



Fieldbus International AS

The Modbus RTU to WirelessHART gateway, the T910

Reference Manual





Fieldbus International AS

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About this document

The Reference Manual gives an overview of the capabilities and the use of the T910 DIN rail mounted generic WirelessHART gateway. Furthermore, it explains how to configure the device.

The following abbreviations are used in this document:

HART	Communication protocol.
PV	Primary dynamic variable in the transmitter
SV	Secondary dynamic variable in the transmitter
TV	Third dynamic variable in the transmitter
QV	Quarternary dynamic variable in the transmitter
DD	Device Description
CRC	Cyclic redundancy check. Check bits that ensure that bit errors are detected.
PLC	Control or monitoring system
DAC	Digital to Analog Converter. The DAC is controlling the 4-20 mA loop.
Dev Type Id	Device Type Id – An Id number in the device that is unique for a particular HART device

Summary

The T910 capabilities can be summarized as follows:

- Interfaces one Modbus RTU device to a WirelessHART network
- WirelessHART Slave interface
- Wired HART Slave interface for configuration (Maintenance channel)
- Modbus Master interface
- Reading of up to 8 simultaneous Device Variables with individually configurable update rate
- Reading of 1 Modbus Status Register with configurable update rate
- 3 burst messages
- Transducer Simulation Mode allows testing without Modbus Instrument connected.

The instrument interface:

Physical interfaces:

- RS 485

Protocols:

- HART Token-Passing Data-Link over FSK (Frequency Shift Keying)
- WirelessHART TDMA Data-Link over 2.4GHz DSSS (Direct-Sequence Spread Spectrum)
- Modbus RTU

1. INTRODUCTION

1.1. Functional Description

The T910 is a WirelessHART compliant DIN rail mountable gateway for connecting Modbus RTU instruments (Modbus slaves) to a WirelessHART network..



Figure 1: The T910

One Modbus instruments can be connected through one T910 module.

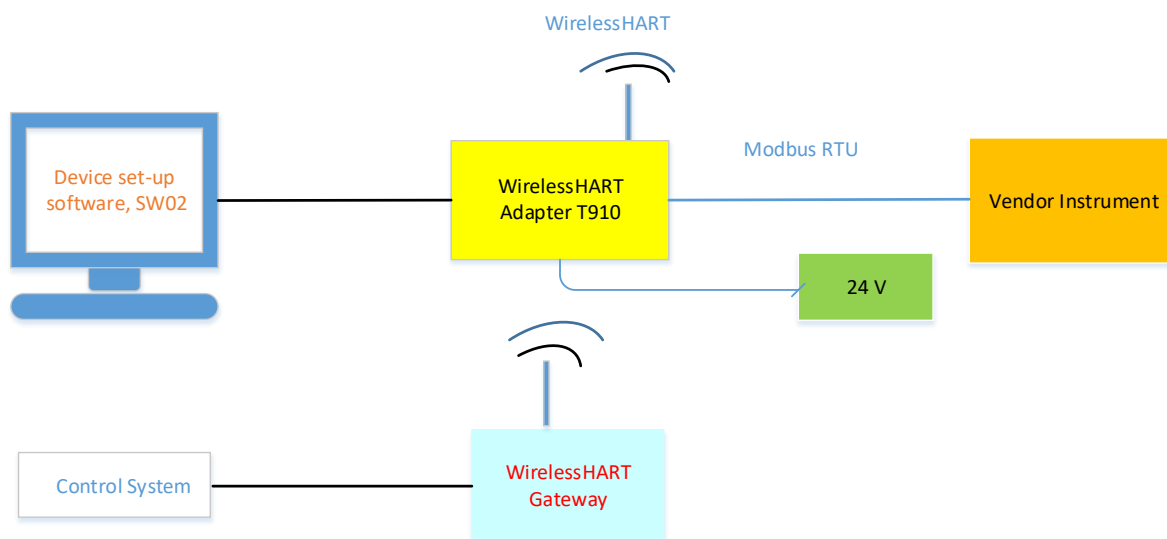


Figure 2: T910 used in a WirelessHART application

T910 has communication routines for communicating with a Modbus instrument (Modbus slave). Applying the T910 enables an existing Modbus instrument to become a WirelessHART compliant device.

1.2. Mechanical Dimensions

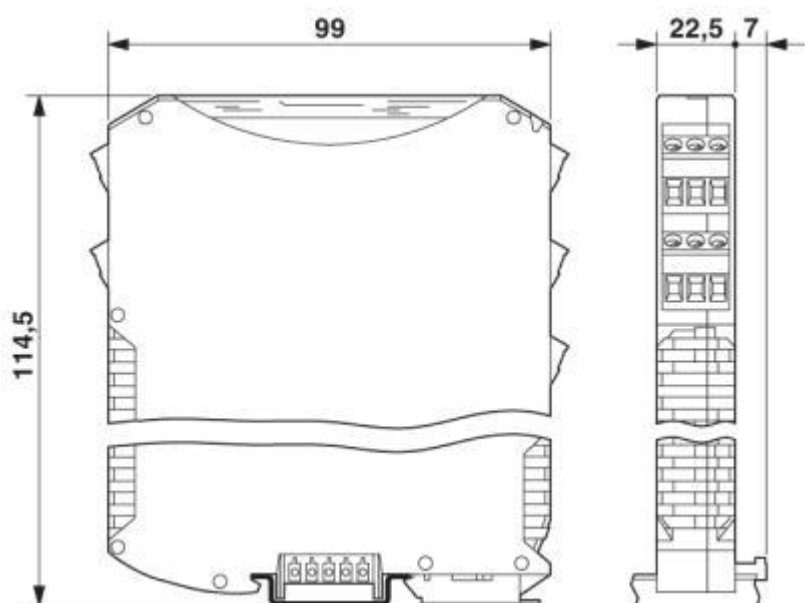


Figure 3: ME MAX Dimensions

The T910 is designed for being mounted in a cabinet on a DIN rail.

2. INSTALLATION

2.1. Electrical Connections

The T910 contains 2 pluggable screw terminals. Use the connector pinout as shown in Table 1

Table 1 Connector Arrangement Table

Connector	Pin	Comment
PWR	1	24 V Positive supply
	2	Gnd Negative supply
	3	No Connection
	4	No Connection
Modbus	5	Modbus – Signal B (+)
	6	Modbus – Signal A (-)
	7	No Connection
	8	No Connection

2.2. Termination

The RS485 Modbus line may be terminated in the T910. Whether to terminate is selected by a Specific HART Command

2.3. Programming utility

Behind the panel on bottom there is an USB connector, see Figure 4, for software download. This is not implemented in the first release.

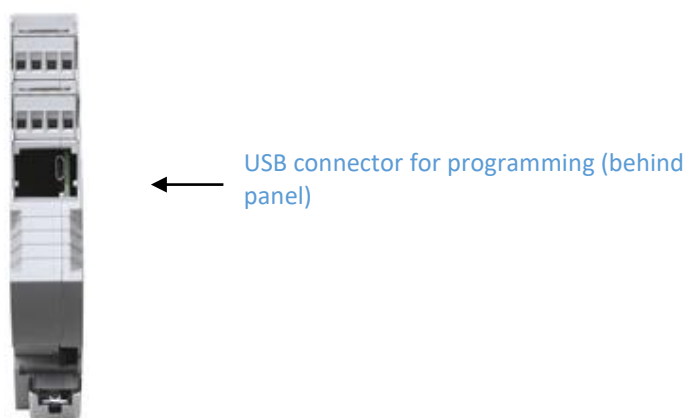


Figure 4: USB connector for programming the T910

2.4. Power, Termination and Diagnostic LEDs

There are 6 LEDs on the front, see Figure 5. One for Power ON, One for Modbus Termination ON/OFF, one for Join status, one for Bursting activity, one for the Modbus communication and one for Error status. The communication LEDs are bicolor. One color is blinking on request telegrams and the other on responding telegrams. A slow blink in one of the Modbus LED indicates that there is no Modbus communication. The blinking frequency is determined by the configured time-out time on Modbus.

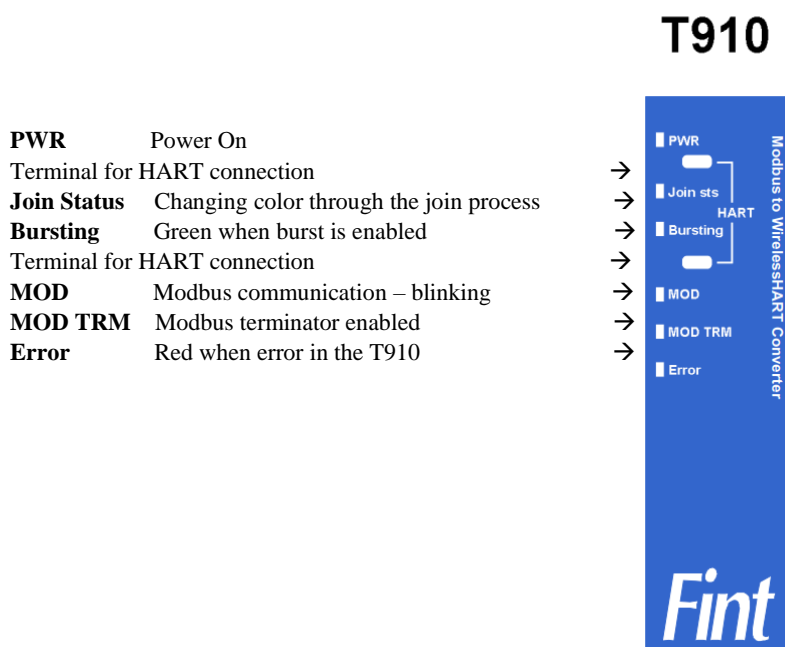


Figure 5: Front Label mounted on T910, showing the LED functions and connection for the HART configurator

Join Status coding

<i>Blinking Blue</i>	Network Packets Heard - Synchronized to Slot Time – Advertisement heard
<i>Blinking Red</i>	Join Requested - Join Retrying
<i>Constant Red</i>	Join Failed
<i>Blinking Green</i>	Authenticated - Network joined - Negotiating network
<i>Constant Green</i>	Normal Operation

Error

<i>Blinking Red</i>	Modbus Error
<i>Constant Red</i>	Radio Error

2.5. Antenna Connector

The SMA Female Connector placed on top of the module as shown in Figure 1, is the connection point for the antenna. As an option, the antenna can be externally mounted by use of a cable. Fint provides a generic 2.4 GHz antenna with the T910.

The antenna connector is of type SMA Male.

3. HART

The HART Maintenance Channel uses HART FSK Interface (Frequency Shift Keying) for serial communication at 1200 baud. A HART Field Configurator may be connected on this interface. The interface is not loop-powered and does not support current signaling.

The T910 WirelessHART Radio operates on the 2.4GHz band using IEEE 802.15.4 standard for the Physical Layer, and WirelessHART TDMA Data-Link Layer (Time-Division Multiple Access) for robust, deterministic wireless operation.

4. OPERATIONAL BEHAVIOR

The T910 is a protocol converter, to allow legacy Modbus devices to communicate on a WirelessHART network.

4.1. Wireless Configuration

The configuration of the wireless operation of the T910 is performed using standard HART commands specified in HCF document *Wireless Command Specification (HCF_SPEC-155)*. The parameters that need to be configured in a WirelessHART device, are the following:

4.2. Network ID

For the T910 to discover a network and attempt to join a network, it must be configured with the Network ID of the network it shall join. The Network ID may be written with Command 773 (using a field configurator) or using the supplied SW02 Software (see Chapter 0 Device Configuration with SW02).

4.3. Join Key

For the T910 to be allowed to join a WirelessHART network, it needs to be pre-configured with the correct Join Key, which must be obtained from the network administrator. The key may be written with Command 768 (using a field configurator) or using the supplied SW02 Software (see Chapter 0,

Wireless Setup).

4.4. Join Mode

The T910 is pre-configured not to attempt to join the network. After the network parameters have been configured, the Join Mode must be set. This may be done with Command 771 (using a field configurator) or using the supplied SW02 Software (see Chapter 0,

Wireless Setup). After the Join Mode has been set, the device will always attempt to join a WirelessHART network using the configured parameters, even after a power cycle. The Join Mode setting must be reverted (in the same way) to stop this behavior.

5. DEVICE VARIABLES

Device Variables are the measurement values that can be read from a HART Device. A Device Variable has an index that is called the Device Variable Code. Every Device Variable represents a transducer measurement of a certain type (e.g. Pressure or Temperature). This type is called the Device Variable Classification. The Device Variable Code is used to refer to a certain Device Variable e.g. when reading variables with HART Command 9.

The T910 is a WirelessHART device designed to be able to operate independently on a WirelessHART network. It is defined as a generic WirelessHART Field Device, which means that it may be configured to work with a wide variety of instruments of different types. As such, it has a pre-defined set of Device Variables with pre-defined Device Variable Classifications and supported units. The list of supported Device Variables Classes can be found in Appendix A.

5.1. HART Dynamic Variables and Device Variables

Dynamic Variables are a legacy concept from earlier HART versions, before Device Variables were introduced. The Primary Variable is special, as it may represent a variable directly communicated via an analog current signal on a current loop network. The T910 is a WirelessHART device and as such does not support analog current signaling.

