APPLICATION NOTE

Power Quality for Process Loads in F&B Industrial Buildings

Ensure operational continuity and reduce downtime

Power supply disturbances can lead to costly downtime since they interrupt operation and production in your F&B facility. Our Power Quality solutions protect electric power from the most threatening Power Quality events, thereby ensuring smart process continuity, efficient operation and enhanced productivity.

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 indirect costs due to delayed revenue and possible fines for late deliveries.

Why you need Power Quality (PQ) solutions
Industry analysts estimate the cost of downtime in an F&B facility to be between $100,000 and $1million per hour, as power supply disturbances can interrupt the operations of the precision machinery used in the production of food and beverages.
To ensure operational continuity and reduce downtime, ABB offers dedicated Power Quality solutions to protect electric power from the most threatening Power Quality events.

Main benefits

Maximized operational availability
ABB PQ solutions ensure operational continuity by protecting loads against network events and avoiding loss of productivity and downtime.

Intuitive design
ABB PQ solutions are intuitively designed for rapid installation, easy commissioning, low maintenance requirements and guaranteed high reliability.

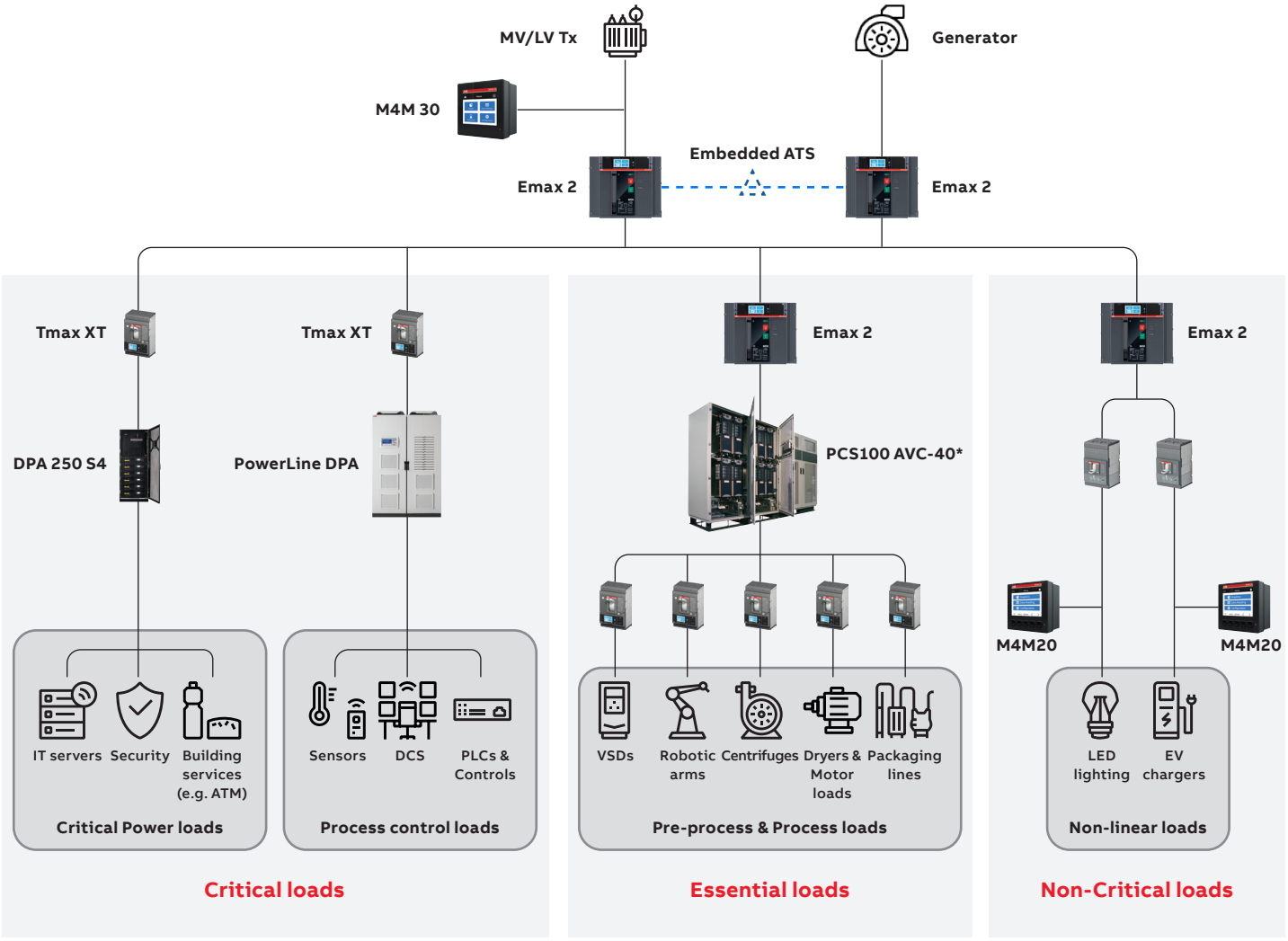
Quick Return On Investment
ABB PQ solutions ensure quick ROI by mitigating financial losses, prolonging equipment lifetime and reducing maintenance costs.

