PQ2F & PQ4F

Power Quality Analyzer

TÜBİTAK

MAM

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Genuine Design

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POWER QUALITY MONITORING SYSTEM

The electricity consumption has sharply increased on which the industrial revolution had a significant impact, beginning with the initial years of electricity usage. Increasing electric demand expanded electrical (power) systems inducing a number of related technical issues, namely, power quality problems. These had not attracted the attention of industrial corporations and research centers up until 90s. Increasing industrialization, developing semi-conductor technology, and growing urbanization have recently revealed the importance of power quality problems, and research conducted on this topic has substantially increased.

In order to detect the sources and types of power quality problems which lead to considerable economic loss, current and voltage of the electrical grid should be continuously monitored. Thereby, issues including

- identification of the problems
- under which conditions these occur
- possible outcomes that these problems can lead to
- which loads connected to the point of common coupling cause these problems
- which customers are negatively affected from the problems and at what ratio they are affected

should be determined, and the necessary sanctions and measures should be applied.

Power Quality Monitoring System, developed by TÜBİTAK Marmara Research Center (MRC), has been installed at circa 625 transformer substations to monitor 1,970 feeders in real-time, with 1140 installed Power Quality Analyzers, as of 2019. Measurements performed by the analyzers are automatically sent to the National Power Quality Monitoring Center built by TÜBİTAK MRC at TEİAŞ facilities.

Power Quality Monitoring System

Common Use

Flexible Software

TECHNICAL FEATURES

	Voltage Inputs
Number of Inputs	PQ2F ➡ 2x (3 phase voltage + neutral), PQ4F ➡ 4 x (3 phase voltage + neutral)
Rated Voltage	100V/3 (phase-neutral) or 100V/√3 for V connection
	Current Inputs
Number of Inputs	PQ2F ➡ 2x (3-phase current + neutral), PQ4F ➡ 4x (3 phase current + neutral)
Rated Current	1A/5A
	Digital Inputs-Outputs
Number of Inputs	PQ2F ➡ 2x8 isolated 24V digital inputs, PQ4F ➡ 4x8 isolated 24V digital inputs
Number of Outputs	PQ2F ➡ 2x4 isolated 24V digital outputs, PQ4F ➡ 4x8 isolated 24V digital outputs
Communication Input	Ethernet, RS485
	Power
Supply Input	85-264 VAC (@50Hz, @60Hz) or 100-370 VDC
Supply Power Consumption	PQ2F ➡ < 20W, PQ4F ➡ <25W
	Device Features
Power Quality Analyzer	IEC61000-4-30 ed2.0, IEC61000-4-7, IEC61000-4-15 ed2.0 (Class A)
Synchronization	Sample-based GPS-synchronization and NTP-based time synchronization
Event Recorder	IEC 61000-4-30 ed2.0
Mounting	Rail mounting
Dimensions	PQ2F ➡ 132x284x87 mm, PQ4F ➡ 132x390x87 mm
Weight	PQ2F ➡ 2150 grams, PQ4F ➡ 2950 grams
Working Temperature	-10°C -50°C (non-condensing)

Sampling System

16 bit	**Resolution**
512 sample/cycle, simultaneously for all analog channels (1)	**Samples per Cycle**
25600 sample/sec/channel (2)	**Maximum Sampling Rate**
Simultaneous sampling for all channels	**Sampling Method**
Synchronized data collection with GPS	**Synchronization**

Measurement Modes

Vrms, Arms(3) IEC 61000-4-30 ed2.0 (Class A) <	**RMS**
Watt, VA, VAr, PF, kWh, kVAh, kVArh(3) IEC 61000-4-30 ed2.0 (Class A), IEC 61000-4-7, IEEE Std 1459-2010 <	**Power and Energy**
Hz(3) IEC 61000-4-30 ed2.0 (Class A) <	**Frequency**
Up to the 50th harmonic(3,6) IEC 61000-4-30 ed2.0 (Class A), IEC 61000-4-7, IEC 61000-2-4 <	**Harmonics** **(Group and Subgroup)**
Up to the 50th harmonic(3,6) IEC 61000-4-30 ed2.0 (Class A), IEC 61000-4-7, IEC 61000-2-4 <	**Interharmonics** **(Group and Subgroup)**
(Voltage)(3) IEC 61000-4-30 ed2.0 (Class A) <	**THD** **(Total Harmonic Distortion)**
(Current)(3) IEC 61000-4-30 ed2.0 (Class A) <	**TDD** **(Total Demand Distortion)**
Pst(3) (Short-term flicker, can be configured as 1/5/10-minute averages) IEC 61000-4-30 ed2.0 (Class A), IEC 61000-4-15 ed2.0 < Plt(3) (Long-term flicker, as 2-hour averages) IEC 61000-4-30 ed2.0 (Class A), IEC 61000-4-15 ed2.0 <	**Flicker**