In T910, the Dynamic Variables function is as a method to read device variables via e.g. HART Command 1 (Primary Variable) or HART Command 3 (All four Dynamic Variables). A Device Variable can be mapped to any of the four Dynamic Variables using either the provided software SW02 or with the HART Command 50. Figure 6 shows the structure of the Device Variables in T910 and how they can be assigned to the Dynamic Variables. In this example, the Device Variable 5 is assigned to the Quaternary Variable, and so reading QV (through Command 3) is equivalent to reading out Device Variable 5.

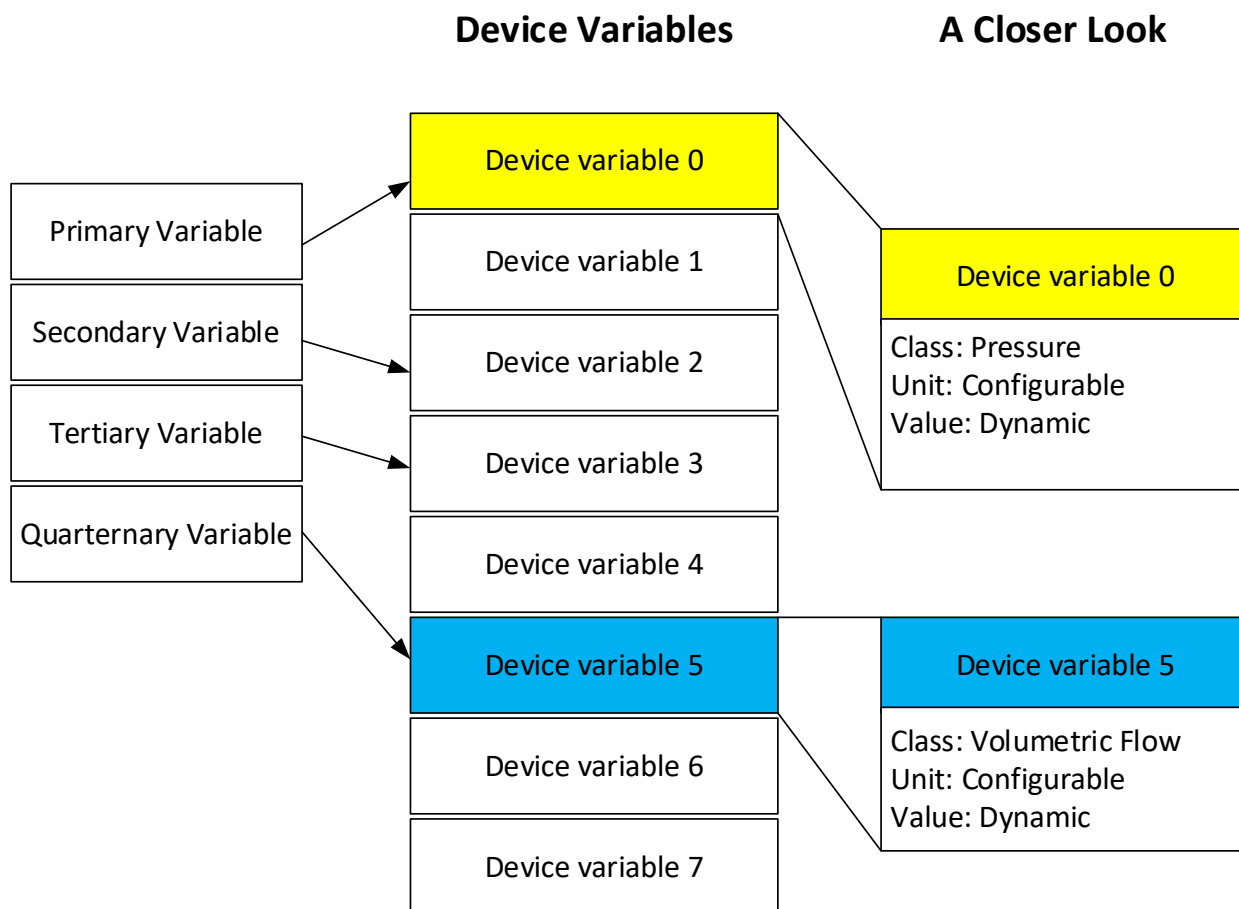


Figure 6: *Dynamic Variables and Device Variables*

Each Device Variable shall be allocated to a Device Variable Classification (Class). The Unit used when presenting a variable through HART may be configured to be different compared to how it is saved in the Modbus device (as long as it is compatible with the Device Variable Classification). As such, the user may choose to read the Device Variable 0 value in the example in Figure 6 in *bar*, *psi* or any other *pressure unit*. The unit conversion is handled internally in T910.

6. MODBUS VARIABLES

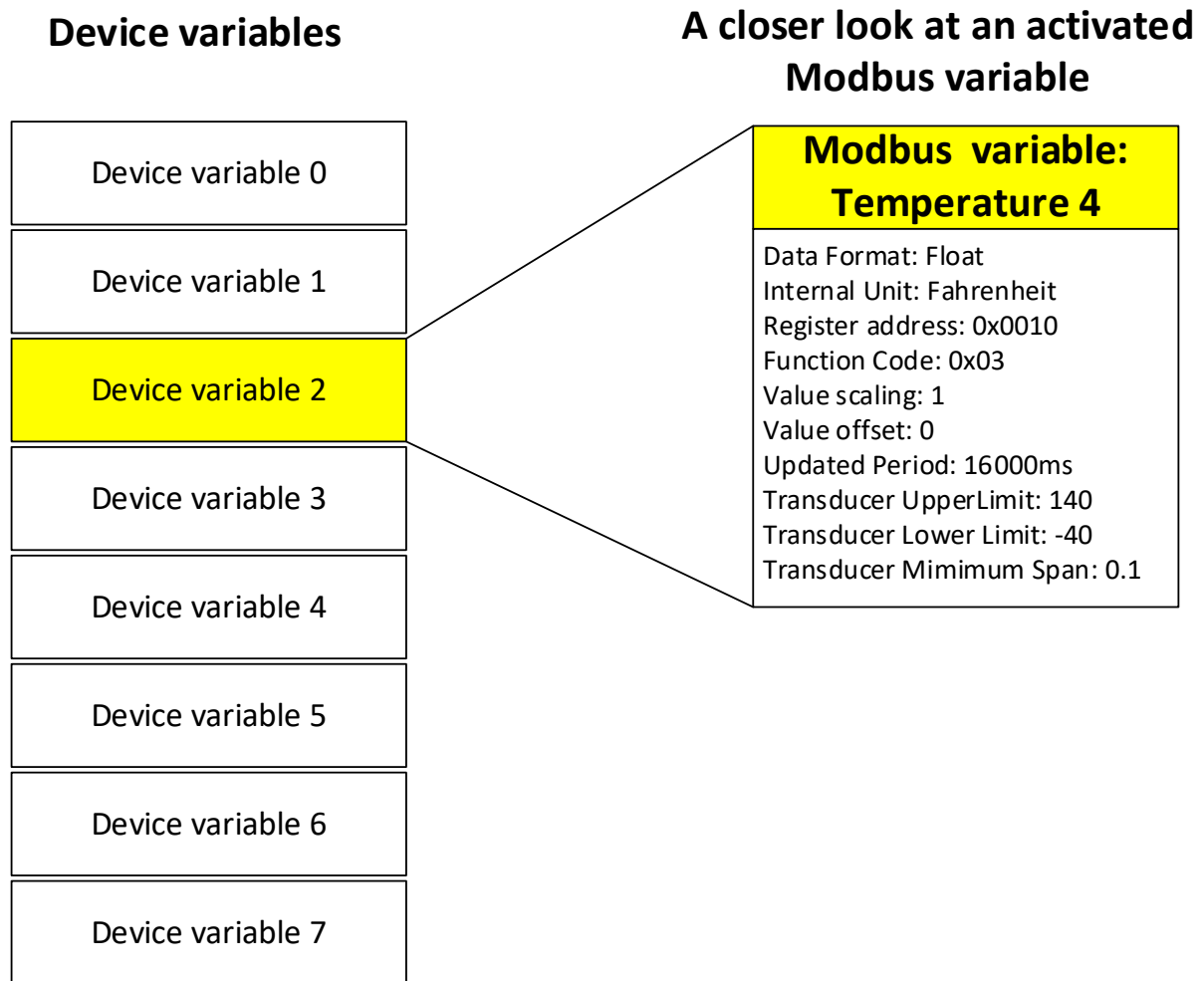


Figure 7: Modbus Variables and Device Variables

For each Device Variable there is a configuration setup. The T910 will read the measurement value periodically from a Modbus register address in the Modbus instrument. The Device Variable must be set up with the parameters needed to read and interpret the variable correctly (see Figure 7, Modbus Variables and Device Variables). These parameters are:

- The Device Variable Class and Unit. The unit and Variable class shall correspond to what is stored in the Modbus registers.
- Function Code: T910 will use the Modbus function code when reading the Modbus Variable from the device.
- Register Address: The Modbus Register Address at which the data is located in the vendor instrument.
- Data Format: Informs the T910 of the data size, byte ordering and data type of the variable to allow T910 to fetch and interpret the data correctly.
- Value Scaling and Offset: T910 will use this value to process the data after the data format interpretation. First, the Value Offset is added to the value and then the Scaling factor is multiplied by the scaling factor. The value obtained after this procedure is the real measurement value and must be in line with the Unit Code provided. In mathematical terms:

$$value_{after} = (value_{before} + offset) * factor_{scaling}$$

- Internal Unit: This unit will be stored and used when reading out the value. If this unit is not the same as the unit configured for the Device Variable (see Figure 6, Dynamic Variables and Device Variables), the value will be converted between the two units when the value is read. Provided the setup of the Modbus Variable is correct, the T910 will handle this conversion correctly.
- Transducer Limits and Span: These values should be set to store information about the limits of the sensor/measurement device. The information may be read with several HART commands, but does not generally have a direct impact on the value or functionality of T910.

- **Update Period:** The Update Period governs how often the T910 will update the Modbus Variable (reading the value from the instrument). It must be a value divisible by 1000 ms, which is the "heartbeat" of the T910. The value must also reflect the Modbus baud rate (see Tables 3, 4, 5). For example, a Modbus Connection of 9600 baud may not be fast enough to update all Modbus Variables every second within the required time margin (depending on configured timeouts). A configuration, which does not adhere to the guidelines in these tables, might lead to unexpected results and is strongly advised not to be used.

The T910 supports up to eight Device Variables to be set up, each with its own individual update period. The Device Variables must be configured using the supplied software SW02 (see Chapter 7, Device Configuration with SW02) or using a field configurator.

Figure 7 shows the Device Variables and a close look at the configuration items in a Modbus Variable. If a Variable in the Modbus instrument is to be activated, it must be configured with Modbus parameters, and linked to a Device Variable Code.

7. BURST MESSAGE

Burst Messages are the WirelessHART method for reporting of measurements. A Burst message is a HART command message initiated by the WirelessHART. HART commands dedicated for measured variables (Device Variables or Dynamic Variables) can be bursted. The user have large flexibility to arrange the bursting according to the requirements.

To be able to send data the transfer needs to be triggered. The trigger can be on a timer (Continuous) or on an event. The Event could be the measurement passing the Trigger level on Rising or Falling edge. In the latter the level, Unit and Unit Class must be configured

8. DEVICE CONFIGURATION WITH SW02

Fint provides the software Fint Hart Master (SW02) with the T910, which runs on a PC with Windows 7 or later. SW02 is used to configure the device, as well as performing simple testing. The following sections will guide the user through the usage of this software for a typical application.

8.1. Requirements

To use the SW02 software you will need the following:

- A PC running Windows 7 or a later version.
- A HART FSK-modem, for example the HM-USB-ISO from ProComSol.
- A powered T910 and both of the terminals of the HART modem connected to one of the H+ and H- connections of the T910 (see Figure 5, T910 Front panel). Polarity is not an issue.

8.2. Installation

If any earlier version of SW02 is installed, uninstall it first.

To install the software, click on the file setup.exe and the installer will launch. Follow the on-screen instructions to complete the installation.