Maximized Sustainability
Highly efficient ABB PQ solutions optimize energy usage and reduce heat losses, thereby taking a step closer towards the 2030 global target for $C0_2$ reduction.

Application overview

Depending on the nature of their business, F&B industrial buildings include a mix of different processes and equipment with greatly varying power protection requirements.

They have been categorized into the following classes of loads and are protected separately but in a centralized way:



1. Critical power loads
require continuous operation, protection against outages and abnormal supply conditions in order to ensure security, personnel safety and reliability.

2. Process Control loads
require continuous operation, protection against outages and Power Quality problems in order to support process automation and equipment reliability needs.

3. Pre-process & Process loads
require continuous operation, protection against outages and Power Quality problems.

4. Non-linear loads
can trip or fail but restart without impacting the performance of the system. For this reason they do not require protection against outages but can be separated.

Power Quality solutions for Process load applications

To prevent tripping and failure of critical processes, ABB offers a complete solution able to provide clean power free from PQ events such as voltage sags, under/over-voltage and outages.

The solution includes:

Upstream CB

- PQ equipment protection
- Individual process protection

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

Metering & Monitoring

- PQ monitoring
- Process energy metering

Product	ABB smart CB	Old or 3rd party CB
Tmax XT	●	-
Ekip UP	-	●

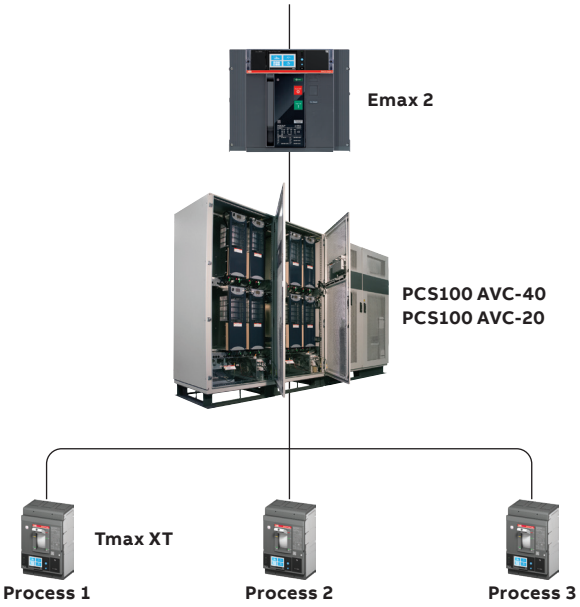
PQ conditioning & protection

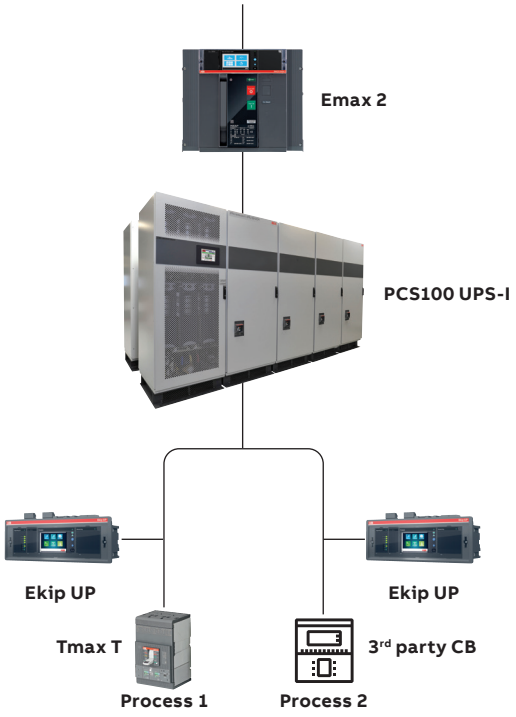
- Voltage protection (AVC)
- Voltage protection + backup time (UPS-I)

Product	Sags/ swells	Undervoltage/ overvoltage	Deep sags (<50%)(1)+ Backup time for outages
PCS100 AVC-40	●	-	-
PCS100 AVC-20	-	●	-
PCS100 UPS-I	-	-	●

(1) Based on AVC-40 performance during three phase events.
In single phase sag events, AVC-40 can start correction from 30% remaining voltage.

ABB solutions





Useful links:

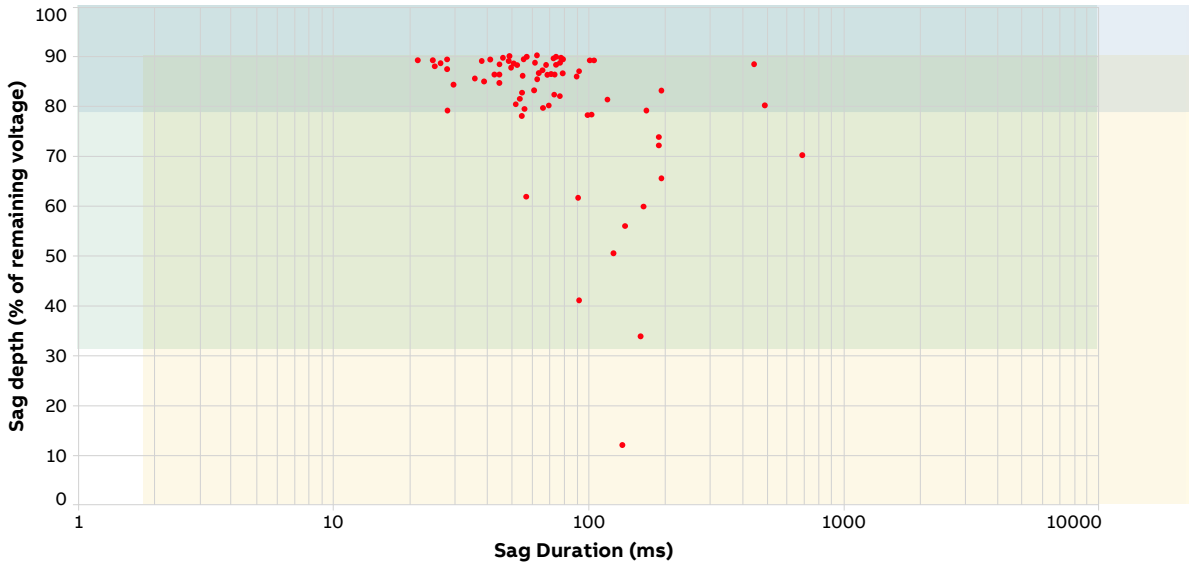
- **Emax 2**
- Emax2 catalog
- **PCS**
- PCS100 AVC-40 catalog
- PCS100 AVC-20 catalog
- PCS100 UPS-I catalog
- **Tmax XT**
- Tmax XT catalog
- **Ekip UP**
- Ekip UP catalog

Choice of PQ conditioning & protection equipment

Choice of the right solution varies from site to site since it depends on utility network reliability, process criticality and financial losses with respect to investment size.
Let's take sag events as an example since, according to the EPRI [(1)], voltage sags account for over 92% of the financial losses sustained by industry due to PQ events.
The easiest way to interpret a voltage sag event is by plotting it as a single point on the depth duration curve, where the X-axis represents total event duration and the Y-axis represents the remaining voltage during the voltage sag.

