## Your Trusted Partner in Automation

Moxa is a leading provider of industrial networking, computing, and automation solutions for enabling the Industrial Internet of Things. With over 25 years of industry experience, Moxa has connected more than 30 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for industrial communications infrastructures.


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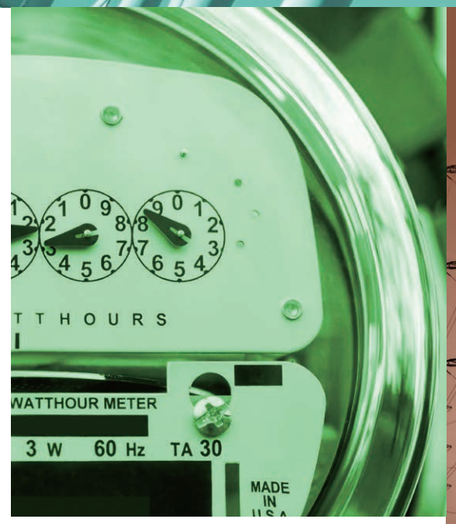
MOXA®
Reliable Networks ▲ Sincere Service

# IEC 61850 Communication and Computing Solutions for Substation Automation Systems

MOXA®
Reliable Networks ▲ Sincere Service






# Moxa and the Smart Grid

## *Connect To The Smart Grid Today*

Create rock-solid and future-proof power networks by partnering with Moxa. You can rely on our over 25 years of expertise in proven solutions that include power-hardened products. Moxa's products are toughened for harsh environments, ensuring consistent operations even in the most demanding conditions. Tap into Moxa's expertise in device control, computing, and communications to easily build an efficient and effective smart grid.

Moxa is a Collective Member of CIGRE and has delivered communication and computing solutions to over 500 successful power transmission and distribution applications around the world. Moxa is now the leading solar energy monitoring supplier in North America and has many diverse projects in advanced metering infrastructures worldwide. You can rely on our expertise of more than 25 years in proven solutions in the following industrial applications.

## Application Focus

- Solar power
- Wind power
- Power transmission and distribution
- Advanced metering infrastructure

## Leading Technologies

- Industry's first IEC 61850 switch with MMS data modeling: MMS management with integrated network monitoring solutions for power substation SCADA applications
- Noise Guard: The world's only wire speed zero packet loss technology that exceeds IEEE 1613 class 2
- Industry's first integrated PRP/HSR redundancy box and computer with zero recovery time
- Turbo Ring and Turbo Chain: Self-Healing redundancy technology ensures non-stop wind power operation
- Patented computing platform for heat dissipation with wide temperature tolerance
- Cloud management for solar energy monitoring

# IEC 61850 Makes Substations Smarter

The goal of IEC 61850 is to transform the electricity distribution industry by building more intelligence and more complete automation into power substations. With intelligent electronic devices (IED), it's possible to extend new controls and automation deep into the substation's process layer, thus allowing for real-time monitoring and management from a centralized remote control hub.

According to IEC 61850, an intelligent substation is characterized by these three basic features:

- All primary substation machinery (switchgear, transformers) are engineered with a relatively high level of device intelligence.
- All secondary devices are networked.
- All routine operations and management are fully automated.

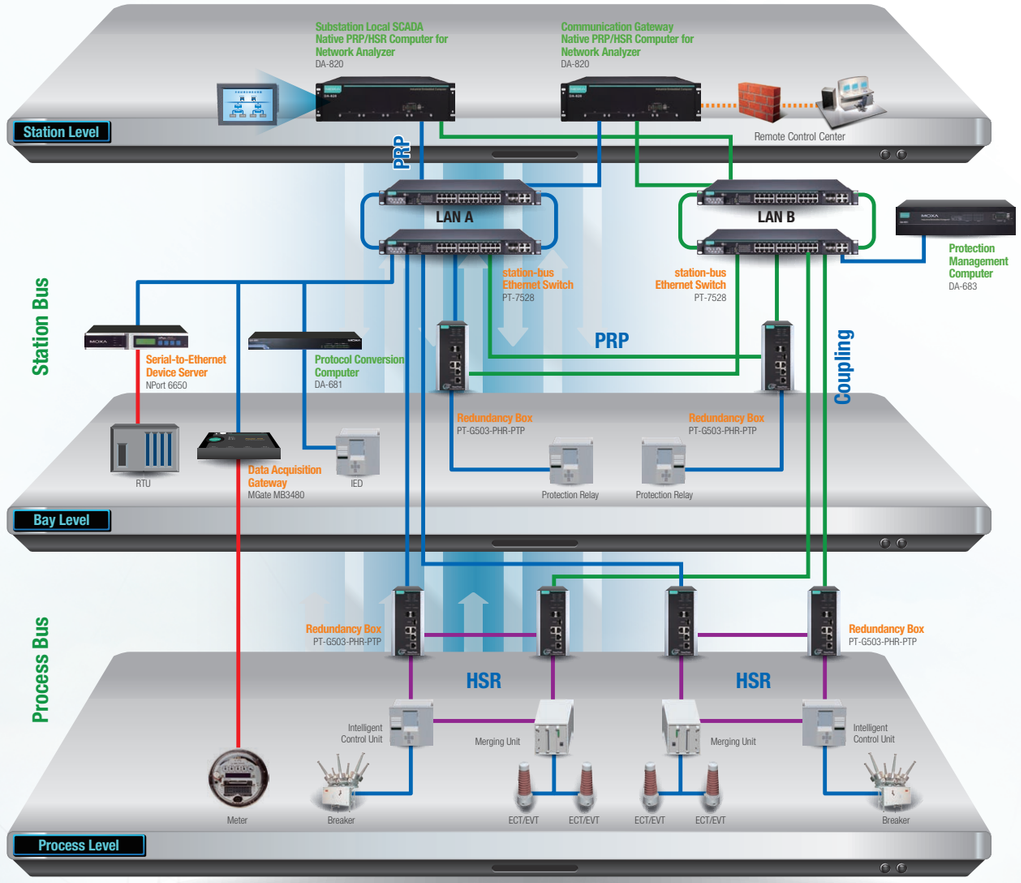
To meet these objectives, the IEC 61850 standard stipulates that power substations will use Ethernet switches and embedded computers for data communications and computing all throughout the station, bay, and process levels. Because commercial devices are far too frail for the demanding conditions of a power substation environment, devices specifically engineered industrial applications and optimized for use in power substations are required.