8.3. Connecting to device

After launching the program, you will be met with the introduction screen. Click on *Settings* to set up the device. The following screen will be displayed (Figure 8):

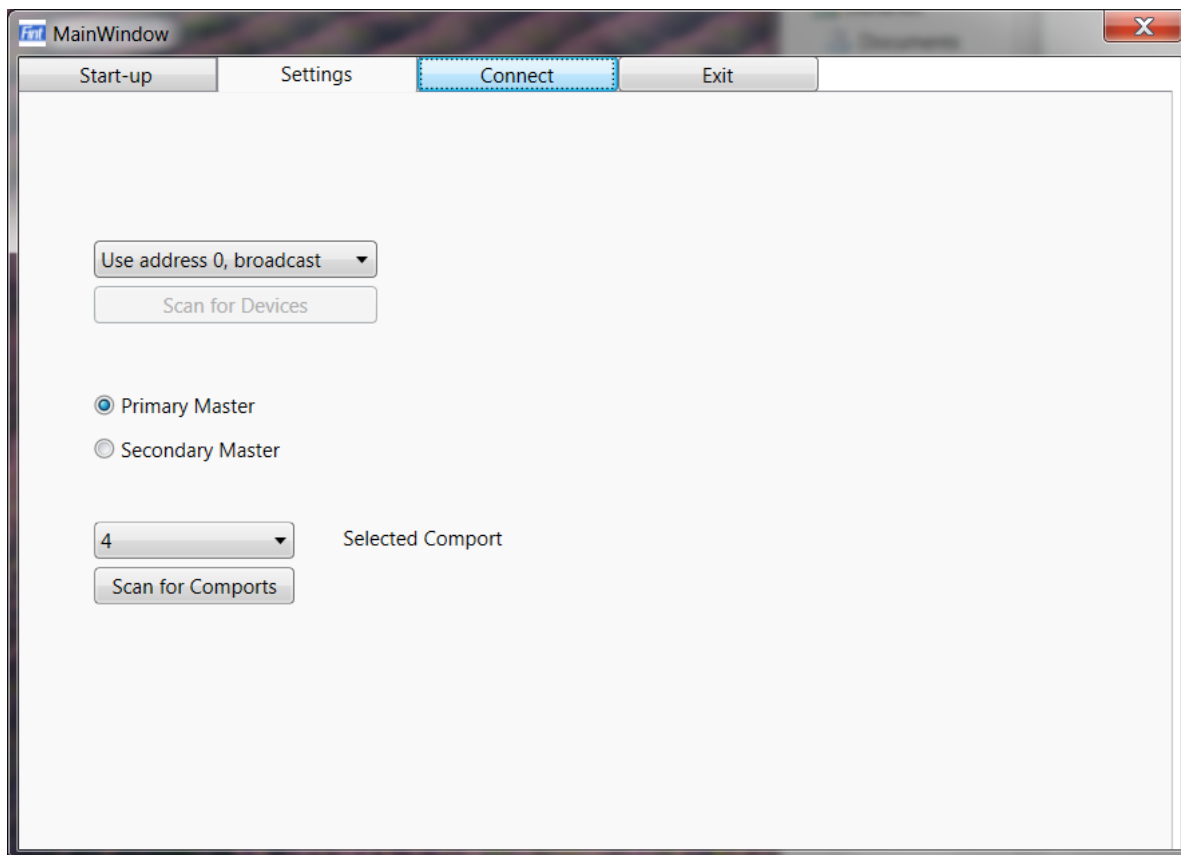


Figure 8 : SW02 COM Settings

First, choose the COM port of your HART modem (see Section 2 in the SW02 manual). If the COM port of the HART modem is not displayed on the list, click *Scan for Comports*. Otherwise, leave the settings as shown in Figure 8. Now click *Connect*. If the T910 is properly connected, SW02 will now start communicating with the device. This might take a while, up to a minute. If you get an error message, make sure to try the following:

- Check that the selected COM port is correct. (see *Device Manager* under *Control Panel* in Windows and look for your HART modem under *Ports*)
- Cycle the power on the T910
- Double-check the physical connections.

If everything works as it should, a new screen will show up, the "Front Page".

8.4.Front Page

The *Front Page* will show some basic information about the device, as well as some measurements and a plot. Figure 9 shows what to expect from that view.

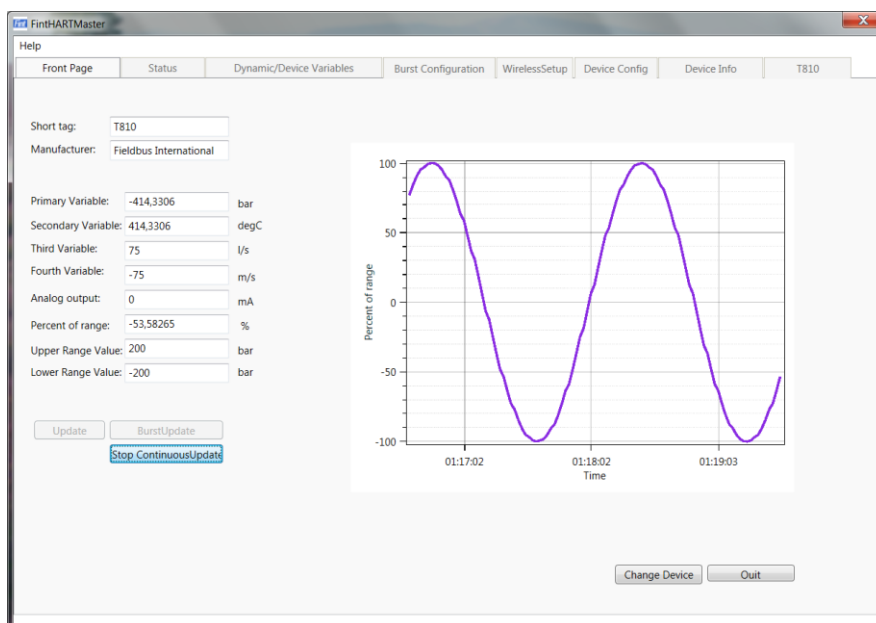


Figure 9: SW02 Front Page

The Dynamic Variables are read here. The plot shows the Percent-of-Range value, which is a representation of the Primary Variable (PV). See Chapter 6, HART Dynamic Variables and Device Variables. A Factory configured T910 will simulate a sinus on PV and some related values on the other dynamic variables.

This page may be used at a later stage to test the readout of variables. Before doing anything else, let us get the Modbus set up. If you wish to skip this and go straight to the Wireless Configuration using simulated variables, click on *Wireless Setup* and go to Section 3.8 in the SW02 manual.

Now, click on the tab T910. The sub-tab *Modbus Config* will show.

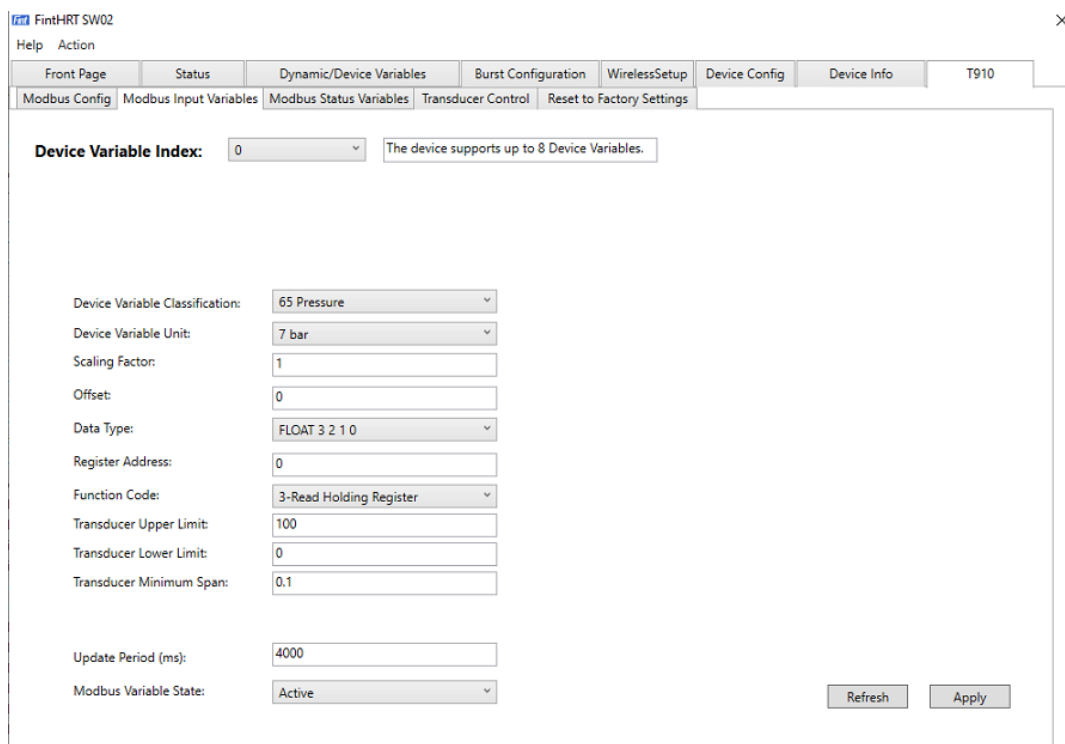
8.5. T910, Modbus Config

On this page, the Modbus Serial Communication is configured. Refer to the Modbus Instrument spec on how to configure the *baud rate*, *parity*, *stop bits*, *CRC order* and *instrument address*. The rest is explained here:

- *CRC order* – byte ordering of the bytes in the CRC
- *Startup Delay* – After a power cycle or software reset, this is the amount of time that the T910 will wait before initiating communication on the Modbus line. This value is configurable.
- *Response Timeout* – This is the amount of time that the T910 will wait after the transmission of a request, before considering the response to be lost/failed. This must be a value between 8 and 256ms, and divisible by 4ms.
- *Post Response Delay* – After receiving a successful response from the Modbus slave, the T910 will wait for this amount of time before initiating a new request. This must be a value between 4 and 128ms, and divisible by 4ms.

8.6. T910, Modbus Input Variables

On this page, the Modbus Variables are set up (see Chapter 6, Modbus Variables).



The screenshot shows the configuration interface for the T910 device. The main configuration area is titled "Modbus Input Variables" and contains the following settings:

- Device Variable Index:** 0 (The device supports up to 8 Device Variables.)
- Device Variable Classification:** 65 Pressure
- Device Variable Unit:** 7 bar
- Scaling Factor:** 1
- Offset:** 0
- Data Type:** FLOAT 3 2 1 0
- Register Address:** 0
- Function Code:** 3-Read Holding Register
- Transducer Upper Limit:** 100
- Transducer Lower Limit:** 0
- Transducer Minimum Span:** 0.1
- Update Period (ms):** 4000
- Modbus Variable State:** Active

Buttons for "Refresh" and "Apply" are located at the bottom right of the configuration area.

Figure 10 Device Variables

Figure 10 shows the example of the factory configuration for the T910. First, let us choose *Device Variable Index* "0". The saved configuration of Device Variable Code "0" will now be shown. Index 0 is currently pointing to variable class 65", which is *Pressure*. The Engineering unit is *bar*. This is supposed to be the engineering Unit that the variable is stored in in the Modbus device. It is configured to update its value every 4000 ms, it shall be read each 4000 ms across Modbus. It is set to *Inactive* and will not be read until it is activated. Refer to Chapter 6,

Modbus Variables for a detailed explanation of each of the parameters on this page.

Now, let us set up a temperature sensor for the *Device Variable* “0”. For a temperature sensor, use *Device Variable Classification Temperature*.

Let us say the variable is stored in Degrees C at Holding register 0 as a float value in Big Endian format in the Modbus registers of the connected Modbus device. Choose Degrees Celsius for the unit, a Scaling Factor of 1 and an offset of 0. The Data Type “Float3210” has standard Big Endian byte alignment. The Register Address is set to “0” and the function code is *Function Code 3 – Read Holding Register*.

Configure the limits of the sensor to 0 and 100 respectively and the *minimum span* to 1 (the minimum span is related to current signaling and is not of importance in the T910).

Click *Apply* to configure the device with these settings.

Next, configure the Update Period to 16 seconds (16000 ms). The value may be set to any value between 1 s and 3600 s and must be divisible by 1 second. If Burst is to be used with this device, it is advisable to adhere to the allowed Burst Update Periods of HART (see Section 3.7, SW02 Burst Configuration). Click *Apply* to commit the setting.

Lastly, the Variable State must be configured. Set it to *Active* and click *Apply*.

Repeat this procedure for every variable that shall be configured for the device, proceeding with the next *Device Variable*. Configure the variables in increasing number and leave no gap in Variable code numbering.

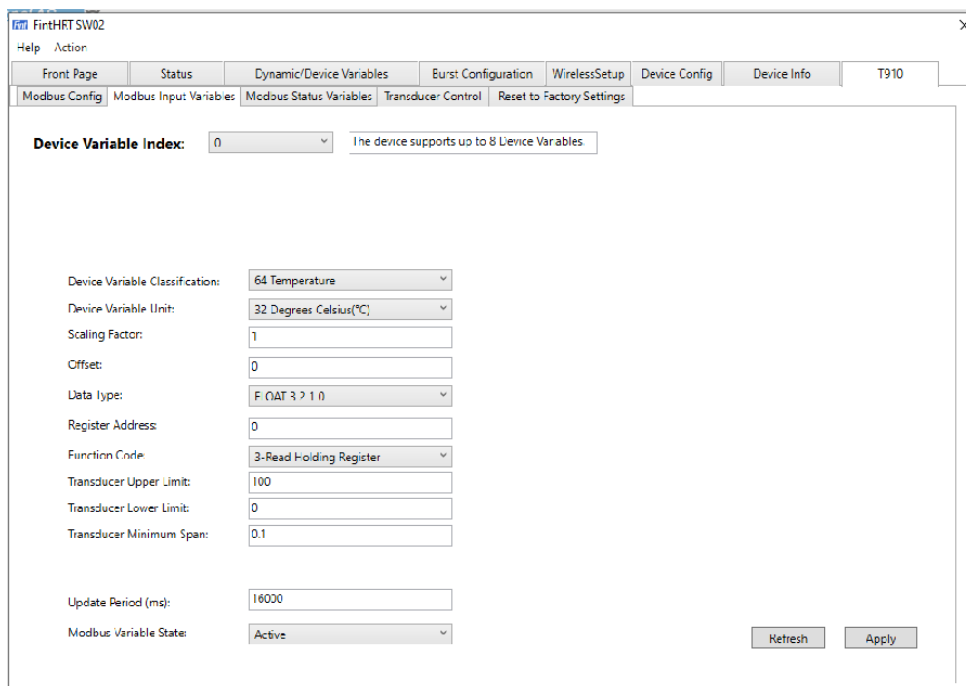


Figure 11 Modbus variable configuration

8.7.T910, Transducer Control

The Transducer Control Mode is the main switch to enable Modbus. There are two possible settings, *Modbus ON* and *Simulated Instrument*. The factory configuration of the T910 is *Simulated Instrument*.