In the example below, 132 voltage sag events were extracted from the event log of a PCS100 AVC-40 installed in an industrial customer site in Turkey. As shown, all the sag events were in the operational region of PCS100 AVC-40 and below the 1 second limit except for one deep sag in the range of 10% remaining voltage.
From the economic viewpoint, PCS100 AVC-40 was the correct solution for this customer since it meant that they would only experience one process shut-down annually instead of all the process shut-downs that would have happened if voltage events between 30-80% remaining voltage had occurred.

(1) 1st International Conference on Energy, Systems and Information Processing (ICESIP) - Assessment of Financial Loss Due to Voltage Sag in an Industrial Distribution System (link)



PCS100 AVC-40
Active voltage conditioner*
(No energy storage)

PCS100 AVC-20
Active voltage regulator
(No energy storage)

PCS100 UPS-I
Industrial UPS (Seconds - batteries/Ultracapacitors)

* Based on PCS100 AVC-40 performance during a single-phase sag event

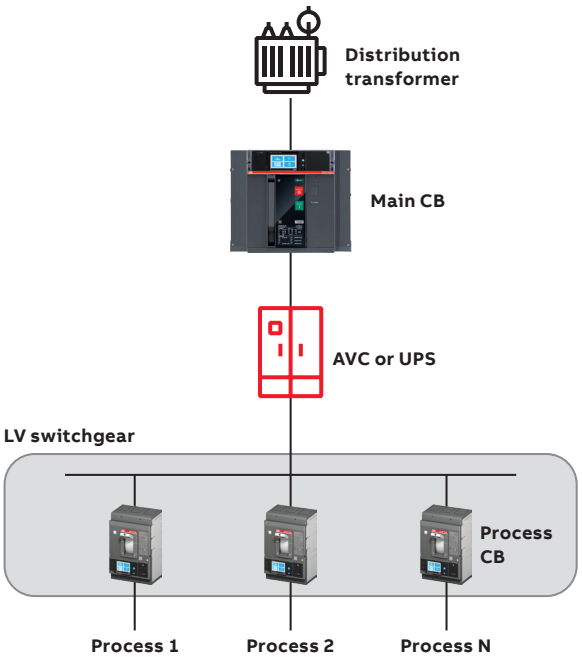
If most of the events had been deep voltage sags or if power outages had taken place more often and ride-through backup time had been needed until a generator started and took over the load, PCS100 UPS-I [(2)] would have been the best solution due to the availability of energy storage.

On the other hand, if the voltage events had been sustained under/over-voltage lasting for long duration in the +/- 20% range, the PCS100 AVC-20, which is able to provide continuous voltage regulation, would have been the correct solution.

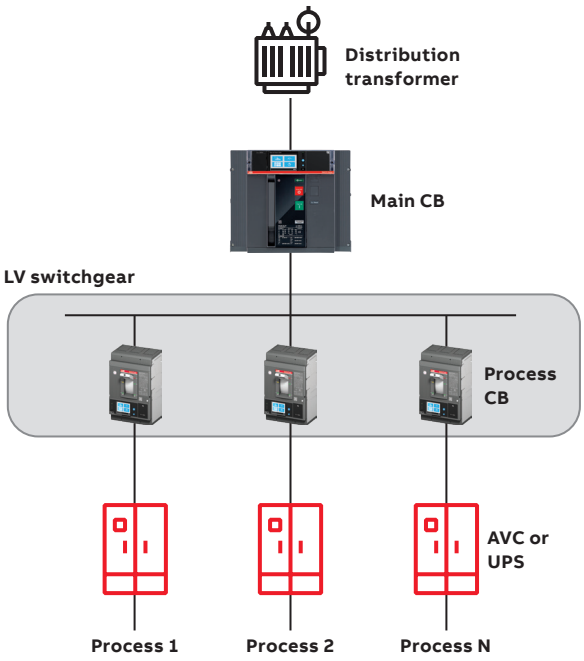
(2) Battery energy storage autonomy for UPS-I is typically 30 seconds at rated kVA and 0.8 PF, which is typically the required bridging time for the generator to start and run during outage events. This can also be extended to 300 seconds by derating the system (please contact ABB if the required autonomy is >300 seconds).

