Vecto II®

Power Quality Recorder

User Manual

Version 1.1

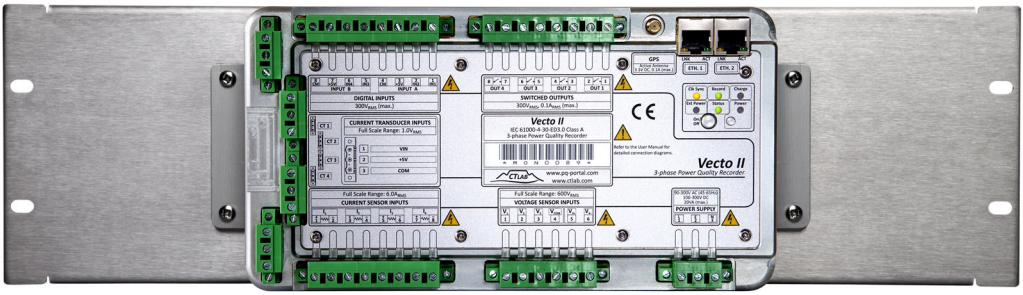

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Table of Contents

1 Safety Instructions

This section provides information on safe handling, installation and commissioning of the Vecto II. 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 instrument's wiring diagram and the ratings before any installation can commence.

1.1 Symbols

Notice Used to call attention to important information.

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

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

1.2 Safety Standards Compliance

The instrument comply to the IEC61010-1 safety standard:

- *Pollution: Degree 2*
- *Over-voltage category: CAT III*
- *Measurement category: CAT III*

The instrument comply to 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 instrument should only be performed by a qualified and certified electrician/technician with appropriate training and experience with high voltage and current devices.

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

If the instrument 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 instrument is in operation, dangerous 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 instrument and also cause personal injury or physical damage.

The terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated. Failure to properly isolate the instrument can create a risk of electric shock, injury or death.

Failure to earth the instrument will compromise the correct functioning of the internal protection circuitry of the instrument.

During normal operation, hazardous voltages are present on the connector terminals. The standard safety precautions must be followed while performing both the installation and service work.

The user must inspect the instrument and all accessories before use; attention must be placed on inspecting:

- Damage to instrument and accessories – do not use any damaged equipment.
- The rating of the input terminals – Do not apply input voltages above the rating of the Instrument.

Do not expose the instrument to extreme moisture and or rain. Avoid use should the instrument be exposed to moisture/rain.

The digital output of the instrument must not be used for primary protection functions. The digital outputs can however be used for secondary protection functions.

Vecto II 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 IP54 (dust and splashing water protected).

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

1.4 Statements and Notices

1.4.1 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 for the latest copy of this document.

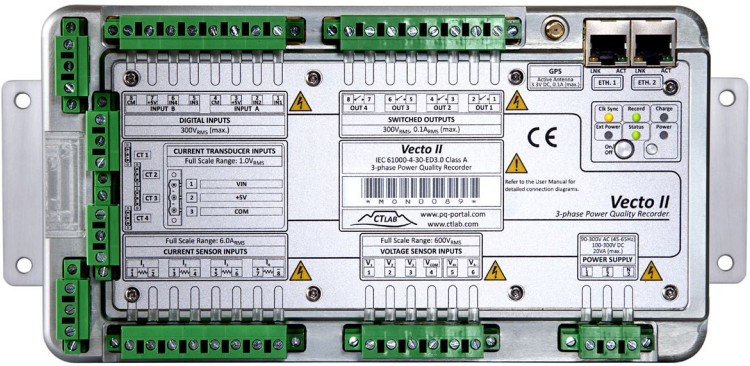
1.4.2 Proprietary rights

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.

1.4.3 Copyright

1.4.4 Trademarks

Impedo DUO, Vecto II, Osprey Lite, Osprey Pro, Xross-Trigger, Snapshot and 6th-sense are registered trademarks of CT Lab (Pty.) Ltd.



2 Introduction to the Vecto II

This chapter introduce the Vecto II ®. The latest version of this document is shipped with the instrument but all new releases are available at www.ctlab.com.

2.1 Vecto II Product Description

The Vecto II is a single feeder version of the Vecto II, but without a display. It 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 II 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 II

The Vecto II packaging is shown Figure 1 with the high-density foam cavity for the Vecto II and the accessories supplied with the instrument. Figure 2 shows the sealed ImpedoDUO box that is shipped.

Figure 1: Inside of the Vecto II box

Figure 2: Closed and strapped Vecto II box

2.2.1 Receiving your shipment

Upon receiving your Vecto II shipment check the following:

- Outside
  - Box is seal
  - Box is not damaged
  - Box has no water damage
- Inside
  - Vecto II in a plastic enclosure
  - Vecto II has no water damage or damp in the plastic enclosure
  - Vecto II screen is intact and has no cracks
  - Ethernet cable, Flash drive and the screw driver 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 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 high-density 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 II from the cavity and inspect for damage

2.2.3 Checking the Battery Level

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

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

When the instrument 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 instrument will not power up from the battery until mains power is connected to the instrument for the first time

2.2.4 Return shipment

Should the instrument be returned to CT Lab for calibration or repairs please follow these instructions:

1. Insert the instrument into a plastic bag to prevent water damage during shipment transit; and
2. Protect the instrument 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 instrument to CT Lab.
    - Notify info@ctlab.com, provide details on the instrument and how it was shipped and how it can be tracked and with a copy of the fault report.

The package and instrument remain the responsibility of the client until delivered to CT Lab.

2.3 Instrument Overview

2.3.1 Key Features

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

1. 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.
        - The first 4 terminals connect 3 different phase voltages such as in a 3-phase system.
        - Input channel 1-3 is referenced to a neutral (4^{th} terminal) connection. This 4^{th} terminal acts as a reference channel and can be any phase voltage if a 3-phase line-line voltage circuit is measured.
        - If it is a 3-phase line-neutral voltage circuit, then the 4^{th} terminal will be connected to the neutral voltage.

- The 5th and 6th terminal is the 4th channel and a fully differential (2 terminal) input channel.

2. Current inputs:
   - 4 X 1/5 A CT inputs
   - 4 X 1 V_{rms} differential voltage transducer inputs with a 5 V power supply (to be used to power Rogowski coils).
3. 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.
4. 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 $LiFePO^4$ battery.
5. 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 63rd harmonic component.
6. Time stamping
   - GPS time synchronization resulting in a time-stamping certainty better than 100 ns.
   - PTP time synchronization resulting in a time-stamping certainty better than 1 ms.
   - NTP time synchronization as an option.
7. Communication
   - Communication is via Ethernet.
   - Modbus over Ethernet.
   - DNP3 over Ethernet.
   - IEC 61850 – optional.
8. Advanced triggering
   - User-configurable triggering between different instruments: the patented Xross-Trigger feature (Described in the OspreyLite user manual)
9. Configuration of instrument
   - The Vecto II has to be configured by means of an Ethernet connection to a local laptop with Osprey Lite installed.

