

VECTO

TRANSIENT

5 MHZ Wave Synchronised Edge Computer
TRANSIENT+ | PQI+ | PMU+ | AUTOMATION+ | OSCILLATION+

User Manual (v1.0)



More Information: www.VECTOsystem.com

Manufactured By CT LAB (PTY)LTD

Riesling House, Brandwacht Complex, Stellenbosch, 7600, South Africa

Table of Contents

1	Safety Instructions	7
1.1	Symbols	7
1.2	Intended Use	8
1.3	Safety Standards Compliance	8
1.4	General Safety Information	8
1.5	How to Mitigate Risks.....	10
1.5.1	Always earth the device first	10
1.5.2	Install external shorting blocks	10
1.5.3	Locking of terminal plugs.....	10
1.5.4	Use of external fuses or circuit breakers	10
1.5.5	Provide surge arrestors.....	10
1.6	Statements and Notices.....	10
1.6.1	Statement of reliability	10
1.6.2	Proprietary rights.....	11
1.6.3	Copyright	11
1.6.4	Trademarks	11
2	Introduction to the VECTO Transient	12
2.1	VECTO Transient Product Description.....	12
2.2	Receiving your VECTO Transient.....	13
2.2.1	Receiving your shipment	13
2.2.2	Unpacking the goods	14

2.2.3	Powering up the device for the first time.....	14
2.2.4	Return shipment	14
2.3	Hardware Features	16
2.4	Functional Features	16
2.5	Voltage Inputs	18
2.6	Current Inputs	18
2.7	Power sources	18
2.8	Analog/Digital Inputs	18
2.9	Relay Outputs.....	18
2.10	Communication Interfaces	19
2.11	Osprey Lite Support Software.....	19
2.12	Built-in HMI (Web Interface)	19
2.13	VECTO Grid OS (Enterprise Support).....	19
2.14	Sampling Rate	20
2.15	The 1/6th Cycle Data Stream	20
2.16	Event Type Data Recording.....	20
2.17	10/12-Cycle Block Recording ($\pm 200\text{ms}$ interval or 5Hz)	21
2.18	Variable time interval trends.....	21
2.19	Synchrophasors	22
2.20	Sub Synchronous Oscillation Phasor Measurement.....	22
2.21	Trended RMS & Fundamental Parameters	23
2.22	Trended Power Parameters	25
2.23	Trended Individual Harmonic/Interharmonic Parameters	26
3	Technical Specification	27
4	External Interfaces	30
4.1	Physical Appearance.....	30
4.2	VECTO Transient User Interface.....	32

4.3	Power Supply Input	32
4.4	Communication Interfaces	35
4.5	Voltage Inputs	36
4.6	Current Inputs	37
4.7	Relay Outputs.....	39
4.8	Digital inputs	40
4.9	GPS.....	41
4.10	Gigabit Ethernet Ports	42
4.11	SFP Gigabit Fiber Port, SIM Slot & USB-C	43
4.12	WiFi port	44
4.13	Built-in GPRS Modem	44
4.14	Firmware Update	45
5	Operating Instructions	46
5.1	Precautions when first using the device	46
5.2	Interpretation of Status LEDs.....	46
5.3	Powering up the VECTO Transient device	48
5.4	Shutting down	49
5.5	HMI (Web Interface).....	49
5.5.1	HMI Features	50
5.5.2	HMI User Documentation.....	51
6	VECTO Transient Installation	52
6.1	Portable Installation	52
6.2	DIN Rail Installation.....	52
6.2.1	19" Rack Mounting Installation	52
7	Electrical Connections to the device	53
7.1	External AD/DC Power	53
7.2	Power Over Ethernet.....	53

7.3 Voltage connections 54

7.3.1 Single Phase Systems 54

7.3.2 4- Wire (Star) Systems 55

7.4 Current Connections..... 57

7.4.1 Single-phase current sensor connection 57

7.4.2 Three-phase current sensor connection..... 58

8 Maintenance 59

9 Cleaning 59

10 Decontamination 59

11 Storage 59

12 Warrantee and Support 60

12.1 Technical Support..... 60

12.2 Sales Assistance..... 60

12.3 Repair..... 60

12.4 Calibration..... 61

12.4.1 Disposal..... 61

13 Symbols and Abbreviations 63

List of Figures

Figure 1: Front view of the VECTO Transient device.....	12
Figure 2: Packaging Opened.....	13
Figure 3: Front view of the VECTO Transient.....	30
Figure 4: Right-hand view of the VECTO Transient.....	31
Figure 5: User Interface	32
Figure 6: VECTO Transient power supply connection	33
Figure 7: Communication Interfaces.....	35
Figure 8: VECTO Transient – In 4-wire (star) connection	36
Figure 9: VECTO Transient – In 3-wire (delta) connection	37
Figure 10: Current connection	39
Figure 11: Relay switch connection layout	40
Figure 12: Digital inputs connection layout	41
Figure 13: GPS & other antenna connector	42
Figure 14: Gigabit Ethernet ports	42
Figure 15: SFP cage with dust cover, SIM Slot and USB-C port.....	44
Figure 16: WiFi and Cellular Modem Connections.....	45
Figure 17: Status LEDs and START UP / SHUT DOWN Button	48
Figure 18: VECTO Transient AC power supply connection	53
Figure 19: VECTO Transient Single-Phase Voltage Connection Layout.....	54
Figure 20: VECTO Transient - 4-Wire (Star) Voltage Connection Layout	55
Figure 21: VECTO Transient 3-wire Delta Voltage Connection Layout	56
Figure 22: Single Phase Current Sensor Connection Layout	57
Figure 23: Three-phase Current Sensor Connection Layout	58

1 Safety Instructions

This section provides information on safe handling, installation, and commissioning of the VECTO Transient. 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.
	Caution	Used to indicate operating or maintenance procedures to be respected to prevent damage or destruction of equipment.
	Warning	Used to call attention to potentially dangerous situations or danger in general, that requires specific procedures to be respected to prevent personal injury.
	AC/DC	Both Direct Current (DC) and Alternating Current (AC)
	Protective Earth	Protective Earthing point
	Earth (ground)	Ground point



**Hazardous
Voltage**

Hazardous Voltage Present



CE Certified

Chartered Engineers (CE) Certification



ETL Safety

ETL Product Safety Listed Mark & Number

1.2 Intended Use

The VECTO Transient is used to measure advanced broadband electrical grid parameters.

It can either be used as a portable device or it can be permanently installed.

1.3 Safety Standards Compliance

The device complies with the IEC61010-1 safety standard:

- *Pollution: Degree 2*
- *Power Supply over-voltage category: CAT III <150V, CAT II <300V*
- *Measurement over-voltage 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*

1.4 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 Transient 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.

