

Introduction:

VCL-PMU-30 is a modular Phasor Measurement Unit (PMU) that is designed to provide measured Synchrophasor values in accordance with the IEEE C37.118.1-2011, IEEE C37.118.2-2011, C37.118.1a-2014 & IEC/IEEE 60255-118-1:2018 synchrophasor standards.

What is a "Synchrophasor"?

A phasor is a complex numerical waveform representing a sinusoidal function whose amplitude, frequency and phase are time invariant (time-dependent system function) and these phasor measurements, when accurately time stamped using GPS universal time, are called "Synchrophasors".

With ever increasing power demand, the power grid requires efficient and reliable technologies to monitor voltage, frequency, phase angle and shifts in the power transmission network, in realtime, to detect grid imbalances which can result in catastrophic grid failure and blackouts. The synchrophasor technology is used to monitor the power-grid in real time.

The VCL-30-PMU is a Phasor Measurement Unit (PMU) which uses synchrophasor technology, which may be used to provide precise data, in real-time, for steady-state and dynamic-state conditions for both M class and P class, at the desired frame rates. VCL-PMU-30 monitors voltage, frequency, phase angle and shifts in the power transmission network in real time to detect grid imbalances, excessive loads zones and trouble spots which if undetected, can result in a grid failure and power blackout.

VCL-30-PMUs includes an integrated GPS receiver (with the option of an external GPS receiver) to provide an accurate Stratum 1 quality time reference.

VCL-PMU-30 can be configured to provide accurate P and M class measurements using its internal GPS / GNSS Receiver, to acquire an accurate time reference. It can also synchronize with an external IRIG-B + 1PPS time input with better than 50ns. phase synchronized accuracy. Designed for use in the harsh substation environments, the VCL-PMU-30 is highly dependable and reliable, real-time power monitoring and measurement solution.

Phasor Measurement Units (PMUs), on the other hand, are the key elements of the Wide Area Measurement System (WAMS) for monitoring dynamic-state data and for providing transient analysis of a large and complex power grid in real-time.

The system architecture of a Wide Area Measurement System (WAMS) primarily consists of:

- GPS receiver for time synchronization
- PMU- Phasor Measurement Unit
- TCP/IP and / or UDP/IP communication equipment
- PDC- Phasor Data Concentrator

VCL-30-PMUs communicate as per IEEE C37.118.1-2011, IEEE C37.118.2-2011, C37.118.1a-2014 & IEC/IEEE 60255-118-1:2018 standards with Phasor Data Concentrators (PDCs) which are installed at the monitoring and control centres to provide a continuous realtime snap shot of the power grid, so that problem areas in the power grid can be isolated before any catastrophic grid failure and resulting power-blackout can occur. The PMU applications also include its use as a core element in a Grid Islanding Scheme.



Features and Compliance:

- High precision, 16-bit accuracy on current and voltage inputs
- Integrated GPS Receiver for Time Synchronization - GPS and GNSS (GPS + GLONASS) options
- Optional External GPS Receiver for Time Synchronization
- High precision clock base <50 ns with internal GPS
- Best in Class Holdover Accuracy: Better than 9µs/24-hour accuracy in a 24-hour holdover clock mode in the absence of the loss, or unavailability of the GPS signal.
- Uses EKF (Extended Kalman Filtering) for improved accuracy
- User configurable C37.118 message rate - 25 frames per second and 50 frames per second, 50Hz, 60Hz
- Time-Stamped Syslog and Event Logging
- Provides standardized synchrophasor data format for easy integration with the third-party grid management tools.
- Best in Class frequency measurement accuracy of 0.001Hz (when locked to internal GPS / GNSS Receiver)
- Total Vector Error (TVE): Less than 0.50% in steady conditions.
- HMI (Human Machine Interface) / External Laptop provided
- User configurable options - Station name, Phasor name, Analog name, Digital name
- In compliance with IEEE C37.118.1-2011, IEEE C37.118.2-2011, C37.118.1a-2014 & IEC/IEEE 60255-118-1:2018 standards
- In compliance with both P and M class requirements of IEEE C37.118.1 standard
- In compliance with Steady State and Dynamic State as per IEEE C37.118 standard
- Configuration of Frame-2 and Frame-3 supported
- 3 Phase active and reactive power measurement supported

Benefits:

- A comprehensive and a compact PMU solution that is designed to build an intelligent and an effective real-time control system for implementing advanced remedial action and protection schemes.
- Event recorder provides advanced system knowledge with correlated event reporting and real-time system visualization of the power grid.
- Provides self monitoring, diagnostic feature, and alarm to PDC
- Configure multiple data streams independently (contents, sampling rate, TCP/UDP, different destinations with separate IDCODE)
- Designed for implementing an intelligent grid-monitoring and an analytical solution. Provides a predictive and proactive configuration tools to monitor the power grid for power angle voltage frequency, power factor and harmonics to improve the grid's dynamic stability.
- Adjustable reporting / sampling rates: 25 frames per second and 50 frames per second.
- Resilient by design. Designed to provide excellent performance in stressed and distributed power systems.

Communication Interfaces and Communication Protocols:

- C37.118 Network Communication Ports:
 - Number of ports: 2
 - 1 x Ethernet (Electrical) port of 10/100BaseT
 - 1 x Ethernet (Optical) 100Base-FX (SFP)
- Communication Protocols: TCP/IP, UDP, Multicast and Unicast.

