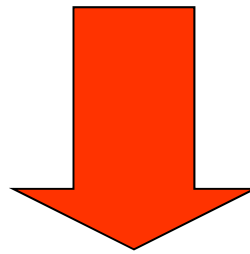


# SCADA



## **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition

Es un sistema que colecta datos provenientes de diferentes sensores en una industria o en lugares remotos, y envía esos datos a una unidad central que realiza el procesamiento de los datos. En la actualidad los sistemas SCADA emplean una unidad de procesamiento central (computadora) que toma decisiones basadas en los datos recibidos, como ser implementación de algoritmos de control de proceso.

# SCADA

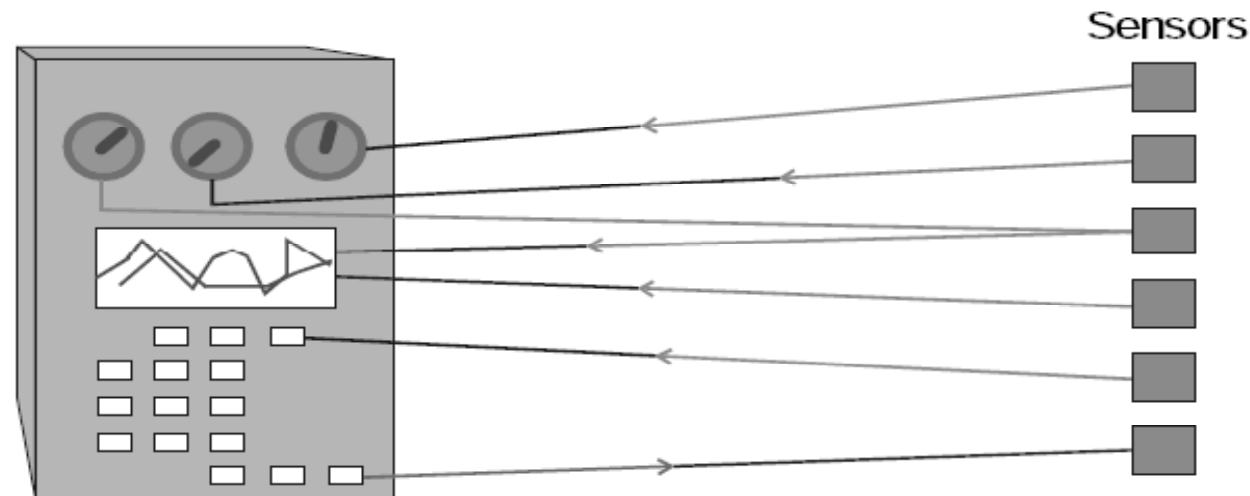
## **Definición :**

Es una aplicación de software especialmente diseñada para funcionar sobre ordenadores en el control de producción, proporcionando comunicación con los dispositivos de campo (sensores y actuadores) y controlando el proceso de forma automática desde la pantalla del ordenador. También provee de toda la información que se genera en el proceso productivo a diversos usuarios, tanto del mismo nivel como de otros supervisores dentro de la empresa (supervisión, control calidad, control de producción, almacenamiento de datos, etc).

Comprende todas aquellas soluciones de aplicación para referirse a la captura de información de un proceso o planta industrial (aunque no es absolutamente necesario que pertenezca a este ámbito), para que, con esta información, sea posible realizar una serie de análisis o estudios con los que se pueden obtener valiosos indicadores que permitan una retroalimentación sobre un operador o sobre el propio proceso

## SCADA (primeros sistemas)

SCADA (supervisory control and data acquisition) has been around as long as there have been control systems. The first 'SCADA' systems utilized data acquisition by means of panels of meters, lights and strip chart recorders. The operator manually operating various control knobs exercised supervisory control. These devices were and still are used to do supervisory control and data acquisition on plants, factories and power generating facilities. The following figure shows a sensor to panel system.



**Figure 1.1**  
*Sensors to panel using 4–20 mA or voltage*

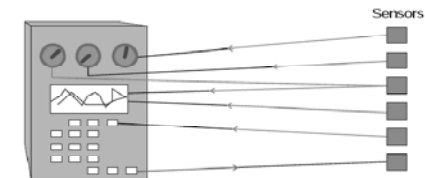
# SCADA (primeros sistemas)

The sensor to panel type of SCADA system has the following advantages:

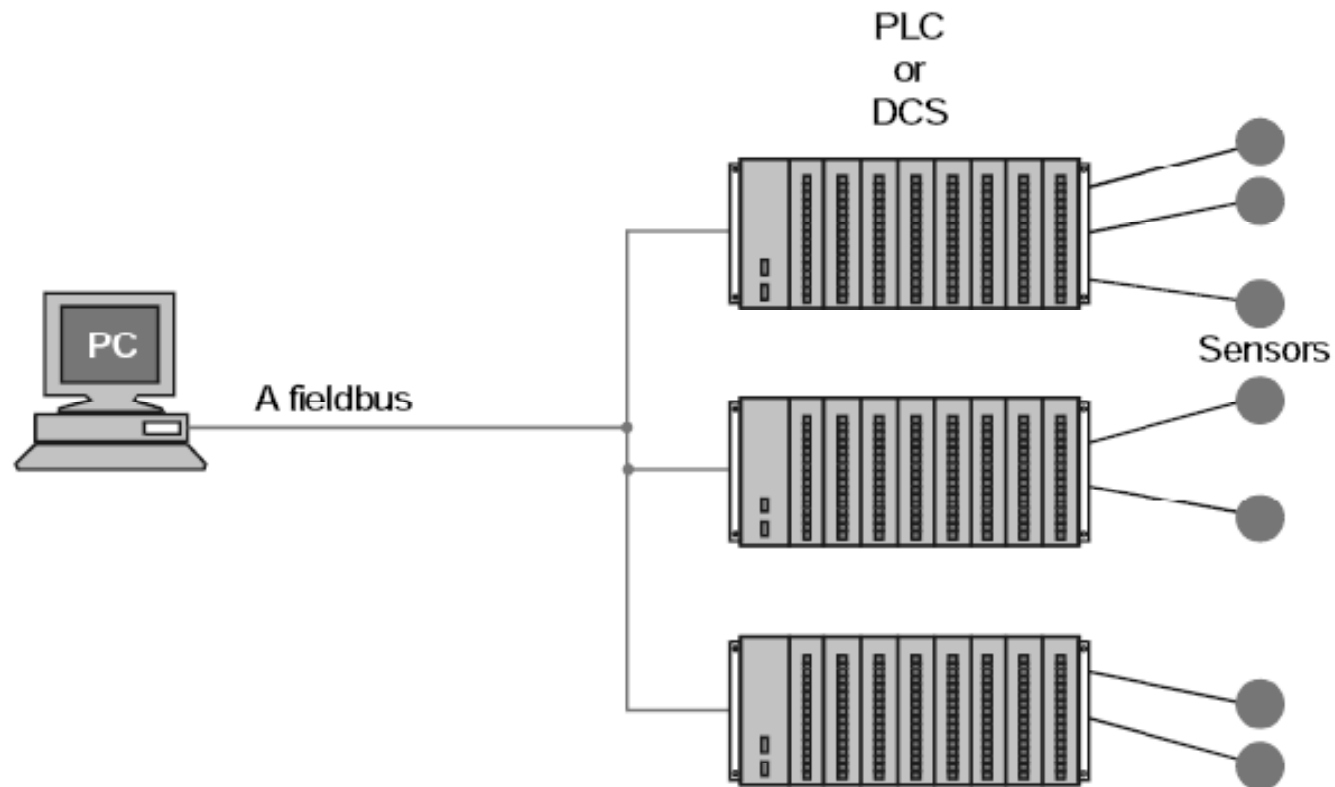
- It is simple, no CPUs, RAM, ROM or software programming needed
- The sensors are connected directly to the meters, switches and lights on the panel
- It could be (in most circumstances) easy and cheap to add a simple device like a switch or indicator

The disadvantages of a direct panel to sensor system are:

- The amount of wire becomes unmanageable after the installation of hundreds of sensors
- The quantity and type of data are minimal and rudimentary
- Installation of additional sensors becomes progressively harder as the system grows
- Re-configuration of the system becomes extremely difficult
- Simulation using real data is not possible
- Storage of data is minimal and difficult to manage
- No off site monitoring of data or alarms
- Someone has to watch the dials and meters 24 hours a day



# SCADA con DCS y PLC

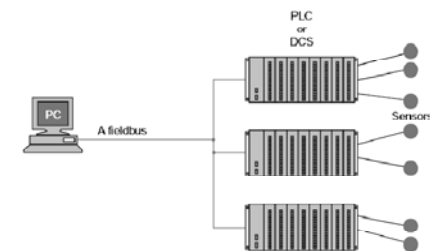


**Figure 1.2**  
*PC to PLC or DCS with a fieldbus and sensor*

# SCADA con DCS y PLC

The advantages of the PLC / DCS SCADA system are:

- The computer can record and store a very large amount of data
- The data can be displayed in any way the user requires
- Thousands of sensors over a wide area can be connected to the system
- The operator can incorporate real data simulations into the system
- Many types of data can be collected from the RTUs
- The data can be viewed from anywhere, not just on site