1.5 How to Mitigate Risks

1.5.1 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.

1.5.2 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.

1.5.3 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 or arcing.

1.5.4 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.

1.5.5 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.

1.6 Statements and Notices

1.6.1 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.

1.6.2 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.

1.6.3 Copyright

No part of this publication may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form, by any means, electronic, mechanical, magnetic, optical, chemical, manual, or otherwise, without the prior written consent of CT LAB (PTY) LTD.

1.6.4 Trademarks

VECTO II, VECTO 3, VECTO Transient, Osprey Lite, VECTO Grid OS, Xross-Trigger, Snapshot, and 6th-Sense are registered trademarks of CT LAB (PTY) LTD.



Figure 1: Front view of the VECTO Transient device

2 Introduction to the VECTO Transient

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

2.1 VECTO Transient Product Description

The VECTO Transient is a comprehensive multi-function IEC 61000-4-30 Class-A- 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 Transient 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 Transient

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



Figure 2: Packaging Opened

2.2.1 Receiving your shipment

Upon receiving your VECTO Transient shipment, check the following:

- Outside
 - Box is sealed
 - Box is not damaged
 - Box has no water damage
- Inside
 - VECTO Transient in a sealed plastic bag
 - VECTO Transient has no water damage or damp in the plastic enclosure
 - Ethernet cable, Flash drive and 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 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 accessory's 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 Transient from the cavity and inspect for damage

2.2.3 Powering up the device for the first time

The device will not power up from the battery until external power is connected to the device.

When the device is connected to external power the EXT PWR LED will power up.

Press and hold the PWR UP/SHUT DOWN button until the STATUS LED lights up. The device will boot.



The device will not power up from the internal battery until external power is connected to the device.

2.2.4 Return shipment

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

- *Insert the device into a plastic bag to prevent water damage during shipment transit; and*
- *Protect the device properly and 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. 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 Hardware Features

- 5MHz Sampling Rate
 - 2.5MHz Analog Bandwidth
 - 5MHz, 500kHz, and 50kHz Diagnostic Waveform Capturing
- GPS, IEEE 1588V2 (PTP) & NTP Time Synchronisation
- 128 GB Internal Storage
- Battery Backed GPS w Active Antenna
- Battery Backed 4G Cellular Modem w MIMO Antennae
- Battery Backed WiFi w MIMO Antennae
- 2 x Gigabit Ethernet Ports
- 1 x Gigabit SFP Fiber Port
- Lockable USB-C Expansion port
- Li-Ion Battery
- Universal AC/DC Unity PF Corrected Power Supply
- Fanless Design
- Rugged Aluminium Enclosure
- Comprehensive Device Telemetry

2.4 Functional Features

- Transient Wave Capturing
- Power Quality
- PMU - Class-M Performance at Class-P Time Constraints
 - (Additional Licence Required)
- Sub Synchronous Oscillation PMU
 - (Additional Licence Required)
- Comprehensive Cyber Security Support
- Encrypted Communication with On-Board Open VPN Client

- Role Based Security
- Web Server (HMI) with Real-Time Viewer
- Field Upgradeable
- On-Board Sequential Database Storage
- First In First Out Memory Management
- On-Board LUA Software Prototype Environment
- Rich Diagnostic Event Data Streams with long Pre- & Post Data
- Diagnostic Waveform Data sampled at Fixed Sampling Rate
- XrossTrigger Mechanism
- Measures AC & DC Parameters
- Offline Synchrophasor Recording
- Fast Parameter update speed for Power Plant Controller Input
- Calculate frequency according to NERSA – BESF Frequency Requirements
- 16.66Hz, 50Hz, 60Hz & 400Hz
- Harmonic Powers & Phase
- Prevailing Phasors
 - Prevailing Harmonic Magnitude Ratio
- Higher Harmonic Bands (up to 25kHz)
- Frequency Lock on Chopped Voltage Waveforms
- Calculate 3rd or 4th Current from existing 2- or 3-Current inputs
- Compensate Harmonic Amplitude & Phase Angle of External Sensors
- Can selectively enable Trends
- Simultaneously record various time interval data streams
- Autonomous or Under Control of Central Data Store

2.5 Voltage Inputs

The programmable gain voltage inputs of the VECTO Transient devices directly interfaces to existing VT circuits or directly to LV circuits where the input voltages are up to 500 V line to neutral.

Interfacing to 3-wire, 4-wire & Single-Phase circuits are supported.

The voltage input supports both AC & DC inputs.

The 4th voltage input is a generic input mainly used to record Neutral to Earth voltages in LV circuits.

2.6 Current Inputs

The device interfaces to voltage output current sensors with a maximum of 10 V_{RMS}. Other ranges supported are 5 V_{RMS}, 2.5 V_{RMS} and 1.25 V_{RMS}.

The device can derive “missing current” by assuming the sum of all currents is zero. (Please refer to Section **Error! Reference source not found.** for more detail.)

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 4.6 for more detail.)

2.7 Power sources

The device can be powered from an AC supply source or from an IEEE 802.3-2008 compliant PoE Plus (< 12 W) source.

The internal battery cells power the device in the absence of power.

Please refer to Section 4.3 for more detail.

2.8 Analog/Digital Inputs

Four (4) high impedance analog inputs are available to generate digital event inputs. When the Digital Input Monitor is configured and the input voltage exceeds 4.5 V, a user-defined threshold, the device will trigger a digital event. Like with all other events the device can record waveform, RMS, & Phasor data with long pre- and post-information. The analog value of the input can also be trended.

2.9 Relay Outputs

Four (4) solid state relays are available on the VECTO Transient. Four LEDs are available indicating the current state of each relay.

2.10 Communication Interfaces

Two (2) Gigabyte Ethernet ports and one (1) SFP Fiber port facilitate local and networked external communication. ETH1 and the Fiber port is used to interface with corporate networks (DHCP or fixed IP support). ETH2 is used to create a local network via an onboard DHCP server.

Please refer to Section 0 for more detail.

The WiFi interface with MIMO antenna interfaces supports both access point and infrastructure modes. Please refer to Section 4.12 for more detail.

The built-in industrial cellular modem module with MIMO antenna interfaces supports an external SIM card. Please refer to Section 0 for more information. The cellular modem module can be exchanged with future technology to future-proof the remote link.

2.11 Osprey Lite Support Software

Osprey Lite support software is bundled with each device. The SW is feature rich and supports only one device at a time. It is mostly used when undertaking detailed high data volume investigations.

The remote support software supports automatic service discovery protocols. Laptops, when connected to the VECTO Transient device, 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.

