



# HART

## Communication Module



## Technical Manual

(For Actuators with Software Above Rev.3.2)



[ontracactuators.com](http://ontracactuators.com)

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## ***1. Introduction.***

The Ontrac HART Interface module is an optional module that provides Ontrac Actuators with a means of communication with host systems (Distributed Control Systems, Programmable Logic Controllers, or Handheld Communicator) DCS/PLC. The operation of the device is based on the industry standard HART (Highway Addressable Remote Transducer) revision 7 communications protocol. The Point-to-point connection is the simplest HART communication setup that is often used in automation systems, nevertheless, many more connection variants are possible.

Ontrac manufactures a range of actuator device, including the Multitrac (MME/MOE) Intelligent Electric Actuators and the Easytrac (EME/EOE) Intelligent Electric Actuators. The modular design of the actuators' communication interface enables them to communicate using a wide range of communication protocols. Aside from the HART protocol, Ontrac Actuators also support MODBUS, and PROFIBUS.

### **Functions of the OHM.**

- The OHM connects Ontrac actuators to your process.
- The OHM converts the analog signal (4mA-20mA) to digital values (the unit depends on the physical variable; mass displacement or a ratio) that is used by the control logic of the actuators or read by the master DCS/PLC.
- The device can also convert digital values from the actuator into electrical analog signals (4mA-20mA).
- The OHM also serves as a communication interface for configuration and troubleshooting of smart field devices through the SCADA or HMI.
- The input of the OHM receives signals from process controllers and converts them to corresponding control signals for the actuators (for example, Torque, Speed, Position or Operation Mode).
- The output of the OHM provides electrical (voltage or current) output signals that can be read by the process controllers and used for automation.
- The OHM allows the process controller to read several parameters from a single, provides access to operation status and diagnostics parameters, and it facilitates remote configuration and troubleshooting.

This document provides a brief overview of the HART communication protocol, this will enable readers to understand the content of this document and how the device operates. A more detailed technical description of the HART protocols can be found in on the website of Fieldcomm Group. (<https://www.fieldcommgroup.org/>).

## Benefits of HART Communication Protocol.

HART is arguably the most deployed digital communications protocol in the process automation industries. There are currently over 40 million field instruments worldwide that support the HART communication protocol. The HART protocol is a global standard for the transmission of digital information through the 4-20mA analog current loop that is integrated in the majority of smart field devices. At the physical layer, the HART protocol consists of a digital signal that is modulated using frequency shift key and then superimposed on a DC (4mA to 20mA) current loop. This provides a dual communication channel through the encoded FSK signal and the varying the level of the analog signal. It is a reliable solution for extending automation plant communication infrastructure that is based on existing 4-20mA analog based communication infrastructure. The HART protocol also provides access to digital process data, maintenance, and diagnostic (troubleshooting) information. The important features of the HART protocol are outlined below.

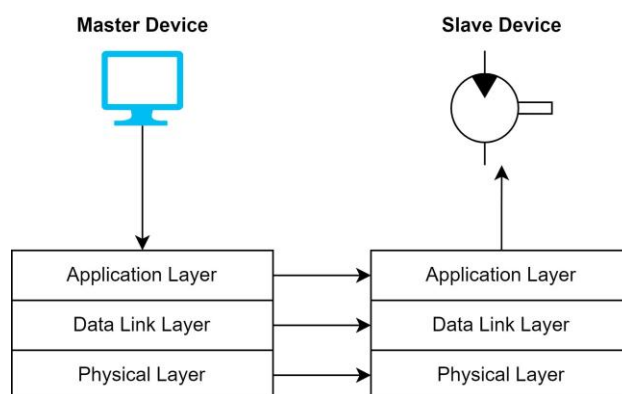
- Proven in practice, simple design, easy to maintain and operate.
- Compatible with conventional analog instrumentation.
- Simultaneous analog and digital communication.
- Option of point-to-point or multi drop operation.
- Flexible data access via up to two master devices.
- Supports multivariable field devices.
- Sufficient response time of approx. 500 ms.
- Open de-facto standard freely available to any manufacturer or user.

## 2. HART Protocol Specifications

The HART protocol is an open communication protocol that connects master devices with the field devices. Being an open protocol, it can be implemented by any manufacturer and freely employed by the user. HART Communication Foundation (HCF) is the organization that is responsible for providing the necessary technical support. This manufacturer-independent, not-for-profit organization encourages widespread use of the HART technology. HCF is responsible for coordinating and supporting the open protocol standard and managing within this framework the device descriptions of all registered devices. Since inception, there have been several versions of the HART protocol, the current version is revision 7.3.

This section describes revision 5 of the HART protocol; differences between this version and version 6 and 7 will be highlighted later in the document. The three HART versions are backward compatible because version 7 includes all the required functionality of version 6 which includes all the required functionality of version 5. Understanding how version 5 works is a precursor to understanding version 6 and 7. The title of the specification document for version 5, 6, and 7 are added in the appendix. For the rest of this section, any mention of the HART protocol refers to the version 5 of the HART protocol.

The HART communication system consists of devices that want to transmit data and a communication link between these devices. HART devices can be grouped into two classes; the master and slave devices. Master devices include handheld terminals, DCS, and PC-based Process Control Interface (PCI) while HART slave devices include sensors, transmitters and various actuators. On the other hand, the network is divided into layers and each of the network layers performs a specific task in the communication process.



*Figure 1 Layers of the HART Protocol (Revision 5).*

When compared with the OSI reference model, the HART has the physical layer, the Data Link layer and the Application layers. The HART protocol does not implement Network, Transport, Session and Presentation Layers; the functions of these layers are implemented by host applications or not necessary for the task at hand.

|   | OSI Layer           | Functions                                                                     | HART                                                                      |
|---|---------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 7 | <b>Application</b>  | Provides the User with Network Capable Applications                           | Command Oriented, Predefined Datatypes, and Application Procedure.        |
| 6 | <b>Presentation</b> | Converts Application Data Between Network and Local Machine Format.           |                                                                           |
| 5 | <b>Session</b>      | Connection Management Services for Applications.                              |                                                                           |
| 4 | <b>Transport</b>    | Provides Network Independent Transparent Message Transfer.                    |                                                                           |
| 3 | <b>Network</b>      | End to End Routing of Packets, Resolving Network Addresses.                   | A Binary Byte Oriented, Token Passing, Master/Slave Protocol.             |
| 2 | <b>Data Link</b>    | Establishes Data Packet Structure, Framing, Error Detection, Bus Arbitration. |                                                                           |
| 1 | <b>Physical</b>     | Mechanical/Electrical Connection. Transmits Raw Bit Stream.                   | Simultaneous Analog and Digital Signaling<br>Normal 4-20mA Copper wiring. |

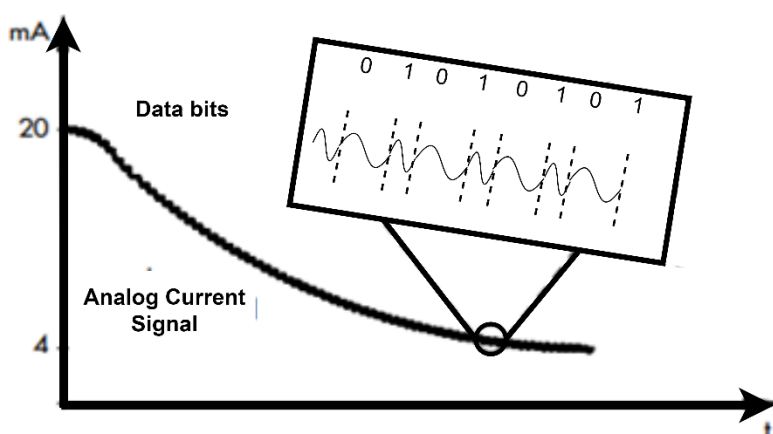
*Figure 2 OSI 7-Layer Model*

## Benefits of the HART Protocol

- Proven in practice, simple design, easy to maintain and operate.
- Compatible with conventional analog instrumentation.
- Simultaneous analog and digital communication.
- Option of point-to-point or multi-drop operation.
- Flexible data access via up to two master devices.
- Supports multivariable field devices.
- Sufficient response time of approx. 500 ms.
- Open de-facto standard freely available to any manufacturer or user.

