APPLICATION NOTE

Power Quality Monitoring for Points of common coupling & non-linear loads in F&B Industrial Buildings

Ensures regulatory compliance & maximizes equipment lifetime

ABB PQ monitoring solutions help you to promptly identify potential Power Quality (PQ) problems and root causes by providing information for optimization and efficient operation.

What is Power Quality (PQ)?
A process failure resulting from a power quality event (e.g. voltage sag) produces immediate consequences since it can spoil the work in process, damage the equipment and require a recovery period to restore the process by patching, clean up, repair and restarting. All this downtime leads to high costs, which include direct costs for labor and materials and indirect costs due to delayed revenues and possible fines for late deliveries.

Why you need Power Quality monitoring solutions
Power quality monitoring solutions are essential since they avoid unexplained shut-downs, damage to equipment, failures and prevent critical operations from being interrupted. The data provided will help you to monitor voltage stability, harmonic distortion, unbalance and to identify their root causes, thereby enabling prompt action to be taken to ensure continuity of service. It will also assist in improving energy performance, while reducing greenhouse gas emissions and operational energy costs for the facility.

Main benefits

Reduced maintenance costs
Ensures quick problem identification and solving, thereby reducing maintenance costs, e.g. monitoring voltage unbalance helps to reduce up to **14%** of premature AC motor failures.

Maximized Sustainability
Improves energy efficiency by reducing energy waste caused by poor PQ, e.g., increasing the efficiency of a 150 kW system by 1% reduces CO_2 emissions by **3.89 Tons** annually.

Lower electricity bills
Avoid penalties by performance verification and regulatory compliance, e.g. improving PF from 0.7 to 0.9 in a 5 MVA facility saves up to **167 kEUR** in electrical bills annually.

Extended equipment lifetime
Early fault detection promotes longer equipment lifetime, e.g. monitoring harmonics helps to avoid up to **50%** of transformer loss of life due to the thermal stress applied.

F&B facilities typically have hundreds of loads that interact differently with the network. Some of these loads, such as LED lighting, printers, IT servers, etc., are non-linear by nature and therefore withdraw non-sinusoidal currents from the power supply, resulting in distorted harmonics and voltage. These poor power quality events have a negative impact on cables, distribution transformers and loads using power electronics to track voltage waveform zero-crossing.

Most building management systems (BMS) monitor and analyze energy consumption by deploying meters in the primary and secondary distribution systems. This data is useful but not sufficient to analyze a potential problem. For example, the sudden change in a certain load current consumption profile suggests that there might be a problem affecting that load but does not provide enough information to identify and solve its root cause. Voltage stability, harmonic distortion and unbalance are good indicators of load and distribution system health.

Current and energy measurements are also important in identifying changes in the way a load is drawing current.

The PCC (or point of common coupling) is the point at which connection between facility and utility feed takes place (typically, this point is on the customer side of the utility revenue meter).

It is also very important to monitor the PCC to ensure that facility performance remains within the local regulation boundaries and avoid paying penalties to the utility for a low power factor or a high level of harmonics emitted into the network. A bilateral contract between the utility and facility guaranteeing a certain level of power quality is also very useful for the purpose of verifying utility performance.

A facility manager needs power quality monitoring and control to avoid unexplained shut-downs, damage to equipment, failures and interruption of critical operations. It will also assist in improving energy performance, while reducing greenhouse gas emissions and operational energy costs for the facility.

PQ monitoring solutions for PCC & Non-linear loads

ABB offers solutions that provide real-time metering and monitoring information able to describe the PQ profile of loads or overall facility performance.

