Application Guide

April 2022

High-Performance Wireless Communications Enabling Modern Robotics

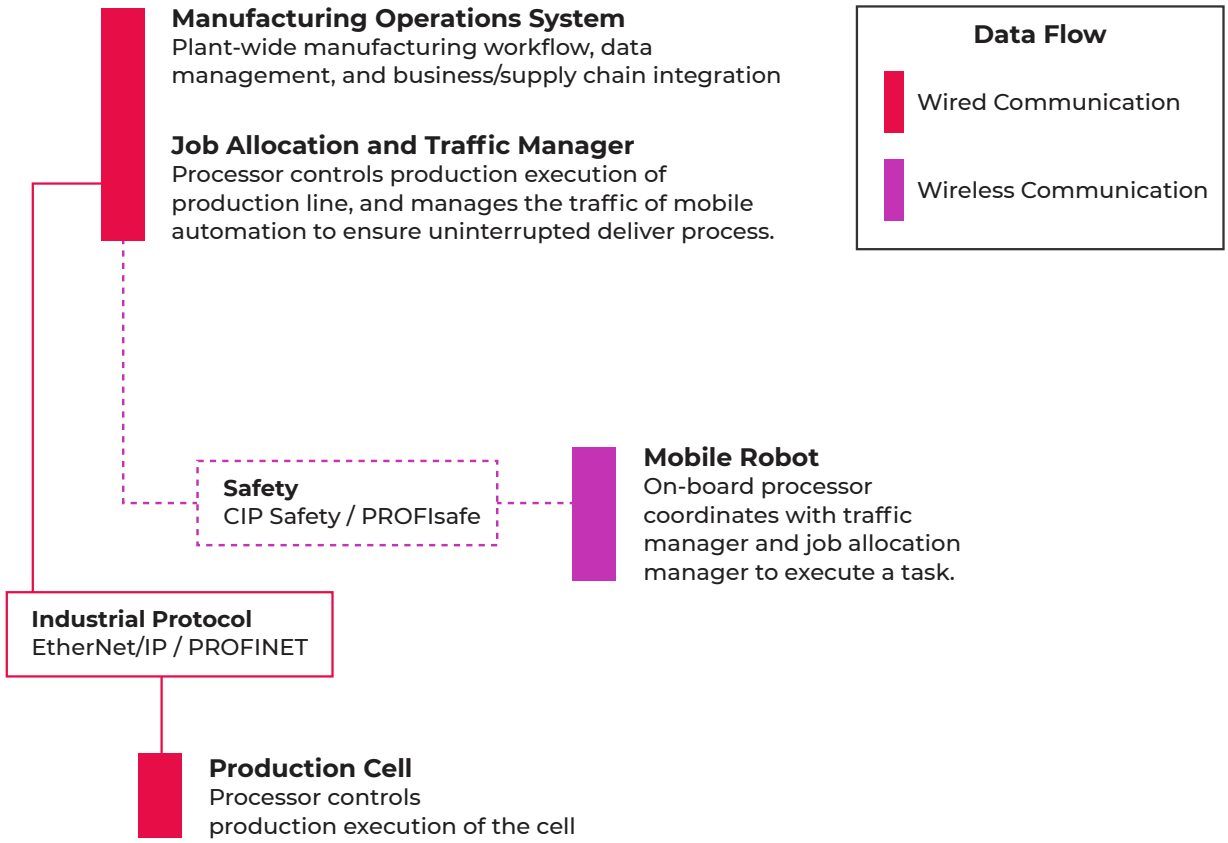
Automation in virtually every industry is evolving at a rapid pace. Businesses are relying on mobile machines to supplement critical parts of their process to improve quality, productivity, and safety. ProSoft Technology has developed a dedicated portfolio of industrial communications products to ensure reliability, flexibility, and efficiency while enabling modern mobile robotic technologies like automated guided vehicles (AGVs), autonomous mobile robots (AMRs), skillets, EMS, automated storage and retrieval systems (ASRS), and others.