Inputs:

- Voltage: VA, VB, VC (2 Inputs), 50Hz, 60Hz
- Current: IA, IB, IC (2 Inputs)
- 6 x Analog Inputs
- 16 x Digital Inputs. 8 (DPS) / 16 (SPS) Digital Inputs for Breaker Status Monitoring

Measurements:

- 3-Phase Voltage Phasors
- 3-Phase Current Phasors
- Positive sequence voltage
- Positive sequence current
- Breaker Status
- Frequency (0.001 Hz frequency reading accuracy, when VCL-PMU-30 is synchronized with GPS / GNSS) Frequency
- Rate of Change of Frequency (ROCOF) - df/dt
- Power Quality Measurements:
 - "Sags" and "Swells"
 - Power Factor
 - Harmonic Measurement - THD and K-factor

Time Synchronization Interfaces:

- Synchronization Accuracy <50ns (nanosecond) [i.e. <0.05 microsecond]
- Stability in absence of Synchronization: Better than 1.0 microsecond in 2000 seconds
- Integrated, high performance GPS / GNSS (GPS + GLONASS) Receiver. GPS / GNSS Antenna
- External IRIG-B006 (un-modulated) + 1PPS Input
- External 1 PPS + NMEA Input
- Synchronization Interfaces: one GPS antenna port; one IRIG-B port and 1 PPS port. Any one synchronization interface option may be used.
- Time stability of internal time base: 9 ppb (i.e. <0.009 ppm)

Management Interfaces:

- One x 10/100BaseT Fast Ethernet (RJ45) port Management (OAM) Port for monitoring the system performance and alarms.
- One RS232 serial port and one USB port for local operator access.

Power Supply options:

- 24V DC, 48V DC, 110V DC / 125V DC, 220V DC / 250V DC

Power Consumption:

- < 30 Watts.

CE compliance:

Immunity as per EN 60255-26	EN50082-2	EN 50081-2
Low voltage directive as per EN 60255-27	IEC 61000-4-5 / IEC 60255-22-5	IEC 61000-4-4 / IEC 60255-22-4
CISPR 32 / EN55022 Class A Conducted Emission	IEC 61000-4-3 / IEC 60255-22-3	IEC 61000-4-18 / IEC 60255-22-1
CISPR 32 / EN55022 Class A Radiated Emission)	IEC 61000-4-2 / IEC 60255-22-2	IEC 61000-4-10/IEC 61000-4-8
IEC 60068-2-3	IEC 60068-2-14	

Accuracy Test:

- As per IEEE C37.118.1-2011, IEEE C37.118.2-2011, C37.118.1a-2014 & IEC/IEEE 60255-118-1:2018 standards.

Remote Management, Monitoring and Security:

- Password Controlled Access with Password Strength Monitor.
- SSH - Secured remote access using "Secure Shell Protocol" over IP links
- Telnet / CLI, RADIUS, SNMPv2

Testing, Regulatory, EMI, EMC Surge, Immunity, Insulation Test compliances:

- Electrostatic Discharge test (61000-4-2) Level 3
- Radiated electromagnetic Field Test Level 3
- Damped Oscillatory magnetic Field Test (61000-4-10) Level 3
- Power frequency magnetic field (61000-4-8) Level 3
- DC Voltage Dips & Interruptions I Variation as per IEC 61000-4-29
- Power frequency voltage withstand Test as per IEC 60255-22-5
- 1.2/50μs impulse voltage withstand Test as per IEC 60255-22-5
- Insulation Resistance Test as per IEC 60255-22-5
- Conducted Emission Class A, CISPR 32 / EN55022
- Radiated Emission (In Chamber) >1 GHz 6GHz, Class A, CISPR 32 / EN55022
- Surge Immunity Test Level 3
- Electrical Fast Transient Burst Test Level 3

Environmental Tests and compliances:

- Dry heat operation test - Continuous operation at 55° C for 16 hours as per IEC 60068-2-2
- Dry heat storage test - at 65° C for 16 hours as per IEC 60068-2-2
- Damp heat test - at 95% RH and 400 C for 16 hours as per IEC 60068-2-78
- Cold operation test - Continuous operation at 0° C for 96 hours as per IEC 60068-2-1
- Cold storage test - at -20° C for 24 hours as per IEC 60068-2-1
- Temperature Variation Test - at 450 C, 10 C/Minute, 5 Cycles as per IEC 60068-2-14
- Vibration Test - Freq. 1-55Hz, Disp. 0.35mm as per IEC 60255-21-1

Other Regulatory Compliances:

- Compliant to IEC 61850
- Compliant to IEC 62351
- CE, RoHS

Environmental:

- **Operating Temperature:** -20 C to +55 C
- **Maximum Operating Humidity:** 95%R.H., Non-Condensing
- **Maximum Operating Altitude:** Upto 3,000meters above sea level
- **Operation:** Complies with ETS 300 019 Class 3.2
- **Storage Temperature:** -40 C to +70 C
- **Storage:** Complies with ETS 300 019 Class 1.2
- **Maximum Storage Humidity:** 98%R.H., Non-Condensing
- **Maximum Storage Altitude:** Upto 3,000meters above sea level
- **Transportation:** Complies with ETS 300 019 Class 2.3

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