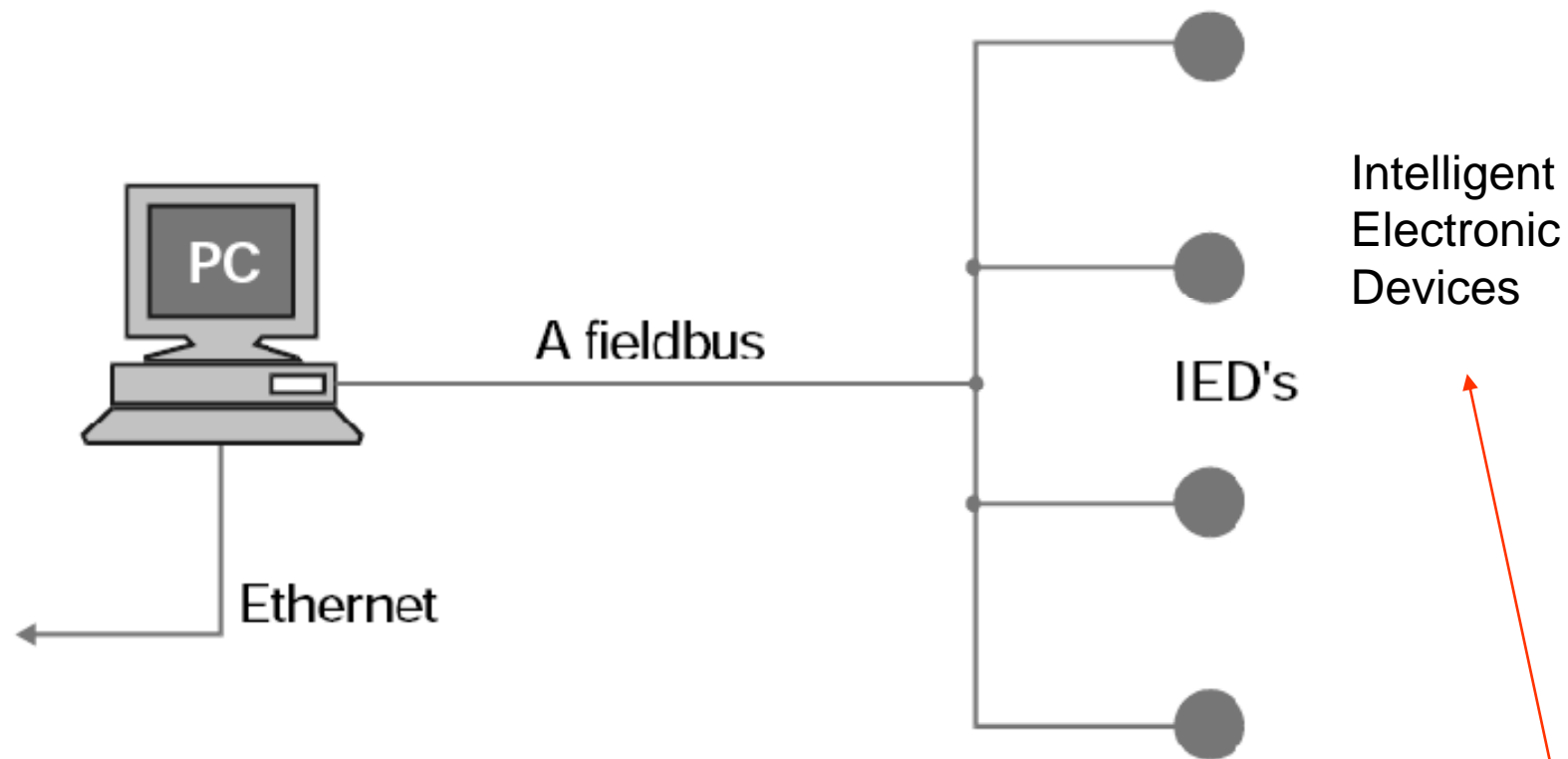


The disadvantages are:

- The system is more complicated than the sensor to panel type
- Different operating skills are required, such as system analysts and programmer
- With thousands of sensors there is still a lot of wire to deal with
- The operator can see only as far as the PLC



# SCADA con Dispositivos Inteligentes



combine an analog input sensor, analog output, PID control, communication system and program memory in one device.

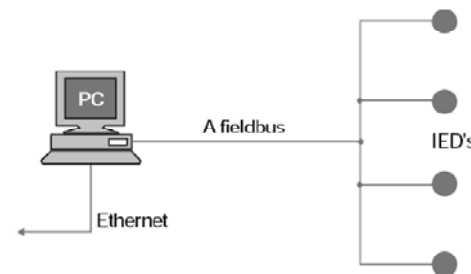
# Red de Dispositivos Inteligentes

The advantages of the PC to IED fieldbus system are:

- Minimal wiring is needed
- The operator can see down to the sensor level
- The data received from the device can include information such as serial numbers, model numbers, when it was installed and by whom
- All devices are plug and play, so installation and replacement is easy
- Smaller devices means less physical space for the data acquisition system

The disadvantages of a PC to IED system are:

- More sophisticated system requires better trained employees
- Sensor prices are higher (but this is offset somewhat by the lack of PLCs)
- The IEDs rely more on the communication system





## Hardware de un SCADA

A SCADA system consists of a number of remote terminal units (RTUs) collecting field data and sending that data back to a master station, via a communication system. The master station displays the acquired data and allows the operator to perform remote control tasks.

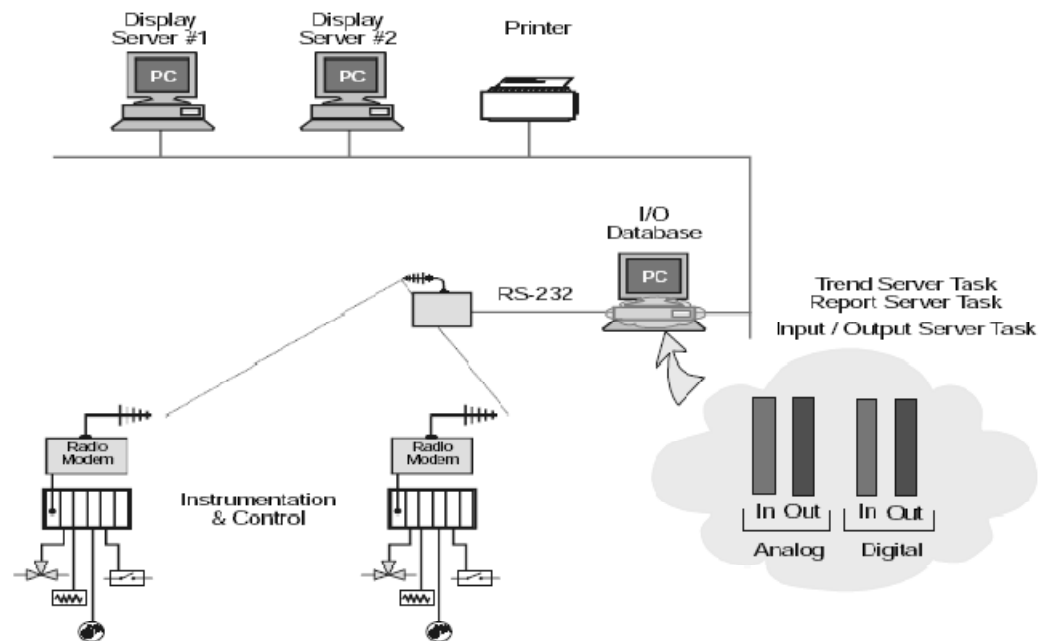
The accurate and timely data allows for optimization of the plant operation and process. Other benefits include more efficient, reliable and most importantly, safer operations. This results in a lower cost of operation compared to earlier non-automated systems.

On a more complex SCADA system there are essentially five levels or hierarchies:

- Field level instrumentation and control devices
- Marshalling terminals and RTUs
- Communications system
- The master station(s)
- The commercial data processing department computer system

## Software de un SCADA

- Proprietario: para comunicación con hardware del propio fabricante (llave en mano). Alta dependencia del fabricante y difícil de crecer.
- Abierto: Permiten interoperabilidad (equipo de distintos fabricantes).



