

# VECTO 3

Multi-function Power, Power Quality and Micro  
Synchrophasor Recorder

## User Manual

Version 1.13



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# 1 Safety Instructions

This section provides information on safe handling, installation and commissioning of the VECTO 3. Before carrying out any work on the equipment the user should be familiar with the contents of this document.

Reference should be made to the device’s wiring diagram and the ratings before any installation can commence.

## 1.1 Symbols



Notice      Used to call attention to important information.



Used to indicate operating or maintenance procedures to Caution be respected in order to prevent damage or destruction of equipment.



Used to call attention to potentially dangerous situations  
Warning or danger in general, that requires specific procedures to be respected in order to prevent personal injury.



AC/DC      Both Direct Current (DC) and Alternating Current (AC)



Safety Earth      Safety Earthing Terminal



Hazardous  
Hazardous Voltage Present Voltage



the      device      Battery On      Battery is connected to



Battery Off     Battery is disconnected from the device



CE Certified     Chartered Engineers (CE) Certification

## 1.2 Safety Standards Compliance

The device complies with the IEC61010-1 safety standard:

- Pollution: Degree 2
- Power supply over-voltage category: CAT IV <150V, CAT III <300V
- Measurement category: CAT IV <300V, CAT III <600V

The device complies with the IEC60529 protection standard:

- Penetration of dust & water: Class I
- IP Rating: IP52
- Inadvertent contact

## 1.3 General Safety Information

Installation and maintenance of the device should only be performed by a qualified and certified electrician/technician with appropriate training and experience with high voltage and current devices.

The device must be installed in accordance with the approved national electrical codes.

If the device is used in a manner not specified by the manufacturer, protection from electric shock, fire, etc. provided by this equipment may be compromised.

When the device is in operation, hazardous voltages will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and the device may cause personal injury or physical damage.

The terminals exposed during installation, commissioning and maintenance may present a hazardous voltage. Failure to properly earth the device will compromise the

correct functioning of the internal protection circuitry and may create a risk of electric shock, injury or death.

Standard safety precautions must be followed while performing both the installation and service work. The user must inspect the device and all accessories before use; special attention must be given to the following:

- Damage to the device and accessories that might compromise personal safety or risk to the installation.
- The operational rating of the input terminals

Do not expose the device to abnormal environmental conditions exceeding the requirements for IP52.

The digital outputs are not intended for use within primary protection circuits.

VECTO 3 is intended for indoor installation and use only. If it is required for use in an outdoor environment, then it must be mounted in a specific cabinet or housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP52.

Do not use the device in situations where failure of the device can cause injury, death, or cause sufficient energy to be released that may start a fire.

## 1.4 How to Mitigate Risks

### 1.4.1 Always earth the device first

It is recommended to always earth the device first before making any other electrical connections. This ensures the device casing to be at the same potential of the safety environment and will eliminate the risk of electric shock. At the same time it improves signal quality by providing a return path for all built-in Electro Magnetic Interference (EMI) filters.

### 1.4.2 Install external shorting blocks

Install external shorting blocks on Current Input Circuits (CT). The output of conventional 1A/5A CT circuits may not be interrupted (opened) when under load. It is recommended to install external shorting blocks to allow users to first short out the CT circuits prior to device installation and in the event of device replacement.

### 1.4.3 Locking of terminal plugs

Lockable plug terminals are provided with each device. Please ensure that all locking screws are secured during installation. This will ensure that current input circuits are not accidentally opened under load and it will reduce risk of electrical shock.

### 1.4.4 Use of external fuses or circuit breakers

It is recommended to install external fuses or circuit breakers on all voltage inputs and on the mains supply input. It simplifies device installation and it keeps the installation safe and hazardous free in the event of device replacement.

### 1.4.5 Provide surge arrestors

It is recommended to install external surge arrestors on all voltage inputs and on mains supply input on installations that is located in a high lightning area. It is also recommended to properly earth all antennae as well as external routers or other communication equipment. This will significantly improve system reliability and will reduce the possibility of electrical shock or equipment failure.

## 1.5 Statements and Notices

### 1.5.1 Statement of reliability

The information in this manual has been reviewed and is believed to be entirely reliable, however, no responsibility is assumed for any inaccuracies. All material is for informational purposes only and is subject to change without prior notice. Please see [www.ctlab.com](http://www.ctlab.com) for the latest copy of this document.

### 1.5.2 Proprietary rights

This publication contains information proprietary to CT LAB (PTY) LTD. By accepting and using this manual, you agree that the information contained herein will be used solely for the purpose of operating equipment of CT LAB (PTY) LTD.

### 1.5.3 Copyright

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## 1.5.4 Trademarks

Vecto II, VECTO 3, Osprey Lite, VECTO Grid OS, Xross-Trigger, Snapshot and 6<sup>th</sup>-sense are registered trademarks of CT LAB (PTY) LTD.



Figure 1: Front view of the VECTO 3 device

## 2 Introduction to the VECTO 3

This chapter introduces the VECTO 3. The latest version of this document is shipped with the device.

### 2.1 VECTO 3 Product Description

The VECTO 3 is a comprehensive multi-function IEC 61000-4-30 Class power quality recorder with GPS-locked time synchronisation.

It has 4 x voltage, 4 x current sensor and 4 x powered current transducer inputs. The VECTO 3 has an on-board GPS, 2 x Gigabit Ethernet ports, a USB2.0 (HS) expansion port, 4 x digital inputs (5V power available) and 4 x digital outputs.

### 2.2 Receiving your VECTO 3

The VECTO 3 packaging is shown Figure 2 with the high-density foam cavity for the VECTO 3 and the accessories supplied with the device.



Figure 2: Packaging Opened

### 2.2.1 Receiving your shipment

Upon receiving your VECTO 3 shipment, check the following:

- Outside o      Box is sealed o  
                          Box is not damaged o  
                          Box has no water damage
- Inside o      VECTO 3 in a  
                          plastic enclosure
  - o      VECTO 3 has no water damage or damp in the plastic enclosure o

Ethernet cable, Flash drive and the screwdriver is included in the box If the shipment is damaged or not in a working condition, please take a picture of the damage and send the pictures to [info@ctlab.com](mailto:info@ctlab.com) as soon as possible. Please also phone CT LAB on +27 (21) 880 9915 to handle the problem as soon as possible.

2.2.2      Unpacking the goods

| Step | Action                                                                                                                                               |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Remove all literature inside the box on top of the highdensity foam                                                                                  |
| 2    | Remove the accessories in the accessories cavity on the right side of the box. Check that the standard accessories (see section 2.2.1) are included. |
| 3    | Carefully remove the lid of the high-density foam enclosure                                                                                          |
| 4    | Remove the VECTO 3 from the cavity and inspect for damage                                                                                            |

2.2.3      Checking the Battery Level

After calibration and testing, the VECTO 3 is switched off by means of the Power Button. It disconnects the battery.

- The device will not power up from the battery until mains power is connected to the device for the first time.

When the device is connected to mains power (90-300V AC or DC) press the Power button, check that the power LED starts to flash and that the battery charge LED is on.

- If the battery LED is switched off the battery is fully charged.



The device will not power up from the battery until mains power is connected to the device for the first time

2.2.4      Return shipment

Should the device be returned to CT LAB for calibration or repairs please follow these instructions:

- Insert the device into a plastic bag to prevent water damage during shipment transit; and

- Protect the device properly and also put it inside a padded box to prevent mechanical damage during transit.
- Complete the fault report and sent it and the device to CT LAB.
- Notify [info@ctlab.com](mailto:info@ctlab.com), provide details on the device and how it was shipped and how it can be tracked and with a copy of the fault report.



The package and device remain the responsibility of the client until delivered to CT LAB.

## 2.3 Device Overview

### 2.3.1 Key Features

The VECTO 3 records both voltages and currents of a single 3-phase feeder with IEC 61000-4-30 Class A performance.

- Voltage inputs:
  - Class A performance over all of the input range inclusive of 63.5 V (if L-N measurements are done in a 110 V line-line VT circuit)
  - 6 terminals are used for 4 voltage input channels with maximum input ratings of 600 V.
    - o The first 4 terminals connect 3 different phase voltages such as in a 3-phase system.
    - o Input channel 1-3 is referenced to a neutral (4<sup>th</sup> terminal) connection. This 4<sup>th</sup> terminal acts as a reference channel and can be any phase voltage if a 3-phase line-line voltage circuit is measured.
    - o If it is a 3-phase line-neutral voltage circuit, then the 4<sup>th</sup> terminal will be connected to the neutral voltage.
    - o The 5<sup>th</sup> and 6<sup>th</sup> terminal is the 4<sup>th</sup> channel and a fully differential (2 terminal) input channel.
- Current inputs:
  - 4 X 1/5 A CT inputs

- 4 X 1 V<sub>rms</sub> differential voltage transducer inputs with a 5 V power supply (to be used to power Rogowski coils).
- Digitisation of input signals
- 500 kHz sampling of primary input signals.
- 50 kHz is digitally retained and subjected to the IEC 61000-4-30 Class A signal processing requirements.
- Power supply
- PoE and/or a 90-300 V AC/DC power factor corrected power supply.
- 1/2 hour power failure ride-through via an internal LiFePO<sub>4</sub> battery.
- Data storage
- 4 GB on-board storage providing data storage of all IEC 61000-4-30 voltage and current 10-minute values up to the 63<sup>rd</sup> harmonic component.
- Time stamping
- GPS time synchronization resulting in a time-stamping certainty better than 1 μs.
- PTP time synchronization resulting in a time-stamping certainty better than 100 μs.
- NTP time synchronization as an option.
- Communication
- Communication is via Ethernet.
- Modbus over Ethernet.
- DNP3 over Ethernet.
- IEC 61850 – optional.
- Advanced triggering
- User-configurable triggering between different devices: the patented Xross-Trigger feature (Described in the Osprey Lite user manual)
- Configuration of device

- The VECTO 3 has to be configured by means of an Ethernet connection to a local laptop with Osprey Lite installed.
- Data analysis and reporting
- Osprey Lite is supplied free of charge and continuously updated.
- Download from [www.ctlab.com](http://www.ctlab.com).
- It generates both NRS 048 and EN 50160 PQ reports.
- It allows basic and advanced analysis of PQ waveform events and trends.
- Data can be exported to in .csv and PQDIF format for additional analysis in third party software packages.
- Data downloading can be automated by configuration of the VECTO 3 with Osprey Lite.

### 2.3.2 VECTO 3 External Interfaces

#### 2.3.2.1 Voltages

The voltage inputs to the VECTO 3 interface directly to 110 V VT circuits or directly to a mains connection, which has to be less than 600 V line to neutral.

- Voltage measurements are differential.
- 6 input terminals for voltages are used.
- The first 4 terminals are used for 3 voltage inputs  $V_1$ ,  $V_2$  and  $V_3$  and are neutral ( $V_{com}$ ) referenced ( $V_1-N$ ,  $V_2-N$ ,  $V_3-N$ ).
- Input channel 1-3 is referenced to a neutral (4th terminal) connection. This 4th terminal acts as a reference channel and can be any phase voltage if a 3phase line-line voltage circuit is measured.
- If it is a 3-phase line-neutral voltage circuit, then the 4th terminal will be connected to the neutral voltage.
- The 5th and 6th terminal is the 4th differential channel.
- It can be used to for example measure the difference between neutral and earth.

#### 2.3.2.2 Currents

Permanently installed 1 A or 5 A CT's, or clamp-on CT's interface directly to the galvanically isolated current inputs.

The device calculates the “missing current” by assuming the sum of all currents is zero. (Please refer to Section 2.4.5 for more info)

Alternatively, 1 V<sub>RMS</sub> voltage output current transducers or Rogowski coils with 5 V<sub>DC</sub> power supply can be used to measure current.

Current to voltage transducers can interface directly to 4 low voltage differential inputs. (Please refer to Section 2.4.6 for more info)

### 2.3.3 Power sources

The device is powered from a power factor corrected AC supply input (90–300 V AC/DC).

It can also be powered from an IEEE 802.3-2008 compliant PoE Plus (< 12 W) source.

The internal LiFePO<sub>4</sub> battery powers the device in the absence of power. This battery guarantees 2,000 charge/discharge cycles. If cycled once per day, it translates to at least a 5-year useful life.