While the principles in this document can be used as a reference for all of the aformentioned mobile robotic technologies, the rest of this document refers to mobile automation as an AMR (Autonomous Mobile Robot).

System Data Flow

Whether we are looking at a factory automation application, like what we might see in an automotive manufacturing environment, or an automated logistics application, like what we may see in automated distribution centers, understanding the system data flow of the application as a whole is important.

Just as the Purdue Model outlines, under the enterprise network and the DMZ zone is the operational technology network (OT). The OT network is the control level of the mobile robotic application, and leverages automation protocols like EtherNet/IP™ or PROFINET. This OT level is where ultra-reliable communications, with millisecond latency, is a requirement to ensure the performance of the automation.

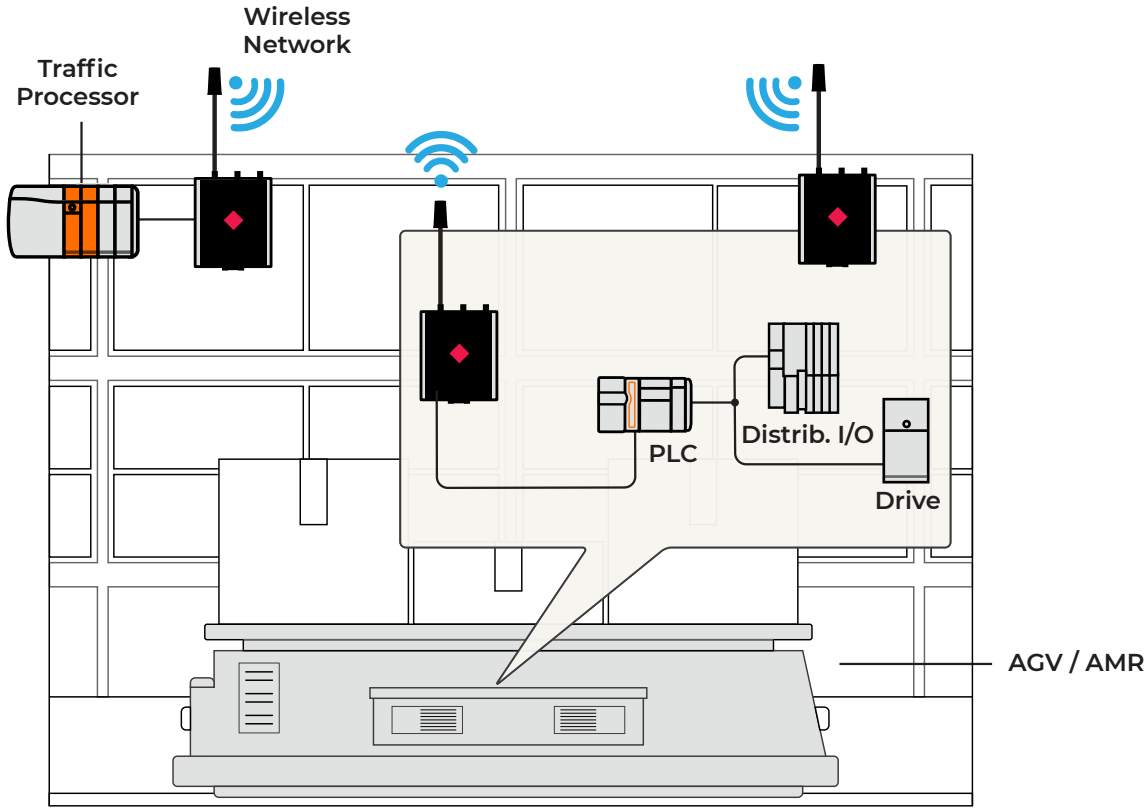


You can see in the image above that wireless technologies are required to enable connectivity to the mobile automation equipment. Considering the critical nature of the industrial communications in the OT network, it is important to leverage an industrial-grade and purpose-built wireless Ethernet solution, like the RLX2 product family from ProSoft Technology, to communicate between the mobile automation equipment, and the processors allocating the workflow and managing the mobile robot traffic (aka Traffic Cop).