10. Data analysis and reporting
    - Osprey Lite is supplied free of charge and continuously updated.
    - Download from 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 II with Osprey Lite.

2.3.2 Vecto II External Interfaces

2.3.2.1 Voltages

The voltage inputs to the Vecto II 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 3-phase 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 instrument 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_{RMS} voltage output current transducers or Rogowski coils with 5 V_{DC} 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 instrument 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 $LiFePO^4$ battery powers the instrument 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 remote support software supports automatic service discovery protocols. Laptops, when connected to the Vecto II, will receive an IP from the instrument. The remote support software can automatically discover which instruments are connected to the local network.

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

2.3.5 Osprey Pro (Enterprise Support)

When connected, each instrument automatically establishes a permanent secure communication link to a corporate server (local or internet based). An instrument management system (IMS) keeps track of each instrument'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 instrument is password protected. More information can be obtained at www.pq-portal.com.

2.3.6 Sampling Rate

The instrument 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 610000-4-30 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.

2.3.7 The 1/6th Sense

The Vecto II 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 1/6th cycle data.

2.3.8 Event Recording

Users can customise the recording of an event. The IEC 610000-4-30 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, 1/6th sense, 10/12-cycle block and aggregated parameters.

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

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

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

2.3.9 10/12-Cycle Block Recording

The Vecto II records all RMS and harmonic data from each 10/12-cycle block (≈200ms 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 63th harmonic order.

Each block is time-stamped with a 1 μs time resolution and within a 100 ns time uncertainty[1].

The user can average N x blocks to reduce the sampling rate for the number of blocks up to 299 blocks[2].

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

[1] When GPS synchronized

[2] Averaged block harmonic and unbalance phasors do not contain angle information.

2.3.10 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.

2.3.11 Synchrophasors

The Vecto II 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.

2.3.12 Measured parameters

MEASURED PARAMETERS	Waveforms	1/6th Cycle	10/12 - Cycle block	10/12 - Cycle Harmonics	10/12 - Cycle Inter-Harmonics	Aggregated Trends	Aggregated Harmonics	Aggregated Inter-Harm
VOLTAGE								
Frequency (Hz)		✓	✓			✓		
Voltage (Volt)	✓	✓	✓	✓	✓	✓	✓	✓
Voltage (% of Nominal)		✓	✓	✓	✓	✓	✓	✓
Voltage (% of Fundamental)				✓	✓		✓	✓
Voltage Phase Angle (Degrees)		✓	✓	✓				
Voltage Unbalance (%)		✓	✓	✓		✓	✓	
V-Positive Amplitude (Volt)			✓			✓		
V-Positive Angle (Degrees)			✓					
V-Negative Amplitude (Volt)			✓			✓		
V-Negative Angle (Degrees)			✓					
V-Zero Amplitude (Volt)			✓			✓		
V-Zero Angle (Degrees)			✓					
Voltage Under-Deviation			✓			✓		
Voltage Over-Deviation			✓			✓		
Voltage THD			✓			✓		
Flicker (Pst)			✓			✓		
Flicker (Plt)						✓		

MEASURED PARAMETERS	Waveforms	1/6th Cycle	10/12 - Cycle block	10/12 - Cycle Harmonics	10/12 - Cycle Inter-Harmonics	Aggregated Trends	Aggregated Harmonics	Aggregated Inter-Harm
CURRENT								
Current (Ampere)	✓	✓	✓	✓	✓	✓	✓	✓
Current (% of Fundamental)		✓		✓	✓		✓	✓
Current Phase Angle (Degrees)		✓	✓	✓				
Current Unbalance (%)		✓	✓	✓		✓	✓	
I-Positive Amplitude (Ampere)			✓			✓		
I-Positive Angle (Degrees)			✓					
I-Negative Amplitude (Ampere)			✓			✓		
I-Negative Angle (Degrees)			✓					
I-Zero Amplitude (Ampere)			✓			✓		
I-Zero Angle (Degrees)			✓					
Current THD			✓			✓		
Crest Factor		✓	✓			✓		
K-Factor			✓			✓		

MEASURED PARAMETERS	Waveforms	1/6th Cycle	10/12 - Cycle block	10/12 - Cycle Harmonics	10/12 - Cycle Inter-Harmonics	Aggregated Trends	Aggregated Harmonics	Aggregated Inter-Harm
POWER								
Active Power (Watt)		`	✓			✓		
Reactive power (VAR)	✓	✓	✓	✓	✓	✓	✓	✓
Apparent Power (VA)		✓	✓	✓	✓	✓	✓	✓
Power Angle (Degrees)				✓	✓		✓	✓
Power Factor		✓	✓	✓				
POWER – IMPORT		✓	✓	✓		✓	✓	
Imported Active Power (Watt)			✓			✓		
Imported Reactive Power (VAR)			✓					
Imported Apparent Power (VA)			✓			✓		
Imported Power Angle (Degrees)			✓					
Imported Power Factor			✓			✓		
POWER – EXPORT			✓					
Exported Active Power (Watt)			✓			✓		
Exported Reactive Power (VAR)			✓			✓		
Exported Apparent Power (VA)			✓			✓		
Exported Power Angle (Degrees)			✓			✓		
Exported Power Factor						✓		

2.3.13 Technical Specification

VOLTAGE INPUTS	
Number of channels	4 x differential inputs (3/4 Wire + 4th Diff)
Measurement input range	0 – 600 V_{RMS}
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_{RMS}
Maximum continuous current	6.0 A_{RMS}
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_{RMS} (± 1.414 V Peak)
Input impedance/channel	> 1 MΩ
DIGITAL INPUTS	
Number of Channels	2 sets of 2 galvanically isolated digital outputs

Switch Rating	0.1 A_{RMS}, 300 V_{RMS} (max)
ACCURACY & BANDWIDTH	
Power frequency range	DC, 50 H_Z (40-60 Hz), 60 Hz (50-70 Hz)
Harmonic bandwidth	1-64th (harmonic and inter-harmonic)
Measurement sampling rate	0.5 MHz (simultaneously sampled)
Waveform storage rate	1 kHz (user configurable)
ADC Resolution	16-Bit
Overall accuracy class	0.1%
Fast Transient Capturing	> 20 μs
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	± 20 μs from absolute time
On-Board RTC drift	1 ppm (32-seconds per annum)
	NTP, PTP
POWER	
Maximum Power Consumption	< 15 W

AC / DC supply voltage input range	90-300 V_{RMS} 42-69 Hz (power factor corrected)
Power over Ethernet	IEEE 802.3 compliant (35-60 V_{DC})
On-board battery	$LifePO^4$ (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	0 °C to 75 °C
COMPLIANCE	
PQ Measurement	IEC 61000-4-30, Class A
Harmonics	IEC 61000-4-7
Flicker	IEC 61000-4-15
SCADA	IEC 61850

2.4 Vecto II External Interfaces

2.4.1 Physical Appearance

Figure 3 shows the front of the Vecto II. The nameplate displays the name and serial number of the instrument, detail layout of the external interfaces of the instrument and instrument 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 instrument. The Vecto II can be installed as a temporary investigation instrument, be surface mounted or on a DIN rail as respectively shown in Figure 4 a, b and c.