2.12 Built-in HMI (Web Interface)

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

2.13 VECTO Grid OS (Enterprise Support)

VECTO Grid OS is an enterprise class cloud-based Big Data SW platform designed from ground up to support thousands of permanently connected recording devices via secure IP links.

It is a “Live” system. Data automatically migrate from recording devices to the central data store in near real-time from where users can access it in various graphical, tabled and report formats via a powerful web type interface.

Main functionality includes the following:

- *Automated data collection*
- *Event & Trend Viewer with phasor & spectrum animations*
- *Geo & Single Line mapping of device data*
- *Automated data classification (according to local & international regulations like EN50160 & NRS048)*
- *Grouping and annotation of simultaneously recorded events into network incidents.*
- *Alarming & Notification*
- *Extensive Fleet Management*
- *Import/Export of data*

More information can be obtained at www.vectosystem.com

2.14 Sampling Rate

Both voltage and current inputs are sampled at a rate of 5MHz. The analog bandwidth of the VECTO Transient devices is 2.5MHz. All parameters are directly calculated from this broadband data stream.

When capturing transient as well as some PQ events, it is possible to enable 5MHz *Hyper Waves*, and normal 50kHz waveforms simultaneously.

2.15 The 1/6th Cycle Data Stream

The VECTO Transient 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, i.e. only 2 values per cycle per phase. The 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.

2.16 Event Type Data Recording

The VECTO Transient devices records two (2) types of data:

- *Trended data like RMS voltage, current, power & harmonic spectra*
- *Event type data like dips, swells, current inrush & mains signalling*

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 Transient will retain pre- and post-diagnostic information of the event.

5 MHz *Hyper Wave* voltage transients can be captured based on absolute value exceedance or a rise/fall time exceedance (dU/dt).

50 kHz waves are captured in 200 ms sections at a time. Up to 30s pre- and post-event recordings can be specified. 5 MHz *Hyper Waves* are captured in 20 ms sections at a time. Up to 500ms pre- and post-event recordings can be specified.

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

2.17 10/12-Cycle Block Recording (± 200 ms interval or 5Hz)

The VECTO Transient records all RMS and harmonic data from each 10/12-cycle block (≈ 200 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 63rd harmonic order.

Each block is time-stamped with a 20 μ s time resolution and within a 1 μ s time uncertainty¹.

The user can average N x blocks to reduce the sampling rate for the number of blocks up to 299 blocks².

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

2.18 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.

¹ When GPS synchronized

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

2.19 Synchrophasors

The VECTO Transient is a certified Phasor Measurement Unit (PMU). An additional licence is required to activate the PMU capability. However, offline recording of synchrophasor data can be activated in the configuration setup.

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

Please Note: Recording of synchrophasor data generates large amounts of data.

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

2.20 Sub Synchronous Oscillation Phasor Measurement

The Oscillation Phasor measurement module requires an additional licence to be activated. Up to 3 x individual sub-synchronous oscillation frequencies can be simultaneously tracked by the VECTO Transient device. Each frequency is treated exactly the same as synchrophasors. The device therefore records the oscillation frequency, amplitude, phase angle & ROCOF. These values can be trended.

An event monitor is also available to trigger when the oscillation exceeds a user-defined threshold. Upon triggering, the VECTO Transient may record waveform, RMS & Phasor data with pre-and post-information.

2.21 Trended RMS & Fundamental Parameters

MEASURED PARAMETERS	1/6th - Cycle	10/12 - Cycle block	Aggregated Trends	1/6th - Cycle	10/12 - Cycle block	Aggregated Trends
	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	1/6th - Cycle	10/12 - Cycle block	Aggregated Trends	1/6th - Cycle	10/12 - Cycle block	Aggregated Trends
	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)		✓	✓			

2.22 Trended Power Parameters

MEASURED PARAMETERS	1/6th - Cycle	10/12 - Cycle block	Aggregated Trends
	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)	✓	✓	✓

2.23 Trended Individual Harmonic/Interharmonic Parameters

MEASURED PARAMETERS	10/12 - Cycle block	Aggregated Trends	10/12 - Cycle block	Aggregated 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)	✓	✓		

3 Technical Specification

VOLTAGE INPUTS	
Number of channels	4 x differential voltage inputs (3/4 Wire + 4 th Diff)
Maximum measurement input range	0 – 500 V _{RMS} (V _{LN}), 0 – 860 V _{RMS} (V _{LL}) ± 700 V _{DC}
Selectable input ranges (V _{LN})	500 V _{RMS} , 250 V _{RMS} , 125 V _{RMS} , 62.5 V _{RMS} , 31.25 V _{RMS}
Voltage measurement	DC, Single Phase, 3-Phase (Star, Delta)
Input impedance/channel	> 1 MΩ
CURRENT INPUTS	
Number of channels	4 x differential low voltage inputs
Maximum measurement input range	0 – 10 V _{RMS} , ± 14.14 V _{DC}
Selectable input ranges	0 – 10 V _{RMS} , ± 14.14 V _{DC}
Input impedance/channel	> 1 MΩ
DIGITAL OUTPUTS	
Number of channels	4 x galvanically isolated solid-state relays
Switch Rating	100 mA _{RMS} , 300 V _{DC} (max)
DIGITAL INPUTS	
Number of channels	4 x differential voltage inputs
Input Voltage Rating	± 150 V _{DC}
Input impedance/channel	> 1 MΩ
ACCURACY & BANDWIDTH	
Analog Bandwidth	5 MHz

Sampling rate	5 MHz (GPS/PTP time synchronised)
Hyper Wave storage rate	5 MHz
Waveform storage rate	1 kHz – 50 kHz (user configurable)
ADC Resolution	>16-Bit
Overall accuracy class	0.1%
Fast Transient Capturing	≥ 200 ns
Power frequency range	DC, 50 Hz (40-60 Hz), 60 Hz (50-70 Hz)
Harmonic bandwidth	1-64 th (harmonic and inter-harmonic)
Higher Harmonic Bands	DC – 2.5 MHz (200Hz bands)
COMMUNICATION	
Ethernet	2 x gigabit ethernet
Fiber	1 x 1000base-x SFP cage
Cellular Modem	1 x Battery backed industrial 4G module
Cellular Antennae	2 x MIMO antenna ports
WiFi	1 x industrial WiFi module
WiFi Antennae	2 x MIMO antenna ports
Operating Modes	Access Point or Infrastructure Mode
USB – Expansion Port	1 x USB-C port (USB 2.0 – 480 Mbit) (powered)
TIME STAMPING	
On-board precision time source	Battery backed industrial GPS (3.3V powered active external antenna)
On-board fall-back time source	Battery Backed Real Time Clock