To better understand the critical nature of this wireless communication, we can look at an example of the architecture of a mobile robot.

Mobile Robot Architecture

A mobile robotic solution will be comprised of three essential components, as shown below:



The Traffic Processor maintains constant connection between the Mobile Robot and the Manufacturing Operations System. This communication consists of valuable diagnostic data, essential control data, and critical safety data.

In these mobile robotic applications, it is critical that the communication between the traffic processor and the AMR happen reliably, and as predictably as possible without any risk of unnecessary latency or jitter. This is especially true when the application is leveraging a safety protocol like CIP Safety or PROFIsafe, and ProSoft Technology's RLX2 product family has several proprietary algorithms engineered to enable safety protocols over wireless.

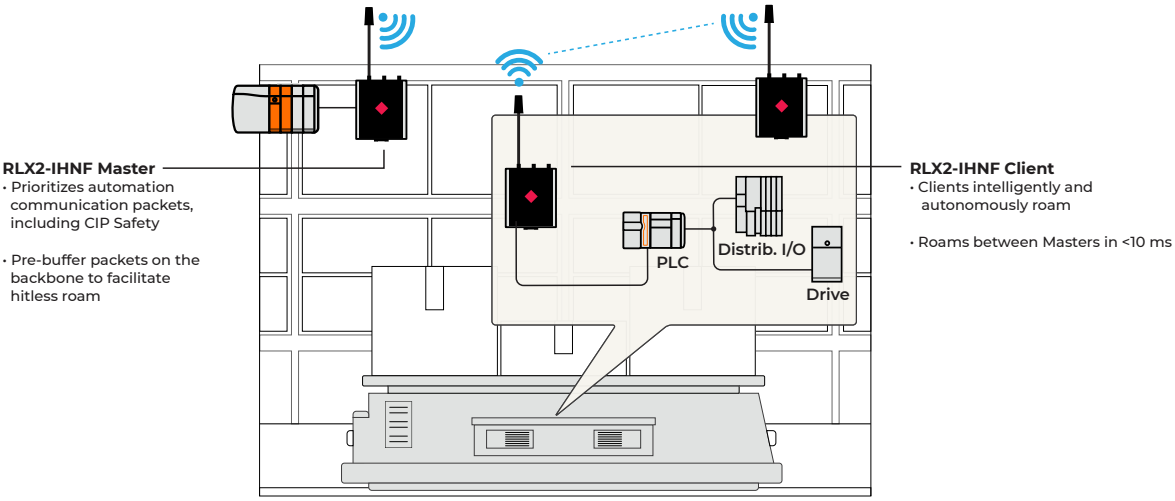
Industrial Safety Protocols over ProSoft Technology Wireless Ethernet

Beyond improving quality, uptime, and productivity, functional safety is often a requirement in applications leveraging mobile robotics. While local proximity sensors, E-Stops, safety zones, and safety curtains are often used in AMR applications, a SIL 2 or SIL 3 safety rating for the AMR system as a whole requires the use of a SIL 3-rated safety protocol like CIP Safety or PROFIsafe.

Both CIP Safety and PROFIsafe follow the "black channel principle," which is described in IEC 61508. The black channel principle specifies that two safety devices must have enough intelligence, and enough diagnostics in their communications, to ensure the communication network between the safety devices has zero impact on the ability of the safety device to detect communication errors. In other words, safety protocols like CIP Safety and PROFIsafe have error detection mechanisms built within the safety protocol itself. These error-detection mechanisms consist of time stamps to ensure packets are not lost, delayed, repeated, or out of order, and various identifiers and diagnostics to authenticate and validate the messages.