**Figure 1.4**  
*Typical SCADA system*

# Software de un SCADA

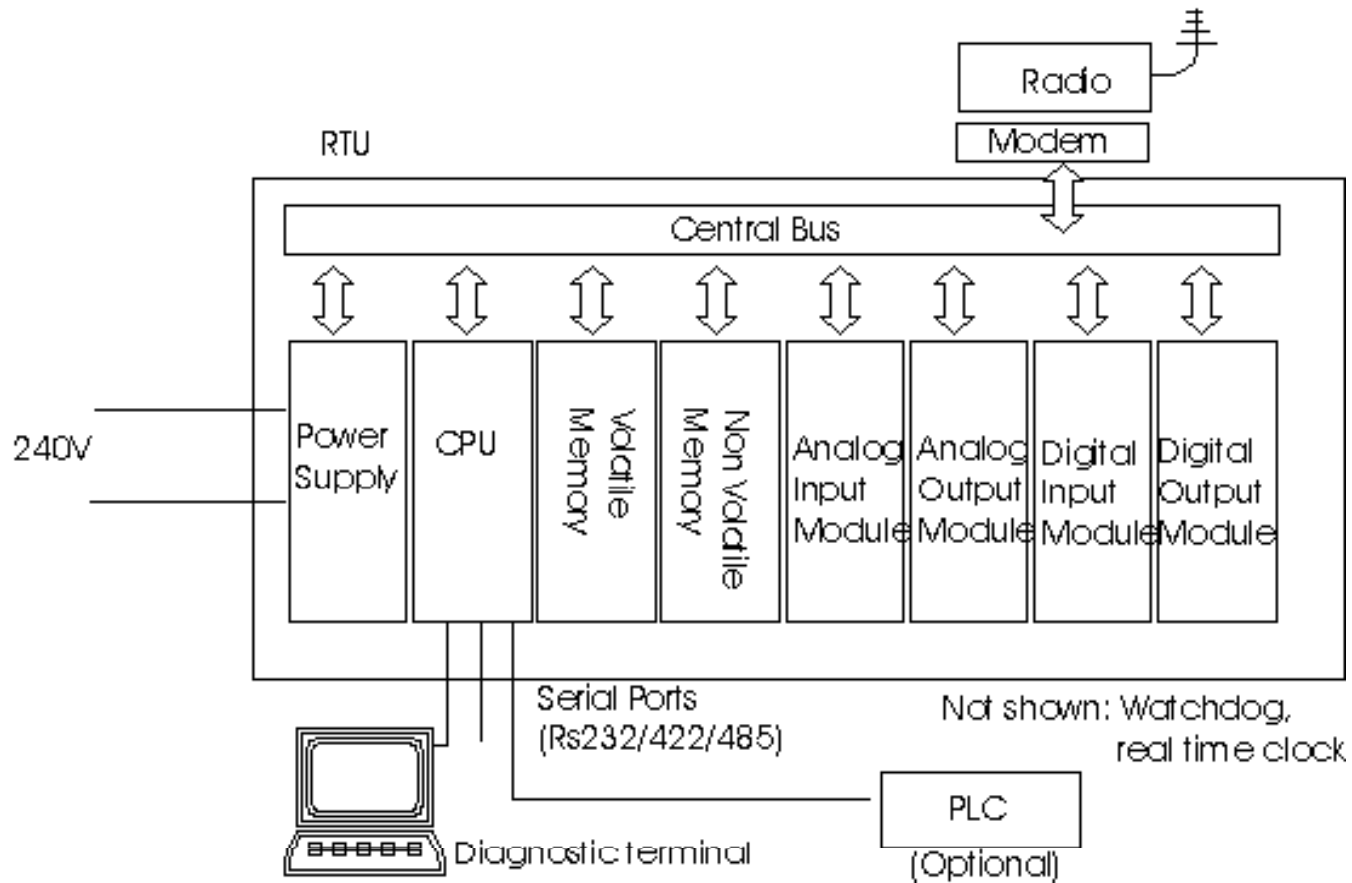
Key features of SCADA software are:

- User interface
- Graphics displays
- Alarms
- Trends
- RTU (and PLC) interface
- Scalability
- Access to data
- Database
- Networking
- Fault tolerance and redundancy
- Client/server distributed processing

## SCADA – Elementos principales

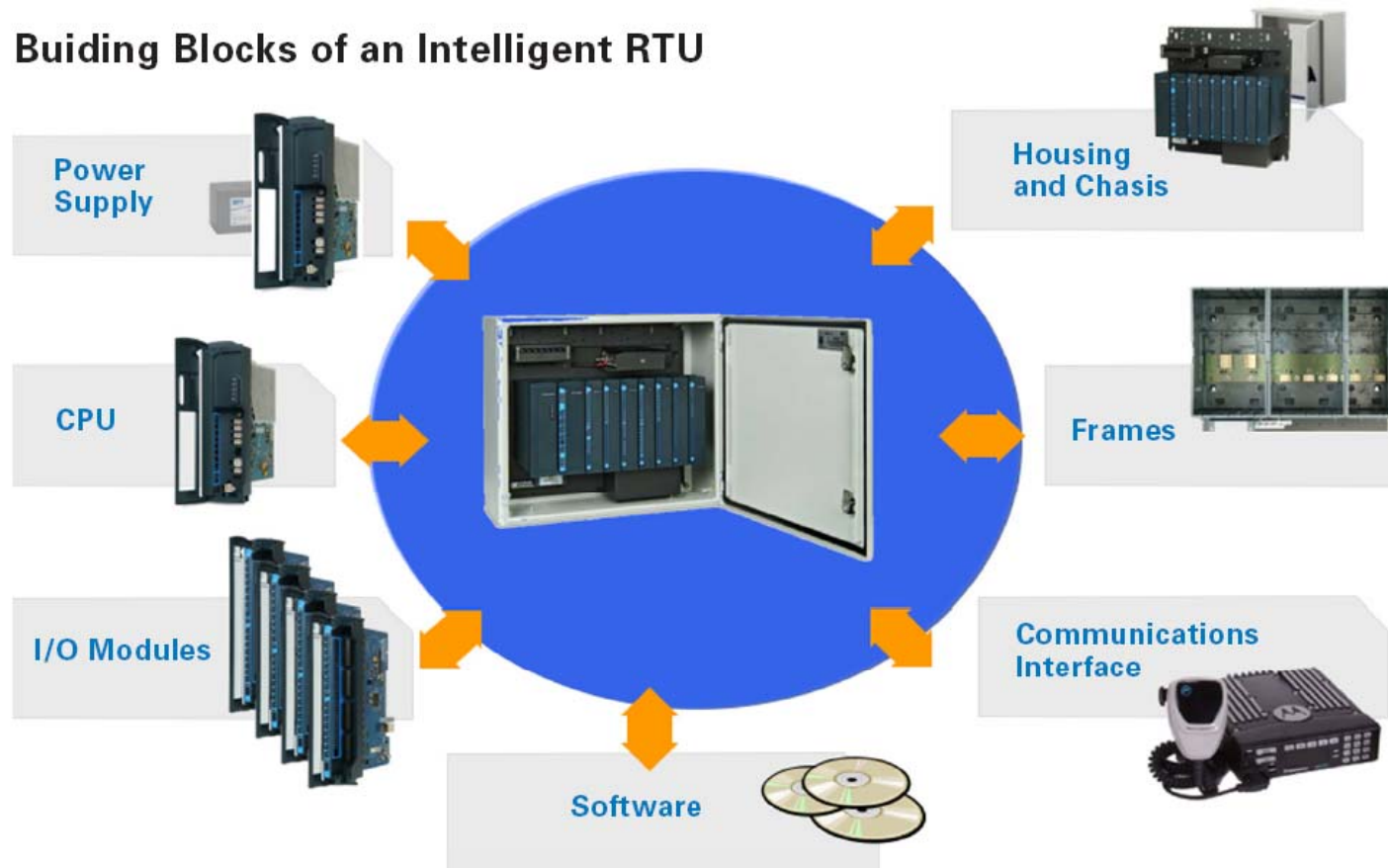
- RTU (Remote Terminal Unit):
  - Es una pequeña unidad de procesamiento que provee inteligencia en el campo y permite comunicarse a la central de procesamiento comunicarse con los dispositivos e instrumentos de campo.
- HMI (Human Machine Interface):
  - Presenta la información sobre el sistema al operador.  
Permite visualizar datos y controlar dispositivos.
- Comunicación: protocolo de comunicación entre las RTU y la central de procesamiento.
  - RS232
  - RS485
  - IEEE 802.11x

