smartphone app.

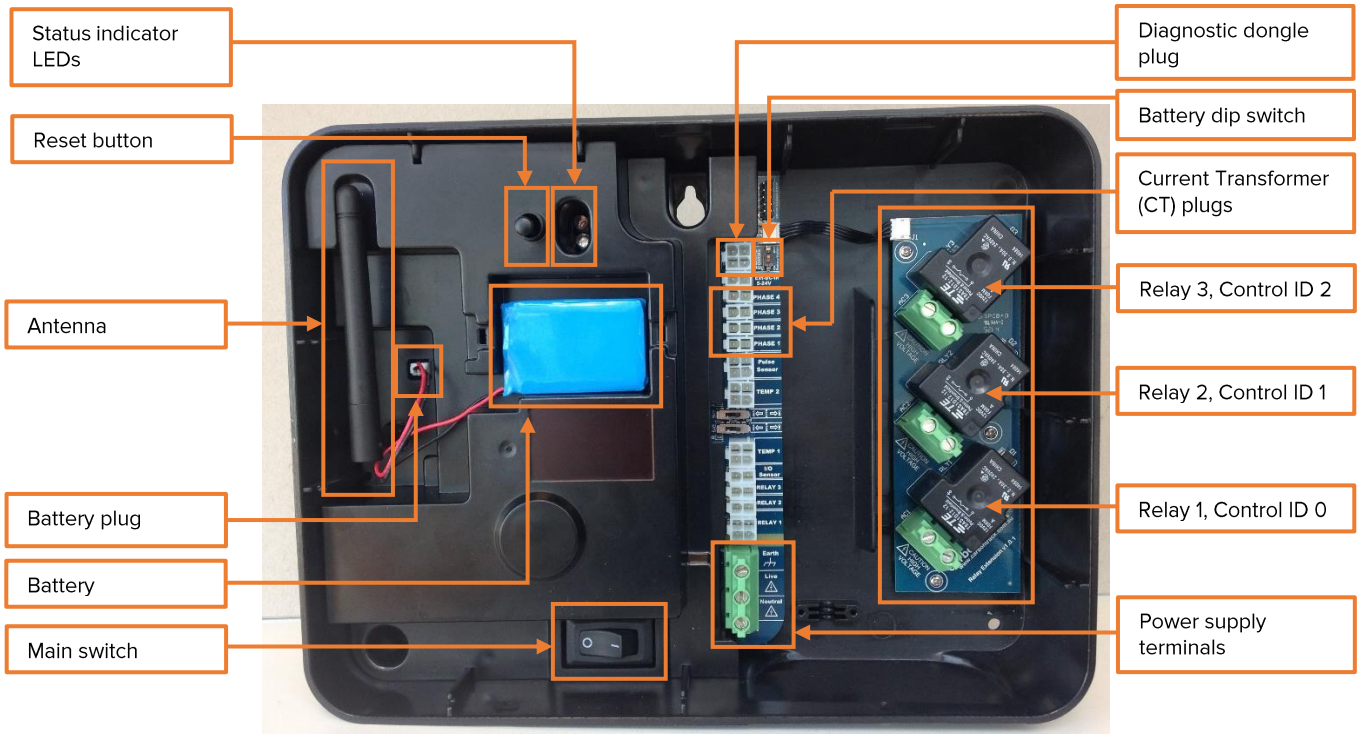
If the house is multiphase additional CTs will be required to measure the total site energy consumption. Refer to section 4.7.2 & 4.7.3 for further detail on multiphase installations.

If there are two hot water cylinders on the same switchboard, wire each cylinder to a separate relay. If there is a second cylinder on a separate switchboard to the Carbontrack unit, it should not be wired to a relay.

4.4 General Installation

- The unit must be installed indoors, or inside an appropriately IP rated plastic enclosure if outdoors.
- Mount the unit within 2m of the switchboard. Cabling between the unit and the switchboard is to run internally through the wall. Cable entries can be made through the rear of the unit using a hole saw and conduit for mechanical protection.
- An alternative is to enter via the bottom right of the unit, in this case use a deep mounting block immediately below the unit to keep cabling neat and tidy.
- Wire a separate circuit to power the unit with a twin and earth from a dedicated circuit breaker on the Delta backup supply (minimum 1.5mm2). This ensures that the unit continues to operate if there is a grid outage.

4.5 Device overview



4.6 Hot Water Cylinder Relay installation

- Wire the hot water to one of the solarZero hub relays using appropriate sized twin active cable. Note that the maximum current rating of the relays is **20A**.
- A bypass switch must be installed in parallel to the relay to ensure hot water supply in the event of a relay failure.
- **Bypass switches must be fed from the same circuit breaker that protects the circuit being switched to avoid a dual feed.**
- **The bypass switch should be an isolator, not a circuit breaker, to ensure correct circuit protection.**
- Wire the bypass switch so that the relay is bypassed when the switch is in the 'On' position.
- Refer to the relay wiring schematic attached to this document for wiring instructions.
- If the customer doesn't have an electric hot water cylinder, then a CT and relay control can be installed on an appropriate alternative circuit that can be switched without causing damage to equipment.

Examples include pumps and lighting circuits – but you may need to check regulations around smoke alarms that may be connected to lighting circuits.

4.7 Current Transformer (CT) installation

CTs should be clamped securely around the correct cable, with the arrow pointing in the direction of primary current flow.

There are two types of 60A CTs (blue and black), which may be mixed and both used within a single installation. Any other combination of CTs cannot be mixed e.g. 60A and 100A CTs cannot both be used in an installation. If a 100A CT is required, all other CTs in that installation must be 100A.

Up to 4 CTs can be connected to the device via the 'Phase 1' to 'Phase 4' plugs. When commissioning the device Phase 1 corresponds to Current Sensor 1 and so forth.

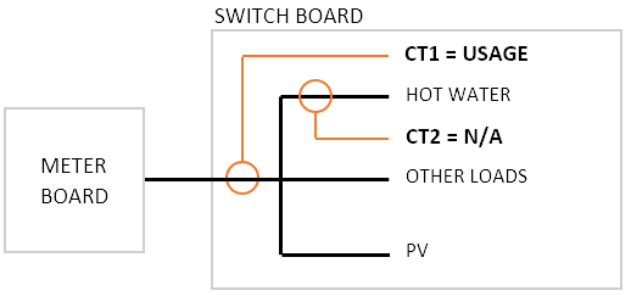
The 'Phase 1' plug in the unit will always be for the CT which is around the mains cable of the same phase as the solar is on. This phase must also be the one used to power the solarZero hub.

'Phase 2' and 'Phase 3' can be used either for auxiliary circuits such as hot water, or in multiphase installations, for the additional mains phases.

The 'Phase 4' slot in the unit is usually used for the solar circuit, however this is not required for Delta Hybrid Inverter installations as the solar information is sent via the wireless Zigbee comms link. For multiphase installations 'Phase 4' should be used for the CT measuring the hot water circuit.

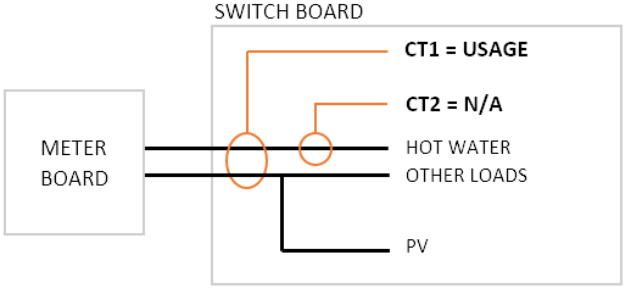
4.7.1 Measuring mains circuits correctly

Mains clamps should be installed on the supply side of the mains breaker. It is very important to ensure that all consumption is included in the mains CT, if there is a separate hot water feed then the mains CT needs to clamp both wires. If you are installing the CT clamp around more than 1 cable, ensure that the current flow is in the same direction in all circuits. In the case where these separate feeds are on other phases, they should be included in the CT for their corresponding phase.