TECHNICAL FEATURES

Voltage Unbalance Analysis	Voltage unbalance - % (negative component/positive component) > IEC 61000-4-30 ed2.0 (Class A)
Event Detector	Voltage sag, swell and interruption > IEC 61000-4-30 ed2.0 (Class A)
PMU (Phasor Measurement Unit)	Calculation of synchrophasor data(4) > IEE Std. C37. 118
Raw Data Collection	Raw data recording for PQ2F ➡ 12 channels x 25600 samples/sec, PQ4F ➡ 24 channels x 25600 samples/sec

Communication

IP-based	Real-time direct communication with the Power Quality Monitoring Centers (5) through IP-based ADSL / Fiber Optic / 3G / Satellite links
Encrypted Communication	1024-bit RSA encryption
Internal Storage	In case of communication problems, power quality event and parameter data can be stored up to 3 years on the internal hard drive of 64 GB storage.

(1) On demand, the samples per second can be configured as 256, 512, or 1024.

(2) On demand, the maximum sampling rate can be configured as 12800, 25600 or 51200 samples/sec/channel.

(3) It can calculate all power quality parameters in the measurement standards with Class A measurement accuracy at the resolutions of 10 cycles, 3 seconds, 10 minutes, or 2 hours.

(4) On demand, the power quality analyzer can be configured to work in PMU mode. The analyzers working in PMU mode can record data as 100-msec averages.

(5) Power quality analyzers can send real-time data to power quality and wind power monitoring and forecast centers.

(6) On demand, harmonics up to the 63rd harmonic can be measured.

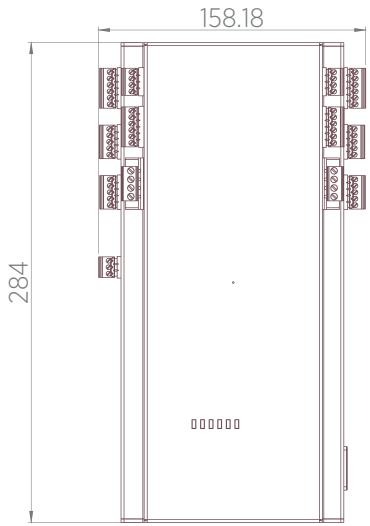
TECHNICAL FEATURES

MEASUREMENT PRECISION OF THE POWER QUALITY ANALYZER

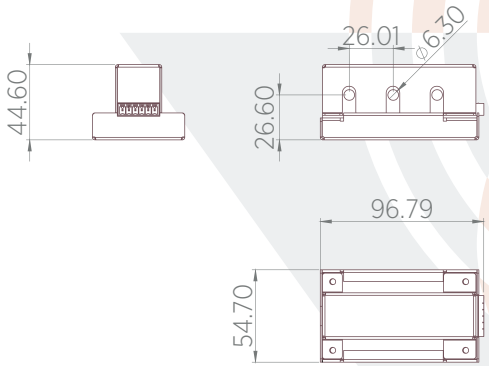
Power Quality Parameters	Measurement Interval	Conditions	Requirements of the Connection Agreement	PQ2F & PQ4F
Vrms (AC)	10%~200 V_{rated}	Always	≤0,1%	≤0,05%
Irms (AC)	%10~200 I_{rated}	Always	≤0,1	≤0,05%
Frequency	42,5 - 57,5 Hz	Always	≤0,01% Hz	≤0,05% Hz
Power (kW, kVAr, kVA)		P ≥ 150W P < 150W	≤1% P_m ≤1,5 W	≤0.08% P_m
THD, Voltage Harmonics and Interharmonics	Up to the 50th harmonics	V_m ≥1% V_{rated} V_m <1% V_{rated}	≤5% V_m ≤0.05% V_{rated}	≤0.5% (2nd to 20th harmonics) ≤1.5% (21st to 40th harmonics) ≤2% (41st to 50th harmonics)
TDD, Current Harmonics and Interharmonics	Up to the 50th harmonics	I_m ≥3% I_{rated} I_m <3% I_{rated}	≤5% I_m ≤0.15% I_{rated}	≤0.5% (2nd to 20th harmonics) ≤1.5% (21st to 40th harmonics) ≤2% (41st to 50th harmonics)
Flicker	0.2-10 P_{st}	Always	≤5%	≤2,5%
Voltage Unbalance		$0 < \frac{V\text{negative}}{V\text{positive}} < \%$	≤0,15%	≤0,15%