# RTU en detalles



# RTU

## Building Blocks of an Intelligent RTU

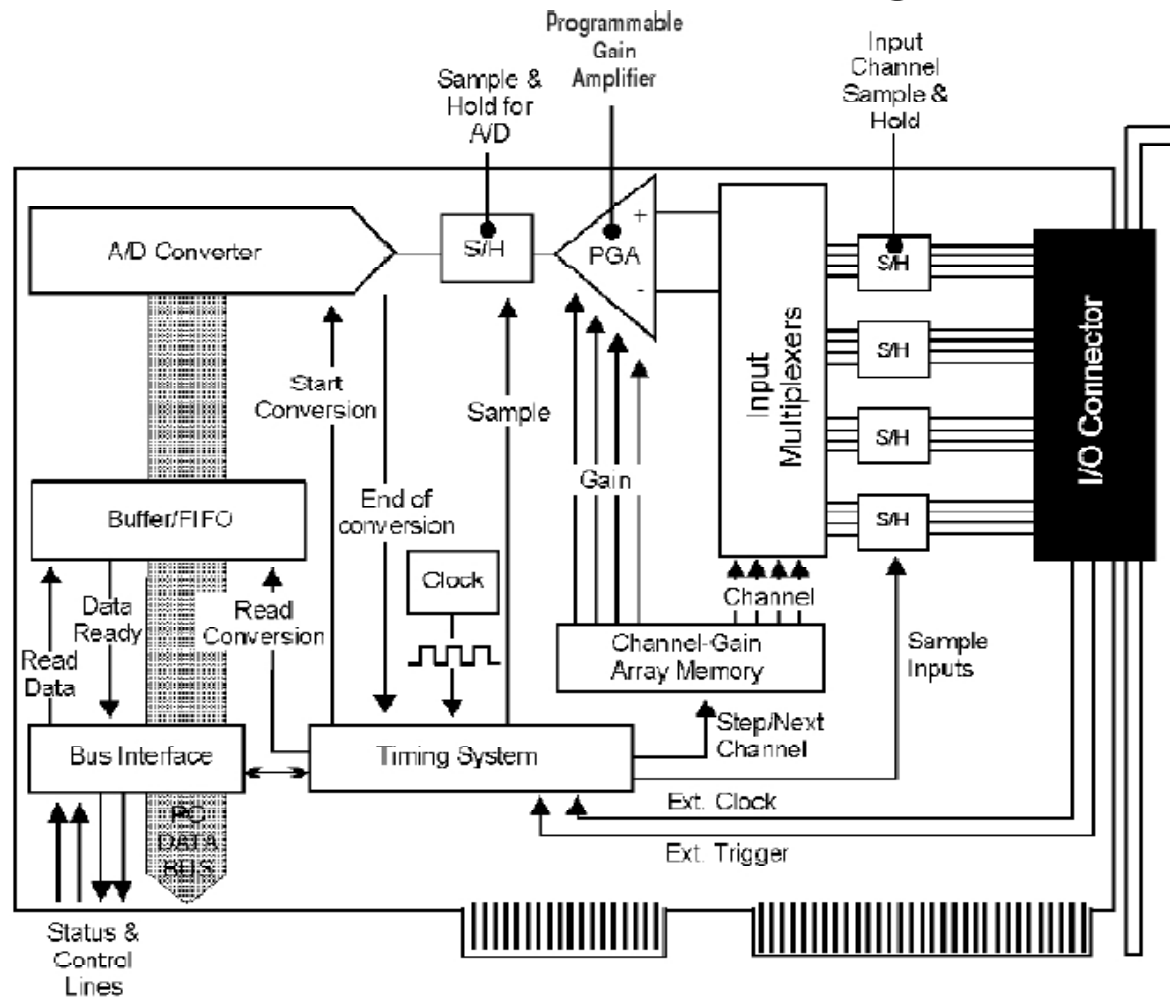




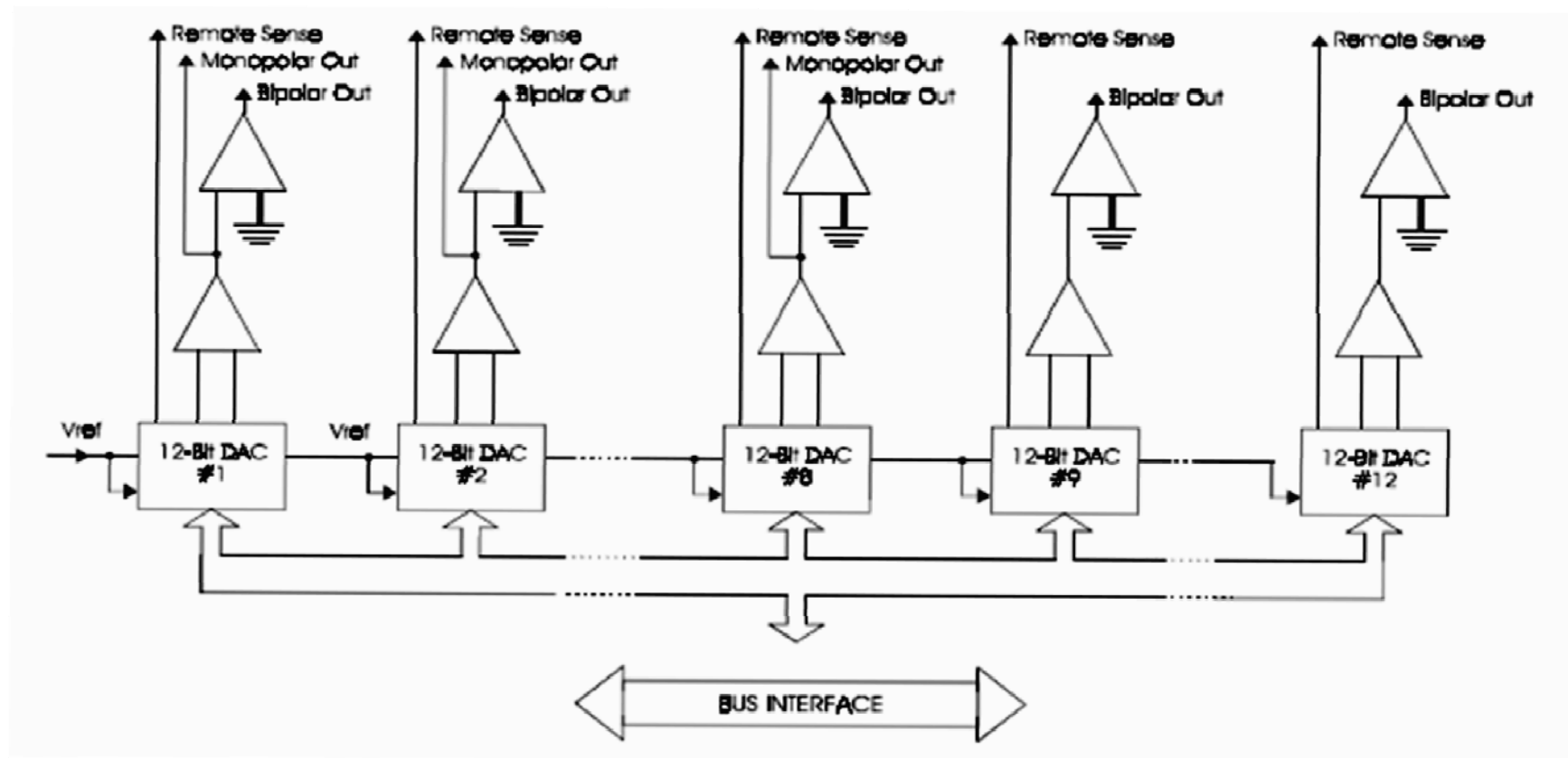
# CPU

- Microprocesador
- RAM: EPROM (o RAM con batería), EEPROM
- Coprocesador matemático
- Puertos de comunicaciones: RS-232, RS-422, RS-485 para interface con terminales de diagnóstico, terminales de operador, vínculo a estación central
- LEDs de diagnóstico
- Reloj de tiempo real para etiquetar los eventos
- Watchdog timer

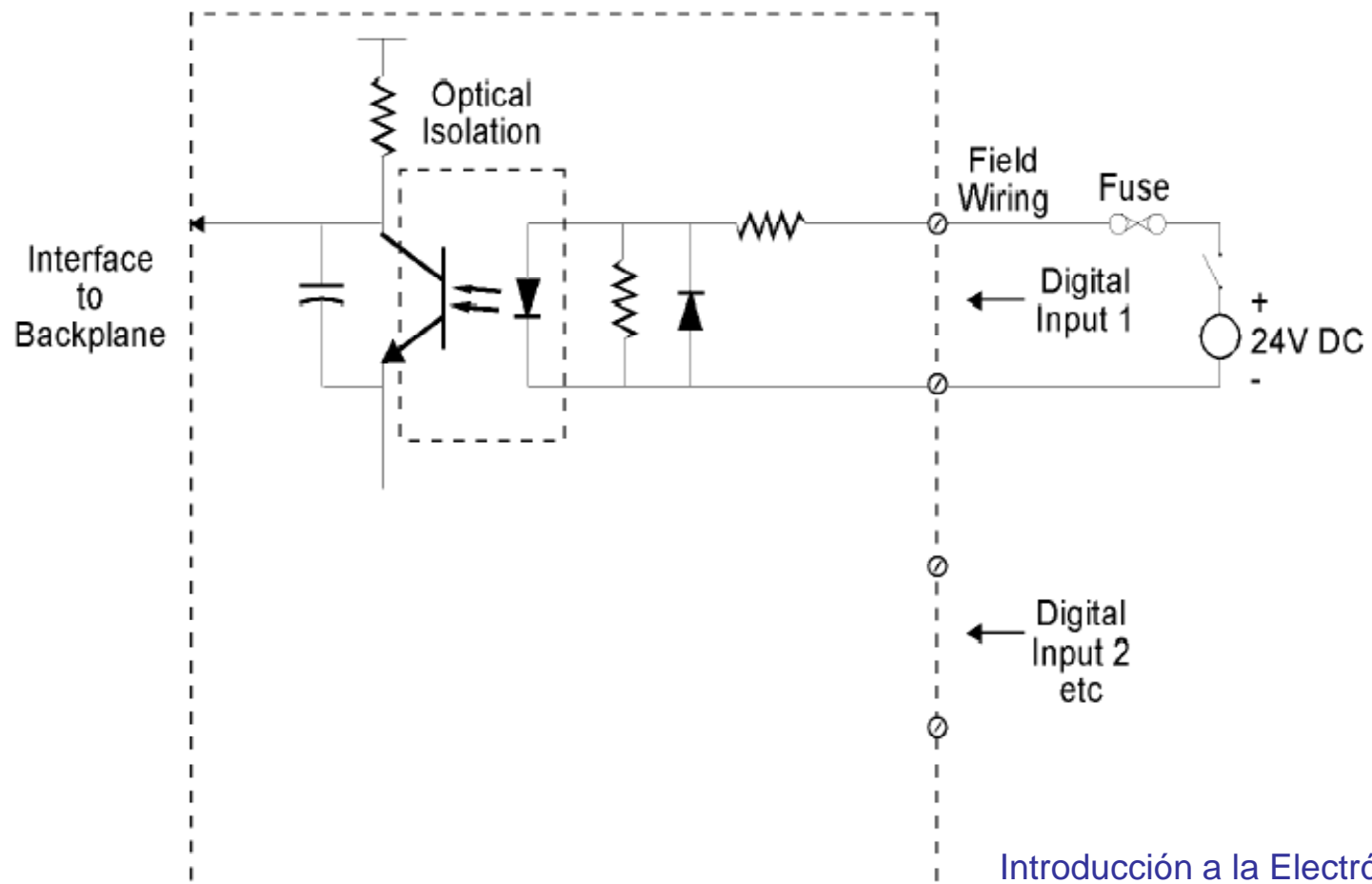
# Entradas analógicas (AI)



