

MicroPMUs for distribution grids and microgrids

Synchrophasors (also called PMU's) measure the angle between voltages and currents, at different physical locations on a grid. Traditionally, synchrophasors have been used to investigate the stability of transmission grids. Distribution grids have much tinier angle differences – too small, and changing too rapidly, to resolve with traditional transmission-type Phasor Measurement Units (PMU's).

Increasing dispersed generation (photovoltaics, fuel cells, battery storage, small wind turbines) on the distribution grid has raised questions about stability of the distribution grid – questions that can be answered with synchrophasor measurements from microPMU's.

The U.S. Department of Energy's Advanced Research Project Agency (ARPA-E) funded a US\$4 million project to develop the most precise synchrophasor instrument ever made, with 100 times the resolution of traditional transmission-type PMU's: 0.001° and 2PPM!

The microPMU is ideal for research projects that need ultra-precise synchrophasor measurements for investigating stability and impedance questions on distribution grids and microgrids.



microPMU Highlights

- Ultra-accurate phasor measurements!
0,001° resolution on voltage and current phase angles, **2 PPM resolution** on voltage and current magnitudes.
- Fast recording and reporting rate : 2 times per cycle (100/sec second at 50 Hz, 120/sec at 60 Hz)
 - 3 voltage and 3 current angle-magnitude pairs
 - Frequency, fundamental total apparent, active, reactive and power factor
- Ultra-accurate time stamping thanks to patent-pending calibrated GPS antenna/receiver (fully electrically isolated for safety – cable length delay compensated).
- Phasor data streaming according to C37.118-2011, rate up to 100/120 frames/sec.
Fully compatible with OpenPDC, the standard phasor data concentrator software. Compatible with the Plotter Application software (see microPMU start kit).
- Measurement data recorded in (16GB) internal memory for 14 days – tolerates complete loss of communication channel with no loss of research data.
- Recordings can be downloaded via FTP, embedded Web server (HTTP) for configuration modification, firmware updates
- Tiny footprint. Can be snapped into electrical panels, distribution poles, pad-mount transformers
- Direct connection to any world-wide power grid voltage: 50/60 Hz, 100V ~ 690V, single-phase or three-phase.
- Fully supports PT's (up to 100kV) and CT's.
- Powers from POE (power over Ethernet), 24-48VDC, 24VAC, or 110VAC/230VAC with a plug-in module, optional 30min or up to 3 hour backup power modules available.
- UL Listed, CE-marked, fully certified for emissions and immunity.

Micro PMU Specifications (*)

MAINS VOLTAGE INPUT CHANNELS

Connection	L1, L2, L3, N PQube3 screw terminals (max torque 5 inch-pounds (0,6Nm))
Frequency Range	Nominal 50 Hz, 60 Hz.
Mains Configuration	Single-phase, split-single-phase, delta, wye/star. User selected or auto-selected.
Range of Nominal Input Voltage	100 VAC ~ 960 VAC L-L (69 VAC ~ 480 VAC L-N). User selected or auto-selected.
Measurement Channels	Line-to-Earth, Neutral-to-Earth
Sampling Rate	25,600 samples/s @ 50Hz and 30,720 samples/s @ 60Hz
Measurement Range	0 VAC ~ 750VAC L-N (0 VAC ~ 1300 VAC L-L)
Isolation	PQube3 tested up to 5100VAC isolation to Earth. UL/IEC 61010 test pending.
Installation Category	CAT IV UL/IEC 61010 for voltages up to 300 VAC L-N (equivalent to 480 VAC L-L), CAT III for voltages up to 600VAC L-N. Pollution degree 2. UL/IEC 61010 test pending.
TVE (Total Vector Error)	Typical TVE $\pm 0,01\%$ Typical short-term TVE stability for differential measurements: $\pm 0,002\%$
Amplitude resolution	0,0002%FS (2 PPM) (noise floor – useful for short-term difference measurements)
Amplitude Accuracy	$\pm 0,050\%$ (10VAC - 750VAC L-N). Typical : $\pm 0,010\%$ (120V - 600VAC L-N)
Angle resolution	0.001° (noise floor - useful for short-term difference measurements)
Angle Accuracy	$\pm 0,010^\circ$ 1 Standard Deviation Typical : $\pm 0,003^\circ$

CURRENT INPUT CHANNELS

Measurement Type	External current transformer, voltage-type secondary – Screw terminal (Max torque 2 inch-pounds (0,25Nm))
CT Input Ratio Range	1:1 to 50000:1
Nominal Input	0.333 V RMS
Input Impedance	33.3k Ω
Crest Factor	3.5 (± 1.17 Vpk)
Sampling Rate	Same rate as mains voltage measuring channels
Wire Connection	Min. 28AWG (0,8 mm ²), Max. 16AWG (1,31mm ²). 600V UL- recognized insulation required

POWER MEASUREMENTS

Definitions

Watts (power)	Sum of true instantaneous per-phase power.
Volt-Amps (apparent power)	Sum of per-phase product of RMS voltage and RMS current, taken over the measurement interval.
Power Factor	True power factor—ratio of Watts to Volt-Amps
VARs (volt-amps reactive)	Fundamental VARs

(*) Full specifications are found in the microPMU installation and instruction manual

Order Information

Part Nb:	microPMU-DINRail-000-000-XXXX
	<i>Includes MicroPMU core module, 'MS1' synchronization module 'GPS1' GPS receiver&antenna and its connection cable to the GPS receiver, and a convenient DIN rail mounting kit.).</i>
	<i>microPMU in-a-box packages available contact PSL for more information.</i>

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