Cellular and Wi-Fi IIoT Gateway Application Guidebook

MOXA®

Foreword

The Industrial Internet of Things (IIoT) is enabling companies everywhere to reap the benefits of faster and more informed decision-making, predictive maintenance, and more. Although these advantages may seem fairly obvious, how to actually connect industrial devices and equipment to the Internet for diverse applications in different locations and environments is less clear.

All IIoT applications need to effectively and reliably transmit collected data from remote field sites to a public or private cloud server for analysis. After all, there is little value to data sitting in siloes. This requirement is especially crucial for outdoor or distributed applications, such as remote control and monitoring systems for solar PV panels, wind farms, pump jacks, wellheads, water and wastewater facilities, or industrial machinery.

That's where IIoT gateways with cellular, low-power wide area network (LPWAN), or Wi-Fi connectivity come in. These wireless computers not only bring Internet connectivity to previously isolated areas and applications, but also enable local data preprocessing and protocol conversion for communication between remote edge systems and the cloud.

Long before "IIoT" became the buzzword it is today, Moxa has been helping automation professionals around the world achieve reliable industrial computing for both wired and wireless applications. Over the years, we have identified several key factors to successfully deploying industrial computers with reliable wireless connectivity in the field. We are excited to share these factors with you and wish you the best of success on your project!

The Moxa Team

What Is an IIoT Gateway and When Do I Need One?

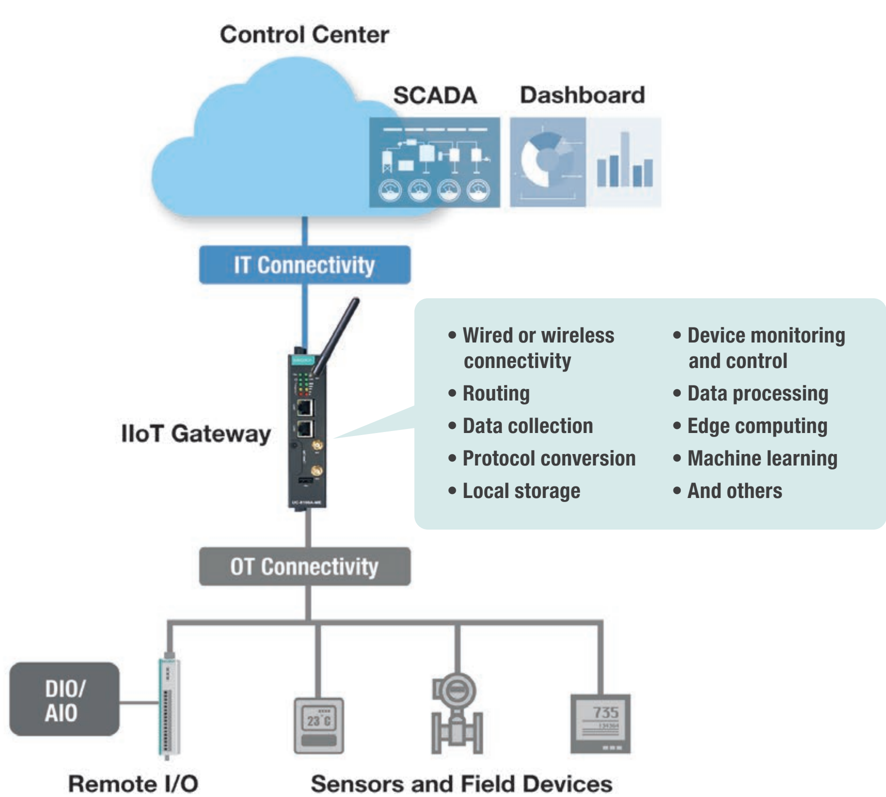
The Industrial Internet of Things (IIoT) is all about collecting and connecting data from various field devices to enable informed business decisions and achieve greater productivity and efficiency. Whether your IIoT application involves data collection, OT/IT protocol conversion, remote monitoring and control, or edge computing and machine learning, you need a way to convert data from field devices for common cloud services, such as Azure or AWS, or use MQTT protocol to **enable communication** with private cloud servers.

However, industrial field devices, sensors, and equipment can generate massive amounts of data every second. Immediately transmitting all of this raw data to a public or private cloud could be slow and costly. By connecting all the different devices at a field site to an IIoT gateway first, you can **locally store** and **preprocess data** before forwarding the aggregated, filtered, and tactically analyzed information on to the cloud.

Besides minimizing the volume of data that needs to be transmitted, improving response times, and reducing network transmission costs, cellular or Wi-Fi IIoT gateways also bring scalable, easy-to-deploy network connectivity to **distributed IIoT applications**—such as smart cities, solar energy, wind farms, oil fields, and industrial water treatment systems—that may be difficult or cost-prohibitive to wire.

Indeed, IIoT applications can benefit from a number of **different wireless technologies**. Besides traditional 802.11 Wi-Fi networks, IIoT gateways may also support various cellular technologies, including LTE and NB-IoT (a type of LPWAN), to fulfill different application requirements.

General IIoT Gateway Application Diagram



Five Key Factors for Choosing Wireless IIoT Gateways

Industrial computers with sufficient processing power, programmability, and connectivity can be ideal IIoT gateways for data collection and transfers. However, in industries that rely on distributed data acquisition in remote areas, such as renewable energy or oil and gas, wired infrastructure is often lacking or impractical.

Although wireless computers provide an ideal solution for these applications, each scenario has different requirements for communication distance, transfer speed, bandwidth, power consumption, costs, and more. Choosing the best wireless IIoT gateway or alternative solution for your application requires taking these factors and their inherent trade-offs into consideration.

The following key factors—namely, wireless performance, network infrastructure, carrier approvals and compatibility, edge computing, and data and hardware reliability—describe the main considerations for selecting the best wireless solutions for your Industrial IoT gateway application and provide suggestions for how to overcome common pitfalls.

Key Factor 1: **Wireless Performance**

When choosing a cellular or Wi-Fi IIoT gateway, you need to consider the wireless bandwidth and communication distance for connecting edge systems to the cloud. These wireless performance requirements are largely determined by the **data volume.** For example, video surveillance files and system logs for remote control and monitoring systems can be quite large. In order to transmit higher volumes of these types of data to the cloud, you need more **bandwidth** to support faster uplink and downlink speeds, such as LTE Cat. 4 or even a Wi-Fi network.

However, since the wireless modules that provide higher uplink and downlink consume more power and are costlier for wireless carriers to support, data plans for these services are also more expensive. Some wireless carriers may offer more affordable **data plans** for low-power wide area networks (LPWAN) to businesses that require less data consumption. Although you may be able to negotiate a low monthly rate, such as US$1 per month[1], choosing the most suitable option requires carefully calculating your daily or monthly data consumption in advance to stay within the limits of the plan.