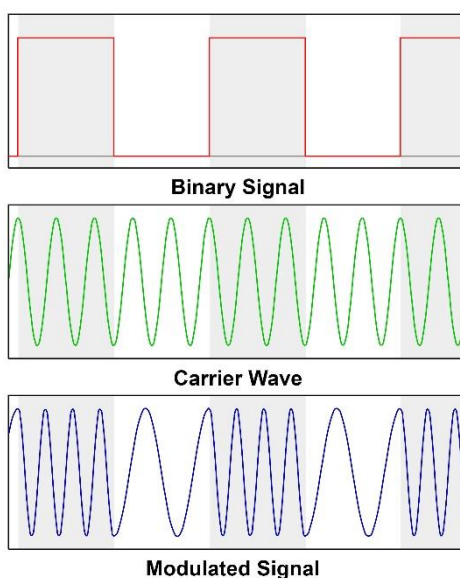
## Physical Layer

The HART physical layer specifies the signaling method, signal voltages, device Impedances, media, connection topologies and other specifications of the physical connection between HART devices. The physical layer is responsible for simultaneous analog and digital signaling using a modified version of the Bell 202 standard which is based on FSK modulation. Though the FSK signaling is widely used, PSK (Phase Shift Keying) signaling also exists. A high-frequency current is superimposed on a low-frequency (4-20 mA) analog current, 1200 Hz represents a mark (1) while 2200 Hz represents a space (0).



*Figure 3 Hart signal superimposed on the analog current signal.*

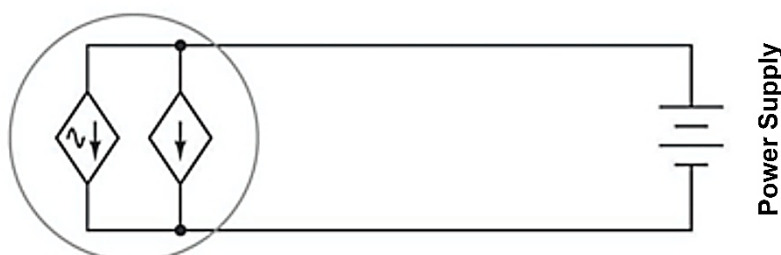
The HART specification defines that master devices send voltage signals, while the field devices (slaves) convey their messages using load-independent currents. The current signals are converted to voltage signals at the internal resistance of the receiver. To ensure a reliable signal reception, the HART protocol specifies the total load of the current loop including the cable resistance to be between minimum of 230 ohms and maximum 1100 ohms. Usually, the upper limit is not defined by this specification, but results from the limited power output of the power supply unit.



*Figure 4 Modulation of HART signals using FSK.*

The type of phase continuous binary FSK signaling used in HART is the same as the one employed by Bell 202 modems. The similarities between the physical layer of the two standards include the signaling rate, mark and space frequencies, and some performance specifications. The major features that distinguish Bell 202 and HART are filtering requirements and voltage level requirements.

### HART Transmitter



*Figure 5 Simplified Schematics of HART Transmitter.*

The HART transmitter may be modeled as an AC current source and a DC current source that are connected in parallel. The DC current source supplies the 4-20 mA regulation necessary to represent the process variables as an analog current value. The frequency and amplitude of the AC current source is varied (Amplitude: 1 mA P-P, Frequency: 1200 Hz and 2200 Hz) as necessary to modulate the audio-frequency HART signal along the two wires.

The transmitter also has the necessary circuitry for demodulating the AC voltage tones as HART data packets. For ease of connection, HART devices are designed to be connected together in parallel. This simplifies the connection process. With a parallel connection, there will not be a need to break the loop and interrupt the DC current signal when a new device needs to be added to the network. In summary, data transmission takes place through the AC current source, and data reception takes place through a voltage-sensitive modem.

### Cabling.

Twisted pair cables are usually used for connecting field devices to the HART network. The science guiding the choice of cables used in HART communication is fairly simple. Since signaling uses current and voltage levels, then the resistance of the cable is an important factor. The higher the resistance, the more the power consumed. The expression relating the resistance of a cable to its length and cross-sectional area is given below.

$$R = \frac{\rho L}{A}$$

R is the Resistance, L is the Length, A is the cross-sectional Area, and  $\rho$  is the Resistivity of the cable. From the expression, the resistance increases with the length of the cable and it reduces with increase in the cross sectional area of the cable. Therefore, the length and the cross sectional area of the cables should be chosen to optimize the performance of the system. If very thin and/or long cables are used, the cable resistance increases and this translates to increased total load.

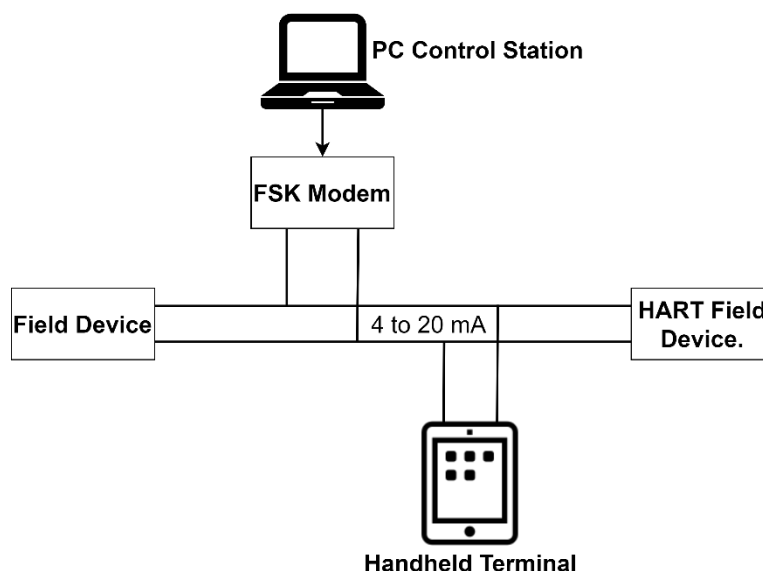
While long distance transmission is desirable, it increases signal attenuation and distortion, this also reduces the critical frequency of the transmission network. To improve the quality of the data transmission, the cables must have a sufficient cross section and an appropriate length. To reduce the effect of interference, long lines must be shielded and the signal loop and the cable shield should be grounded at one common point only.

The HART specification provides the following recommendations for reliable communication.

- For short distances, simple unshielded 0.2 mm<sup>2</sup> two-wire lines are sufficient.
- For distances of up to 1,500 m, individually twisted 0.2 mm<sup>2</sup> wire pairs with a common shield over the cable should be used.
- For distances of up to 3,000 m, individually twisted 0.5 mm<sup>2</sup> two-wire lines shielded in pairs are required.

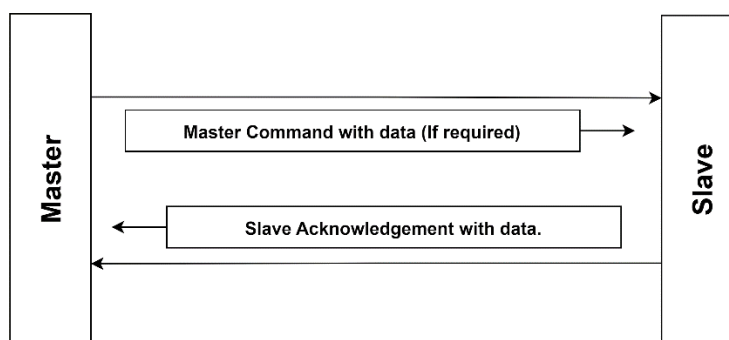
## Data Link Layer

The Data Link Layer provides a reliable master-slave protocol for transaction oriented communication between the field device and the DCS/PLC devices for digital data transfer. When operating in normal use, a field device only transmits data when a master sends a request to the field device. They respond with the appropriate message to the command that is encoded in the telegram that is received from the master.