On-Board RTC drift	10 ppm (320 seconds per annum)
External Sources	NTP, PTP (IEEE1588-V2)
Overall time accuracy	<100 ns (from absolute time) (when locked to GPS or PTP)
POWER	
Power Consumption	< 10 W (25 W Max - when charging battery)
AC supply voltage range	80-300 V _{AC} (45-65Hz) (power factor corrected)
DC supply voltage range	80-300 V _{DC}
Power over Ethernet	IEEE 802.3 compliant
On-board battery	2 x Li-Ion Cells
PHYSICAL	
Dimensions	250 x 135 x 65 (L x W x H)
Material	Aluminium front & back plates, plastic collar
Weight	1.9 kg
Mounting options	Portable, DIN Rail
Electrical connections	Pluggable screw type (screw lock-down)
Electrical isolation class	600 V Class II
Rated range of Operation	-20 °C to 60 °C (Internal Battery Enabled)
Limit range of Operation & Storage	-40 °C to 70 °C (Internal Battery Disabled)
Operating humidity	0-95% (non-condensing)

4 External Interfaces

4.1 Physical Appearance

Figure 3 shows the front of the VECTO Transient. 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 4.2 to 0.



Figure 3: Front view of the VECTO Transient

The VECTO Transient can be installed as a temporary investigation device or permanently when mounted on a DIN rail. Mountable DIN rail clips and mounting screws are provided with each device.



Figure 4: Right-hand view of the VECTO Transient

Figure 4 shows the SFP cage with its dust cover, the external SIM slot and the USB-C port located on the right-hand side of the device.

4.2 VECTO Transient User Interface

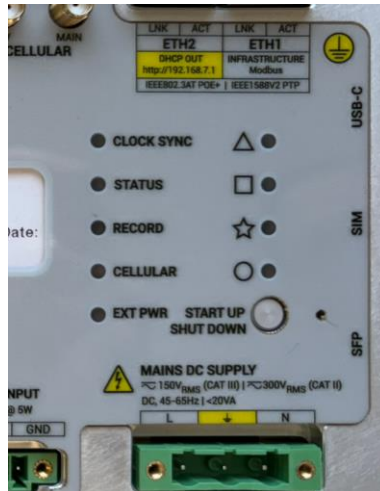


Figure 5: User Interface

The user interface consists of a series LEDs and 2 x Power buttons.

The first row of LEDs provides device status information. The second row of LEDs is multifunction and may have different meanings dependent on the current device mode.

The interpretation of the status LEDs is discussed in Section 5.2.

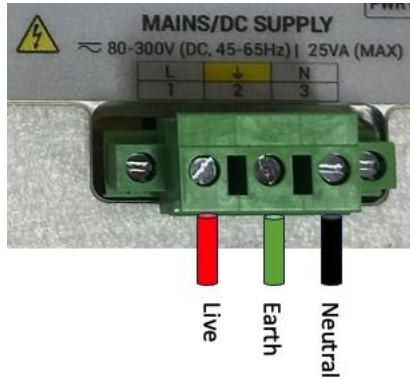
Two buttons located below the LEDs are used to control the power state of the device. The PWR button is recessed to avoid accidental switching. The START UP SHUT DOWN button is a push-button that returns to the non-pressed state when released. The use of the buttons is discussed in Chapter 0.

4.3 Power Supply Input

The VECTO Transient can be powered and charged directly from external AC & DC sources via a power factor corrected internal power supply.

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

Two battery cells will power the device in the absence of power.



The Mains/DC Supply port, as shown in

Figure 6, contains 3 terminals on a removable/ lockable plug. Each terminal can accommodate conductors with sizes up to 2.5 mm².

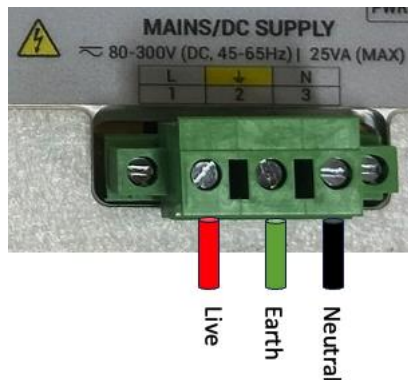


Figure 6: VECTO Transient power supply connection

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

Table 1: Power supply connection



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

The current consumed is low in harmonic content and power factor corrected.

The VECTO Transient can be powered directly from 110 V 50/60 Hz VT circuits due to this low burden.

An internal electronic fuse protects the VECTO Transient from sustained over voltage. The VECTO Transient will automatically disconnect from mains if excessive current is drawn from the universal AC/DC supply input. After operation supply voltage must be removed for a few minutes to allow the element to cool down.

During a short power interruption, the internal battery will power the device for a few seconds. The battery support duration is user configurable through the HMI interface.

To protect the battery, the device will automatically shut down when powered from the battery when the battery voltage drops below a pre-defined threshold.

When power is restored, the device will automatically restart.

When the device is shut down manually, the device will not automatically restart when power is restored. The user will have to press the START UP SHUT DOWN button to start-up the device.

4.4 Communication Interfaces

The VECTO Transient device supports multiple IP based communication interfaces:

- 2 x Gigabit Ethernet Ports (one with built-in DHCP server)
- 1 x Gigabit SFP Fiber Port
- 1 x Industrial Cellular Module with MIMO antennae
- 1 x WiFi Module with MIMO Antennae

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

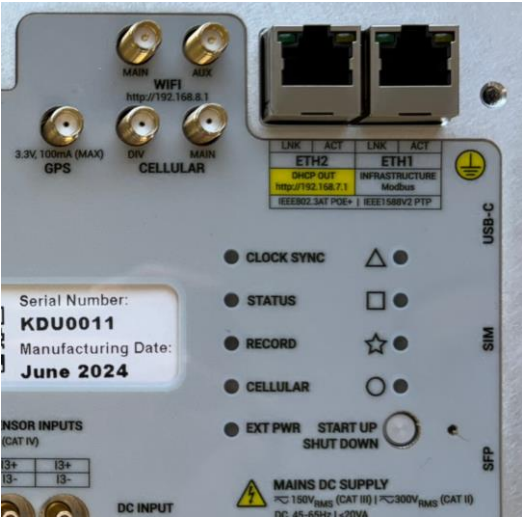


Figure 7: Communication Interfaces

4.5 Voltage Inputs

The VECTO Transient has 4 c broadband high impedance resistive voltage inputs made up of 6 terminals on BNC connectors. Only the central conductor carries signal. The external conductor is only used to shield the signal and is connected to the aluminium housing of the device.