Example 1 – Single Feed

The hot water isn't on a separate feed, any power flowing to the hot water is included in the mains cable.



Example 2 – Separate Feed

The hot water comes to the switchboard on a separate feed from the rest of the house. In this case both circuits must be clamped in CT1 so that all power used by the house is accounted for.

4.7.2 **Multi-phase installations**

If the installation is a two or three phase installation 'Phase adjust' needs to be turned on during commissioning (see section 5.4.4 for further detail). This sets each CT plug to the following phase rotation

- Phase 1 = 0° Phase rotation
- Phase 2 = 120° Phase rotation with respect to phase 1
- Phase 3 = 240° Phase rotation with respect to phase 1
- Phase 4 = 0° Phase rotation

This makes it critical that the CTs are connected to the device in the correct order.

In addition to this, the unit **must be** powered from the same phase that the first mains clamp and the solar is installed on e.g. powered from Red, mains clamp 1 on Red, solar on Red.

Phase rotation may be checked using a phase rotation meter, or the diagnostic dongle and an android device with the diagnostic app installed. If the phase rotation is correct, the power factor of each CT should be close to 1.

Three Phase Installations

For three phase installs all mains phases and the hot water circuit are clamped. Two additional CTs are required. The hot water clamp should be connected to Phase 4 on the device.

Two Phase installations

For two phase installs each mains phase and the hot water circuit are clamped. One additional CT is required. The hot water clamp should be connected to Phase 4 on the device.

It can be complicated selecting the correct CT plugs for two phase installations. The following examples will help you determine how to do this correctly.

Example 1

You have Red phase mains, White phase mains and Solar and Hot Water on Red phase.

- Power the unit from Red
- Phase 1 = Red Mains
- Phase 2 = White Mains
- Phase 3 = Empty
- Phase 4 = Hot Water

Example 2

You have Red phase mains, White phase mains and Solar and Hot Water on White phase.

- Power the unit from White
- Phase 1 = White Mains
- Phase 2 = Empty
- Phase 3 = Red Mains
- Phase 4 = Hot Water

4.7.3 **CT configuration and device profiles**

Use the following table as a guide to clamping the correct circuits and which device profile to use when commissioning the device. Note that some two phase installations may require phase 2 and phase 3 to be swapped depending on the phase rotation.

System Setup	Device Profile	Phase 1	Phase 2	Phase 3	Phase 4
1 phase mains	SCY-1PU-1PH	Mains*	(Unused)	(Unused)	(Unused)
1 phase mains + HW	SCY-1PU-1PH + CIR	Mains*	(Unused)	(Unused)	Hot Water
2 phase mains	SCY-2PU-1PH	Mains (ph 1)*	Mains (ph 2)*	(Unused)	(Unused)
2 phase mains + HW	SCY-2PU-1PH + CIR	Mains (ph 1)*	Mains (ph 2)*	(Unused)	Hot Water
3 phase mains	SCY-3PU-1PH	Mains (ph 1)*	Mains (ph 2)*	Mains (ph 3)*	(Unused)
3 phase mains + HW	SCY-3PU-1PH + CIR	Mains (ph 1)*	Mains (ph 2)*	Mains (ph 3)*	Hot Water

*Ensure that all consumption is included as per section 4.7.1.

4.8 solarZero Hub Battery

The battery has two functions: to boost the antenna signal, and to provide the device with emergency power if the mains power is disrupted.

Ensure that the battery is plugged in and the battery dip switch is turned on (see section 4.5 for the battery connector and battery switch location). If this is not done, the device will have problems with comms and may fail.

4.9 External antenna

If the signal strength is not enough to achieve reliable communication through the mobile network an external antenna needs to be installed. Please make sure to add this information in the notes field during commissioning (see section 0) e.g. *'external antenna w. 300mm cable added to improve comms'*

5. COMMISSIONING

5.1 Pre-commissioning checks

Before commissioning the unit check that the unit is powered by both the battery and the mains by performing the following procedures.

5.1.1 Battery check

With the main switch in the off position turn the battery switch to the on position. The status indicator LED should light up solid blue. If the LED doesn't come on check that the battery is plugged in correctly.

5.1.2 Mains power check

Turn off the battery switch and turn on the main switch. The status indicator LED should light up solid blue. If the LED doesn't come on check for 230V at the power supply terminals using a multimeter.

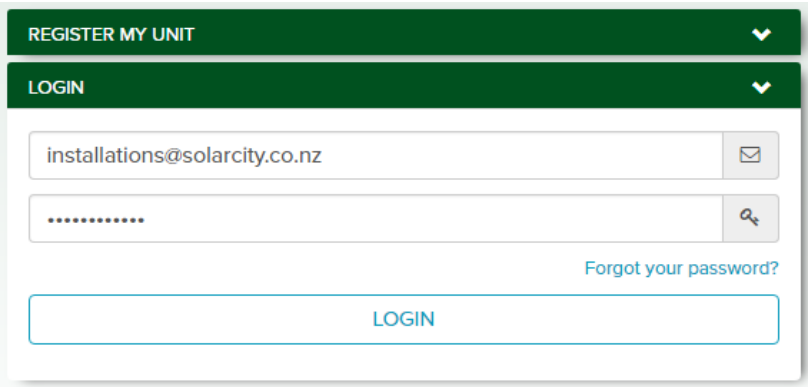
After performing the above two tests turn on both the battery switch and the main switch and leave both on.

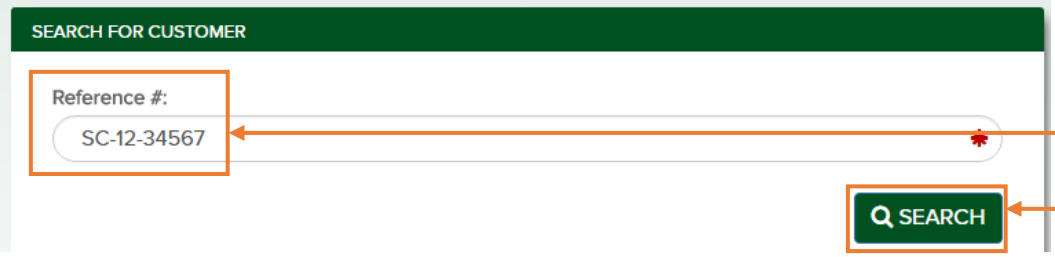
Note: The blue light on the unit needs to be solid blue before the commissioning test can pass. If it is flashing red, please hold down the button for 10-20 seconds until the blue light is solid. This will force reset the unit. Sometimes this can occur if the button has accidentally been pressed on the unit and the unit will go into debug mode (LED flashing blue).

5.2 Commissioning login

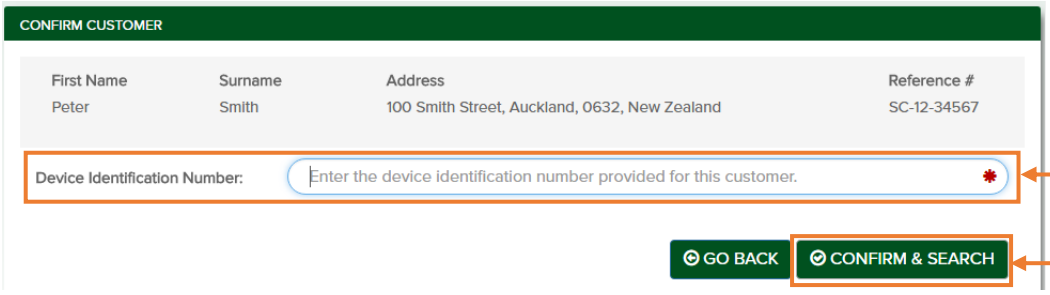
Leave the unit for 5-7 minutes once powered on, and ensure LED is blue, mains and battery switches are on before beginning the commissioning process. This allows the unit to go through its start-up procedure and start communicating with the server.