Besides the data volume, the frequency and **availability** of data transmissions also need to be taken into consideration. For instance, some carriers may periodically disconnect NB-IoT modules in order to continuously optimize the number of connected devices on their LPWAN. Moreover, some NB-IoT modules are even designed to enter power saving mode immediately after connecting to an LPWAN in order to save power consumption on the connected device.

Last but not least, the wireless **communication distance** from your edge systems to the cloud also needs to be considered. To illustrate, Wi-Fi networks that generally have a maximum transmission distance of 50 meters may be insufficient for highly distributed IIoT applications, such oil fields that span vast distances in remote areas far from civilization.

1 As of 2019, U.S. carriers AT&T (https://www.business.att.com/products/lpwa.html) and Verizon (https://www.verizonwireless.com/biz/plans/m2m-business-plans/) offer data plans starting at US$1 per month to business customers with low data volume requirements.

Key Factor 2: **Network Infrastructure**

After assessing the wireless performance requirements for your industrial application, you will need to carefully consider the type of network infrastructure. Besides the data rates and volume requirements, **initial setup fees** and **total cost of ownership** should also be factored into deciding whether you build your own wireless network or use an existing network from a local carrier.

In addition, new cellular connectivity technologies, such as LTE Cat. M1 (LTE-M) or NB-IoT, might not be available in your region yet. As a result, it is crucial to first check **carrier availability** in order to determine which options you actually have. For the latest deployment status of various mobile IoT networks around the world, refer to the GSM Association (GSMA) website at https://www.gsma.com/iot/deployment-map/#deployments.

Another infrastructure issue to consider is the actual **environment** in which your application takes place. For instance, Wi-Fi may provide more stable signals and connectivity for restricted areas near densely populated urban communities. On the other hand, cellular solutions may provide better service to remotely located applications that span a wider area, offer considerable **savings on cabling fees**, and require **less deployment effort**. Moreover, LTE technologies can provide a scalable solution in remote outdoor areas where Ethernet wiring is impractical or cost-prohibitive.

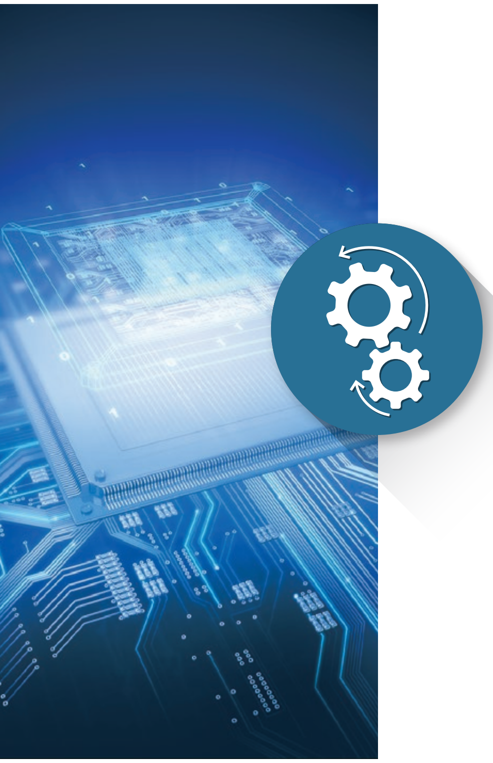
Key Factor 3: **Approvals and Compatibility**

Each region has its own radiofrequency (RF) regulations that specify the wireless equipment you are allowed to import and use within the region. To avoid the risks associated with using a wireless device that is not permitted in your region, Moxa recommends choosing wireless devices that are already covered by the **local RF regulator** in the region where you want to deploy[2].

In addition, different wireless carriers within the same region may also use **different LTE bands**. Some carriers may even use a specific RF band that is not generally supported by major LTE manufacturers or local competitors. Consequently, you should clarify requirements with your end users before selecting your wireless connectivity solution for collecting and transferring remote data.

Furthermore, some countries—such the United States, Canada, Japan, and South Korea—also require **carrier approval** before you can register your devices on the carrier's network. Carrier approval guarantees your devices can operate normally on the carrier's network and satisfies any criteria for interoperability.

2 Examples of regional regulators and certifications include the Federal Communications Commission (FCC) in the United States, the PTCRB for cellular operators in North America, the Radio Equipment Directive (RED) in the European Union, or the Regulatory Compliance Mark (RCM) certification system in Australia and New Zealand.



Key Factor 4: **Edge Computing**

All IIoT applications involve collecting data from field devices, sensors, and other industrial equipment before transmitting the information to the cloud for advanced analytics. These field devices are said to be on the "edge" of the system, which is why they're called "edge systems". Although it is possible to send raw data from each edge system directly to the cloud, the **latency** and associated **costs** in most cases would be too burdensome. "Edge computing" essentially moves some of the data processing and actuation from the cloud to an IIoT gateway that connects all the field devices at a particular site.

Since each IIoT gateway may act as a data concentrator, protocol converter, and data preprocessing device for all the sensors and equipment that connect to it, a simple cellular router or Wi-Fi access point would not suffice. Industrial applications need to collect data from many **different signals and protocols** that need to be **converted, stored,** and **preprocessed** before transmitting the information over cellular or Wi-Fi networks.

Different IIoT applications may also have varying CPU, memory, storage, or power budget requirements. For example, most data acquisition and transfer applications use a customizable Linux OS platform with basic built-in and external storage, such as an SD card. More advanced applications may even run edge software that requires a Windows platform with higher CPU power and memory specifications. Consequently, **CPU, memory, storage,** and **power budget** requirements may also determine whether you choose an Arm-based or Intel-based edge computer with wireless connectivity for the IIoT gateway.

Key Factor 5: **Data and Hardware Reliability**

Ensuring reliability for your data connection may require more than one wireless technology, such as using both **Wi-Fi and LTE failovers**. Although Wi-Fi access points (AP) almost always offer better reliability and cost savings than cellular connections, there is still a chance that Wi-Fi AP credentials may be mistakenly changed or the Wi-Fi network is accidentally disconnected. LTE solutions can provide an affordable backup since the cellular connection only activates when the Wi-Fi link is down.

Dual-SIM functionality can also provide redundancy and help ensure network availability by allowing you to install SIM cards from two different carriers on a single device. You can even split your entire network between two different carriers if you wish. Not being bound to a single carrier increases your bargaining power when negotiating the cost of your data plan and provides an additional backup in case one of the cellular connections goes down.

For both Wi-Fi and LTE connectivity in outdoor or harsh environments, it is important to choose IIoT gateways that work reliably in a **wide operating temperature** range, such as from -40 to 70°C (-40 to 158°F). IIoT gateways that satisfy rugged industrial certifications are ideal for outdoor field installations. Many are even available in **small form factors** for cabinets and provide various interfaces—such as RS-232/422/485, Modbus, I/O, and Ethernet—to connect adjacent equipment, PLCs, and other edge devices.

