Industrial Protocols Guide

Uses in Arduino, ESP32 and Raspberry Pi PLCs

Industrial Shields®

Raspberry Pi

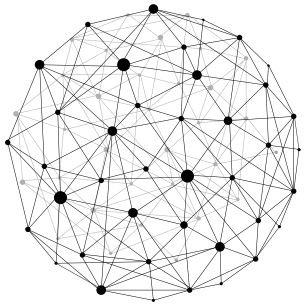
ARDUINO

Industrial Protocols Guide

In this Guide we share the main communication protocols, and the specific ones in Industrial Shields PLCs.

Protocol?

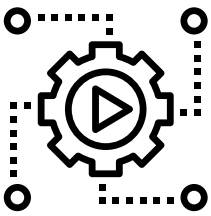
A **Communication Protocol** is a system of rules that allow **two or more entities** in a communication system to communicate with each other to **transmit information** by means of any type of variation of a physical magnitude.



It is also defined as a set of standards that allows communication between computers, establishing how they are identified on the network, how data is transmitted and how the information is processed.

The ultimate goal of these processes is the exchange of information between two or more entities, using the same previously agreed structure.

- With the introduction of technology in industrial processes with monitoring, control or automation, the number and variety of elements that can communicate has increased.



In the industrial environment, there are sensors, motors, actuators, etc. which have also incorporated local or remote control through all kinds of devices or automations.

When the type and number of entities that must communicate is so large and varied, it is imperative to define and delimit how they must do so; hence the importance of communication protocols.

List of some of the most common protocols in industrial communication environments*.

- *AS-i: Actuator-Sensor interface*
- *BSAP: Bristol Standard Asynchronous Protocol*
- *CC-Link: Industrial Networks*
- *CIP: Common Industrial Protocol*
- *ControlNet*
- *DeviceNet*
- *DNP3*
- *DirectNet*
- *EtherCAT*
- *EtherNET/IP*
- *FINS: Factory Interface Network Service*
- *Foundation Fieldbus: H1 & HSE*
- *HART Protocol*
- *HTTP/HTTPS*
- *Interbus*
- *MECHATROLINK*
- *MelsecNet, and MelsecNet II, /B, and /H*
- *Modbus: RTU, TCP/IP or ASCII.*
- *MQTT: Message Queuing Telemetry Transport*
- *OSGP – The Open Smart Grid Protocol*
- *Optomux*
- *PieP: An Open Fieldbus Protocol*
- *Profibus*
- *PROFINET*
- *RAPIEnet: Real-time Automation Protocols for Industrial Ethernet*
- *SERCOS III*
- *GE SRTP*
- *SynqNet*
- *TTEthernet*
- *MPI – Multi-Point Interface*

**Some of these protocols are proprietary, although widely used in professional and industrial environments.*

HTTP & HTTPS

HTTP is the acronym for Hypertext Transfer Protocol.

When you type http:// in your address bar in front of the domain, it tells the browser to connect via HTTP.

HTTP uses **TCP (Transmission Control Protocol)**, usually through **port 80**, to send and receive data packets over the web.

HTTPS stands for Hypertext Transfer Protocol Secure (also known as HTTP over TLS or HTTP over SSL).

When you type https:// in the address bar in front of the domain, you are telling the browser to connect over HTTPS.
Generally, sites that operate over HTTPS will have a redirect in place, so even if you type http:// you will be redirected to deliver over a secure connection.

HTTPS also uses **TCP (Transmission Control Protocol)** to send and receive data packets, but it does so through **port 443**, within a Transport Layer Security (TLS) encrypted connection. (TLS).

The HTTP protocol presents a security problem in that the information flowing from a server to a browser is not encrypted, which means it can be easily stolen. HTTPS (Hypertext Transfer Protocol Secure) protocols solve this by using an SSL (secure sockets layer) certificate, which helps to create a secure encrypted connection between the server and the browser.

HTTP messages are in plain text which makes them more readable and easier to debug. This has the disadvantage of making messages longer.

Ethernet

Ethernet is the traditional technology, computer networking technologies, which are commonly used in local area networks **(LAN),** metropolitan area networks **(MAN)** and wide area networks **(WAN).**

Ethernet communication uses the **LAN protocol** which is technically known as the **IEEE 802.3 protocol**. This protocol has evolved and improved over time to transfer data at the rate of one gigabit per second.

Ethernet uses different protocols to communicate. Some of them are HTTP, HTTPS, MQTT and Modbus protocols.

The PLCs of the **M-Duino** family incorporates the W5500 IC. The W5500 is an integrated TCP/IP Ethernet controller that provides an easier Internet connection to the embedded systems.

MQTT

MQTT (Message Queuing Telemetry Transport) is an open OASIS and ISO (ISO/IEC 20922) lightweight, subscribe-and-publish network protocol that transports messages between devices.

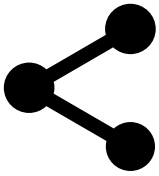
The protocol typically runs over TCP/IP; however, any network protocol that provides orderly, lossless and bidirectional connections can support MQTT.

It is designed for connections to remote locations where a **"small code footprint"** is required or network bandwidth is limited.

MODBUS

The Modbus Protocol is a messaging framework developed by Modicon. It is used to establish master-slave/client-server communication between devices. Modbus has many protocol options, but the two most commonly used are **Modbus RTU (Remote Terminal Unit)** and **Modbus Transmission Control Protocol (TCP/IP).**

Modbus is an open standard and is a widely used network protocol in the industrial manufacturing environment. Modbus RTU mode is the most common implementation, although the Modbus TCP/IP protocol is gaining ground and is ready to overtake it.



