

PQube Specifications

(for PQube Model 02-0000)

PQube Specifications Version 1.3

Reference conditions for factory tests: 19 ~ 25°C, 15% ~ 50% RH, steady-state 10/12 cycle signals. $\pm 1/2$ display count on all accuracies

Inputs	
Mains Voltage Measuring Channels	
Connection	L1, L2, L3, N PQube screw terminals [9], [11], [13], [15]
Frequency Range	40 Hz ~ 70 Hz and 320 Hz ~ 560 Hz. Nominal 50 Hz, 60 Hz, or 400 Hz auto, 320-560 Hz manually selected. Specifications below apply at 50/60 Hz.
Mains Configuration	Single-phase, delta, wye or star. User selected or auto-selected
Range of Nominal Input Voltage	100 VAC ~ 690 VAC L-L (69 VAC ~ 400 VAC L-N). User selected or auto-selected
Measurement Channels	Line-to-Neutral, Line-to-Line, Neutral-to-Earth
Sampling Rate	256 samples per cycle, phase-locked to input frequency
Measurement Range	0 VAC ~ 900 VAC L-L (520 VAC L-N)
Accuracy	$\pm 0.05\%$ rdg $\pm 0.05\%$ FS typical (10% ~ 150% of nominal). Every PQube factory tested at better than $\pm 0.04\%$ rdg $\pm 0.04\%$ FS. Note: FS = 345 VAC or 520 VAC, selected based on nominal line-to-earth voltage.
RMS Measurement Method	True single-cycle RMS, phase-locked to each channel, updated every 1/2 cycle. $U_{RMS/2}$ per IEC 61000-4-30 Class A. Also 10/12 cycle true-RMS per IEC 61000-4-30 Class A.
HF Impulse Detection	L1-E, L2-E, L3-E. $\pm 450 V_{pk}$ nominal threshold detected through 2-pole high-pass 4.8 kHz nominal filter. Every PQube factory tested with 1- μ sec 10%-to-90% impulses; trigger required at $\pm 650 V_{pk}$, must not trigger at $\pm 250 V_{pk}$.
Unbalance – Voltage	ANSI, IEC, and GB measurement methods. Range: 0.0% ~ 100.0%. Accuracy equivalent to rms voltage specification applied to measurement method.
THD – Voltage	Measurement method: Discrete Fourier Transform of phase-locked 256 samples-per-cycle. Range: 0.0% ~ 100.0%. Accuracy: $\pm 0.2\%$ at 60-Hz test waveform having typical harmonic content (5% 5 th , 2.5% 7 th , 1.5% 9 th , and 1% 11 th). Samples measured through 6-pole low-pass analog anti-alias filter, 3-dB frequency 4.7 kHz.
RMS Flicker	P_{inst} – average absolute difference between $U_{RMS/2}$ and 1-second RMS, in percent of nominal, multiplied by scaling factor for improved compatibility with Incandescent Flicker in IEC 61000-4-15. P_{ST} – mean value of P_{inst} over previous 10 minutes, synchronized to real-time clock. P_{LT} – mean value of P_{inst} over previous 2 hours, synchronized to real-time clock. Range: 0.0 ~ 20.0. Accuracy: ± 0.1 .
Harmonics and Interharmonics	Range: 0% ~ 100% of fundamental, measured up to the 63 rd order (harmonics displayed up to the 50 th order). Harmonic accuracy*: IEC 61000-4-7:2002 Class II, typical, up to the 50 th order, for units manufactured after February 2010. Voltage: $\pm 5\% U_m$ for $U_m \geq 3\% U_{nom}$, $\pm 0.15\% U_{nom}$ for $U_m < 3\% U_{nom}$ Current: $\pm 5\% I_m$ for $I_m \geq 10\% I_{nom}$, $\pm 0.5\% I_{nom}$ for $I_m < 10\% I_{nom}$ where U_{nom} , I_{nom} = nominal voltage or current range of the instrument, U_m , I_m = measured values <i>*Preliminary specification, subject to further evaluation</i>
Isolation	PQube provides more than 7500 VDC isolation to Earth. UL/IEC 61010 reinforced insulation.
PT Input Ratio Range	1:1 to 10000:1
Installation Category	CAT IV UL/IEC 61010 for voltages up to 300 VAC L-N (equivalent to 480 VAC L-L), CAT III for higher voltages. Pollution Degree 2
Analog Input Channels	
Connection	AN1, AN2 PQube screw terminals [22], [30]
Nominal Input	0 ~ 30 VAC or ± 60 VDC to Earth max
Input Impedance	800 k Ω to Earth
Full Scale	70 VAC, ± 100 VDC
Measurement Channels	AN1-Earth, AN2-Earth, AN1-AN2
User-specified Input Ratio	1:1 to 10000:1
Sampling Rate	12.8 kHz or 15.4 kHz (measured at same rate as mains voltage measuring channels)
Accuracy	$\pm 0.2\%$ rdg $\pm 0.2\%$ FS typical (10% ~ 100% FS), ANx-Earth. Every PQube factory tested at better than $\pm 0.1\%$ rdg $\pm 0.1\%$ FS AC.
Digital Input	
Connection	DIG1 PQube screw terminal [24]
Rating	60 VDC to Earth