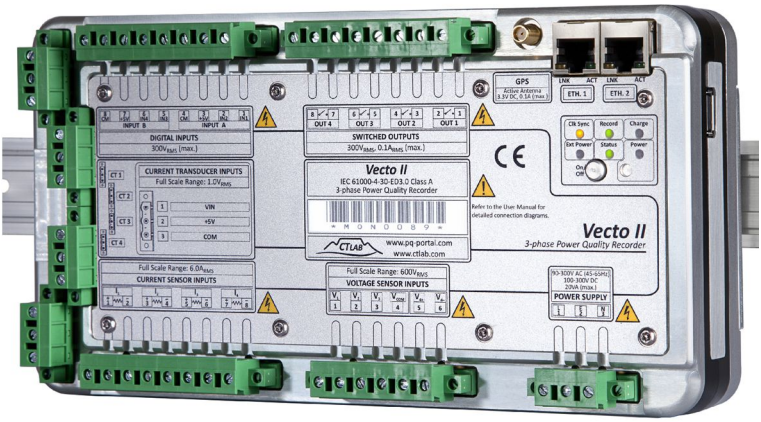
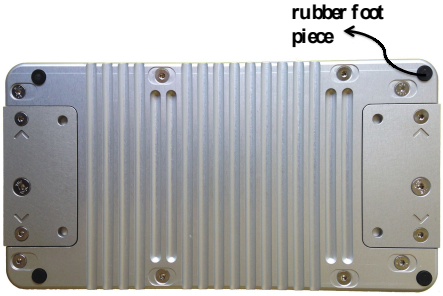
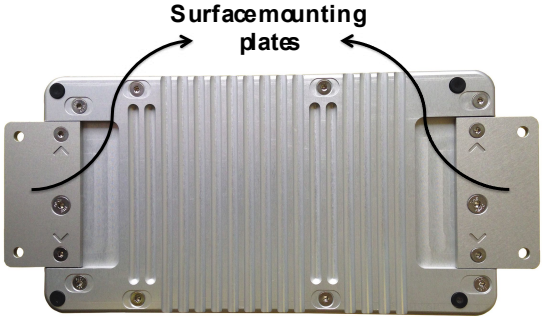


Figure 3: Front of instrument

a) Investigation instrument



b) Surface mount installation



c) DIN rail installation

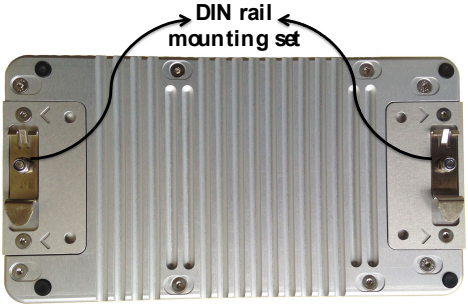


Figure 4: Back of instrument

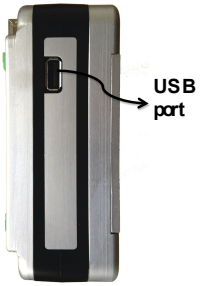


Figure 5: Right side of instrument

Figure 5 show the USB port located on the right hand side of the instrument.

2.4.2 Vecto II User Interface

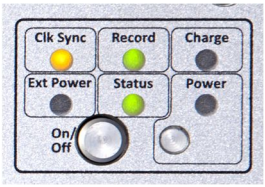


Figure 6: Right side of instrument

Six LEDs on the top-left front side of the instrument 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 instrument. The Power button is recessed to avoid accidental switching. It rests flush with the surface plate in the off-state and sits below the surface plate in the on-state. The On/Off button is a push-button 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 II can be powered and charged directly from mains (90 – 300 V AC/DC) via a power factor corrected internal power supply.

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

A built in LiFePO^4 battery will power the instrument 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^2.

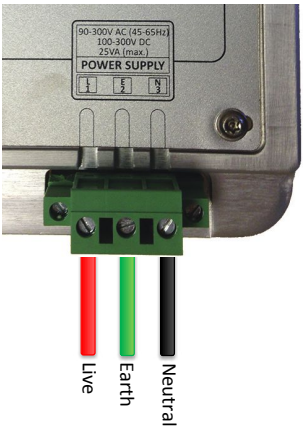


Figure 7: Vecto II power supply connection

Table 1: Power supply connection

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

The supply voltage input range is from 90 V_{RMS} to 300 V_{RMS} AC or DC (42-69 Hz for AC sources).

The supply current is power factor corrected and the maximum power consumption of the Vecto II is actively limited to 12.5 VA. The Vecto II 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 II from over and under voltage. The Vecto II 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 II will not restart even with valid mains voltage.

During a power interruption/failure, the internal battery will power the instrument for ± 30 minutes. When the battery charge drop below 50% of full capacity, the instrument will gracefully shut down to protect the battery from being damaged.

When power is restored, the instrument 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

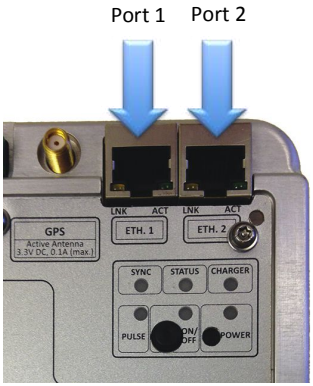


Figure 8: Ethernet ports

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 II to be powered

through the communication infrastructure. The Vecto II will therefore be continuously available if the communication infrastructure remains active.