## Communication Solutions:

- Secondary Device Networking
- IEEE 1588 Transparent Clock
- Protocol Converter

## Computing Solutions:

- Back-end Host
- Communication Gateway
- Protocol Converter
- Protection Management Computer



# Maximize System Availability: Tackling Errors in Substation Automation Systems on Three Fronts

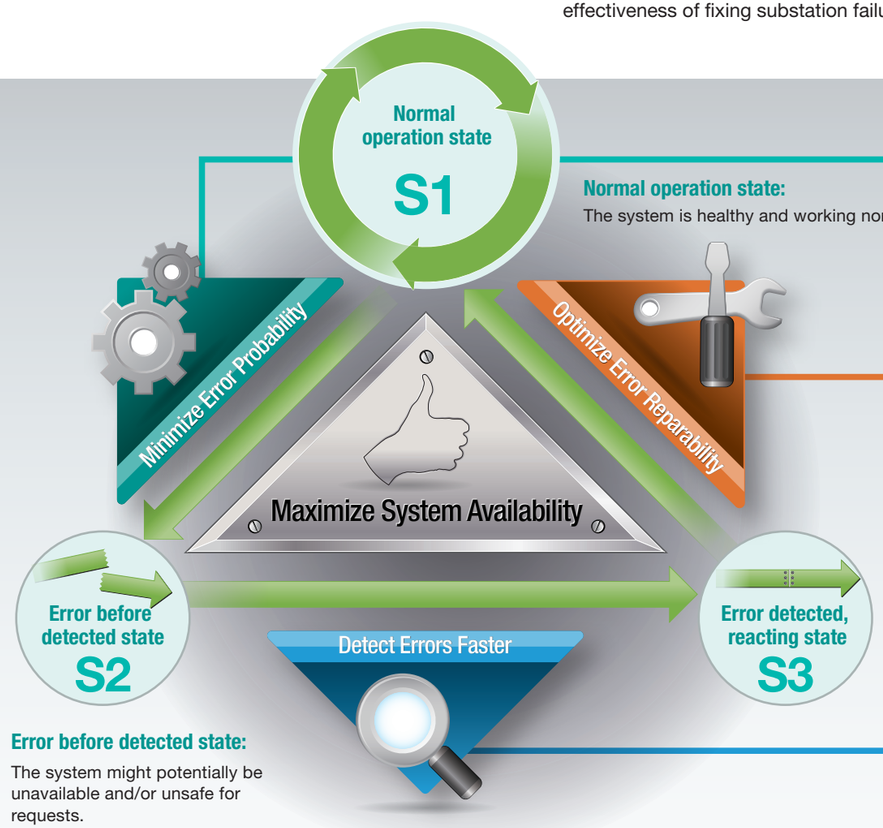
Maximizing a power substation's availability and safety is the ultimate goal for both transmission grid operators and SAS (Substation Automation System) integrators. A properly optimized SAS ensures safe and continuous operation of substations.

## A substation's daily operation can be in one of three states:

- State 1 is when the system is healthy and working properly.
- State 2 is when the system encounters errors that reduce availability and/or make it unsafe.
- State 3 is when a State 2 error has been detected and measures are being taken to make the system available, to return it to State 1.

An optimized SAS can maximize substation availability through three approaches

- **Minimize Error Probability:** Cut the possibility for errors in any way possible.
- **Detect Errors Faster:** Increase the speed at which errors are detected, thereby minimizing interruptions to the smallest possible window.
- **Optimize Error Reparability:** Increase the efficiency and effectiveness of fixing substation failures.




**Normal operation state:**
The system is healthy and working normally.

**Error detected, reacting state:**
The failure of the system has been detected and measures are being taken to make the system safe again.

**Error before detected state:**
The system might potentially be unavailable and/or unsafe for requests.



# Moxa Solutions Make Smart Substations Even Smarter

This brochure examines some key application scenarios that involve availability and safety, and considers the practical concerns electricity suppliers must account for when planning substation upgrades. As the conceptualization above indicates, in each case the focus is on how Moxa's communication and computing solutions best minimize error probability, detect errors faster, and speed up fault corrections within the context of IEC 61850.

## Minimize Error Probability

**Communication**
- PRP/HSR Seamless Redundancy
- Wire Speed Zero Packet Loss Technology
- IEC 61850 QoS
- Substation Configuration Wizard

**Computing**
- Patented Fanless Thermal Design
- IEC 61850-3 and IEC 60255 Compliant

## Detect Errors Faster

**Communication**
- IEC 61850 Switch Modeling for Power SCADA
- ST/SC/SFP Fiber Diagnosis

**Computing**
- PRP/HSR Monitor and Control Intelligence
- SNMP-based Self-Health Management and Alert
- IEC 61850 Computer Modeling for Power SCADA

## Optimize Error Reparability

**Communication**
- Modular Design to Minimize MTTR (Mean Time To Repair)
- Turbo Ring/Turbo Chain 20 ms Fast Redundancy

**Computing**
- OS Smart Recovery: Troubleshoot Remotely and Fast

# Minimize Error Probability

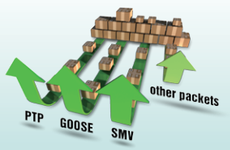
## PRP/HSR Standardized Protocols for Zero Recovery Time

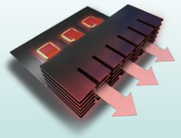
Compliant with the IEC 62439-3:2012 standard, Moxa has developed the industry's first integrated PRP/HSR redundancy box (RedBox) and native PRP/HSR computer for mission-critical applications in SAS communication. See pages 9 and 10 for more benefits.

## Noise Guard™: Wire-Speed Zero Packet Loss Technology

To meet IEEE 1613 Class 2 requirements, network devices must have a level 4 EMC rating to guarantee they will reliably tolerate high EMI conditions.

- **Mechanical Design: Integrated housing for better conduction**
- **Customized Components: Newly redesigned fiber transceiver**
- **Enhanced Power Supply Unit: Optimized circuit design and upgraded components**


Noise Guard™ | IEC 61850 QoS | Patented Fanless Thermal Design | PRP/HSR

## Substation Configuration Wizard

To enable a reliable and effective configuration especially for substation applications, simplifying and streamlining the configuration process makes a lot of sense: by reducing the configuration interface to only the relevant network features setup and maintenance become much more efficient. Moxa's Ethernet switches support a browser-based configuration wizard, making it possible to deploy one of our network devices in as little as 7 steps.

## IEC 61850 QoS: Substation Automation Packet Priority

Substation automation devices must communicate critical IEC 61850 multicasts (GOOSE/SMV) with the highest priority, without fail. Prioritizing the transmission of GOOSE/SMV packets guarantees that these messages are clearly received without distortion throughout the entire network, regardless of what other communications may be currently congesting the lines. Ping-based solutions are not sufficient to achieve this. To comply with the IEC 61850 standard, substation switches must support strong QoS traffic shaping.

- Critical packets can be prioritized in different levels
- Packet types: GOOSE, SMV, PTP
- Packet priorities: High, medium, normal, low



## Patented Fanless & High-efficient Heat Dissipation Design

A major worry for any system that depends on high performance computers are burnouts caused by failed fans or clogged grills. Ideally, a substation computer should be fully sealed from the outer environment and not require a fan in any capacity. This extends its life significantly, but is complicated by the extreme heat that is often generated in substation environments. Engineers must therefore work to situate the PCB's highest thermal concentration in the very center of the device, so that heat has the largest immediate area available to dissipate into. With fanless systems, generally the entire outer shell is utilized as one large heat sink, with careful analysis and adjustment of fin heights, gaps, thicknesses, and points of contact to further optimize dissipation. All of these factors must be carefully evaluated and adjusted to achieve maximum dissipation efficiency.

## IEC 61850-3 Compliant

The IEC 61850-3 and IEEE 1613 standards precisely define EMC and communication requirements for network equipment used in power substations. Substation computers and Ethernet switches must be IEC 61850-3/IEEE 1613 compliant to guarantee adequate protection against a variety of environmental conditions.