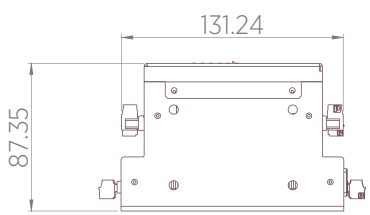
Compact Design

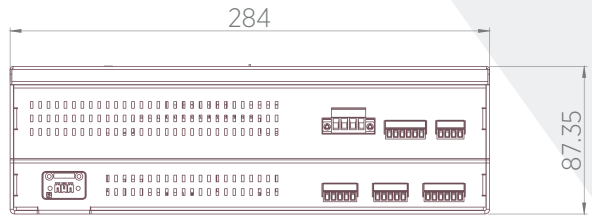
PQ2F DIMENSIONS OF THE POWER QUALITY ANALYZER



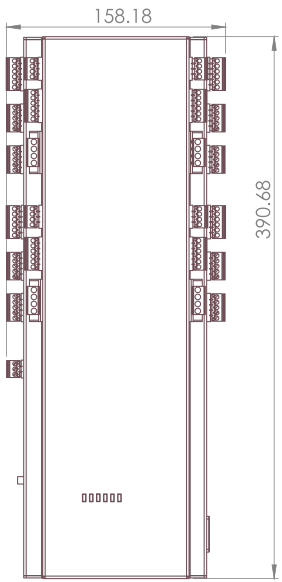
Toroid Current Transformer

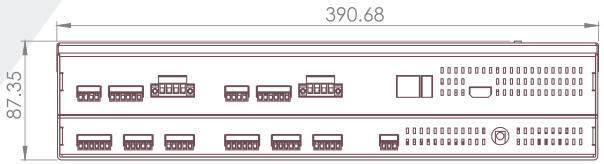


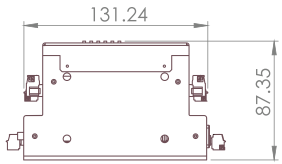




PQ4F DIMENSIONS OF THE POWER QUALITY ANALYZER







— Rail Mounting

Lower Costs

100% Compatibility with the National Power Quality Monitoring Center

100% Compatibility with the Wind Monitoring and Forecast Center

Lossless Data Transmission

Large Data Storage Capacity

Raw Data Collection Feature

OUTSTANDING FEATURES OF THE POWER QUALITY MONITORING SYSTEM

- Lower costs

  - Simultaneously sending data to 3 different servers is possible, without needing an intermediate equipment.
  - There is no need for extra software and license fees.
  - There are no yearly usage and maintenance fees.
  - There is no limit on the number of users.

- In case of a networking problem between the Power Quality Analyzer and the Monitoring Center, the analyzer can store data for up to 3 years on its disk of 64 GB storage capacity. When the networking problem is solved, the analyzer can transmit this stored data to the Monitoring Center in a lossless manner.

- While the Power Quality Analyzer can analyze power quality parameters conforming to IEC 61000-4-30 standard, it can also simultaneously save raw data and perform PMU analyses. Thereby, it enables detailed analyses regarding power quality problems.

- Software running on the Power Quality Analyzer can be automatically updated via the central server.

- It is possible to perform measurements for 2, 4, or 7 feeders simultaneously[1].
- It is designed to be easily installed with its compact structure.
- It can transmit the measured data to one or more monitoring centers in a simultaneous and lossless manner[2].
- It can supply data to SCADA or similar systems using the Modbus TCP protocol.
- The measurement data can be monitored in real-time using the Real-time Power Quality Monitoring Software (as 100 msec[2] and 3 sec. averages).
- Automatic reporting facilities are available for retrospective data analysis.
- Automatic e-mails can be sent to authorized users in order to report analyzers with networking problems.
- It has high measurement precision and peculiar time synchronization features.

[1] For devices measuring 2 and 4 feeders, the voltage signals are independent while the voltage signals are shared in devices for 7 feeders.
[2] 100 msec averages are applicable for the analyzers operating in PMU mode.