Comparing Wireless Technologies

Industrial applications can benefit from a variety of wireless technologies, which include cellular (e.g., LTE, NB-IoT) and Wi-Fi connectivity. The following table compares the key features supported by popular wireless IIoT technologies, as well as some typical use cases to help you determine which ones are best for your project.

Technology	Communication Distance (Max)	Transfer Speed (Max)	Data Roaming	Typical Applications / Use Cases
Wi-Fi (IEEE 802.11ac 5 GHz)	50 M	450 Mbps (1x1) 1.3 Gbps (3x3)	Yes	• Factory automation • Machine automation, automatic guided vehicles (AGV) • Smart homes, smart buildings • Video surveillance • Railroad wayside communications
LTE Cat. 4 / 6	Dependent on carrier	150 Mbps / 300 Mbps	Yes	• Generic IoT gateway applications • Routers, network bridges • Traffic control • In-car hotspot • Video surveillance
LTE Cat. 1	Dependent on carrier	10 Mbps	Yes	• Renewable energy monitoring • Artificial lift monitoring • Drilling and well monitoring • Machine monitoring • Digital signage • Retail kiosk/ATM • Telematics
LTE Cat. M1	Dependent on carrier	1 Mbps	Yes	• Smart metering and EMS • Water and wastewater monitoring • Asset trackers • Parking lot control • Smart lighting
NB-IoT	Dependent on carrier	250 Kbps	No	• Pipeline monitoring • Smart lighting • HVAC control • Pollution monitoring • Industrial monitoring • Agricultural monitoring

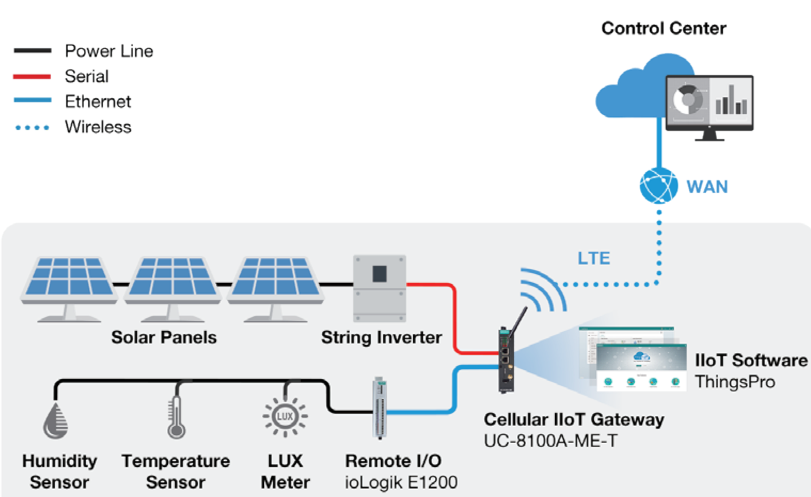
Solar Power Plant Monitoring and Control System

Background

A utility-scale solar power plant can consist of hundreds to thousands of photovoltaic (PV) panels and installations that require continuous operation and monitoring. Besides comparing power output under actual climatic conditions to predicted forecasts, solar power plants also need data to schedule repairs or preventive maintenance.

A utility-scale solar energy operation and management (O&M) company requested a solution to collect and transfer data from remote solar farms over cellular networks to their own private cloud database.

System Architecture



System Requirements

- Industrial-grade edge computer for acquiring and logging inverter and climatic data to monitor PV panel performance
- Low power consumption to maximize the electrical output of a solar power plant
- Reliable operation in wide-temperature outdoor environments
- Web-based remote monitoring of solar array performance, battery load, and environmental data from sensors

Why Moxa

- Rugged Arm-based UC-8100A-ME-T IIoT gateway with 1 GHz processor and power consumption under 10 W
- -40 to 70°C wide operating temperature range with LTE
- Robust LTE Cat. 4 connectivity with RF and carrier approvals
- ThingsPro IIoT software provides Modbus RTU/TCP and MQTT connectivity, cellular network settings, and supports C/Python APIs for Modbus data acquisition

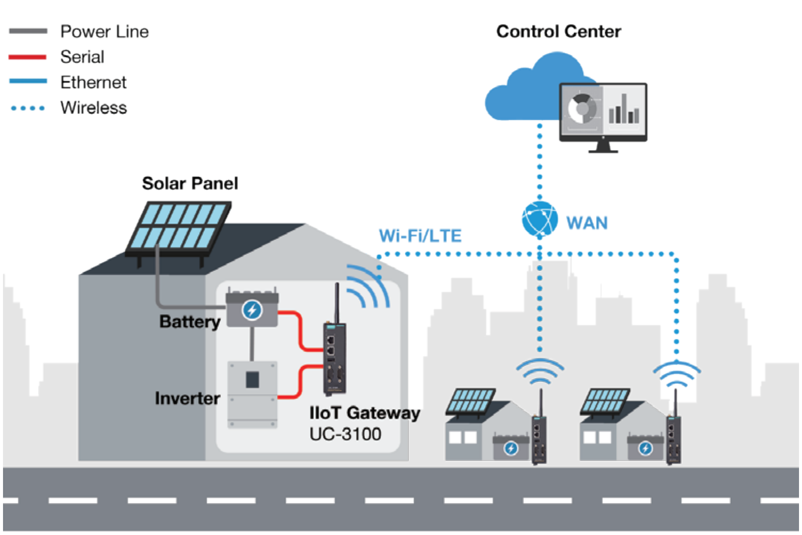
Residential Solar Power Monitoring System

Background

Advancements in power grid technologies have made it possible for residential solar energy providers to sell excess energy to utility companies. Residential solar power systems need to process data from various devices that use a variety of protocols while reliably managing accounting, monitoring, and control tasks for electricity generation and billing.

A residential solar power solution provider needed an IIoT gateway to perform the aforementioned tasks. Wi-Fi was the primary connection option, while LTE support was required for redundancy to ensure accurate electricity generation and billing information. Since the data volume of the information is low, the provider also considered using LTE Cat. 1 for lower monthly data fees.