*Figure 6 Connection of HART master devices*

For a given HART connection, there can be two masters, this could be the DCS/PLC as a primary master and a handheld HART communicator as a secondary master. After receiving a response from the slave, the primary master is expected to pause for a specified period of time, this allows the secondary master to take control of the communication channel. When there are two master on a specific channel, they have to take turns to communicate with the slaves.



*Figure 7 HART transaction: data exchange between master and slave*

Errors can be introduced into the signal due to noise on the communication link; the Data Link Layer performs the task of error detection using the Automatic Repeat Request (ARQ) protocol. The ARQ protocol simply requests the re-transmission of data blocks that may be corrupted. The Data Link Layer can be divided into two sublayers; the Logical Link Control (LLC) and the Medium Access Control. The LLC is responsible for addressing, framing and error detection. The MAC sublayer controls the transmission of messages across the physical link.

The Data Link Layer will also arbitrate access to the field device between a single secondary master device such as a handheld terminal and a single primary master device such as a control or data acquisition system. The Data Link Layer gives equal communication channel access to both kinds of masters when they are being simultaneously used. The Data Link Layer will not arbitrate between two secondary or two primary masters trying to talk on the same link.

To support the regular transfer of information from field device to master device, the Data Link Layer supports a mode of operation in which field devices periodically broadcast information onto the communication link. When data exchange between the control station and the field device is complete, the master will pause for a fixed time period before sending another command, allowing the other master to break in. The two masters observe a fixed time frame when taking turns communicating with the slave devices.

Information transfer between devices on the communication link is through a defined message format. The entire message is protected by a single parity check product code (sometimes also known as vertical and longitudinal parity checking). Message framing is through a combination of a start of frame delimiter and a message length field. The Data Link Layer provides services for data transfer, and communication configuration. Other HART Protocol documents cover the interpretation of data transferred by this Data Link Layer between various field devices and the primary or secondary master.

## **HART Message format**

The structure of the HART telegram is shown in the diagram below. The telegram consists of eight sections with different byte lengths, but before transmission 3 more bits (a start bit, stop bit and a parity bit are added to each byte) are added such that each byte becomes a UART character.

| PREAMBLE | START | ADDR | COM | BCNT | STATUS | DATA | CHK SUM |
|----------|-------|------|-----|------|--------|------|---------|
|----------|-------|------|-----|------|--------|------|---------|

|                 |                                                                    |                                                  |
|-----------------|--------------------------------------------------------------------|--------------------------------------------------|
| <b>PREAMBLE</b> | Bytes (0xFF) for synchronizing.                                    | 5 to 20 bytes depending on parameter assignment. |
| <b>START</b>    | Start character (start delimiter).                                 | 1 byte.                                          |
| <b>ADDR</b>     | Addresses of the field device.                                     | 1 byte; short address or 5 bytes; long address.  |
| <b>COM</b>      | HART command number.                                               | 1 byte.                                          |
| <b>BCNT</b>     | Byte count, number of bytes to follow without checksum.            | 1 byte.                                          |
| <b>STATUS</b>   | HART device status. Only present for a response frame.             | 1st and 2nd status bytes.                        |
| <b>DATA</b>     | Transferred user data / parameters, the length depends on command. | 0 ... 253 bytes                                  |
| <b>CHK SUM</b>  | Checksum.                                                          | 1 byte                                           |

**Preamble: (5 - 20 bytes):** This consists of repetitive bytes containing 0xFF, and allows the receiver(s) to synchronize.

**Start Delimiter (1 byte):** This indicates the end of the preamble. It can have one of several values, indicating the type of message viz. master to slave, slave to master, or burst message from the slave. It also indicates the address format i.e. short frame or long frame.

**Address (1 or 5 bytes):** This includes the master address (a single '1' for a primary master, '0' for a secondary master) and the slave address. In the short frame format, the slave address consists of 4 bits containing the polling address (0 to 15). In the long frame format, it consists of 38 bits containing the 'unique identifier' for that particular device. Another single bit is used to indicate if a slave is in 'burst' mode.

**Command (1 byte):** This contains the HART command. Universal commands are in the range 0 to 30, Common Practice commands are in the range 32 to 126, and Device-specific commands are in the range 128 to 253.

**Byte Count (1 byte):** This contains the number of bytes to follow in the status and data bytes. This is needed by the receiver to know when the message is complete, since there is no special character to indicate the end of the message.

**Status (2 byte):** This is also known as the 'response code' and is only present in response messages from a slave. It contains information about communication errors in the outgoing message, the status of the received command, and the status of the device itself.

**Data (0-253 bytes):** The data field may or may not be present, depending on the particular command. A maximum length of 25 bytes is recommended, to keep the overall message duration reasonable, although some devices have device-specific commands that use longer data fields. The 253 quoted above is the theoretical limit as the Byte Count field cannot contain more than 0xFF or 255, and two bytes are taken up by 'Status'.

**Checksum (1 byte):** This contains the 'longitudinal parity' of all previous bytes, from the start character onwards)

## Error Detection

Corrupted bits and erroneous commands are some of the sources of errors in HART systems. Bits can be corrupted when the device is operated in an environment with electrical noise and interference. The HART specification demands class 3 noise immunity according to IEC 801-3 and IEC 801-4. The LRC checksum is also employed to detect errors in telegram packets. LRC can reliably detect up to three corrupted bits in the transmitted telegram. Other forms of error such as sending a wrong command, or sending a telegram to the wrong address can still occur, the slave devices respond to these type of errors by setting the relevant bits in the status byte of the response telegram.

## HART Status Byte.

### 1st status byte

|                                       |                                |
|---------------------------------------|--------------------------------|
| When bit 7 = 1: "Communication error" |                                |
| Bit 6 = 1                             | Parity error                   |
| Bit 5 = 1                             | Overflow                       |
| Bit 4 = 1                             | Framing error                  |
| Bit 3 = 1                             | Checksum error                 |
| Bit 2 = 0                             | Reserved                       |
| Bit 1 = 1                             | Overflow in the receive buffer |
| Bit 0 = 0                             | Reserved                       |

When bit 7 = 0: "Specific in line with response frame"

More details on the status byte of Ontrac Actuators are under the Device parameters section.

## HART Addressing

Each version of the HART protocol has a slightly different addressing scheme. These schemes include the polling address and unique identifier. Polling address (short address) is single byte. Unique identifier (long address) is 5 bytes. The address fields for the two address formats are shown below.

| Short Frame Format. |       |   |   |       |             |
|---------------------|-------|---|---|-------|-------------|
| Master              | Burst | 0 | 0 | Bit 3 | Bit 2 to 0  |
| Long Frame Format.  |       |   |   |       |             |
| Master              | Burst | 0 | 0 | Bit 3 | Bit 35 to 0 |

The polling address format is used with old HART devices (Version 5) that do not support the long address format. In the frame of the short address format, one bit distinguishes the two masters while another bit indicates the type of the telegram (burst mode telegrams or slave mode telegram). The remaining four bits distinguish the field devices (from 0 to 15). For a point-to-point topology, the address of the field device is set to zero, for multi-drop mode, the address of the field devices can be in the range of 1–15.

The 5-byte unique identifier is a hardware address that consists of 1-byte manufacturer code, 1-byte device type code, and a 3-byte sequential number. This 5-byte ID is unique for each device. HART communication Foundation (HCF) administers the manufacturer code, therefore the possibility of two HART devices sharing the same address is eliminated.