Open a browser window on your computer or smartphone and login using your installer account via https://solarzero.solarcity.co.nz/





Enter the solarcity SC number as the reference number e.g. SC-17-123456 and click 'search'

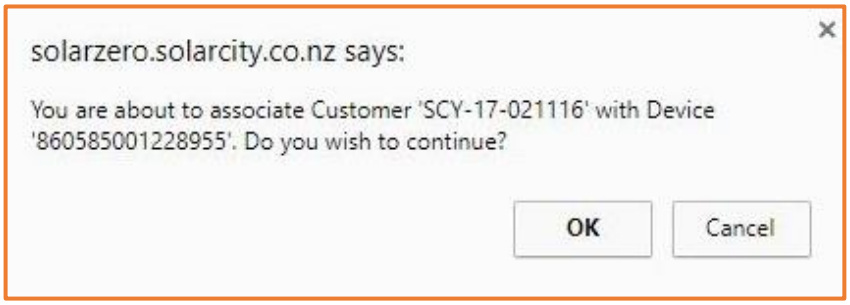


Confirm the customer details are correct

Enter the Device Identification Number (DIN) found on the side of the unit e.g. 8605850012XXXXX.

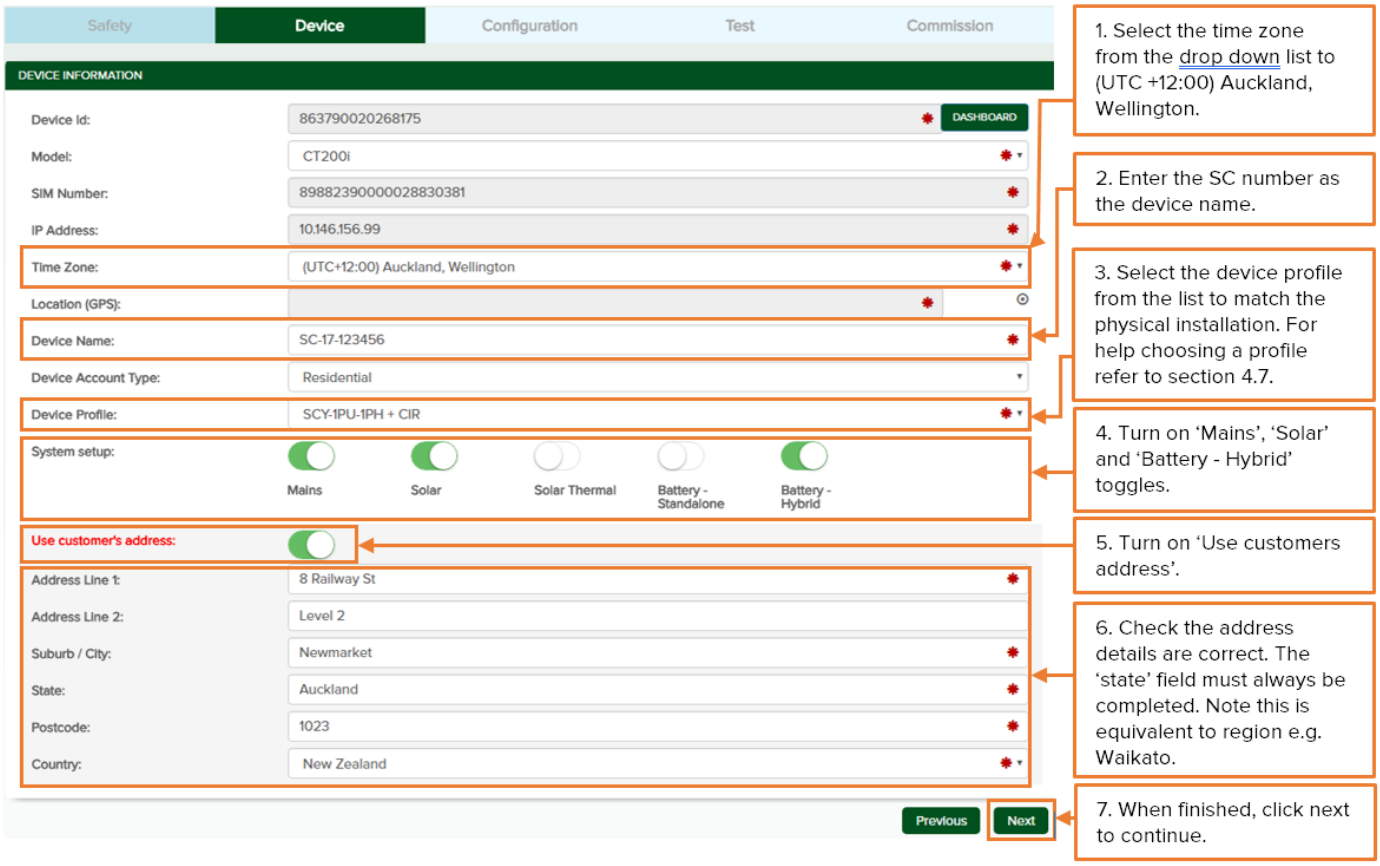
Click 'Confirm & Search'

Once the DIN is successfully found, click the 'confirm' button to move to the next section.



5.3 Device Section

The 'device information' section allows the installer to name the device, set the timezone, set the device profile, and set the customer's address.



Leave all the other inputs as they are and press 'Next'. A popup will display to confirm the customer and device are about to be associated with each other. Click 'Ok' to continue and move to the configuration section.

5.4 Configuration Section

5.4.1 Device Control section

The 'device control' section is where the communication link between the solarZero Hub and the Delta Hybrid inverter is established and where the hot water cylinder relay control is configured.

