4-20ma or Modbus?

Many process instruments now have the ability to transmit either a 4-20ma signal or 485 Modbus or Modbus over Ethernet. Most of us shy away for Modbus communications as this requires interfacing and terminology that is new to us and we do not understand. Hopefully this article will shed some light on Modbus communications and make connecting modbus devices as simple as connecting 4-20ma devices.

The advantages of using Modbus communications over individual 4-20ma signals are as follows:

1. ***Wiring 485 modbus devices is nothing more than 2 wires (same as 4-20ma). Difference is that units can be daisy chained. This means that one can wire to node 1, and Node 1 can be connected to node 2. This does not require individual pair of wires for each node. Therefore, for 31 devices, only 2 wires are required to communicate to all 31 devices. 4-20ma devices would require 31 pairs of wires. (Ethernet Modbus follows Ethernet wiring practices and would require homeruns into an Ethernet hub),***

2. ***With Modbus, one has access to all the variables in the connecting device. For Example with a MSA Ultima X device, not only can we see the current Gas concentration, but we can also see the exact status of the device, the scaling of the instruments, last calibration date, the date of the sensor, etc.***

3. ***Most devices today are digital devices. You hear terms such as 12 or 16 bit resolution. This means that a 12 bit resolution is 2 to the power of 12 or 1bit out of 4096, or 16 bit resolution would be 2 to the power of 16 or 65536. The processors in today's instruments are digital. Now for 4-20ma signals, we have to add a digital to analog conversion, and output the signal. An example of this would be a type j T/C device. The range of type J T/C is from -328 to 1400 Deg F. Total span is 1,728 and using 12 bit resolution the resulting accuracy is 1728/4096 = .42 deg F. This means that the best resolution one could hope for is .42 deg F. This can be worse if you have lower than 12 bit resolution or even a R or S type thermocouple that has a much greater span than a type J thermocouple. With Modbus communication one reads the actual digital value and is not subject to the additional inaccuracies due to the Analog to Digital conversion. Analogous to this would be to buy a High Definition TV and use regular analog cable or even digital cable and not the High definition cable box.***

4. ***Most devices accepting Modbus, now have an OPC driver. OPC driver, is a Software program that maps the registers of all your devices on the network to registers on your PC that are now easily accessible to any OPC compliant software such as Wonderware, Citect, and Intellution. Make sure there is an OPC driver for the receiving device.***

Now that we uncovered some differences, lets see if we can simplify the mystic behind communicating with modbus.

Each individual device on the modbus network must have a unique Node ID. Assign Node ID's from 1 to 32. Do not use 0. We will only discuss a master / slave communications. This means that the master controls the communications and will send out request to individual nodes, and in return wait for the answers from the nodes. The master is typically the PLC, recorder or the gateway Device. Node ID's on the devices are set by selector or dip switches, by software or by some type of programming device. Each device on the network must have a unique ID including the mater device).

Once the nodes on the devices are set, the communications must be set. Typically, communications are 19,200 baud rate, 8 data bits, with one stop bit and parity can be none, even or odd. Make sure that all devices along with the master have the same values for the communication parameters.

The next step is making sure that the master device (recorder, PLC, DCS, etc.), can interrupt correctly the values in the register. The values that we typically want to read are held in the "holding registers". Each modbus device includes a register map. This register map shows the locations for the parameters of interest. There is always a base address, typically 40,000 or 40,001(for 5 digit addressing) or 440,000(for 6 digit addressing). The data map typically will say base + 401. Then it will identify the type of register. Following is a type of the most common register types along with the number of registers:

Type	Number of registers	Range
16 bit signed Integer	1	-32767 to 32768
16 bit unsigned register	1	0-65535
32 bit signed integer	2	4294967296
32 bit unsigned register	2	-2147483648 to 2147483648
IEEE Floating point	2	x.xx to power Y
Big Endian / Little Endian	2 or 4	(Big Endian=1234, Little=4321)
Byte swap for all above	2 or 2	

Notes: Each register consist of 16 bits divided up into 8 bits called a byte or a word. Big Endian is the most popular method. When a register is sent, the most significant byte(MSB) is sent first and the least significant byte(LSB) is sent second. Little Endian is the reverse with the LSB being sent first and the MSB being sent second. I believe that Byte swap, and Modbus- X are the same. Floating point is a combination of Sign, Exponent and Mantissa. Sign is one byte, Exponent is 8 Bytes and Mantissa is 23 bytes.

The master device needs to know the node, then the register address of the stored value, along with the format and or type of register to interrupt. If the value on the receiving device is different than the value at the device, then chances are you are reading the incorrect register location or have not identify the correct type of register.(also try asking for the previous or the next address location) At Gilson Engineering we can supply both the receiving device as well as the sensor communicating by modbus. Following are some modbus devices that Gilson currently offers:

MSA Ultima X Gas monitors for toxics, combustibles and Oxygen detection
Siemens Milltronics Multi Ranger, Hydroranger Level monitors/controllers
Siemens Sirec paperless recorders
Banner DX80's Wireless 4-20ma. T/C's, RTD's and humidity devices
Elpro Wireless Gateways
Unitronics HMI/PLC combination device
Siemens Milltronics LU10 multipoint controller
B/W Controls Magnetostrictive Level and or interface monitor
Siemens Magnetic flow meters and Massflow meters
Siemens Moore 353 controllers
Moore Industries NCS Net concentrator multiplexor device
Siemens Milltronics Weigh scales and impact flow meters
Precision Digital Snooper and Consolidator
Brainchild recorder

In closing when possible work with a company that provides both the receiving device as well as the sensor or monitoring device. Most importantly work with a company that can provide the technical resources and knowledge to support you in efforts of getting all your devices communicating with each other.