System Architecture



System Requirements

- Low power consumption to maximize the electricity output of the solar panel
- Wi-Fi and LTE communication redundancy ensures data accuracy for energy usage and billing
- LTE Cat. 1 support to balance data volume needs and monthly cellular data fees
- Open platform for application development
- Able to perform remote device management for easy maintenance

Why Moxa

- UC-3100 Arm-based IIoT gateway with built-in Wi-Fi and LTE Cat. 1 connectivity
- Robust cellular connectivity with RF and carrier approvals (Verizon, AT&T)
- Moxa Industrial Linux with extensive software library for easy application development
- Modbus RTU/TCP support with Moxa's ThingsPro software to reduce programming effort
- ThingsPro software provides RESTful APIs for device management to help IT administrators manage IIoT gateways remotely

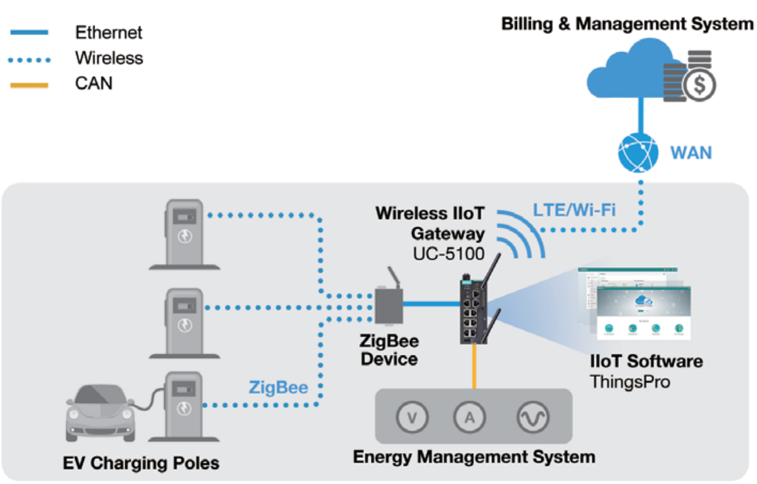
Electric Vehicle Charging Control and Monitoring

Background

Growth in the plug-in electric vehicles (PEV) market is creating an opportunity for utility companies to deploy PEV charging infrastructure, which is essential for encouraging more drivers to switch to electric cars and expanding the PEV market in general.

The PEV charging infrastructure consists of charging stations spread over a large area, which requires a fair amount of energy if they are used on a regular basis. Most charging stations are unmanned, and many are located in suburban areas, far away from centralized control rooms. With the increase in the number of charging stations, operators face multiple challenges in maintaining good network connections and centralized management of billing and maintenance.

System Architecture



System Requirements

- Low power consumption to maximize electrical output
- Reliable operation in outdoor environments
- CAN port support to connect with energy management system
- Open platform for billing program development

Why Moxa

- UC-5100 rugged Arm-based IIoT gateway with power consumption under 10 W and CAN port support
- -40 to 70°C wide operating temperature range with LTE and -10 to 70°C with Wi-Fi
- Moxa Industrial Linux open platform and ThingsPro software with RESTful APIs to enable easy integration with a user billing and monitoring dashboard

Industrial Wastewater Pipeline Monitoring

Background

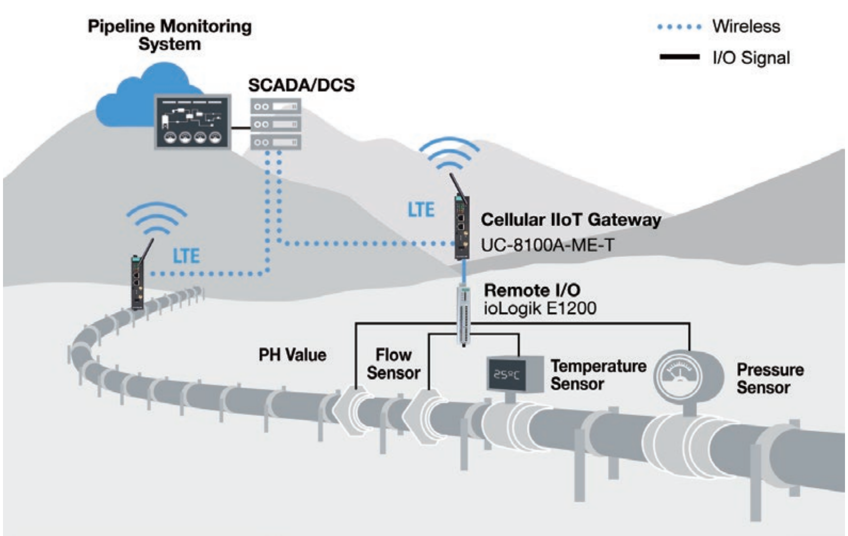
A leading water treatment company is building a computer-based remote monitoring solution to monitor the status of industrial wastewater pipelines for their customers.

The solution consists of a remote I/O to collect readings from water temperature, pressure, flow, and PH sensors, and to send Modbus data to an IIoT edge gateway via serial communications. The IIoT gateway then transmits the data over cellular networks to the remote monitoring system.

System Requirements

- Serial connectivity to collect Modbus data and programmability for preprocessing field data to monitor the status of the water pipelines remotely
- LTE connectivity and compact size to fit inside small cabinets
- Wide operating temperature range to withstand harsh outdoor environments
- Low power consumption due to the limited power available

System Architecture



Why Moxa

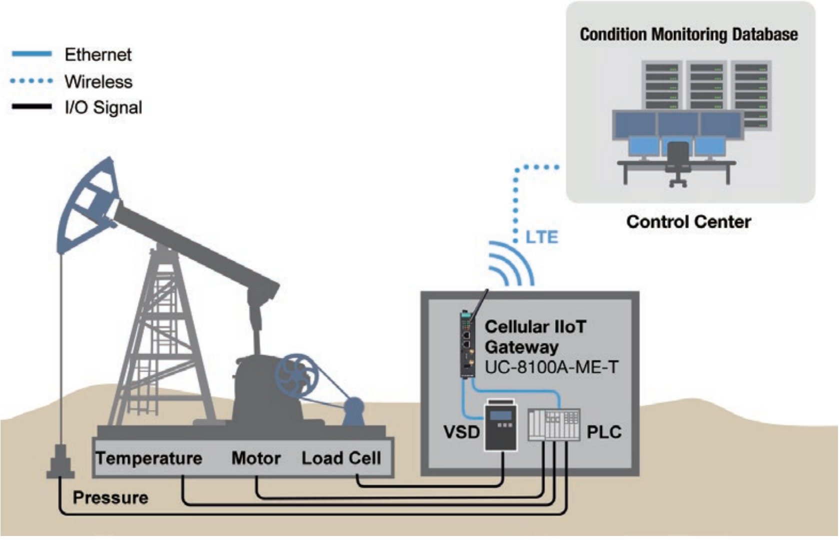
- UC-8100A-ME-T Series Arm-based IIoT gateway with 1 GHz processor and 1 GB RAM for data processing
- Supports 2 serial ports and 2 LAN ports for collecting data
- Delivers reliable LTE connectivity in a wide operating temperature range of -40 to 70°C

Enabling Predictive Maintenance in Artificial Lift Monitoring Systems

Background

With the trend of oil field digitization gaining momentum, telematics can be tremendously useful in understanding equipment status so as to facilitate predictive maintenance and to avoid operation downtime. Leading oil and gas service companies are building telematics solutions for their customers to run smooth operations and conduct predictive maintenance for artificial lifts in oil fields. Collecting the data generated by the equipment during operations is the key to achieving this goal. As a result, oil and gas service companies need a reliable and secure solution to ensure that the data is brought back to the control center for further analysis.