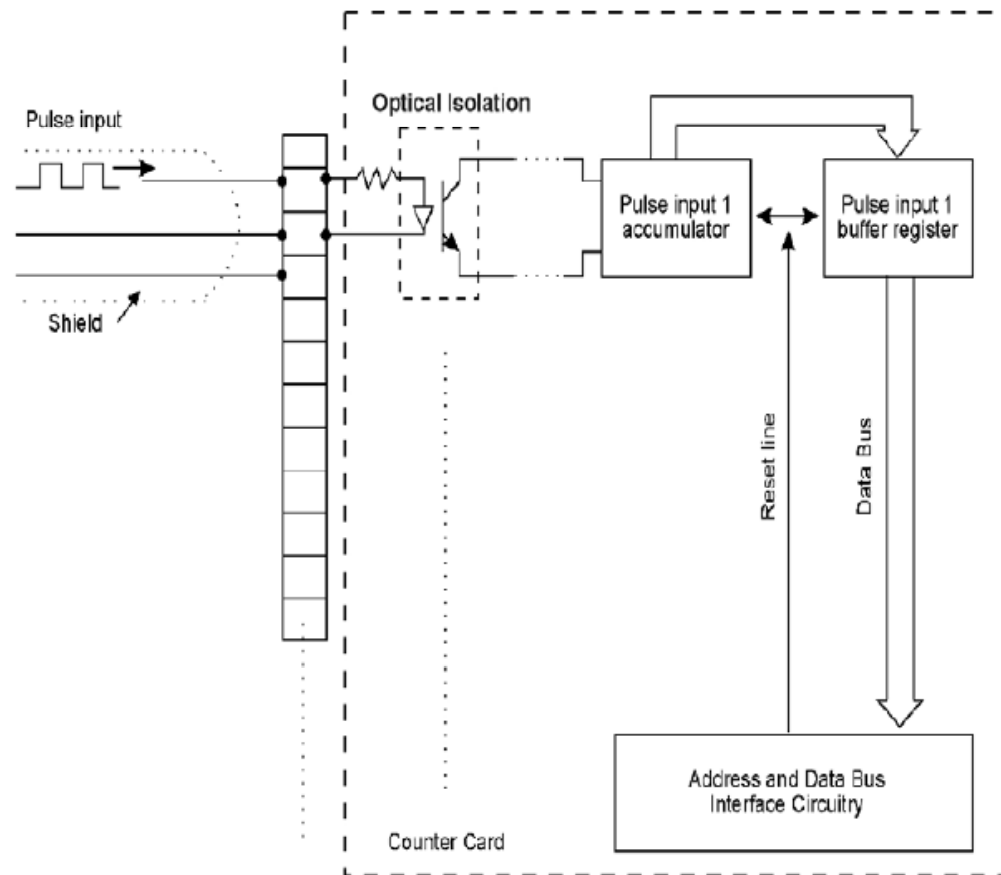
# Salidas analógicas (AO)



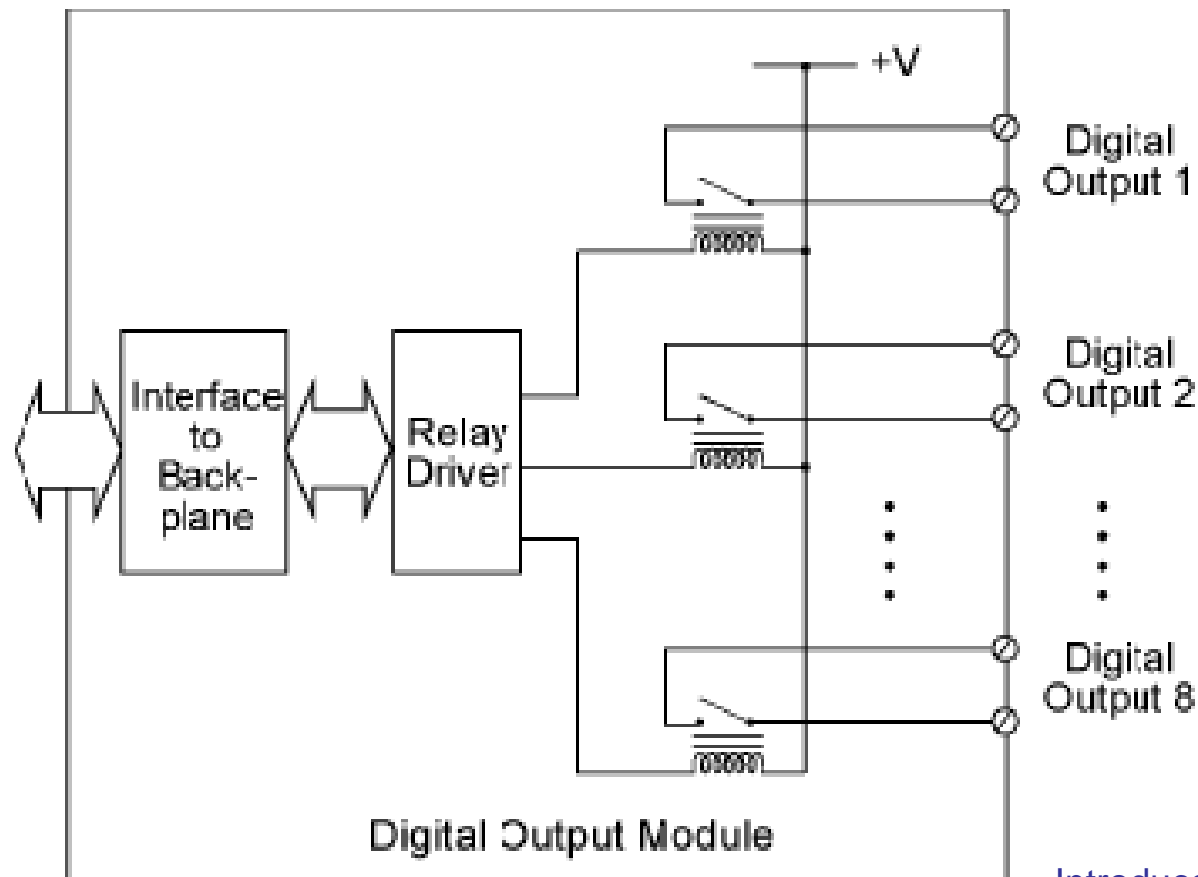
## Entradas Digitales (DI)



# Módulos de conteo



# Salidas Digitales (DO)





# Software Master Station

## Master station software

There are three components to the master station software:

- The operating system software
- The system SCADA software (suitably configured)
- The SCADA application software

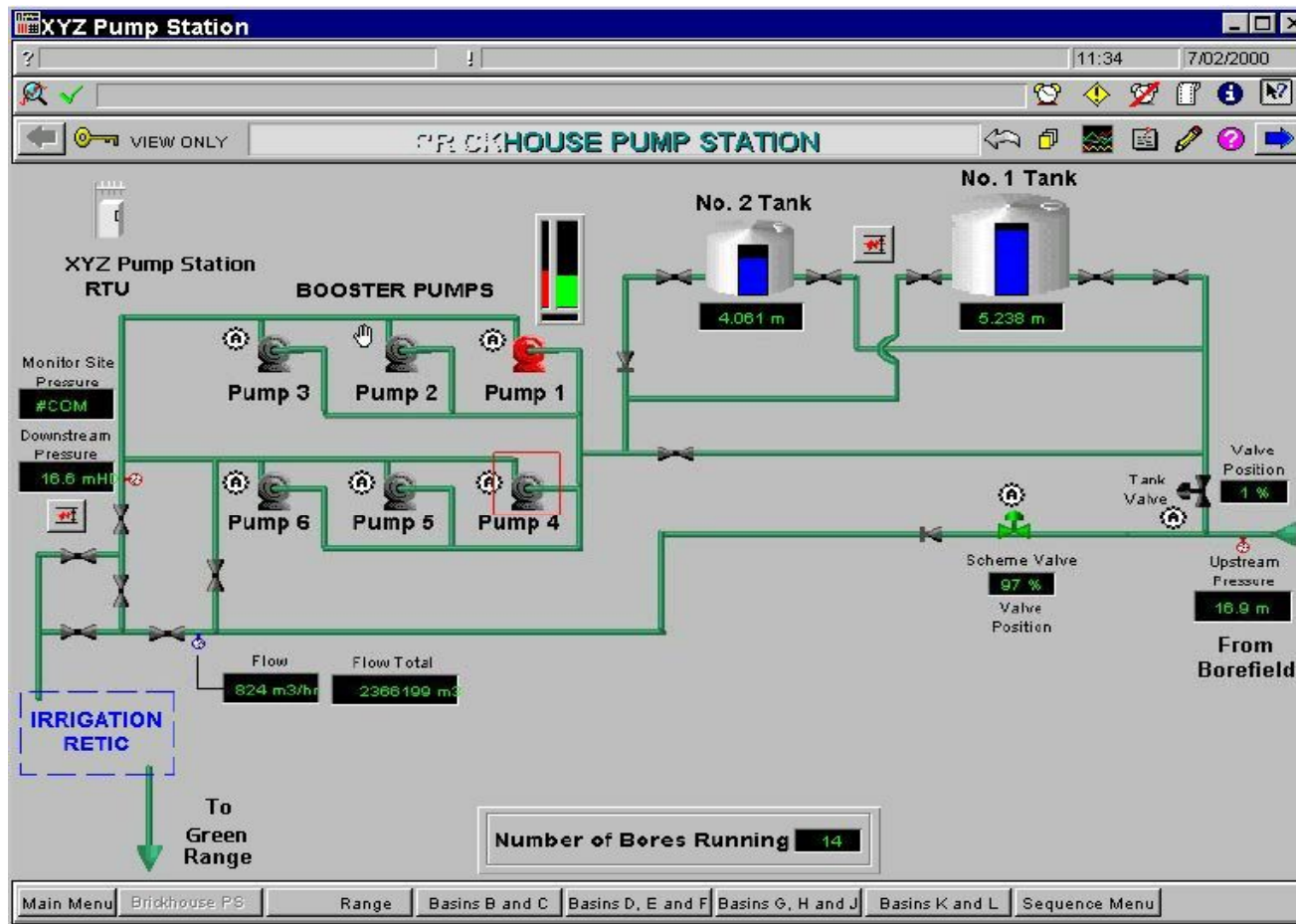
There is also the necessary firmware (such as BIOS) which acts as an interface between the operating system and the computer system hardware. The operating system software will not be discussed further here. Good examples of this are DOS, Windows, Windows NT and the various UNIX systems.