### These minimum requirements include:

- Level 4 EMC, for stronger protection against electrical interference
- -40 to 75°C ambient temperature tolerance
- High tolerances for constant vibrations and shocks

## IEC 60255-22 Compliant

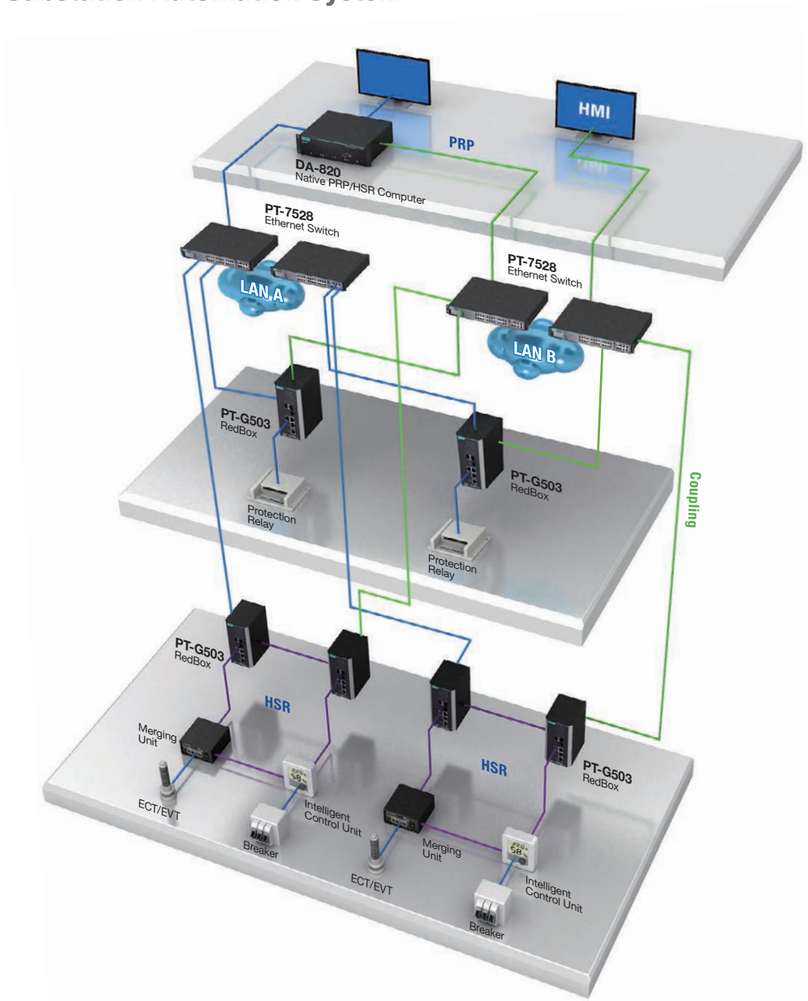
The IEC 60255 standard specifies the requirements for measuring relays and protection equipment used in power system protection. In power substations, embedded computers also act as a protocol conversion gateway to relay signals between protection and control IEDs. Therefore, these embedded computers must be type tested against related standards such as IEC 60255-11, IEC 60255-22-1, IEC 60255-22-2, IEC 60255-22-3, IEC 60255-22-4, IEC 60255-22-5, IEC 60255-22-6, IEC 60255-25.

# Enabling Efficient and Visually Represented PRP/HSR Network Management

## Integrated PRP/HSR Communication Computing Solution

Although there is a unified standard for PRP/HSR protocols, there is no standard for the network management interface. Thus, using a native PRP/HSR management server with a built-in management middleware can help collect, analyze, and integrate all raw data from various devices on one single management platform. This makes network diagnosis, troubleshooting, and device monitoring easier than ever.

## PRP/HSR Substation Automation System




## Built-in PRP/HSR Management Middleware to Monitor and Troubleshoot Redundant Network Health

Built-in PRP/HSR management middleware should support both SNMP and MMS interfaces to allow the connection of a variety of substation devices (e.g., IEDs, embedded computers, Ethernet switches) that use different communication protocols. The integration of the middleware and Power SCADA makes it easier for data to be used and read into the substation Power SCADA system through the MMS protocol. Substation operators can easily manage all the devices in their PRP/HSR system using the Power SCADA's visual tools. In addition, troubleshooting becomes simple since any single point of failure can be shown on the Power SCADA diagram, making the SAS or any other PRP/HSR application more reliable and stable.

## Benefits of Moxa's Integrated PRP/HSR Technology

### Versatile and Scalable PRP/HSR Redundancy Box

- IEC 62439-3 Clause 4 (PRP) and Clause 5 (HSR) Compliant
- All-in-one device supporting Gigabit, Coupling, QuadBox, and PTP for maximum scalability
- MMS server built-in for power SCADA integration
- Designed for NERC CIP-compliant system development

### Native PRP/HSR Computer

- Power SCADA host without single link failure
- Built-in PRP/HSR management middleware for monitoring and troubleshooting redundant network
- Visual representation of PRP/HSR devices to enable efficient network management

# Detect Errors Faster

## SNMP/MMS Management: Integrated Network Monitoring Solutions for Power Substation SCADA

With MMS-capable platform, substation SIs and automation engineers will be able to render a full accounting of the entire network of automation devices right alongside process layer information, all under a single SCADA view. Because substation systems will no longer need to resort to installing and configuring separate NMS software for networking devices, station operators will achieve the combined benefits of more thorough automation integration, improved management efficiency, and savings on deployment costs. Integrating networking devices via MMS makes substation networks more controllable, more flexible, and more responsive.

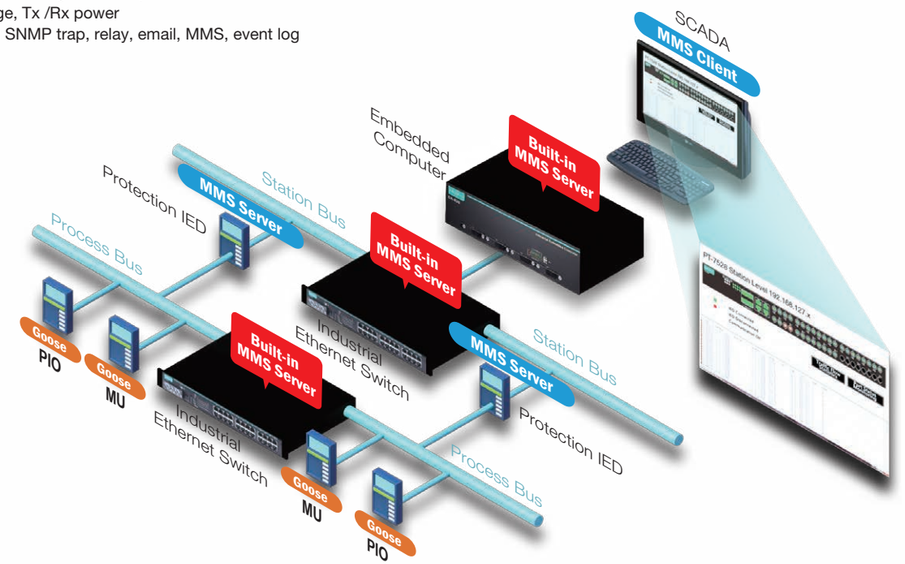
### Administrators may now use MMS to:

- Monitor and control IEDs, switches, embedded computers, device servers, and process data from a single power SCADA interface
- Configure devices for event triggers, polling reports, or both
- Precisely locate devices relative to other devices within the network hierarchy in a single software view
- Directly configure and control networking devices from the SCADA system
- Batch configuration by CID (Configured IED Description) files

## Fiber Check™: A Fiber Digital Diagnostic Monitoring (DDM) Tool

Using Fiber Check™, a fiber Digital Diagnostic Monitoring (DDM) tool, Moxa's IEC 61850 substation switches can monitor ST/SC as well as SFP (LC) connectors, and notify power SCADA systems via SNMP trap or MMS when abnormalities are detected, allowing operators to initiate maintenance procedures. Fiber Check™ reports and alarms can be communicated via web, CLI, or serial console, via MMS reporting or SNMP traps, by a digital relay, or in the system log. This arrangement further allows system operators real time monitoring of transmission and reception power, temperature, voltage/current along optical fiber connections, and similar items.

- Fiber status monitoring: fiber temperature, working voltage, Tx /Rx power
- Auto-warning: SNMP trap, relay, email, MMS, event log




## SYNMAP: SNMP-based Self-Health Management and Alert

Synmap is Moxa's revolutionary software virtualization for industrial computers, an evolutionary advance in network device control that adapts solid, reliable SNMP into a fully portable remote procedure interface. Synmap not only provides SNMP functionality, but also allows remote monitoring and control of device internals like temperature, BIOS parameters, and local interfaces. Synmap is SNMP-based health management and alert software, and Synmap devices are a flexible and cost-effective upgrade that returns obvious benefits to any IA network.

SYNMAP

**CPU Usage Alert**
When CPU usage exceeds a threshold over a period of time (usage threshold and time period defined by the user).

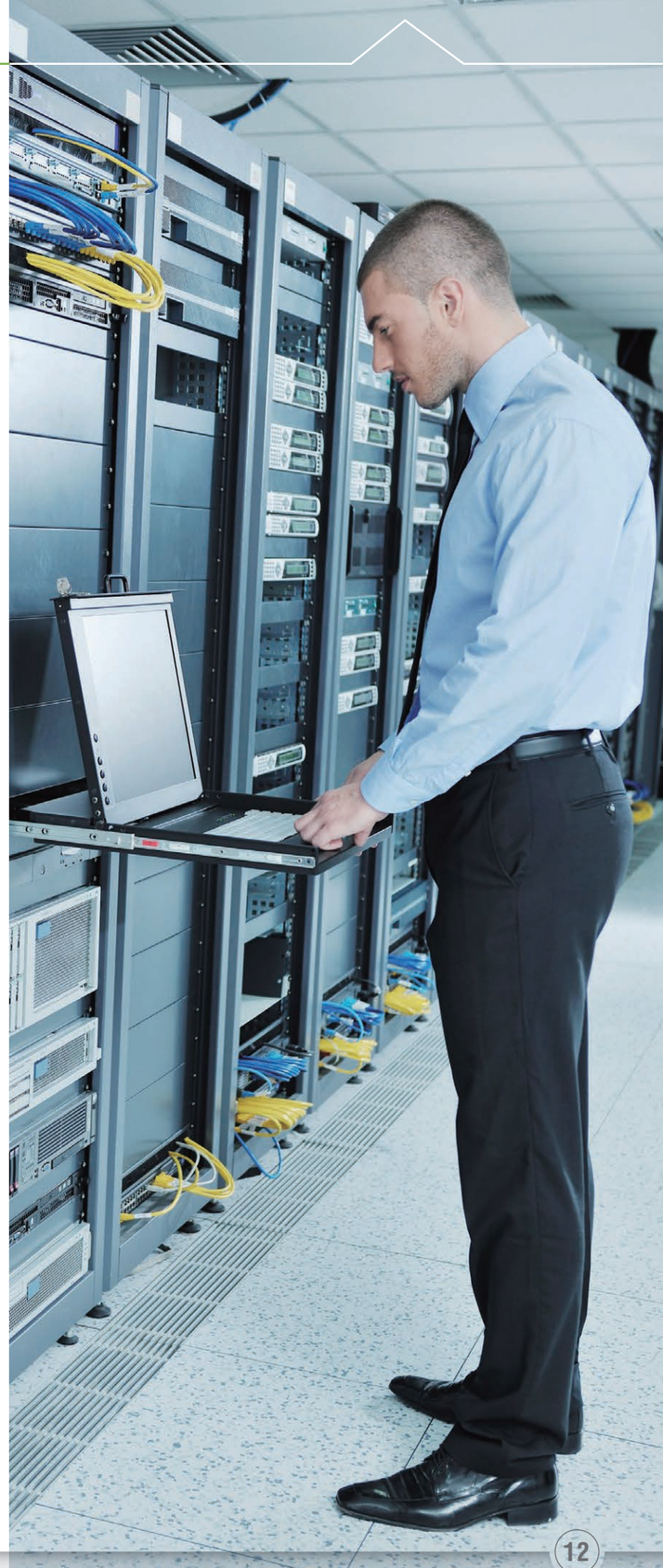
**Temperature Alert**
When the system temperature exceeds a user-defined threshold over a configured time period.

**Memory Usage Alert**
When memory usage exceeds a specified threshold over a configured time period.

**Storage Drive Alerts**
Thresholds may be configured for S.M.A.R.T. values, including dwindling storage capacity.

## PRP/HSR Monitor and Control Intelligence

Moxa's rackmount substation computers are compliant with the IEC 62439-3:2012 standard for mission-critical applications in SAS communication. PRP and HSR modes are implemented in a standard PCIe interface expansion card, so that the network status of Moxa's PRP/HSR nodes can be monitored by substation computers. See pages 9 and 10 for more benefits.



# Optimize Error Reparability

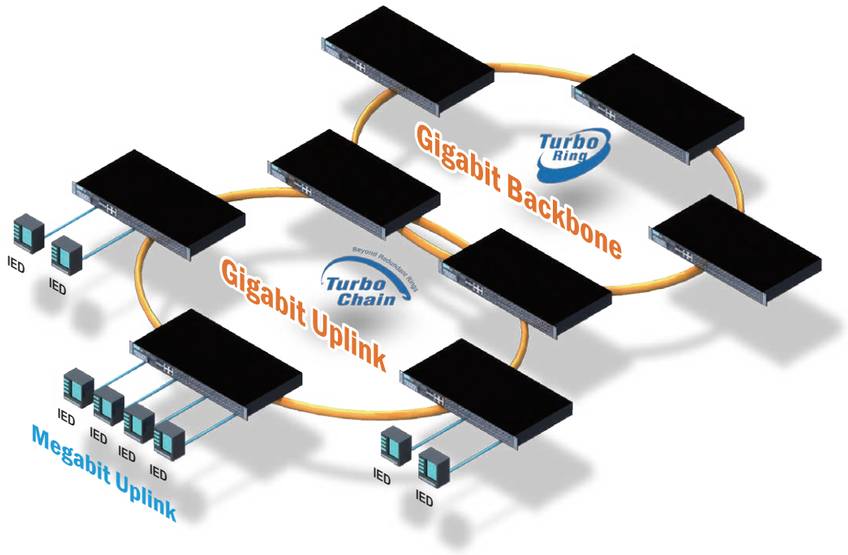
## Modular Design for a Better MTTR (Mean Time To Repair)

A modular design is easier to maintain since engineers can make quick field-site replacements by swapping out modules. The benefits for the end user are less system downtime and a better MTTR value.