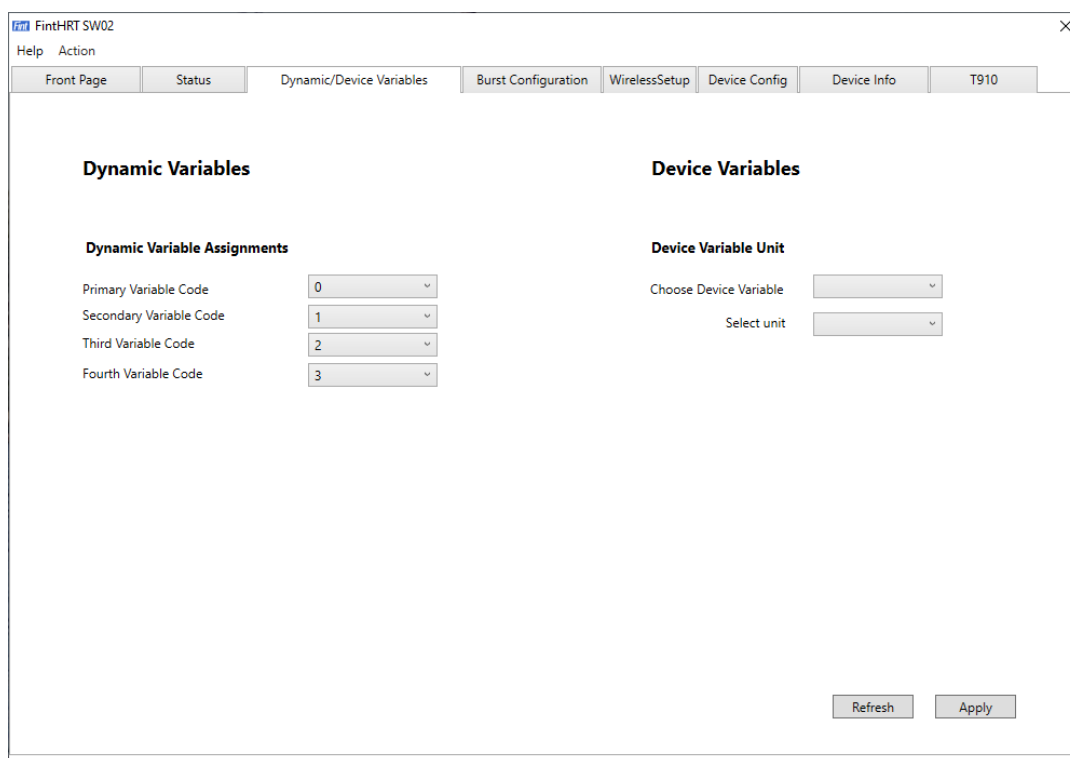
The T910 device must be reset for the Transducer Control mode to change. Therefore, on this page, notice the Configured mode and Active Mode of this parameter. The Active Mode is the current Active Mode. The configured mode is the mode that will take effect upon the next reset of the device.

Choose the desired Transducer Control Code in the dropdown menu and click *Apply*. Notice that the Configured Mode has changed to Modbus, but the Active Mode remains as *Simulated Instrument*. Click *Reset Device*. After the reset, notice that both fields are now *Active*. If everything has been set up correctly, the device should now read values from the Modbus instrument that may be read out using the configured Device Variable.

Now, let us head to the *Dynamic/Device Variables* tab to configure reading of the variables. Click *Dynamic/Device Variables*

8.8. Dynamic/Device Variables

Here you may configure the Dynamic Variables and the Device Variables of the device. Refer to Chapter 5.1, HART Dynamic Variables and Device Variables for an explanation of these concepts.



The screenshot shows a software window titled "FintHRT SW02" with a menu bar containing "Help" and "Action". Below the menu bar is a tabbed interface with tabs for "Front Page", "Status", "Dynamic/Device Variables" (which is active), "Burst Configuration", "WirelessSetup", "Device Config", "Device Info", and "T910".

The main content area is divided into two columns:

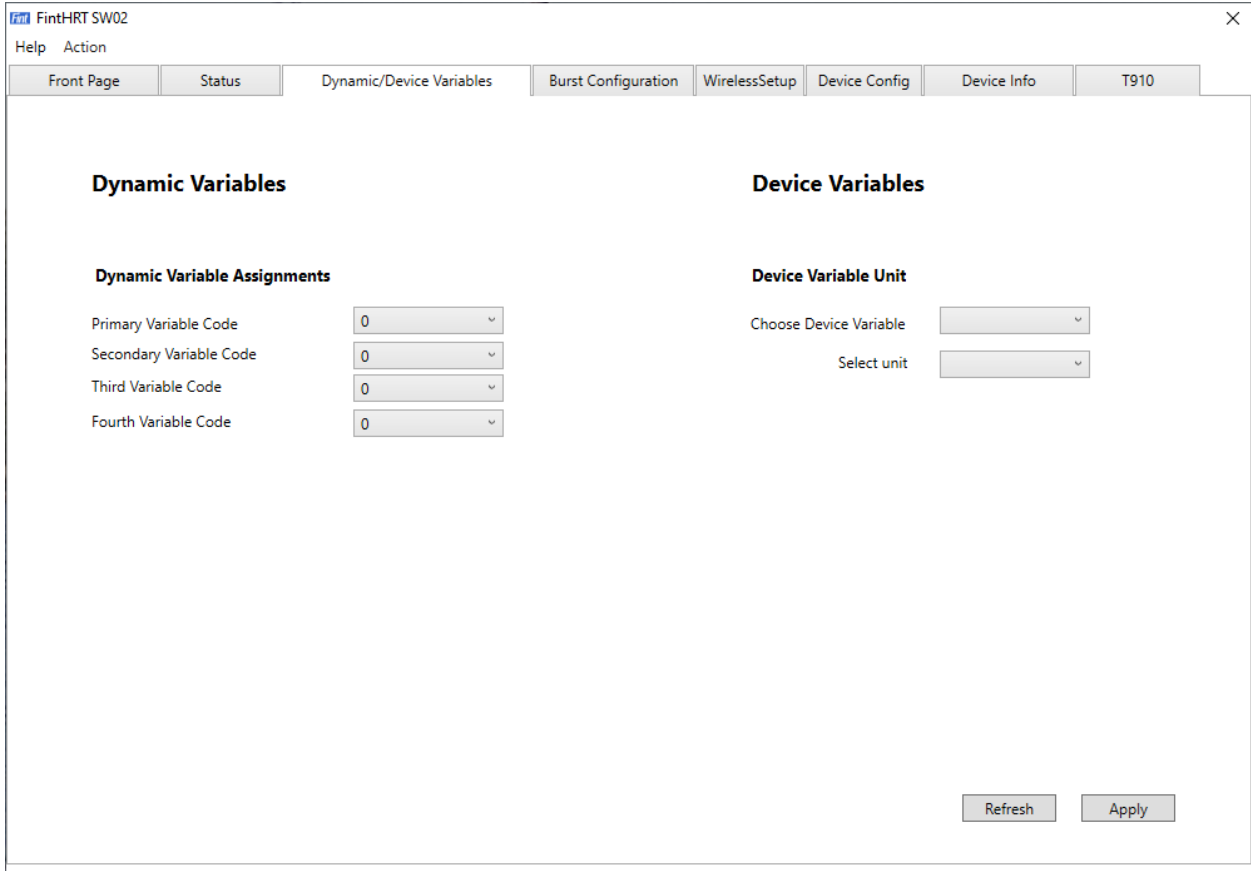
- Dynamic Variables:**
 - Dynamic Variable Assignments:**
 - Primary Variable Code: 0
 - Secondary Variable Code: 1
 - Third Variable Code: 2
 - Fourth Variable Code: 3
- Device Variables:**
 - Device Variable Unit:**
 - Choose Device Variable: [dropdown]
 - Select unit: [dropdown]

At the bottom right of the window, there are two buttons: "Refresh" and "Apply".

Figure 12: SW02 Dynamic/Device Variables

See Figure 12 on the left side of this screen, where the Dynamic Variable Assignments are shown.

In Chapter 8.6, T910, Modbus Input Variables, a Modbus temperature sensor instrument was configured for Device Variable "0". Let us say we want this to be the Primary Variable (PV) so we want to assign Device Variable "0" to PV. For the sake of this example all other Dynamic Variables is assigned to the same Device Variable. Click *Apply*.



The screenshot shows a web-based configuration interface for FintHRT SW02. The window title is "FintHRT SW02" and it includes a "Help" and "Action" menu. The main navigation bar contains tabs for "Front Page", "Status", "Dynamic/Device Variables", "Burst Configuration", "WirelessSetup", "Device Config", "Device Info", and "T910". The "Dynamic/Device Variables" tab is active, displaying two sections: "Dynamic Variables" and "Device Variables".

Dynamic Variables

Dynamic Variable Assignments

Primary Variable Code	0
Secondary Variable Code	0
Third Variable Code	0
Fourth Variable Code	0

Device Variables

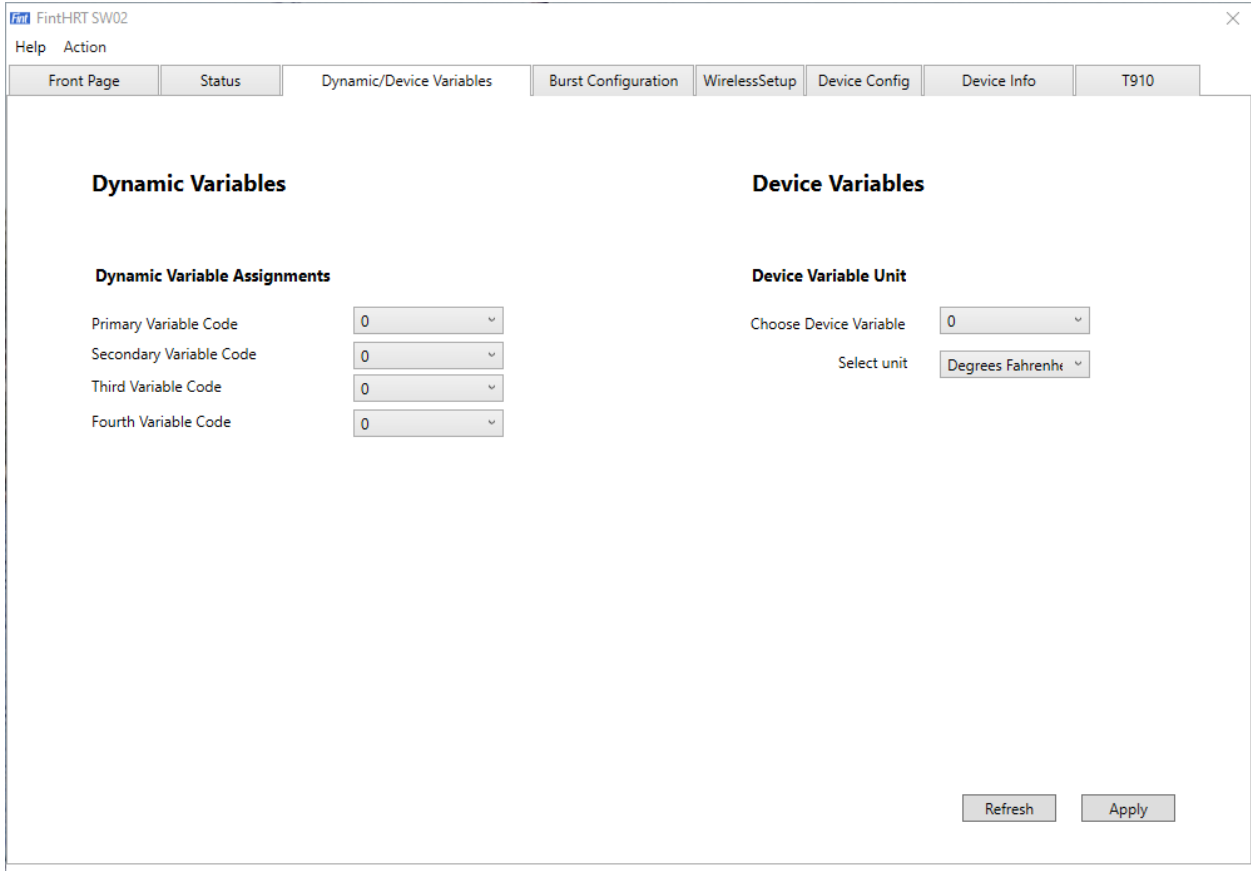
Device Variable Unit

Choose Device Variable	
Select unit	

At the bottom right of the configuration area, there are "Refresh" and "Apply" buttons.