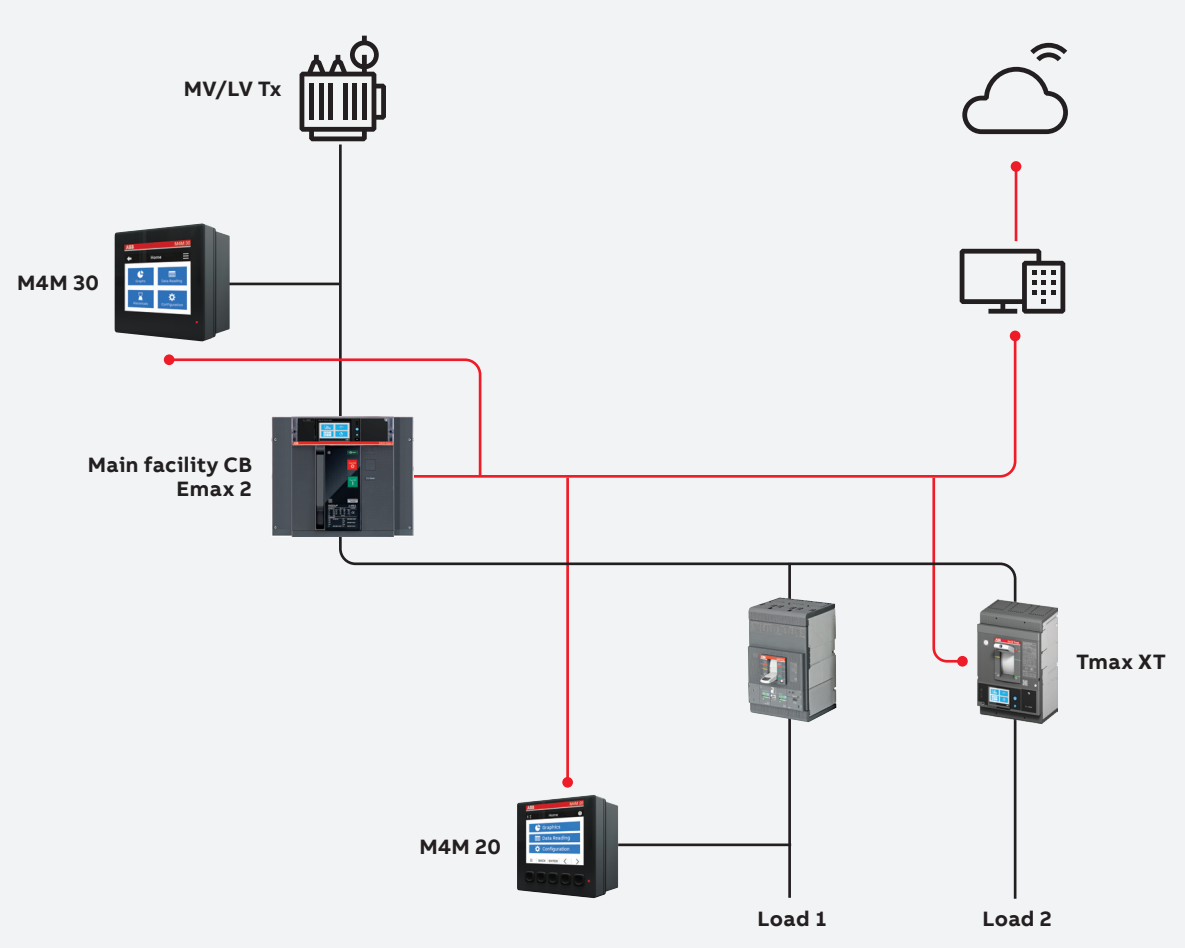
The solution includes:

PQ monitoring & Energy metering

- M4M20
- M4M30
- Tmax XT
- Emax 2

Upstream circuit breaker for load protection

Product	Rated current
Tmax XT	Up to 1600 A
Emax 2	>1600 A



Useful links:

- Emax 2
- Emax2 catalog
- Tmax XT
- Tmax XT catalog
- Ekip UP
- Ekip UP catalog
- M4M
- M4M catalog