The master uses this unique address to communicate with the slaves. One advantage of this unique Identifier ID is that the number of multi-dropped devices is essentially unlimited because no 2 devices will have the same address. The limit is determined based on the application's required rate of scan of the devices on the communication link, and the noise tolerance level. The more the number of devices connected together, the higher the noise and the signal-to-noise ratio, decoding the communication signal becomes difficult.

## Application Layer.

The HART protocol implements the master/slave communication model (transaction-oriented communication), this means that a device (the master) is in total control of other devices (known as slaves). HART protocol allows two active masters in a system, one is "primary master", another is

“secondary master”. The primary master would be the DCS/PLC while the secondary master may be a hand-held HART communicator or a diagnostic device.

The protocol also defines the commands that are used by command-response communication software. When the master sends a telegram to a field device, the field device immediately responds by sending an acknowledgement telegram which can contain requested status reports and/or the data of the field device. To facilitate interoperability and universal communication, HART commands are classified into commands for master devices and commands for field devices. For field devices, there are three classes of HART commands;

- Universal commands
- Common Practice commands
- Device Specific commands.

For master devices, there are six conformance classes of commands;

- Read Measure Variables.
- Read Universal Information.
- Write Common Practice Parameters.
- Read Device Specific Information.
- Write Selected Parameters.
- Read and Write Entire Database.

These commands enable the master device to send instructions, messages and data to field devices. With these commands, set points, physical values and parameters can be transmitted and various services for start-up, diagnostics and troubleshooting are performed. When field devices receive a command from the master, they respond immediately by sending an acknowledgement telegram back to the master device. Some of the likely content of the telegram are the command's corresponding status reports and/or the data of the field device.

**Universal commands:** are primarily used by a controller to identify a field device and read process data. All HART devices are required to implement Universal commands.

**Common Practice commands:** are the set of commands that are generally applicable to only field devices. Most common practice commands can be carried out by many, though not all, field devices. They include commands to change the range, select engineering units and perform self-tests.

**Device Specific Commands:** are different for each device. They implement unique configuration and adjustment functions. It is possible for devices from different manufacturers that externally implement similar functionality (e.g. temperature measurement, Load measurement, Differential pressure measurement) may have completely different hardware and hence different Device Specific command set.

| Command Type | Example |
|--------------|---------|
|--------------|---------|

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Universal Commands       | <ul style="list-style-type: none"> <li>• Read manufacturer and device type.</li> <li>• Read primary variables (PV) and units.</li> <li>• Read current output and per cent of range.</li> <li>• Read up to 4 predefined dynamic variables.</li> <li>• Read or write 8-character tag, 16-character descriptor, date.</li> <li>• Read or write 32 character messages.</li> <li>• Read device range, units and damping time constant.</li> <li>• Read or write the final assembly number.</li> <li>• Write polling address.</li> </ul>                                   |
| Common Practice commands | <ul style="list-style-type: none"> <li>• Read selection of up to 4 dynamic variables.</li> <li>• Write damping time constant.</li> <li>• Write device range.</li> <li>• Calibrate (set zero, set span).</li> <li>• Set fixed output current.</li> <li>• Perform self-test.</li> <li>• Perform master reset.</li> <li>• Trim PV zero.</li> <li>• Write PV units.</li> <li>• Trim DAC zero and gain.</li> <li>• Write transfer function (square root/linear).</li> <li>• Write sensor serial number.</li> <li>• Read or write dynamic variable assignments.</li> </ul> |
| Device Specific Command. | <ul style="list-style-type: none"> <li>• Read or write low flow cut-off value.</li> <li>• Start, stop or clear totalizer.</li> <li>• Read or write density calibration factor.</li> <li>• Choose PV (mass flow or density).</li> <li>• Read or write materials or construction information.</li> <li>• Trim sensor calibration.</li> </ul>                                                                                                                                                                                                                           |

Each HART message transaction originates from the master station; the slave device only responds when a message is addressed to it. The reply from the slave device acknowledges that the command has been received and it may contain extra data depending on the nature of the request.

**Broadcast in HART Communication system:** Universal commands, Common Practice Commands and Device Specific commands share one similarity; they are meant for master/slave data exchange. It is possible to send a broadcast message that is received by all the devices on the network, the HART command 11 is used for this purpose.

### ***3. Communication Topology.***

The physical layer supports point to point and multi-drop wiring topology. The choice of topology determines the number of devices that can connect to a DCS/PLC over a single pair of wires and the speed of the communication. Ontrac actuators support only point to point topology.

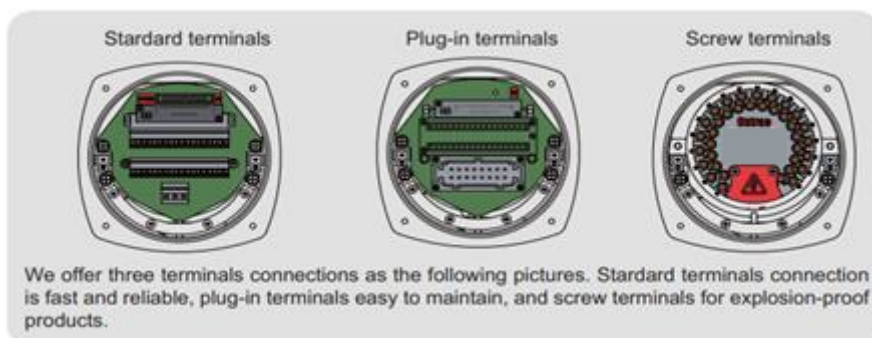
***In point-to-point configuration***, the 4–20 mA signal is used to communicate one process variable; this variable is referred to as the primary variable. For a device to communicate in this mode, the address of the device must be set to zero. When a HART instrument operates in this mode, each device must have its own dedicated wire pair for communicating the 4-20 mA DC signal between it and a controller.

Since it's an analog signal, less processing is required to decode the information present in the signal. The digital channel transmits process variables, device status, diagnostic information between the connected devices. The HART protocol combines these communication channels to be used in a complementary fashion. The major disadvantage of this configurations is that only two devices can be connected together by a single current loop, which will be a master and one slave.

The point-to-point configuration can also be enhanced using another technique. Since only one device is using a loop, the device can be allowed to send data to the host at a faster rate, this is referred to as the burst mode. A slave device is said to be in "burst mode" when it is providing asynchronous cyclic broadcasting of data, without continuous polling by a master device. No matter how many field devices are on a communication link, only one may be in burst mode, this is why it's adequate for only point-to-point configuration.

## 4. Electrical and Technical Parameters.

The Ontrac HART Module (OHM) is designed to fit into the casing of Ontrac Actuators and fully integrate into printed boards of the operation panel of the actuators. Operating power is received from the Actuator and the Ontrac HART Module requires no external power source. For Ontrac actuators, there are three possible terminal options (Standard Terminals, Plug-In Terminals and Screw Terminals). The choice of connector type depends on the operational conditions and the application.



*Figure 8 Terminals Supported by the Actuators*

The Ontrac Cloud (**Smarttrac**) gives users complete global access to an actuator's specific technical details and parameters without the use of special tools or proprietary software. Every Ontrac actuator comes with a permanent QR code attached. Simply scanning the QR (Quick Response) code on your actuator connects you to Smarttrac. The cloud provides access to the specific information for the actuator.