Figure 13 Dynamic variable assignment

Now look at the right side of the screen, under *Device Variable Unit*. The temperature sensor configured in Chapter 8.6, T910, Modbus Input Variables, operates with the unit *Degrees Celsius*. However, suppose we want the HART Device to report the measurement values in the unit *Degrees Fahrenheit*. Choose *Device Variable* “0” and in the drop-down menu select the unit *Degrees Fahrenheit*. Then click *Apply*.



FintHRT SW02

Help Action

Front Page Status Dynamic/Device Variables Burst Configuration WirelessSetup Device Config Device Info T910

Dynamic Variables

Dynamic Variable Assignments

Primary Variable Code

Secondary Variable Code

Third Variable Code

Fourth Variable Code

Device Variables

Device Variable Unit

Choose Device Variable

Select unit

Refresh Apply

Figure 14 Unit selection

The T910 has now been set up with a temperature sensor via a Modbus Connection, and acts as a WirelessHART Temperature sensor. The values can be seen by returning to the front page and see the values reported for the Primary Value (PV).

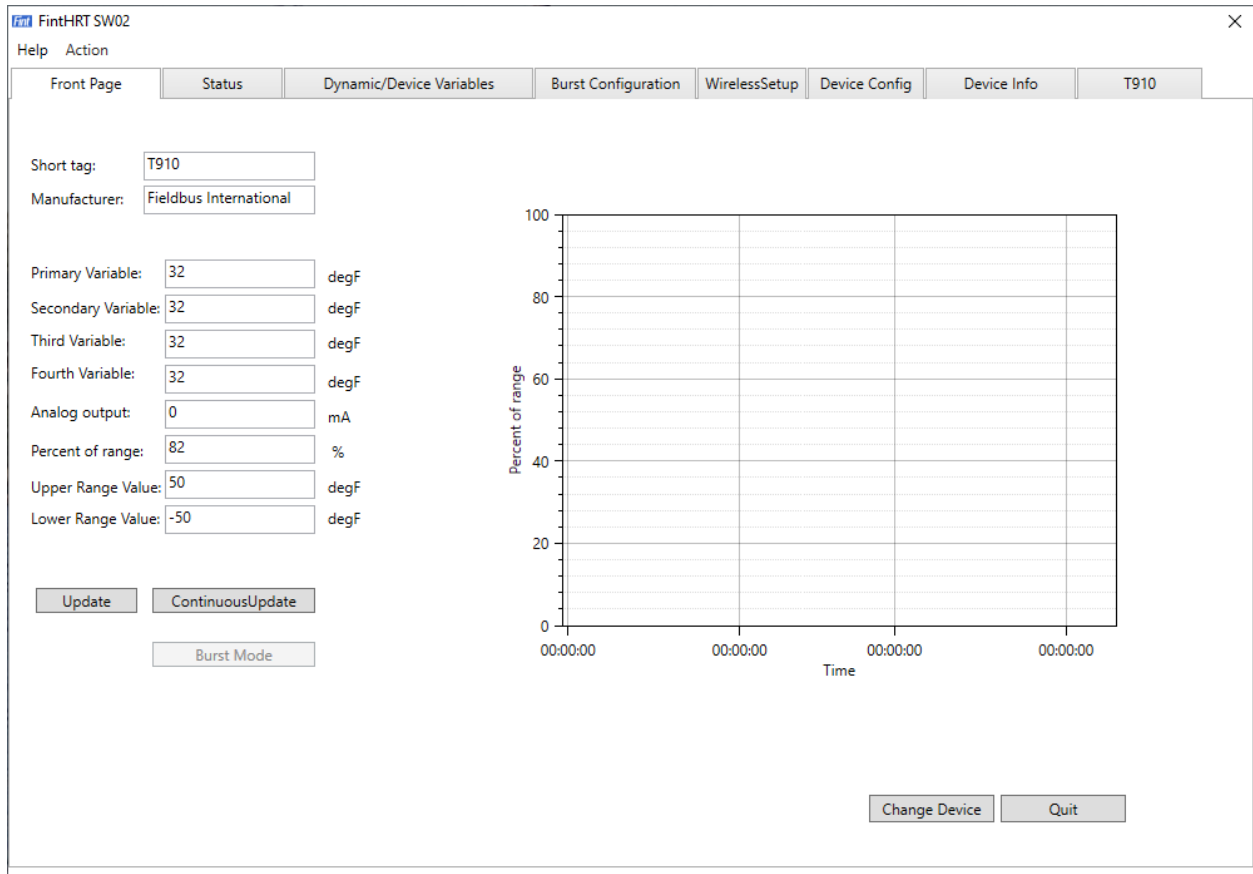


Figure 15 Reading of Dynamic Variables

8.9. Wireless Setup

Next, let us look at the Wireless Configuration, found by clicking on the Wireless Setup tab.

On this screen, the parameters for wireless networking are configured (discussed in Chapter 4.1, Wireless Configuration).

They are located at the top of the screen under *Wireless Setup*. (See Figure 16)

Error! Reference source not found.: **Wireless Setup**

Notice the Parameters on the lower part of the screen. The Monitor Join Status is ON by default. This means that SW02 is polling the device for Network Join Status. The T910 is factory-configured to not search for a network on boot, so the device will show Wireless Mode Idle. This means that the T910 is not yet connected to a WirelessHART network and may only be reached via the wired maintenance channel.

This User Guide will demonstrate the procedure of attempting to connect the T910 to a test WirelessHART Network with *Network ID 5903* and *Join Key 12341234 12341234 ABCDABCD ABCDABCD*

1. Set Join Mode to *On – Attempt to Join*. Click **Write**.
2. Set *Network ID*: Enter **5903** and click **Write**.
3. Set Join Key: Enter the Join Key as shown in Figure 13, SW02 Wireless Setup. Click **Write**.
4. Now, to activate the changes the device must be reset. Click *Reset Device*. (*Force Join* is supported by T910, but not by SW02).

After a reset, the T910 will search for and attempt to join the network.

- Wireless Mode refers to the state of the device concerning Wireless Operation. If the device manages to join the network successfully and is available for communication, this will show *Operational*.
- *Number of Available Neighbors*, *Advertising Packets Received* and *Join Attempts* are statistics of events occurring after the last reset (during the current Join Attempt).
- The **Join Status Flags** on the right side of the screen shows whether certain events have occurred during the stages of joining the network. Most of them are self-explanatory, but a few will be explained in the following.

- *Network Packets Heard* means that the T910 has detected a network with the configured *Network ID*
- *ASN Acquired and Synchronized to Slot Time* – These variables are connected to the time synchronization of the WirelessHART network. After these flags are set, the device is communicating efficiently with the network.
- *Advertisement heard* – The Device may only request to join the network after hearing an advertisement packet.

After successfully joining the WirelessHART network, the device is available to respond to WirelessHART commands sent from a WirelessHART Network Manager or Gateway.

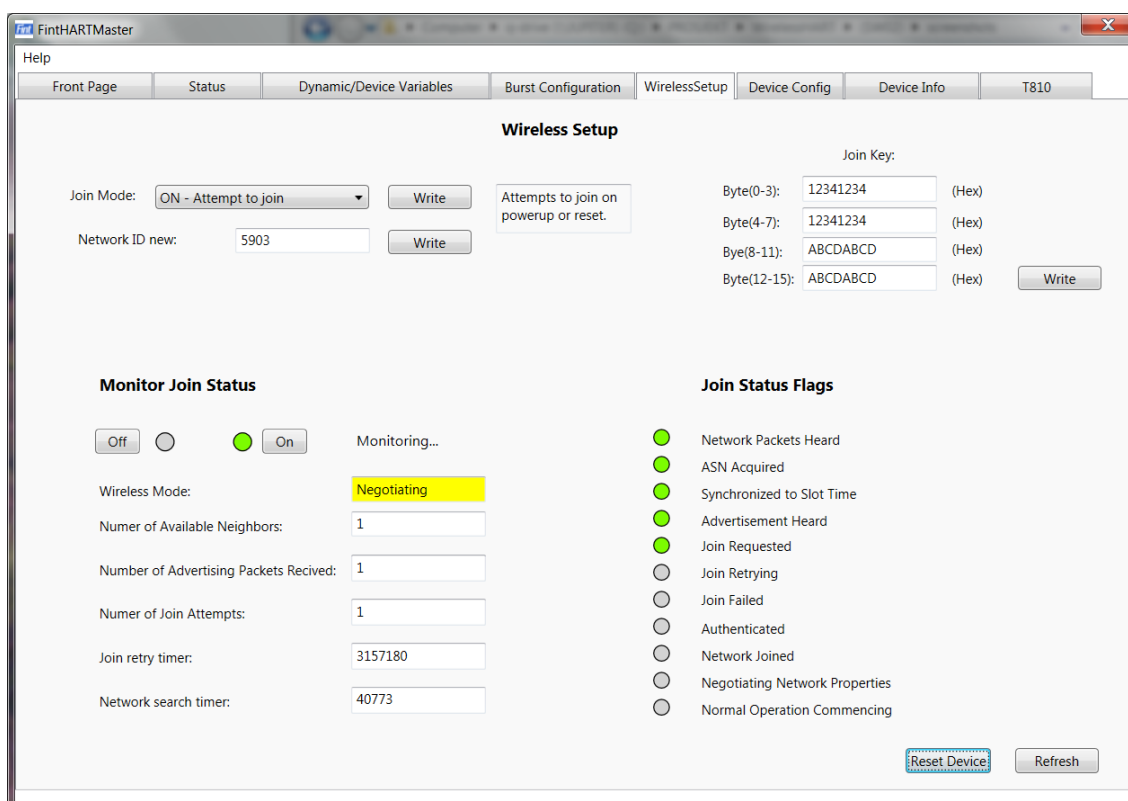


Figure 16: Wireless Setup Joining Network

8.10. SW02 Burst Configuration

The T910 supports Bursting Data on the WirelessHART channel. To configure Burst Messages with SW02, the T910 must be logged off the wireless network (see SW02, Section 3.8

Wireless Setup), i.e. the Join Mode must be set to *OFF – Do not attempt to Join*.

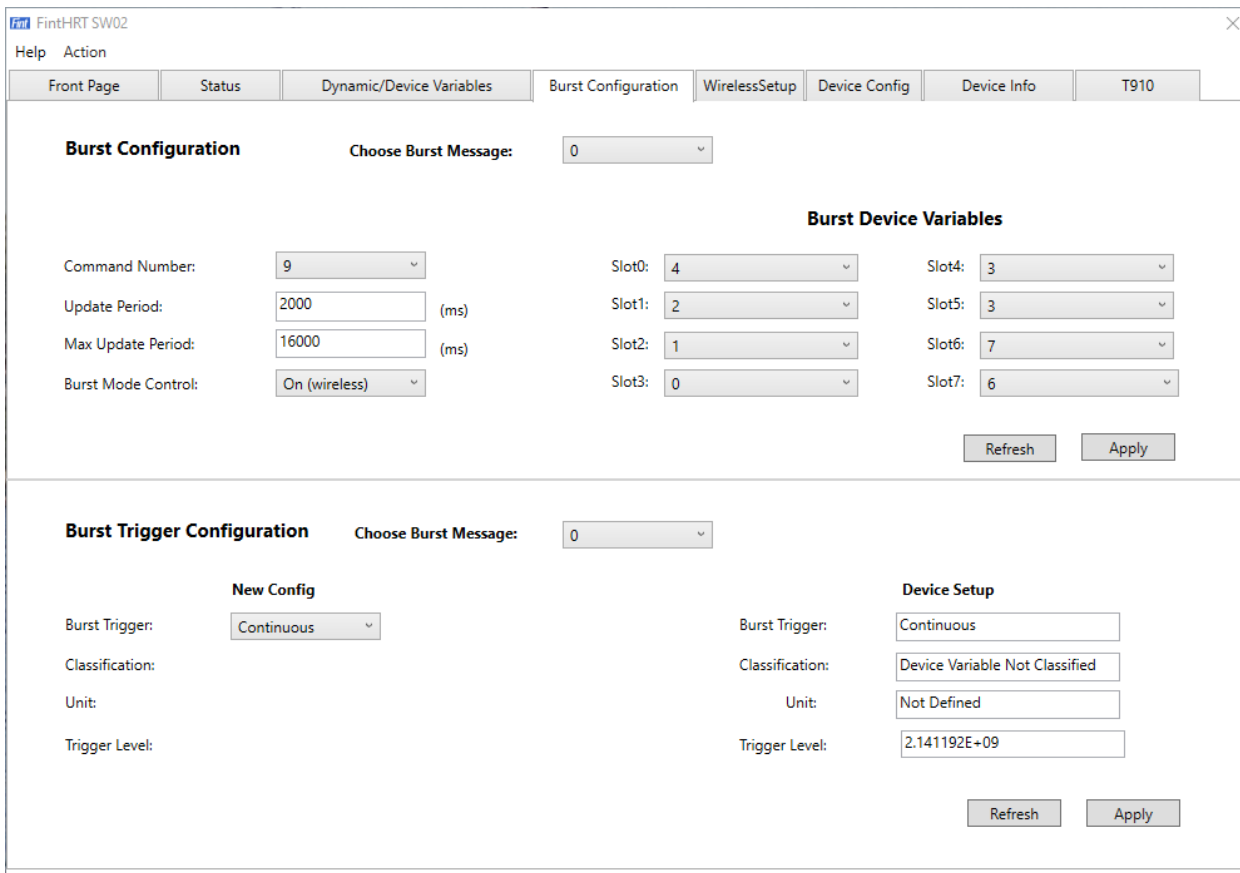
When setting up a Burst Message, first choose the Burst Message Number from the drop-down menu (The T910 supports three Burst messages). Select the Command Number to use for bursting, then click *Apply*.