PCC metering & monitoring

M4M 30

Measurements	Availability	Accuracy	Note
Currents (RMS) [A] L1, L2, L3, Ne	●	0.2	
Phase-phase voltage (RMS) [V] U12,U23,U31	●	0.2	
Phase-neutral voltage (RMS) [V] U1,U2,U3	●	0.2	
Frequency [Hz] f	●	0.1	
Active power [kW] P1,P2,P3,Ptot	●	0.5	
Reactive power [kVAR] Q1,Q2,Q3,Qtot	●	1	
Apparent power [KVA] S1,S2,S3,Stot	●	0.5	
Power factor PF1,PF2,PF3,PFtot	●	0.5	
Active energy [kW] Ep total, Ep positive, Ep negative	●	0.5	
Reactive energy [kVAR] Eq total, Ep positive, Ep negative	●	2	
Apparent energy [KVA] Es total	●	0.5	
Power Quality	●		Up to 40th harmonic
Sampling frequency			128 samples per cycle

Communication protocols	Availability	Note
Modbus RTU	●	
Modbus TCP	●	
IEC61850		
Profibus-DP	●	
Profinet		
Ethernet / IP		
DeviceNet		
BACnet/IP	●	
Cloud connectivity		
Bluetooth	●	Available in all versions
Ekip Link		
Digital I/O	●	4 programmable I/O(or 6 opt.)
Analog Outputs (4-20mA, 0-20mA)	●	2 optional

OTHER NOTES
Field device integrated in EDCS via cloud gateways
Internal memory (32MB, 1-year of load profiles, max/min demand, energy trends)
Standard CT (5A or 1A) or Rogowski coil acceptance
4 programmable I/O - standard option; 6 programmable I/O and 2 analog outputs (4-20mA / 0-20mA) – extended I/O option

Load metering & monitoring

M4M 20

Measurements	Availability	Accuracy	Note
Currents (RMS) [A] L1, L2, L3, Ne	●	0.2	Calculated Ne
Ground fault current (RMS) [A] Ig			
Phase-phase voltage (RMS) [V] U12,U23,U31	●	0.2	
Phase-neutral voltage (RMS) [V] U1,U2,U3	●	0.2	
Frequency [Hz] f	●	0.1	
Active power [kW] P1,P2,P3,Ptot	●	0.5	
Reactive power [kVAR] Q1,Q2,Q3,Qtot	●	2	
Apparent power [KVA] S1,S2,S3,Stot	●	0.5	
Power factor PF1,PF2,PF3,PFtot	●	0.5	
Active energy [kW] Ep total, Ep positive, Ep negative	●	0.5	
Reactive energy [kVAR] Eq total, Ep positive, Ep negative	●	2	
Apparent energy [KVA] Es total	●	0.5	
Power Quality	●		
Harmonics	●	1	THD
Network analyzer	●		
Sampling frequency			1200-2400-4800-9600 Hz

Communication protocols	Availability	Note
Modbus RTU	●	
Modbus TCP	●	
IEC61850		
Profibus-DP	●	
Profinet		
Ethernet / IP		
DeviceNet		
BACnet/IP	●	
Cloud connectivity		
Bluetooth	●	Available on all versions
Ekip Link		
Digital I/O	●	2 Digital outputs (+ 2 programmable I/O opt.)
Analog Outputs (4-20mA, 0-20mA)	●	2 optional

Process PQ metering & monitoring

Tmax XT/Emax 2 embedded Network Analyzer
The Network Analyzer function continuously monitors energy quality and presents the results on a display or via a communication module.

PQ functionality	
Harmonic analysis	real-time availability of the harmonic content of voltages and currents (measured to the 50th harmonic), as well as the total harmonic distortion value (THD).
Hourly average voltage values	the positive sequence voltage is compared with the limits. If the limits are exceeded, the network analyzer generates a signaling event. The number of these events is stored in a suitable counter. The counter values are available for each of the last 7 days, as well as the total.
Voltage sags & swells	when the voltage strays beyond a range of acceptable limit values for longer than the set time, the network analyzer generates an event that is counted. Three values can be configured for voltage sags and two for voltage swells, each associated with a time limit. This allows the voltage to be monitored to find out whether it remains within a curve of values that are acceptable to equipment such as computers.
Voltage unbalance	the unbalance that occurs when the voltage values are not equal or when the phase displacements between them are not exactly 120° is manifested by a negative sequence voltage value. An event is stored and counted if this limit exceeds the set threshold value.