Figure 8 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 9 shows the voltage connections for a 3-phase 3-wire delta connection. Three-phase power is calculated by the 2-watt meter method.

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



Only the central conductors of the BNC connectors carry signal. The external conductor is only used to shield the signal and is connected to the aluminium housing of the device.

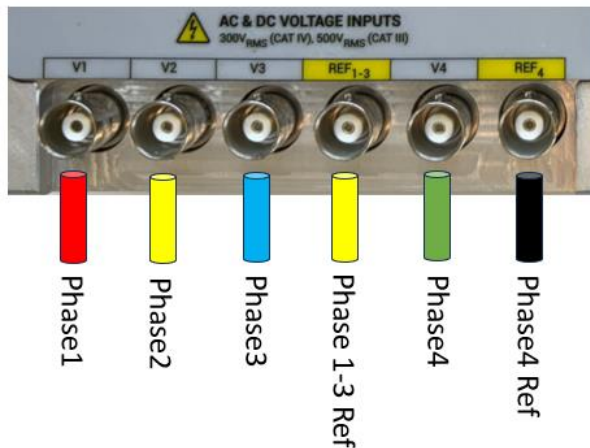


Figure 8: VECTO Transient – In 4-wire (star) connection

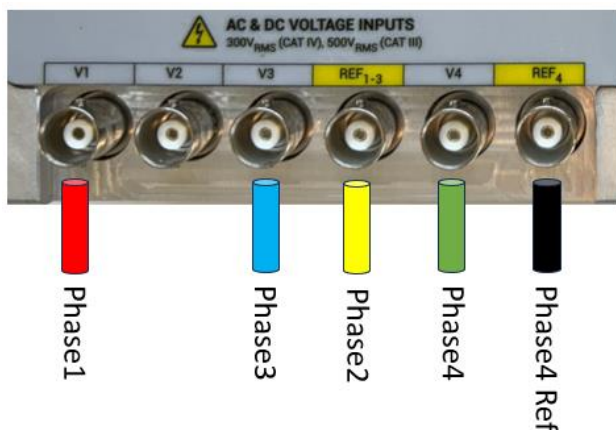


Figure 9: VECTO Transient – In 3-wire (delta) connection

Terminal	Legend	Description
1.	V ₁	Phase 1
2.	V ₂	Left Unconnected
3.	V ₃	Phase 3
4.	REF1-3	Phase 2
5.	V ₄₊	Phase 4
6.	V ₄₋	Reference for V ₄

Table 2: Voltage connection layout

The high input impedance of the REF1-3 terminal prevents the accidental shorting of VT inputs to system ground and eliminates ground loops.

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

4.6 Current Inputs

Eight SMB connectors are used to interface to external current sensors such as Hall-effect devices and Rogowsky coils.

Only the central conductor carries signal. The external conductor is only used to shield the signal and is connected to the aluminium housing of the device, as well as power earth.

If the sensor requires power, the on-board 2-pin 5V DC ground referenced power source can be used to power the sensors. Up to 1A is available.



Only the central conductors of the SMB connectors carry signal. The external conductor is only used to shield the signal and is connected to the aluminium housing of the device.



The 5V DC power supply is not galvanically isolated! Accidental shorting of the power output may affect the functional operation of the device.

Terminal	Legend	Current Sensor Circuits
1.	I1+	Phase 1 Positive Current Input
2.	I2+	Phase 2 Positive Current Input
3.	I3+	Phase 3 Positive Current Input
4.	I4+	Phase 4 Positive Current Input
5.	I1-	Phase 1 Negative Current Input
6.	I2-	Phase 2 Negative Current Input
7.	I3-	Phase 3 Negative Current Input
8.	I4-	Phase 4 Negative Current Input

Table 3: Current connection layout

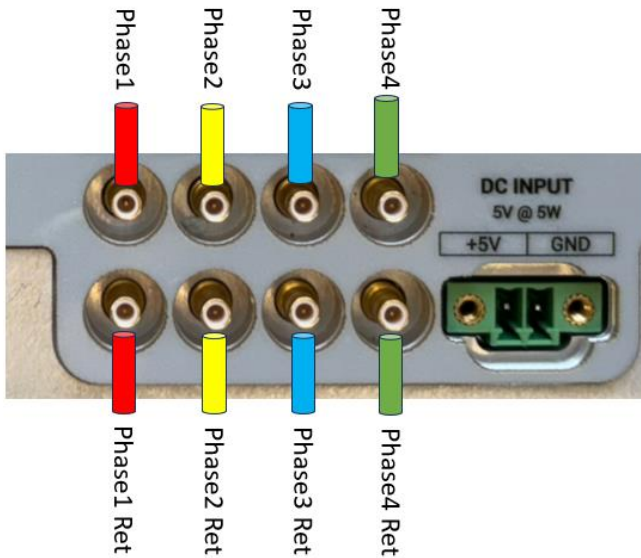


Figure 10: Current connection

4.7 Relay Outputs

Four digital relay outputs provide digital output/control information to external processes. The relay outputs are available on an 8-terminal lockable connector plug with screw terminals. Each terminal can accommodate conductors with size up to 2.5 mm².

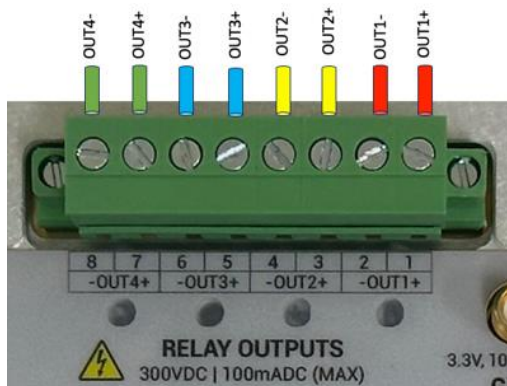


Figure 11: Relay switch connection layout

Terminal	Legend	Description
1.	OUT1+	Switch 1+
2.	OUT1-	Switch 1-
3.	OUT2+	Switch 2+
4.	OUT2-	Switch 2-
5.	OUT3+	Switch 3+
6.	OUT3-	Switch 3-
7.	OUT4+	Switch 4+
8.	OUT4-	Switch 4-

Table 4: Relay switched outputs layout

4.8 Digital inputs

Four differential analog inputs are used to create digital events. If the analog value exceeds a user defined threshold, a digital event is triggered.

The input is available on an 8-pin lockable terminal plug. 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 2.5mm².