While the safety protocol and safety devices host the intelligence to ensure the safety of the application, there is a risk that a network device, like a wireless Ethernet radio, could have a negative impact on the timing requirements within the error detection mechanism. In a CIP Safety system, the timing expectation is defined by the Requested Packet Interval (RPI), the Timeout Multiplier, and the Delay Multiplier. In a PROFIsafe system, the timing expectation is defined by the F-Monitoring or PROFIsafe Monitoring time. Regardless of which protocol is being deployed, it is important to configure these parameters to meet both your functional safety requirements and your uptime requirements.

With a focus on both uptime and safety, it's critical to leverage purpose-built wireless technology to transmit the safety packets as reliably as possible, and with as little latency as possible. The RLX2 product family from ProSoft does just that.



The illustration above shows that there are several RLX2 Masters (Access Points) connected to the traffic processor for the AMR application. As the AMR moves out of proximity of one Master, and into the proximity of the next Master, the RLX2 Client on the AMR needs to roam from one Master to the next. In these applications, the RLX2 Client intelligently and autonomously roams to the next best RLX2 Master in an industry-leading time of less than 10 milliseconds.

In addition to this industry-leading roam time, RLX2 master radios communicate on the backbone to pre-buffer packets in an effort to prevent dropped packets during the roam. This reduces the frequency of wireless retries, resulting in lower latency when compared to competitive wireless systems.

All of this intelligence, engineered into both the Master and the Client, allows RLX2 radios to use the spectrum more efficiently than other competitive wireless systems. As a result, the RLX2 solution only requires one 20 MHz channel for the typical AMR application, which is a significant benefit for the customer.

Wireless Deployment Considerations

While the RLX2 product family was purpose-built to enable safety communications over wireless in critical mobile automation applications, there are still several topics to consider during deployment.

- Choose a channel free from other networks (including IT-owned networks)
    - Wireless Ethernet networks can operate in both the 2.4 GHz and 5 GHz frequency band. A frequency band is divided into a number of smaller bands know as channels.
    - Channels used in AGV/AMR applications are 20 MHz wide, and cannot overlap.
    - 2.4 GHz Frequency Band
        - Use Channel 1, 6, or 11 to avoid overlapping
    - 5 GHz Frequency Band
        - North America
            - Use Channel 36, 40, 44, 48, 149, 153, 157, 161, or 165 to avoid overlapping
    - EMEA
        - Use Channel 36, 40, 44, or 48 to avoid overlapping
- Ensure line-of-sight between antennas
    - It is critical to ensure the antenna onboard the AGV/AMR has line of sight to the Master antenna connected to the traffic controller. ProSoft Technology's team of application engineers can conduct site surveys and drawing reviews to help specify the best antenna technology for the application, and their portfolio includes everything from radiating cable to omnidirectional MIMO antennas.
- Manage the Ethernet traffic
    - The fewer the packets that need to be sent between the Client and the Master, the faster each packet can get to its destination. This is important to consider when communicating with a produced/consumed protocol. For this reason it's critical to ensure only data that needs to be sent wirelessly is being sent over the wireless network.
    - CIP Safety RPIs should be configured with considerations for both safety and wireless reliability.
        - Typical configuration is RPI of 60 ms and Timeout of 4.
- Hire a Pro
    - ProSoft's Wireless Application Engineers provide services to ensure a success wireless network deployment:
        - Engineering Drawing Review
        - Pre/Post Site Survey
        - Troubleshooting Support

Example Bill of Materials and Configuration

Considering the critical nature of AMR deployments and the complexities associated with wireless communications, ProSoft Technology's team of application engineers is a great resource to help with engineering design and configuration support for a wireless solution that meets the safety and uptime requirements of any AMR application.