Wetting	5.4 VDC at 3 μ A	
Threshold	1.5 V \pm 0.2 V with respect to PQube's Earth terminal, with 0.3 V hysteresis typical	
Sampling Rate	12.8 kHz or 15.4 kHz (sampled at same rate as mains voltage measuring channels)	
Frequency Measurement		
Range	40 Hz to 70 Hz and 320 Hz to 560 Hz	
Accuracy	\pm 0.01 Hz, steady state	
Method	Cycle-by-cycle zero-crossing detection on L1-E or L2-E (auto-selected). Firmware phase-locked for frequency slew rate up to 5 Hz/sec. For 50/60 Hz, measured through an 9-pole low-pass analog filter, 3-dB frequency 76 Hz. For 400 Hz, measured through 7-pole low-pass filter, 3-dB frequency 1 kHz. Poles and 3 dB frequency are auto-selected based on nominal frequency.	
Optional Temperature/Humidity Probes		
Connection	2.5 mm stereo jack. Functional electrical isolation from PQube	
Location	Optional probes plug into the PQube directly or through PSL-provided extension cables	
Scan Time	5 seconds max	
Temperature Accuracy	Typical: \pm 0.5°C. Max: \pm 2°C (-20 ~ +80°C)	
Humidity Accuracy	Typical: \pm 4.5% RH (20 ~ 80% RH), max: \pm 7.5% (0 ~ 100% RH)	
	Note: For optimal ambient temperature and humidity accuracy, use extension cable to avoid self-heating of probe by PQube	
Optional Current Measuring Modules		
CT4-20A-00, CT4-50A-00		
Measurement Type	Pass-through (built-in current transformers)	
Nominal Input	20 amps RMS for CT4-20A, 50 amps RMS for CT4-50A	
Crest Factor	3.5 (\pm 70 amps instantaneous for CT4-20A, \pm 350 amps instantaneous for CT4-50A)	
Sampling Rate	12.8 kHz or 15.4 kHz (sampled at same rate as mains voltage measuring channels)	
Accuracy	\pm 0.2% rdg \pm 0.2% FS typical (10% ~ 120% FS). Every PQube factory tested at better than \pm 0.15% rdg \pm 0.15% FS.	
Burden	less than 0.1VA	
Conductors	0.34 inches (8.6 mm) max. diameter, 600 V UL-recognized insulation required	
XCT4-1A-00, XCT4-5A-00		
Measurement Type	External current transformer	
CT Input Ratio Range	1:1 to 10000:1	
Nominal Input	1 amp RMS for XCT4-1A, 5 amps RMS for XCT4-5A	
Crest Factor	3.5 (\pm 3.5 amps instantaneous for XCT4-1A, \pm 17.5 amps instantaneous for XCT4-5A)	
Sampling Rate	12.8 kHz or 15.4 kHz (measured at same rate as mains voltage measuring channels)	
Accuracy - excluding external CT's	\pm 0.2% rdg \pm 0.2% FS typical (10% ~ 120% FS). Every PQube factory tested at better than \pm 0.15% rdg \pm 0.15% FS.	
Burden	Less than 0.1 VA	
Wire Connection	Min. 20 AWG (0.52 mm ²), max. 14AWG (2.1 mm ²). 600 V UL-recognized insulation required	
Max. Screw Torque	7 inch-pounds (0.8 Nm)	
XCT4-0.333V-00, XCT4-1V-00, XCT4-5V-00, XCT4-10V-00, XCT5-0.333V-00, CTE1		
Measurement Type	External current transformer	
CT Input Ratio Range	1:1 to 10000:1	
Nominal	0.333 V RMS, 1 V RMS, 5 V RMS, or 10 V RMS	
Crest Factor	3.5 (\pm 1.17 V _{pk} , \pm 3.5 V _{pk} , \pm 17.5 V _{pk} , or \pm 35 V _{pk})	
Sampling Rate	12.8kHz or 15.4kHz (measured at same rate as mains voltage measuring channels)	
Accuracy - excluding external CT's	\pm 0.2% rdg \pm 0.2% FS typical (10% ~ 120% FS). Every PQube factory tested at better than \pm 0.1% rdg \pm 0.1% FS.	
Wire Connection	Min. 20AWG (0,52 mm2), Max. 14AWG (2,1mm2). 600V UL- recognized insulation required	
Max. Screw Torque	5 inch-pounds (0,6Nm)	
Optional Voltage Attenuator Modules for Analog Input Channels		
	ATT1-0600V	ATT1-1200V
Rated Full-Scale Voltage	\pm 600 VDC/300 VAC to Earth	\pm 1200 VDC/600 VAC to Earth
Nominal Measurement Range	\pm 1000 V _{pk} to Earth	\pm 2000 V _{pk} to Earth
Analog Input Channel Ratio	10:1	20:1
Test Voltage to Earth	7250 VDC	14500 VDC