Installation location for PQ equipment

AVC or UPS equipment could be installed to protect factory processes in their entirety between the main incoming breaker and the factory LV distribution system.



PQ equipment could also be installed within the LV distribution system to protect a specific process or load. i.e., dedicated feeder protection.



Application tables

The tables below provide the most relevant electrical data required for site planning and an upstream protection device able to ensure the PQ equipment functions correctly, thereby guaranteeing a highly reliable solution in addition to suitable protection for the equipment and, consequently, the process load.

PCS100 AVC-40 (400V Model)

Rated Power (kVA)						Upstream protection		
400V, 415V	380V	Rated input Current (A)	Rated output Current (A)	Fault capacity (kA)	AVC Type code	Device	Type	Rated current
150	142	253			PCS100-07-400-0B5-40-x	MCCB	Tmax XT5 N	400
225	213	377	325	15	PCS100-07-400-0B75-40-x	MCCB	Tmax XT5 N	400
300	285	498	431	15	PCS100-07-400-01B-40-x	MCCB	Tmax XT5 N	630
450	427	742	650	31.5	PCS100-07-400-01B5-40-x	MCCB	Tmax XT7 S	800
600	570	985	867	31.5	PCS100-07-400-02B-40-x	MCCB	Tmax XT7 S	1000
750	712	1232	1083	31.5	PCS100-07-400-02B5-40-x	MCCB	Tmax XT7 S	1250
900	855	1474	1300	31.5	PCS100-07-400-03B-40-x	MCCB	Tmax XT7 S	1600
1200	1140	1962	1733	40	PCS100-07-400-04B-40-x	ACB	Emax 2.2 B	2000
1500	1425	2448	2166	50	PCS100-07-400-05B-40-x	ACB	Emax 2.2 N	2500
1800	1710	2932	2599	63	PCS100-07-400-06B-40-x	ACB	Emax 4.2 N	3200
2400	2280	3938	3465	65	PCS100-07-400-08B-40-x	ACB	Emax 4.2 S	4000
3000	2850	4922	4331	65	PCS100-07-400-10B-40-x	ACB	Emax 6.2 H	5000
3600	3420	5906	5197	65	PCS100-07-400-12B-40-x	ACB	Emax 6.2 H	6300

PCS100 AVC-20 (380V & 400V Model)

Rated Power (kVA)	Rated Real power (kW)						Upstream protection		
	Utility Voltage 400V, 415V	±15% regulation	±20% regulation	Rated input current	Fault capacity	Type code	device	Type	Rated current
400V	250	250	187	361	15	PCS100-28-400-0B5-20	MCCB	Tmax XT5 N	400
	500	500	375	722	15	PCS100-28-400-01B-20	MCCB	Tmax XT7 S	800
	1000	1000	750	1444	31.5	PCS100-28-400-02B-20-x	MCCB	Tmax XT7 S	1600
	1500	1500	1125	2166	31.5	PCS100-28-400-03B-20-x	ACB	Emax 2.2 N	2500
	2000	2000	1500	2887	40	PCS100-28-400-04B-20-x	ACB	Emax 4.2 N	3200
	2500	2500	1875	3609	50	PCS100-28-400-05B-20-x	ACB	Emax 4.2 N	4000
	3000	3000	2250	4331	63	PCS100-28-400-06B-20-x	ACB	Emax 6.2 H	5000