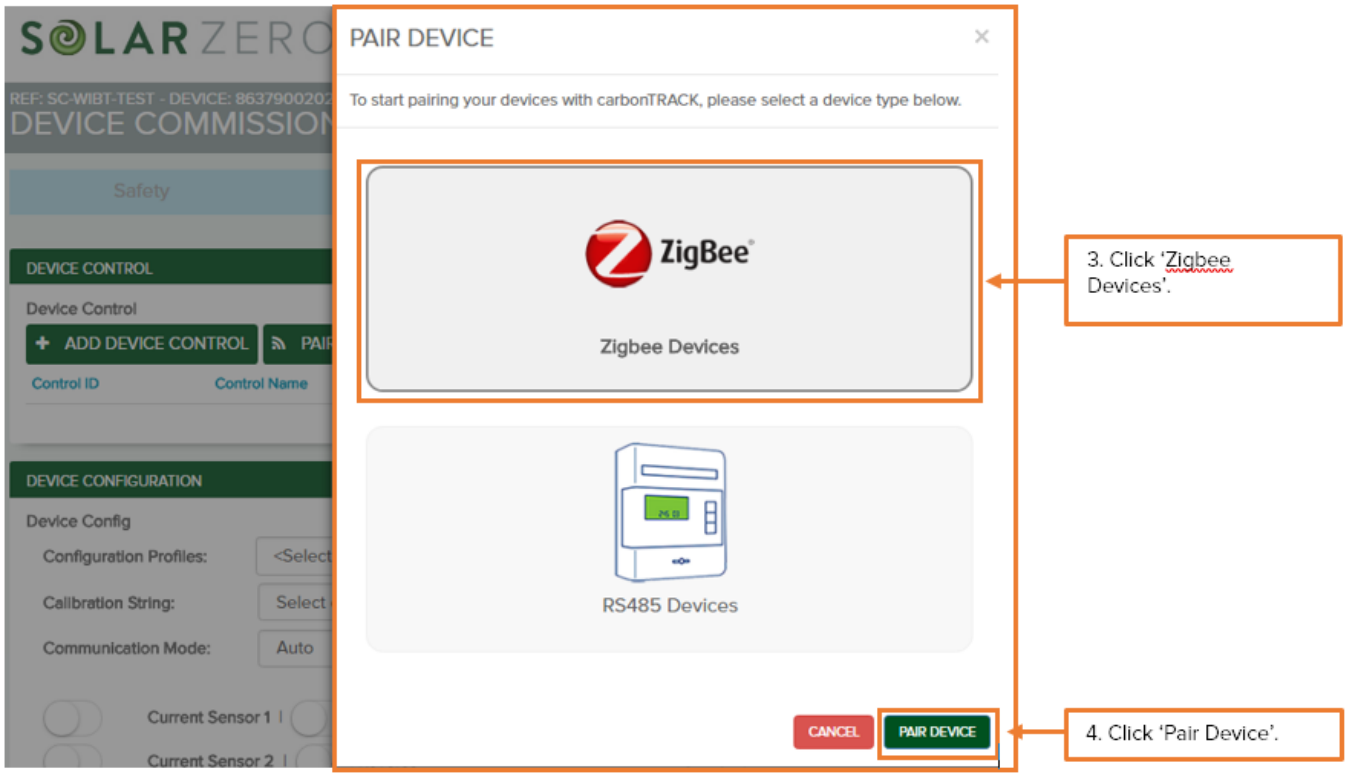
5.4.2 Delta Hybrid Inverter setup

Follow these steps to pair the solarZero Hub with the Delta Hybrid Inverter.

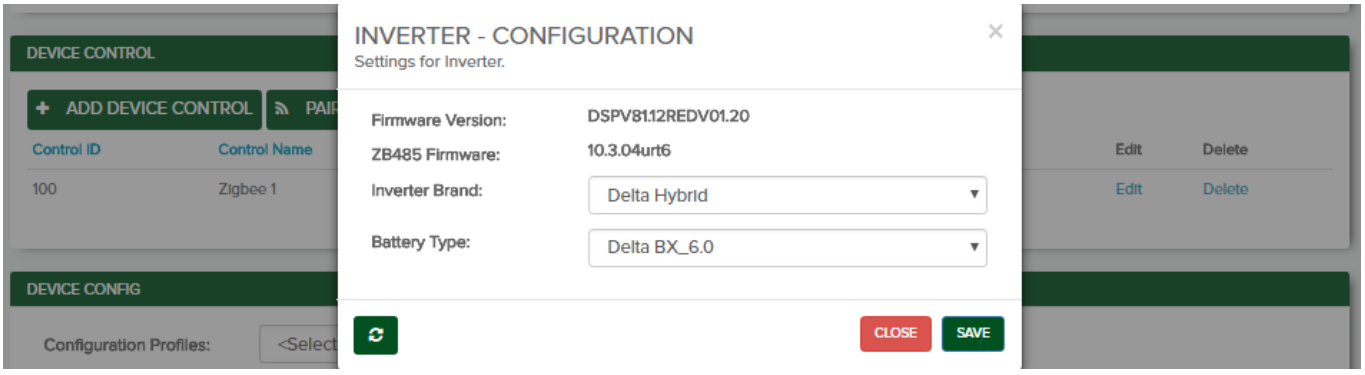
Note: The hub and the inverter communicate wirelessly via ZigBee, which has a range of approximately 15-20m. If the pairing is unsuccessful because the inverter is out of range, Zigbee SmartPlugs can be used to extend the Zigbee network from the hub to the inverter. The SmartPlugs have a range of approximately 10m which will determine how many plugs are required to extend the network until the inverter is within range. Only one device can be paired at a time, so the inverter and any other unpaired plugs should be turned off/unplugged before pairing a device. Refer to section 5.9 for SmartPlug pairing instructions.

1. The Inverter must be commissioned and in the 'on grid' mode before attempting to pair the devices together. Note the orange/red LED on the bottom of the comms module of the inverter blinks when the devices are not yet paired.

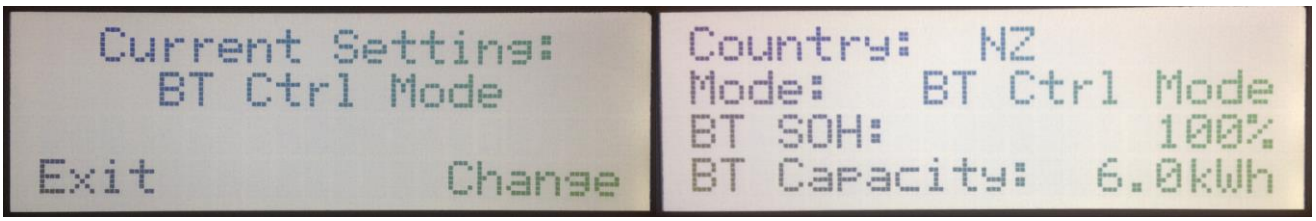
2. Click 'Pair Device' in the Device Control section.



4. After a minute the orange LED on the bottom of the comms module turns solid and a 'pairing successful' message will pop up on the screen and you will be able to see a ZigBee device listed under 'Device Control'. Click edit and make sure the correct inverter brand and battery type are selected as per the below screenshot.

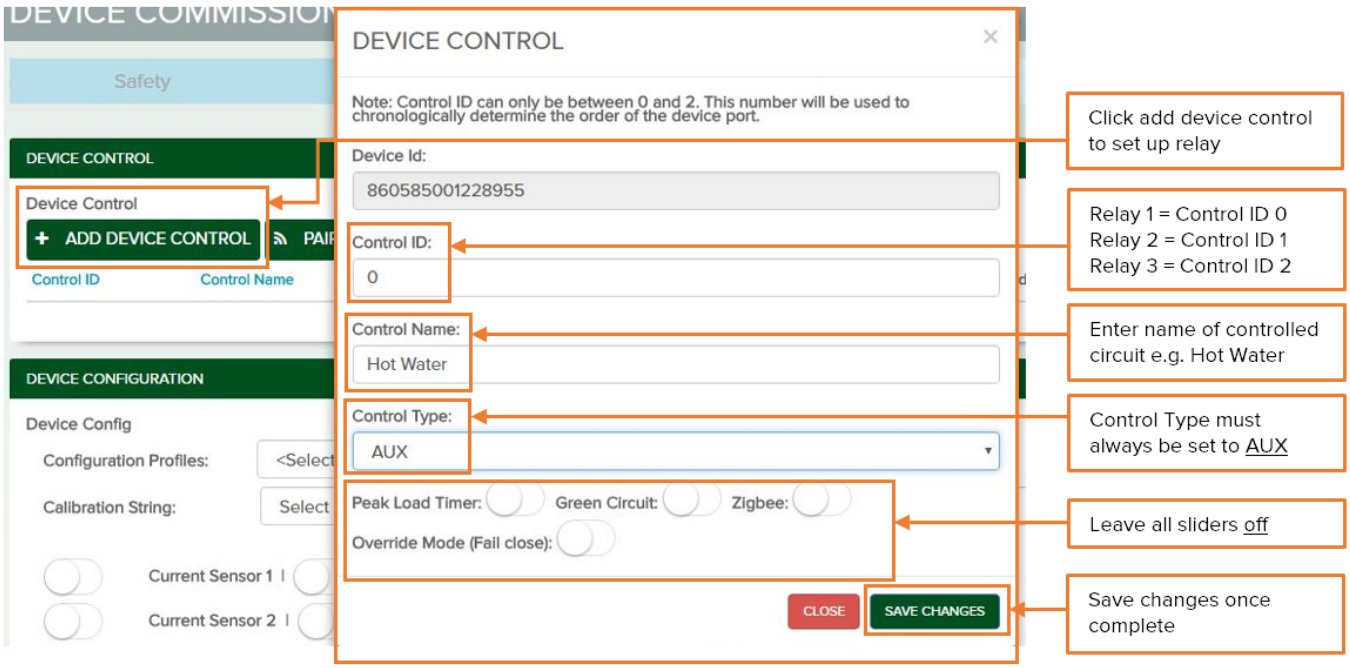


5. Two minutes after successfully paring the devices, on the Delta Hybrid Inverter LCD screen check that both the Operation Mode and Inverter Info show "BT CTRL MODE"



