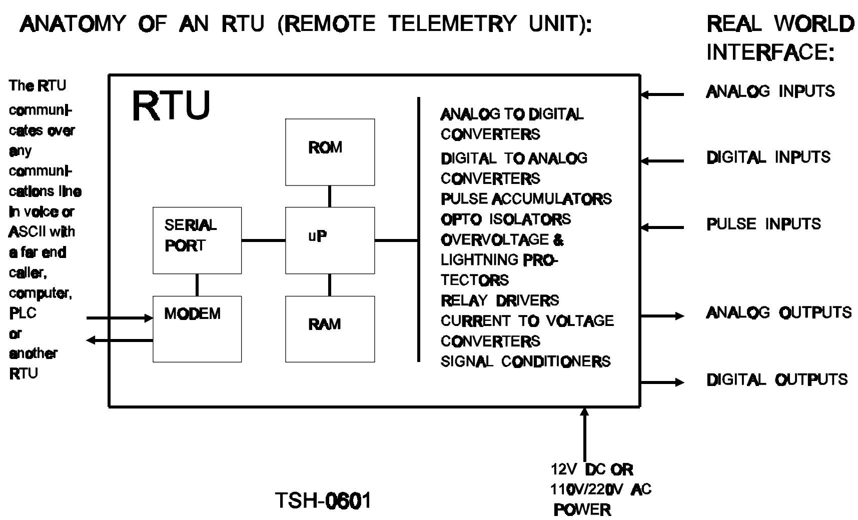
CHAPTER 6, WHAT ARE THE RTU INPUT AND OUTPUT (I/O) SIGNALS?

6.A SUMMARY:

Digital (on or off) signals were the first to be transmitted over cable and radio. Morse code was used (and still is). It consists of a number of dots and dashes which were easy to transmit. You closed a key and current flew along the wire. You opened the key and the current stopped flowing.

This method is still used to transmit digital and alarm conditions along a pair of wires. A contact closure at the remote station causes current to flow in a pair of wires to the central where a lamp is lit or a bell is rung.

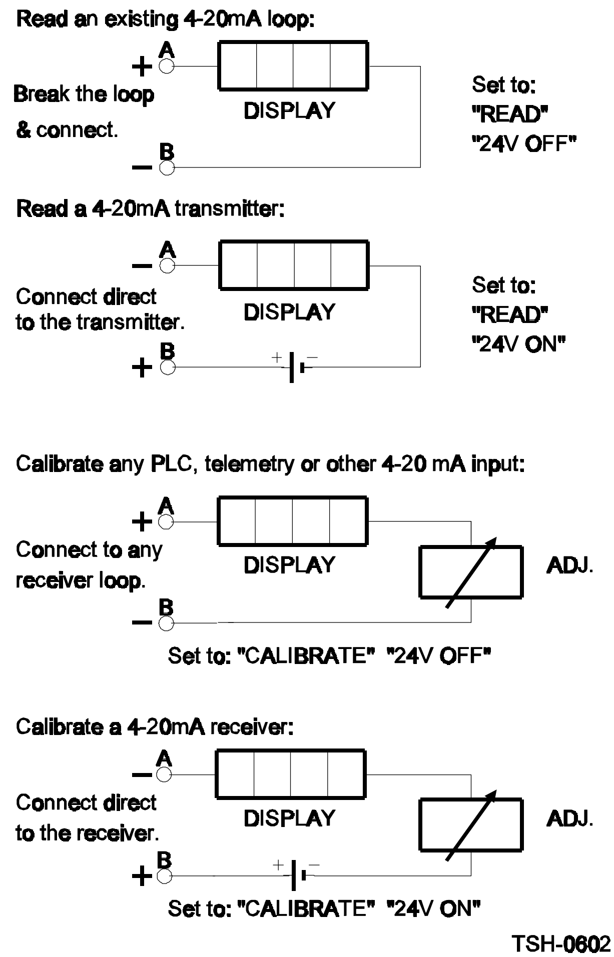


This system of transmitting digital information is very wasteful of cable runs. It is therefore surprising to learn how many utilities still use this method which is based on the capability of the cable circuit to transmit DC current. This type of cable circuit is referred to as a 'metallic' circuit.

As the telephone companies are switching over to fiber optic circuits, these old metallic circuits are being phased out and more modern methods of transmission are adopted.

Modern SCADA and Telemetry RTUs are able to digitize virtually any amount of digital, analog and pulse signals and to send it over any media, cable, fiber optics and radio, over any distance.

6.B ANALOG INPUT (A/I) SIGNALS:



The RTU has to receive information from field sensors on flow rates, pressures, levels, etc. This type of information is called analog as the electrical signals the RTU receives are analog to the actual flow rates, pressures, levels, etc. These type inputs are classified as Analog Inputs or A/I.

6.B.1 A LITTLE ANALOG INPUT HISTORY:

Years ago it was very difficult to transmit analog signals over cable or radio.

At first a Pulse Duration Measuring (PDM) system was developed and used. It closed and opened a contact at the transmitting end. The ratio of the time the contact was closed to the time the contact was open was proportional to the analog value. This time ratio was measured at the receiving end and the corresponding analog value recovered.

These systems used mechanical rotating cams at both ends. Today this appear nightmarish in complexity but at the time it was a good way to transmit analog information over a metallic cable pair. One may be surprised to learn that some of these systems remain in use to this day with many utilities.

After the PDM another method appeared. As the cable circuit could carry frequencies from about 300 Hertz to 3,000 Hertz, why not send the analog value as a variable frequency? Why not indeed? Why not use different frequencies on the same cable, each one carrying its own analog signal?