Next, enter a desired *Update Time*. The Update Times supported by the T910 are the following: **1 s, 2 s, 4 s, 8 s, 16 s, 32 s, 60 s** and every value up to **3600 s** divisible by 1 s. If a different value is entered, the device will respond with a warning and adjust the time to the nearest supported value. The value is entered in milliseconds. Click *Apply*.

Now, the next time the T910 joins the network it will try to negotiate with the Network Manager to obtain the bandwidth required for bursting at the configured rate. See Section 3.4 in SW02 Status for help on how to determine if the bandwidth is granted by the Network. If the bandwidth requirement is rejected by the network, try to configure fewer burst messages or increase the Update Time.

The parameters under *Burst Device Variable* set up the Burst Device Variable Slots in the Device. They determine which Device Variables are published when bursting Command 9 or Command 33.

The Burst Trigger Configuration stored in Device Setup is showing the settings stored in the T910. To configure it to a proper setting enter the settings under “New Config”.



The screenshot shows the 'FintHRT SW02' software window with a navigation bar containing 'Front Page', 'Status', 'Dynamic/Device Variables', 'Burst Configuration', 'WirelessSetup', 'Device Config', 'Device Info', and 'T910'. The 'Burst Configuration' section includes a 'Choose Burst Message' dropdown set to '0', and fields for 'Command Number' (9), 'Update Period' (2000 ms), 'Max Update Period' (16000 ms), and 'Burst Mode Control' (On (wireless)). The 'Burst Device Variables' section contains seven slot dropdowns: Slot0 (4), Slot1 (2), Slot2 (1), Slot3 (0), Slot4 (3), Slot5 (3), Slot6 (7), and Slot7 (6). The 'Burst Trigger Configuration' section has a 'Choose Burst Message' dropdown set to '0' and two columns: 'New Config' and 'Device Setup'. 'New Config' includes 'Burst Trigger' (Continuous), 'Classification', 'Unit', and 'Trigger Level'. 'Device Setup' includes 'Burst Trigger' (Continuous), 'Classification' (Device Variable Not Classified), 'Unit' (Not Defined), and 'Trigger Level' (2.141192E+09). Both sections have 'Refresh' and 'Apply' buttons.

Figure 17 Burst configuration

8.11. SW02 Status

This page shows the different status registers of the Device, including the Field Device Status Additional Status.

- **Field Device Status:** One status byte transmitted with every HART response.
- **Additional Status:** In the T910, this is 14 Bytes of status bits. This status is read using Command 48.

The Field Device Status is shown at the top of the page. Further down on the page, on the left side, notice the Additional Status area. Click *Read* to fetch these status bytes from the device.

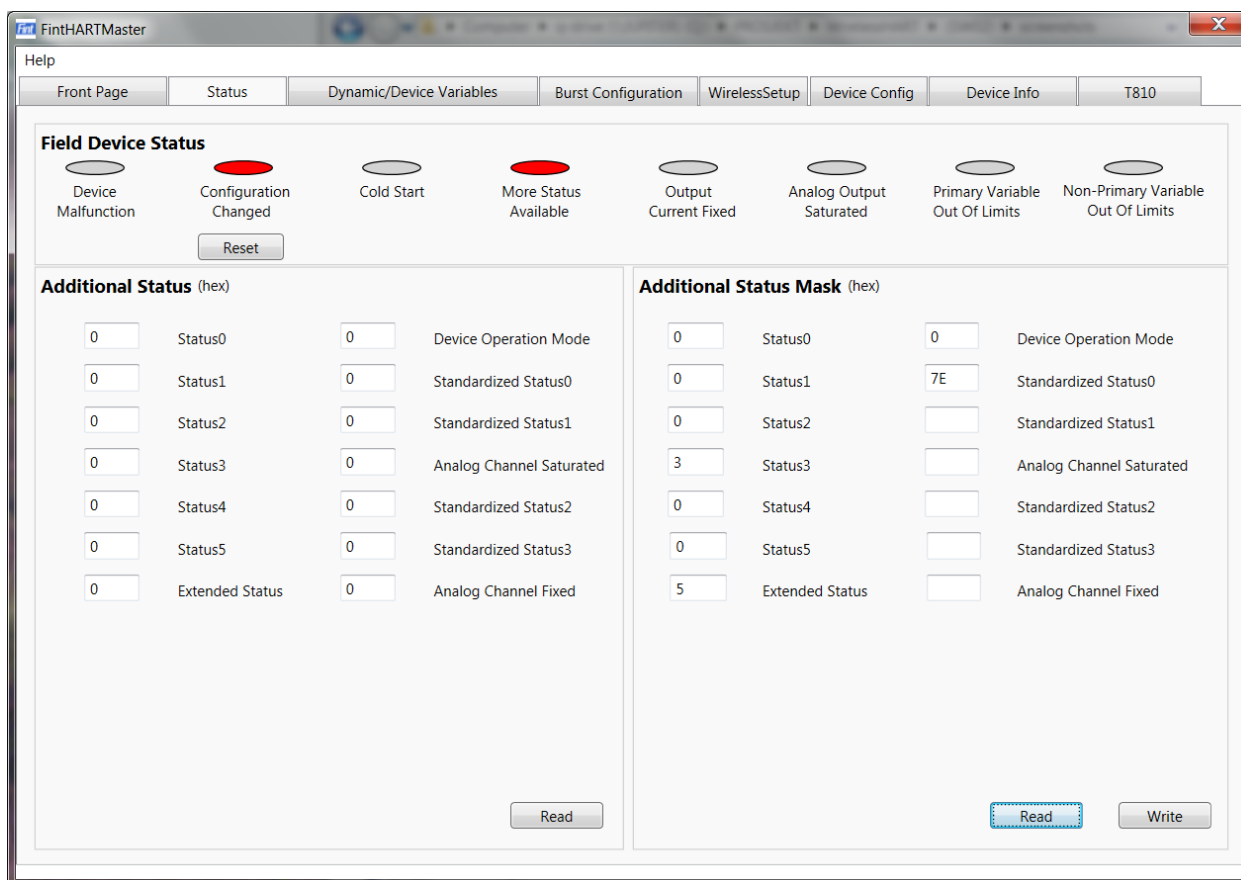


Figure 18 : Status

On the right side is the Additional Status Mask. This mask governs which individual bits of the Additional Status will cause the device to react by setting the More Status Available bit in the Field Device Status. The Field Device Status is transmitted with every single HART response, wired or Wireless, so this will cause the Network Host to discover a potential situation without having to specifically read the Additional Status from the Device.

The device is pre-configured with a test mask (see Figure 19, Status).

Many of these status flags have pre-determined meanings, defined in the HART specification from HCF. The *Standardized Status 3 byte*, for example, implements the following two flags concerning wireless operation:

- **0x01 Capacity Denied** – This means that the bandwidth requested from the device was rejected by the Network Manager, and the device is unable to publish commands at the configured rate. See Section 3.7 in SW02 Burst Configuration.

- **0x04** *Bandwidth Allocation Pending* – Network bandwidth is being requested from the Network Manager.

The Bytes *Status0* through *5* are Device-Specific and not described in the HCF specification. In the T910, these bytes are defined as follows:

- *Status0* and *Status1* – 16 status bits that may be mapped directly from the Modbus instrument. (The functionality of mapping a Modbus Register to these bytes is not working in the current version of SW02, but may be done using regular HART commands. Contact FINT for more information).
- *Status2* – Modbus Error Reporting
 - **0x01** – A Modbus Instrument Configuration Error has been detected. Either the Modbus Instrument does not respond, responds with an error message or the CRC cannot be verified.
- *Status3* – FINT debugging information. If any of these bits are set, please report to FINT.
- *Status4* – This byte is related to burst and bandwidth requests. If the *Capacity Denied* flag is set, this status gives more information on which burst message is being denied bandwidth.
 - **0x01** – Burst Message 0
 - **0x02** – Burst Message 1
 - **0x04** – Burst Message 2
- *Status5* – This byte does the same as *Status4*, except with *Bandwidth Allocation*.

9. CONFIGURE FROM A DD HOST

When the T910 is received from factory, it will be in Simulation Mode with one variable reporting. The Modbus set-up parameters will be Read-Only and all the eight Device Variables supported will be inactive.

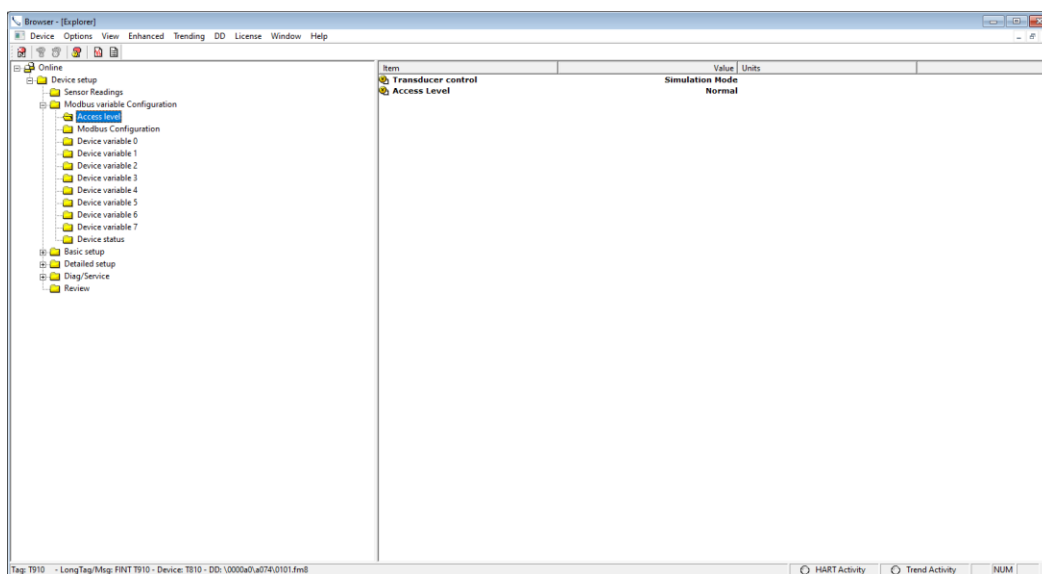


Figure 19 Transducer Control and Access level

Start by selecting AccessLevel “Modbus config”; the Modbus Configuration menu get writable and suitable parameters for the Modbus communication can be defined.

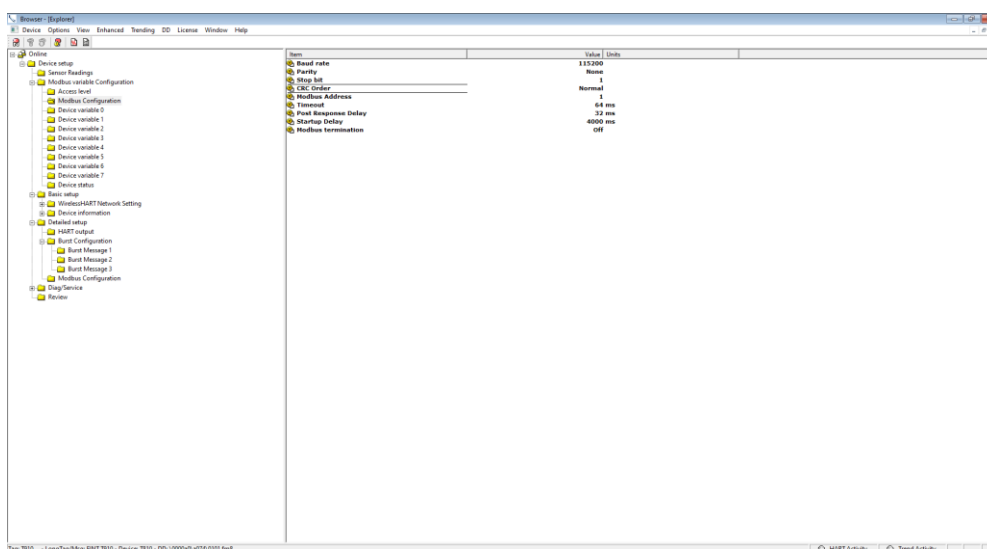


Figure 20 Modbus configuration

Start to configure the Device Variables that you want to support. Start with Device Variable 0 and work your way upwards.

The first thing to do is to “Activate” the Device Variable.