Users will then be able to download instruction and data sheets as well as actuators' specific wiring diagram. This simple aid to set up, commissioning and fault finding will save users considerable time and ensure the right connections are made. An example of the actuator wiring diagram is shown in the diagrams below. In this case, the HART network connects to terminals 35 and 36.

| Pin | Description             |
|-----|-------------------------|
| 35  | HART Negative Terminal. |
| 36  | HART Positive Terminal. |

An example of the wiring diagram for some of the actuators is shown in the diagram below. It is important to note that the wiring diagram may be slightly different for different actuator's model and type of the terminal. The OHM terminal and the wiring diagram for a specific actuator can be obtained from the Cloudtrac. When the QR code on the actuator is scanned, the wiring diagram is and other technical information about it can be obtained.

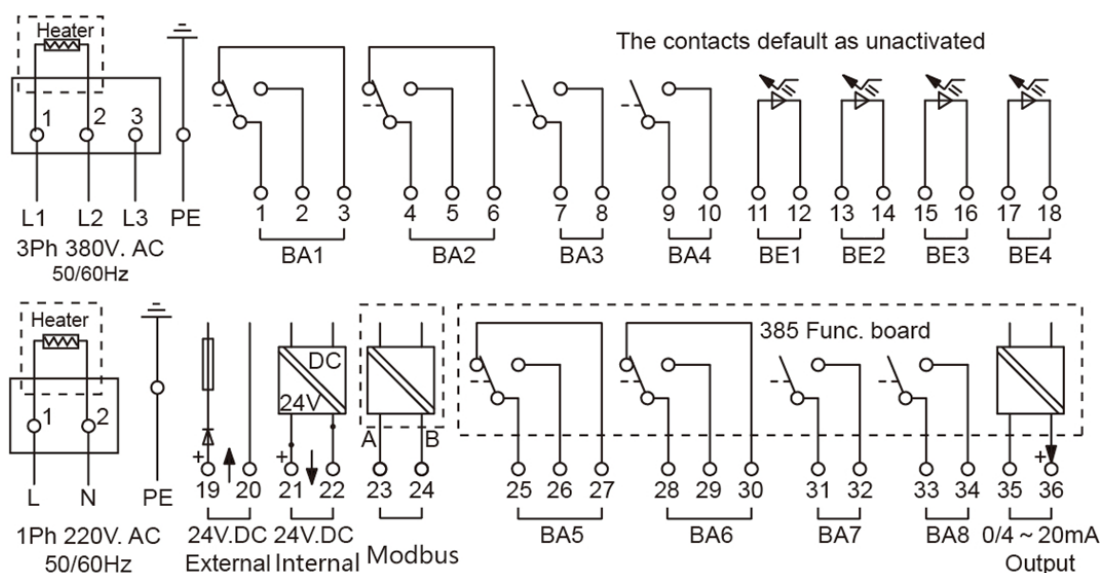


Figure 9 Electrical Wiring for digital signal input

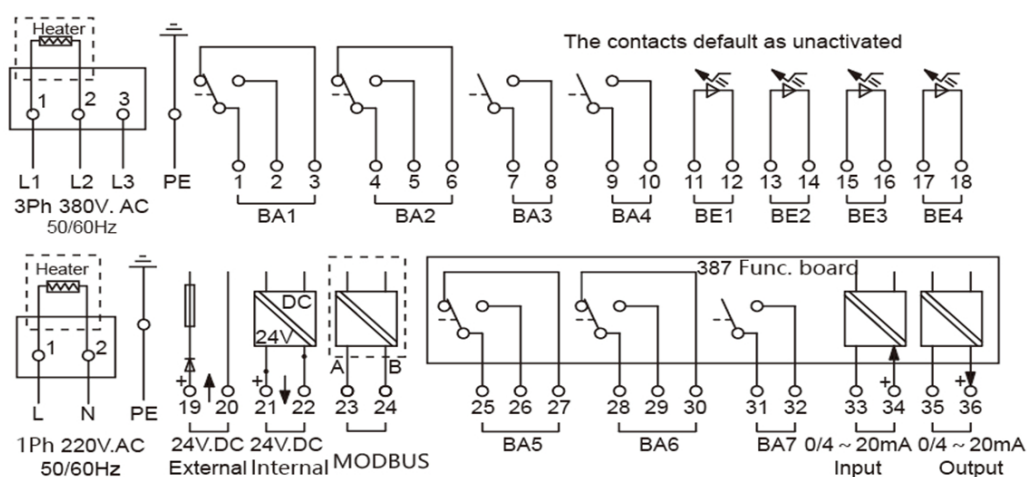


Figure 10 Electrical Wiring for Analog signal input

## Operation and Storage

The OMM is designed to operate under the same environmental conditions as the actuator.

The constraints are:

- ☐ Operating temperature: -40°C to +65°C
- ☐ Humidity: ≤ 100% (<25°C) non-condensing.
- ☐ Air Media: Without Corrosive flammable or explosive gas.

## Summary of Parameters

| Parameter                 | Value                                                   |
|---------------------------|---------------------------------------------------------|
| Operating Voltage         | 12 - 24 VDC                                             |
| Maximum Power Consumption |                                                         |
| Communication Protocol    | HART Protocol, Revision 7                               |
| Communication Parameters  | Speed: 1.2Kbps                                          |
| Topology                  | Multi-drop Configuration, Point-to-point Configuration. |
| Transfer Type             | Half Duplex                                             |
| Maximum Cable Length      | Depends on the Characteristics of the Line.             |
| Operating Temperature     | -20°C to +65°C                                          |
| Humidity                  | Humidity: 100% (<25°C) non-condensing.                  |

## 5. Actuator HART Parameters.

Ontrac actuators implement the implements the revision 7 of the HART protocol. This version is compatible with revision 6 and revision 5 of the protocol. The table below compares the three revisions of the HART protocol.

| HART Feature Summary            | HART Protocol Revision |           |            |
|---------------------------------|------------------------|-----------|------------|
| Feature                         | 5                      | 6         | 7          |
| PV with Status                  | Mandatory              | Mandatory | Mandatory  |
| Device Status                   | Mandatory              | Mandatory | Mandatory  |
| Broadcast Messaging             | Mandatory              | Mandatory | Mandatory  |
| Device Configuration            | Mandatory              | Mandatory | Mandatory  |
| 4-20 mA Analog Loop Check       | Mandatory              | Mandatory | Mandatory  |
| Multi-Variable Reads            | Optional               | Mandatory | Mandatory  |
| 32 Character Tag                | -                      | Mandatory | Mandatory  |
| All Variables with Status       | -                      | Mandatory | Mandatory  |
| Digital Loop Check              | -                      | Mandatory | Mandatory  |
| Enhanced Multi-Variable Support | -                      | Mandatory | Mandatory  |
| Local Interface Lock            | -                      | Optional  | the manual |
| Manual ID of Device by Host     | -                      | Mandatory | Mandatory  |
| Visual ID of Device             | -                      | Mandatory | Mandatory  |
| Peer-to-Peer Messages           | -                      | Optional  | Optional   |
| Report by Exception             | -                      | -         | Optional   |
| Synchronized Sampling           | -                      | -         | Optional   |
| Time or Condition based Alerts  | -                      | -         | Optional   |
| Time Stamp                      | -                      | -         | Mandatory  |
| PV Trends                       | -                      | -         | Optional   |
| Wireless Coexistence            | -                      | -         | Optional   |
| Wireless Diagnostics            | -                      | -         | Optional   |
| Wireless Mesh & Star Topologies | -                      | -         | Optional   |

|                          |   |   |          |
|--------------------------|---|---|----------|
| Wireless Message Routing | - | - | Optional |
| Wireless Security        | - | - | Optional |