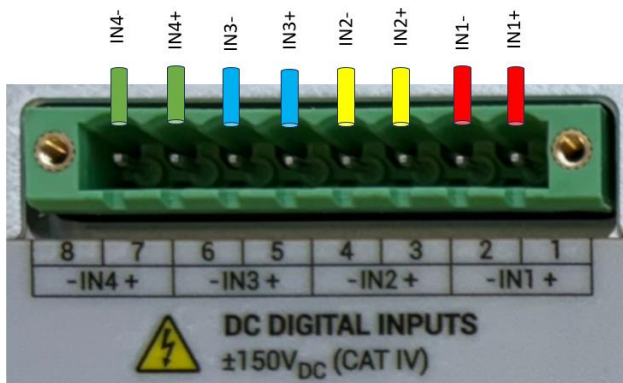


Figure 12: Digital inputs connection layout

Terminal	Legend	Description
1.	IN1+	Input 1+
2.	IN1-	Input 1-
3.	IN2+	Input 2+
4.	IN2-	Input 2-
5.	IN3+	Input 3+
6.	IN3-	Input 3-
7.	IN4+	Input 4+
8.	IN4-	Input 4-

Table 5: Digital inputs connection layout

4.9 GPS

The female SMA port is used to interface an external powered (+3V3) GPS antenna to the VECTO Transient. The built-in GPS is used to measure absolute time.



Figure 13: GPS & other antenna connector

4.10 Gigabit Ethernet Ports

The device has 2 Gigabit Ethernet ports as depicted in Figure 14. The IP address of port ETH2 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 ETH1 supports fixed or DHCP issued IP addresses as well as IEEE1588-V2 PTP time synchronisation.

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

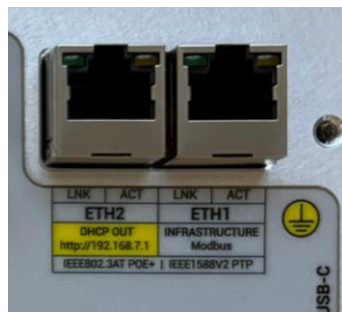


Figure 14: Gigabit Ethernet ports



Do not connect Ethernet port ETH2 to a network with an active DHCP server, as this may cause the network to stop functioning properly



The IP address of Ethernet port ETH2 is fixed at 192.168.7.1



The device serves as a DHCP server for equipment connected to port ETH2

4.11 SFP Gigabit Fiber Port, SIM Slot & USB-C

A SFP connector available on the right side of the device facilitates connectivity to Gigabit Fiber networks. The IP address of the fiber port supports fixed or DHCP issued IP addresses as well as IEEE1588-V2 PTP time synchronisation.

A powered USB-C 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. This port supports a locking screw to lock the USB-C connector in position.

A normal size push-push SIM slot is available.

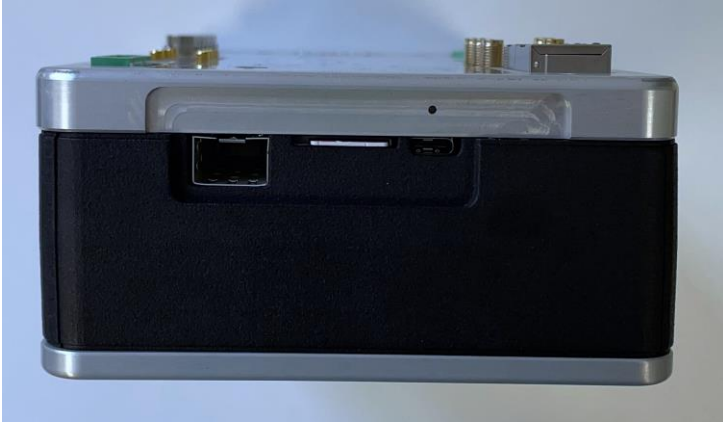


Figure 15: SFP cage with dust cover, SIM Slot and USB-C port

4.12 WiFi port

The onboard WiFi port with MIMO antenna supports both infrastructure and access point modes. The default IP address when configured in access point mode is 192.168.8.1.

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.

4.13 Built-in GPRS Modem

The VECTO Transient is shipped with a built-in industrial cellular modem module (see Figure 16). Please refer to either the HMI or 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.



Figure 16: WiFi and Cellular Modem Connections

4.14 Firmware Update

Both the VECTO Transient application and OS firmware can be updated remotely.

The firmware revision can be verified through the on-board HMI or by connecting to the device using Osprey Lite support software. Please see Osprey Lite™ user manual for more information.

The VECTO Transient support firmware upgrade via Osprey Lite™, VECTO Grid OS or the on-board HMI. Please see Osprey Lite™ user manual for more information.

5 Operating Instructions

5.1 Precautions when first using the device

When connected to an external power source, the VECTO Transient device will power up regardless of the state of charge of its internal battery. It is therefore recommended to first allow the internal battery to charge for at least 10-minutes before starting it up for the first time. This will ensure that adequate battery energy be present to gracefully shut the device down in the event of an immediate power failure.



Ungraceful shutdown due to insufficiently charged battery may corrupt device storage device.

5.2 Interpretation of Status LEDs

LEDs as shown in Figure 17 provide information about the status of the device.

Table 6 describes the various states. In storage mode, all LEDs are off.

Name	Function	
CLK SYNC	Green	The device is synchronised to GPS or PTP
	Orange	The device is synchronised to NTP
	Off	The device is not synchronised to an external source, but has valid time and can record
	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)
STATUS	Toggle Green	The device is operating normally
	Orange	The device is booting or shutting down
	Red	The device is in an error condition.
RECORD	Green	The device is recording
	Orange	The device is recording an event

	Red	An error condition is preventing the device from recording
	Off	The device is not recording because no meter point is attached
EXT PWR	On when external power is present	
✕ □ ○ △	Multifunction depending on the device mode. The support SW will describe the functionality of each of these symbols.	

Table 6: Status LED Interpretation

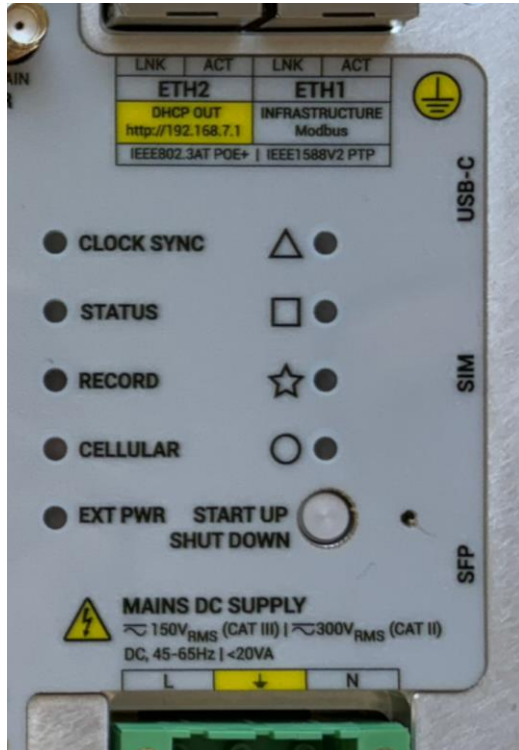


Figure 17: Status LEDs and START UP / SHUT DOWN Button

5.3 Powering up the VECTO Transient device

Connect external power to the device (AC, DC or POE). The EXT PWR LED should be on.