Please refer to Section 2.4.3 for more detail.

### 2.3.4 Communication

Two (2) Gigabyte Ethernet ports facilitate local and networked external communication. One port is used to interface with corporate networks (DHCP or fixed IP support). The second Ethernet port is used to create a local network by means of being a local DHCP server. Please refer to Section 2.4.10 for more detail.

The VECTO 3 supports WIFI communication. Please refer to Section 2.4.12 for more detail. The VECTO 3 has an optional built-in cellular modem. Please refer to Section 2.4.13 for more information.

The remote support software supports automatic service discovery protocols. Laptops, when connected to the VECTO 3, will receive an IP from the device. The remote support software can automatically discover which devices are connected to the local network. Please refer to the Osprey Lite™ user manual for more information.

### 2.3.5 Built-in HMI (Web Interface)

The VECTO 3 provides the user with a human-machine interface in the form of a builtin secure web application. Via this interface the VECTO 3 can be configured, inspected, and downloaded.

### 2.3.6 VECTO Grid OS (Enterprise Support)

When connected, each device automatically establishes a permanent secure communication link to a corporate server (local or internet based). An device management system (IMS) keeps track of each device's location, configuration, health (telemetry) and PQ data recorded.

Downloading of data is automated and recorded data can be accessed via the Internet in graphical, tabled and report form as and when it becomes available. Raw data can be analysed in Osprey Lite™ or exported for further analysis in for example Microsoft Excel™ or Matlab™.

Osprey Lite™ simplify the analysis of waveform events such as dips and swells by the time-aggregation of multiple waveform events to single network incidents.

Osprey Lite™ classify and report on recorded data according to industry standards such as NRS048, EN50160 and IEE1158. All communications are

encrypted and each device is password protected. More information can be obtained at [ospreypro.com](http://ospreypro.com).

### 2.3.7 Sampling Rate

The device samples all analog input signals at a rate of 500 kHz (10 000 samples per cycle) and then digitally down-sample the data to 50 kHz (1000 samples per cycle). All IEC 61000-4-30 parameters are calculated based on this 50 kHz resolution for both voltage and current.

Waveform and other events are triggered from the 500 kHz digitised waveforms. These waveforms are locked to the fundamental frequency to prevent multiple zero crosses.

Captured waveform data can be further subsampled to reduce stored data size. The user can configure the waveform-sampling rate from 1 kHz to 50 kHz.

Please refer to the Osprey Lite™ user manual for more information on selecting the down-sampling rate.

### 2.3.8 The 1/6<sup>th</sup> Sense

The VECTO 3 calculates a complete set of 1-cycle sliding RMS and fundamental phasor parameters on each of the 3 voltage phases resulting in a resolution of 6 values per cycle per phase. The IEC 61000-4-30 Class A requirements are based on a ½ cycle sliding approach. This higher resolution data improves the detail of the event profile and enable more accurate depth/duration calculations.

Please refer to the Osprey Lite™ user manual for more information on 1/6<sup>th</sup> cycle data.

### 2.3.9 Event Recording

Users can customise the recording of an event. The IEC 61000-4-30 definition of for example a dip event, can be changed to improve the understanding of phenomena of concern.

Upper and/or lower thresholds to define an event can be set by the user based on waveform, 1/6<sup>th</sup> sense, 10/12-cycle block and aggregated parameters.

Single-phase and multiple-phase triggers can be defined.

When a threshold is exceeded, the VECTO 3 will retain pre- and post-diagnostic information of the event.

Please refer to the Osprey Lite user manual for more information on event recordings.

### 2.3.10 10/12-Cycle Block Recording

The VECTO 3 records all RMS and harmonic data from each 10/12-cycle block ( $\approx 200\text{ms}$  block) for both voltage and current as prescribed the Class A performance requirements of the IEC 61000-4-30, edition 3.

These block values contain both amplitude and angle information of all voltage and current harmonic components up to the 63<sup>rd</sup> harmonic order.

Each block is time-stamped with a 20  $\mu\text{s}$  time resolution and within a 1  $\mu\text{s}$  time uncertainty<sup>1</sup>.

The user can average N x blocks to reduce the sampling rate for the number of blocks up to 299 blocks<sup>2</sup>.

Please refer to the Osprey Lite™ user manual for more information on 10/12 cycle block intervals and down sampling.

### 2.3.11 Variable time interval trends

10/12-Cycle block RMS and harmonic parameters are aggregated according to IEC 61000-4-30 requirements over a user-defined time interval (1 to 30 minutes).

Clock synchronised parameters are time-stamped with a 1 second time resolution.

---

<sup>1</sup> When GPS synchronized

<sup>2</sup> Averaged block harmonic and unbalance phasors do not contain angle information.

2.3.12 Synchrophasors

The VECTO 3 is also a phasor measurement recorder. Recording of 50 Hz (or 60 Hz) synchrophasors can be activated in the configuration setup.

Please refer to the Osprey Lite™ user manual for more information.

Note that this can generate large amounts of data.

Contact CT LAB for support if interested in a PMU (Phasor Measurement Unit) application.

2.3.13 Trended RMS & Fundamental Parameters

| MEASURED PARAMETERS                   | /6th-Cycle | /12-Cycleblock | AggregatedTrends | /6th-Cycle | /12-Cycleblock | AggregatedTrends |
|---------------------------------------|------------|----------------|------------------|------------|----------------|------------------|
|                                       | VOLTAGE    |                |                  | CURRENT    |                |                  |
| RMS                                   |            |                |                  |            |                |                  |
| RMS Magnitude                         |            | ✓              |                  | ✓          | ✓              |                  |
| RMS Magnitude (% of Declared)         | ✓          |                | ✓                |            |                | ✓                |
| RMS Magnitude (% of Rated)            |            |                |                  | ✓          | ✓              | ✓                |
| Voltage Under-Deviation (%)           | ✓          | ✓              | ✓                |            |                |                  |
| Voltage Over-Deviation (%)            | ✓          | ✓              | ✓                |            |                |                  |
| Fundamental                           |            |                |                  |            |                |                  |
| Fundamental Magnitude                 |            |                |                  |            |                |                  |
| Fundamental Phase Angle (Degrees)     | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| Fundamental Magnitude (% of Declared) | ✓          | ✓              | ✓                |            |                |                  |

|                                   |            |                |                  |            |                |                  |
|-----------------------------------|------------|----------------|------------------|------------|----------------|------------------|
| Unbalance                         |            |                |                  |            |                |                  |
| Unbalance (%)                     | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| Positive Sequence Magnitude       | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| Positive Sequence Angle (Degrees) | ✓          | ✓              |                  | ✓          | ✓              |                  |
| Negative Sequence Magnitude       | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| Negative Sequence Angle (Degrees) | ✓          | ✓              |                  | ✓          | ✓              |                  |
| Zero Sequence Magnitude           | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| Zero Sequence Angle (Degrees)     | ✓          | ✓              |                  | ✓          | ✓              |                  |
| Flicker                           |            |                |                  |            |                |                  |
| Flicker (Pst)                     | ✓          | ✓              |                  |            |                |                  |
| Flicker (Plt)                     |            |                | ✓                |            |                |                  |
| Distortion                        |            |                |                  |            |                |                  |
| THD                               | ✓          | ✓              | ✓                | ✓          | ✓              | ✓                |
| TDD (%)                           |            |                |                  | ✓          | ✓              | ✓                |
| Crest Factor                      |            | ✓              | ✓                | ✓          | ✓              | ✓                |
| K-Factor                          |            | ✓              | ✓                | ✓          | ✓              | ✓                |
| MEASURED PARAMETERS               | /6th-Cycle | /12-Cycleblock | AggregatedTrends | /6th-Cycle | /12-Cycleblock | AggregatedTrends |
|                                   | VOLTAGE    |                |                  | CURRENT    |                |                  |

|                                     |   |   |   |  |
|-------------------------------------|---|---|---|--|
| Frequency                           |   |   |   |  |
| Frequency (Hz)                      | ✓ | ✓ | ✓ |  |
| Rate of change of Frequency (ROCOF) | ✓ | ✓ | ✓ |  |
| Mains Signalling                    |   |   |   |  |
| Magnitude (Frequency 1)             |   |   |   |  |
| Magnitude (Frequency 2)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 3)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 4)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 5)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 6)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 7)             |   | ✓ | ✓ |  |
| Magnitude (Frequency 8)             |   | ✓ | ✓ |  |

### 2.3.14 Trended Power Parameters

| MEASURED PARAMETERS                | /6th-Cycle<br>1 | /12-Cycleblock | AggregatedTrends |
|------------------------------------|-----------------|----------------|------------------|
|                                    | POWERS          |                |                  |
| RMS Power (Nett)                   |                 |                |                  |
| Active Power (per phase & total)   |                 | ✓              |                  |
| Reactive Power (per phase & total) | ✓               | ✓              | ✓                |

|                                    |   |   |   |
|------------------------------------|---|---|---|
| Apparent Power (per phase & total) | ✓ | ✓ | ✓ |
| Power Angle (per phase & total)    | ✓ | ✓ | ✓ |
| Power Factor (per phase & total)   | ✓ | ✓ | ✓ |
| RMS Power (Import)                 |   |   |   |
| Active Power (per phase & total)   | ✓ | ✓ | ✓ |
| Reactive Power (per phase & total) | ✓ | ✓ | ✓ |
| Apparent Power (per phase & total) | ✓ | ✓ | ✓ |
| Power Angle (per phase & total)    | ✓ | ✓ | ✓ |
| Power Factor (per phase & total)   | ✓ | ✓ | ✓ |
| RMS Power (Export)                 |   |   |   |
| Active Power (per phase & total)   | ✓ | ✓ | ✓ |
| Reactive Power (per phase & total) | ✓ | ✓ | ✓ |
| Apparent Power (per phase & total) | ✓ | ✓ | ✓ |
| Power Angle (per phase & total)    | ✓ | ✓ | ✓ |
| Power Factor (per phase & total)   | ✓ | ✓ | ✓ |
| Fundamental Power (Nett)           |   |   |   |
| Active Power (per phase & total)   | ✓ | ✓ | ✓ |
| Reactive Power (per phase & total) | ✓ | ✓ | ✓ |
| Apparent Power (per phase & total) | ✓ | ✓ | ✓ |
| Power Angle (per phase & total)    | ✓ | ✓ | ✓ |
| Power Factor (per phase & total)   | ✓ | ✓ | ✓ |

2.3.15 Trended Individual Harmonic/Interharmonic Parameters

| MEASURED PARAMETERS                    | /12-Cycle<br>block<br>10<br>Aggregated<br>Trends | /12-Cycle<br>block<br>10<br>Aggregated<br>Trends |
|----------------------------------------|--------------------------------------------------|--------------------------------------------------|
|                                        | VOLTAGE                                          | CURRENT                                          |
| RMS                                    |                                                  |                                                  |
| Magnitude                              | ✓                                                | ✓                                                |
| Magnitude (% of Declared)              | ✓                                                | ✓                                                |
| Magnitude (% of Fundamental)           | ✓                                                | ✓                                                |
| Magnitude (% of Rated)                 |                                                  | ✓                                                |
| Phase Angle (Degrees)                  | ✓                                                | ✓                                                |
| Sequence Components                    |                                                  |                                                  |
| Positive Sequence Magnitude            | ✓                                                | ✓                                                |
| Positive Sequence Angle (Degrees)      | ✓                                                | ✓                                                |
| Negative Sequence Magnitude            | ✓                                                | ✓                                                |
| Negative Sequence Angle (Degrees)      | ✓                                                | ✓                                                |
| Zero Sequence Magnitude                | ✓                                                | ✓                                                |
| Zero Sequence Angle (Degrees)          | ✓                                                | ✓                                                |
| Prevailing Phasors                     |                                                  |                                                  |
| Prevailing Magnitude                   |                                                  |                                                  |
| Prevailing Phase Angle (Degrees)       | ✓                                                | ✓                                                |
| Prevailing Positive Sequence Magnitude | ✓                                                | ✓                                                |

|                                              |   |   |   |   |
|----------------------------------------------|---|---|---|---|
| Prevailing Positive Sequence Angle (Degrees) | ✓ | ✓ | ✓ | ✓ |
| Prevailing Negative Sequence Magnitude       | ✓ | ✓ | ✓ | ✓ |
| Prevailing Negative Sequence Angle (Degrees) | ✓ | ✓ | ✓ | ✓ |
| Prevailing Zero Sequence Magnitude           | ✓ | ✓ | ✓ | ✓ |
| Prevailing Zero Sequence Angle (Degrees)     | ✓ | ✓ | ✓ | ✓ |
| Power                                        |   |   |   |   |
| Active Power (per phase & total)             | ✓ | ✓ |   |   |
| Reactive Power (per phase & total)           | ✓ | ✓ |   |   |
| Apparent Power (per phase & total)           | ✓ | ✓ |   |   |
| Power Angle (per phase & total)              | ✓ | ✓ |   |   |

|                                  |   |   |  |  |
|----------------------------------|---|---|--|--|
| Power Factor (per phase & total) | ✓ | ✓ |  |  |
|----------------------------------|---|---|--|--|