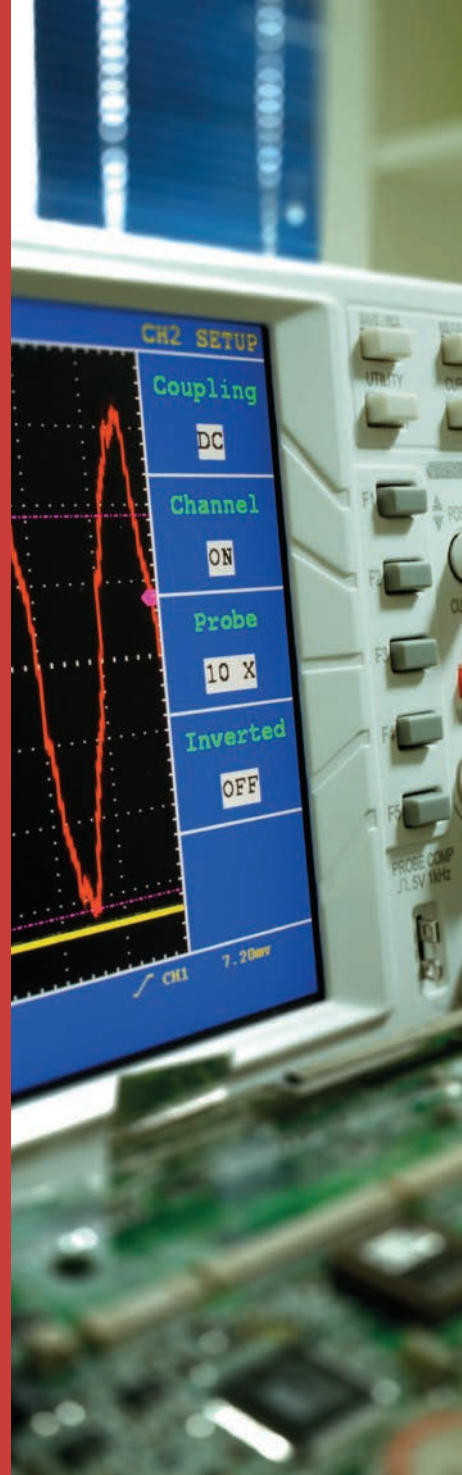
Ability to Monitor Two or More Feeders with a Single Device

Easy Installation

Custom Solutions Tailored to Needs

User Support

Automatic Software Updates



Real-time Data Monitoring

SOFTWARE FEATURES OF THE POWER QUALITY MONITORING SYSTEM

Power Quality Monitoring System Software are designed to easily monitor the collected data and to simply interpret them. They are implemented using open-source platforms and hence do not need usage or license fees. Developed by national engineering staff, this suit of software can be easily adapted to newly-emerging requirements, to changing regulations and standards. The users can use this software suit with their defined usernames and passwords through an internet connection.

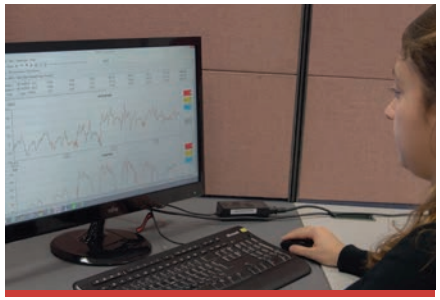
The data computed and collected with the Power Quality Monitoring System can be accessed with three basic types of software.

1. Real-time Power Quality Monitoring Software

Real-time Power Quality Monitoring Software enables real-time monitoring of parameters like current, voltage, frequency, power and power factor as 100 msec(1) and 3 sec. averages.

Additionally, the data can be queried for user-specified intervals as graphs of 100 msec-3 sec-1 min-10 min-1 hr averages and the software enables exporting of the queried data.

(1) 100 msec averages are applicable for the analyzers that operate in PMU mode.



2. Client Software

(Power Quality Analysis, Reporting and Event Data Examination Software)

The Client Software has features to query all power quality parameters within specified date intervals, for detailed examination with cursors on graphs, and for automatic reporting.

- Root-Mean-Square (RMS) Analysis
  - Voltage-Current RMS
  - Active, Reactive, Apparent Power/Power Factor
- Frequency
- Harmonics (V-I)
  - Total Harmonic Distortion (V-I)
  - Interharmonics (V-I)

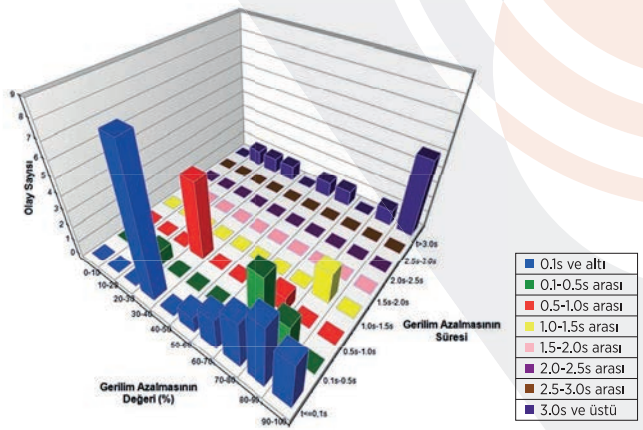
Software Features of the Power Quality Monitoring System