## HART Parameters.

### HART Commands for Ontrac Actuators

| No | Function                                    | Byte | Data in Command | Byte  | Data in Reply                       |
|----|---------------------------------------------|------|-----------------|-------|-------------------------------------|
| 0  | Read Unique Identifier.                     |      | None            | 0     | Type of Code.                       |
|    |                                             |      |                 | 1     | Number of Preambles                 |
|    |                                             |      |                 | 2     | Universal Command Revision.         |
|    |                                             |      |                 | 3     | Device-Specific Command Revision.   |
|    |                                             |      |                 | 4     | HART Mod, Software Revision.        |
|    |                                             |      |                 | 5     | HART Mod, Hardware Revision HART    |
|    |                                             |      |                 | 6     | Device function flags               |
|    |                                             |      |                 | 7-8   | Final Assembly Number.              |
| 1  | Read Primary Variable                       |      | None            | 0     | Unit "Percent"                      |
|    |                                             |      |                 | 1-4   | Actual position/process value in %. |
| 2  | Read Current and Percentage Value of Range. |      | None.           | 0-3   | Current in mA.                      |
|    |                                             |      |                 | 4-7   | Percentage of Range.                |
| 3  | Read Current and Dynamic Variables.         |      | None.           | 0-3   | Current in mA.                      |
|    |                                             |      |                 | 4     | Primary Variable Code.              |
|    |                                             |      |                 | 5-8   | Primary Variable.                   |
|    |                                             |      |                 | 9     | Secondary variable code.            |
|    |                                             |      |                 | 10-13 | Secondary variable.                 |

|    |                                           |      |         |       |                              |
|----|-------------------------------------------|------|---------|-------|------------------------------|
|    |                                           |      |         | 14    | Third variable code.         |
|    |                                           |      |         | 15-18 | Third variable.              |
|    |                                           |      |         | 19    | Fourth Variable Code.        |
|    |                                           |      |         | 20-23 | Fourth Variable.             |
| 12 | Read Message.                             |      | None.   | 0-23  | Message.                     |
| 13 | Read Tag, Descriptor, Date                |      | None.   | 0-5   | Tag.                         |
|    |                                           |      |         | 6-17  | Descriptor.                  |
|    |                                           |      |         | 18-20 | Date.                        |
| 14 | Read primary variable sensor information. |      | None    | 0-2   | Unused.                      |
|    |                                           |      |         | 3     |                              |
|    |                                           |      |         | 4-7   |                              |
|    |                                           |      |         | 8-11  |                              |
|    |                                           |      |         | 12-15 |                              |
| 15 | Read output information                   |      | None    | 0     | Unused.                      |
|    |                                           |      |         | 1     | Unused.                      |
|    |                                           |      |         | 2     | Primary variable units code. |
|    |                                           |      |         | 3-6   | Upper range value.           |
|    |                                           |      |         | 7-10  | Lower range value.           |
|    |                                           |      |         | 11-14 | Damping value (seconds).     |
|    |                                           |      |         | 15    | Unused.                      |
|    |                                           |      |         | 16    | Unused.                      |
| 16 | Read final assembly number.               |      | None    | 0-2   | Final assembly number.       |
| 17 | Write message.                            | 0-23 | Message |       | As in command.               |

## Register Mapping for HART Dynamic Variable in Ontrac Actuators.

| Variable Name          | Variable Definition                         | Register Address | Function Description                                                                                     |
|------------------------|---------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------|
| Primary Variable<br>PV | Valve position (per millage valve position) | 30001            | Dial indicator valve position, if the value is 500, it means that it is currently at 50% valve position. |
| Second Variable<br>SV  | Actuator operation status                   | 30002            | The operating status of the actuator is defined in the following table;                                  |

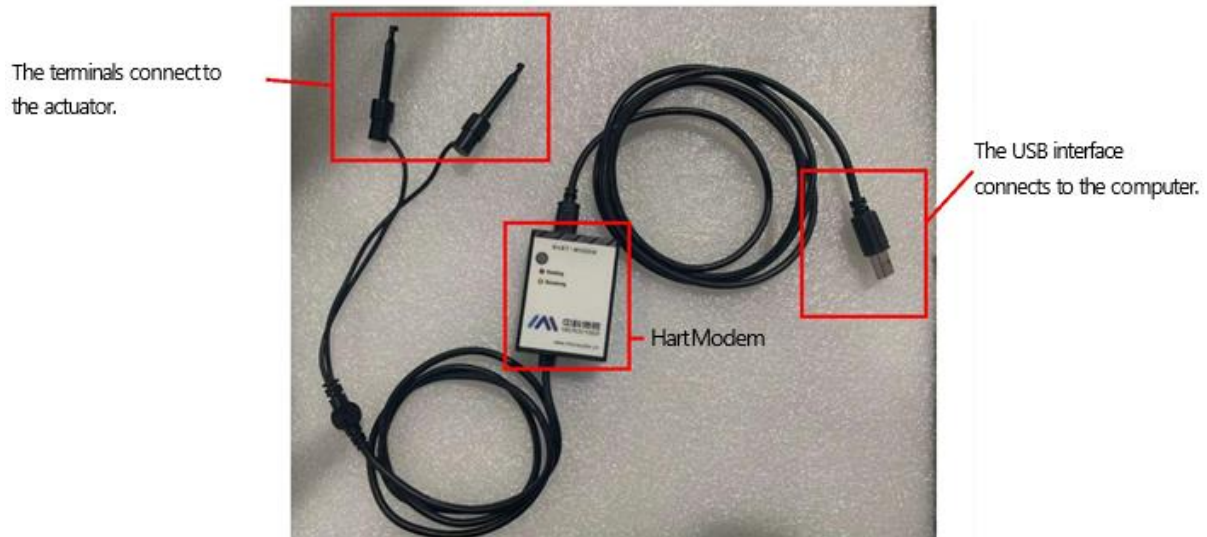
## Status bits in Ontrac Actuators. (Status Byte 2)

The actuator operating status (SV) bit is defined as follows.

| Function Definition                                              | Position |
|------------------------------------------------------------------|----------|
| Mode switch at "LOCAL" position                                  | Bit 0    |
| Wrong running direction of electric actuator                     | Bit 1    |
| Opening torque of electric actuator exceeds the limit torque     | Bit 2    |
| Closing torque of the electric actuator exceeds the limit torque | Bit 3    |
| The electric actuator rotates in the "Open" direction            | Bit 4    |
| The electric actuator rotates in the "Close" direction           | Bit 5    |
| Motor/electronic unit temperature alarm                          | Bit 6    |
| End position fault                                               | Bit 7    |
| Mode switch at "O/S"(Out of Service) position                    | Bit 8    |

## 6. Connect a Computer and Actuator with HART Modem.

1. Connect the USB interface of Hart Modem to the computer.

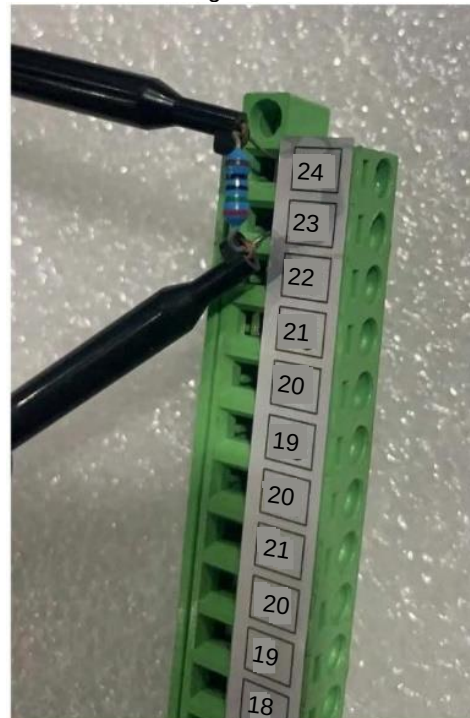


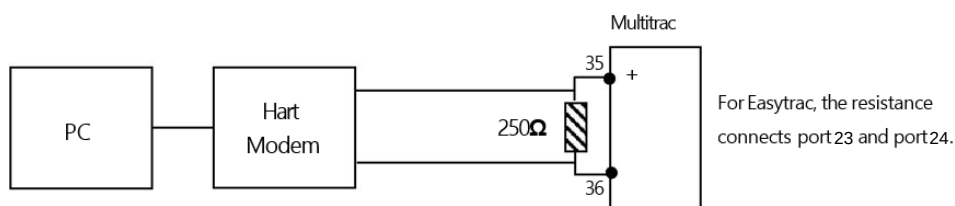
- 2

The wiring on the Multitrac wiring board is shown in the figure below, and the resistance in the figure is about 250  $\Omega$ .