## 20 ms Fast Redundancy with Turbo Ring™ and Turbo Chain™

Moxa's Turbo Ring™ and Turbo Chain™ are field-proven redundancy technologies that enable fast fault recovery under 20 milliseconds at a full load of 250 switches. Turbo Chain™ is extremely versatile and can accommodate any type of complex network topology, allowing you to quickly expand your network in a very cost-effective way to create as many redundant connections, such as STP, RSTP, and Turbo Ring™, as needed. This type of deployment is an ideal solution for substation buses that require network redundancy and have budget considerations and cabling difficulties associated with coupling.

- **Fast fault recovery < 20 ms (50 ms @ Gigabit connection)**
- **Unlimited redundant network expansions**
- **Live node expansion without network interruptions**
- **Tremendous savings on cabling costs**




## OS Smart Recovery: Fast Remote Troubleshooting

Driven by smart grid integration, unmanned substations are the trend for substation automation. In an automated substation, a computer manages the complex automation systems that include the IEDs, protection relays, merging units, fault recorders, GOOSE/SMV analyzers, environmental controls, and surveillance.

Knowing how to easily troubleshoot system software errors on computers to minimize downtime is crucial for maintaining a reliable system.

Some estimate that computer failure attributable to software corruption is as high as 30%. Thus, without a smart OS software recovery system, corruption of system software—whether in the OS or in local substation applications—can mean catastrophic failure for remote industrial installations and sites with mass computer deployments.

Although a range of commercial backup and recovery software is available on the market, the setup procedure is complex and manual operation is still required to restore a failed computer.

Moxa Smart Recovery™ is an automated BIOS-level software recovery system that allows engineers to automate the remote monitoring of a computer's health and to trigger OS recovery automatically. Moxa Smart Recovery™ is an extremely valuable addition to power substation installations.

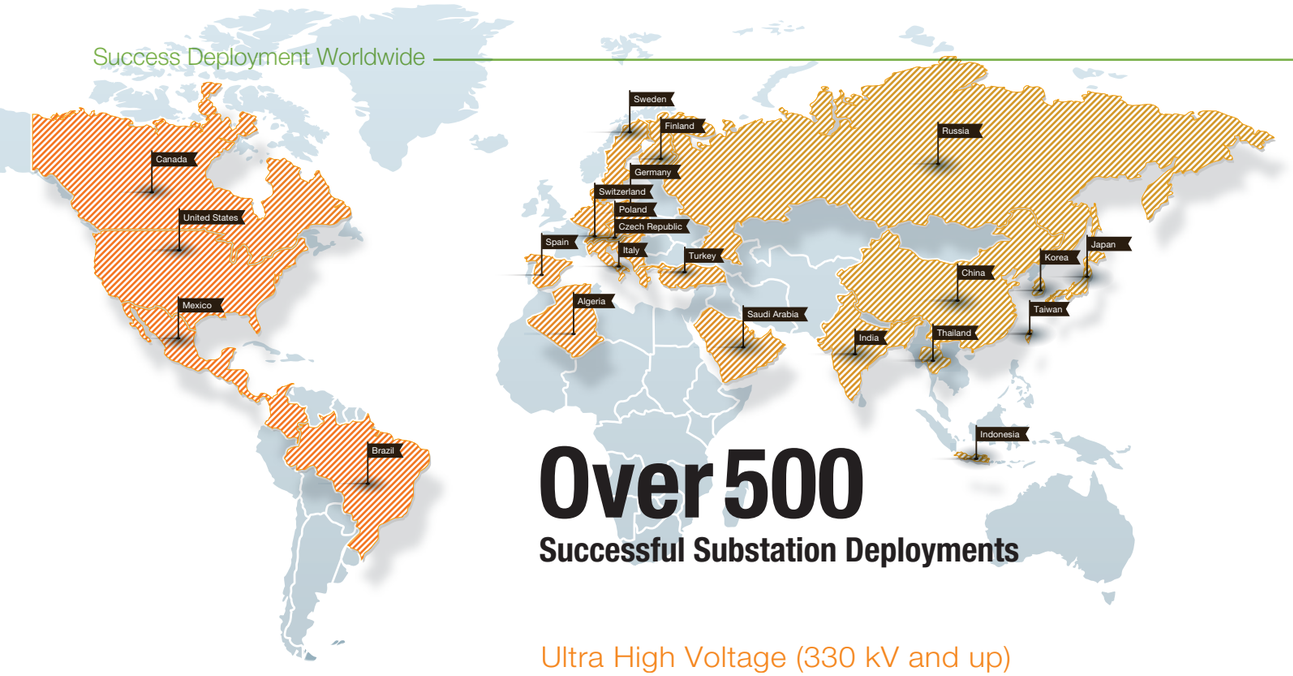
- One-click OS image generation tool
- Automatic or one-click Moxa smart recovery tool

**Power shutdown:**
- Auto boot up

**System slowdowns:**
- Configure recovery periods to speed things up

**Bootable but damaged systems:**
- Configure a rewrite procedure that will let you know if the damage is in the hardware or software

**System crash and boot failure:**
- Use auto-recovery to verify if the problem is hardware or software related, and resurrect the computer if it's a software problem




# Over 500

## Successful Substation Deployments

### Ultra High Voltage (330 kV and up)

| Territory | Type | End User |
|---|---|---|
| Poland | Utility | Lublin, Poland, 400 kV Substations |
| India | Utility | Nabinagar, India, 415 kV Substation |
| Algeria | Utility | Sonelgaz, 400 kV IEC 61850 Substation |
| Ukraine | Enterprise | Ukraine, 750 kV Kiev Substation |
| China | Utility | Anxi, Gansu, China, 750 kV IEC 61850 Substation |
| China | Utility | Suzhou, Jiangsu China IEEE 1588v2 500 kV Substation |
| China | Utility | Nanyang City, Henan Province, China, 500kV/220kV/35kV step-down substation |
| China | Utility | Jiuquan, Gansu, China, 750 kV Substation |
| China | Utility | Dezhou, Shandong, China, 500 kV Substation |
| China | Utility | Anxi, Gansu, China, 750 kV IEC 61850 Substation |