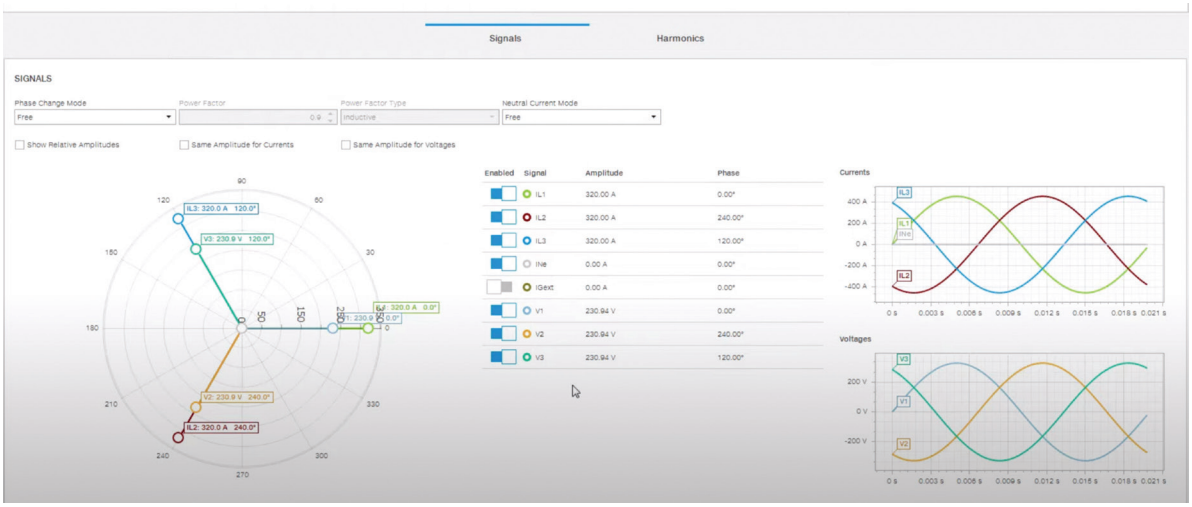
To upgrade the trip units and achieve the required functionality, three different software packages are available for the breakers:

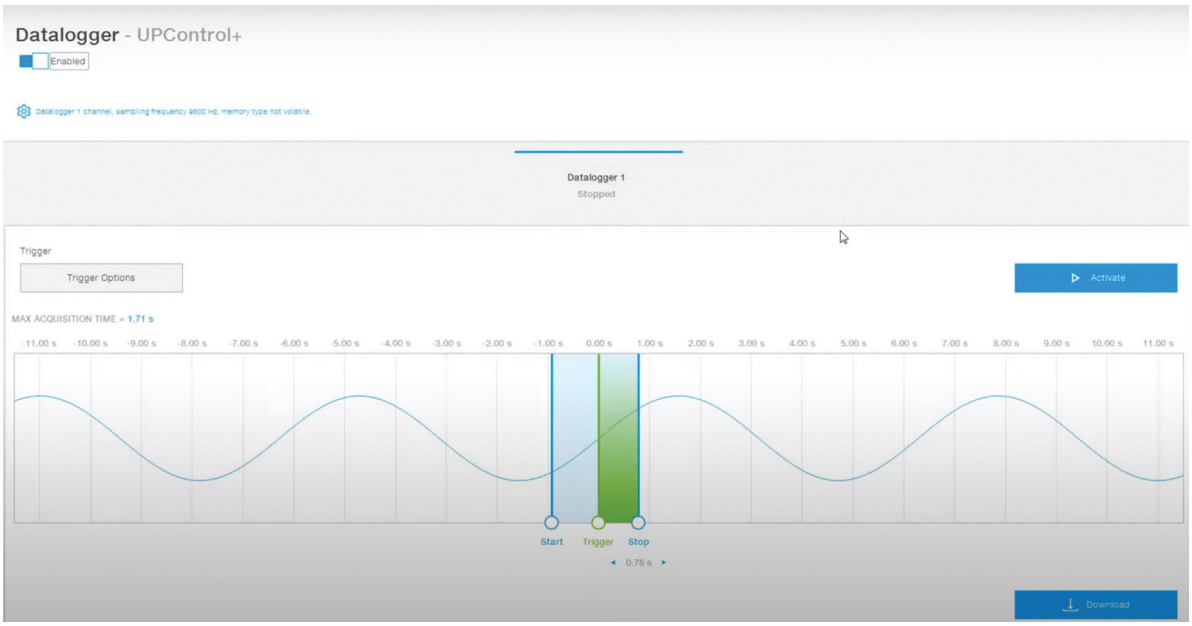
- **Measuring package** for voltage, power and energy measurement
- **Datalogger** for data recording
- **Network Analyzer** for evaluating power quality.

