LUFP9
Telemecanique

User's manual

Gateway
DeviceNet / Modbus RTU

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1.1. Introduction to the user guide

Chapter 1 Introduction (page 6) describes the gateway, the user guide that comes with it and the terms used in it.

Chapter 2 Hardware Implementation of the LUFP9 Gateway (page 13) gives an introduction to the gateway and describes all the items used when setting it up, both inside (thumb wheels) and outside (cables and connectors) the gateway.

Chapter 3 Signalling (page 22) describes the six LEDs on the front of the gateway.

Chapter 4 Software Implementation of the Gateway (page 23) describes the successive steps for setting the gateway up with its default configuration, with a PLC using DeviceNet. LUFP9 gateways are shipped pre-configured to allow you to interface a DeviceNet master with 8 predefined Modbus slaves (TeSys U motor starters).

Chapter 5 Gateway Initialization and Diagnostics (page 33) describes two registers in the gateway's memory reserved for initializing and carrying out diagnostics on the gateway. They are only exchanged between the DeviceNet master and the gateway.

Chapter 6 **Configuring the Gateway** (page 40) describes how to use the "ABC-LUFP Configurator" software application, which allows you to modify or create a new configuration for the gateway and shows the various features of this software (add or remove a Modbus slave, add or change a Modbus command, etc.).

This chapter also shows the changes to be made to software implementation operations in RsNetWorx.

Appendix A: Technical Characteristics (**chapter 7**, page 80) describes the technical aspects of both the gateway and the DeviceNet and Modbus RTU networks it is interfaced with.

Appendix B: Default Configuration (**chapter 8**, page 83) describes the main features of the default configuration of the LUFP9 gateway. However, it does not go into AbcConf in detail.

Appendix C: Practical Example (RSLogix 500) (**chapter 9**, page 86) gives a simple example using the LUFP9 gateway's default configuration. This example exploits the command and monitoring registers for 8 TeSys U motor starters and uses the aperiodic read and write services used to acces the value of any motor starter parameter.

Appendix D: DeviceNet Objects (**chapter 10**, page 94) describes both the generic DeviceNet objects and the DeviceNet objects specific to the LUFP9 gateway. The values of the attributes of these objects are also given.

Appendix E: Modbus Commands (**chapter 11**, page 113) describes the content of the Modbus command frames supported by the LUFP9 gateway.

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1. Introduction

1.2. Introduction to the LUFP9 Gateway

The LUFP9 gateway allows a master located on a DeviceNet network to enter into a dialogue with the slaves on a Modbus RTU network. This is a generic protocol converter operating in a way which is transparent to the user.

This gateway allows you to interface many products marketed by *Schneider Electric* with a DeviceNet network. These include TeSys U motor starters, Altivar drives and Altistart soft start- soft stop units.