### 2.3.16 Technical Specification

| VOLTAGE INPUTS             |                                                                                           |
|----------------------------|-------------------------------------------------------------------------------------------|
| Number of channels         | 4 x differential inputs (3/4 Wire + 4 <sup>th</sup> Diff)                                 |
| Measurement input range    | 0 – 600 V <sub>RMS</sub> (V <sub>LN</sub> ), 0 – 1000 V <sub>RMS</sub> (V <sub>LL</sub> ) |
| Voltage measurement        | Single Phase, 3-Phase (Star, Delta), DC                                                   |
| Input impedance/channel    | > 1 MΩ                                                                                    |
| CURRENT INPUTS             |                                                                                           |
| Number of channels         | 4 x galvanically isolated inputs                                                          |
| Measurement input range    | 0 - 5.0 A <sub>RMS</sub>                                                                  |
| Maximum continuous current | 6.0 A <sub>RMS</sub>                                                                      |

|                              |                                                   |
|------------------------------|---------------------------------------------------|
| 3 sec over-current withstand | 50 A                                              |
| VA Burden @ 5A               | < 1 VA                                            |
| Galvanic isolation           | 1,000 V                                           |
| CURRENT TRANSDUCER INPUTS    |                                                   |
| Number of channels           | 4 differential inputs                             |
| Measurement input range      | 0 – 1.0 V <sub>RMS</sub> (± 1.414 V Peak)         |
| Input impedance/channel      | > 1 M $\Omega$                                    |
| DIGITAL OUTPUTS              |                                                   |
| Number of channels           | 2 sets of 2 galvanically isolated digital outputs |
| Switch Rating                | 0.1 A <sub>RMS</sub> , 300 V <sub>RMS</sub> (max) |

|                           |                                                  |
|---------------------------|--------------------------------------------------|
| DIGITAL INPUTS            |                                                  |
| Number of channels        | 4 digital inputs                                 |
| Input Voltage Rating      | 5 - 300 V DC                                     |
| Isolation                 | 1 kV                                             |
| ACCURACY & BANDWIDTH      |                                                  |
| Power frequency range     | DC, 50 Hz (40-60 Hz), 60 Hz (50-70 Hz)           |
| Harmonic bandwidth        | 1-64 <sup>th</sup> (harmonic and inter-harmonic) |
| Measurement sampling rate | 0.5 MHz (simultaneously sampled)                 |
| Waveform storage rate     | 1 kHz – 50kHz (user configurable)                |
| ADC Resolution            | 16-Bit                                           |
| Overall accuracy class    | 0.1%                                             |

|                          |                                                  |
|--------------------------|--------------------------------------------------|
| Fast Transient Capturing | $\geq 20 \mu\text{s}$                            |
| COMMUNICATION            |                                                  |
| Ethernet                 | 2 x Gigabit Ethernet – IEEE 802.3.2008 compliant |
| USB                      | USB 2.0 – 480 Mbit (powered)                     |
| CLOCKS                   |                                                  |
| On-Board GPS             | On-board 3V3 power for active external antennae  |
| Overall accuracy Class   | $\pm 1 \mu\text{s}$ from absolute time           |
| On-Board RTC drift       | 10 ppm (320 seconds per annum)                   |
|                          | NTP, PTP                                         |

|                                    |                                                           |
|------------------------------------|-----------------------------------------------------------|
| POWER                              |                                                           |
| Maximum Power Consumption          | < 15 W                                                    |
| AC / DC supply voltage input range | 90-300 V <sub>RMS</sub> 42-69 Hz (power factor corrected) |
| Power over Ethernet                | IEEE 802.3 compliant (35-60 V <sub>DC</sub> )             |
| On-board battery                   | LiFePO <sub>4</sub> (2,000 charge/discharge cycles)       |
| PHYSICAL                           |                                                           |
| Construction                       | Aluminium, 250 x 135 x 65 (L x W x H)                     |
| Mounting options                   | 3U-19" Rack, Panel Mount, Portable Case                   |

|                            |                                                              |
|----------------------------|--------------------------------------------------------------|
| Electrical connections     | Pluggable screw type (screw lock-down)                       |
| Electrical isolation class | 600 V Class II                                               |
| Operating temperature      | -10 °C to 55 °C (ambient)<br>0 °C to 70 °C (device internal) |
| Storage temperature        | -10 °C to 70 °C                                              |
| Operating humidity         | 0-95% (non-condensing)                                       |
| Max Operational Altitude   | 2,000m                                                       |
| Weight                     | 1.9 kg                                                       |
| COMPLIANCE                 |                                                              |
| PQ Measurement             | IEC 61000-4-30, Class A                                      |
| Harmonics                  | IEC 61000-4-7                                                |
| Flicker                    | IEC 61000-4-15                                               |
| SCADA                      | IEC 61850, Modbus, DNP3                                      |

## 2.4 VECTO 3 External Interfaces

### 2.4.1 Physical Appearance

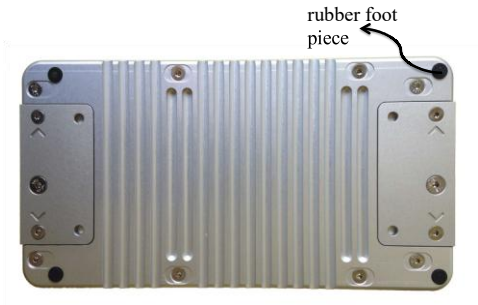
Figure 3 shows the front of the VECTO 3. The nameplate displays the name and serial number of the device, detail layout of the external interfaces of the device and device power and On/Off switches. A detail description of the external interfaces is provided in Sections 2.4.2 to 2.4.11.

Figure 4 shows the back of the device. The VECTO 3 can be installed as a temporary investigation device, be surface mounted or on a DIN rail as respectively shown in Figure 4 a, b and c.

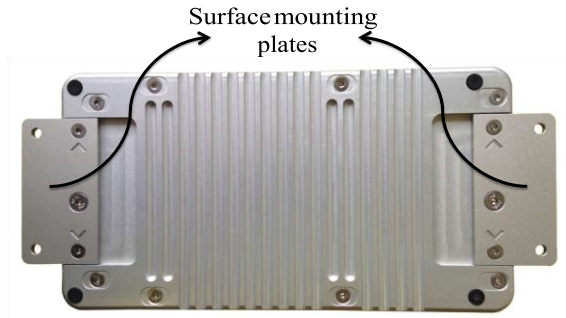


Figure 3: Front view of the VECTO 3 device

a) Investigation device



b) Surface mount installation



c) DIN rail installation

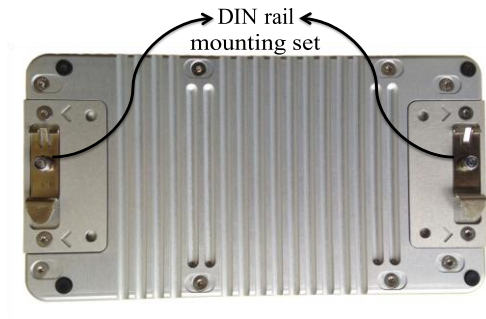


Figure 4: Rear view of the VECTO 3 device



Figure 5: Right-hand view of the VECTO 3 device

Figure 5 shows the USB port located on the right-hand side of the device.

## 2.4.2 VECTO 3 User Interface



Figure 6: User Interface

Information LEDs on the top-left front side of the device provide status information. The interpretation of the status LEDs is discussed in Section 3.2. Two buttons located below the LEDs are used to control the power state of the device. The Power button is recessed to avoid accidental switching. It rests flush with the surface plate in the offstate and sits below the surface plate in the on-state. The On/Off button is a pushbutton that returns to the non-pressed state when released. The use of the buttons is discussed in Chapter 3.

## 2.4.3 Power Supply

The VECTO 3 can be powered and charged directly from mains (90 – 300 V AC/DC) via a power factor corrected internal power supply.

The VECTO 3 can also be powered and charged via an IEEE 802.3-2008 compliant Power over Ethernet (PoE) power supply.

A built in LiFePO<sub>4</sub> battery will power the device for up to a half an hour in the absence of power. This battery has a design life expectancy of more than 2,000 charge/discharge cycles.

The Power Supply port, as shown in Figure 7, contains 3 terminals on a removable/lockable plug. Each terminal can accommodate conductors with sizes up to 2.5 mm<sup>2</sup>.



Figure 7: VECTO 3 power supply connection

| Terminal | Legend | Description      |
|----------|--------|------------------|
| 1.       | L      | Live Terminal    |
| 2.       | E      | Safety Earth     |
| 3.       | N      | Neutral Terminal |

Table 1: Power supply connection

The supply voltage input range is from 90 V<sub>RMS</sub> to 300 V<sub>RMS</sub> AC or DC (42-69 Hz for AC sources).

The supply current is power factor corrected and the maximum power consumption of the VECTO 3 is actively limited to 12.5 VA. The VECTO 3 can be powered directly from 110 V 50/60 Hz VT circuits due to this low burden.

The power supply is protected from brief periods of overvoltage conditions by built-in surge protection.

An internal electronic fuse protects the VECTO 3 from over and under voltage. The VECTO 3 will automatically disconnect from mains if excessive current is drawn from the universal AC/DC supply input port. When this protection was activated, it needs a few minutes to cool, during which the VECTO 3 will not restart even with valid mains voltage.

During a power interruption/failure, the internal battery will power the device for  $\pm 30$  minutes. When the battery charge drops below 50% of full capacity, the device will gracefully shut down to protect the battery from being damaged.

When power is restored, the device will automatically restart within 15 seconds if the battery status is above 30% or first recharge until the battery reach 30% and only then restart.



The Safety Earth terminal connects all exposed metal parts to external earth

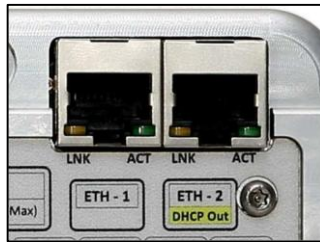


Figure 8: Ethernet ports

IEEE 802.3-2008 compliant Power over Ethernet (PoE) Plus is available on both Ethernet ports at 48 V. The PoE capability enables the VECTO 3 to be powered through the communication infrastructure. The VECTO 3 will therefore be continuously available if the communication infrastructure remains active.

#### 2.4.4 Voltage Inputs

The VECTO 3 has 4 resistive differential voltage inputs made up of 6 terminals.

The first 4 terminals are used for 3 voltage inputs.  $V_1$ ,  $V_2$  and  $V_3$  are Neutral ( $V_{com}$ ) referenced ( $V_1-N$ ,  $V_2-N$ ,  $V_3-N$ ).

The last 2 terminals are used for the 4<sup>th</sup> ( $V_{4+}$ ,  $V_{4-}$ ) voltage input. It is a full differential measurement normally used for Neutral to Earth measurement.

The voltage inputs make use of a 6-terminal lockable connector plug. Each terminal can accommodate conductors with sizes up to 2.5 mm<sup>2</sup>. Figure 9 shows the voltage

connections for a 3-phase 4-wire star system. Power is calculated per phase and arithmetically added to obtain the 3-phase powers.

Figure 10 shows the voltage connections for a 3-phase 3-wire delta connection. Threephase power is calculated by the 2-watt meter method.