### High Voltage (330 kV to 220/110 kV)

| Territory | Type | End User |
|---|---|---|
| Poland | Utility | Lubocza, Poland, 220 kV Substations |
| Poland | Utility | Wrocław, Poland, 220 kV/110 kV Substations |
| Poland | Utility | Boguchwała, Poland, 220kV Substations |
| India | Utility | Delhi, India, 220 kV Substation |
| Russia | Utility | Russia,TVER Nuclear Plant 220 kV Substation |
| Russia | Utility | Russia,Smolenskaya NPP |
| Russia | Utility | Russia, Volga Hydro Power Station |
| Korea | Utility | YoungWol, Korea, 141 kV Substation |
| Korea | Utility | Korea (YoungWol), Korea Southern Power Co., Ltd. (KOSPO), 154 kV Substation |
| China | Utility | Xijing City Power, World's 1st IEEE 1588v2 200 kV Substation |

### Medium/Low Voltage (220/110 kV to 35 kV)

| Territory | Type | End User |
|---|---|---|
| USA | Utility | Longmont, Colorado, USA United Power, 34.5 kV, 115 kV, and 230 kV |
| USA | Utility | Longmont, Colorado, USA United Power, 34.5 kV Substation |
| USA | Utility | Longmont, Colorado, USA United Power, 115 kV Substation |
| USA | Utility | Longmont, Colorado, USA United Power, 230 kV Substation |
| Germany | Utility | Germany, 110 kV Substations |
| India | Utility | India, 66/131/220 kV Substations |
| China | Enterprise | Jinan Stainless Steel Works, 35 kV/10 kV |
| China | Enterprise | Shanghai Pudong Airport, 35 kV Substation |
| China | Utility | Shanghai, China, 110 kV Substation |
| Russia | Enterprise | Berezovskie Elektricheskiye Seti, LLC. 110 kV Substation |
| Taiwan | Enterprise | Hsinchu, Taiwan Semiconductor, 10 kV/35 kV Substation |
| Indonesia | Utility | Bali, Jakarta, and Bandung, Indonesia, 10 kV/35 kV Substation |

# IEC 61850-3 Ethernet Switches

| | PT-7728-PTP | PT-7828 | PT-7728 | PT-7528 | PT-7710 | PT-G7509 | PT-508/510 | PT-G503-PHR-PTP | EOM-G103-PHR-PTP |
|---|---|---|---|---|---|---|---|---|---|
| **Number of Ports** | | | | | | | | | |
| Max. Number of Ports | 28 | 28 | 28 | 28 | 10 | 9 | 8/10 | 3 | 3 |
| Max. Number of Hardware PTP Ports | 14 | – | – | – | – | – | – | 3 | |
| Gigabit Ethernet, 10/100/1000 Mbps | Up to 4 | Up to 4 | Up to 4 | Up to 4 | Up to 2 | 9 | – | 3 | 3 |
| Fast Ethernet, 10/100 Mbps | Up to 28 | Up to 28 | Up to 28 | Up to 28 | Up to 10 | 9 | 8/10 | | |
| **Power Supply** | | | | | | | | | |
| 12 VDC | | | | | | | | | Evaluation board power input |
| 24 VDC, isolated | ✓ | ✓ | ✓ | – | – | ✓ | ✓ | – | |
| 48 VDC, isolated | ✓ | ✓ | ✓ | – | – | ✓ | ✓ | – | |
| 12/24/48 VDC | – | – | – | – | ✓ | – | – | – | |
| 24/48 VDC, isolated | – | – | – | ✓ | – | – | – | ✓ | |
| 88-300 VDC or 85-264 VAC, isolated | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **Installation Options** | | | | | | | | | |
| Rack Mounting | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | |
| Panel Mounting | – | – | – | – | ✓ | – | w/ optional kit | w/ optional kit | |
| DIN-Rail Mounting | – | – | – | – | – | – | ✓ | ✓ | |
| **Operating Temperature** | | | | | | | | | |
| -40 to 85°C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **Redundancy and Backup Options** | | | | | | | | | |
| PRP/HSR (Recovery Time 0 ms) | – | – | – | – | – | – | – | ✓ | ✓ |
| Turbo Ring/Turbo Chain (Recovery Time < 20 ms) | ✓ | ✓ | ✓ | ✓ | ✓ | – | ✓ | – | – |
| Turbo Ring/Turbo Chain (Recovery Time < 50 ms) | – | – | – | – | – | ✓ | – | – | – |
| STP/RSTP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| Automatic Backup Configurator (ABC-01) | ✓ | ✓ | ✓ | – | ✓ | ✓ | ✓ | – | – |
| Automatic Backup Configurator (ABC-02) | – | – | – | ✓ | – | – | – | ✓ | – |
| Ethernet console port | – | – | – | – | – | – | – | ✓ | ✓ |
| **Network Management and Control** | | | | | | | | | |
| VLAN Filtering | – | – | – | – | – | – | – | ✓ | ✓ * |
| Multicast Filtering | – | – | – | – | – | – | – | ✓ | ✓ * |
| Layer 3 Switching | – | ✓ | – | – | – | – | – | – | – |
| IPv6 | ✓ | – | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| DHCP Option 66/67/82 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| NTP/SNTP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ * |
| Software-based IEEE 1588v2 PTP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| Hardware-based IEEE 1588v2 PTP | ✓ | – | – | – | – | – | – | ✓ | ✓ |
| LLDP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ * |
| Modbus TCP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| EtherNet/IP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| IGMP/GMRP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| Port Trunking | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| IEEE 802.1X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| Port Lock | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| TACACS+/RADIUS | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ * |
| Port Mirror | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | by Ethernet console port | by Ethernet console port |
| SNMP/RMON | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ * |
| VLAN | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| QoS | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – |
| Relay Warning | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Standards and Certifications** | | | | | | | | VLAN/Multicast Filtering | |
| CE/FCC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| UL/cUL 60950-1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – | – | – |
| UL 508 | – | – | – | – | – | – | ✓ | ✓ | – |
| IEC 61850-3 (Power Substation) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| IEEE 1613 (Power Substation) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| 50121-4 (Way-side Applications) | – | ✓ | ✓ | ✓ | ✓ | – | – | ✓ | – |
| EN 50155 (Railway Applications) | – | ✓ | ✓ | – | ✓ | – | – | – | – |
| NEMA TS2 (Traffic Control System) | – | ✓ | ✓ | ✓ | ✓ | – | – | – | – |