1.3. Terminology

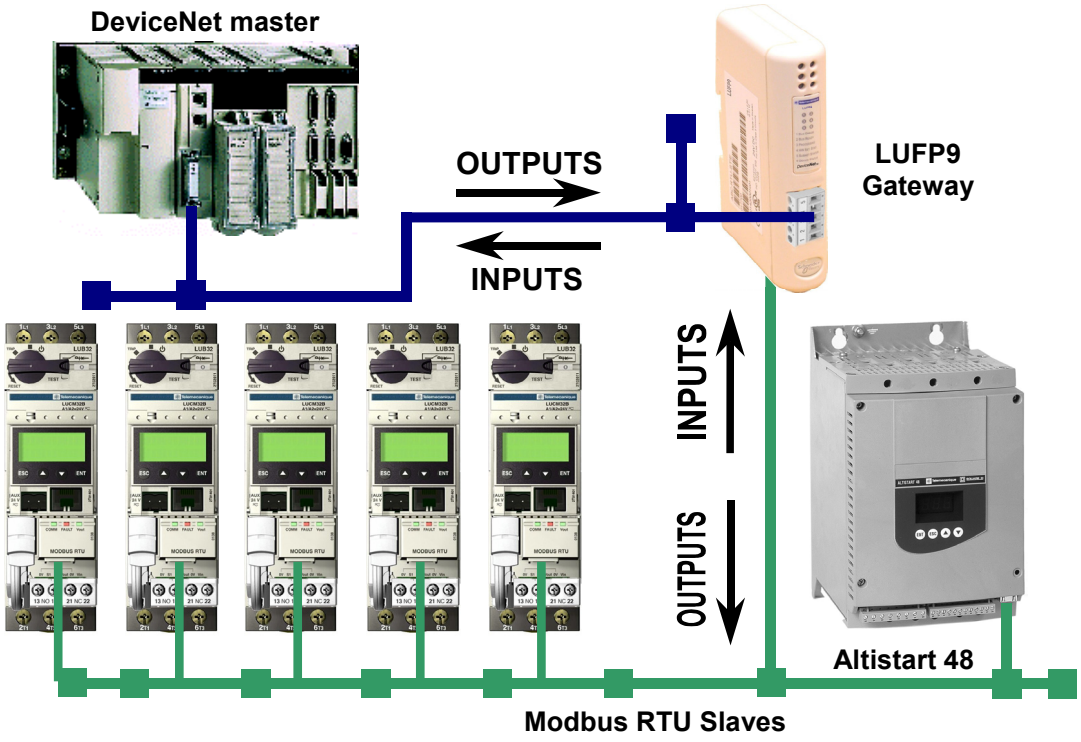
Throughout this document, the term “user” refers to any person or persons who may need to handle or use the gateway.

The term “RTU”, which refers to the Modbus RTU communication protocol, will be omitted most of the time. As a result, the simple term “Modbus” will be used to refer to the Modbus RTU communication protocol.

As is still the case with all communication systems, the terms “input” and “output” are somewhat ambiguous. To avoid any confusion, we use a single convention throughout this document. So the notions of “input” and “output” are always as seen from the PLC, or the DeviceNet master / scanner.

Hence, an “output” is a command signal sent to a Modbus slave, whereas an “input” is a monitoring signal generated by this same Modbus slave.

The diagram below shows the flows of “inputs” and “outputs” exchanged between a DeviceNet master and Modbus RTU slaves via the LUFP9 gateway:



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1. Introduction

1.4. Notational Conventions

16#•••• .....Value expressed in hexadecimal, which is equivalent to the H••••, ••••h and 0x•••• notations, sometimes used in other documents. **N.B.** The AbcConf software uses the 0x•••• notation.

E.g. 16#0100 = 0x0100 = 256.

02#•••• •••• .....Value expressed in binary. The number of '•' digits depends on the size of the item of data represented. Each nibble (group of 4 bits) is separated from the other nibbles by a space.

Examples: byte 2#0010 0111 = 39, word 2#0110 1001 1101 0001 = 16#69D1 = 27089.

AbcConf .....Abbreviation that refers to the tool used to configure and implement the LUFP9 gateway: "ABC-LUFP Configurator".

ATS .....Abbreviation of "Altistart" (soft start- soft stop unit).

ATV .....Abbreviation of "Altivar" (drive).

CRC .....Cyclical Redundancy Check.

LED .....Light-Emitting Diode.

EDS.....Electronic Data Sheet. Refers to the file format ("`.eds`" extension) which allow a tool used for configuring and preparing DeviceNet masters to configure their exchanges using this same protocol.

Fieldbus .....A term referring to the upstream DeviceNet network in AbcConf.

Handshake.....An old term referring to the two registers used for initializing and carrying out diagnostics of the LUFP9 gateway. This term has been replaced by the expression "Control/Status Byte".

LRC.....Longitudinal Redundancy Check.

Node .....A term referring to the connection point of a Modbus slave under AbcConf.

ODVA.....*Open* DeviceNet *Vendor Association, Inc.*

LSB: .....Least significant byte in a 16-bit word.

MSB: .....Most significant byte in a 16-bit word.

Sub-Network ....A term referring to the downstream Modbus network under AbcConf.

XML.....EXtensive Markup Language. The language used by AbcConf to import/export the configuration of a Modbus slave.