If voltages are connected in star (4-wire) on the terminals the user can select star (4-wire) or delta (3-wire) topology in the software

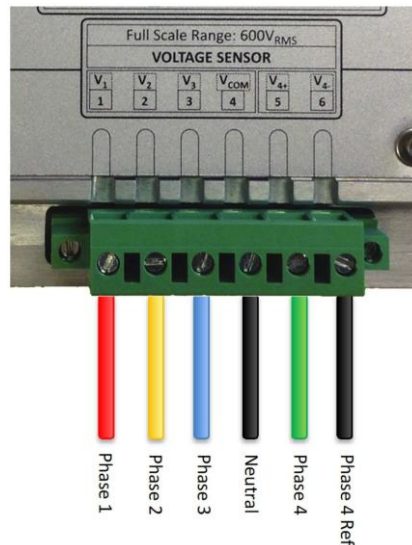


Figure 9: VECTO 3 4-wire star connection

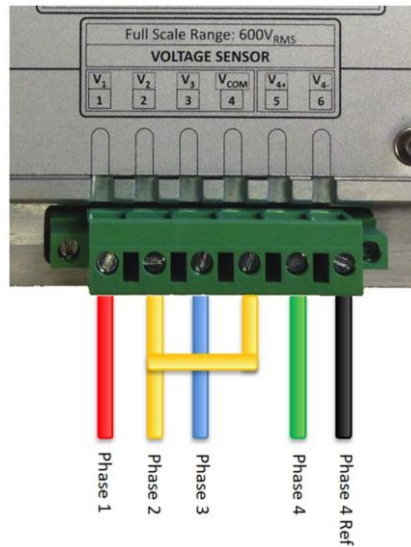


Figure 10: VECTO 3 3-wire delta connection

| Terminal | Legend    | Description             |
|----------|-----------|-------------------------|
| 1.       | $V_1$     | Phase 1                 |
| 2.       | $V_2$     | Phase 2                 |
| 3.       | $V_3$     | Phase 3                 |
| 4.       | $V_{com}$ | Reference for $V_{1-3}$ |
| 5.       | $V_{4+}$  | Phase 4                 |
| 6.       | $V_{4-}$  | Reference for $V_4$     |

Table 2: Voltage connection layout

Input voltages can be up to 600  $V_{AC-RMS}$ . The 20 mV resolution results in accurate recording of all harmonic components up to the 63<sup>rd</sup> harmonic component.

A high impedance input prevents the accidental shorting of VT inputs to system ground and also eliminates ground loops.

Differential resistive inputs assure a safe and stable analog input stage with minimal phase error, a high bandwidth and zero temperature drift.

2.4.5 Current Inputs

The VECTO 3 has 4 galvanically isolated resistive current shunt inputs with input impedance of 20 m $\square$  and a full-scale measurement range of 6 A<sub>AC-RMS</sub>.

Resistive shunts provide excellent AC and DC response; zero offset drift and very low temperature drift.

The 3-second overcurrent withstand rating of each input is 50 A. The galvanic isolation voltage between each channel and earth is 1 kV.

The current inputs are by an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to 2.5 mm<sup>2</sup>.

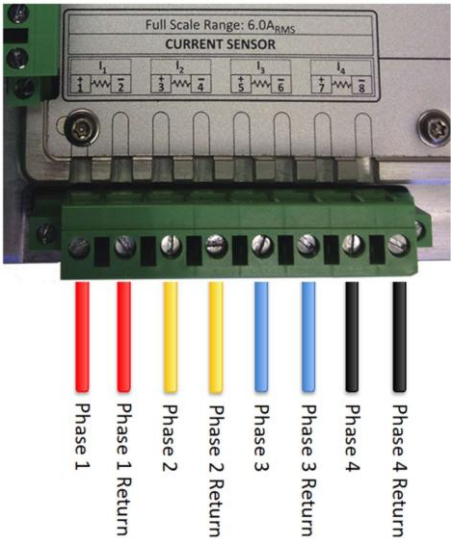


Figure 11: Current sensor connection

| Terminal | Legend | Description |
|----------|--------|-------------|
|----------|--------|-------------|

|    |          |                        |
|----|----------|------------------------|
| 1. | $I_{1+}$ | Phase 1 Current Input  |
| 2. | $I_{1-}$ | Phase 1 Current Return |
| 3. | $I_{2+}$ | Phase 2 Current Input  |
| 4. | $I_{2-}$ | Phase 2 Current Return |
| 5. | $I_{3+}$ | Phase 3 Current Input  |
| 6. | $I_{3-}$ | Phase 3 Current Return |
| 7. | $I_{4+}$ | Phase 4 Current Input  |
| 8. | $I_{4-}$ | Phase 4 Current Return |

Table 3: Current sensor connection layout



Do not disconnect the current terminals. It requires bridging the CT circuits and can only be done by an appointed and certified electrician

#### 2.4.6 Current Transducer Inputs

The VECTO 3 has 4 voltage-output current transducer inputs with a full-scale rating of  $1.4 V_{AC-RMS}$ . These voltage inputs can be used to directly interface with voltage-output current sensors such as Hall-effect devices and Rogowsky coils.

The current inputs are by an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to  $2.5 \text{ mm}^2$ .

The current transducer inputs also have a 5 V output to power Hall-effect devices or Rogowsky coils if needed.

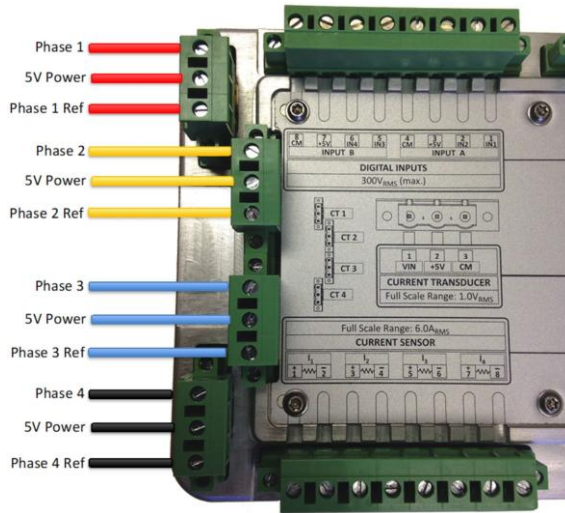


Figure 12: Current transducer connection

| Terminal | Legend           | 1V Output Current Transducer Circuits |
|----------|------------------|---------------------------------------|
| 1.       | CT 1 - $V_{IN}$  | Voltage 1                             |
| 2.       | CT 1 - +5V       | 5 V Power Supply                      |
| 3.       | CT 1 - $V_{Com}$ | Voltage 1 Reference                   |
| 4.       | CT 2 - $V_{IN}$  | Voltage 2                             |
| 5.       | CT 2 - +5V       | 5 V Power Supply                      |
| 6.       | CT 2 - $V_{Com}$ | Voltage 2 Reference                   |
| 7.       | CT 3 - $V_{IN}$  | Voltage 3                             |
| 8.       | CT 3 - +5V       | 5 V Power Supply                      |

|     |                         |                     |
|-----|-------------------------|---------------------|
| 9.  | CT 3 - V <sub>Com</sub> | Voltage 3 Reference |
| 10. | CT 4 - V <sub>IN</sub>  | Voltage 4           |
| 11. | CT 4 - +5V              | 5 V Power Supply    |
| 12. | CT 4 - V <sub>Com</sub> | Voltage 4 Reference |

Table 4: Current transducer connection layout

### 2.4.7 Relay Outputs

Four digital relay outputs (100 mA<sub>AC-RMS</sub>, 350 V<sub>AC-RMS</sub>) are used to provide digital output information or to control external processes. The outputs are arranged into 2 galvanically isolated clusters (1 kV isolation); each containing a switch contact. The relay outputs are on an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to 2.5 mm<sup>2</sup>.

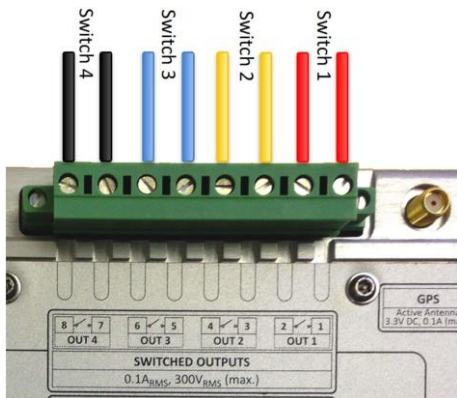


Figure 13: Relay switch connection layout

| Terminal | Legend            | Description |
|----------|-------------------|-------------|
| 1.       | OUT1 <sub>1</sub> | Switch 1    |

|    |                   |          |
|----|-------------------|----------|
| 2. | OUT1 <sub>2</sub> | Switch 1 |
| 3. | OUT2 <sub>1</sub> | Switch 2 |
| 4. | OUT2 <sub>2</sub> | Switch 2 |
| 5. | OUT3 <sub>1</sub> | Switch 3 |
| 6. | OUT3 <sub>2</sub> | Switch 3 |
| 7. | OUT4 <sub>1</sub> | Switch 4 |
| 8. | OUT4 <sub>2</sub> | Switch 4 |

Table 5: Relay switched outputs layout

#### 2.4.8 Digital inputs

The inputs are arranged into two clusters (1 kV isolation); each containing two digital inputs (300 V<sub>DC</sub> max) and a 5 V power source with a common. These inputs can be used to attain information like breaker position or disturbance information that can be added to the PQ events/data. The inputs are available on an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to 2.5mm<sup>2</sup>.

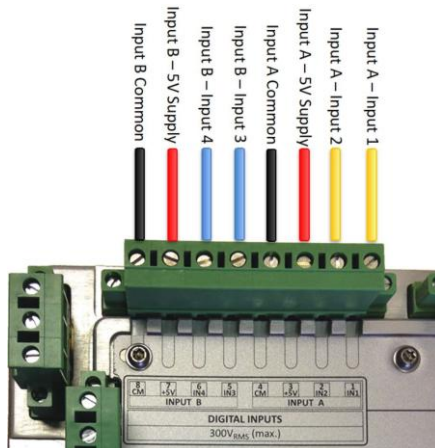


Figure 14: Digital inputs connection layout

| Terminal | Legend | Description          |
|----------|--------|----------------------|
| 1.       | IN1    | Input 1              |
| 2.       | IN2    | Input 2              |
| 3.       | +5 V   | Input A – 5 V Supply |
| 4.       | CM     | Input A - Common     |
| 5.       | IN3    | Input 3              |
| 6.       | IN4    | Input 4              |
| 7.       | +5 V   | Input B – 5 V Supply |
| 8.       | CM     | Switch B - Common    |