Rated Power (kVA)	Rated Real power (kW)						Upstream protection		
	Utility Voltage 380V	±15% regulation	±20% regulation	Rated input current	Fault capacity	Type code	device	Type	Rated current
380V	237	237	177	343	15	PCS100-28-400-0B5-20	MCCB	Tmax XT5 N	400
	475	475	356	686	15	PCS100-28-400-01B-20	MCCB	Tmax XT7 S	800
	950	950	712	1372	31.5	PCS100-28-400-02B-20-x	MCCB	Tmax XT7 S	1600
	1425	1425	1068	2057	31.5	PCS100-28-400-03B-20-x	ACB	Emax 2.2 N	2500
	1900	1900	1425	2743	40	PCS100-28-400-04B-20-x	ACB	Emax 4.2 N	3200
	2375	2375	1781	3429	50	PCS100-28-400-05B-20-x	ACB	Emax 4.2 N	4000
	2850	2850	2137	4114	63	PCS100-28-400-06B-20-x	ACB	Emax 6.2 H	5000

For PCS100 AVC-40 & PCS100 AVC-20

- Please contact ABB if other voltage models are required.
- Choice of the downstream CB depends on the number of parallel branches and the size of each branch
- To complete the Type Code: put R for right termination side or L for left termination side instead of x
- To provide discrimination time for downstream protection, AVC- 40 can withstand rated fault capacity for 200ms.
- AVC maximum overload capacity in bypass
  - 125% for 10 minutes / 150% for 1 minute / 500% for 1 s / 2000% for 200 ms

PCS100 UPS-I (400V Model)

PCS100 UPS-I (400V model)						Upstream protection		
Rated Power (kVA)	Inverter rated current (A)	Num. of Modules	Utility disconnect rated current	Fault current (kA) / Withstand capacity (ms)	Type code	device	Type	Rated current
150	217	1	900	25 / 10	PCS100-12-400/50-01-L	MCCB	XT4 N	250
300	433	2	900	25 / 10	PCS100-12-400/50-02-L	MCCB	XT5 N	630
450	650	3	900	25 / 10	PCS100-12-400/50-03-L	MCCB	XT7 S	800
600	866	4	900	25 / 10	PCS100-12-400/50-04-L	MCCB	XT7 S	1000
750	1083	5	2200	50 / 120	PCS100-12-400/50-05-R	MCCB	XT7 H	1250
900	1299	6	2200	50 / 120	PCS100-12-400/50-06-R	MCCB	XT7 H	1600
1200	1732	8	2200	50 / 120	PCS100-12-400/50-08-R	ACB	Emax 2.2 N	2000
1500	2165	10	2200	50 / 120	PCS100-12-400/50-10-R	ACB	Emax 2.2 N	2500
1800	2598	12	4200	65 / 120	PCS100-12-400/50-12-R	ACB	Emax 4.2 N	3200
2100	3031	14	4200	65 / 120	PCS100-12-400/50-14-R	ACB	Emax 4.2 N	3200
2400	3464	16	4200	65 / 120	PCS100-12-400/50-16-R	ACB	Emax 4.2 N	4000
2900	4186	20	4200	65 / 120	PCS100-12-400/50-20-R	ACB	Emax 6.2 H	5000

- Overload ratings (Inverter) 110% of rated current for 30 seconds
- Overload ratings (UD)
  - 120% of rated current for 60s every 10 minutes,
  - 150% of rated current for 30 s every 10 minutes,
  - 200% of rated current for 10 s every 10 minutes,
  - 300% of rated current for 5 s every 10 minutes.