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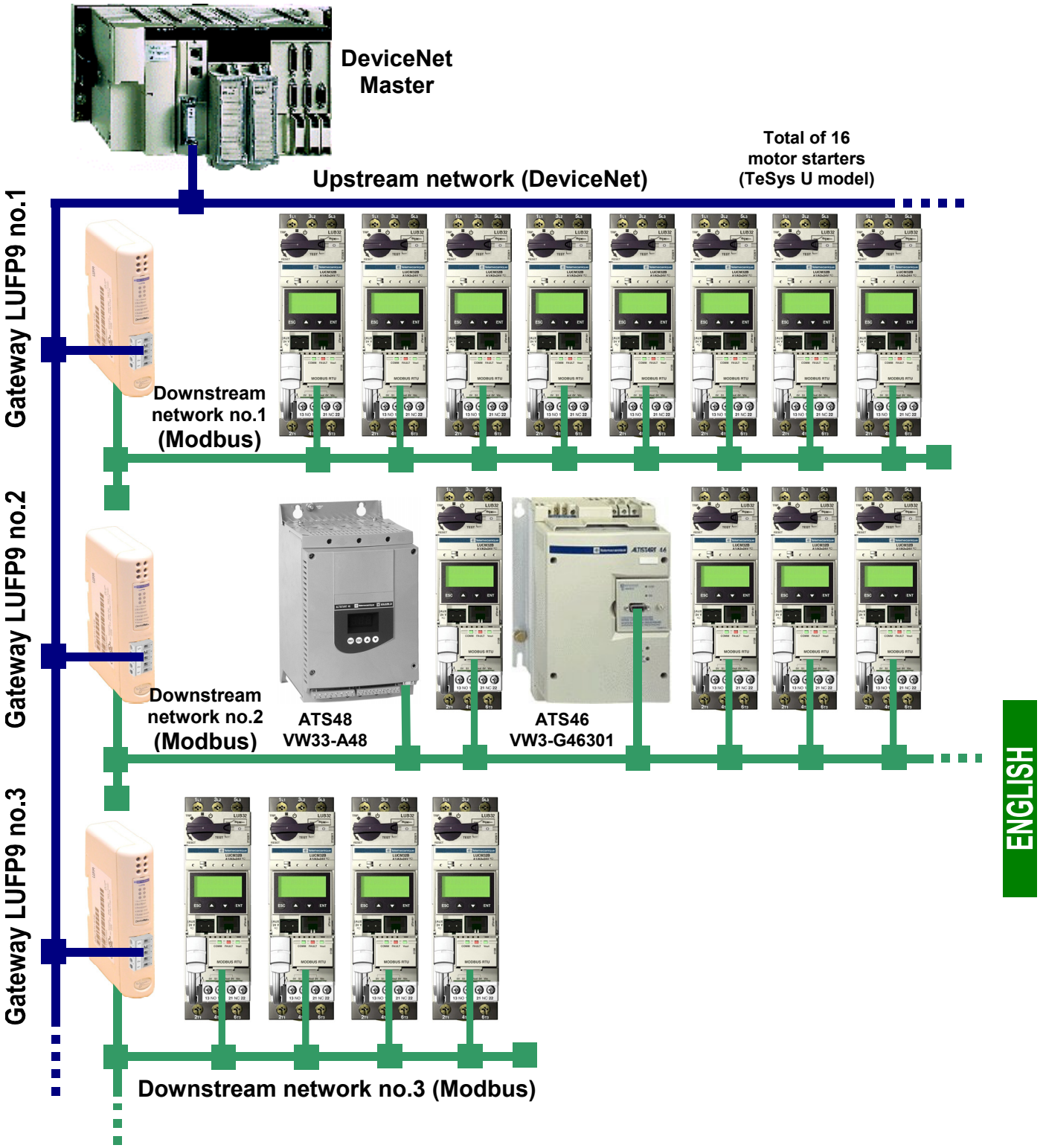
1.5. Additional Documentation

In the case of Modbus slaves, the features, services and adjustment of the Modbus communications are not dealt with in this document.