System Architecture

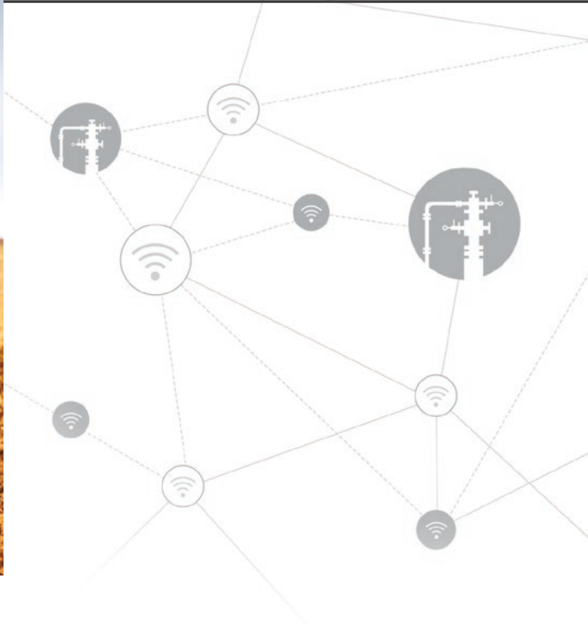


System Requirements

- Computer systems that are small enough to fit inside existing control cabinets, and have low power consumption and hazardous location certifications
- Reliable 4G LTE connectivity in high operating temperatures for constant data aggregation
- Supports Trusted Platform Module (TPM) to ensure data integrity
- Open platform for custom application development

Why Moxa

- Compact Arm-based UC-8100A-ME-T IIoT gateway compliant with C1D2 and ATEX certification standards for harsh industrial environments
- Reliable LTE connectivity in a wide operating temperature range of -40 to 70°C
- Optional TPM feature and 10-year Linux support for security patches for Moxa Industrial Linux
- Open platform for rapid development of customer applications for variable speed drives (VSDs) and PLCs



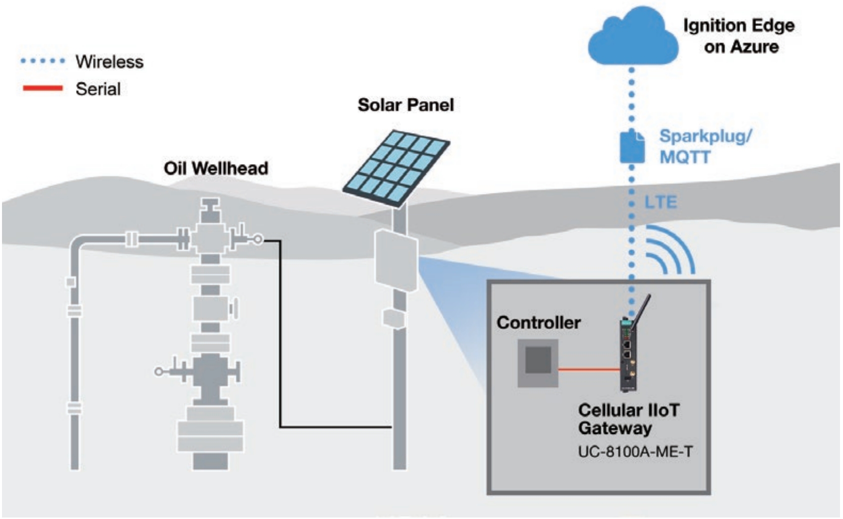
Remote Monitoring for Oil and Gas Wellheads

Background

An oil and gas equipment provider was looking for an IIoT gateway to facilitate their equipment optimization service. In particular, they requested a solution to enable remote condition monitoring of highly distributed oil wellheads in harsh environments. The condition monitoring application also required edge computing capabilities.

The edge gateway must collect over 400 Modbus tag data from the controller through serial ports and communicate with the Ignition SCADA system running on Azure through Sparkplug MQTT. The gateway will also be placed in remote outdoor areas with solar panels as the primary power source, so the power supply is limited and cellular connectivity is required for data transmission.

System Architecture

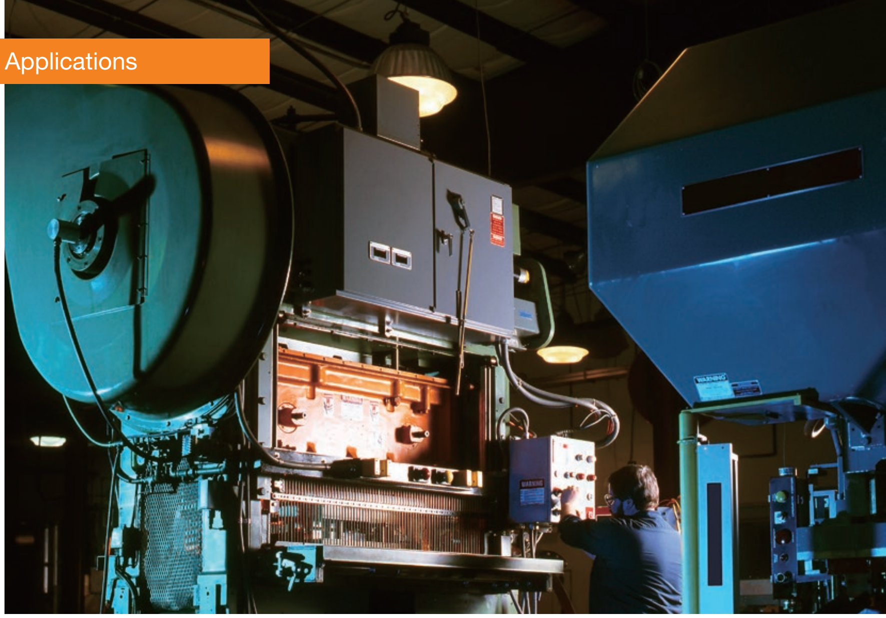


System Requirements

- Edge computing and programmability to collect Modbus tag data through serial ports and publish to Ignition Edge
- Low power consumption to use solar panels as the primary power source
- Certified to work in explosive environments
- LTE connectivity in harsh outdoor environments

Why Moxa

- Arm-based UC-8100A-ME-T IIoT gateway with less than 10 W of power consumption
- Compliant with C1D2 and ATEX Zone 2 certification standards for oil and gas applications
- Reliable LTE Cat. 4 connectivity with USA carrier approvals and wide operating temperature range of -40 to 70°C
- Industry-leading 5-year hardware warranty
- ThingsPro IIoT software enables easy Modbus tag polling, cellular management, and MQTT support for publishing data to Ignition Edge