Network Analyzer			**Interval**
Hourly average voltage value	[V] [no]	- Umin= 0.75…0.95 x Un - Umax= 1.05…1.25 x Un - Event counter (1)	t = 5…120min
Short voltage interruptions	[no]	- Umin= 0.75…0.95 x Un - Event counter (1)	t <40ms
Short voltage spikes	[no]	- Umax= 1,05…1,25 x Un - Events counter (1)	t <40ms
Slow voltage sags and swells	[no]	- Umin1= 0.75…0.95 x Un - Umin2= 0.75…0.95 x Un - Umin3= 0.75…0.95 x Un - Umax1= 1.05…1.25 x Un - Umax2= 1.05…1.25 x Un - Event counter (1)	t = 0.02s...60s
Voltage unbalance	[V] [no]	- U neg. seq.= 0.02…0.10 x Un - Event counter (1)	t = 5…120min
Harmonic analysis		Current and Voltage - up to 50th - Alarm THD: 5…20% - Single harmonic alarm: 3...10% plus a count of minutes the harmonic has been exceeded	

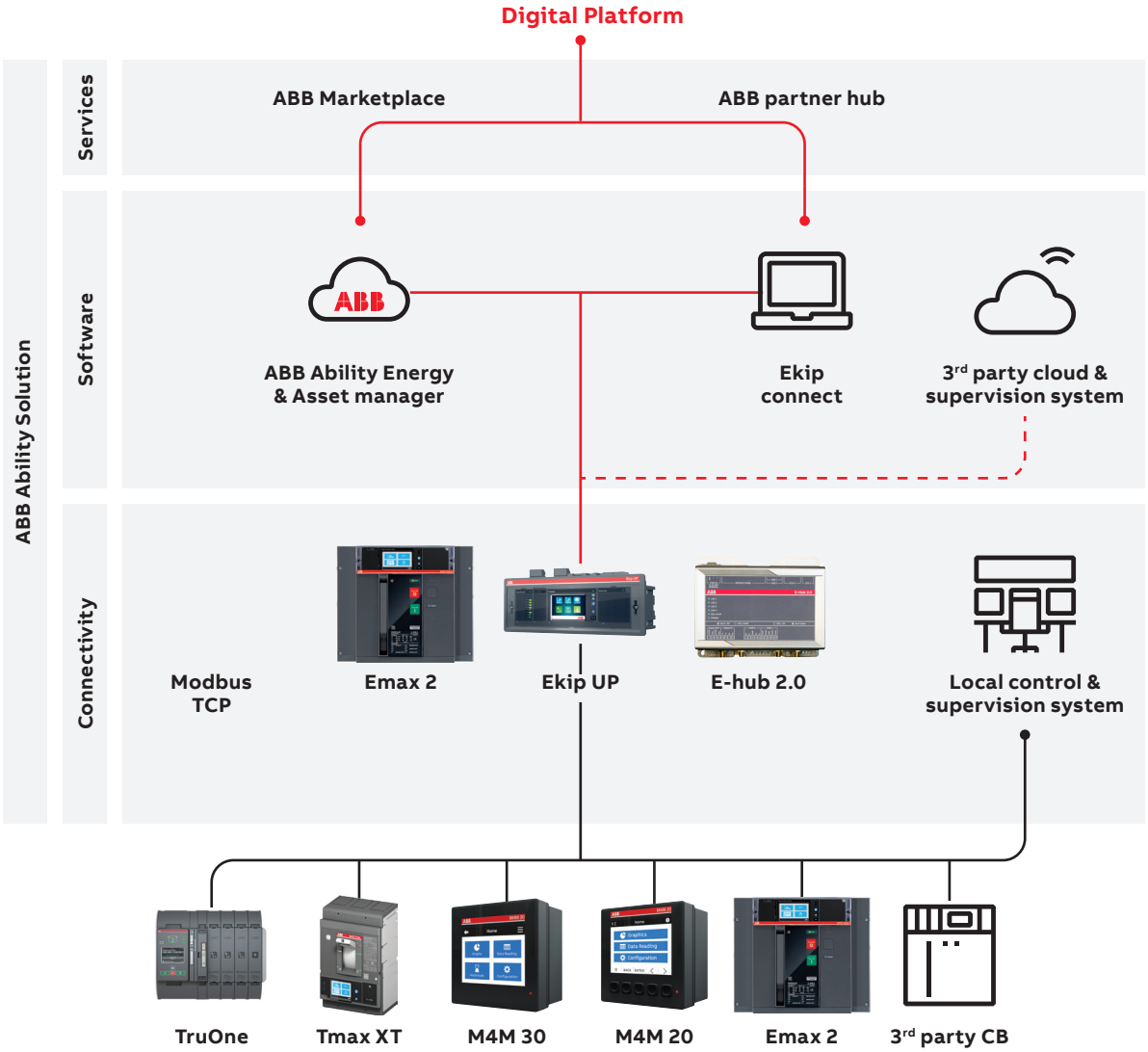
Record of values: for each interval with time-stamping		Parameters	Window & interval
Current: minimum and maximum	[A]	I Min, I Max	Fixed synchronizable by remote
Phase-to-phase voltage: minimum and maximum	[V]	U Min, U max	Duration: 5…120min
Active power: average and maximum	[kW]	P Mean, P Max	Number of intervals: 24
Reactive power: average and maximum	[kVAR]	Q Mean, Q Max	
Apparent power: average and maximum	[KVA]	S Mean, S Max	
Data logger: high rate sampling record of parameters		Parameters	
Currents	[A]	L1, L2, L3, Ne, Ig	Fixed synchronizable by remote