Table 6: Digital inputs connection layout

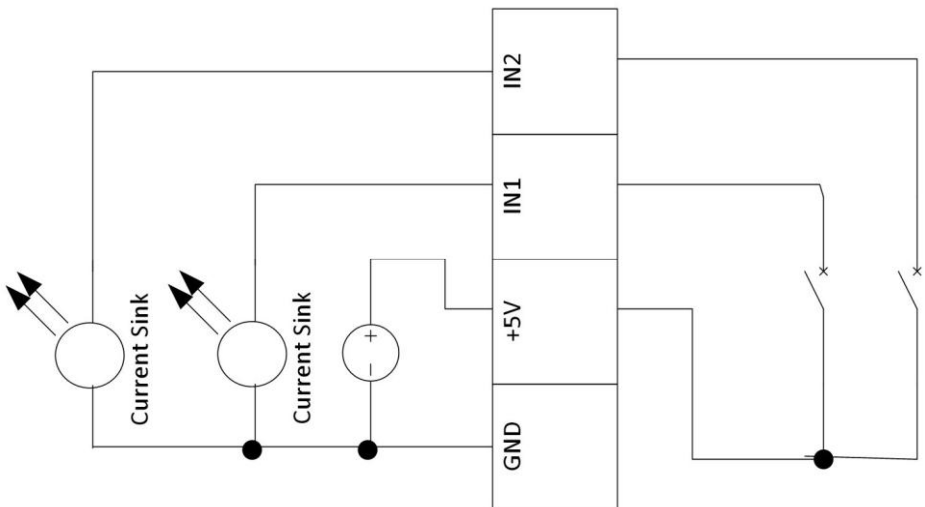


Figure 15: Digital input configuration for a dry contact

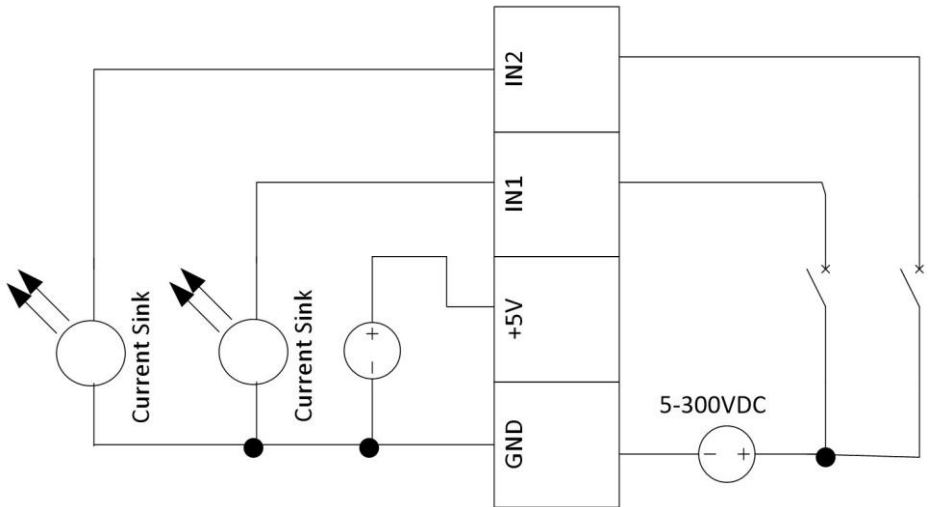


Figure 16: Digital input configuration for a wetted contact

#### 2.4.9 GPS

The female SMA port is used to interface an external powered (+3V3) GPS antenna to the VECTO 3. The built-in GPS is used to measure absolute time. The VECTO 3 locks its internal clock to within  $1\mu\text{s}$  from absolute time.



Figure 17: GPS antenna connector

#### 2.4.10 Ethernet Ports

The device has 2 Gigabit Ethernet ports as depicted in Figure 18. The IP address of port 2 is fixed at 192.168.7.1. The device serves as a DHCP server for the network connected

to this port. The IP address of port 1 can be set using the Osprey Lite™ software (see Osprey Lite™ User Manual).



Do not connect Ethernet port 2 to a network with an active DHCP server, as this may cause the network to stop functioning properly



The IP address of Ethernet port 2 is fixed at 192.168.7.1



The device serves as a DHCP server for equipment connected to port 2

IEEE 802.3-2008 compliant Power over Ethernet (PoE) is available on both Ethernet ports. The PoE capability enables the VECTO 3 to be powered through the communication infrastructure. The VECTO 3 will therefore be available at all times while the communication infrastructure stays on-line.

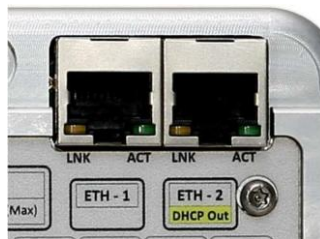


Figure 18: Ethernet ports

#### 2.4.11 USB Peripheral Port

A powered USB2.0 compliant (450 MBit) USB port is used to interface to external peripherals such as Memory sticks, WiFi dongles, GPRS modems, RS485 serial ports, external I/O modules.

The USB port can power peripherals with a peak power of 2.5 W.



Figure 19: USB port



Figure 20: WiFi and Cellular Modem Connections

#### 2.4.12 WIFI

The VECTO 3 can communicate via WIFI either as an access point or with existing supported infrastructure access points (see Osprey Lite™ User Manual). Please contact CT LAB for an updated list of supported WIFI routers.



Before enabling WIFI, first ensure that the WiFi antenna is connected, as enabling WiFi without the antenna connected may cause damage to the device.

#### 2.4.13 Built-in GPRS Modem (Optional)

The VECTO 3 can be shipped with a built-in modem (see Figure 20). Please refer to the Osprey Lite™ user manual for instructions on configuring modem communication.



Before enabling the modem, first ensure that the modem antenna is connected, as enabling the modem without the antenna connected may cause damage to the device.

## 2.5 Firmware

The VECTO 3 firmware revision is shown in Osprey Lite™ when connected to the device, please see Osprey Lite™ user manual for more information.

### 2.5.1 Upgrading

The VECTO 3 support firmware upgrade via Osprey Lite™, please see Osprey Lite™ user manual for more information.

## 3 Operating Instructions

### 3.1 Precautions when first using the device

Ensure that the VECTO 3's battery is charged, and that mains power is connected to the device power supply before switching the device on for the first time.



The device will not power up until sufficiently charged

### 3.2 Toggling Storage/Ready Mode

The device is in ready mode when the power button is depressed (Figure 21). In ready mode the device can be turned on/off using the On/Off button (see Section 0). In this mode the built-in RTC, the PDU and the health sensors are powered.

When the VECTO 3 will not be used for an extended period of time it can be put into storage mode. To place the device in storage mode the Power button is toggled off (not depressed). Ensure that the device is powered down before placing it in storage mode. Do not put the device in storage mode while the system is powered up. Doing so may lead to loss of data and/or permanent damage to the device .

In storage mode the battery is decoupled from the rest of the system. After being fully charged, the VECTO 3 can be safely stored in this mode for up to 3 months.



Do not put the device in storage mode if the system is powered up - doing so may lead to loss of data and/or permanent damage to the device.

Note that removing power from the device also removes power from the real-time clock (RTC). Upon start-up after a power cycle the RTC is in an unknown state and the device must first be connected to a valid time source (GPS or NTP) to ensure it timestamps data correctly.



After power cycling the device with the Power Button, the RTC is in an undefined state – the PQ recording system will require a valid time source after power up before it can function

correctly

### 3.3 Interpretation of Status LEDs

| Name      | Function                                                                                                                                                                                                                                                                                                                                                                          |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power     | Briefly flashes periodically while the device is ready to run                                                                                                                                                                                                                                                                                                                     |
| Charge    | On while charging the battery, off otherwise                                                                                                                                                                                                                                                                                                                                      |
| Ext Power | On when the device receives power from an external source, off otherwise                                                                                                                                                                                                                                                                                                          |
| Clk Sync  | <div>Green - The device is synchronised to GPS</div> <div>Orange - The device is synchronised to NTP</div> <div>Red - The device does not have valid time and recording will not be possible until it receives time from an external time source (PC, GPS, or NTP)</div> <div>Off - The device is not synchronised to an external source, but has valid time and can record</div> |
| Record    | <div>Green - The device is recording</div> <div>Orange - The device is recording an event</div> <div>Red - An error condition is preventing the device from recording</div> <div>Off - The device is not recording because no meter point is attached</div>                                                                                                                       |
| Status    | <div>Flashing Green - The device is operating normally</div> <div>Solid Orange - The device is booting or shutting down</div> <div>Red - The device is in an error condition (refer to Section 3.6)</div>                                                                                                                                                                         |

Table 7: Status LED Interpretation



Figure 21: Status LEDs, On/Off button and Power Button

LEDs as shown in Figure 21 provide information about the status of the device.

Table 7 describes the various states. In storage mode, all LEDs are off.

## 3.4 Powering up the VECTO 3 device

The following two sections describe the method for powering up the VECTO 3. After powering up the device the Status LED will be flashing green. Osprey Lite™ can be now used to configure the device (please refer to Osprey Lite™ User manual for more detail). The device will not turn on and the Status LED will turn red in an error condition. Please refer to Section 3.6 for information on interpreting error condition codes.

### 3.4.1 Powering up from Storage Mode

First connect the device to mains power (90-300V AC or DC) or POE. Press the Power button with a pen or pencil and check that the Power LED starts to flash. The external power LED should be on. Unless the battery is 100% full, the battery charge LED should be on as well. When the Power LED starts to flash, switch the device on by pressing and holding the On/Off button. The Status LED will turn orange to indicate that the device is booting normally. It will start to flash green once the boot cycle completed.

### 3.4.2 Powering up from Ready Mode

The device may be turned on without being connected to external power if the battery capacity is sufficient. Press the On/Off button to power up the device . The Status LED will turn orange to indicate that the device is booting. It will start to flash green once the boot cycle completed.

## 3.5 Shutting down

Press and hold the On/Off button (see Figure 21) until the Status LED turns orange to power the device down and stop recording data.



The shutdown sequence may take up to 60 seconds

## 3.6 HMI (Web Interface)

The VECTO 3 has a built-in Human-Machine Interface (HMI) accessible via a Chrome web browser (other browsers may work, but were not tested for). The web interface is accessible via HTTP/HTTPS on both Ethernet ports. Ethernet port 2 has a default IP address of 192.168.7.1 while Ethernet port 1 can either be set statically to an IP address, or be configured to get an IP address from a DHCP server. The factory default is for the VECTO 3 to get an IP address from a DHCP server.

For security reasons, the HMI in factory default state is not enabled. To enable the HMI, insert the USB key shipped with the meter into its USB port and wait 30 seconds before attempting to connect. The FAT32 formatted USB drive needs to have the named folder MeterKey, which should contain matching the .key file. Alternatively, the HMI can be enabled with Osprey Lite / VECTO Grid OS.

Once connected to the HMI, the user will need to log into the device before accessing any functionality. The factory default credentials are:

Username:     super

Password:     Stellenbosch:7600

After login completed, the default password should be changed by navigating to the Users page, selecting the user super, and clicking on Change Password.



Failure to change the default login credentials will leave the device vulnerable to unauthorized access.

### 3.6.1 HMI Features

The HMI exposes the following features:

- User creation: Users can be created/deleted/updated

- Role-based security based on three roles: administrator, device manager, and standard user
- Enterprise security: RADIUS or Windows LDAP users can be used without the need for local users
- Communication configuration: Configure the Ethernet port (IPv4 and IPv6), WiFi and Modem.
- Device Status: View various device status and communication registers, including current time synchronization performance.
- Create/Update/Detach a measurement point with all its relevant configuration
- Real-time View: Get a real-time view of the currently measured data
- Device Management: Manage the various functions of the device, including connecting it to VECTO Grid OS, network and security configuration, and time configuration.
- Data Deletion: Delete selected data
- Firmware: View and update firmware
- Logs: View and download device status logs
- Events: View captured events
- Export: Download measured data

### 3.6.2 HMI User Documentation

To ensure the VECTO 3 HMI user documentation stays up to date, the documentation is built into the interface. User documentation can be accessed on the relevant pages by clicking on the ⓘ icons.

## 3.7 Error Conditions

### 3.7.1 Health Failure Conditions

In ready mode, the device may fail to turn on under an error condition. Instead of turning the device on when the On/Off button is pressed, the Status LED will turn red to indicate an error state.

To display the error state, continue to hold the On/Off button. The error condition will be displayed using the Clock Sync and Record LEDs. Each possible state will be clocked out in order, with one second delay between each state, until the highest state that is in error is reached. The respective error states, in order, are:

1. Cavity temperature sensor 1
2. Cavity temperature sensor 2
3. Battery temperature
4. Charging status
5. State of charge (no auxiliary power)
6. State of charge (auxiliary power present)
7. Battery voltage

A red Clock Sync LED indicates that the specific health parameter falls beyond the specified norms. A green led indicates nominal conditions.

A red Record LED indicates that a specific health parameter could not be read from internal systems. This represents a more serious, but rare, condition. A persistent red Record LED indicates a hardware failure. A green led indicates nominal conditions.

### 3.7.2 Recovery conditions

The VECTO 3 continuously performs internal health checks. Should one of these checks fail, the device will attempt to recover itself. In case the battery voltage or temperature readings exceed operating limits, the device will perform a controlled shutdown which is indicated by an orange Status LED. An uncontrolled shutdown is indicated by a solid red Status LED.

Once the device is powered down, the health check system will flash the red Status LED to indicate a non-user initiated shutdown. The shutdown reason can be obtained using the method described in Section 3.7.1. The device will attempt to power up again if all health checks passed.

In the unlikely event of permanent internal system corruption the device will not be able to boot correctly. In this case, the Status LED will change directly from the orange boot state to the red error state, and back to the flashing red state, until the device is turned off by pressing the On/Off button. Please contact CT LAB for support if this state is encountered and not cleared by switching the device to storage mode and back to ready mode.