2.4.4 Voltage Inputs

The Vecto II 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^{th} (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^2. 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. Three-phase 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

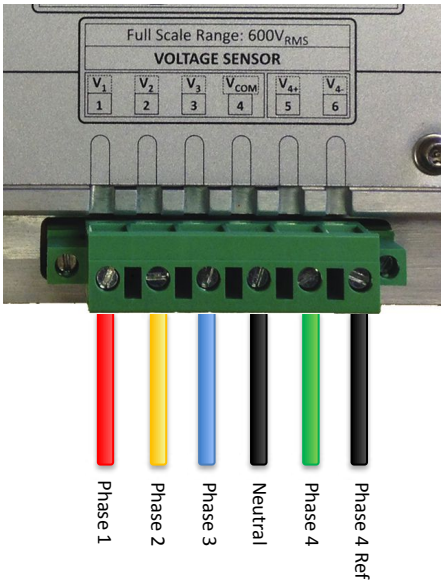


Figure 9: Vecto II 4-wire star connection

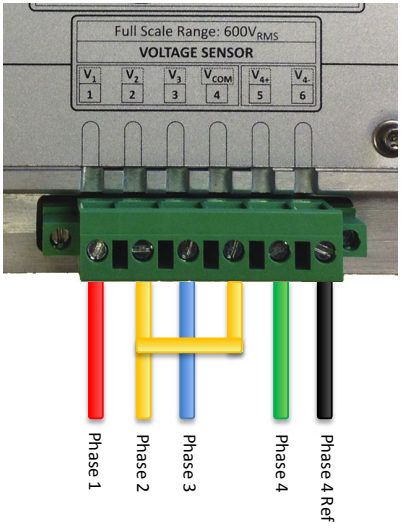


Figure 10: Vecto II 3-wire delta connection

Table 2: Voltage connection layout

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

Input voltages can be up to 600 $V_{AC\text{-}RMS}$. The 20 mV resolution results in accurate recording of all harmonic components up to the 63rd 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 II has 4 galvanically isolated resistive current shunt inputs with input impedance of 20 mΩ and a full-scale measurement range of 6 $A_{AC\text{-}RMS}$.

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^2.

Table 3: Current sensor connection layout

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

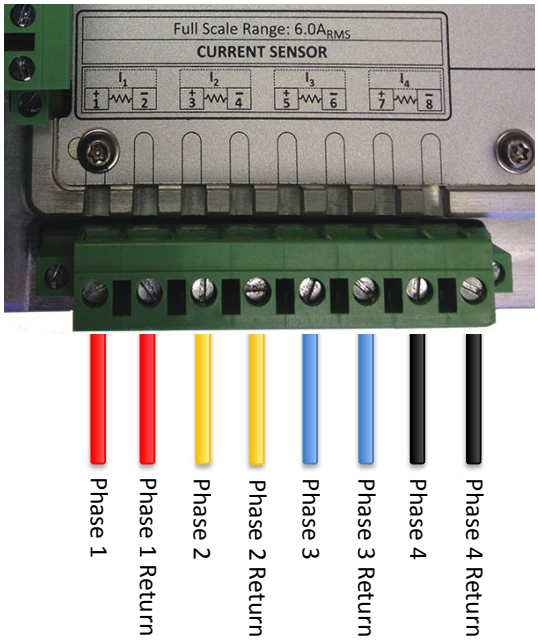


Figure 11: Current sensor connection

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 II has 4 voltage-output current transducer inputs with a full-scale rating of 1.4 $V_{AC\text{-}RMS}$. 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 mm^2.

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

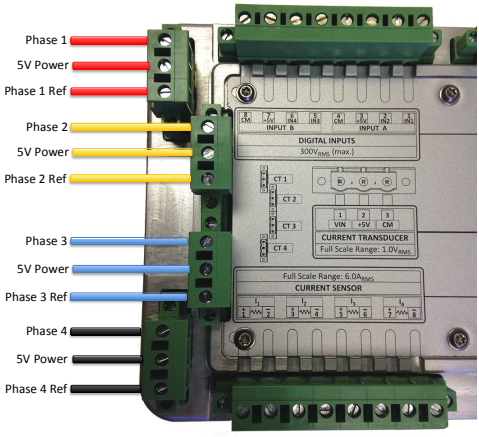


Figure 12: Current transducer connection

Table 4: Current transducer connection layout

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_{Com}	Voltage 3 Reference
10.	CT 4 - V_{IN}	Voltage 4
11.	CT 4 - +5V	5 V Power Supply
12.	CT 4 - V_{Com}	Voltage 4 Reference

2.4.7 Relay Outputs

Six relay outputs (100 $mA_{AC\text{-}RMS}$, 350 $V_{AC\text{-}RMS}$) are used to provide pulsed outputs 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 by an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to 1.5 mm^2.

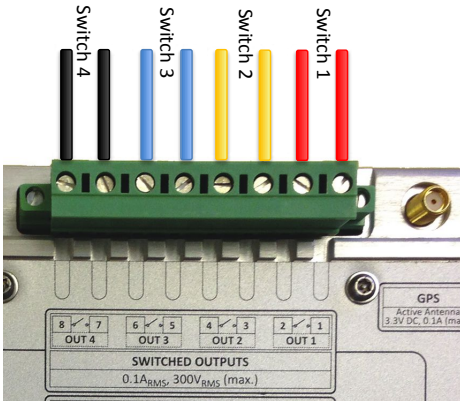


Figure 13: Relay switch connection layout

Table 5: Relay switch connection layout

Terminal	Legend	Description
1.	S_1	Switch A1
2.	S_2	Switch A2
3.	S_3	Switch A3
4.	C_A	Switch A Common
5.	S_4	Switch B1
6.	S_5	Switch B2
7.	S_6	Switch B3
8.	C_B	Switch B Common

2.4.8 Digital inputs

The inputs are arranged into two clusters (1 kV isolation); each containing two digital inputs (300 $V_{AC\text{-}RMS}$) 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^2.

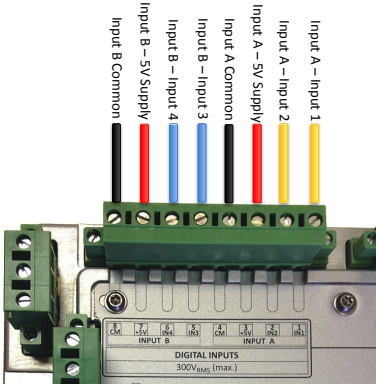


Figure 14: Digital inputs connection layout

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

2.4.9 GPS

The female SMA port is used to interface an external powered (+3V3) GPS antenna to the Vecto II. The built-in GPS is used to measure absolute time. The Vecto II locks it's internal clock to within 100 ns from absolute time.

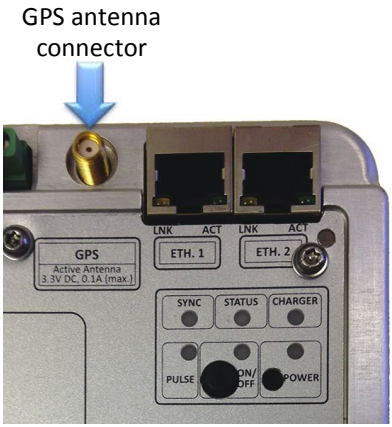


Figure 15: GPS antenna connector

2.4.10 Ethernet Ports

The instrument has 2 Gigabit Ethernet ports as depicted in Figure 16. The IP address of port 2 is fixed at 192.168.7.1. The instrument 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 instrument 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 II to be powered through the communication infrastructure. The Vecto II will therefore be available at all times while the communication infrastructure stays on-line.