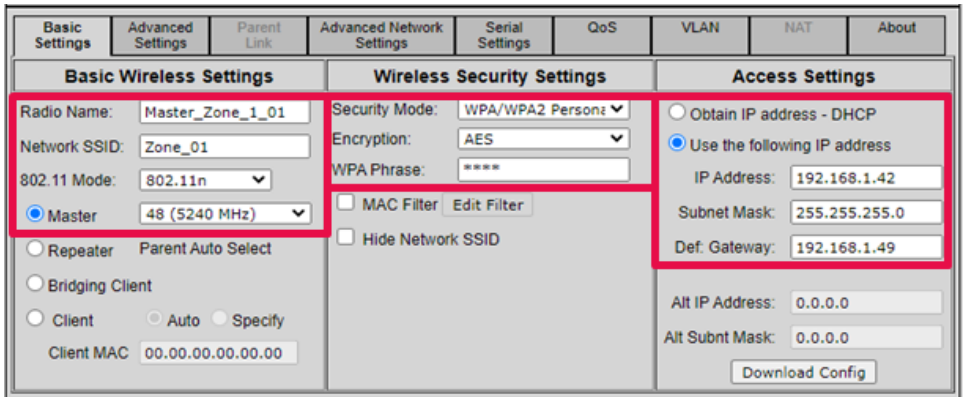
While each application is custom-engineered considering its unique requirements and environment, the typical wireless deployment for an AMR application will have several Master (AP) radios deployed throughout the anticipated path of travel for the mobile automation, with antennas and extension cables. For example:

Master Radio

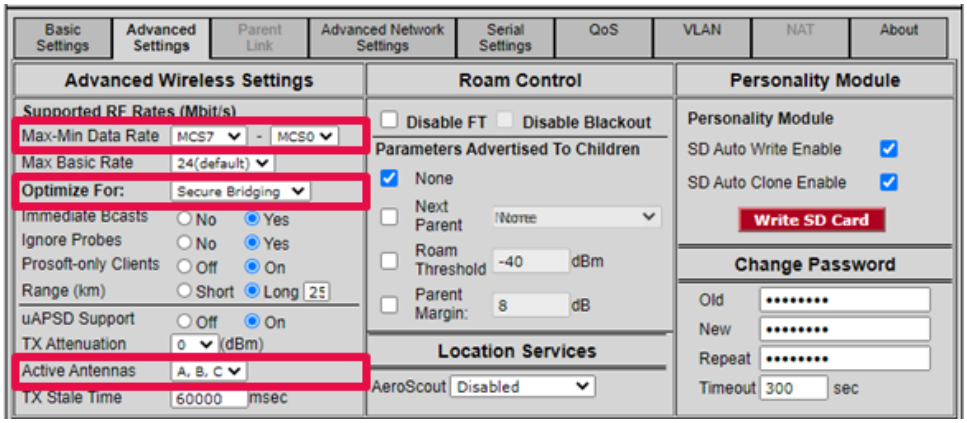
Part #	Description	Quantity
RLX2-IHNF-W	802.11n Industrial Hotspot, Watertight Version	1
C40M40-40-xxx	xx-foot LMR 400 N Plug -> N Plug Cable	3
A2506NJ-O	6dBi Omni N-Jack MIMO antenna with 3 foot pigtail 2.4/5GHz	1

Considering the intelligence is already built into the RLX2 radio, configuration for the master is typically as easy as:

- Toggle Master
- Create SSID
- Select frequency
- Select security mode, encryption, and WPA phrase
- Create IP address



- Select MCS rate (most are MCS7-MCS0)
- Optimize for secure bridging
- Select antenna ports being used



Of course, in these applications, each AMR will also have its own radio, optimized for fast roaming, with an antenna.