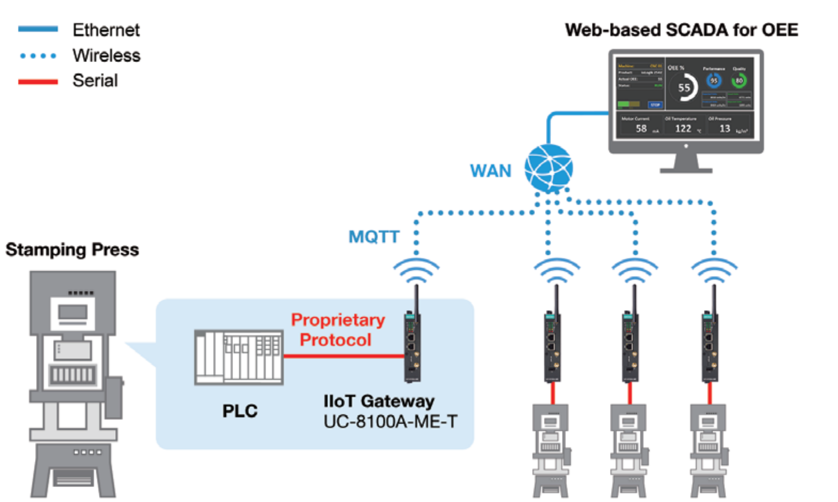
PLC Data Acquisition for Machine Tool Builders

Background

Traditional machine tool builders are now willing to invest in new IIoT technologies so that they can provide more value with their products and improve the quality of machine status data collected for post-sales management and services, such as scheduling preventive maintenance or measuring overall equipment efficiency (OEE).

The data acquisition system must be able to acquire data from different brands of PLCs with their own proprietary protocols, send the data to a backend control server, and display the data on a dashboard remotely and locally. Furthermore, a compact and reliable device for data acquisition is required without having to change the structure of the machines. This means the system also needs to be small enough to fit inside existing control cabinets.

System Architecture



System Requirements

- Edge computing solution with Wi-Fi to collect data from PLCs to monitor the status of remote stamping presses
- Compatibility with PLCs from Mitsubishi, Delta, and Allen-Bradley
- Compact-sized and vibration-proofed systems for reliable operation in the cabinet of a stamping press

Why Moxa

- The UC-8100A-ME-T Series embedded computer can collect proprietary data from PLCs, perform local intelligence, and provide wireless capability
- Compact industrial-grade computers with DIN-rail installation inside cabinets with limited space
- Moxa Industrial Linux with 10-year long-term support* and Debian-compatible open platform for local database and dashboard applications

* Terms and conditions apply. Contact Moxa for details.

IIoT Gateway Reference Cases

Moxa industrial computers have been deployed in thousands of locations in various IIoT gateway applications. Here is a snapshot of our global reference cases:

Renewable Energy

Application	Cloud Service	Region/Country
Residential solar monitoring and billing system	AWS	USA
Commercial solar monitoring	Private cloud	Europe and USA
Utility-scale solar power monitoring	Private cloud	Taiwan
Grid-connected and distributed solar power system	Private cloud	Taiwan
Wind turbine SCADA system	Private database	Europe
EV charging pole monitoring and billing system	Private cloud	China

Oil and Gas

Application	Cloud Service	Region/Country
Upstream dry pump condition monitoring	AWS	USA
Upstream artificial lift condition monitoring	Azure	USA
Upstream oil well condition monitoring	Ignition Sparkplug	USA
Midstream pipeline condition monitoring	AWS	USA
Downstream oil tank monitoring	Azure	USA
Gas production monitoring	Azure	Russia

Water and Wastewater

Application	Cloud Service	Region/Country
Industrial wastewater pipeline monitoring	AWS	USA
Organic waste-treatment system	Azure	USA
Remote pump station monitoring	Ignition	USA
Wastewater plant quality monitoring and analysis system	Azure	Europe
Water treatment SCADA system	Private database	Taiwan

Machine Monitoring and Facility Management

Application	Cloud Service	Region/Country
HVAC OEM Equipment Monitoring	AWS	USA
Building energy monitoring	Private cloud	Europe
Pump system status monitoring	Azure	Europe
Machinery status monitoring	Private cloud	Taiwan
Semiconductor production line monitoring	Private database	Taiwan
Lighting & HVAC condition monitoring & control system	Azure	Taiwan