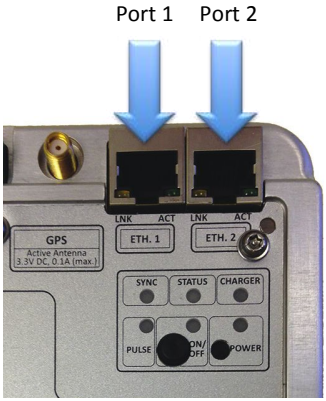


Figure 16: Ethernet ports

2.4.11 USB Peripheral Ports

A powered USB2.0 compliant (450 MBit) USB ports 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 17: USB ports

2.5 Firmware

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

2.5.1 Upgrading

The VectoII 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 II's battery is charged and that mains power is connected to the instrument power supply before switching the instrument on for the first time.

The instrument will not power up until sufficiently charged

3.2 Toggling Storage/Ready Mode

The instrument is in ready mode when the power button is depressed (Figure 18). In ready mode the instrument 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 II will not be used for an extended period of time it can be put into storage mode. To place the instrument is in storage mode the Power button is toggled off (not depressed). Ensure that the instrument is powered down before placing it in storage mode. Do not put the instrument in storage mode while the system is powered up. Doing so may lead to loss of data and/or permanent damage to the instrument.

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

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

Note that removing power from the instrument 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 instrument must first be connected to a valid time source (GPS or NTP) to ensure it time-stamps data correctly.

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

Table 7: Status LED Interpretation

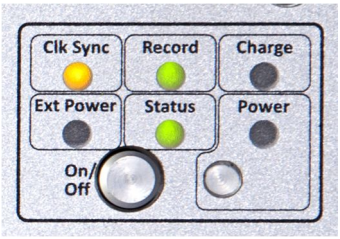


Figure 18: Status LEDs, On/Off button and Power Button

Six LEDs as shown in Figure 18 provide information about the status of the instrument. Table 7 describes the various states. In storage mode, all LEDs are off.

3.4 Powering up the VectoII

The following two sections describe the method for powering up the Vecto II. After powering up the instrument the Status LED will be flashing green. Osprey Lite™ can be now used to configure the instrument (please refer to *Osprey Lite™ User manual* for more detail). The instrument 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 instrument 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 instrument on by pressing and holding the On/Off button. The Status LED will turn orange to indicate that the instrument is booting normally. It will start to flash green once the boot cycle completed.

3.4.2 Powering up from Ready Mode

The instrument 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 instrument. The Status LED will turn orange to indicate that the instrument 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 18) until the Status LED turns orange to power the instrument down and stop recording data.

The shutdown sequence may take up to 60 seconds

3.6 Error Conditions

3.6.1 Health Failure Conditions

In ready mode, the instrument may fail to turn on under an error condition. Instead of turning the instrument 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.

3.6.2 Recovery conditions

The Vecto II 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 instrument 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 3.6.1. The instrument will attempt to power up again if all health checks passed.

In the unlikely event of permanent internal system corruption the instrument 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 instrument 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 instrument to storage mode and back to ready mode.

4 Vecto II Installation

4.1 Mounting the Vecto II

4.1.1 Panel Mounting Installation

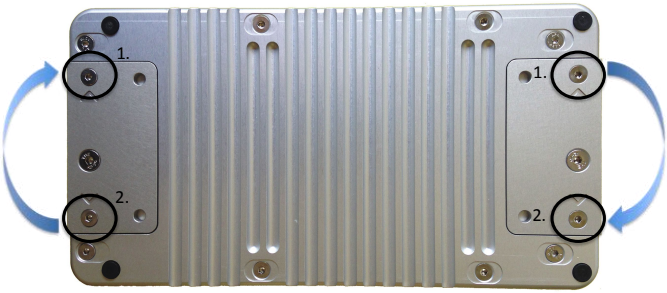


Figure 19: Vecto II back as supplied by CT Lab

Unscrew the Allen-key screw shown in Figure 19 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 20, to install the instrument on the required surface.

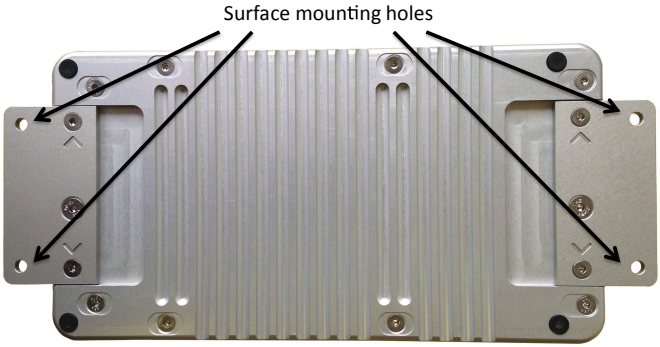


Figure 20: Surface mount Vecto II

4.1.2 19” Rack Mounting Installation

A 19” rack (4U) stainless steel mounting plate secures the Vecto II and provides a mechanical interface for 19” racks[3].

The 19” plate and the Vecto II is shipped separate and must be assembled on site.

Step 1:

Change the Vecto II configuration to panel mounting configuration as described in section 4.1.1.

Step 2:

Install the Vecto II onto the 19” plate using the screws provided with the 19” plat set.

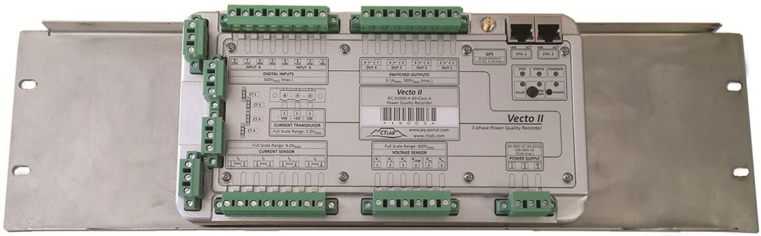


Figure 21: 19’’ Vecto II

4.1.3 DIN rail mounting

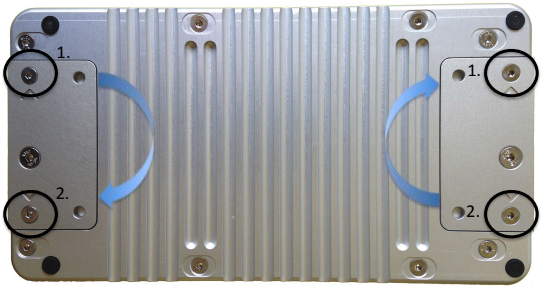


Figure 22: Vecto II backside as shipped by CT Lab

[3] Optional accessory

Unscrew the Allen-key screw shown in Figure 22 and turn the installation plates over as indicated. The Din rail mounting is in a Vecto II cavity and will be available for use when the installation plates are turn over as shown in Figure 23.