These variable frequency systems were called tone telemetry systems and they were an improvement over the PDM systems although they still had many shortcomings. You needed a tone transmitter at one end and a tone receiver at the other for each analog value transmitted. Drift in the tones would cause inaccuracy. They were prone to interference. A receiver could lock in on the wrong transmitter, if they were spaced too close.

6.B.2 USING MODERN ANALOG SYSTEMS:

Modern computer technology has made both these old systems obsolete. Today the analog information is digitized and transmitted with several levels of error checking and error correction so that inaccuracy in transmission is a thing of the past.

WHY THE 4-20 mA LOOP?

There have been many voltages and currents used over the years to represent varying analog measurements. Process variables such as level, flow, voltage, current and others have been converted by transducers to 0-1 mA, 1-5 volts, 0-1 volts, 4-20 mA and others.

The much preferred way is to convert the process variables to 4- 20 mA. It has rapidly become a standard and most process instrumentation uses this method. There are now converters available that will convert non standard transducer outputs to 4- 20 mA.

The 4-20 mA method offers many advantages. It is capable of great accuracy as the resistance in the transducer wires and power supply voltage variations have no effect on accuracy. As 4 mA represent a zero value, broken wires or bad transducer generate 0 mA, an obvious fault indication.

A 4-20 mA transducer is called a transmitter. The wires connecting the transmitter and the power supply (normally 24V DC) to the receiver are called the loop. More than one receiver can be connected into the loop without affecting accuracy as long as there is only one ground point in the loop. Loop isolators are available to eliminate ground problems.

An RTU or PLC input is a receiver. So is the 4-20 mA input to a chart recorder and to a motorized valve actuator.

Wire your 4-20 mA or 1-5V transmitter output into the RTU analog input circuit. Observe polarity. You can find out what kind of input you have by checking across the input terminals. If you find an impedance larger than 100 K you have a 1-5V input. If you find less than 500 ohms you have a 4-20 mA input and you need an external power supply in series with your transmitter. If you find 12V or 24V you have a 4-20 mA input and you need no external power supply for your transmitter.

Scan-Data manufactures a wide variety of accessories for the 4-20mA loop. Calibrators, single, double and triple isolators and splitters, trip point generators, power supplies and readouts, to name a few. Check section 9 in the Design Guide and Price List and check our numerous technical descriptions and application notes. Another very good source for information is **www.4-20maloop.com**

6.C DIGITAL INPUT (D/I) SIGNALS:

The RTU also has to receive information as to whether a pump is running or stopped, a door is opened or closed, a fire alarm is on or off, etc. This type of information is called digital as it is either ON or OFF. These type inputs classified as Digital Inputs or D/I and they are most often a 'dry' contact pair, meaning that they are not connected to any power supply.

Wire these directly into the RTU digital input terminal pair. Observe polarity.

6.D PULSE INPUT (P/I) SIGNALS:

Flow meters, gate counters and other flow metering devices deliver pulses to the RTU. Each pulse signifies a unit of flow. These pulses are counted (accumulated) by the RTU and the total count or accumulation is reported by the RTU. These inputs are classified as Pulse Inputs or P/I.

These signals can be either dry contact or +5 volt signals. Both can be wired directly into the RTU pulse input terminal pair. Observe polarity.

6.E ANALOG OUTPUT (A/O) SIGNALS:

Positioning command signals to a valve or an analog setpoint signal to a PLC, for instance, require that the RTU outputs an variable analog current, proportional to commands from the central station or to the analog inputs from other RTUs. These outputs are classified as Analog Outputs or A/O.

Analog outputs nowadays always take the form of 4-20 mA signals. To determine if the RTU analog output has an internal power supply, use a tester. If you measure 12V or 24V across the analog output terminals, you need no external loop supply. If not, place a 12V or 24V loop power supply in series between the positive terminal of the analog output and your receiver. The negative terminal of the analog output is normally tied to ground internally.

If you have to deal with non-standard analog signals, check Scan-Data's wide variety of voltage to 4-20mA and 4-20mA to voltage converters. A good source for information for these devices is **www.4-20maloop.com**

6.F DIGITAL OUTPUT (D/O) SIGNALS:

Commands to the RTU to open valves, start motors or close switches, for instance, require relay contact (digital) outputs from the RTU. These outputs can be in response to commands from the central station computer or from contact inputs from other RTUs which are multiplexed to one or more RTUs (Mode-C systems). These outputs are classified as Digital Outputs or D/O.

Digital outputs take the form of a relay driver open collector transistor. This means that the digital output can interface directly with a variety of devices, such as relay coils, 5V and 12V logic, etc. The transistor in the ScanData RTUs are capable of handling up 100 mA and up to 24 volts.

The output transistors can be powered by the RTU or they can be externally powered. To determine which is the case, measure from the positive output terminal on the RTU to ground. If you read 12V or 24V, you need no external power supply and you can wire your 12V or 24V relay coil directly onto the digital output terminals. Observe polarity. It is always preferable to use diode protected relays, where a diode is placed across the relay coil.

WHERE CAN I GET MORE INFORMATION?

The following descriptions, pertinent to this chapter, are included in the DESCRIPT directory on the SCADAtech(TM) CD:

pri-0901.pdf Design Guide and Price List.

app-1104.pdf How to send multiple analog and digital signals.

app-1115.pdf How the 4-20mA instrument loop works.

app-1127.pdf How to test RTU communication circuits.

v2c-1496.pdf 4-20mA signal conditioners, V2C and C2V.

iti-1504.pdf 4-20mA current isolators.

ips-1495.pdf Isolated DC to DC converters.

An easy way to get the latest and most recently updated versions of these descriptions is to go on our WEB site:

www.scan-data.com

When you are there, click on the blue button near the bottom of the WEB page that says **Technical Information.** Then click on the description # you need.