1. Introduction

1.6. Introduction to the Communication “System” Architecture



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1. Introduction

Each LUFP9 DeviceNet / Modbus RTU gateway allows a PLC on the DeviceNet network to command, control and configure up to 8 Modbus slaves. If there are more than 8 Modbus slaves, you will need to use an appropriate number of LUFP9 gateways. In the same way, if the exchanges with the Modbus slaves require more than 25 Modbus commands (that is to say more than 50 queries and responses), you will have to distribute the Modbus slaves over several gateways.

The LUFP9 gateway behaves both as a DeviceNet slave on the upstream network and as a Modbus RTU master on the downstream network.

See chapter 7.2 Communication Characteristics, page 80, if you would like to read about the technical communication characteristics of the LUFP9 gateway.

The gateway can carry out its data exchanges (inputs and outputs of all types) with the Modbus slaves cyclically, aperiodically or in an event-driven way. All of these Modbus exchanges make up the gateway's "Modbus scanner" and we use the "ABC-LUFP Configurator" software application to configure this scanner's exchanges. Each item of data exchanged in this way is made available to the DeviceNet master, which can gain access to it in a number of ways (cyclical, aperiodic or event-driven exchanges).

N.B. If, for example, a communication is periodic on the Modbus network, the corresponding data does not have to be exchanged periodically on the DeviceNet network and *vice versa*.

The diagram on the page to the left illustrates the distribution of several slaves over three downstream Modbus RTU networks, each of these networks being interfaced with the DeviceNet master PLC using an LUFP9 gateway.

1.7. Principle Used to Configure and Operate the LUFP9 Gateway

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The gateway is part of a family of products (referred to as LUFP●) designed to meet generic needs for connection between two networks using different communication protocols.

The software elements common to all these gateways (a configuration tool known as "ABC-LUFP Configurator" and the on-board Modbus software) cohabit with the specific features of the network upstream of each of them (DeviceNet in the case of the LUFP9 gateway) generically. This is one of the reasons why the interfacing between the upstream network and the Modbus network is carried out entirely via the gateway's physical memory.

⇨ The exchanges between the gateway (which operates as a Modbus master) and the Modbus slaves are wholly configured using the "ABC-LUFP Configurator". This configuration tool goes into great detail (setting timers for exchanges, communication modes, frame content, etc.), which makes it all the more delicate to use. So a whole chapter in this guide (chapter 6 Configuring the Gateway, page 40) has been devoted to this tool.

By configuring the queries and responses for Modbus commands via this tool the user can create links between a part of the content of the corresponding Modbus frames and the content of the gateway's physical memory (input memory for the content of the Modbus responses and output memory for the content of the queries).

⇨ The exchanges between the DeviceNet master PLC and the LUFP9 gateway should be configured in such a way that the DeviceNet master can read the input data and write the output data from the gateway, but *only* the data used for the Modbus exchanges (see previous point).