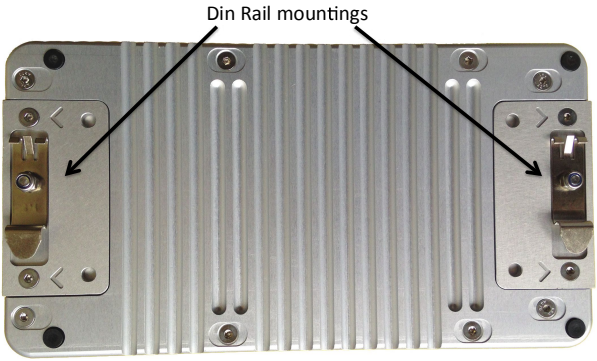


Figure 23: Vecto II back when Din rail mountings are to be used

4.2 Connections

4.2.1 AC Power

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

Table 8 and Figure 24 depict how to connect the AC power supply.

Table 8: AC power connection layout

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

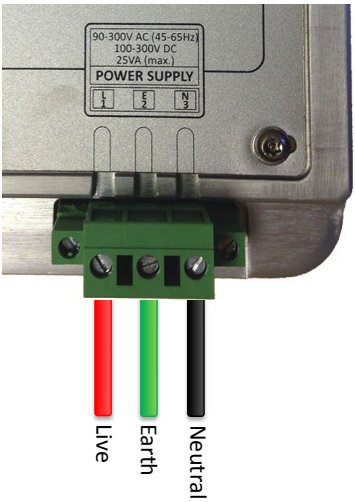


Figure 24: Vecto II AC power supply connection

4.2.2 Power Over Ethernet

In addition to, or as alternative to AC power, the instrument 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

Table 9: VT circuit connection layout for single phase connection

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

- *Connect the phase Voltage to Voltage Inputs 1 as shown in Figure 25.*
- *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.*

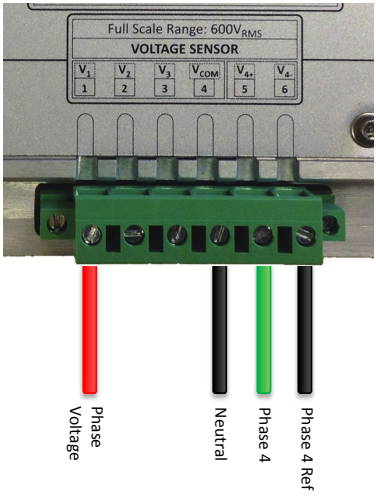


Figure 25: Vecto II single-phase connection

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

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

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

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_{4+}	Earth (optional for 400 V systems only)
6.	V_{4-}	Star connection point (Neutral) (Optional and for 400 V systems only)

- *Connect Phase 1,2 and 3 to Voltage Inputs 1-3 as shown in Figure 26 below.*
- *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 on 400 V systems to measure Neutral-Earth voltage.*

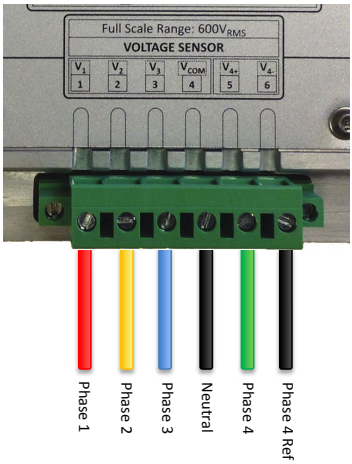


Figure 26: Vecto II 4-wire star connection

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

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

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

1) *Connect Phase 1,2 and 3 to Voltage Inputs 1-3 as shown in the Figure 27.*

2) *Leave V_{com} open or connect V_{com} to the earthed Phase (Phase 2) on 110 V VT circuits.*

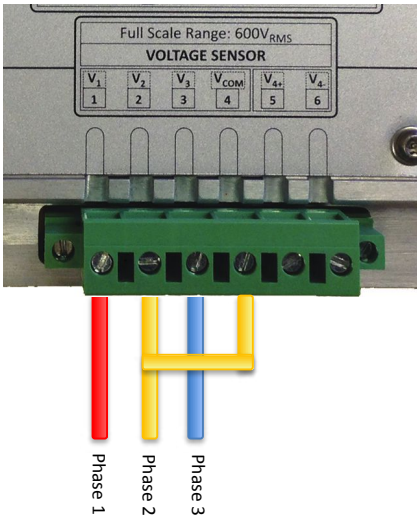


Figure 27: Vecto II 3-wire delta connection

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 II 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.

Table 12: CT circuit connection layout

Terminal	Legend	Description
1.	I_{1+}	Phase 1 Current Input
2.	I_{1-}	Phase 1 Current Return
3.	I_{2+}	None
4.	I_{2-}	None
5.	I_{3+}	None
6.	I_{3-}	None
7.	I_{4+}	None
8.	I_{4-}	None

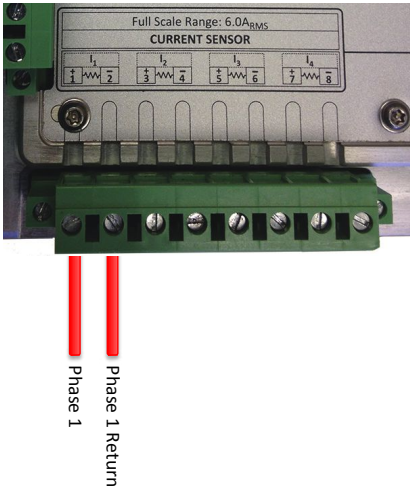


Figure 28: CT circuit connection layout

4.2.4.1.2 Three-phase connection

The Vecto II 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.

Table 13: CT circuit connection layout

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

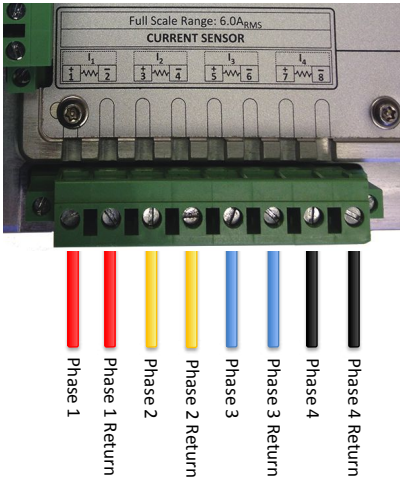


Figure 29: CT circuit connection layout

The Vecto II 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 VectoII has a peak voltage input range of 2 V (1.4 V_{RMS}).