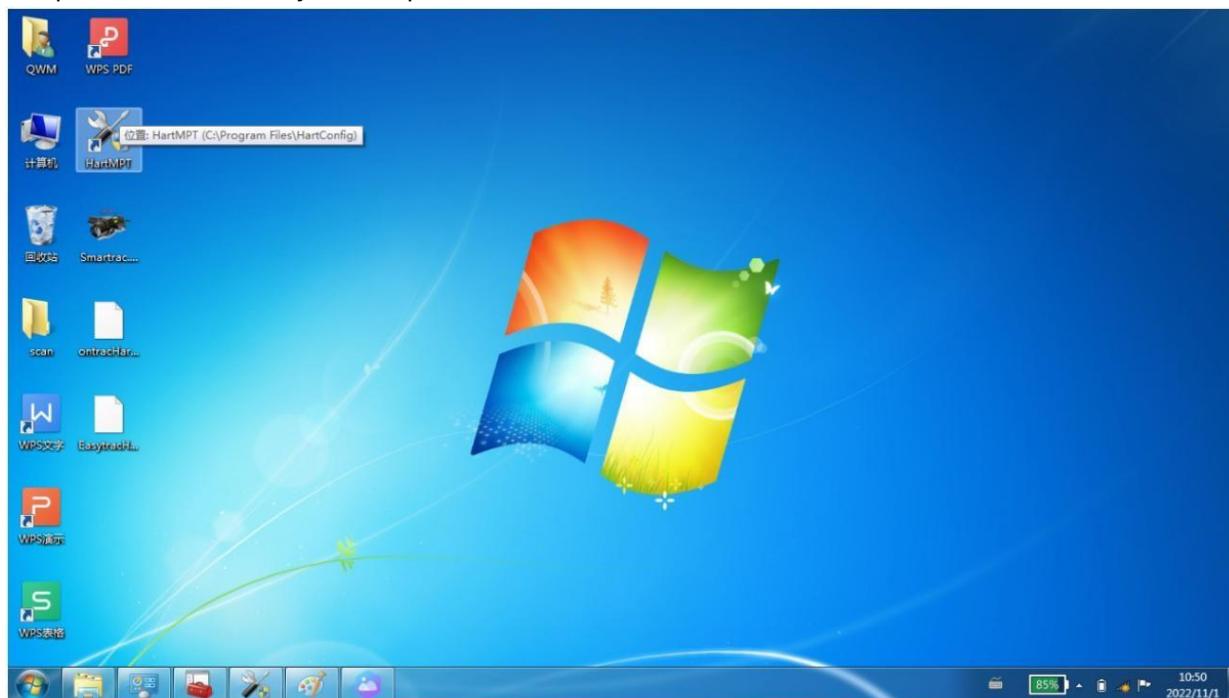


The wiring on the Easytrac wiring board is shown in the figure below, and the resistance in the figure is about 250  $\Omega$ .

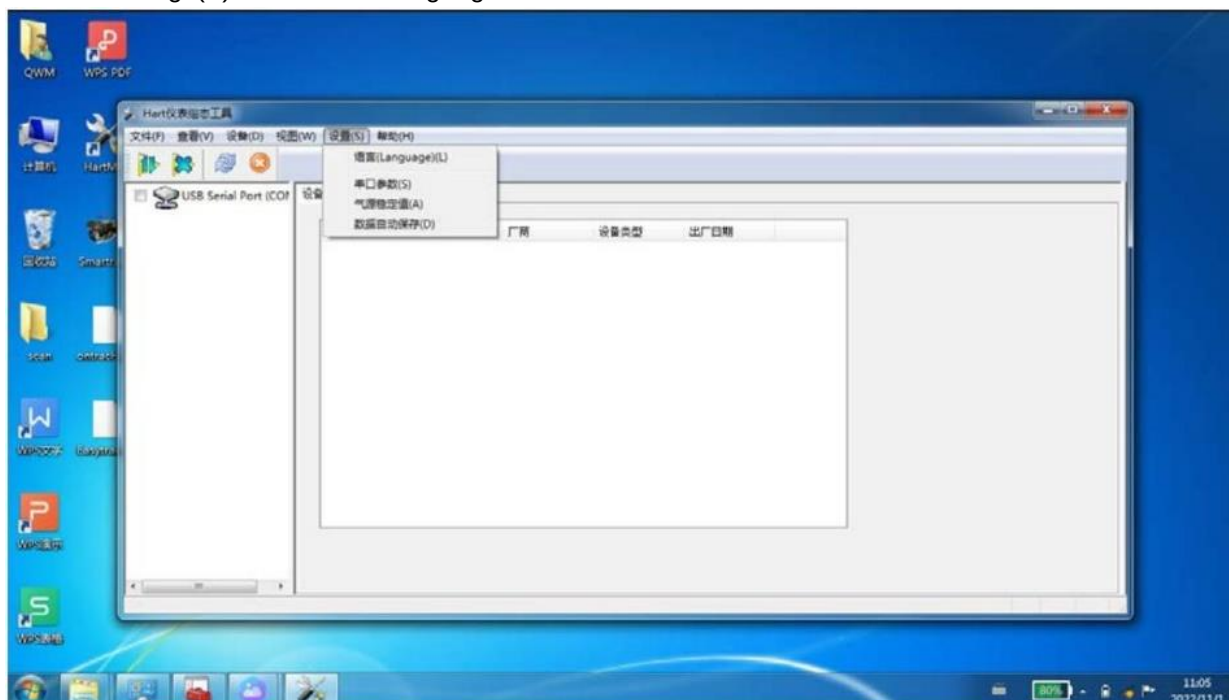




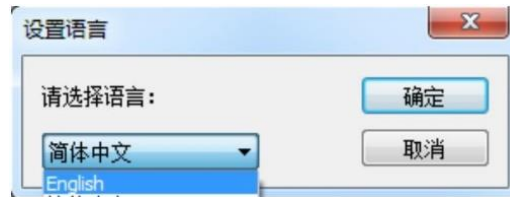
3. Open the software on your computer.



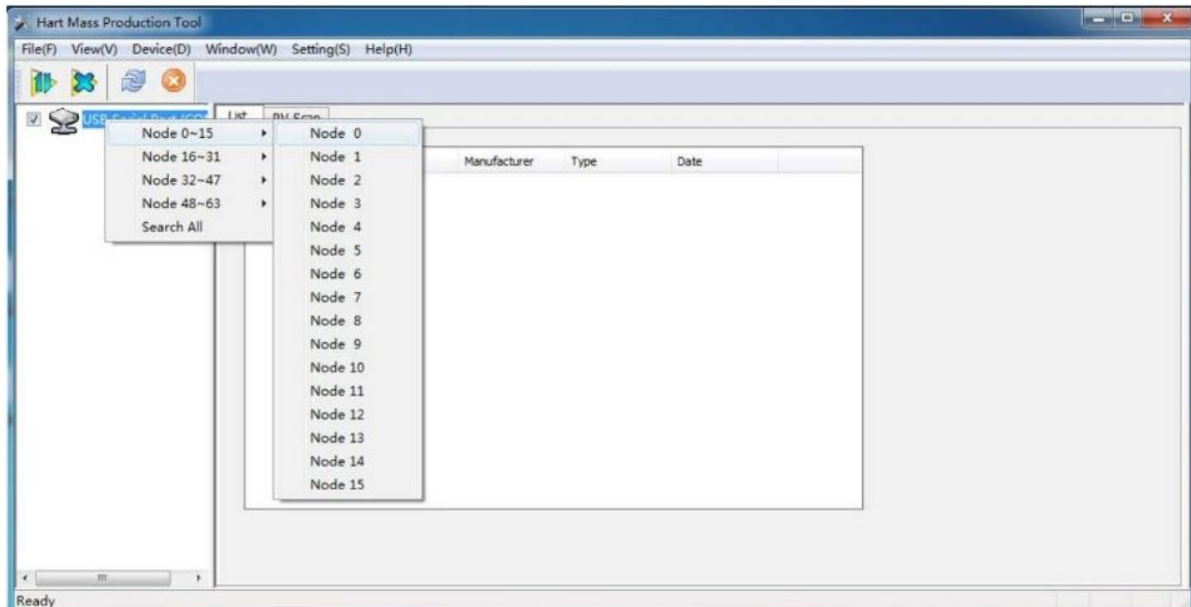
4. Click Settings(S) to select the language.