1. Introduction

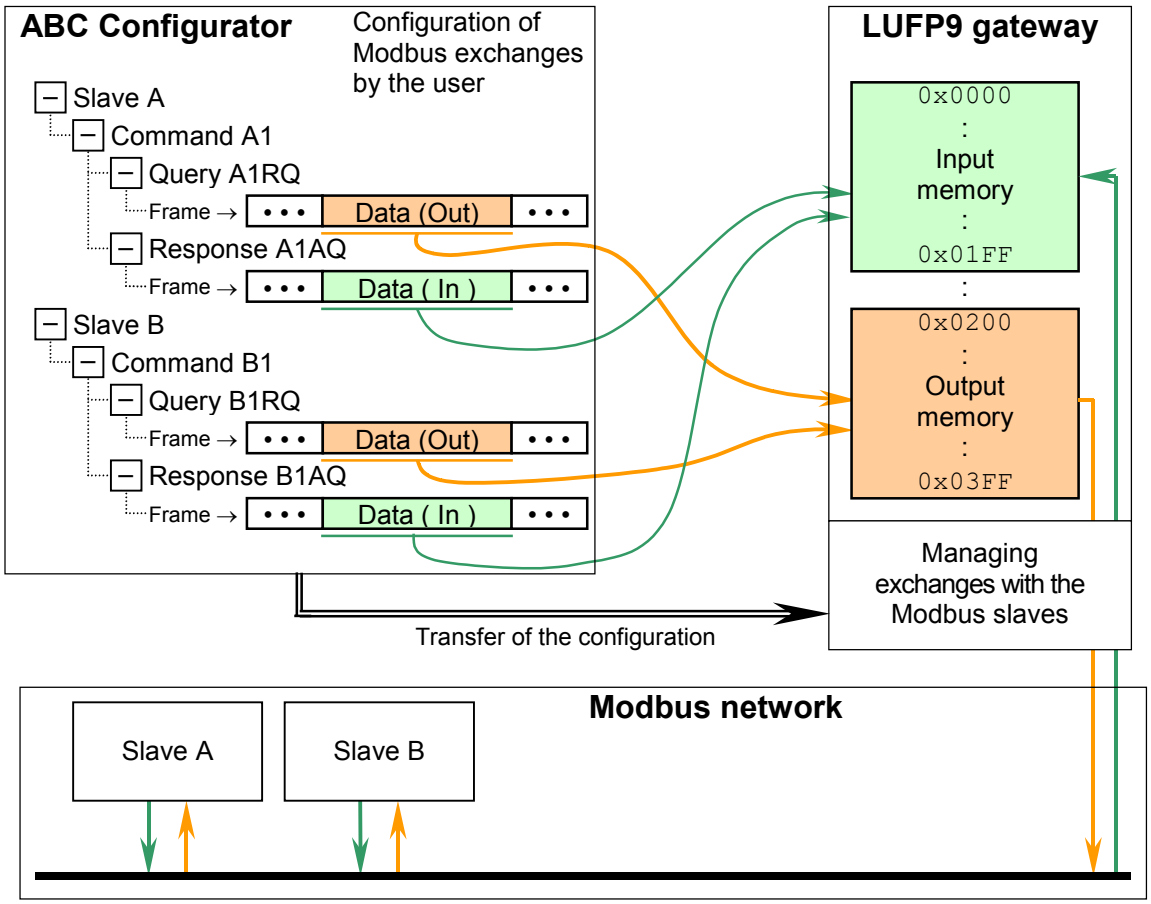
⇨ Each LUFP9 gateway is shipped pre-configured so as to make it easier to operate and the factory settings can be used as a basis for a configuration which will best meet the user's expectations. The typical operations applicable to this default configuration are described in chapter 6 Configuring the Gateway, page 40.

The DeviceNet network is totally separate from the Modbus network. The frames on a network are not directly "translated" by the gateway to generate frames on the other network. Instead, the exchanges between the content of the gateway's memory and the Modbus slaves make up a system which is independent of the one which is entrusted with managing the exchanges between this same memory and the DeviceNet master.

So the user must ensure that the size of the DeviceNet data corresponds to the size of the memory used for the Modbus exchanges, because the gateway configures its DeviceNet exchanges on the basis of the memory used by the Modbus frames.

The two synopses which follow illustrate the independent management of each of the two networks:

— Managing Gateway ↔ Modbus slaves exchanges —



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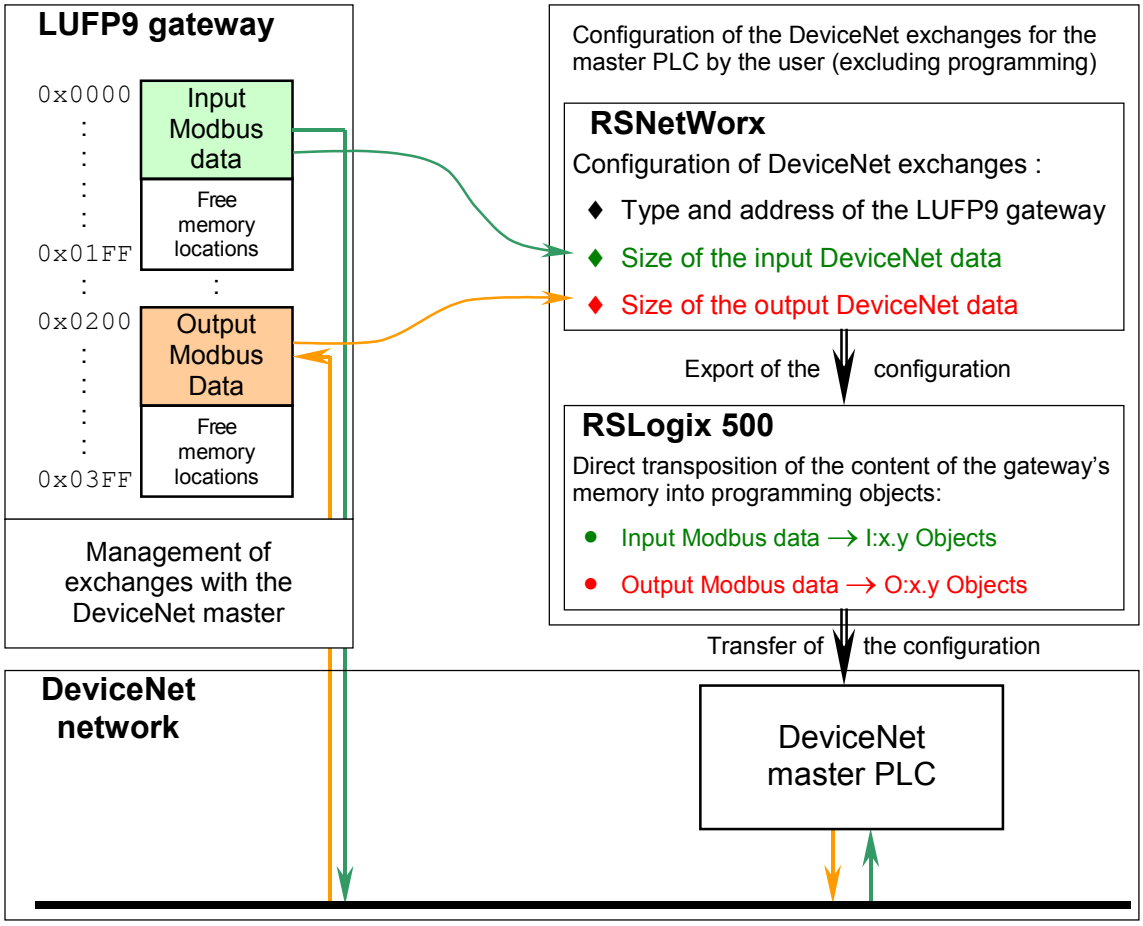
— Managing Gateway ↔ DeviceNet master exchanges —



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2. Hardware Implementation of the LUFP9 Gateway