Table 14: Current transducer sensor connection layout

Terminal	Legend	1 V Output Current Transducer Circuits
1.	V_{1+}	Voltage 1
2.	V_{1-}	Voltage 1 Reference
3.	V_{2+}	None
4.	V_{2-}	None
5.	V_{3+}	None
6.	V_{3-}	None
7.	V_{4+}	None
8.	V_{4-}	None

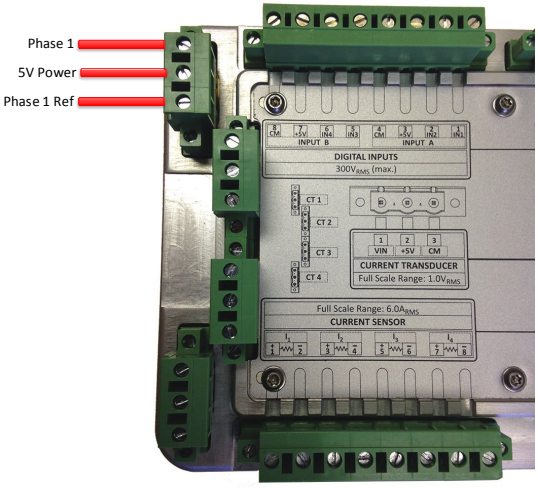


Figure 30: CT circuit connection layout

4.2.4.2.2 Three-phase connection

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

Table 15: Current transducer sensor connection layout

Terminal	Legend	1V Output Current Transducer Circuits
1.	V_{1+}	Voltage 1
2.	V_{1-}	Voltage 1 Reference
3.	V_{2+}	Voltage 2
4.	V_{2-}	Voltage 2 Reference
5.	V_{3+}	Voltage 3
6.	V_{3-}	Voltage 3 Reference
7.	V_{4+}	Voltage 4
8.	V_{4-}	Voltage 4 Reference

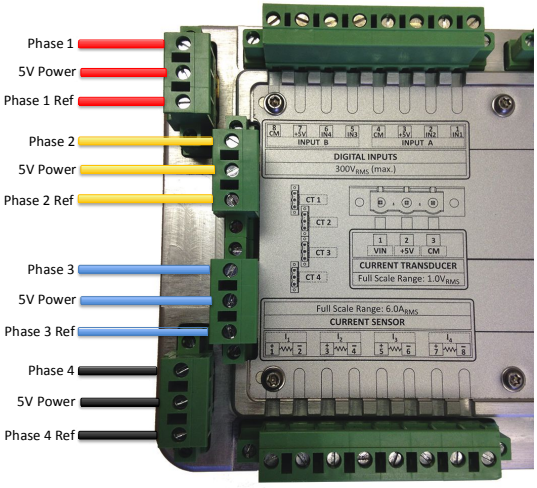


Figure 31: CT circuit connection layout

The Vecto II 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 instrument. The GPS provides accurate time and location information to the instrument. See Section 2.4.8 for details.

5 Maintenance

The Vecto II is designed to be a very low maintenance that can operate unattended for years. It contains no user-replaceable parts.

5.1 Battery

The internal $LiFePO^4$ battery powers the instrument in the absence of power. This battery guarantees 2,000 charge/discharge cycles. If cycled once per day, it translates to a 5-year life expectancy. The battery is charged when external power is applied to the AC power supply, or the instrument is connected to an IEEE 802.3-2008 compliant POE source via either of its Ethernet ports.

5.2 Transport

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

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

Or

Use the CT Lab packaging in which the instrument was supplied.

5.3 Storage

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

Instrument Power Down:

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

Note that removing power from the instrument also removes power from the RTC. Upon start-up after a power cycle the RTC is in an unknown state and the instrument 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.

1. *CT Lab (Pty.) Ltd. warrants the ImpedoDUO and Vecto II 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.*
2. *Warrantee repair:*
    a. *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.*
    b. *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 non-conforming services to assure compliance with the contract requirements.*
3. *Warranty Exceptions. This General Limited Warranty does not include costs for removal or installation of products, or costs for replacement labor 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

Please contact CT Lab for technical support.

CT Lab

info@ctlab.com

+27 (21) 880 9915

5.4.3 Sales Assistance

Please contact CT Lab for any sales assistance.

CT Lab

info@ctlab.com

+27 (21) 880 9915

15 Thermo Lane, Techno Park, Stellenbosch, South Africa

5.4.4 Repair and Calibration

Should the instrument be returned to CT Lab for repairs please follow these instructions:

1. Insert the instrument into a plastic bag to prevent water damage during shipment transit; and

2. Protect the instrument 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 instrument to CT Lab.
    - Notify info@ctlab.com, provide details on the instrument and how it was shipped and how it can be tracked and with a copy of the fault report.

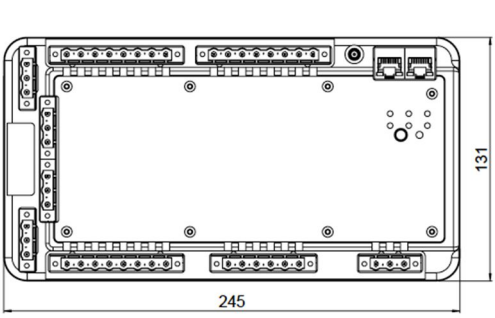
The package and instrument remain the responsibility of the client until delivered to CT Lab

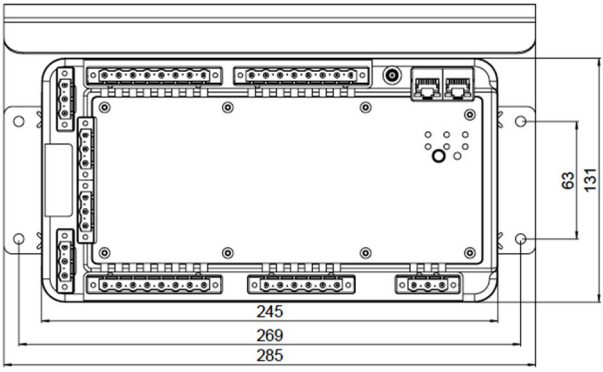
The Vecto II does not require recalibration. Calibration constants are stored on EEPROM that can never be lost for the live of the IC. All systems in the Vecto II are protected against power interruptions and voltage event with an internal LiFPO4 battery that enables the instrument to shutdown without damaging any system in the instrument.