## System SCADA software

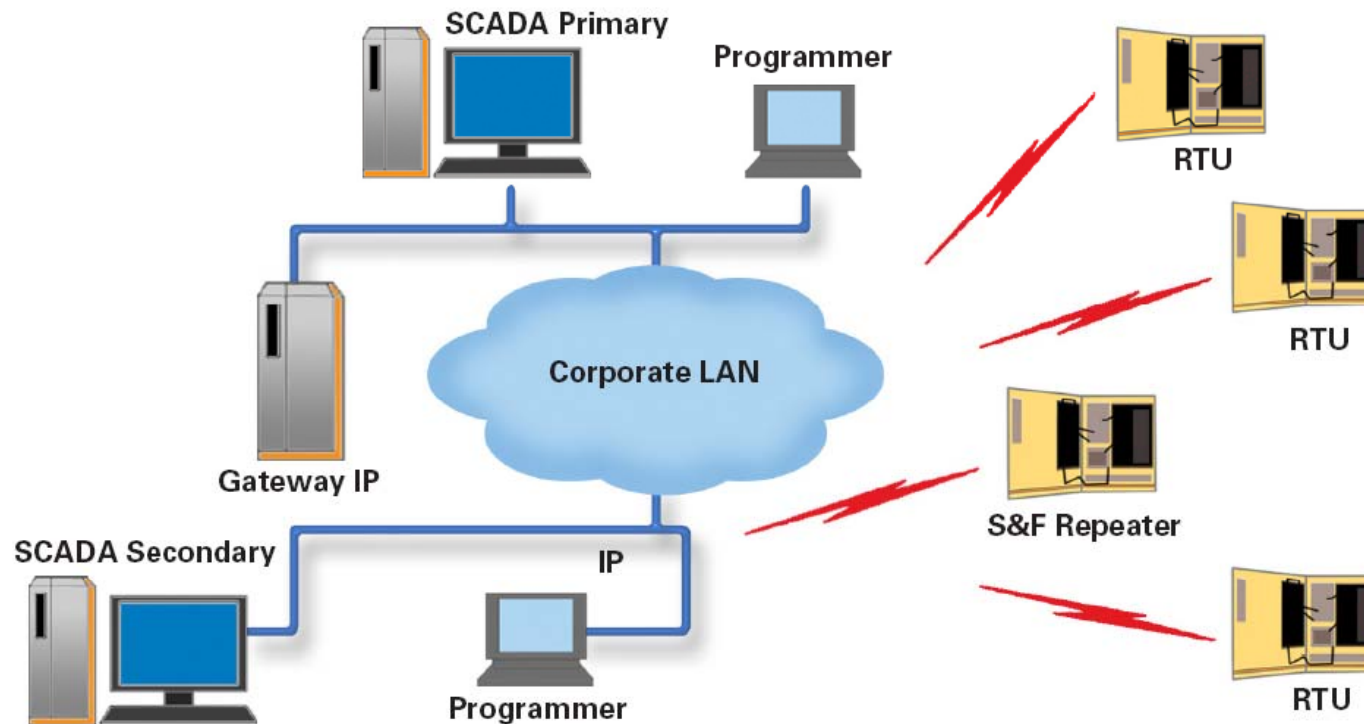
This refers to the software put together by the particular SCADA system vendor and then configured by a particular user. Generally, it consists of four main modules:

- Data acquisition
- Control
- Archiving or database storage
- The man machine interface (MMI)