Voltages	[V]	U12, U23, U31	
Sampling rate	[Hz]	1200-9600	Duration: 5…120min
Maximum recording duration	[s]	18	Number of intervals: 24
Recording stop delay	[s]	0-10s	
Number of registers	[no]	2 independent	
Info on trip & opening data: after a fault without auxiliary supply		Parameters	
Type of protection tripped		e.g. L, S, I, G, UV, OV	
Fault values per phase	[A/V/Hz w/VAR]	e.g. I1, I2, I3, neutral for S protection V12, V23, V32 for UV protection	
Time-stamping		Date, time and progressive number	

The information could be monitored through a laptop using Ekip Link.


Signals
Harmonics
SIGNALS
Phase Change Mode
Free
Power Factor
Power Factor Type
Inductive
Neutral Current Mode
Free
Show Relative Amplitudes
Same Amplitude for Currents
Same Amplitude for Voltages
IL3: 320.0 A 120.0°
V3: 230.9 V 120.0°
V2: 230.9 V 240.0°
IL2: 320.0 A 240.0°
Enabled
Signal
Amplitude
Phase
IL1 320.00 A 0.00°
IL2 320.00 A 240.00°
IL3 320.00 A 120.00°
INe 0.00 A 0.00°
IGext 0.00 A 0.00°
V1 230.94 V 0.00°
V2 230.94 V 240.00°
V3 230.94 V 120.00°
Currents
Voltages


Datalogger - UPControl+
Enabled
Datalogger 1 channel, sampling frequency 9600 Hz, memory type not volatile.
Datalogger 1
Stopped
Trigger
Trigger Options
Activate
MAX ACQUISITION TIME = 1.71 s
Start
Trigger
Stop
0.78 s
Download

Digital connectivity



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