1. Introduction

There is an increasing need for fast and voluminous data transmission between HIMA Safety PESs and different DCSs. Modbus TCP is a protocol which can fulfil this need. Modbus TCP communication combines the proven reliability of the Modbus protocol with the flexibility and speed of Ethernet networks. The well known Modbus Telegrams are coded into TCP packages and can than be communicated via Ethernet. As transport layer standard off-the-shelf Ethernet equipment like twisted pair network cables, switches and fiber optic converters can be used with communication speeds of up to 1 GB/s. In contrast to standard Modbus RTU the Modbus TCP protocol is multi master capable, meaning that several communication masters can access the same slaves for information.

The Modbus TCP communication protocol was made available to HIMA´s H41q/H51q and Emerson´s DeltaV system through market introduction of new communication modules in 2005 and 2006 respectively. Modbus TCP support was added to H41q/H51q systems through introduction of the new ethernet communication module F 8627X. A communication module from third-party supplier Mynah named Virtual I/O Module (VIM) added Modbus TCP capability to DeltaV. The Mynah VIM achieves this through simulating four DeltaV serial cards (eight serial cards for redundant layout) which are virtually mapped to the last I/O slots (61-64 for non-redundant and 57-64 for redundant communication) of the DeltaV systems eight possible I/O carriers. The way to configure the data communication and the applicable communication limitations is therefore the same like with standard DeltaV serial cards.

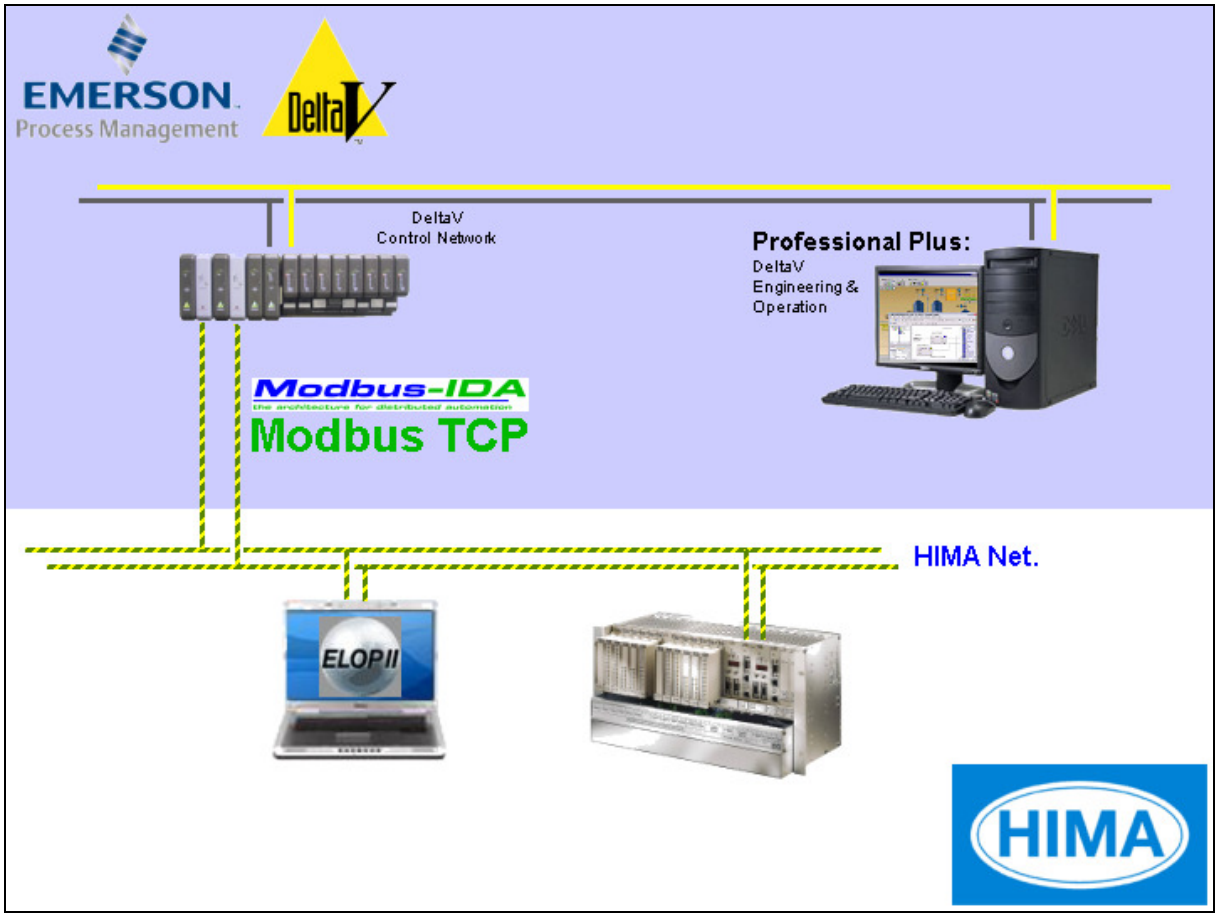

Figure 1.1 General Network Layout for Modbus TCP Communication

This Application Note should give an overview of the necessary configuration steps for establishing a Modbus TCP communication between HIMA's H41q/H51q safety PES and Emerson Process Management's DeltaV DCS.