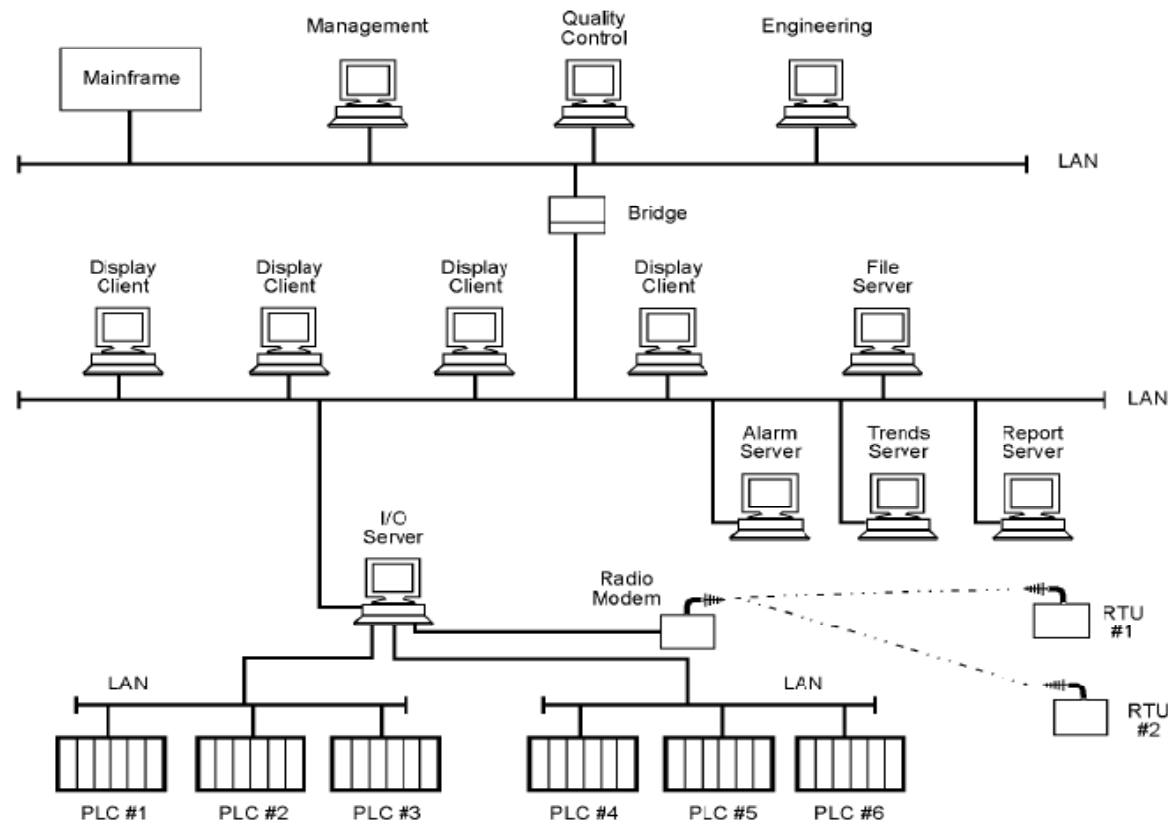
# SCADA



# SCADA – Alto nivel



# SCADA – Alto nivel

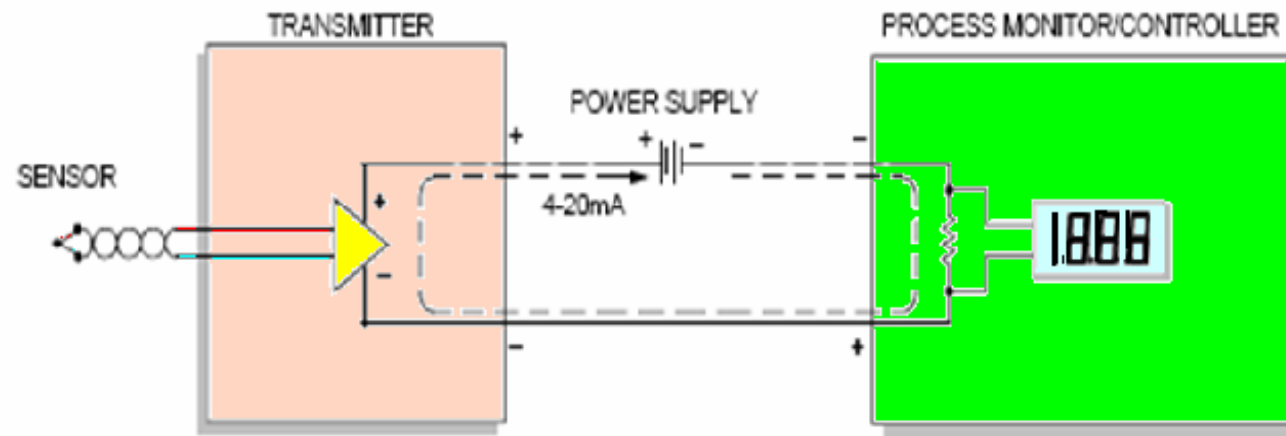


**Figure 3.5**  
*A large SCADA application*

# Interfases

- La comunicación entre las diferentes partes de un sistema de control en un ámbito industrial, se hace por diversos medios:
  - Tensión: 0-10V o +/-10V (distancias cortas)
  - Corriente 0-20mA o 4-20mA
  - Digital (24V)
  - Serie; como ser RS232 (distancias cortas) o RS485 (Modbus)
  - USB (distancias cortas)
  - Ethernet (poco empleado hoy en día)

## Lazo de corriente 4-20mA

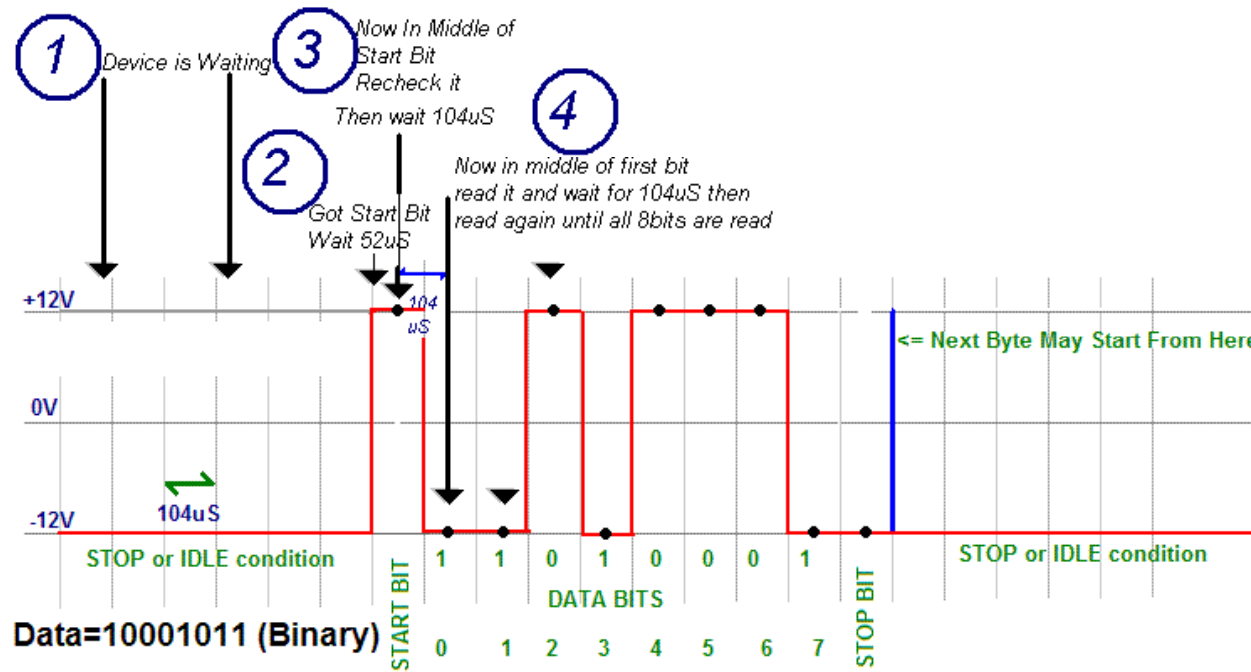


**COMPONENTES BASICAS DEL LAZO Y SU CARGA**

- En un lazo de corriente pueden colocarse varios receptores en serie. Existe si embargo una limitación en la carga resistiva máxima que puede manejar el lazo ( $<1\text{K}\Omega$ ).
- Reemplazó al lazo 0-20mA



# Interfase RS-232

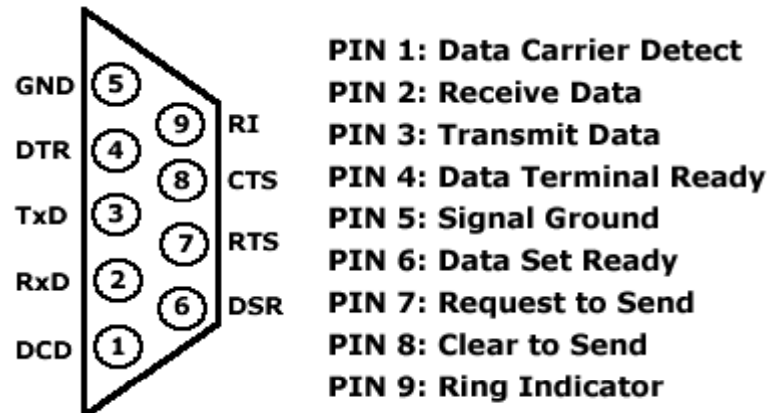


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- El hardware del transceptor RS-232 tiene una señal de reloj para sincronizar el envío/muestreo de cada bit.
- Son para trayectos cortos (15mts) y velocidades de hasta 115200bps

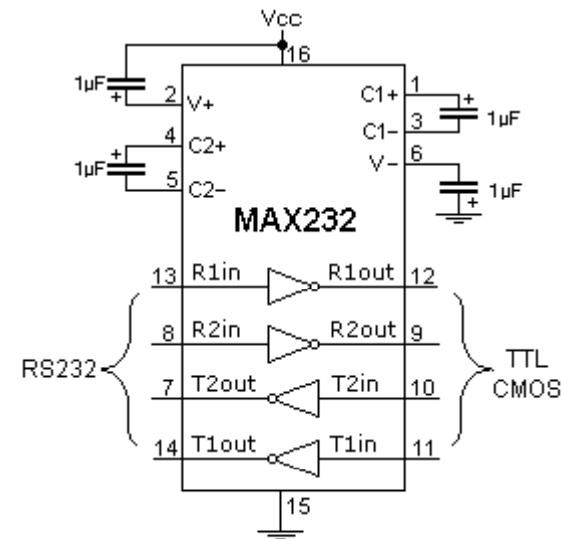
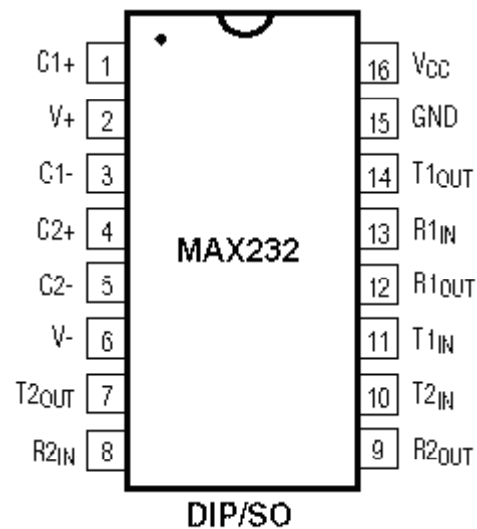
## Interfase RS-232