# 4 VECTO 3 Installation

## 4.1 Mounting the VECTO 3

Please Note: Adequate ventilation must be provided to prevent building up of heat – especially when the device are to be installed inside a sealed enclosure.

### 4.1.1 Panel Mounting Installation



Figure 22: VECTO 3 back as supplied by CT LAB

Unscrew the Allen-key screw shown in Figure 22 and turn the installation plates to the outside and shift hole 1 to 2. This should leave the installer with surface mounting holes, as indicated in Figure 23, to install the device on the required surface.

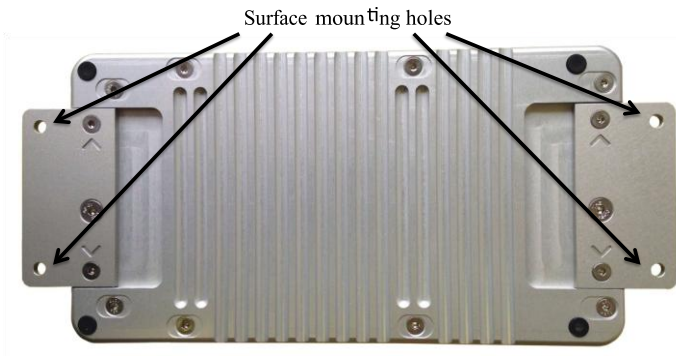


Figure 23: Surface mount VECTO 3

4.1.2 19” Rack Mounting Installation

A 19” rack (4U) stainless steel mounting plate secures the VECTO 3 and provides a mechanical interface for 19” racks<sup>3</sup>.

The 19” plate and the VECTO 3 is shipped separate and must be assembled on site.

Step 1:

Change the VECTO 3 configuration to panel mounting configuration as described in section 0.

Step 2:

Install the VECTO 3 onto the 19” plate using the screws provided with the 19” plat set.



Figure 24: 19” Plate Mounting

4.1.3 DIN rail mounting

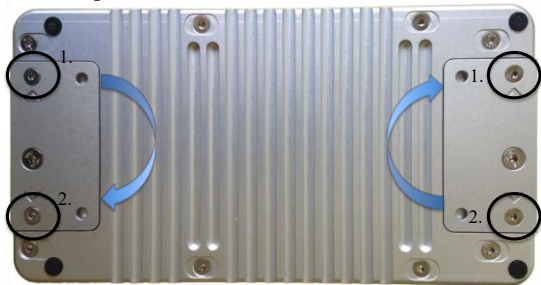


Figure 25: VECTO 3 rear view as shipped by CT LAB

<sup>3</sup> Optional accessory

Unscrew the Allen-key screw shown in Figure 25 and turn the installation plates over as indicated. The Din rail mounting is in a VECTO 3 cavity and will be available for use when the installation plates are turn over as shown in Figure 26.

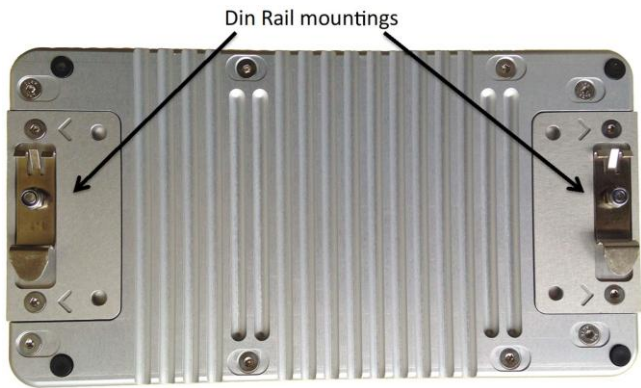


Figure 26: VECTO 3 rear view when Din rail mountings are to be used

## 4.2 Connections

### 4.2.1 AC Power



Always connect the safety earth terminal located on the power connector first

Table 8 and Figure 27 depict how to connect the AC power supply.

| Terminal | Legend | Description      |
|----------|--------|------------------|
| 1.       | L      | Live Terminal    |
| 2.       | E      | Safety Earth     |
| 3.       | N      | Neutral Terminal |

Table 8: AC power connection layout

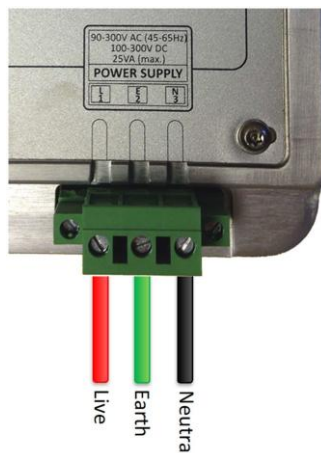


Figure 27: VECTO 3 AC power supply connection

## 4.2.2 Power Over Ethernet

In addition to, or as alternative to AC power, the device can be powered via any of the Ethernet ports using an IEEE 802.3-2008 compliant power source (48 V).

## 4.2.3 Voltage connections

### 4.2.3.1 Single phase connection



Always connect the safety earth terminal located on the power connector first

| Terminal | Legend    | 110V VT Circuit or 400V/550V Star (4-wire) Systems |
|----------|-----------|----------------------------------------------------|
| 1.       | $V_1$     | Phase Voltage                                      |
| 2.       | $V_2$     |                                                    |
| 3.       | $V_3$     |                                                    |
| 4.       | $V_{com}$ | Neutral                                            |

|    |          |         |
|----|----------|---------|
| 5. | $V_{4+}$ | Earth   |
| 6. | $V_{4-}$ | Neutral |

Table 9: VT circuit connection layout for single phase connection

- Connect the phase Voltage to Voltage Inputs 1 as shown in Figure 28.
- Connect Neutral (on 400 V systems) or the star-point (on 110 V VT circuits) to  $V_{com}$ .
- The fourth voltage input may be used to measure Neutral-Earth voltage.

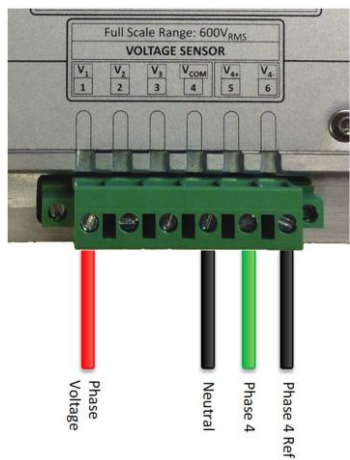


Figure 28: VECTO 3 single-phase connection

4.2.3.2 110 V Voltage Transformer (VT) Circuits & 400 V Direct (Star/ 4-wire systems)

| Terminal | Legend    | 110V VT Circuit or 400V/550V Star (4-wire) Systems |
|----------|-----------|----------------------------------------------------|
| 1.       | $V_1$     | Phase 1                                            |
| 2.       | $V_2$     | Phase 2                                            |
| 3.       | $V_3$     | Phase 3                                            |
| 4.       | $V_{com}$ | Neutral (Star connection point)                    |

|    |                 |                                                                       |
|----|-----------------|-----------------------------------------------------------------------|
| 5. | V <sub>4+</sub> | Earth (optional for 400 V systems only)                               |
| 6. | V <sub>4-</sub> | Star connection point (Neutral) (Optional and for 400 V systems only) |

Table 10: VT circuit connection layout for 4-wire star connection

- Connect Phase 1,2 and 3 to Voltage Inputs 1-3 as shown in Figure 29 below.
- Connect Neutral (on 400 V systems) or the star-point (on 110 V VT circuits) to V<sub>com</sub>.
- The fourth voltage input may be used on 400 V systems to measure NeutralEarth voltage.



Always connect the safety earth terminal located on the power connector first

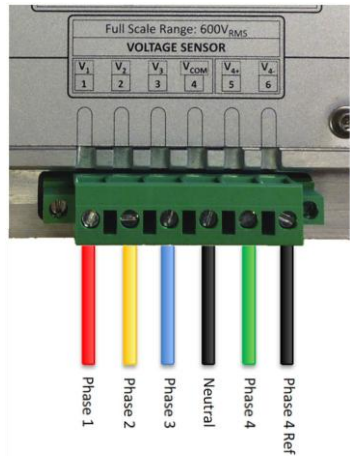


Figure 29: VECTO 3 4-wire star connection

#### 4.2.3.3 110V Voltage Transformer (VT) Circuits or 400V/550V Direct (Delta/3-wire systems)



Always connect the safety earth terminal located on the power connector first

| Terminal | Legend    | 110V VT Circuit or 400 V/550 V Delta (3-wire) Systems                                          |
|----------|-----------|------------------------------------------------------------------------------------------------|
| 1.       | $V_1$     | Phase 1                                                                                        |
| 2.       | $V_2$     | Phase 2                                                                                        |
| 3.       | $V_3$     | Phase 3                                                                                        |
| 4.       | $V_{com}$ | Open (Note: $V_{com}$ may also be connected to the earthed Phase/Phase 2 on 110 V VT circuits) |
| 5.       | $V_{4+}$  | Open                                                                                           |
| 6.       | $V_{4-}$  | Open                                                                                           |

Table 11: VT circuit connection layout for 3-wire delta connection

- 1) Connect Phase 1,2 and 3 to Voltage Inputs 1-3 as shown in the Figure 30.
- 2) Leave  $V_{com}$  open or connect  $V_{com}$  to the earthed Phase (Phase 2) on 110 V VT circuits.

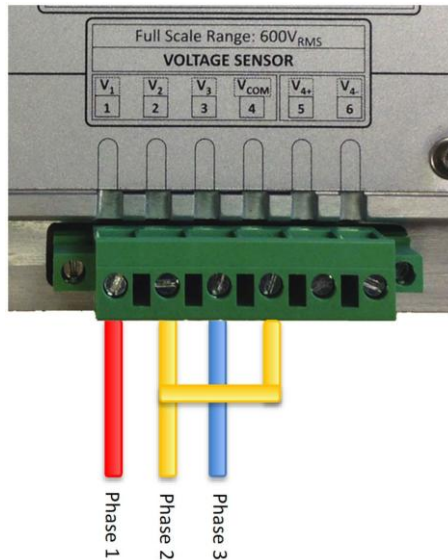


Figure 30: VECTO 3 3-wire delta connection

#### 4.2.4 Current connections

##### 4.2.4.1 Direct (1 A/5 A Current Transformer (CT) Circuits)

###### 4.2.4.1.1 Single phase connection

The VECTO 3 can interface with 1 A or 5 A CT circuits and has a peak long-term current withstand of 6 A and 50 A for 3 seconds.

| Terminal | Legend          | Description            |
|----------|-----------------|------------------------|
| 1.       | I <sub>1+</sub> | Phase 1 Current Input  |
| 2.       | I <sub>1-</sub> | Phase 1 Current Return |
| 3.       | I <sub>2+</sub> | None                   |
| 4.       | I <sub>2-</sub> | None                   |
| 5.       | I <sub>3+</sub> | None                   |

|    |                 |      |
|----|-----------------|------|
| 6. | I <sub>3-</sub> | None |
| 7. | I <sub>4+</sub> | None |
| 8. | I <sub>4-</sub> | None |

Table 12: CT circuit connection layout

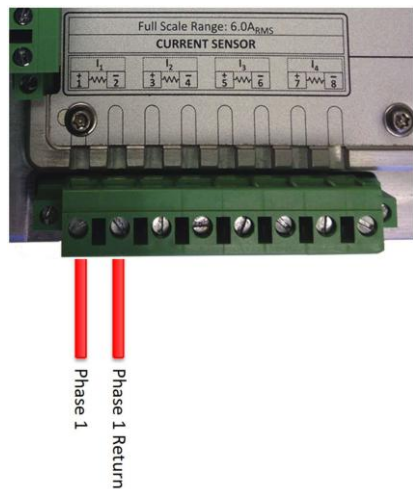


Figure 31: CT circuit connection layout

4.2.4.1.2 Three-phase connection

The VECTO 3 can interface with 1 A or 5 A CT circuits and has a peak long-term current withstand of 6 A and 50 A for 3 seconds.

| Terminal | Legend          | Description            |
|----------|-----------------|------------------------|
| 1.       | I <sub>1+</sub> | Phase 1 Current Input  |
| 2.       | I <sub>1-</sub> | Phase 1 Current Return |
| 3.       | I <sub>2+</sub> | Phase 2 Current Input  |
| 4.       | I <sub>2-</sub> | Phase 2 Current Return |

|    |          |                        |
|----|----------|------------------------|
| 5. | $I_{3+}$ | Phase 3 Current Input  |
| 6. | $I_{3-}$ | Phase 3 Current Return |
| 7. | $I_{4+}$ | Phase 4 Current Input  |
| 8. | $I_{4-}$ | Phase 4 Current Return |

Table 13: CT circuit connection layout

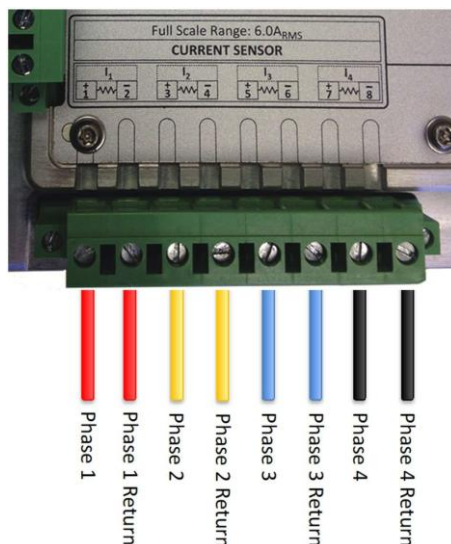


Figure 32: CT circuit connection layout

The VECTO 3 can be configured to:

- Derive the Neutral current by the summation of the 3 line currents in star connected (4-wire) circuits.
- Derive any one of the missing line currents by the summation of the other 2 currents in Delta connected (3-wire) circuits.