As precondition for applying this Application Note general knowledge of the H41q/H51q PES and DeltaV DCS as well as configuring with ELOP II and DeltaV Explorer and Control Studio is assumed (see Recommended Literature [1], [2], [3], [4]).

2. Described Configuration

2.1. Detailed System Layout

The detailed hardware layout on which this Application Note is based is shown in Figure 2.1.

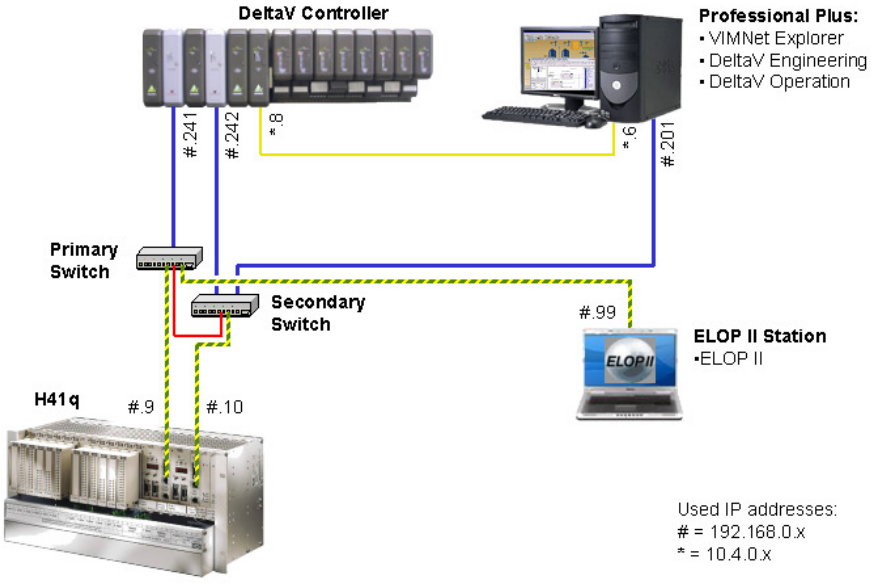

Figure 2.1: Network Overview for H41q/H51q ↔ DeltaV Modbus TCP Communication

The used hardware and software components are:

Hardware:	**Software:**
H41q/H51q PES	ELOP II Engineering Software
F 8627X Ethernet communication module	ELOP II license dongle
DeltaV MD Controller	DeltaV Automation Software
DeltaV Professional Plus Workstation	DeltaV System licenses
Ethernet Cat. 5 network cables	DeltaV serial port licenses
Industrial Ethernet Switches	

For detailed information about the explicitly tested hardware, software, firmware and Operating Systems refer to the Communication Test Report (see [6]).

2.2. Configuration of H41q/H51q Hard- and Software

The necessary configuration of an H41q/H51q PES for Modbus TCP communication consists of the configuration of the ethernet communication module F 8627X on the hardware side and of setting the IP address and defining communication variables in the application software.

2.2.1 Hardware Configuration

The hardware of HIMA safety systems can consist of one or several H41q/H51q safety PESs. The necessary hardware configuration for communication is the same for all PESs and simply consists of setting the **B**us **S**tation **N**umber (**BSN**) of all CPUs and configuring the F 8627X ethernet communication module. All settings are made via DIP switches when the module is removed from the rack.

Setting Bus Station Number (BSN):

The Bus Station Number is the address under which the safety PESs are addressed when serial communication via RS-485 is used. This address should be the same like the numbers ending the resource name in ELOP II from which the IP-Address is generated (see chapter 2.2.2 for details). There is one DIP-switch on each H41q/H51q CPU (e.g. F 8650X and F 8652X for SIL3 operation) setting the BSN and the serial transmission rate for the two integrated serial RS-485 interfaces. The BSN is set with switches 1-5 on DIP-switch S1 in a range from 1 to 99 using standard binary coding (for details about DIP switch settings on the CPU see [1] or the separately available CPU datasheets).

Configuring the F 8627X ethernet communication module:

The F 8627X has two DIP switches which are used for configuring the ethernet communication module.