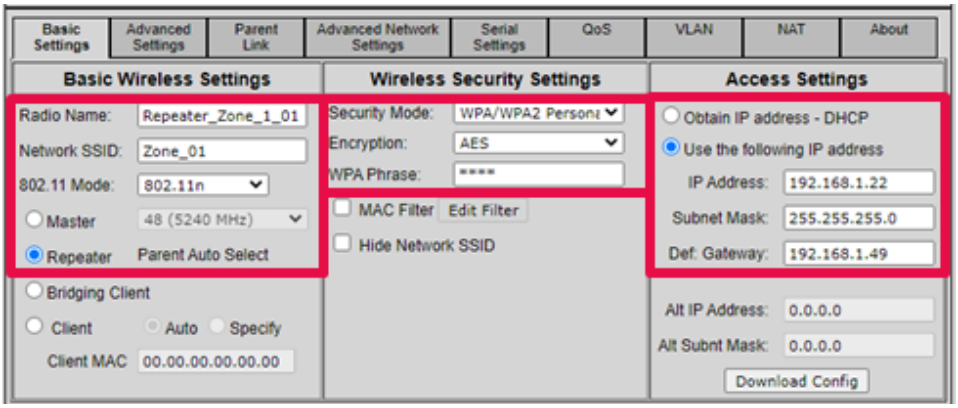
For example:

AMR Radio

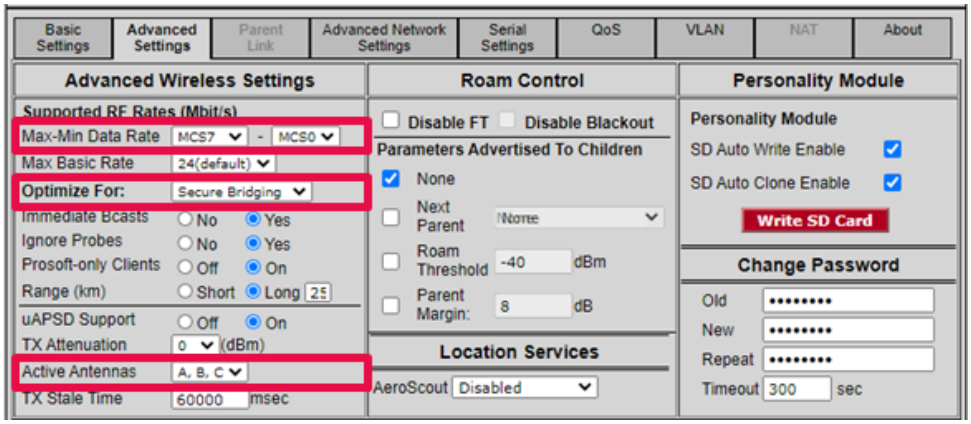
Part #	Description	Quantity
RLX2-IHNF-W	802.11n Industrial Hotspot	1
A2504S3-0-6	4dBi Omni RP-SMA MIMO antenna with 6 foot	1

Configuring the AMR radio is similar to the Master radio, with a few extra steps to optimize fast roaming:

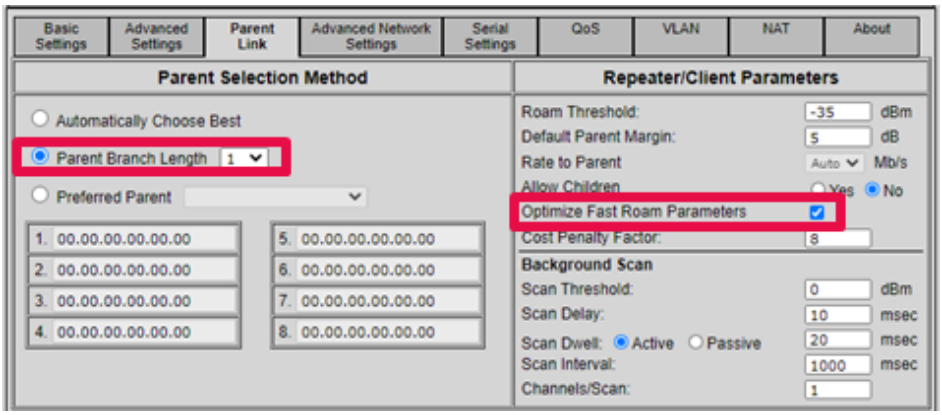
- Toggle Repeater
- Create SSID
- Select frequency
- Select security mode, encryption, and WPA phrase
- Create IP address