Built-in cellular or Wi-Fi module, RF type approvals, and carrier approvals

Wireless-ready Arm-based Computers


Built-in LTE Cat. M1/NB-IoT


Built-in LTE Cat. M1/NB-IoT


Built-in LTE Cat.1


Built-in LTE Cat.1 and Wi-Fi


Built-in LTE Cat.1 and Wi-Fi


Built-in LTE Cat. 4


Built-in LTE Cat.4 with Wi-Fi expansion

Series	UC-2100-W Series		UC-3100 Series			UC-8100A-ME-T Series	UC-8200 Series
Model	**UC-2114**	**UC-2116**	**UC-3101**	**UC-3111**	**UC-3121**	**UC-8112A**	**UC-8220**
Computer							
CPU	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A7 dual core, 1 GHz
Memory	512 MB	512 MB	• 512 MB • 1 GB (US model)	• 512 MB • 1 GB (US model)	• 512 MB • 1 GB (US model)	1 GB	2 GB
Storage Preinstalled	8 GB	8 GB	• 4 GB • 8 GB (US model)	• 4 GB • 8 GB (US model)	• 4 GB • 8 GB (US model)	8 GB	8 GB
Storage Slot	1 x microSD	1 x microSD	–	1 x SD	1 x SD (US model)	1 x SD	1 x microSD
OS	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)
TPM	–	–	–	–	–	–	TPM 2.0 built-in
Ethernet Ports	1 x GbE LAN, 1 x LAN	1 x GbE LAN, 1 x LAN	2 x LAN	2 x LAN	2 x LAN	2 x LAN	2 x GbE LAN
Serial Ports (RS-232/422/485)	2	2	1	2	1	2	2
CAN Ports	2	2	–	–	1	–	1
DI/DO	–	–	–	–	–	–	4 x DI, 4 x DO
USB Ports	–	–	1	1	1	1	1
Wireless							
Wireless Expansion Slot	–	–	–	–	–	–	1 x mPCIe slot
Cellular Connectivity	Built-in LTE Cat. M1/NB-IoT[1]	Built-in LTE Cat. M1/NB-IoT[1]	Built-in LTE Cat. 1[1]	Built-in LTE Cat. 1[1]	Built-in LTE Cat. 1[1]	Built-in LTE Cat. 4[1]	Built-in LTE Cat. 4[1]
SIM Slots	2 x nano-SIM	2 x nano-SIM	2 x nano-SIM	2 x nano-SIM	2 x nano-SIM	1 x mini-SIM	2 x nano-SIM
Wi-Fi	–	–	–	Built-in 802.11a/b/g/n[1]	Built-in 802.11a/b/g/n[1]	–	Expandable[2]
GPS	–	Yes	US model only	US model only	US model only	Yes	Yes
Standards and Certifications							
Safety/EMC/RF	CE, FCC, UL, IC, EAC, RCM	CE, FCC, UL, IC, EAC, RCM	CE, FCC, UL, IC, EAC, RCM	CE, FCC, UL, IC, EAC, RCM	CE, FCC, UL, IC, EAC, RCM	CE, FCC, UL, IC, EAC, RCM, KC, NCC	CE, FCC, UL, IC, EAC, RCM, KC, NCC
Carrier Approval	Verizon, AT&T	Verizon, AT&T	Verizon, AT&T	Verizon, AT&T	Verizon, AT&T	Verizon, AT&T	Verizon, AT&T
Hazardous Locations	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx
Environmental Limits and Power Parameters							
Operating Temperature	-40 to 75°C	-40 to 75°C	• -40 to 70°C (US model) • -30 to 70°C (Other)	• -40 to 70°C (US model) • -30 to 70°C (Other)	• -40 to 70°C (US model) • -30 to 70°C (Other)	-40 to 70°C	-40 to 70°C
Power Consumption (max.)	5.8 W	5.8 W	6 W	9 W	9 W	8 W	10 W
IIoT Software							
ThingsPro	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1. Wireless module is built-in. Refer to the *Wireless Connection and Expansion Modules* section for details.
2. Wireless module must be purchased separately. Refer to the *Wireless Connection and Expansion Modules* section for details.

Flexibility to add cellular or Wi-Fi capability when needed

Wireless-optional Arm-based Computers

1 mPCIe for cellular/Wi-Fi

1 mPCIe for cellular/Wi-Fi

1 mPCIe for cellular/Wi-Fi

1 mPCIe for cellular/Wi-Fi

1 mPCIe for cellular/Wi-Fi

1 mPCIe for cellular
1 mPCIe for Wi-Fi

1 mPCIe for cellular/Wi-Fi

Series	UC-2100 Series	UC-5100 Series		UC-8100 Series	UC-8100A-ME-T	UC-8200 Series	UC-8410A Series
Model	UC-2104	UC-5102	UC-5112	UC-8112	UC-8112A-ME-T-LX	UC-8220	UC-8410A
Computer							
CPU	Arm Cortex-A8 600 MHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A7 dual core, 1 GHz	Arm Cortex-A7 dual core, 1 GHz
Memory	256 MB	512 MB	512 MB	512 MB	1 GB	2 GB	1 GB
Storage Preinstalled	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB
Storage Slot	–	1 x SD	1 x SD	1 x SD	1 x SD	1 x microSD	1 x SD, 1 x mSATA
OS	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Linux Debian 8 (Kernel 4.1)
Ethernet Ports	1 x LAN	2 x LAN	2 x LAN	2 x LAN	2 x LAN	2 x GbE LAN	3 x GbE LAN
Serial Ports (RS-232/422/485)	–	4	4	2	2	2	8
CAN Ports	–	–	2	–	–	1	–
DI/DO	–	4 x DI, 4 x DO	4 x DI, 4 x DO	–	–	4 x DI, 4 x DO	4 x DI, 4 x DO
USB Ports	–	1	1	1	1	1	2
Wireless[1]							
Wireless Expansion Slot	1 x mPCIe slot	1 x mPCIe slot	1 x mPCIe slot	1 x mPCIe slot	1 x mPCIe slot	2 x mPCIe slot	1 x mPCIe slot
SIM Slots	1 x mini-SIM	2 x micro-SIM	2 x micro-SIM	1 x mini-SIM	1 x mini-SIM	2 x nano-SIM	1 x mini-SIM
Standards and Certifications							
Safety/EMC/RF	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM, KC	CE, FCC, UL, EAC, RCM, KC	CE, FCC, UL, EAC, RCM
Hazardous Locations	–	–	–	–	ATEX, C1D2, IECEx	ATEX, C1D2, IECEx	–
Environmental Limits and Power Parameters							
Operating Temperature	-10 to 70°C	• -40 to 85°C • -40 to 70°C (with LTE) • -10 to 70°C (with Wi-Fi)	• -40 to 85°C • -40 to 70°C (with LTE) • -10 to 70°C (with Wi-Fi)	-10 to 60°C	• -40 to 85°C • -40 to 70°C (with LTE/Wi-Fi)	• -40 to 85°C • -40 to 70°C (with LTE/Wi-Fi)	• -40 to 75°C • -40 to 70°C (with Wi-Fi)
Power Consumption (max.)	4 W	11 W	11 W	5.4 W	6 W	8 W	19 W
IIoT Software							
ThingsPro	Yes	Yes	Yes	Yes	Yes	Yes	–

1. Wireless module must be purchased separately. Refer to the *Wireless Connection and Expansion Modules* section for details.

Low power consumption and small form factor

Standard Arm-based Computers

	1 LAN, 1 serial	2 LAN	2 LAN, 2 serial	2 LAN, 2 serial	2 LAN, 4 serial	2 LAN, 4 serial	2 LAN, 1 serial	2 LAN, 2 serial	3 LAN, 8 serial
Series	**UC-2100 Series**				**UC-5100 Series**		**UC-8100 Series**	**UC-8200 Series**	**UC-8410A Series**
Model	**UC-2101**	**UC-2102**	**UC-2111**	**UC-2112**	**UC-5101**	**UC-5111**	**UC-8131**	**UC-8210**	**UC-8410A-NW**
Computer									
CPU	Arm Cortex-A8 600 MHz	Arm Cortex-A8 600 MHz	Arm Cortex-A8 600 MHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 1 GHz	Arm Cortex-A8 300 MHz	Arm Cortex-A7 dual core, 1 GHz	Arm Cortex-A7 dual core, 1 GHz
Memory	256 MB	256 MB	512 MB	512 MB	512 MB	512 MB	256 MB	2 GB	1 GB
Storage Preinstalled	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB	8 GB
Storage Slot	–	–	1 x microSD	1 x microSD	1 x SD	1 x SD	1 x SD	1 x microSD	1 x SD 1 x mSATA
OS	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Moxa Industrial Linux (Debian 9, Kernel 4.4)	Linux Debian 8 (Kernel 4.1)
TPM	–	–	–	–	–	–	–	TPM 2.0 built-in (S model only)	–
Ethernet Ports	1 x LAN	2 x LAN	2 x LAN	1 x GbE LAN, 1 x LAN	2 x LAN	2 x LAN	2 x LAN	2 x GbE LAN	3 x GbE LAN
Serial Ports (RS-232/422/485)	1	–	2	2	4	4	1	2	8
CAN Ports	–	–	–	–	–	2	–	1	–
DI/DO	–	–	–	–	4 x DI, 4 x DO	4 x DI, 4 x DO	–	4 x DI, 4 x DO	4 x DI, 4 x DO
USB Ports	–	–	–	–	1	1	1	1	2
Standards and Certifications									
Safety/EMC/RF	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM	CE, FCC, UL, EAC, RCM, KC	CE, FCC, UL, EAC, RCM
Hazardous Locations	–	–	–	ATEX, C1D2, IECEx	–	–	–	ATEX, C1D2, IECEx	–
Environmental Limits and Power Parameters									
Operating Temperature	-10 to 60°C	-10 to 60°C	-10 to 60°C	• -40 to 75°C (T models) • -10 to 60°C	• -40 to 85°C (T models) • -10 to 60°C	• -40 to 85°C (T models) • -10 to 60°C	-10 to 60°C	-40 to 85°C	• -40 to 75°C (T models) • -10 to 60°C
Power Consumption (max.)	4 W	4 W	4 W	4 W	11 W	11 W	5.4 W	10 W	19 W
IIoT Software									
ThingsPro	Yes	Yes	Yes	Yes	Yes	Yes	–	Yes	–