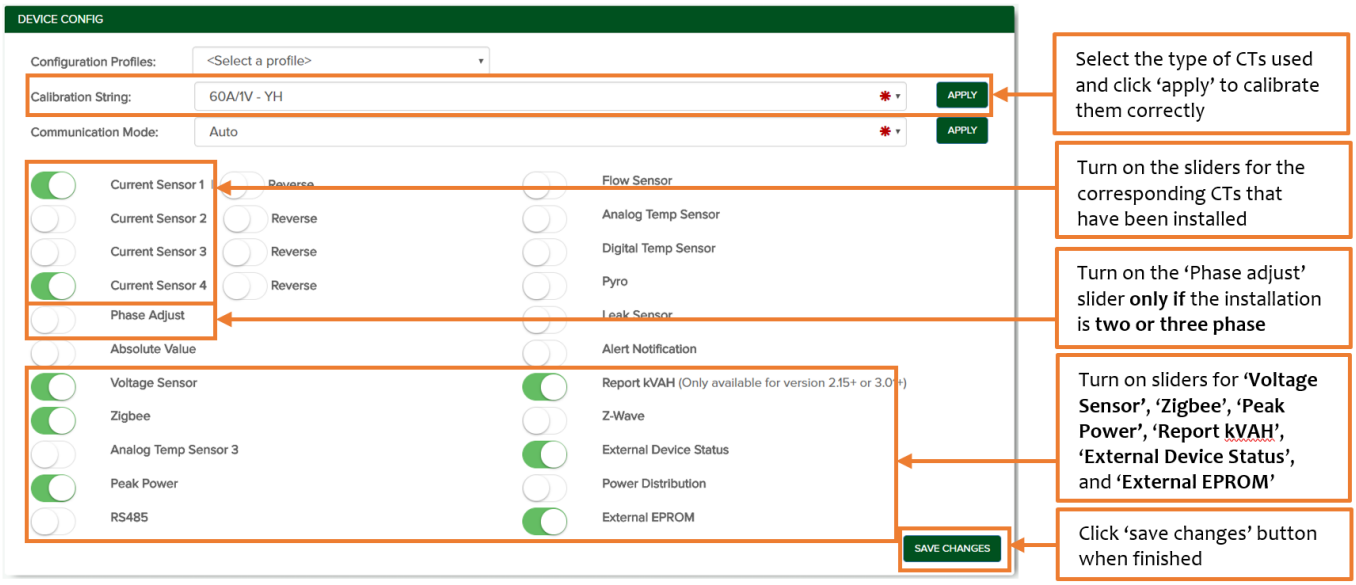
5.4.3 **Hot water relay setup**

Follow these steps to configure the hot water cylinder relay control.



5.4.4 **Device Configuration section**

The 'device config' section allows the installer to turn on the correct current sensors (CTs) and settings for the solarZero hub.



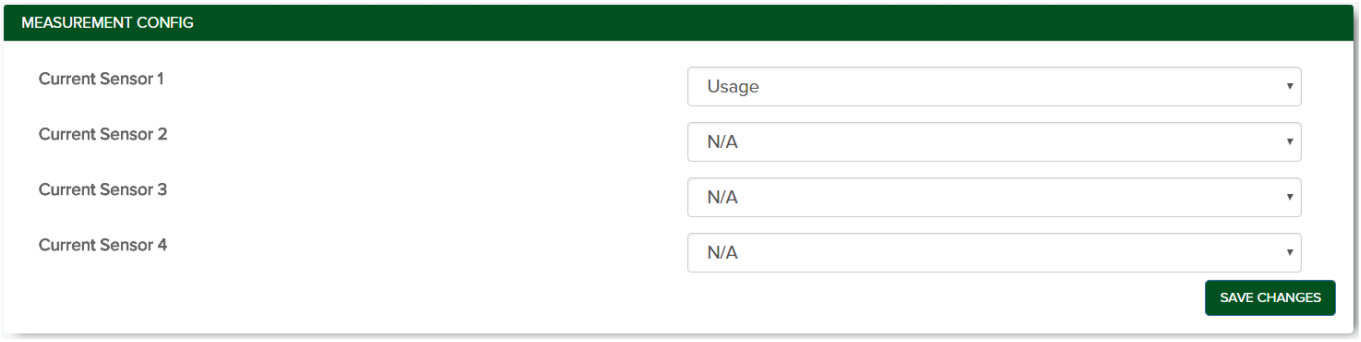
5.4.5 **Device Measurement section**

The 'device measurement' section allows the installer to define what each CT is measuring. There are 3 options: Usage, Generation, and N/A

Generation – Unused with Delta Hybrid Inverter installation.

Usage - Select 'Usage' for CTs measuring mains circuits

N/A – Select 'N/A' for a CT measuring energy which is already measured by an upstream CT e.g. hot water cylinder or battery circuits.