### RS-232 DB-9 Male Pinout



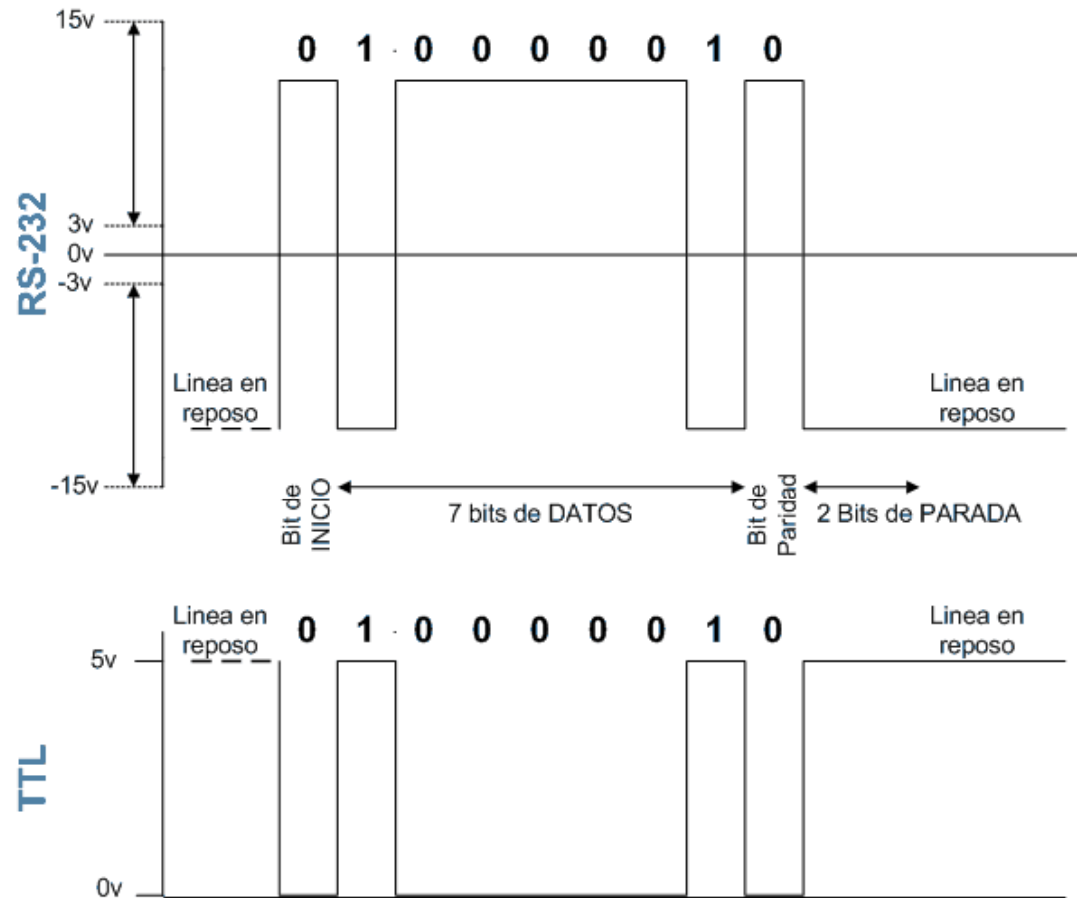
- El protocolo RS-232 completo incluye todas las señales de la imagen anterior; sin embargo en la práctica es común emplear el set básico de señales; es decir RX, TX y masa (pines 2, 3 y 5).
- Es Full Duplex (transmite y recibe simultáneamente)

## Interfase RS-232 (TTL)



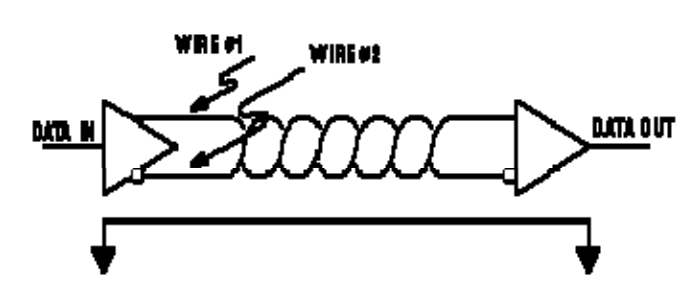
- El estandar RS-232 emplea niveles lógicos de +/- 8V, que no pueden manejarse por la lógica digital. Por ello debe intercalarse un conversor, que invierte además la polaridad. El MAX232 es uno de los CIs más utilizado.

# Interfase RS-232 (TTL)



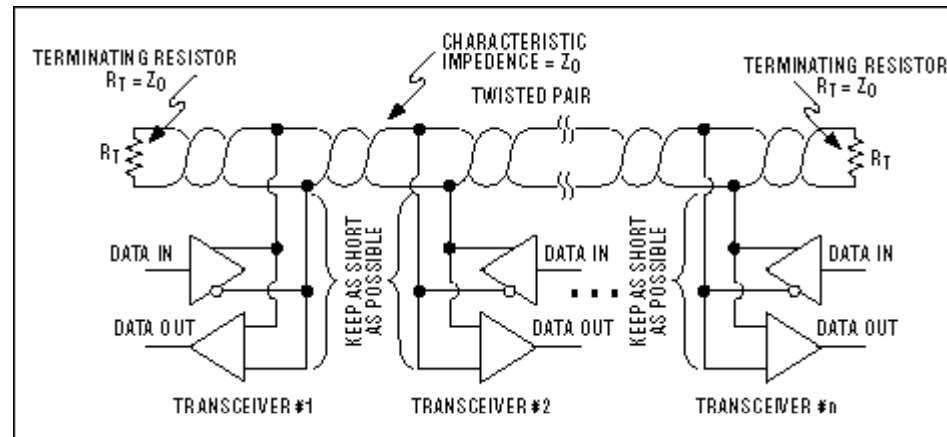
## Interfase RS-485

- Similar al RS-232, salvo que la transmisión se hace de manera diferencial, ofreciendo mayor inmunidad al ruido y mayor distancia de cobertura (1200 mts).
- Cada transmisor tiene control de habilitación, por lo que se puede formar una red (32 nodos).
- Es Half Duplex, y generalmente es un sistema Maestro-Esclavo, donde solamente uno inicia una comunicación y del resto solamente uno responde.
- Necesita sí o sí una capa superior en software para arbitrar la red. Uno de los protocolos más usados en la industria es el MODBUS.

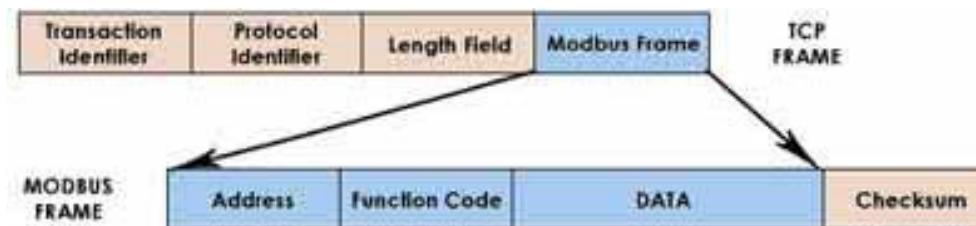


# Interfase RS-485

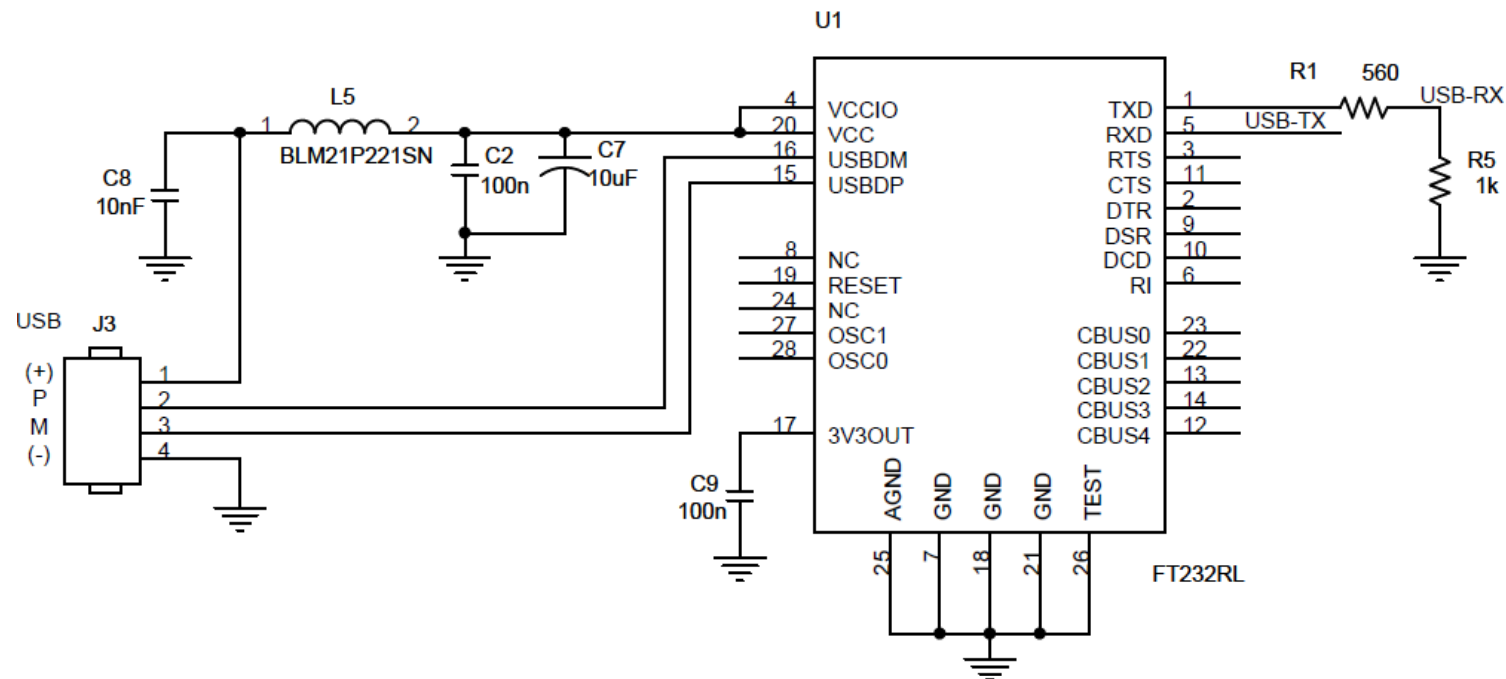
Red RS-485.



Trama MODBUS



## Convertidor USB-RS-232



- El CI FT232RL de Prolifics, directamente permite hacer la conversión directa de USB (12Mbps) a RS-232 TTL para acoplar a un microprocesador. Ya viene con drivers estándar que permiten ver al USB como un puerto COM mas.