Detailed support list with Moxa's wireless module accessories

Wireless Connectivity and Expansion Modules*

Connection	Series	Models	Wireless Module Model	Countries/Regions Supported	Wireless Standard	Supported Bands
Cellular	UC-2100	UC-2104-LX	UC-LTE-CAT1-EU	Europe, Taiwan	LTE Cat. 1	1, 3, 8, 20, 28
			UC-LTE-CAT1-AUS	Australia, New Zealand	LTE Cat. 1	3, 5, 8, 28
			UC-LTE-CAT4-CN	China	LTE Cat. 4	1, 3, 8, 39, 40, 41
	UC-2100-W	UC-2114/2116-T-LX	Built-in	USA, Europe, Taiwan, Australia, New Zealand	LTE Cat. M1/NB-IoT	2, 3, 4, 5, 8, 12, 13, 20, 28
	UC-3100	UC-3101/3111/3121-T-US-LX	Built-in	USA	LTE Cat. 1	2, 4, 5, 12, 13, 14, 66, 71
		UC-3101/3111/3121-T-EU-LX	Built-in	Europe, Taiwan	LTE Cat. 1	1, 3, 8, 20, 28
		UC-3101/3111/3121-T-AU-LX	Built-in	Australia, New Zealand	LTE Cat. 1	3, 5, 8, 28
	UC-5100	UC-5102/5112-LX, UC-5102/5112-T-LX	UC-LTE-CAT1-EU	Europe, Taiwan	LTE Cat. 1	1, 3, 8, 20, 28
			UC-LTE-CAT1-AUS	Australia, New Zealand	LTE Cat. 1	3, 5, 8, 28
			UC-LTE-CAT4-CN	China	LTE Cat. 4	1, 3, 8, 39, 40, 41
	UC-8100A-ME-T	UC-8112A-ME-T-LX-US	Built-in	USA	LTE Cat. 4	2, 4, 5, 13, 17
		UC-8112A-ME-T-LX-EU	Built-in	Europe	LTE Cat. 4	1, 3, 5, 7, 8, 20
		UC-8112A-ME-T-LX-AP	Built-in	Australia, New Zealand, Taiwan	LTE Cat. 4	1, 3, 5, 7, 8, 28
	UC-8200	UC-8220-T-LX-US-S	Built-in	USA	LTE Cat. 4	2, 4, 5, 13, 17
		UC-8220-T-LX-EU-S	Built-in	Europe	LTE Cat. 4	1, 3, 5, 7, 8, 20
		UC-8220-T-LX-AP-S	Built-in	Australia, New Zealand, Taiwan	LTE Cat. 4	1, 3, 5, 7, 8, 28
Wi-Fi	UC-2100	UC-2104-LX	UC-WiFi-USB	–	802.11 a/b/g/n/ac, 1T1R	2.4 GHz / 5 GHz
	UC-3100	UC-3111/3121-T-US-LX, UC-3111/3121-T-EU-LX, UC-3111/3121-T-AU-LX,	Built-in	–	802.11 a/b/g/n, 2T2R	2.4 GHz / 5 GHz
	UC-5100	UC-5102/5112-LX, UC-5102/5112-T-LX	UC-WiFi-USB	–	802.11 a/b/g/n/ac, 1T1R	2.4 GHz / 5 GHz
	UC-8100	UC-8112/8132/8162-LX	WiFi-BGN	–	802.11 a/b/g/n/ac, 1T1R	2.4 GHz / 5 GHz
	UC-8200	UC-8220-T-LX, UC-8220-T-LX-US-S, UC-8220-T-LX-EU-S, UC-8220-T-LX-AP-S	UC-8200 WiFi-AC	–	802.11 a/b/g/n/ac, 2T2R	2.4 GHz / 5 GHz
	UC-8410A	UC-8410A-LX, UC-8410A-T-LX	Wi-Fi-BGN(252NI)	–	802.11 a/b/g/n, 2T2R	2.4 GHz / 5 GHz

* Antennas must be purchased separately

Basic Antenna Accessories*

Antenna Type	Accessory Model Name	Gain	Frequency Bands	Countries/Regions Supported	Note
Cellular	ANT-LTE-ASM-04 BK	2 dBi	704 to 960 MHz / 1710 to 2690 MHz	All	–
Wi-Fi	ANT-WDB-ARM-02	2 dBi @ 2.4 GHz 0.5 dBi @ 5 GHz	2.4 GHz / 5 GHz	–	Included in the Wi-Fi module kit for the UC-8112, UC-8138, and UC-8162 models
	ANT-WDB-ARM-0202 plus ADP	2 dBi	2.4 GHz / 5 GHz	–	Supported on UC-2104, UC-5102, and UC-5112 models only
GPS	ANT-GPS-OSM-03-3m BK	3 dBi	1563 to 1610 MHz	All	–

*For a complete list of compatible antennas and their detailed charateristics, visit Moxa's website or check with your local representative.

Your Trusted Partner in Automation

Moxa is a leading provider of edge connectivity, industrial computing, and network infrastructure solutions for enabling connectivity for the Industrial Internet of Things (IIoT). With over 30 years of industry experience, Moxa has connected more than 65 million devices worldwide and has a distribution and service network that reaches customers in more than 80 countries. Moxa delivers lasting business value by empowering industries with reliable networks and sincere service. Information about Moxa's solutions is available at www.moxa.com.

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