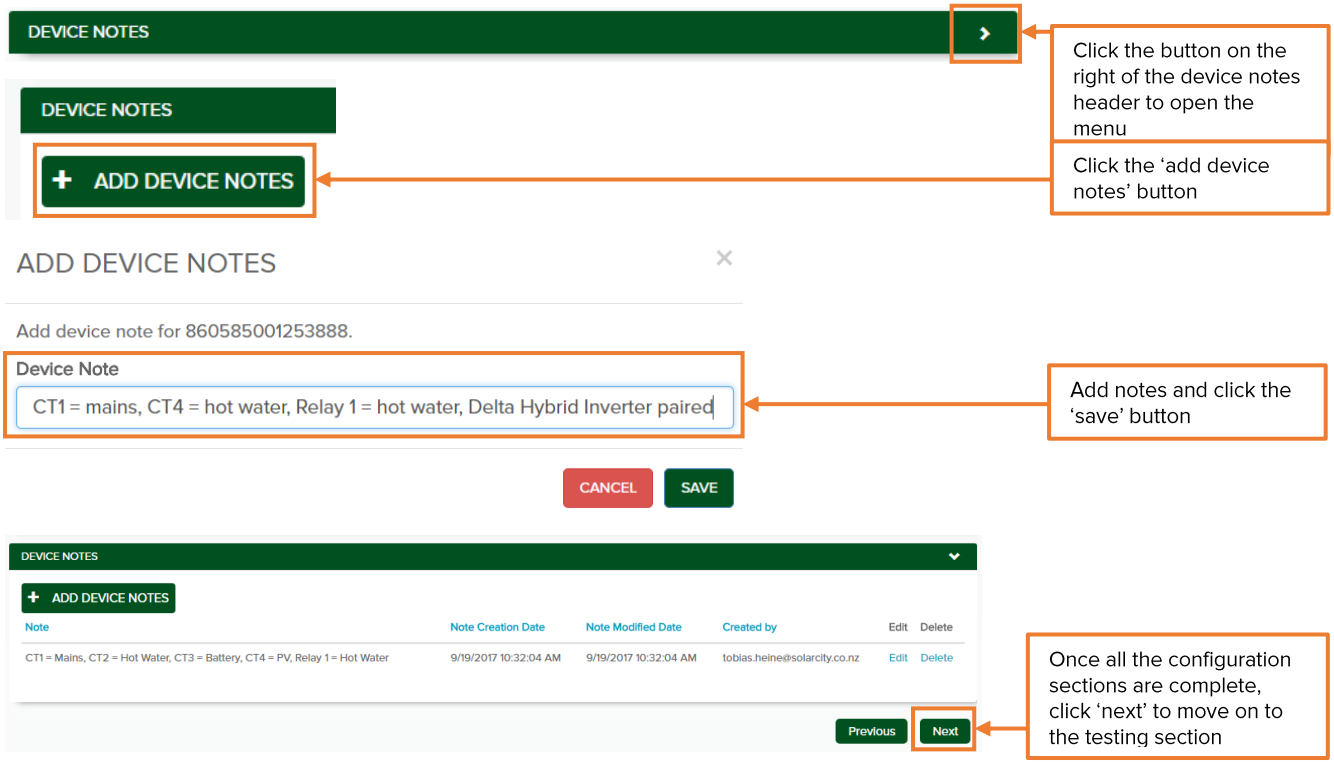


5.4.6 **Auxiliary Graphs Configuration section**

There are no commissioning requirements for this section.

5.4.7 **Device Notes Section**

This section allows the installer to add notes about the installation. Always add a note here detailing the installation e.g. 'CT1 = Mains, CT4 = Hot water, Relay 1 = Hot Water'. Also add a note about which circuits have been moved to the Delta Hybrid Inverter backup supply.



5.5 **Test Section**

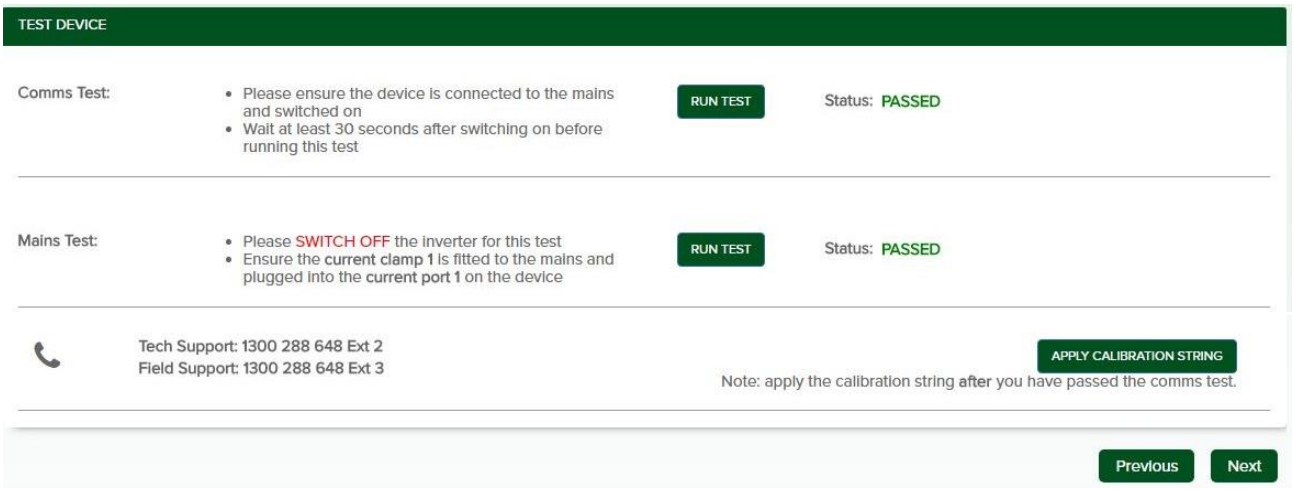
Run each test (order must always be comms then mains). Note that any auxiliary CTs set to 'N/A' as per section 5.4.5 aren't included for testing.

If the comms test fails, running a power cycle is recommended. This will restart the unit and fix most comms issues:

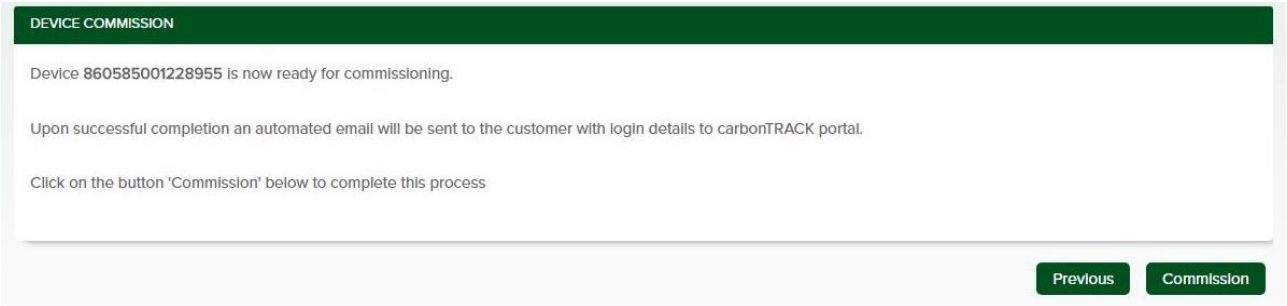
- First, turn off the battery, then turn off the main switch and wait until blue light turns off.
- Then turn the battery and the main switch back on. **Wait 1 min** and try testing comms again.

If the comms test continues to fail an antenna extension may be required. Connect a diagnostic dongle and check the 'CSQ' and 'Signal Strength' values. If the CSQ is below 10, or the signal strength is below -90dBm an antenna extension is recommended.

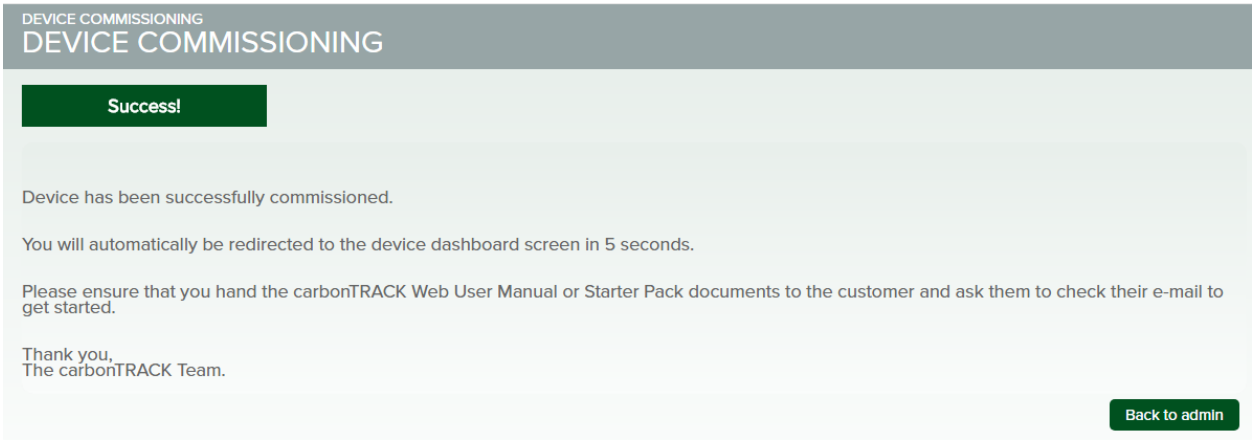
After running the comms test the calibration string should be applied again. Click the 'apply' button to do so. Note that the mains and solar tests require a significant load to pass the test successfully. Use your load tester to ensure this during testing.