- Select MCS rate (most are MCS7-MCS0)
- Optimize for secure bridging
- Select antenna ports being used



- Select parent branch length of 1
- Toggle button to optimize fast roam



Please note: These are just example BOMs. ProSoft Technology has a large portfolio of extension cables and antennas to ensure a custom solution for your application.

Find the best industrial wireless solution for your application:
psft.com/DE9

Brian Allport
ballport@psft.com
(267) 500-4314

Asia Pacific

Regional Office
603.2242.2020
asiapc@prosoft-technology.com
Languages: Bahasa, Chinese, English, Japanese, Korean

Regional Tech Support
support.ap@prosoft-technology.com

North Asia
China, Hong Kong
86.21.5187.7337
china@prosoft-technology.com
Languages: Chinese, English

Southwest Asia
India, Pakistan, Sri Lanka, Bangladesh, Mongolia
91.99.1008.6221
india@prosoft-technology.com
Languages: English, Hindi

Australasia
Australia, New Zealand
61(0)467.023.666
pacific@prosoft-technology.com
Language: English

Southeast Asia
Singapore, Indonesia, Philippines, Thailand, Vietnam, Malaysia, Myanmar, Cambodia, Laos
60.12.275.3307
seasia@prosoft-technology.com
Languages: English, Bahasa, Malay

Northeast Asia
Japan, Taiwan
60.12.275.3307
neasia@prosoft-technology.com
Languages: English, Chinese, Japanese

Korea
82.10.7187.2064
korea@prosoft-technology.com
Languages: English, Korean

Europe, Middle East, Africa

Regional Office
33.(0)5.34.36.87.20
europe@prosoft-technology.com
Languages: French, English

Regional Tech Support
support.emea@prosoft-technology.com

Middle East, Turkey, Sub-Saharan Africa
971(0)4.214.6911
mea@prosoft-technology.com
Languages: Hindi, English

North Western Europe
United Kingdom, Ireland, Iceland, Denmark, Norway, Sweden
44.7415.864.902
nweurope@prosoft-technology.com
Language: English

Austria, Germany, Switzerland
32.474.36.84.51
germany@prosoft-technology.com
Languages: English, French, Dutch

France, Benelux, Portugal, Algeria, Morocco, Tunisia
32.474.36.84.51
france@prosoft-technology.com
Languages: French, English, Dutch

Italy, Greece, Israel, Russia, Eastern Europe
39.342.8651.595
italy@prosoft-technology.com
Languages: Italian, English

Latin America

Regional Office
52.222.264.1814
latinam@prosoft-technology.com
Languages: Spanish, English

Regional Tech Support
support.la@prosoft-technology.com

Argentina, Bolivia, Brazil, Paraguay, Uruguay
55.11.5084.5178
brasil@prosoft-technology.com
Languages: Portuguese, English

Mexico, Andean, Caribbean, Central America
Venezuela, Colombia, Peru, Ecuador
507.6427.48.38
mexico@prosoft-technology.com
andean@prosoft-technology.com
Languages: Spanish, English

North America

Regional Office
1.661.716.5100
info@prosoft-technology.com
Languages: English, Spanish

Regional Tech Support
support@prosoft-technology.com

Tech Support

ProSoft Technology's technical support is unparalleled in the industrial automation industry. To continue our world-class technical support, we have opened offices in most time zones in an effort to support our customers at a local level. See Regional Tech Support contact information above.

Modern-Mobile-Robotics-AG_2022

ProSoft® TECHNOLOGY
www.psft.com