#### 4.2.4.2 Current Transducer Connections

##### 4.2.4.2.1 Single-phase connection

The current transducer input on the VECTO 3 has a peak voltage input range of 2 V (1.4  $V_{RMS}$ ).

| Terminal | Legend          | 1 V Output Current Transducer Circuits |
|----------|-----------------|----------------------------------------|
| 1.       | V <sub>1+</sub> | Voltage 1                              |
| 2.       | V <sub>1-</sub> | Voltage 1 Reference                    |
| 3.       | V <sub>2+</sub> | None                                   |
| 4.       | V <sub>2-</sub> | None                                   |
| 5.       | V <sub>3+</sub> | None                                   |
| 6.       | V <sub>3-</sub> | None                                   |
| 7.       | V <sub>4+</sub> | None                                   |
| 8.       | V <sub>4-</sub> | None                                   |

Table 14: Current transducer sensor connection layout

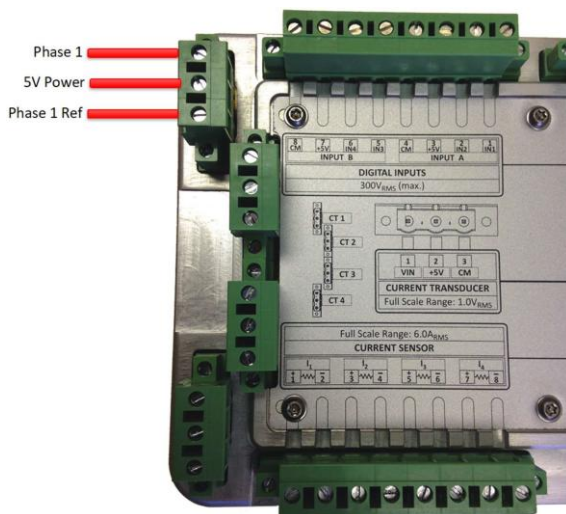


Figure 33: CT circuit connection layout



4.2.4.2.2 Three-phase connection

The current transducer input on the VECTO 3 has a peak voltage input range of 2 V (1.4  $V_{RMS}$ ).

| Terminal | Legend          | 1V Output Current Transducer Circuits |
|----------|-----------------|---------------------------------------|
| 1.       | V <sub>1+</sub> | Voltage 1                             |
| 2.       | V <sub>1-</sub> | Voltage 1 Reference                   |
| 3.       | V <sub>2+</sub> | Voltage 2                             |
| 4.       | V <sub>2-</sub> | Voltage 2 Reference                   |
| 5.       | V <sub>3+</sub> | Voltage 3                             |
| 6.       | V <sub>3-</sub> | Voltage 3 Reference                   |
| 7.       | V <sub>4+</sub> | Voltage 4                             |
| 8.       | V <sub>4-</sub> | Voltage 4 Reference                   |

Table 15: Current transducer sensor connection layout

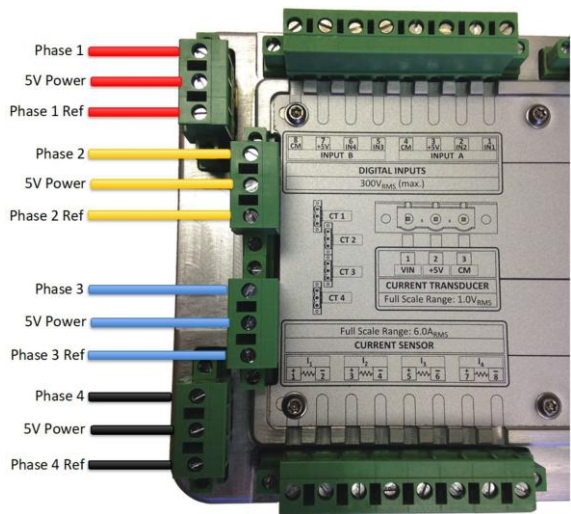


Figure 34: CT circuit connection layout

The VECTO 3 can be configured to:

- Derive the Neutral current by the summation of the 3 line currents in star connected (4-wire) circuits.
- Derive any one of the missing line currents by the summation of the other 2 currents in Delta connected (3-wire) circuits.

#### 4.2.5 Ethernet Based Communication

See Section 2.4.10 for details.

#### 4.2.6 GPS

A GPS antenna can be connected to the device. The GPS provides accurate time and location information to the device. See Section 2.4.8 for details.

#### 4.2.7 WiFi

A WiFi antenna can be connected to the device. See Section 2.4.12 for details.

#### 4.2.8 Modem

A modem antenna can be connected to the device. See Section 2.4.13 for details.

## 5 Maintenance

The VECTO 3 is designed to be a very low maintenance that can operate unattended for years. It contains no user-replaceable parts. If the device needs service, it should be returned to CT LAB (PTY) LTD.

### 5.1 Battery

The internal LiFePO4 battery powers the device in the absence of power. This battery guarantees 2,000 charge/discharge cycles. If cycled once per day, it translates to a 5year life expectancy. The battery is charged when external power is applied to the AC power supply, or the device is connected to an IEEE 802.3-2008 compliant POE source via either of its Ethernet ports.

### 5.2 Transport

Should the device be couriered or shipped please follow these instructions:

1. Insert the device into a plastic bag to prevent water damage during shipment transit; and
2. Protect the device properly and also put it inside a padded box to prevent mechanical damage during transit.

Or

Use the CT LAB packaging in which the device was supplied.

## 5.3 Storage

To prevent damage to the VECTO 3 battery the device should always be stored in the Powered Down state. When the device is powered down the device can be stored for up to 5 years.

Device Power Down:

- Hold the ON/OFF button down for 3 seconds; then
- Switch the Power Button off with a pen or pencil. The device is powered when the switch is in the depressed state.

Note that removing power from the device also removes power from the RTC. Upon start-up after a power cycle the RTC is in an unknown state and the device must first be connected to a valid time source (GPS or NTP) to ensure it time-stamps data correctly.

## 5.4 Warrantee and Repair

### 5.4.1 Warrantee Statement

CT LAB (PTY) LTD Warrants its products and parts as set forth below. Please note that this is only applicable if the product is bought directly from CT LAB (PTY) LTD or CT LAB (PTY) LTD accredited resellers.

- CT LAB (PTY) LTD warrants the Impedo DUO and VECTO 3 to be in compliance with their respective specifications under normal use and service, and to be free from material defects in materials and workmanship for a warranty period of twelve (12) months from the date of the installation or eighteen (18) months from the date of shipment, whichever occurs first. The warranty period for new spare parts and components sold by CT LAB (PTY) LTD is twelve (12) months from the date of shipment. The warranty period for repaired or refurbished parts repaired by CT LAB (PTY) LTD is ninety (90) days from the date of shipment, unless repaired pursuant to a warranty, in which case the repair is warranted for the time remaining of the original warranty period.

- Warrantee repair:
- If any field device fails during the applicable warranty period CT LAB (PTY) LTD can either repair or replace the Failed Good, provided the Customer (a) returns the product to the location designated by CT LAB (PTY) LTD or accredited resellers within the warranty period; and (b) prepays the freight costs both to and from such location. Customer shall, in all cases, be responsible for the In/Out Costs. If CT LAB (PTY) LTD determines that the returned good is not defective, Customer shall pay and/or reimburse CT LAB (PTY) LTD for all expenses incurred by CT LAB (PTY) LTD in the examination of the returned good.
- Customer's remedy under the warranty for services shall be, at CT LAB (PTY) LTD sole cost and expense, to correct or re-perform any defective or nonconforming services to assure compliance with the contract requirements.
- Warranty Exceptions. This General Limited Warranty does not include costs for removal or installation of products, or costs for replacement labour or materials, which are the responsibility of the Customer. The warranties in this General Limited Warranty do not apply to goods that have been: installed improperly or in non-recommended installations; installed to a voltage transformer (VT) or current transformer (CT) that is not functional, or is not in safe operating condition, or is damaged, or is in need of repair; tampered with; modified or repaired with parts or assemblies not certified in writing by CT LAB (PTY) LTD, including without limitation, communication parts and assemblies; improperly modified or repaired (including as a result of modifications required by CT LAB (PTY) LTD; converted; altered; damaged; read by equipment not approved by CT LAB (PTY) LTD. If CT LAB (PTY) LTD identifies any exceptions during examination, troubleshooting or performing any type of support on behalf of Customer, then Customer shall pay for and/or reimburse CT LAB (PTY) LTD for all expenses incurred by Sensus in examining, troubleshooting, performing support activities, repairing or replacing any Equipment that satisfies any of the Exceptions defined above. The above warranties do not apply in the event of Force Majeure.

#### 5.4.2 Technical Support

[Log a support ticket](https://shorturl.at/hiQSV) [shorturl.at/hiQSV](https://shorturl.at/hiQSV)

Alternately, please contact CT LAB (PTY) LTD for technical support.

[info@ctlab.com](mailto:info@ctlab.com)

+27 (21) 880 9915

#### 5.4.3 Sales Assistance

Please contact CT LAB (PTY) LTD for any sales assistance.

[info@ctlab.com](mailto:info@ctlab.com)

+27 (21) 880 9915

Unit 301, Datavoice House, 16 Electron Road, Techno Park, Stellenbosch, 7600, South Africa

#### 5.4.4 Repair and Calibration

Should the device be returned to CT LAB for repairs please follow these instructions:

1. Insert the device into a plastic bag to prevent water damage during shipment transit; and
2. Protect the device properly and also put it inside a padded box to prevent mechanical damage during transit.
3. Complete the fault report and sent it and the device to CT LAB.
  - o Notify [info@ctlab.com](mailto:info@ctlab.com), provide details on the device and how it was shipped and how it can be tracked and with a copy of the fault report.



The package and device remain the responsibility of the client until delivered to CT LAB

The VECTO 3 stores calibration constants on EEPROM that can never be lost for the life of the IC. All systems in the VECTO 3 are protected against power interruptions and voltage event with an internal LiFePO<sub>4</sub> battery that enables the device to shut down without damaging any system in the device. However, in order to verify that the device is measuring correctly, it is recommended to recalibrate the device at least once every five years.



The VECTO 3 does not require recalibration. Calibration constants will not change and can never be lost for the live of the product's EEPROM IC

#### 5.4.5 Disposal

##### 5.4.5.1 EU Countries

The VECTO 3 is subject to the European Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and the corresponding national legislation. The WEEE Directive outlines the procedure for handling electrical waste equipment across the EU.



The VECTO 3 may not be disposed of with normal waste. Should the VECTO 3 reach its end of life, the device may be returned to the distributor free of charge. In addition, CT LAB will accept devices that reached end of life free of charge.