A Modbus communication is always initiated by the master node to the slave node. Also, the slave nodes will never transmit data without receiving a request from the master node or communicate with each other.
The master node initiates only one Modbus transaction at a time.

Modbus RTU mode uses binary coding and CRC error checking.
It is an efficient protocol in which every eight bits (one byte) of a message contains two 4 bit hexadecimal characters. In addition, each message must be transmitted in a continuous flow.

The coding system of each byte (11 bits) in RTU mode is as follows:

- Bits per byte: 1 start bit, 8 data bits, least significant bit sent first, 1 bit to complete parity, 1 stop bit.

Modbus RTU packages are only intended to send data; they do not have the ability to send parameters, such as point name, resolution, units, etc.

PROFINET

PROFINET is an open standard based on **Industrial Ethernet, TCP/IP** and some communication standards belonging to the IT world.

Starting from a basic connectivity, such as the **Ethernet cable**, and established communication frames that would correspond to levels 1 and 2 of the **OSI model**, PROFINET incorporates new functionalities that would allow **modifying level 7**, of application, through a specific interpretation of the transmitted data for each case.

PROFINET is one of the most used communication standards in automation networks.

PROFINET follows the client-server model for data exchange, using three kinds:

IO Controller
It is usually the PLC in which the program with the automation is executed.
It is comparable to a Master device in Modbus.

IO Device
It is a device with multiple inputs and outputs, connected to one or more IO Controllers via PROFINET. It is comparable to a Slave device in Modbus.

IO Supervisor
Usually a programming device, such as a computer, for commissioning or diagnostic purposes.

Its main features are:

It works via Ethernet in **real time**.

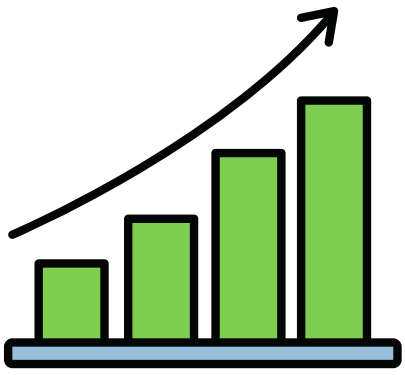
It can work on a **single network cable**, together with other industrial Ethernets also based on standard Ethernet.

Wireless communication. It is part of the PROFINET specification for two standards: Wi-Fi and Bluetooth.

FSU or Fast Start-Up: The PROFINET **Quick Start** function allows the I/O device to immediately enter the "on" state in response to signals from the I/O Controller.

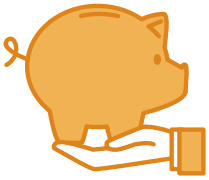
In addition, **PROFINET** offers much better performance than other fieldbuses in terms of:

- Unlimited scalability
- Unlimited address space
- Larger message size (1440 vs. 244 bytes)
- Machine-to-machine communication (M2M)
- Vertical integration capabilities
- The ability to coordinate more drive shafts (32 shafts vs. > 150), with IRT updates in the range of 1 ms, with jitter of less than 1 microsecond.



Benefits of using Arduino, Raspberry Pi or ESP32 controllers

Direct Impact on Costs



Different platforms can be used to program Arduino-based equipment, most of which are free of cost.

No license fees!

ARDUINO

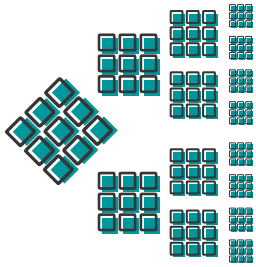
Arduino IDE, original from Arduino and the main software on the market for programming Arduino boards, and therefore f Industrial Shields PLCs, is free to download.

https://www.arduino.cc/en/main/software

Quantity and quality of inputs and outputs

The range of industrial PLCs based on Arduino, Raspberry Pi or ESP32, complete a range of multiple features in terms of types and quantities of inputs and outputs. There are countless applications in which these controllers can be used, whether for **monitoring, control or automation solutions.**

In addition, there is the possibility of installation in master-slave mode, which greatly increases the number of inputs and outputs available.



Standard industrial communications, and more

In industrial environments, standard communications are required to facilitate the connection between all kinds of solutions, hardware or software, in the fastest, cheapest, safest and most reliable way. Industrial Shields PLCs have these requirements, although there may be manufacturers or sectors with specific solutions.

I2C	Serial TTL (UART)	Wi-Fi & BLE	RS485 Half / Full Duplex	LoRa
SPI	Ethernet	GPRS / GSM	RS232	CANBus

...and more Thanks to the flexibility of Industrial Shields, we have added to our products range specific solutions that our customers have demanded, such as:

LoRa

Long Range (LoRa), an ideal technology for long distance connections and for IoT networks where sensors that do not have mains power are required.

DALI
Digital Addressable Lighting Interface

DALI, a protocol created to control lighting systems (Digital Addressable Lighting Interface = Interface Digital de Iluminación Direccionable).

Conclusion

The benefits of the different ranges of PLC, with the particularities of each CPU, the number of inputs and outputs, or specific accessories such as GPRS, WiFi, LoRa or DALI, ensure a range of possibilities. With rare exceptions where the specifications of the solution are going to be very exclusive, Industrial Shields PLCs are a great solution for industrial applications in all sectors, whether for automation, monitoring or control.

Presence in over 100 countries

CONTACT US

Industrial Shields has been working all over the world through distributors, or in direct contact with customers.

Our **sales, technical and support team** will help you by phone, email or by using the ticketing system

Please contact us. We are here to help and assist you.

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