Automatic Reporting

Retrospective Querying

Detailed Analysis Software

- Flicker
  - Short Term Flicker (P_{st})
  - Long Term Flicker (P_{lt})
- Voltage Unbalance
- Event Analysis (Analysis of the event with raw data)
  - Long Term Sag, Swell and Interruption
  - Short Term Sag, Swell and Interruption
- Last 10 Events Analyses (Quick visualization of the most recent 10 events)
- Reporting
  - Detailed Report
  - Compact Report
  - Event Percentage Report



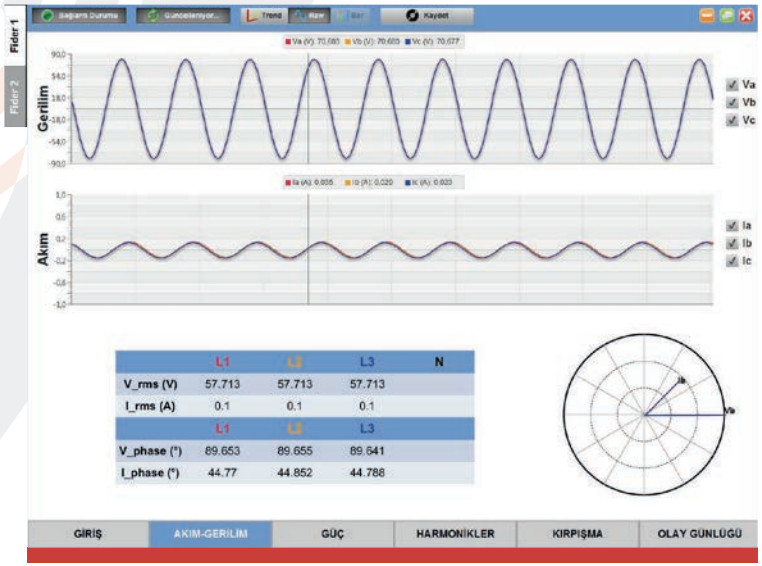
Event Distribution Graph

Software Features of the Power Quality Monitoring System

3. Power Quality Analyzer User Interface Application

This user interface is used during direct connection to the Power Quality Analyzer.

- Capability to monitor more than one Power Quality Analyzer using the same interface
- Simultaneous visualization of the analysis data (current, voltage, frequency, power, power factor, flicker, harmonics) on graphs and tables
- Listing the last 10 event analyses
- Simultaneous saving of the monitored data



Software Features of the Power Quality Monitoring System

— Ease of Use

— Modern Look

Simultaneous Lossless Data Transfer to 3 Different Centers

No Limit on the Number of Users

No License Fee

MONITORING CENTER

Monitoring Center comprises the following components;

Application Server – Database Server – Software running on the servers – Devices related to the network infrastructure – Monitoring displays

The servers at the center have their backup servers. Software running on the servers have been implemented with national engineering staff and they run without any limits on the number of users and without any fees for usage or license.

TEİAŞ National Power Quality Monitoring Center

SERVICES

Beginning from the bidding phase, mounting and deployment tasks of the Power Quality Monitoring System (excluding the responsibilities of the client organization) have been performed by the TÜBİTAK MAM Vice Presidency of Energy Technologies.

TÜBİTAK
ULUSAL METROLOJİ ENSTİTÜSÜ

UME

Kalibrasyon Sertifikası
Calibration Certificate

Cihazın Sahibi / Adresi Customer / Address	:	TÜBİTAK MAM ENERJİ ENSTİTÜSÜ TÜBİTAK Gebze Yerleşkesi P.K. 21 41470 Gebze - KOCAELİ
İstek Numarası Order No	:	2014.01601
Makine / Cihaz Instrument / Device	:	Güç Kalitesi Çözümleyicisi Power Quality Analyser
İmalatçı Manufacturer	:	TÜBİTAK MAM ENERJİ ENSTİTÜSÜ
Tip Type	:	PQ++
Seri Numarası Serial Number	:	M1210
Kalibrasyon Tarihi Date of Calibration	:	19.08.2014
Sayfa Sayısı Number of Pages	:	28

21.08.2014
Tarih
Date

Dr. Mustafa ÇETİNTAŞ
Enstitü Müdürü (V.)
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Calibration Certificate from Accredited Laboratory

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