If the EXT PWR LED is not on, then the device has returned from storage and the power source is still disconnected. Press the PWR ON PWR CUT button using a small pin and check that the LEDs temporarily flash, and the EXT PWR LED should be on. Wait for ± 10 -min while on external power to allow the internal battery to absorb some charge.

Switch the device on by pressing and holding the START UP SHUT DOWN button until the Status LED turns orange to indicate that the device is booting normally. It will start to flash green once the boot cycle completed.

5.4 Shutting down

Press and hold the START UP SHUT DOWN button (see Figure 17) until the Status LED turns orange to power the device down and stop recording data.



The shutdown sequence may take up to 60 seconds

5.5 HMI (Web Interface)

The VECTO Transient 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 ETH2 has a default IP address of **192.168.7.1** and is used to create a local network for Laptops/PC to directly connect to the device.

Ethernet port ETH1 and the SFP fiber port can either be set statically to an IP address, or be configured to get an IP address from a DHCP server. The factory default for port ETH1 and the Fiber port is to get an IP address from a DHCP server.

The HMI can be accessed by typing in the IP address of the Ethernet port in a standard web browser.

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.

5.5.1 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*

5.5.2 HMI User Documentation

To ensure the VECTO Transient 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.

6 VECTO Transient Installation

Please Note: Adequate ventilation must be provided to prevent building up of heat – especially when the device is to be installed inside a sealed enclosure. The device typically consumes less than 10W power. The enclosure temperature might rise maximum of 10 degrees above the ambient temperature.

6.1 Portable Installation

The device has 4 x rubber feet to stand on when used in portable applications. A Kensington security slot is available on the front plate enabling the lockdown of a device during investigations.

6.2 DIN Rail Installation

Two DIN rail clips and mounting screws are provided with each device.

6.2.1 19" Rack Mounting Installation

A 19" rack (4U) mounting plate that contains a DIN rail and a feed-through Ethernet port secures the VECTO Transient and provides a mechanical interface for 19" racks³.

The 19" plate and the VECTO Transient is separate accessory and must be assembled on site.

³ Optional accessory

7 Electrical Connections to the device

7.1 External AD/DC Power



Always connect the protective earth point located next to the 2 x gigabit Ethernet ports first to ensure personal safety.

Use a circular lug on the wire to ensure that it will not come loose when accidentally pulled at.

Table 7 and Figure 18 depict how to connect the AC power supply.

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

Table 7: AC power connection layout

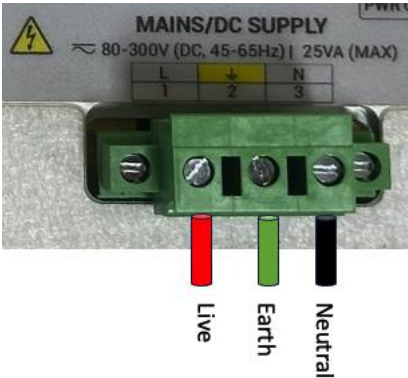


Figure 18: VECTO Transient AC power supply connection

7.2 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).

7.3 Voltage connections



Ensure that the device is earthed first through the protective earth terminal before attempting to make further electrical connections to the device.

7.3.1 Single Phase Systems

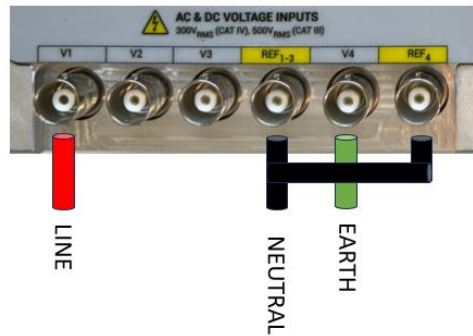


Figure 19: VECTO Transient Single-Phase Voltage Connection Layout

Terminal	Legend	Single phase Network
1.	V ₁	Line
2.	V ₂	
3.	V ₃	
4.	REF1-3	Neutral
5.	V ₄₊	Earth
6.	V ₄₋	Neutral

Table 8: VT circuit connection layout for single phase connection

- Connect the Line Voltage to Voltage Input 1 as shown in Figure 19.
- Connect Neutral (on 400 V systems) to REF1-3.
- The fourth voltage input may be used to measure Neutral-Earth voltage.

7.3.2 4- Wire (Star) Systems

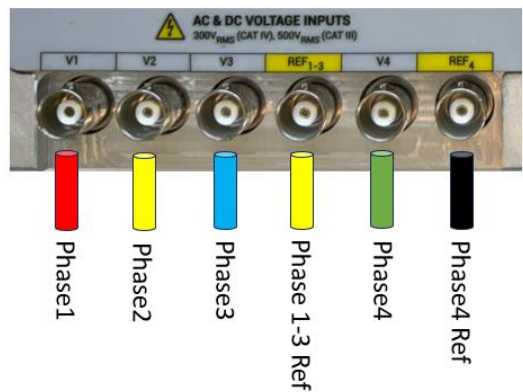


Figure 20: VECTO Transient - 4-Wire (Star) Voltage Connection Layout

Terminal	Legend	4-wire VT Circuit or 400V/550V Star Systems
1.	V ₁	Phase 1
2.	V ₂	Phase 2
3.	V ₃	Phase 3
4.	REF1-3	Star connection point (or NEUTRAL for LV systems)
5.	V ₄₊	Earth (for LV systems only)
6.	V ₄₋	NEUTRAL (for LV systems only)

Table 9: VT circuit connection layout for 4-wire star connection

- Connect Phase 1,2 and 3 to Voltage Inputs 1-3 as shown in Figure 20.
- Connect Neutral (on 400 V systems) or the star-point (on 110 V VT circuits) to REF1-3.
- The fourth voltage input may be used on 400 V systems to measure Neutral-Earth voltage.