Accuracy	±0.2% reading typical at DC (>10% FS), plus error in analog input channels. For 50/60 Hz signals, increase the analog input channel ratio by 0.1% (ATT1-0600V) or 0.4% (ATT1-1200V) per meter of cable to approximately compensate for cable capacitance.
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 (tPF)	True power factor – ratio of Watts to Volt-Amps.
VAR's (volt-amps reactive)	Budeanu definition
Carbon (CO ₂ rate and accumulated)	Based on patent-pending algorithm using watts and user-selected proportions of generator sources, and user-supplied carbon generation rates for each source.
Current unbalance	Measurement method ANSI C84.1.
Inputs	
Voltages	L-N, or L-N _m , for delta configurations. N _m defined as measurement neutral, the instantaneous average L-E voltage. All voltages scaled up to 10000:1 for potential transformers.
Currents	L1, L2, L3, N, E currents. Optional user-selected calculated current on one channel for installations with N-1 current transformers. All voltages scaled up to 10000:1 for current transformers.
Accuracy excluding external CT's	
Watts (power)	±0.2% typical at unity power factor, nominal voltage, 20% ~ 100% FS current. Better than ±0.25% rdg ±0.25% FS plus error due to phase angle uncertainty (<1.5° typical) for $\Theta_{\text{fundamental}} < \pm 30^\circ$, nominal voltage, 10% ~ 120% FS current. $\Theta_{\text{fundamental}}$ = angle between fundamental voltage and fundamental current.
Volt-Amps (apparent power)	Better than ±0.25% rdg ±0.25% FS typical (10% ~ 120% FS)
Measurement interval	
Measurement interval	Phase-locked, 10-cycles (50 Hz nominal) or 12-cycles (60 Hz nominal). Approximately 5 readings per second. Actual readings per second dependent on actual frequency.
Instrument Power	
Screw Terminals (AC or DC) PQube POWER screw terminals [23], [31]	
AC Input	24VAC ± 20% 50/60 Hz
DC Input	24-48VDC ± 20% (polarity independent)
Power Required	5VA max
Isolation	PQube provides more than 150VDC isolation to all other circuits
Internal UPS	
Type	Lithium Polymer Battery (replacement batteries available from PSL)
Capacity	600mAH. 30 minutes typical with new, fully-charged battery.
Backup period	User controlled. 1 to 10 minutes, 3 minute default.
Storage & Discharge Temperature	-20°C to +60°C
Charge Temperature	0°C to +45°C
Charging Cycles	>500 full cycles
Lifetime	Estimated 5+ years, depending on operating and environmental conditions
Replacement Method	User replaceable while PQube is operating (tool required)
Optional PS1 Plug-in Module	
AC Input	100~240VAC ± 10%. 50/60 Hz
Power Required	25VA max
Isolation	Module provides more than 3200VDC isolation to all other circuits
Outputs	
Signal Relay	
Connection	RLY1 PQube screw terminals [19], [27]
Rating	30 VAC/60 VDC, 300 mA max
Function	Normally closed. Contacts open for duration of event or 3 seconds (whichever is longer)
Sense & Operate time	20 milliseconds