* Evaluation board required

# Computers for Power Transmission and Distribution

| | DA-820 Series | DA-685 Series | DA-710 Series | DA-681 Series | DA-682A Series | DA-683 Series | DA-660 Series |
|---|---|---|---|---|---|---|---|
| **Computer** | | | | | | | |
| CPU Speed | 2.5/2.1 GHz | 1.66 GHz | 2 GHz | 1 GHz | 1.4/1.1/1.5 GHz | 1.66 GHz | 533 MHz |
| OS (pre-installed) | Optional | WinXPE Emb, W7E or Linux | WinXP Emb. or Linux | WinXP Emb. or Linux | W7E or Linux | WinXP Emb., W7E or Linux | Linux |
| DRAM | – | – | – | – | – | – | 128 MB |
| FSB | – | 667 MHz | 533 MHz | 400 MHz | – | 667 MHz | |
| Flash | | – | – | – | – | – | 32 MB |
| System Memory | Optional | 1 GB (2 GB max.) | 1 GB (2 GB max.) | 512 MB (1 GB max.) | 1/2 GB (4 GB max.) | 1 GB (2 GB max.) | – |
| PCMCIA | – | – | – | – | – | – | – |
| Expansion Bus | 6 slots | – | 4 slots | – | 2 slots | 2 slots | – |
| USB Ports | 6 (USB 2.0) | 2 (USB 2.0) | 4 (USB 2.0) | 2 (USB 2.0) | 4 (USB 2.0) | 4 (USB 2.0) | 2 (USB 2.0, DA-662) |
| Digital I/O | | 4 DIs, 4 DOs | 4 DIs, 4 DOs | – | – | 4 DIs, 4 DOs | – |
| Analog I/O | – | – | – | – | – | – | – |
| **Storage** | | | | | | | |
| Built-in | – | 2 GB (DOM) | 2 GB (DOM) | 2 GB (DOM) | 2/8 GB (DOM) | 2 GB (DOM) | – |
| CompactFlash Socket | DA-820 | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| HDD Support | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| **Other Peripherals** | | | | | | | |
| KB/MS | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| **Display** | | | | | | | |
| Graphics Controller | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| **LAN Interface** | | | | | | | |
| 10/100 Mbps Ethernet Ports | – | – | – | 6 | – | – | 2 (DA-660)/4 (DA-662) |
| 10/100/1000 Mbps Ethernet Ports | 4 | 6 | 4 | – | 6 | 6 | – |
| Magnetic Isolation Protection | 1.5 kV | 1.5 kV | 1.5 kV | 1.5 kV | 1.5 kV | 1.5 kV | 1.5 kV |
| **Serial Interface** | | | | | | | |
| RS-232 Ports | | 2 | 2 (DB9-M) | 4 (DB9-M) | – | 2 (DB9-M) | – |
| RS-485 Ports | – | 6 | – | 8 (TB) | – | – | – |
| RS-232/422/485 Ports | 2 (DB9-M) | – | – | – | – | – | 16 (RJ-45) |
| RS-422/485 | – | – | – | – | – | – | – |
| ESD Protection | 15K | 15K | 4 kV | 15 kV | 15K | 15K | 1.5 kV |
| Digital Isolation | 2K | 2K | – | 2 kV | – | 2K | – |
| Console Port | – | – | – | – | – | – | ✓ |
| Serial Communication Parameters | Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark | | | | | | |
| Flow Control | RTS/CTS, XON/XOFF | RTS/CTS, XON/XOFF | RTS/CTS, XON/XOFF | RTS/CTS, XON/XOFF | – | RTS/CTS, XON/XOFF | RTS/CTS, XON/OFF, ADDC |
| Baudrate | 50 bps to 115.2 Kbps | 50 bps to 115.2 Kbps | 50 bps to 115.2 Kbps | 50 bps to 115.2 Kbps | – | 50 bps to 115.2 Kbps | 50 bps to 921.6 Kbps |
| **LEDs** | | | | | | | |
| System | Power, Storage | Power, Storage, Power Failure | Power, Storage, Power Failure | Power, Storage, Power Failure | – | Power, Storage, Power Failure | OS |
| LAN | 100M, 1000M | 100M, 1000M | 100M, 1000M | 10M, 100M | 100M, 1000M | 10M, 100M | 10M/100M |
| Serial | TX, RX | TX, RX | TX, RX (for 4 modules), Programmable | TX, RX | TX, RX | TX, RX | Tx, Rx |
| **Physical Characteristics** | | | | | | | |
| Housing | SECC sheet metal (1 mm) | | | | | | |
| Weight | 6 kg | 4 kg | 14 kg | 4.5 kg | 7 kg | 4.5 kg | 2.6 kg |
| Dimensions | 440 x 361 x 133 mm | 440 x 315 x 90 mm | 400 x 480 x 180 mm | 440 x 315 x 45 mm | 440 x 315 x 90 mm | 440 x 315 x 90 mm | 440 x 45 x 198 |
| Mounting | Standard 19-in rackmount | Standard 19-in rackmount | Standard 19-in rackmount | Standard 19-in rackmount | Standard 19-in rackmount | Standard 19-in rackmount | Standard 19-inch rackmount |
| **Environmental Limits** | | | | | | | |
| Operating Temperature | -40 to 75°C | -10 to 60°C | -10 to 50°C | 0 to 60°C | -10 to 60°C | -40 to 75°C | -10 to 60°C |
| Storage Temperature | -20 to 80°C | -20 to 80°C | -20 to 80°C | -20 to 75°C | -20 to 80°C | -40 to 85°C | -20 to 80°C |
| Ambient Relative Humidity | 5 to 95% RH | 5 to 95% RH | 5 to 95% RH | 5 to 95% RH | 5 to 95% RH | 5 to 95% RH | 5 to 95% RH |
| **Regulatory Approvals** | | | | | | | |
| EMC | CE (EN 55022, EN 61000-3-2, EN 61000-3-3, EN 55024), FCC (Part 15 Subpart B, CISPR 22 Class ), CCC (GB9254, GB 17625.1), IEC 61850-3 IEC 60255-22 | FCC, CE (Class A) | EN 55022 Class A, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A | EN 55022, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A, IEC 61850-3 (DPP-T models only) | EN 61000-6-4, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A | CE (EN 55022, EN 61000-3-2, EN 61000-3-3, EN 55024), FCC (Part 15 Subpart B, CISPR 22 Class ), CCC (GB9254, GB 17625.1), IEC 61850-3 (DPP-T models only) | EN 55022 Class A, EN 61000-3-2 Class A, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A |
| Safety | LVD, UL, cUL, CCC | LVD, UL, cUL, CCC | UL 60950-1, CSA C22.2 No. 60950-1-07, CCC (GB4943, GB9254, GB17625.1) | UL 60950-1, CSA C22.2 No. 60950-1-03, EN 60950-1, CCC (GB4943, GB9254, GB17625.1) | UL 60950-1, CSA C22.2 No. 60950-1-03, EN 60950-1, CCC (GB4943, GB9254, GB17625.1) | UL/cUL (UL 60950-1, CSA C22.2 No. 60950-1-03), LVD (EN 60950-1), CCC (GB4943) | UL 60950-1, CSA C22.2 No. 60950-1-03, EN 60950-1 |
| Green Product | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE | RoHS, CRoHS, WEEE |
| **Reliability** | | | | | | | |
| Buzzer, RTC, WDT | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Warranty | 3 years (see www.moxa.com/warranty) | | | | | | |