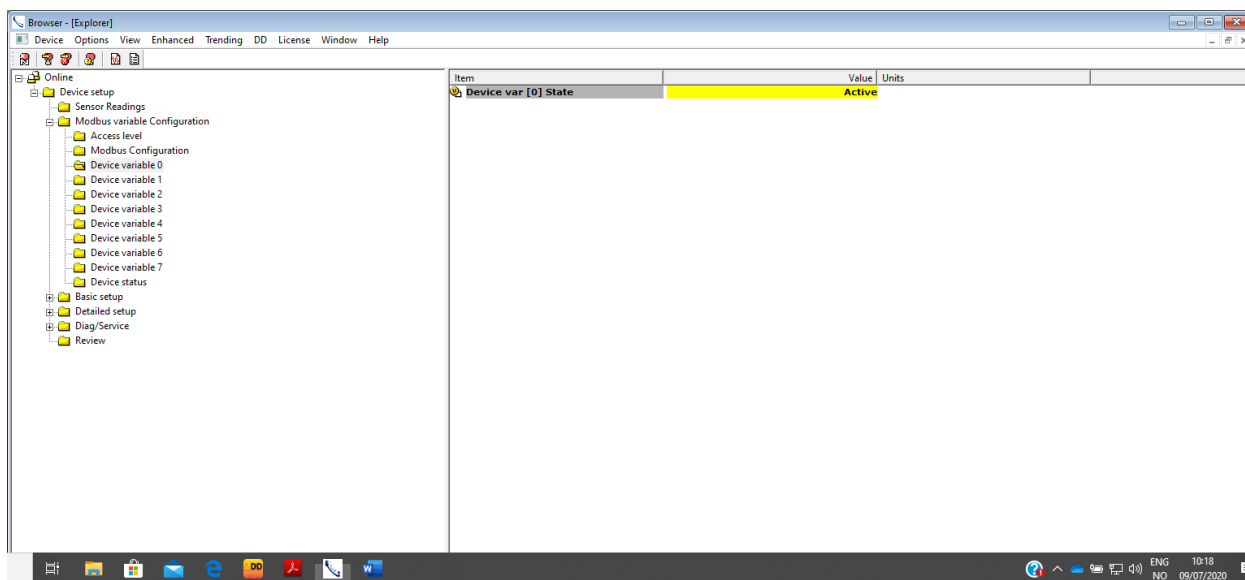


Figure 21 Device Variable activation

Then the variable parameters become visible and editable. See Chapter 6, Modbus Variables, for details on the parameters. Note that the parameters “Variable Type”, “Unit Class” and “Unit” all have to be consistent and written to the device simultaneously.

Item	Value	Units
Device var [0] State	Active	
Device var [0] Variable type	9 Velocity	
Device var [0] Unit Class	Velocity	
Device var [0] Unit	m/s	
Device var [0] Scaling factor	1.0	
Device var [0] Offset	0.0	
Device var [0] Data format in Modbus register	Float32 - byte order 3 2 1 0	
Device var [0] Register address	0	
Device var [0] Function Code	3 - Read Holding Register	
Device var [0] Transducer Upper Limit	50.0	
Device var [0] Transducer Lower Limit	-50.0	
Device var [0] Transducer Min Span	0.1	
Device var [0] Updated periode on Modbus	4000 ms	

Figure 22 Device Variable configuration

With Access Level “Modbus Config”, switch Transducer Control to “Modbus Active” and run Device reset.

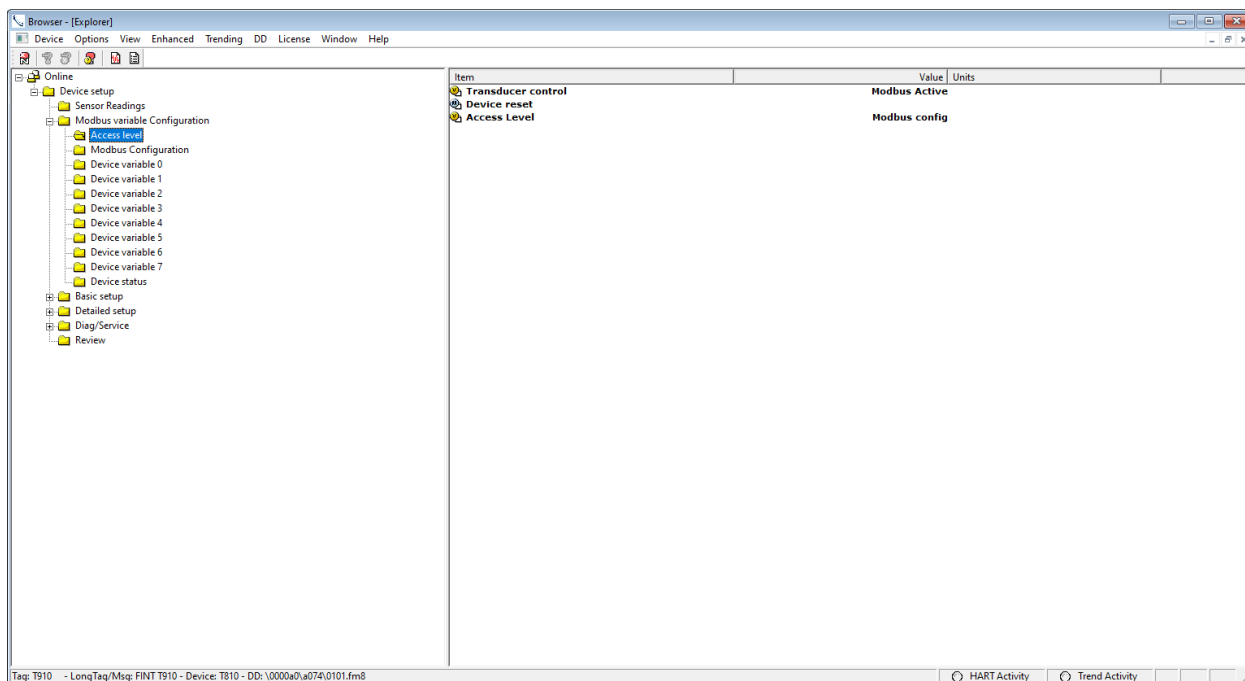


Figure 23 Modbus activation

Now you select the mapping from Device Variables to Dynamic Variables. For each Dynamic Variable the Device Variable source is selected. Note that you get all Device Variables supported by the T910

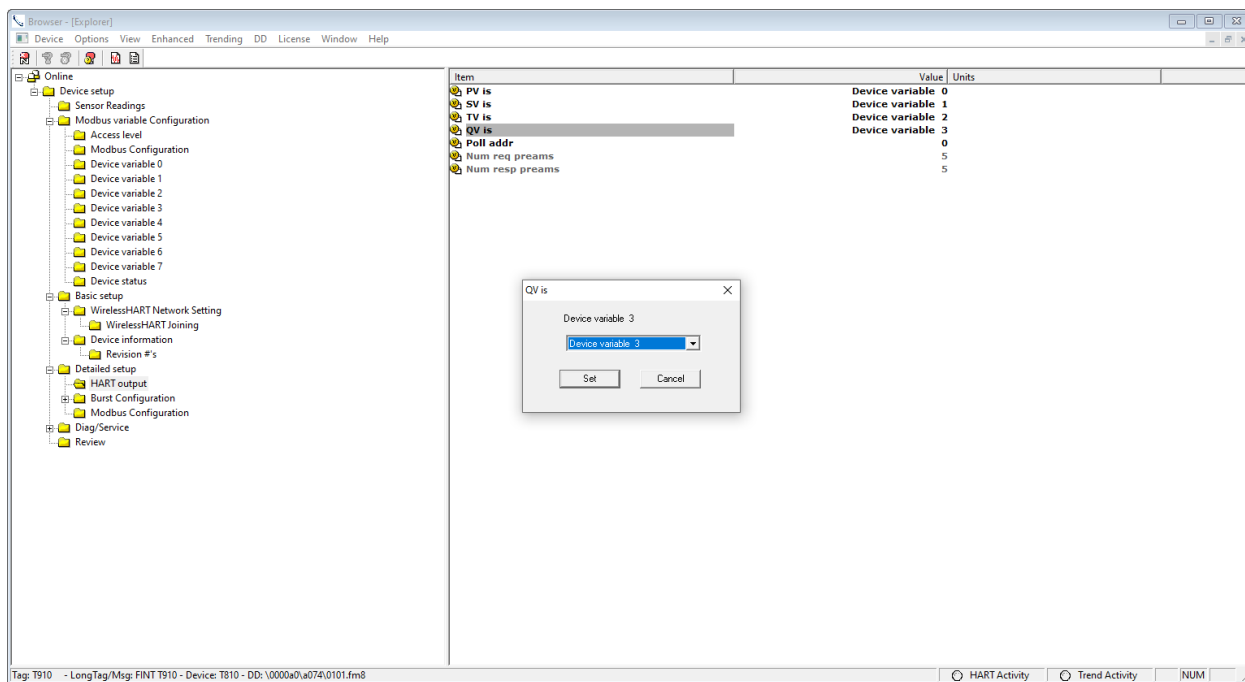


Figure 24 Dynamic Variable configuration

The Unit code for the Device Variable can be changed from what it was stored in in the Modbus instrument.

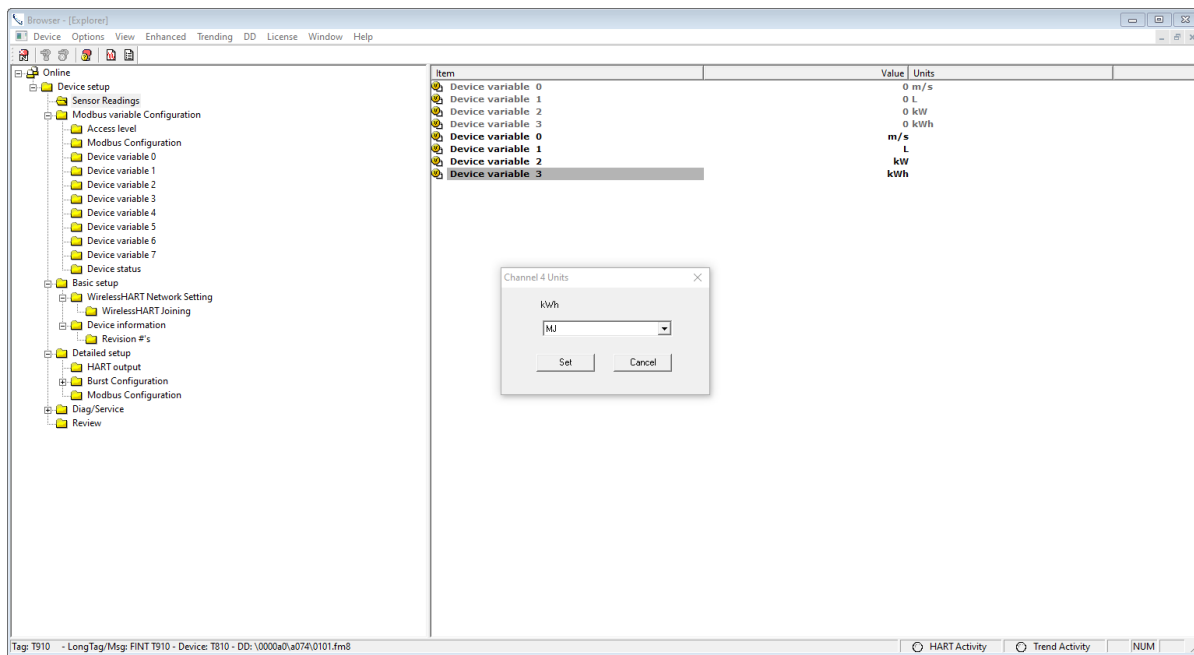


Figure 25 Variable unit selection

The Burst Message configuration can not be configured. There are three Burst configurations that are supported. The HART Command for bursting shall be selected. Command 9 can contain all eight variables if needed.

