POWERSIDE®

Application Note

Remote Facility Monitoring

Many remote industrial, government, and military facilities depend upon electrical supply continuity and quality but lack on-site power engineering expertise and headquarters oversight. Powerside's PQube 3® power analyzer is a versatile, field-proven solution for persistent, real-time remote facility monitoring. It provides priceless transparency and actionable data to support operations.

Today, just about every facility of any economic, governmental, or military significance is in some way or other dependent for its performance on a constant, high-quality electricity supply. Sometimes, of necessity, facilities are located in remote or even in hostile territory, supplied with grid power of varying stability. Local utilities may lack the ability or, worse, the motivation to address problems before they become crises, and repair truck rolls may take hours or even days to arrive. Primary or backup gensets, or UPSs, are no panacea since they create an additional layer of complexity and may compound the risk of surprise outages. Generally lacking on-site power engineering expertise and out of contact with headquarters, life on the power security edge carries an elevated risk of bad outcomes.

In circumstances like these, knowledge is literally power. Whether a warehouse at the far end of a distribution network, or a diplomatic facility in unfriendly territory, or a communications facility in a war-zone, the requirements for managing remote installations are similar:

- Power and critical system operational status require visibility at headquarters 24/7/365 for the entire fleet
- Triggered event data and alerts to activate immediate corrective actions
- Leading-indicator sensors to enable fault avoidance and preventative maintenance (PM) planning
- Comprehensive trend and event data capture to accelerate root cause analysis and recovery planning
- Simple installation, versatile configuration, and global network integration
- Field-proven solutions and partners

Fortunately, there is a tried and tested solution for these requirements, which has been deployed across diverse mission-critical global applications.

PQube 3 a field-proven solution for remote facility monitoring

PQube 3 is a versatile monitoring solution for power quality, load metering, and sensor telemetry, figure 2. PQube 3's key characteristics include:

- Up to 14 AC source/load channels monitored by a single device
- Synchronized data capture across channels for unambiguous cause and effect determination
- Comprehensive power quality analysis per IEC 61000-4-30 Ed3 Class A
- Optional application-specific sensor modules: vibration, pressure, temperature, humidity, fluid level, facility intrusion
- 4 AC or DC custom sensor channels per unit, with options for more
- Event triggers with programmable thresholds
- Immediate alert transmission and actionable data: e.g. waveforms, switching transients, power instability
- Daily, weekly and monthly trend reports on key power indicators, and on alerts: e.g. power, voltage, current, transients, outages, harmonics, emissions, imbalance etc.
- Multi-channel load metering per ANSI C 12.20 0.2%
- A range of backhaul solutions and protocols: ethernet, modem, Modbus, email, IOT
- Robust data security protocols
- Optional UPS modules to ensure critical data is captured and transmitted post-outage

Figure 2: Powerside PQube 3 Power Analyzer module

Powerside customers have deployed 50,000+ PQube 3 systems in a wide range of mission-critical monitoring applications; some examples will serve to illustrate the versatility of the PQube platform for on-the-edge applications.

PQube 3 Application Examples

The typical sensor/analysis suite for monitoring a remote facility can include:

- Grid load: total facility voltage, current, and power, and comprehensive power quality
- Critical sub-loads: voltage, current, power, and power quality
- Environmental: temperature, humidity, vibration
- Genset: output, power quality, fuel level, starter battery voltage/current
- Solar: output, power quality, storage inflow/outflow
- Application-specific sensors, below

These sensors and analytics support four broad use cases, table 1.

Use Case	Supporting Data & Information	Sensors						
		Power Consumption	Subload consumption	Power Quality	Temperature & Humidity	Genset/solar monitoring	Genset fuel, battery I/V	Application-Specific
Operational Oversight "What is happening?"	Real time load, variation, and trends	x	x			x		
	Grid and/or backup feed status	x		x		x		
	Real time failure alerts, signature capture	x	x	x	x	x	x	x
	Facility ambient conditions				x			
Failure avoidance "What needs urgent attention?"	Grid and backup power quality events and trends	x		x		x		
	Documented genset and ATS performance tests	x	x	x	x	x	x	
	Genset fuel, battery voltage and charging current					x	x	
Failure recovery "What just happened?"	Failure detection and fault isolation	x	x	x	x	x	x	x
	Root cause/corrective action plan, fast parts logistics	x	x	x	x	x	x	x
Preventative Maintenance "What needs attention, & when?"	Remote PM: trend analysis	x	x	x	x	x	x	x
	On-condition PM scheduling and parts logistics	x	x	x	x	x	x	x

Table 1: Use cases and sensors for generic remote facility monitoring applications

Operational Oversight answers the most pressing questions for remote facilities: are systems running normally, and are there any immediate threats to regular operation? For example, grid and backup power supply status, and variations in total load and critical sub-loads, as well as application-specific and environmental sensors, describe below, are primary indicators of activity, everyday operation, or trouble. Genset output, fuel level, and battery charge status, or solar output, indicate readiness for and performance in grid-fail contingencies. Real-time alerts provide immediate actionable information directly to headquarters in failure or impending failure, figure 3.

Failure avoidance is a crucial advantage of remote facility monitoring; in the best case, pre-emptive action can mitigate symptoms of problems before they become crises. First, the integrity and quality of the local power supply is of over-riding concern. PQube 3 supports a comprehensive range of power quality analytics, capturing long term trends and transient events, such as lightning strikes, arcing, sags and swells, imbalances, frequency deviations, etc. In managing a local utility, as in maintaining backup power capability, the availability of incontrovertible cause and effect data, including event waveforms and trends, is fundamental to effecting durable improvement.