Process PQ metering & monitoring

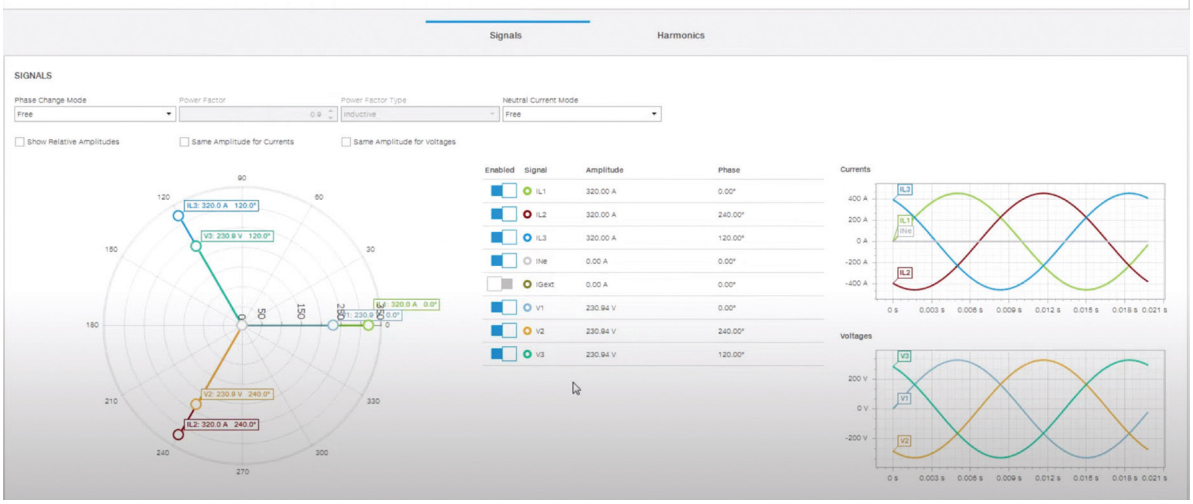
Power Quality monitoring

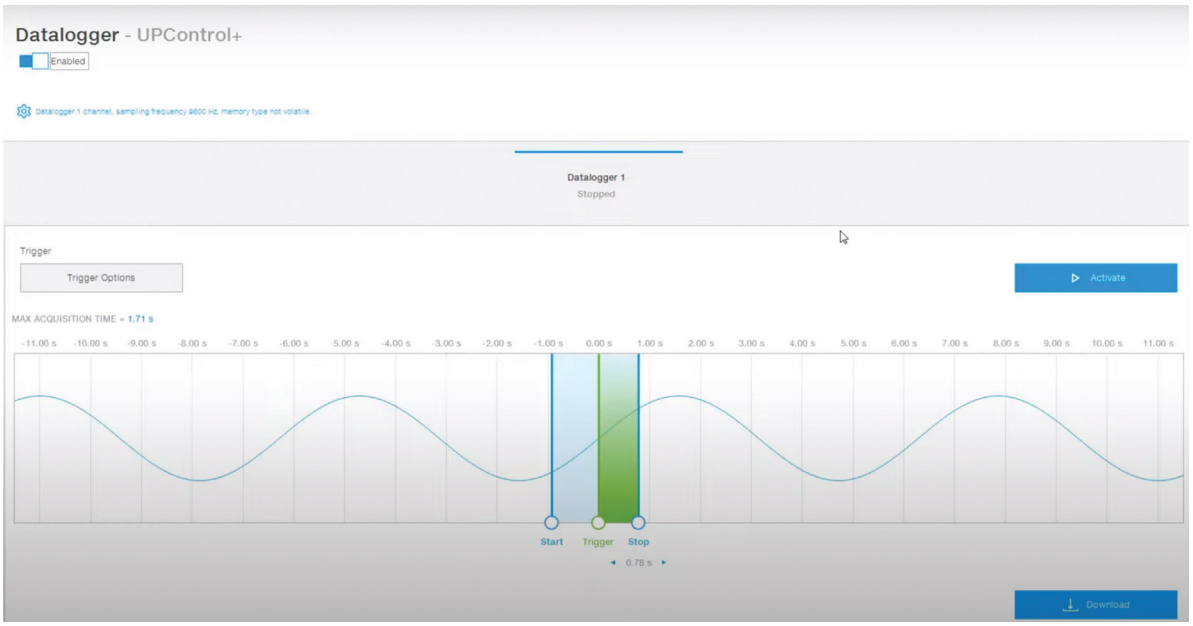
The Network Analyzer function continuously monitors energy quality and presents the results on a display or via a communication module.
To upgrade the trip units and achieve the required functionality, three different software packages are available for the breakers:

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

The information could be monitored through a laptop using Ekip Link

PQ functionality	
Harmonic analysis	Harmonic content of voltages, currents (measured to the 50th harmonic) and the total harmonic distortion value (THD) are available in real time.
Hourly average voltage values	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. If this limit exceeds the set threshold value, an event is stored and counted


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°
V1: 230.9 V 0.0°
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

Monitoring (AVC-20, AVC-40, UPS-I)

PCS products provide remote access for monitoring purposes

- **Integrated Web server.** The same information displayed on the HMI is available on any networked PC connected
- **Modbus TCP.** For connection to plant-wide SCADA or monitoring systems.
- **Email Connectivity.** An email notification service can be set up to send notifications about power quality and system events.

Remote monitoring provides information such as

- Product status
- Input/output measurement readings
- Detailed information about PQ events

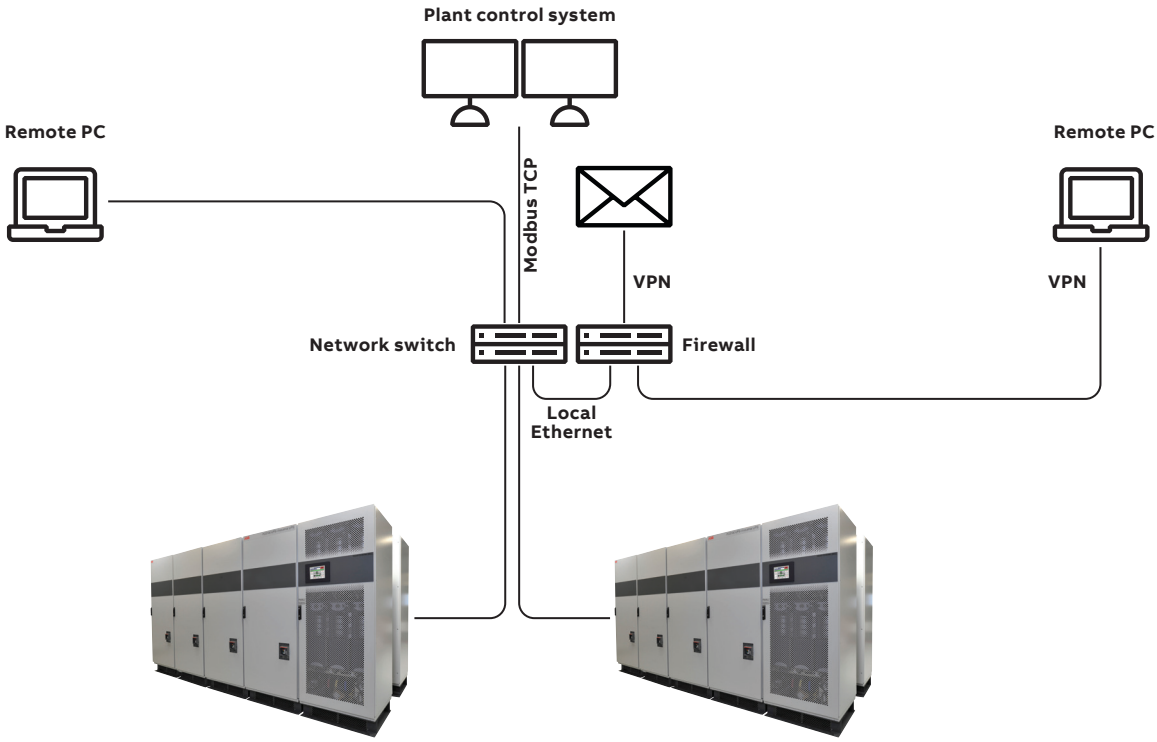


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ABB SACE S.p.A.
Via Pescaria 5,
24123 Bergamo
Italy

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