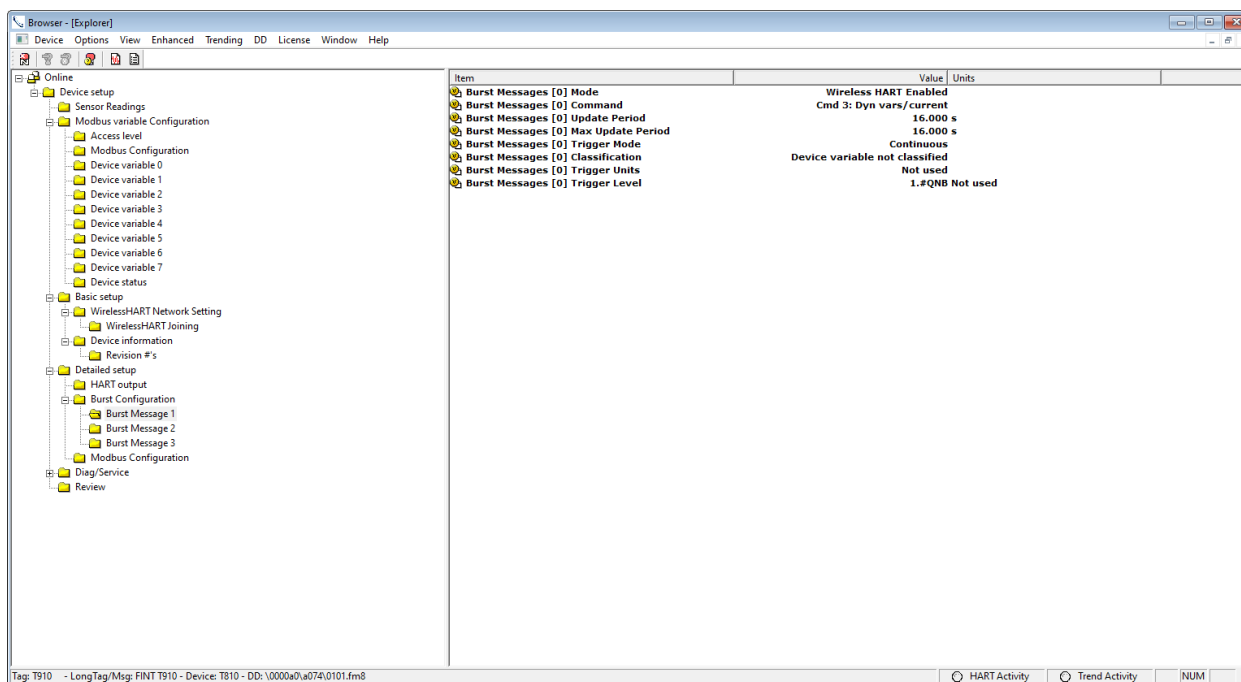


Figure 26 Burst configuration

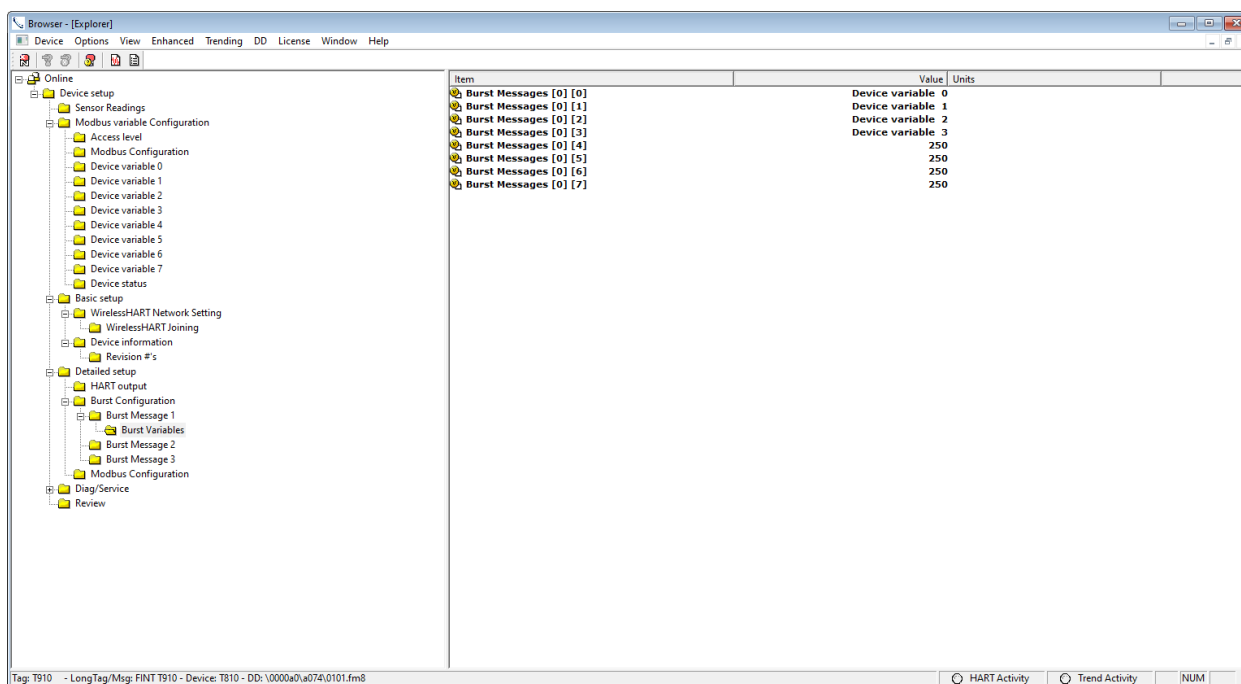


Figure 27 Command 9 configuration

Then it is time for joining the wireless network. The Network Id and Join Key are required for this process. Run the Methode “Join Network” and you will be taken through the process. Joining can take time and in some cases it takes very long time. Be patient!

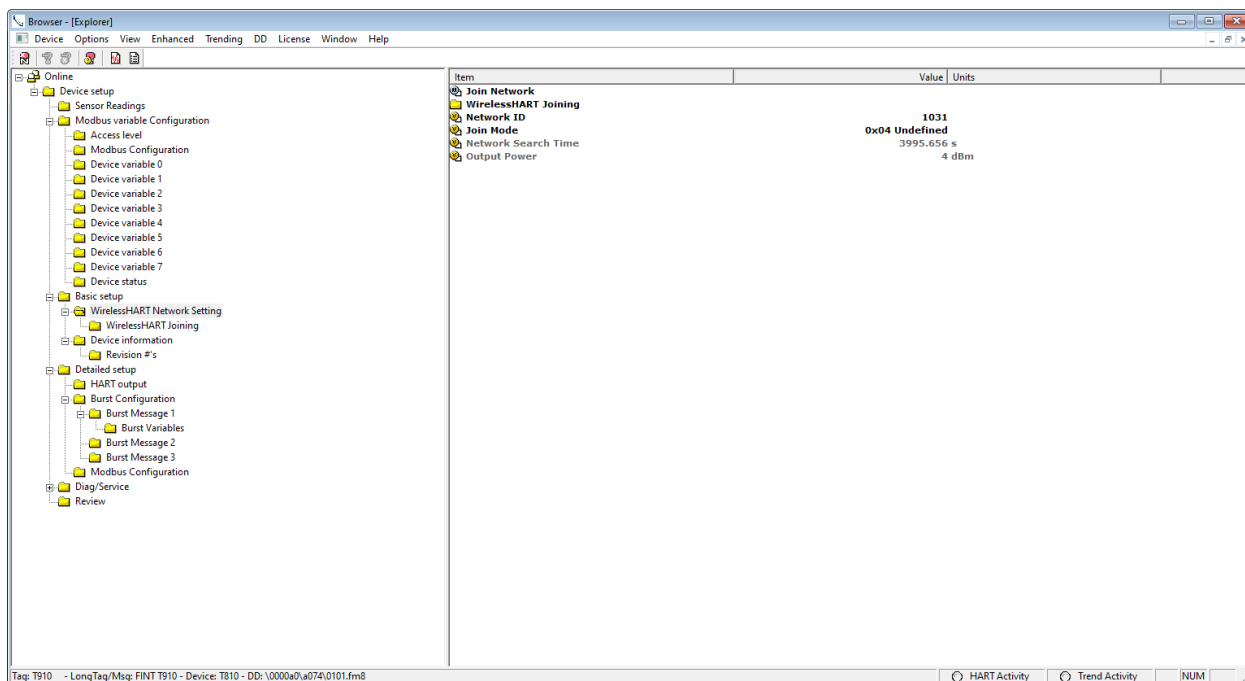


Figure 28 Join Network

If you want to connect to a different network, a new Network Id needs to be entered . Set Join Mode to Not attempt to join and Reset device. Then enter the new Id and enter the Join Keys. The select Join Now.

10. TECHNICAL SPECIFICATIONS

Mechanical:

Size	114,5 * 99 mm
Mounting	DIN rail
Module width	23,2 mm
Weight	136 gram
Housing	Plastic, IP-20 protection

Electrical:

Supply voltage	24 VDC
----------------	--------

Environmental:

Operating temperature range	-40 °C to + 85 °C
Shock	IEC 600068-2-27
Vibration resistance	IEC 600068-2-6

Protocols and Ports:

Number of Modbus ports	1
HART protocol	Slave
Modbus protocol	Modbus RTU, Master
Modbus serial standard	RS-485

1 APPENDICES

Appendix A List of T910 Variable Classification supported by T910

Table 2: T910 List of Device Variable Classifications

Classification	Default Engineering Unit/Internal base unit
Pressure	Bar
Temperature	Degrees Celsius
Volumetric Flow	Litres per second
Velocity	Meters per second
Volume	Litres
Length	Meters
Mass	kilograms
Mass Flow	kilograms per second
Mass per Volume	kilograms per Litre
Electromotive Force	Volt
Analytical	Percent
Frequency	Hertz
Power	kiloWatt
Time	s
Current	mA
Energy	kiloWattHours

Appendix B Modbus Update Timing

The following tables contain safe, conservative estimates of the recommended maximum number of variables under a few select circumstances (different values of baud rate and worst-case timeout). They do not include every possible combination of baud rates and timeouts, but should give a sense of the limits of the configuration. These settings are safe.

The worst-case timeout value is the value that is the largest between the Response Timeout and the Post Response Delay (see Section 3.10 T910, Modbus Config)

Table 3: Max number of Modbus Variables, 1000 ms Update Period (125 ms constraint)

Baudrate	Max packet time based on baudrate	Worst-case timeout (Below: Maximum number of variables)				
		< 4 ms	< 16 ms	< 32 ms	< 64 ms	< 128 ms
1200	~200 ms	0	0	0	0	0
2400	~100 ms	1	1	0	0	0
4800	~50 ms	2	1	1	1	0
9600	~25 ms	4	3	2	1	0
14400	~16 ms	6	3	2	1	0
19200	~12 ms	7	4	2	1	0
28800	~8 ms	9	5	3	1	0
38400	~6 ms	9	5	3	1	0
57600	~4 ms	9	6	3	1	0
115200	~2 ms	9	6	3	1	0
125000	~2 ms	9	6	3	1	0
250000	~1 ms	9	7	3	1	0

Table 4: Max number of Modbus Variables, 2000 ms Update Period (250 ms constraint)

Baudrate	Max packet time based on baudrate	Worst-case timeout (Below: Maximum number of variables)				
		< 4 ms	< 16 ms	< 32 ms	< 64 ms	< 128 ms
1200	~200 ms	1	1	1	0	0
2400	~100 ms	2	2	1	1	1
4800	~50 ms	4	3	3	2	1
9600	~25 ms	8	6	4	2	1
14400	~16 ms	9	7	5	3	1
19200	~12 ms	9	7	5	3	1
28800	~8 ms	9	8	6	3	1
38400	~6 ms	9	9	6	3	1
57600	~4 ms	9	9	6	3	1
115200	~2 ms	9	9	7	3	1
125000	~2 ms	9	9	7	3	1
250000	~1 ms	9	9	7	3	1

Table 5: Max number of Modbus Variables, 4000 ms Update Period (500 ms constraint)

Baudrate	Max packet time based on baudrate	Worst-case timeout (Below: Maximum number of variables)				
		< 4 ms	< 16 ms	< 32 ms	< 64 ms	< 128 ms
1200	~200 ms	2	2	2	1	1
2400	~100 ms	4	4	3	3	2
4800	~50 ms	9	7	6	4	2
9600	~25 ms	9	9	8	5	3
14400	~16 ms	9	9	9	6	3
19200	~12 ms	9	9	9	6	3
28800	~8 ms	9	9	9	6	3
38400	~6 ms	9	9	9	7	3
57600	~4 ms	9	9	9	7	3
115200	~2 ms	9	9	9	7	3
125000	~2 ms	9	9	9	7	3
250000	~1 ms	9	9	9	7	3

Table 6: Max number of Modbus Variables, 8000 ms Update Period (1000 ms constraint)

Baudrate	Max packet time based on baudrate	Worst-case timeout (Below: Maximum number of variables)				
		< 4 ms	< 16 ms	< 32 ms	< 64 ms	< 128 ms
1200	~200 ms	4	4	4	3	3
2400	~100 ms	9	8	7	6	5
4800	~50 ms	9	9	9	8	5
9600	~25 ms	9	9	9	9	6
14400	~16 ms	9	9	9	9	6
19200	~12 ms	9	9	9	9	7
28800	~8 ms	9	9	9	9	7
38400	~6 ms	9	9	9	9	7
57600	~4 ms	9	9	9	9	7
115200	~2 ms	9	9	9	9	7
125000	~2 ms	9	9	9	9	7
250000	~1 ms	9	9	9	9	7

Table 7: Max number of Modbus Variables, 16000 ms Update Period (2000 ms constraint)

Baudrate	Max packet time based on baudrate	Worst-case timeout (Below: Maximum number of variables)				
		< 4 ms	< 16 ms	< 32 ms	< 64 ms	< 128 ms
1200	~200 ms	9	9	8	7	6
2400	~100 ms	9	9	9	9	8
4800	~50 ms	9	9	9	9	9
9600	~25 ms	9	9	9	9	9
14400	~16 ms	9	9	9	9	9
19200	~12 ms	9	9	9	9	9
28800	~8 ms	9	9	9	9	9
38400	~6 ms	9	9	9	9	9
57600	~4 ms	9	9	9	9	9
115200	~2 ms	9	9	9	9	9
125000	~2 ms	9	9	9	9	9
250000	~1 ms	9	9	9	9	9

2 FAILURE

Blinking red LED	The T910 is not able to establish connection with the instrument on Modbus – time-out.	Try to swap the two RS485 wires. Naming convention for RS485 can be confusing.
Blinking red LED	The T910 is not able to establish connection with the instrument on Modbus – time-out.	Try to use reversed CRC byte order. This is configured using SW02 in the Modbus configuration menu.
Blinking red LED	The T910 is not able to establish connection with the instrument on Modbus – time-out.	The Modbus Slave may be too fast in responding. T910 expects 3.5 character silence after a request. Any response faster will be rejected. Try to extend slave response time if possible.
Reading value in SW02 is jumping	The T910 is reading values but not on each request	The Modbus Slave may be slower in responding than the time-out time. The risk of message collision is large. From time to time the message gets through. And a correct reading is obtained. Increase the time-out time on the Modbus configuration menu of SW02.

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