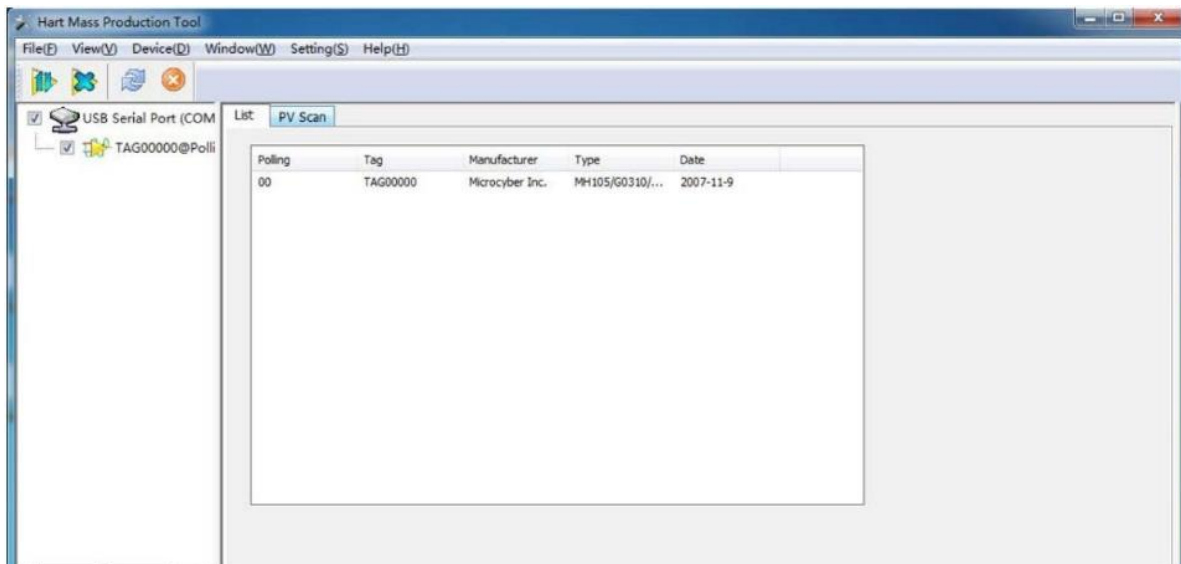
5. Choose English.



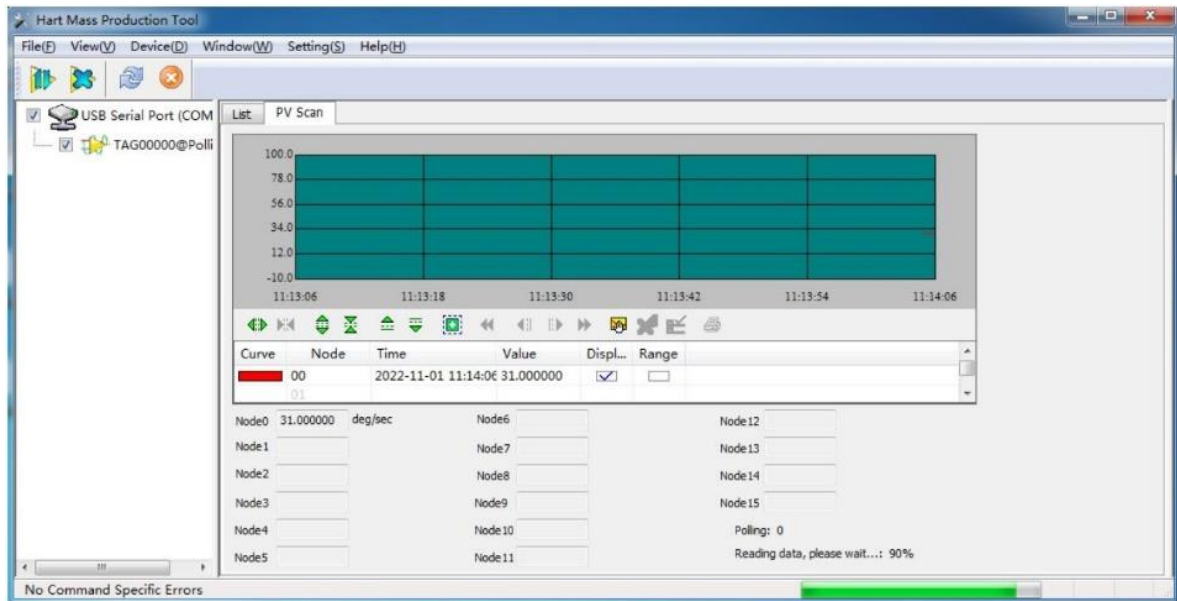
6. Right click “USB Serial Port (COM)” to select the current node.



7. Select PV Scan.



8. Check whether the connection is successful.



## 7. Troubleshooting.

Generally, most of the problems associated with HART-enabled actuators are caused by wiring errors and are simple to test and fix. One of the things to check for is the wiring. The technician needs to confirm if the network cable is connected to the correct actuator terminal.

The correct wiring diagram can be obtained from Cloudtrac. Every Ontrac actuator comes with a permanent QR code attached. Simply scanning the QR (Quick Response) code on your actuator connects you to Cloudtrac. The cloud provides access to specific information for your actuator.

Check the connection loop to see if there is no exposed or bare segment. Ensure that the connectors have good contact with the wire and the terminals of the HART device. Loop impedance is very important, it should have a value between 250 ohms and 1100 ohms. If there are frequent breaks in transmission with a device in the middle of communication, the impedance of the loop should be checked.

Each device that is added to the HART current loop results in a voltage drop. When there are too many devices on a loop, the possibility of not having enough voltage to drive to full-scale 20mA when required creates a risk, it may also create power supply problems for the internal circuitry (transmitter processor and internal modem) of the connected devices. Efforts should be made to prevent the described situation from happening. The number of devices on the loop should be reduced and a good-quality power supply should be used.

The quality of a power supply can also degrade over time because of age and operating conditions. The power supply's output voltage stability under load should be monitored regularly. An AC to DC power supply with excessive ripple at the DC output can also create a problem because ripples in the power source can leak into the current loop, thereby corrupting the transmitted signal. One of the ways to test this is to power the loop with a battery since there should be no ripple in their power output.

 Any form of debugging that involves swapping cables or changing any electrical connection should be carried out only when the actuator is powered down.

If there are still issues with communication after the electrical connections have been verified, please confirm that the correct address and configurations on the device correspond with the settings in a known working actuator.

Please contact the Ontrac Technical Support team through the support page on the website ([www.ontracactuators.com](http://www.ontracactuators.com)) for further assistance. The support agent will request for information about the actuator and provide the necessary assistance.



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For more information and up to date overview of how to contact us : [www.ontracactuators.com](http://www.ontracactuators.com)