Once all tests have been completed successfully click 'next' to move to the commissioning page.



Click the 'commission' button to complete commissioning. A message will display confirming the unit is successfully commissioned and you will be automatically redirected to the device dashboard. **Do not exit this page otherwise you will not be able to test the relay without the diagnostic app**.



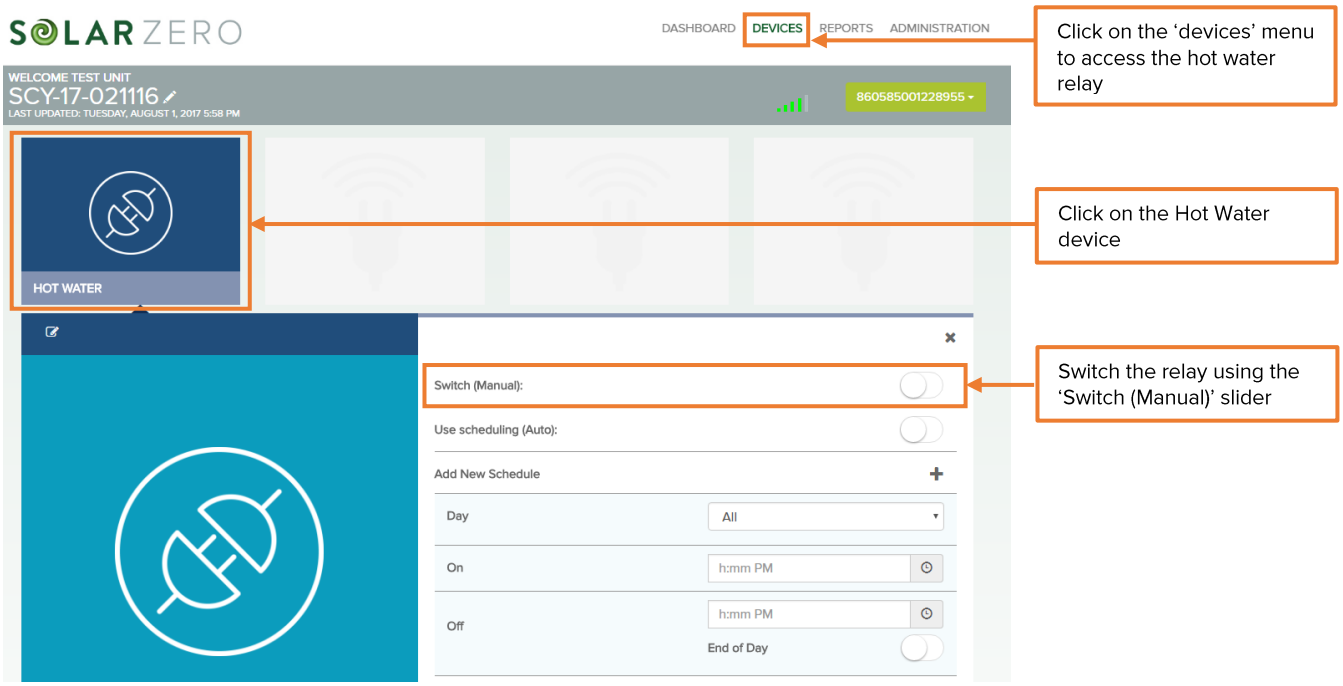
5.6 **Labelling**

The solarZero hub and relay switch gear should be labelled using the PV-LAB-CTK label kit supplied by solarcity with your installer kit. Refer to tech note TN1126-PV-BT-V1 for labelling instructions.

5.7 **Relay testing**

When the unit is successfully commissioned, the relay switch can be tested via the 'device' menu on the user dashboard, or directly via the diagnostic dongle.

To test relay switching, check for voltage with relay both on and off (switching in device section on dashboard) and check for voltage with the bypass switch on and off. Do not leave site if switching does not test successfully.

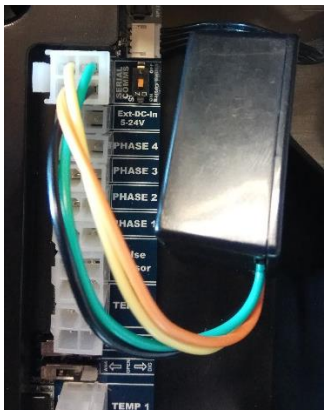


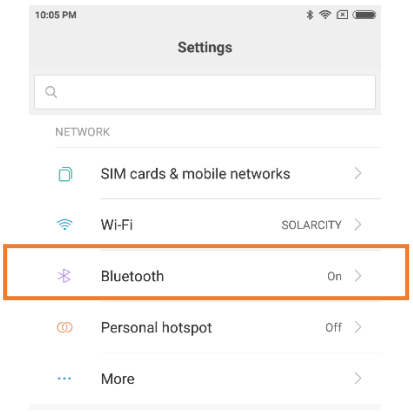
- **Ensure the relay bypass switch is left ON before leaving site**.
- Ensure that the solarZero hub relay is left OFF in the user device interface before leaving site.

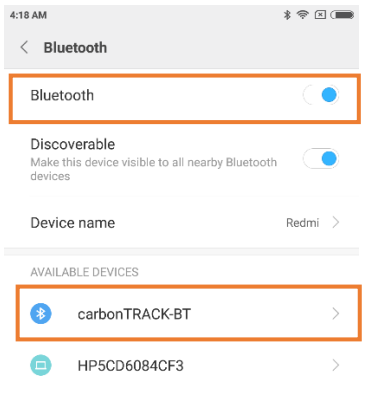
5.8 **Using the diagnostic dongle**

The diagnostic dongle can be used with an android smartphone or Windows laptops. An iOS version will be available soon. The 'carbonTRACK diagnostic' app can be downloaded from the Google Play store.

Note that the diagnostic dongle cannot be used while the solarZero hub is paired with the Delta Hybrid Inverter so diagnostic testing of the signal strength and CT orientation must be performed before pairing the Delta Hybrid Inverter.



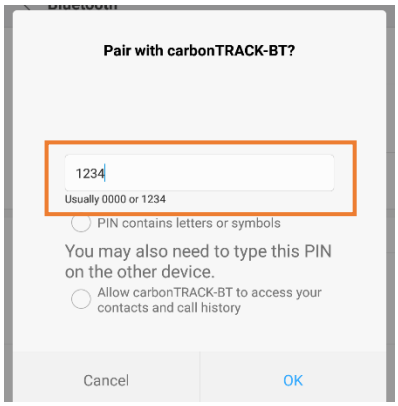


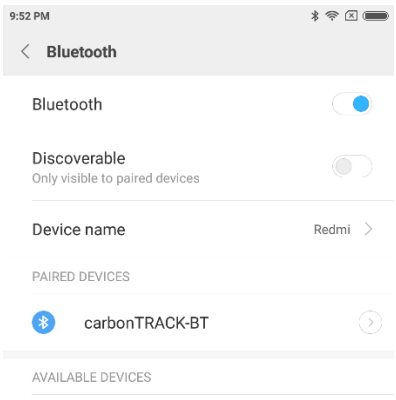


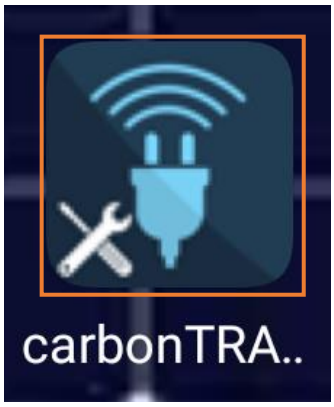
1. Connect the diagnostic dongle to the serial comms plug on the solarZero unit (see section 4.5 for the plug location)