Communications	
USB	
Connection	Mini-B USB socket
Future Applications	Future: USB mass storage device, and USB-based serial COM port.
Isolation	PQube provides at least 150VDC isolation to Earth (eliminates ground loops)
Optional Plug-in Ethernet Module	
Connection	Standard RJ-45 socket (wired Ethernet)
Email	Sends emails after every event with data attached; user request real-time meters via e-mail, PQube firmware upgrade via email, change PQube setup via email, incoming e-mail filters. Includes GIF graphs, CSV spreadsheet files, PQDIF, HTML and XML summaries
Web Server	Real-time meters. All event recordings, trends and statistics recordings. Includes GIF graphs, CSV spreadsheet files, PQDIF, HTML and XML summaries
Modbus over TCP	Real-time meters with update rate of approximately 1 second. Event/trend-statistics counters can be used for triggering downloads via FTP or web server.
FTP Server	File Transfer Protocol. Transfers files from PQube SD card to and from any computer. Limit to one simultaneous connection.
SNTP	Simple Network Time Protocol for synchronizing PQube real-time clock to UTC. (2 second absolute - UTC referenced)
Clock Timing	
Internal Real-Time Clock	
Accuracy	Typical ± 30 seconds/yr. Temperature compensated. ± 120 seconds/yr max drift
Optional SNTP (Requires ETH1)	
Accuracy	± 2 seconds absolute, UTC time
Operating Environment	
Ambient Conditions – Operating	$-20^{\circ}\text{C} \sim 50^{\circ}\text{C}$, 10% RH \sim 90% RH non-condensing
Transient Voltages	100kHz ring wave, 6 kV pk, IEC 61180, IEC 61000-4-5. Applied to voltage measuring terminals with Performance Evaluation Class 1. (When applied to optional power supply mains terminal, supply's fuse may operate in PE Class 3 at test levels greater than 4 kV.)
EFT Burst Immunity	4 kV pk, IEC 61000-4-4, Performance Evaluation Class 1. Applied to power measuring terminals and optional PS1 power supply mains terminals
RF Field Strength Immunity	3V / m, IEC 61000-4-3 Test Level 2
Magnetic Field Strength Immunity	30A / m, IEC 61000-4-8 Test Level 4
Ingress Protection Rating (IP Rating)	IP20H, IEC 60529
Physical	
PQube	
Dimensions	2.8in x 3.5in x 3.2in (72mm x 90mm x 80mm)
Weight	8.7oz (247g)
Mounting	Standard 35mm DIN rail. Optional panel mounting clips available.
Screw Terminal Torque	7inch-pounds (0,8Nm)
PS1 Power Supply	
Dimensions	1.7in x 3.5in x 2.4in (43mm x 90mm x 61mm)
Weight	4.0oz (113g)
Mounting	Standard 35mm DIN rail. Optional panel mounting clips available.
Screw Terminal Torque	7inch-pounds (0,8Nm)
ETH1 Ethernet	
Dimensions	1.7in x 3.5in x 2.4in (43mm x 90mm x 61mm)
Weight	2.1oz (60g)
Mounting	Standard 35mm DIN rail. Optional panel mounting clips available.
XCT4/XCT5 Current	
Dimensions	1.7in x 3.5in x 2.4in (43mm x 90mm x 61mm)
Weight	3.5oz (99g)
Mounting	Standard 35mm DIN rail. Optional panel mounting clips available.
Screw Terminal Torque	7inch-pounds (0,8Nm)

CT4 Current	
Dimensions	4.4in x 3.5in x 1.6in (112mm x 90mm x 41mm)
Weight	8.1oz (230g)
Mounting	Standard 35mm DIN rail. Optional panel mounting clips available.
TH1	
Dimensions	1.8in x 0.7in x 0.4in (46mm x 18mm x 10mm)
Weight	0.2oz (6g)
Connection	2.5mm stereo jack

Agency Approvals and Listings

UL (Underwriters Laboratories)	UL-recognized, cULus – File Number E220936
RoHS	Certified – PSL Construction File PQube-001
CE	Certified – PSL Construction File PQube-001, TUV CB Test Certificate US-TUVR-4368-A2
ITC	Certified – 20080102-01-CE, 20080326-01-RI
TUV Bauart-mark	Certified – TUV Report 30880881.009
ABS Shipyard	Certified – 2009 Steel Vessels Rules 1-1-4/7.7, 4-8-3/Table 2, 2008 MODU Rules: 43-3-3/Table 1