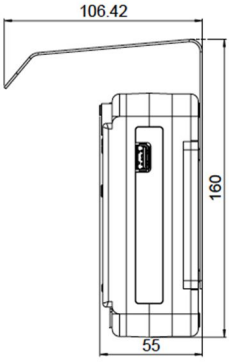
The Vecto II does not require recalibration. Calibration constants will not change and can never be lost for the live of the product's EEPROM IC

Appendices

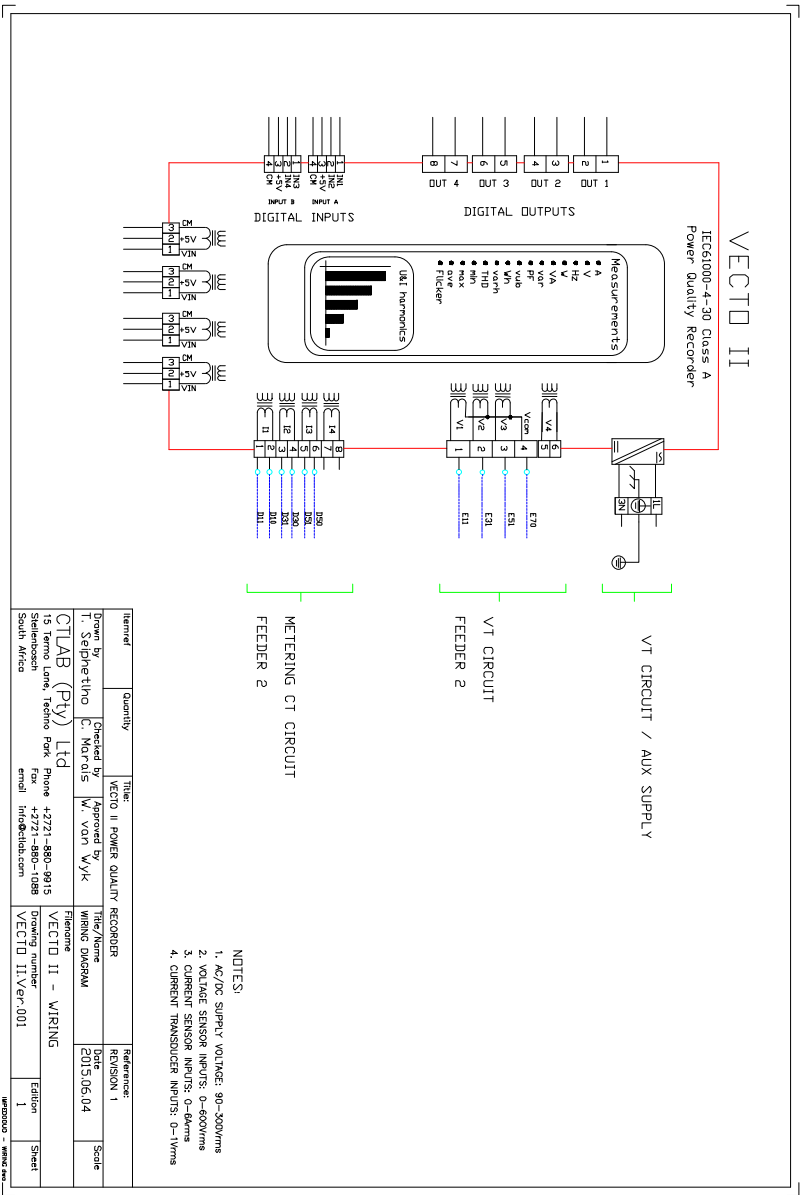
1 Vecto II dimensions



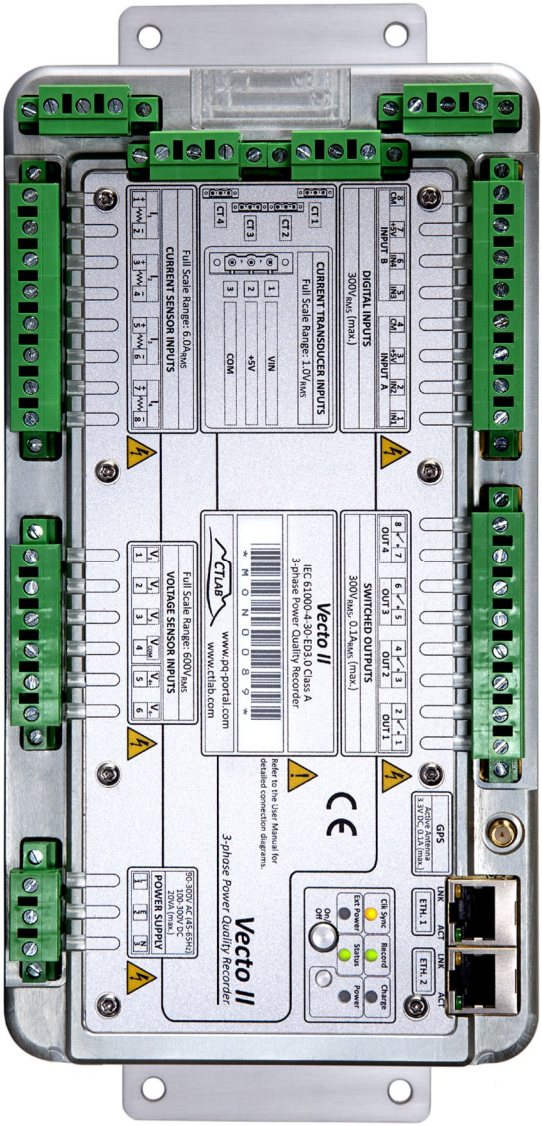




2 Vecto II wiring diagram



3 Vecto II rating plate (Back plate)



4 Accessories and Options

The following are standard options.

Vecto II - Panel mount or Din-Rail

- *Vecto II*
- *GPS antenna & 15m extension cable*
- *GPS antenna mounting bracket*

GPS antenna

15m extension cable

GPS antenna mounting bracket

Ethernet cable

Screw driver

USB with meter key

VectoII – 19”

- *Vecto II*
- *19” mounting plates*
- *GPS antenna & 15m extension cable*
- *GPS antenna mounting bracket*

19” (4U) mounting plate

GPS antenna

15m extension cable

GPS antenna mounting bracket

Screw driver

USB with meter key

Ethernet cable

Vecto II – Portable unit

- *Vecto II*
- *Portable Vecto II case*
- *GPS anteanna + 15m extension cable*
- *Power Connection set*
- *Voltage connection set (Wiring and 5 clips included)*
- *Current sensor and current transducer connection set*
- *3 x US Current Clamp 250/500/1000:5A*
- *3 x Micro Clamps 5A:1V*

Portable case

Magnetic GPS antenna

15m extension cable

Voltage connection wiring

Voltage connection clips

Current connection wiring

US clamps 250/500/1000:5A CT

Micro clamps 5A:1V

Pic-tails for safe connection to the ImpedoDUO

Screw driver

USB with meter key

Ethernet cable

5 Glossary

Instrument	–	Electronic device, such as the Vecto II
Meter	–	Component of an instrument that performs measuring (the Vecto II 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 instruments
Instrument Key	–	Unique key that is required to authenticate an instrument

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