2. Open the settings menu on your smartphone and navigate to 'Bluetooth'

3. Turn on Bluetooth and wait for 'carbonTRACK-BT' to appear in the list. Select carbonTRACK-BT to pair with the dongle



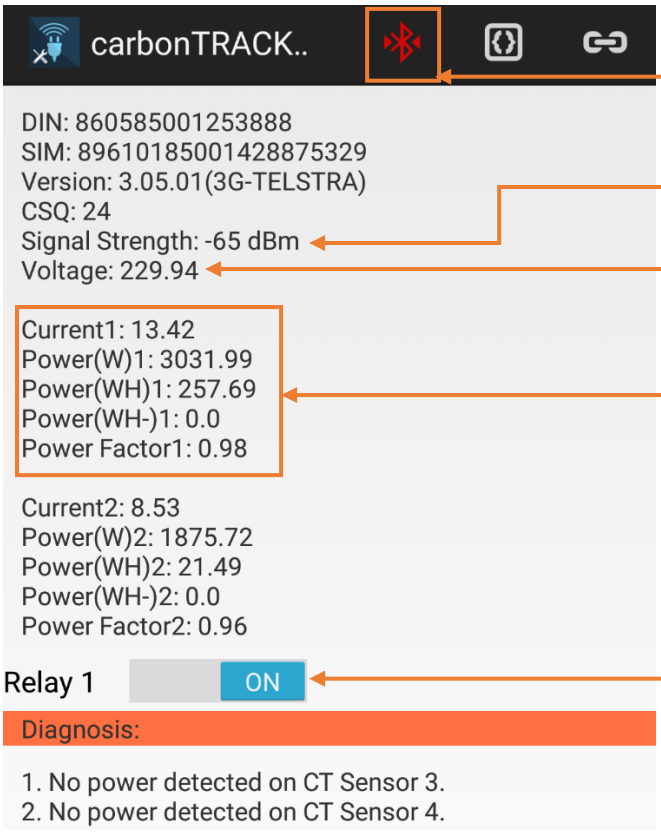




4. Enter 1234 as the PIN

5. carbonTRACK-BT should now be listed as a paired device

6. Open the diagnostic app



Click this icon to connect to the dongle and start reading data

Signal strength of the device – below -90dBm may require an antenna extension

AC voltage at the power supply terminals

Data from each CT is displayed:

- Current
- Power
- Energy (positive)
- Energy (negative)
- Power Factor – should be close to 1. Bad power factor may indicate phase rotation is not in the correct order.

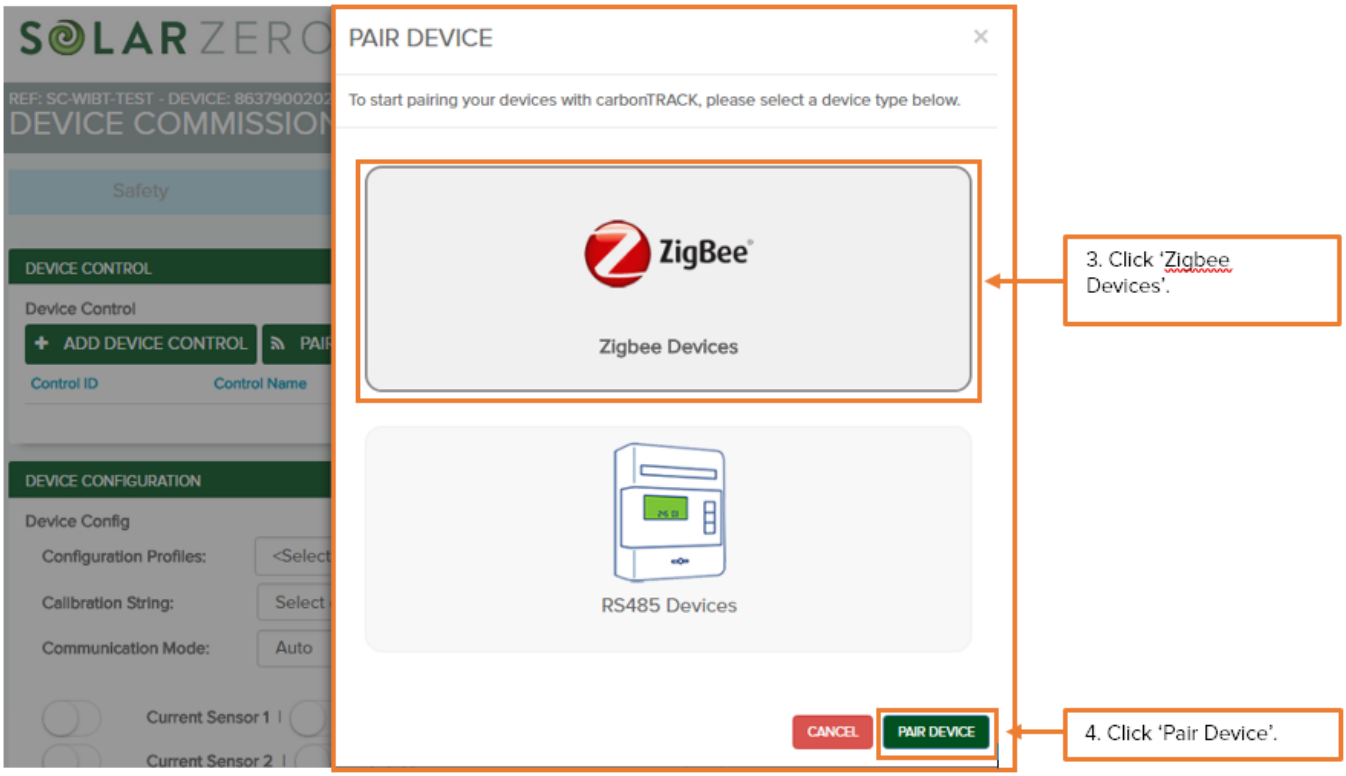
The relays can be switched using the 'on/off' slider.

5.9 Pairing ZigBee SmartPlugs

Note: Only one ZigBee device should be paired at a time, the inverter and any other unpaired plugs should be turned off/unplugged before pairing a new device.

1. Take a ZigBee SmartPlug and plug it into an existing socket outlet and switch the outlet on. The Power LED button on the side of the plug should flash red.

2. Click 'Pair the device' in the Device Control Section of the commissioning web page:



A pairing successful message box should appear and the power LED on the side of the plug should turn solid red. Pressing the LED button will turn the plug on and the LED turns solid green.

If the pairing is unsuccessful, move the plug closer to solarZero hub as it may be out of range. If the LED button is solid red or green and the pairing is unsuccessful, try resetting the plug by pressing the reset button below the LED button for at least 10 seconds after which the LED should begin to flash.

6. CUSTOMER INDUCTION

Once the unit is installed you need to explain several things to the customer about the monitoring unit so do this next to the switchboard.

Explain that the hot water cylinder has been connected to the monitoring unit so that it can be turned on and off remotely using the solarZero app. To use this function in the app the 'Relay bypass' switch must be in the 'OFF' position. To override the app and force the hot water to heat turn the 'Relay bypass' switch to the 'ON' position.

Explain that it is normal to hear a click from the monitoring unit when the hot water cylinder circuit is switched on or off using the solarZero app scheduling option. The click means the relay is working.

Explain that the unit has its own SIM card and communicates with the solarZero app and solarcity via the cellular network rather than using their Wi-Fi connection. Confirm that the monitoring unit will not use any of their broadband data.

DOCUMENT CONTROL

Version no.	Date	Significant Changes	Author	Reviewer
1.0	31/05/18	First Release	T Heine	Engineering