Second, Gensets and their associated automatic transfer switches are a common reliability problem since they sit idle for extended periods and may fail to start or to deliver quality power during an outage. While periodic test is a standard precaution, in-depth data capture, and documentation of each test is critical to ensuring that rigorous procedures (e.g., test duration, temperature, at-load) are followed. The capture of transient phenomena (startup, ATS performance, frequency stability) is also critical to ensure reliable operation and for directing fault recovery if necessary. Likewise, measurement of loads protected by a by-pass UPS can avoid the situation where the UPS fails immediately following grid failure due to unforeseen overload.

Failure recovery is generally slow and costly for unmonitored remote facilities. This is because root cause investigation can't begin until an engineer is on-site, which may take hours, or days. Furthermore, lack of a clear signature of failure, or trend data, lengthens root cause analysis; in the worst case, faults and/or root causes may be overlooked, leading to repeat failures. Finally, once identified, replacement parts may take time to ship resulting in overall extended downtime and high costs. In contrast, remote monitoring enables fault isolation, root cause determination, fault containment decisions, and replacement parts logistics to commence just as soon as the failure is identified at headquarters. Even if a site visit is required to confirm the diagnosis, the engineer arrives knowing what may be at fault, what is known not to be at fault, and with appropriate know-how and replacement parts; therefore, the recovery process is accelerated.

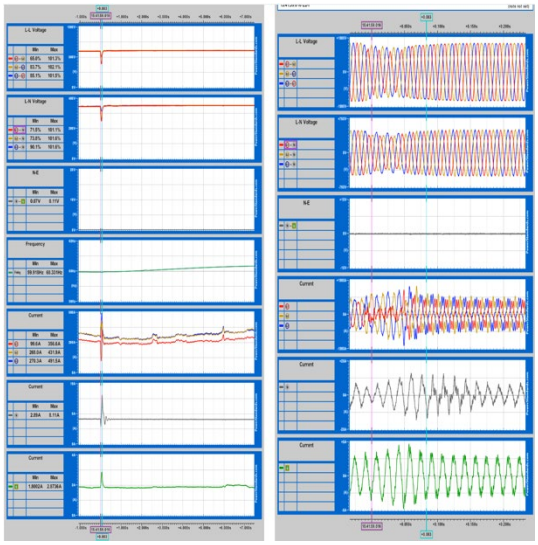

Figure 3: PQube 3 delivers alerts with rich snapshot data to support immediate remote root cause analysis

For example, consider an event where a load fails to start; or abruptly stops, at a remote site. Seen immediately at headquarters, voltage and current waveforms determine whether the fault is on the supply or the load side, whether the fault was due to a power quality transient or to equipment failure, and identify which phase or phases were involved and for how long. From a fault containment standpoint, if a utility disturbance clears itself, then a restart attempt may be acceptable. In contrast, in the case of a persistent equipment fault (e.g., a stuck phase contactor), an imbalanced restart attempt could result in equipment damage and would be prevented. In either case, failure recovery planning commences immediately, either with a data-driven discussion with the utility or by dispatch of maintenance resources with the right know-how and parts.

Finally, time-based PM for un-monitored remote facilities can be inefficient and costly. While air filters need regular replacement or cleaning, more expensive components often wear out at rates dependent on utilization as well as temperature and load. Remote analysis of power and sensor trend and utilization data (e.g., hours run at temperature) enables optimized on-condition PM scheduling, reducing both parts and labor costs while protecting uptime.

Figure 4: PQube is used to monitor remote ATC RADAR facilities

Application-specific sensors

Table 2 provides some examples of application-specific sensors and use cases that PQube 3 supports. Because PQube 3 has general-purpose analog (AC & DC) and digital sensor collection capability, the list is illustrative and not exhaustive. As can be appreciated, a wide range of application-specific leading indicators of failure can be measured and reported, providing significant reliability, uptime, and operating cost benefits.

Application/Location	Sensors/Analytics	Use Cases
Food storage	Refrigeration load Temperature	Operating status, cost management Avoided spoilage
Warehouses	Load & variation AGV charging Temperature, Humidity	Operational/systems oversight Transient/failure detection Avoided spoilage, shutdowns
UPS	Protected loads	Avoided UPS overload trip-outs if grid fails
Power quality	Noise and harmonics Consumption, power factor Outages, load changes	Utility management, failure avoidance Equipment reliability, avoided penalties Fault mitigation and recovery planning
Security	Loads and sub-loads Door sensors	Activity detection Intruder detection
Rotating machinery RADAR systems	Vibration, Load	Activity, wear measurement Preventative Maintenance planning

Table 2: Examples of application-specific sensors and use cases

Conclusion

Predictable performance of remote facilities depends upon expert fleet oversight from afar. Automated monitoring provides data necessary to establish plant status in real time, detect and anticipate fault conditions, recover from failures most efficiently, and optimize preventative maintenance. With power analytics and application-specific sensors, fleet operators have the leading indicators they need to accomplish their cost and uptime improvement goals.

PQube 3 has been deployed in many remote, mission-critical monitoring situations, from civilian warehouses to military ATC RADAR, from post-war mobile phone cell towers to ships at sea, from oil exploration and mining to power quality monitoring for the US Baseball World Series. These applications' range and significance attests to the versatility, value, ease of use, and dependability of PQube 3 power analyzer.

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