# Device Server Gateways for Substations

| | NPort 6600 Series | CN2600 Series | NPort 5600 Series | MGate MB3480 |
|---|---|---|---|---|
| **LAN Interface** | | | | |
| 10/100BaseT(X) Ports | 1 port (8-pin RJ45 connector) | 2 ports (2 IPs, 8-pin RJ45 connectors) | 1 port (8-pin RJ45 connector) | 1 port (8-pin RJ45 connector) |
| Magnetic Isolation Protection | 1.5 KV | 1.5 KV | 1.5 KV | 1.5 KV |
| **Expansion Modules** | | | | |
| 10/100BaseT(X) (RJ45) | Optional | - | - | - |
| Multi-mode Fiber (SC) | Optional | - | - | - |
| Single-mode Fiber (SC) | Optional | - | - | - |
| **Serial Interface** | | | | |
| Protocol | - | - | - | Modbus RTU/ASCII Slave/Master |
| RS-232 Ports | 8/16/32 | 8/16 | 8/16 | - |
| RS-232/422/485 Ports | 8/16/32 | 8/16 | 8/16 | 4 |
| Connectors | 8-pin RJ45 | CN2610/2650: 8-pin RJ45 CN2650I: DB9 male | 8-pin RJ45 | DB9 male |
| Communication Parameters | Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark | Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark | Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark | Data Bits: 7, 8; Stop Bits: 1, 2; Parity: None, Even, Odd, Space, Mark |
| Flow Control | RTS/CTS, DTR/DSR, XON/XOFF | RTS/CTS, DTR/DSR, XON/XOFF | RTS/CTS, DTR/DSR, XON/XOFF | RTS/CTS, DTR/DSR |
| Baudrate | 50 bps to 921.6 Kbps | 50 bps to 921.6 Kbps | 50 bps to 921.6 Kbps | 50 bps to 921.6 Kbps |
| 2 KV isolation protection | - | Optional (CN2650I) | - | - |
| RS-485 Data Direction Control | ADDC | ADDC | ADDC | ADDC |
| RS-232 Console Port | v | v | v | - |
| **Advanced Features** | | | | |
| Serial Data Log | 64 KB | - | - | - |
| Offline Port Buffering | 64 KB | - | - | - |
| SD Slot | v | - | - | - |
| **Software** | | | | |
| Network Protocols | ICMP, IP, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP V1/V2c/V3, DDNS, HTTP, SMTP, HTTPS, SSL, SSH, PPPoE, RFC2217, IPv6, IPv4, Turbo Ring, Turbo Ring 2 | ICMP, IPv4, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP, HTTP, SMTP, ARP, PPPoE, DDNS | ICMP, IPv4, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP V1, HTTP, SMTP, SNTP, ARP, PPP, SLIP, RTelnet, RFC2217 | ICMP, IPv4, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP V1, HTTP, SMTP, ARP |
| Security Protocols | DES, 3DES, AES, SSH, SSL | RADIUS, HTTPS, SSH, PAP, CHAP | - | - |
| Configuration Options | Web Console, Telnet Console, Serial Console, Windows Search Utility | Web Console, Serial Console, Telnet Console, Windows Search Utility | Web Console, Telnet Console, Windows Utility | Web Console, Telnet Console, Windows Utility |
| Driver Support | Windows Real COM Drivers, Linux Real TTY driver, Fixed TTY driver | Windows Real COM Drivers, Linux Real TTY driver, Fixed TTY driver | Windows Real COM Drivers, Linux Real TTY driver, Fixed TTY driver | - |
| Managemen | SNMP MIB-II | SNMP MIB-II | - | SNMP v1 (read only) |
| IP Routing | Static, RIP-I, RIP-II | Static, RIP-I, RIP-II | - | - |
| Standard Operation Modes | Real COM, TCP Server, TCP Client, UDP, Pair Connection, RFC2217, Terminal, Reverse Telnet, Ethernet Modem, Printer, PPP, Disabled | Real COM, TCP Server, TCP Client, UDP, RFC2217,Terminal, Reverse Telnet, PPP, DRDAS, Redundant COM | Real COM, TCP Server, TCP Client, UDP, RFC2217 | - |
| Secure Operation Modes | Secure Real COM, Secure TCP Server, Secure TCP Client, Secure Pair Connection, SSH, Reverse SSH | - | - | - |
| Terminal Sessions | 8 sessions per port | 8 sessions per port | 4 sessions per port | - |
| **Physical Characteristics** | | | | |
| Housing | Metal | Metal | Metal | Metal |
| Dimensions (mm) | 440 x 195 x 44 | 440 x 195 x 44 | 440 x 195 x 44 | 35.5 x 102.7 x 157.2 |
| **Environmental Limits** | | | | |
| Operating Temperature | Standard Models: 0 to 55°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | Standard Models: 0 to 55°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | Standard Models: 0 to 55°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | 0 to 60°C |
| Storage Temperature | Standard Models: -40 to 75°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | Standard Models: -40 to 75°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | Standard Models: -40 to 75°C Wide Temp. Models: -40 to 75°C High Voltage Wide Temp. Models: -40 to 85°C | -40 to 85°C |
| Ambient Relative Humidity | 5 to 95% (non-condensing) | 5 to 95% (non-condensing) | 5 to 95% (non-condensing) | 5 to 95% (non-condensing) |
| **Power Requirements** | | | | |
| Input Voltage | AC Models: 100 to 240 VAC DC Models: ±48 VDC (20 to 72 VDC, -20 to -72 VDC), 110 VDC (88 to 300 VDC) | AC Models: 100 to 240 VAC DC Models: 110 VDC (88 to 300 VDC) | AC Models: 100 to 240 VAC DC Models: ±48 VDC (20 to 72 VDC, -20 to -72 VDC), 110 VDC (88 to 300 VDC) | 12 to 48 VDC |
| Power Consumption | AC Models: 285 mA @ 100 VAC, 190 mA @ 240 VAC DC Models: 293 mA @ 48 VDC | AC models: 235 mA @ 100 VAC, 145 mA @ 240 VAC DC models: 152 mA @ 88 VDC, 86 mA @ 300 VDC | AC models: 174 mA @ 100 VAC, 113 mA @ 240 VAC DC models: 152 mA @ 88 VDC, 86 mA @ 300 VDC | 385 mA @ 12VDC |
| **Standards and Certifications** | | | | |
| Safety | UL 60950-1, EN 60950-1 | UL 60950-1, EN 60950-1 | UL 60950-1, EN 60950-1 | UL 60950-1, EN 60950-1 |
| EMC | CE, FCC | CE, FCC | CE, FCC | CE, FCC |
| **Reliability** | | | | |
| Buzzer, RTC, WDT | v | v | WDT | Buzzer, WDT |
| MTBF | NPort 6610-8: 135,891 hrs NPort 6610-16: 102,373 hrs NPort 6610-32: 68,707 hrs NPort 6650-8: 135,370 hrs NPort 6650-16: 101,783 hrs NPort 6650-32: 68,177 hrs | CN2650I AC models: 99,320 hrs CN2650I-8-HV-T: 191,326 hrs CN2650I-16-HV-T: 116,924 hrs | NPort 5610-8: 97,294 hrs NPort 5610-16: 94,928 hrs NPort 5610-8-48V: 96,758 hrs NPort 5610-16-48V: 94,417 hrs NPort 5630-8: 118,405 hrs NPort 5630-16: 91,483 hrs NPort 5650-8: 117,584 hrs NPort 5650-16: 104,767 hrs NPort 5650-8-S-SC: 116,914 hrs NPort 5650-16-S-SC: 87,528 hrs NPort 5650-8-M-SC: 116,914 hrs NPort 5650-16-M-SC: 87,528 hrs NPort 5650-8-HV: 725,390 hrs NPort 5650-16-HV: 531,264 hrs | 295,812 hrs |
| Warranty | 5 years | 5 years | 5 years | 5 years |