S1	ON	OFF	Description
1	10 ms	0 ms	The "Timeout" is the timeframe within which the receiver must acknowledge receiving packets from the transmitter. It is set via the switches S1/1-5. Standard value: 10 ms (switch 1/1-5 "OFF"). Switches S1/1-5 can be combined by the user. 10 ms must be added for each combination of switches. HIPRO-S-DIRECT must be activated (switch 1/7 "ON").
2	20 ms	0 ms	
3	40 ms	0 ms	
4	400 ms	0 ms	
5	1000 ms	0 ms	
6	ID_IP ON	ID_IP OFF	For OS versions < 4.x no function (See also Chapter 5.2.3) ID_IP ON The bus station number (ID) which is set on the F 865x central module via switches (S1 1-7) is used as Res-ID if no Res-ID could be determined from the loaded user program. ID_IP OFF The bus station number (ID) which is set on the F 865x central module via switches (S1 1-7) is never used for the Res-ID.
7	DIRECT Mode enabled	DIRECT Mode disabled	HIPRO-S-DIRECT Mode must be activated if more than one bus configuration is required. HIPRO-S-DIRECT is supported beginning with the F 8627X OS version 3.x.
8	Passive Mode disabled	Passive Mode enabled	The Passive Mode controls the communication to the HIMA OPC server. Passive Mode enabled: The Token Passing between the F 8627X to the HIMA OPC servers is disabled. The HIMA OPC servers cyclically exchange data with the F 8627X, independent of the token owner. Passive Mode disabled: The Token Passing between the F 8627X and the HIMA OPC servers is enabled. The HIMA OPC servers only exchange data with the F 8627X if they have the Token.

S2	ON	OFF	Description
1	Ethernet Channel 1	Ethernet Channel 2	F 8627X allocation to the Ethernet channel 1 or Ethernet channel 2.
2	Mono	Redundant	Wiring of the modules (Not used in HIPRO-S-DIRECT Mode)
3[1)]	Auto-negotiation On	Auto-negotiation Off	Automatic adaptation of transmission rate (10/100 MBit/s) and duplex mode if is Switch S2/3 is ON.
4	100 MBit/s	10 MBit/s	The switch position of switch is only relevant if switch S2/3 (auto-negotiation) is OFF.
5[1) 2)]	Full duplex	Half duplex	The switch position of switch is only relevant if switch S2/3 (auto-negotiation) is OFF. Simultaneous sending and receiving if switch S2/5 is ON. Note on full-duplex operation: In network topologies where hubs are used, hubs must be replaced by full-duplex switches (hubs are not full-duplex capable).
6	2 OPC server	0	Beginning with the F 8627X OS version 3.x, the number of HIMA OPC servers (0 to 14) must be set via switches. Switches S2/6-8 can be combined by the user. If HIPRO-S-DIRECT is not active the number of HIMA OPC servers is four. For determining the Node Ids and IP addresses for the configuration of HIMA OPC server, see Chapter 6.8.1.4 and Chapter 6.9.1.5.
7	4 OPC server	0	
8	8 OPC server	0	

Figure 2.2: Recommended settings for F 8627X DIP switch S1 and S2

Figure 2.2 shows marked in red the DIP switch settings which are recommended for most ethernet communications.

- The switches S1/1-7 are used for internal H41q/H51q communication and should be sufficient for most applications when set as shown above.
- Switch S1/8 should be set to “Passive Mode enabled” to ensure also fast communication to the HIMA OPC DA Server by disabling time consuming Token Passing.
- Switch S2/1 should be set according to the position where the F 8627X will be placed. “Ethernet Channel 1” for placement next to CPU 1 or “Ethernet Channel 2” for placement next to CPU 2.
- Normally the communication modules are inserted redundant. Then Switch S2/2 should also reflect this.
- Switch S2/3 is set to “Off” as some networking devices do not support Auto-negotiation of transmission rate and duplex mode.
- Switch S2/4 and S2/5 should be set according to the networking hardware you use. Normally “100 Mbit/s” and “Full duplex” is suitable with nowadays networking hardware.
- Switches S2/6-7 should be set to determine the number of HIMA OPC Servers which are connected to this resource. (Be careful: In HIMA documentation the term “HIMA OPC Server” refers to the HIMA OPC DA Server as is the case here.)

2.2.2 Application Software Configuration

When programming a HIMA H41q/H51q safety PES within ELOP II there are two steps necessary to prepare the PES for data communication to any other programmable system via Modbus TCP or any other ethernet based communication method. These are: definition of an IP address and definition of variables to be transmitted through an ethernet communication module (definition of BUSCOM data).