7.3.2.1 3-Wire (Delta) Systems

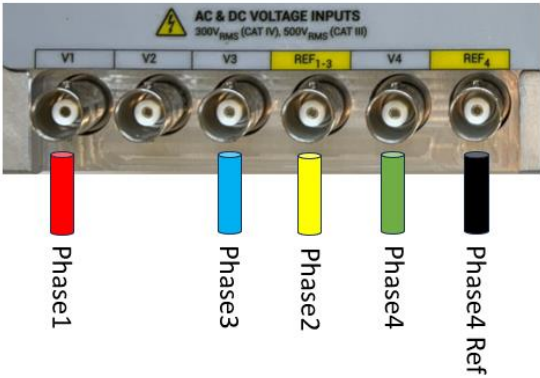


Figure 21: VECTO Transient 3-wire Delta Voltage Connection Layout

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.	REF1-3	Bridge Phase 2 to REF1-3
5.	V ₄₊	Open
6.	V ₄₋	Open

Table 10: 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 21.
- 2) Bridge Phase 2 to REF1-3 or connect REF1-3 to the earth.

7.4 Current Connections

7.4.1 Single-phase current sensor connection

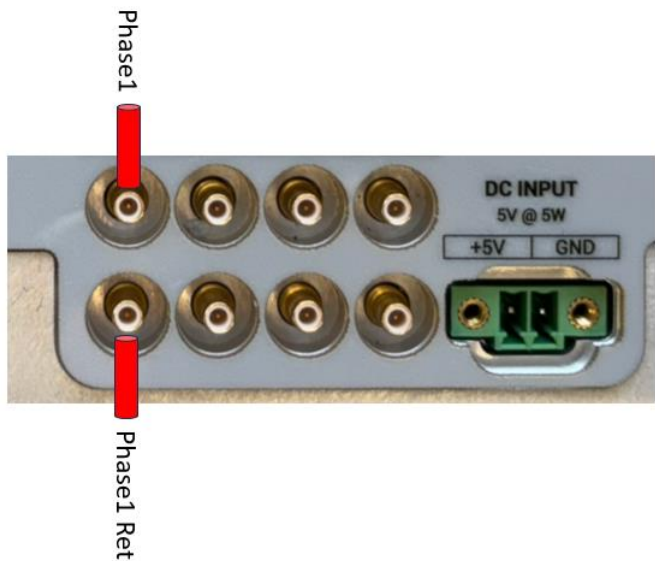


Figure 22: Single Phase Current Sensor Connection Layout

Terminal	Legend	Current Sensor Circuits
1.	+5V	+5V Power Supply
2.	CHAN+	Channel Positive Input
3.	CHAN-	Channel Negative Input
4.	GND	System GND

Table 11: Single Phase Current Sensor Connection Layout

7.4.2 Three-phase current sensor connection

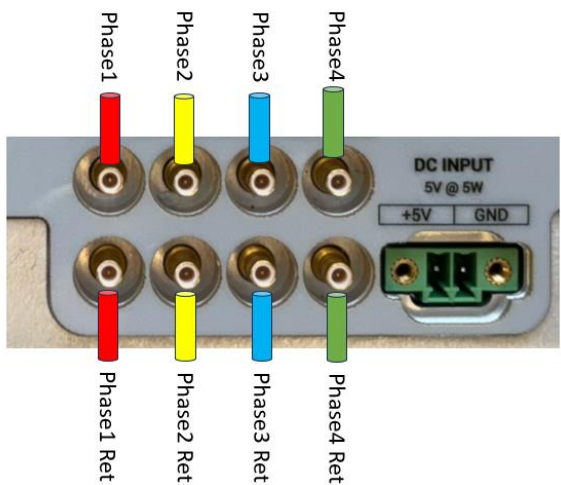


Figure 23: Three-phase Current Sensor Connection Layout

Terminal	Legend	Current Sensor Circuits
1.	+5V	+5V Power Supply
2.	CHAN+	Channel Positive Input
3.	CHAN-	Channel Negative Input
4.	GND	System GND

Table 12: Three-phase Current Sensor Connection Layout

The VECTO Transient 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.*

8 Maintenance

The VECTO Transient has a design life expectation exceeding 10-years.

If the device requires service, it should be returned to CT LAB (PTY) LTD.

9 Cleaning

Before cleaning the equipment, ensure that it is properly powered off and disconnected from any power source.

Use a soft, lint-free cloth dampened with mild soap or recommended cleaning solution to gently wipe the exterior surfaces of the equipment.

Do not use abrasive cleaners, solvents, or harsh chemicals as they may damage the equipment.

Avoid spraying liquids directly onto the equipment; instead, apply the cleaning solution to the cloth first.

Allow the equipment to dry completely before reconnecting or using it.

10 Decontamination

In case of potential contamination, follow appropriate decontamination procedures prescribed by authorized personnel or relevant regulatory guidelines.

Ensure that all necessary personal protective equipment (PPE) is worn during decontamination procedures to minimize exposure risks.

Disconnect power sources and isolate any hazardous materials before initiating decontamination processes.

Clean all accessible surfaces with appropriate disinfectants or detergents recommended for effective decontamination against specific contaminants.

Dispose of contaminated materials as per local regulations and guidelines.

11 Storage

When the device is powered down the device can be stored for up to 5 years.

12 Warrantee and Support

12.1 Technical Support

[Log a support ticket](#)

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

info@ctlab.com

+27 (21) 880 9915

12.2 Sales Assistance

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

info@ctlab.com

+27 (21) 880 9915

12.3 Repair

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

- *Disconnect the power sources by pressing the PWR ON PWR CUT button using a needle or pin.*
- *Insert the device into a plastic bag to prevent water damage during shipment transit; and*
- *Put it inside a padded box to prevent mechanical damage during transit or use the CT LAB packaging in which the device was supplied.*
- *Complete the fault report and sent it and the device to CT LAB.*
 - Notify 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

12.4 Calibration

The VECTO Transient stores calibration information on EEPROM. Each device should retain calibration status during its entire life. CT LAB recommends that the device be re-calibrated once every 10-years.

It is therefore the prerogative of the owner to decide whether the device needs to be re-calibrated.



The VECTO Transient does not mandate recalibration.

12.4.1 Disposal

12.4.1.1 EU Countries

The VECTO Transient 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 Transient may not be disposed of with normal waste. Should the VECTO Transient 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.

12.4.1.2 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, environmentally-friendly 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.

13 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
PMU	Phasor Measurement Unit
PQI	Power Quality Instrument
OPMU	Oscillation Phasor Measurement Unit
I2C	Internal low bandwidth communication channel



CT LAB (PTY) LTD
PO Box 897, Stellenbosch, 7599, South Africa
Richling House, Brandwacht Complex, Stellenbosch, 7600, South Africa

Tel: +27 21 880 9915
Email: info@ctlab.com
Web: www.ctlab.com
www.VECTOsystem.com

[Log an Operational Support Request Here](#)