##### 5.4.5.2 Non-EU Countries

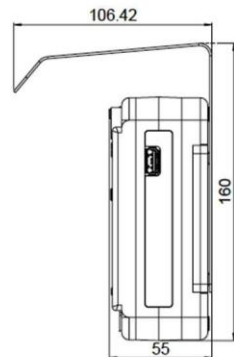
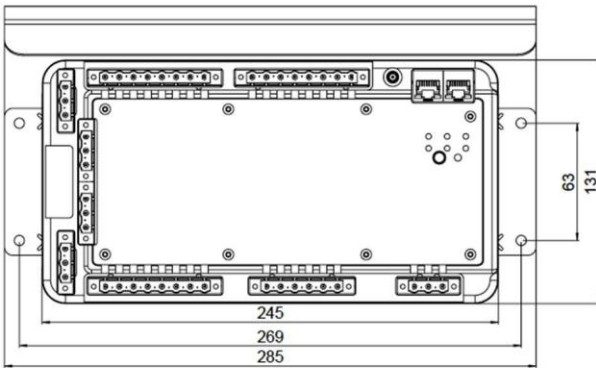
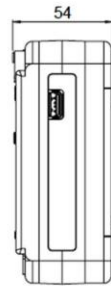
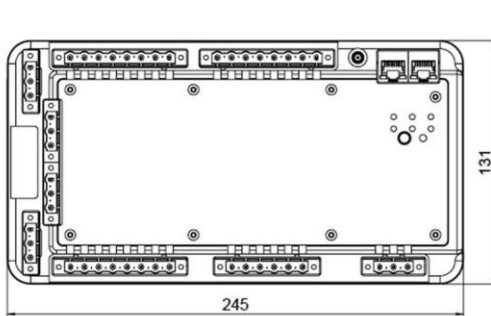
The proper disposal of electrical devices prevents the occurrence of any negative effects on people or the environment, follows the specific procedures for handling harmful substances and enables valuable raw materials to be recycled. Therefore, it is recommended that electrical devices are disposed of in a separate, environmentallyfriendly waste collection and not with normal waste. In some cases, national legislation also stipulates the separate disposal of electric and electronic products. Please ensure you dispose of electrical devices in accordance with the valid regulations in your country. CT LAB will accept devices that reached end of life free of charge.



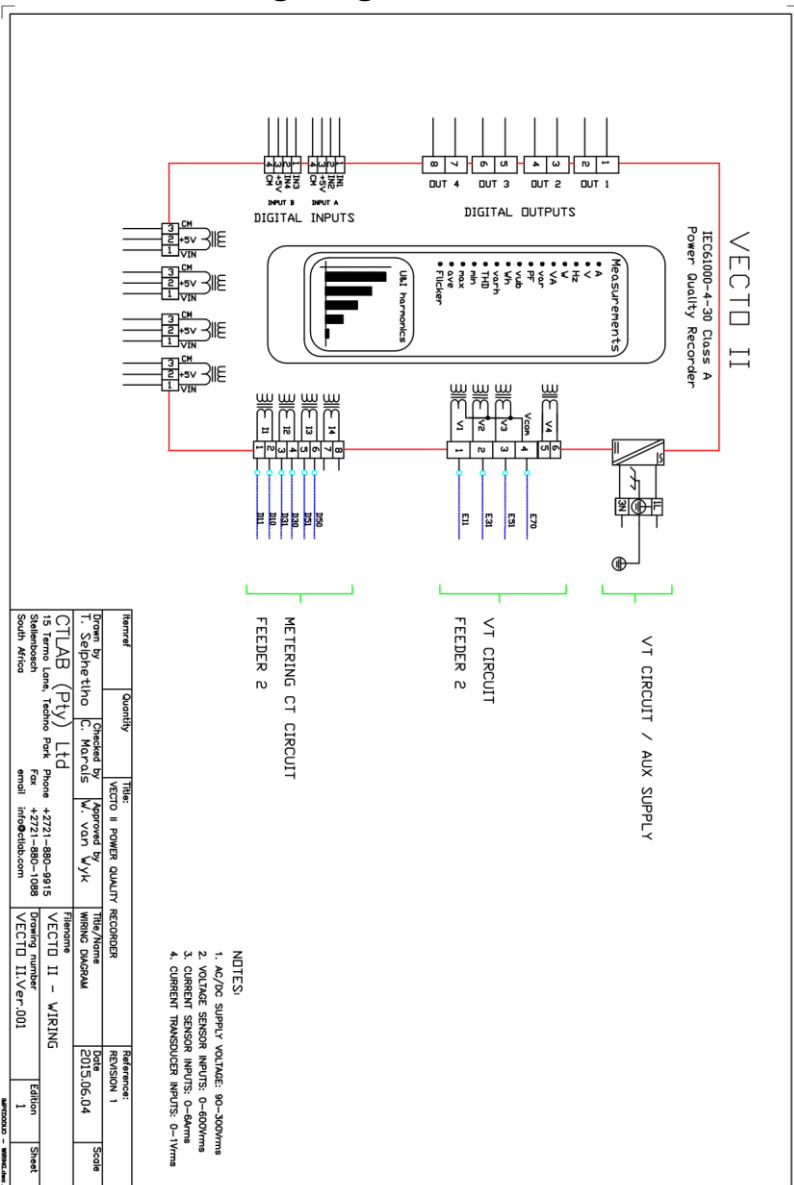
CT LAB will accept devices that reached end of life free of charge for proper disposal.

# Appendices

## 1 VECTO 3 dimensions



## 2 VECTO 3 wiring diagram



### 3 VECTO 3 Top View



## 4 VECTO 3 Purchase Options

### Option 1: VECTO 3 Standard Package

(List ID 2891)

| List ID | Description                                         | Quantity |
|---------|-----------------------------------------------------|----------|
| 2934    | VECTO 3 Device                                      | 1        |
| 3539    | 3-Way 90 Degree Lockable Connector                  | 5        |
|         | 6-Way 90 Degree Lockable Connector                  | 1        |
|         | 8-Way 90 Degree Lockable Connector                  | 3        |
| 1084    | VECTO 3 Straight Communication Cable                | 1        |
| 2431    | USB Flash Drive 4GB                                 | 1        |
| 2487    | Flat Screwdriver Insulated                          | 1        |
| 2297    | T10 Torx Key                                        | 1        |
| 2964    | Stubby WiFi Antenna                                 | 1        |
| 2951    | Cellular Antenna - Magnetic Base Whip with 3m cable | 1        |
| 2569    | GPS Outdoor Dome Antenna with 3m cable              | 1        |
| 3541    | GPS Antenna Bracket Assembly                        | 1        |
| 2197    | 15m Coax Extension Cable                            | 1        |

|                                                                                                                    |                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>VECTO 3 Device</p>           |  <p>Connectors Pack (5 x 3-way, 3 x 8-way, 1 x 6-way)</p> |
|  <p>Straight Ethernet Cable</p> |  <p>USB Flash Drive with latest software</p>             |

|                                                                                                                                                                                                 |                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
|  <p>Flat Screwdriver</p>                                                                                       |  <p>Stubby WiFi Antenna</p>                     |
|  <p>T10 Torx Key</p>                                                                                           |                                                                                                                                  |
|  <p>Cellular Antenna – Magnetic Base Whip with 3m cable (List ID 2951)</p>                                     |  <p>Calibration &amp; Warranty Certificates</p> |
|  <p>GPS Outdoor Dome Antenna with 3m Cable, Bracket and additional 15m Coax Extension Cable (List ID 2534)</p> |                                                                                                                                  |

## Option 2: 19” Rack Mounted Package

(List ID 2891 & 3036)

| List ID | Description            | Quantity |
|---------|------------------------|----------|
| 2934    | VECTO 3 Device         | 1        |
| 3036    | 19 inch Mounting Plate | 1        |

|      |                                                     |   |
|------|-----------------------------------------------------|---|
| 3548 | 3-Way 90 Degree Lockable Connector                  | 4 |
|      | 3-Way Straight Lockable Connector                   | 1 |
|      | 6-Way Straight Lockable Connector                   | 1 |
|      | 8-Way Straight Lockable Connector                   | 3 |
| 1084 | VECTO 3 Straight Communication Cable                | 1 |
| 2431 | USB Flash Drive 4GB                                 | 1 |
| 2487 | Flat Screwdriver Insulated                          | 1 |
| 2297 | T10 Torx Key                                        | 1 |
| 2964 | Stubby WiFi Antenna                                 | 1 |
| 2951 | Cellular Antenna - Magnetic Base Whip with 3m cable | 1 |
| 2569 | GPS Outdoor Dome Antenna with 3m Cable              | 1 |
| 3541 | GPS Antenna Bracket Assembly                        | 1 |
| 2197 | 15m Coax Extension Cable                            | 1 |



VECTO 3 Device



Connectors Pack (5 x 3-way, 3 x 8-way, 1 x 6-way)



VECTO 3  
IEC61000-4-30 (ED3.0) Class-A  
Multifunction Power Quality Analyser



Straight Ethernet Cable



USB Flash Drive with latest software



Flat Screwdriver



T10 Torx Key



Stubby WiFi Antenna



Cellular Antenna – Magnetic Base  
Whip with 3m cable (List ID 2951)



Calibration & Warranty Certificates



GPS Outdoor Dome Antenna with 3m Cable, Bracket and additional 15m Coax  
Extension Cable (List ID 2534)

# Option 3: Portable Investigation Kit Package

(List ID 2894)

## Base Items

| List ID | Description                                                                    | Quantity |
|---------|--------------------------------------------------------------------------------|----------|
| 2934    | VECTO 3 Device                                                                 | 1        |
| 2764    | Portable Investigation Case with Shock Absorbing Foam                          | 1        |
| 1084    | VECTO 3 Straight Communication Cable                                           | 1        |
| 3539    | 3-Way 90 Degree Lockable Connector                                             | 5        |
|         | 6-Way 90 Degree Lockable Connector                                             | 1        |
|         | 8-Way 90 Degree Lockable Connector                                             | 3        |
| 2431    | USB Flash Drive 4GB                                                            | 1        |
| 2951    | Cellular Antenna - Magnetic Base Whip with 3m cable                            | 1        |
| 2487    | Flat Screwdriver Insulated                                                     | 1        |
| 2964    | Stubby WiFi Antenna                                                            | 1        |
| 2535    | Magnetic Base GPS Antenna with 3m Cable, along with a 15m Coax Extension Cable | 1        |
| 2344    | Voltage Connector Set                                                          | 1        |
| 2346    | Power Connection Set                                                           | 1        |
| 2600    | Current Sensor and Current Transducer Connection Set                           | 1        |

## Optional Items

| List ID | Description                                               | Quantity |
|---------|-----------------------------------------------------------|----------|
| 2486    | Micro Clamp 5A to 1V                                      | 3        |
| 2571    | US Clamp 250/500/1000 - 5A                                | 3        |
| 2488    | Rogowski Coil (1000A:333mV) with 3-Way Lockable Connector | 3        |



2934



2764



3539



1084



3587



2431



2951



2487



2964



2535



8014/2486



2571



2488



2344



2346



2600

## 5 Glossary

|                |   |                                                                                 |
|----------------|---|---------------------------------------------------------------------------------|
| Device         | – | Electronic device, such as the VECTO 3                                          |
| Meter          | – | Component of a device that performs measuring (the VECTO 3 contains two meters) |
| Meter Point    | – | The physical measuring point that is measured by a meter                        |
| Fleet password | – | Used to secure communication across a fleet of devices                          |

|            |   |                                                      |
|------------|---|------------------------------------------------------|
| Device Key | – | Unique key that is required to authenticate a device |
|------------|---|------------------------------------------------------|

# 6 Symbols and Abbreviations

|     |                           |
|-----|---------------------------|
| UI  | User Interface            |
| GUI | Graphical User Interface  |
| PQ  | Power Quality             |
| NTP | Network Time Protocol     |
| PTP | Precision Time Protocol   |
| RTC | Real-Time Clock           |
| ppm | Parts Per Million         |
| PDU | Power Distribution Unit   |
| VT  | Voltage Transformer       |
| CT  | Current Transformer       |
| RMS | Root Mean Square          |
| THD | Total Harmonic Distortion |



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