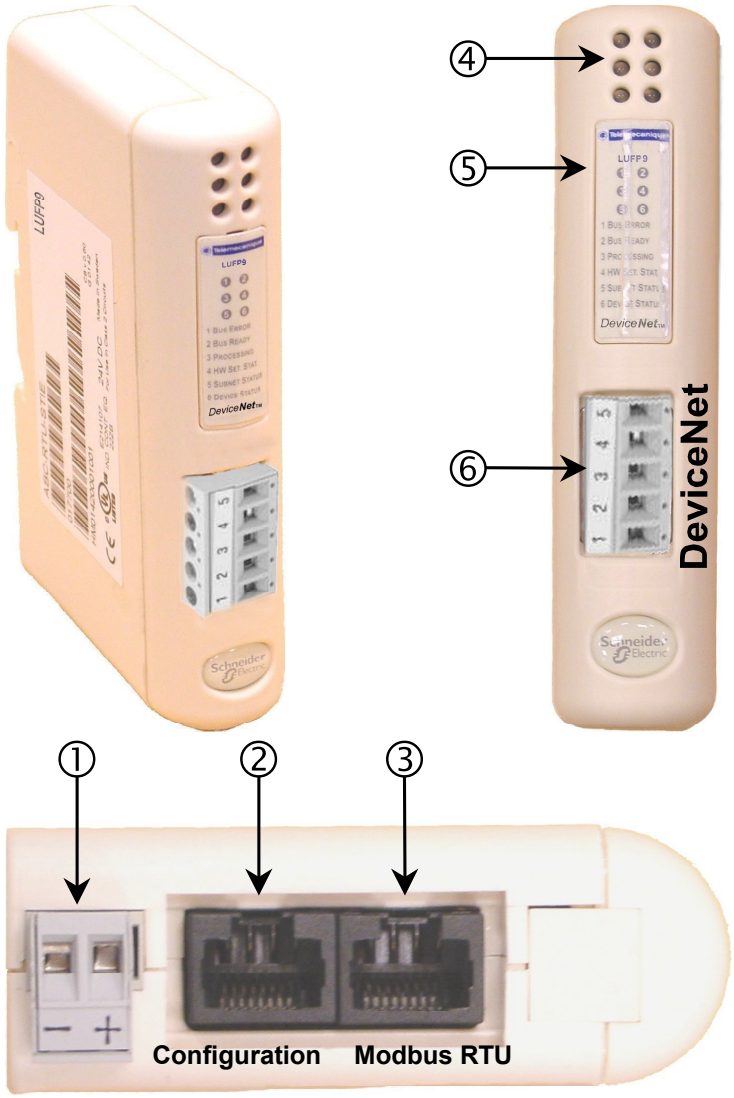
2.1. On Receipt

After opening the packaging, check that the following element is there:

- One LUFP9 DeviceNet / Modbus RTU gateway.

2.2. Introduction to the LUFP9 Gateway

The cables and other accessories for connecting to DeviceNet and Modbus networks need to be ordered separately.



Legend:

① Detachable power connector for the gateway (⎓ 24V ±10%).

② Female RJ45 connector to a PC running AbcConf configuration software.

③ Female RJ45 connector for the downstream Modbus RTU network.

④ Six diagnostic LEDs.

⑤ Removable cover for the selector switches used to configure the gateway, shown and described in chapter 2.7 Configuring DeviceNet Communication Features, page 20. The label describing the LEDs is stuck onto this cover.

⑥ Detachable female DeviceNet connector.

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2. Hardware Implementation of the LUFP9 Gateway

2.3. Mounting the Gateway on a DIN Rail

Mounting the gateway

Start by fitting the rear base of the gateway to the upper part of the rail, pushing downwards (1) to compress the gateway's spring. Then push the gateway against the DIN rail (2) until the base of the gateway box fits onto the rail.

Dismounting the gateway

Start by pushing the gateway downwards (1) to compress the gateway's spring. Then pull the bottom of the gateway box forwards (2) until the box comes away from the rail.

N.B. The spring is also used to earth the gateway (Protective Earth).

2.4. Powering the gateway

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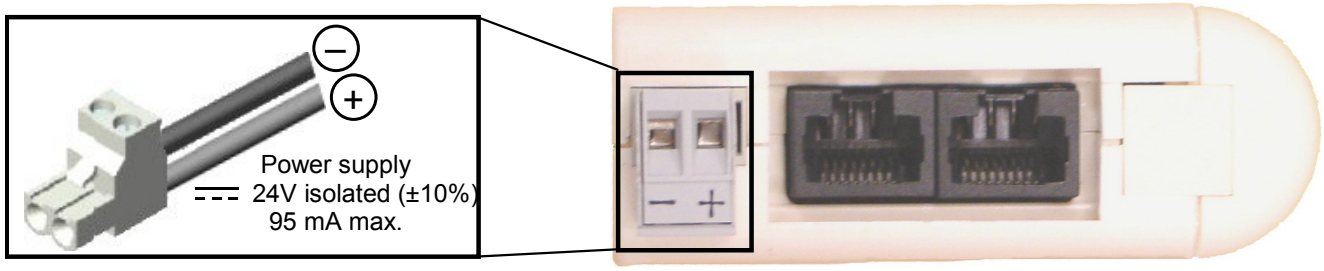
DeviceNet / Modbus RTU gateway – View from underneath



We do not recommend powering the gateway using the 24V power voltage ⎓ on the DeviceNet network. It is better to use a separate power supply, because the gateway needs to be powered using a stabilised voltage, which is not necessarily the case with the power voltage on the DeviceNet network.

N.B. The negative 24V power supply terminal ⎓ should be connected to the installation's earth.

2. Hardware Implementation of the LUFP9 Gateway

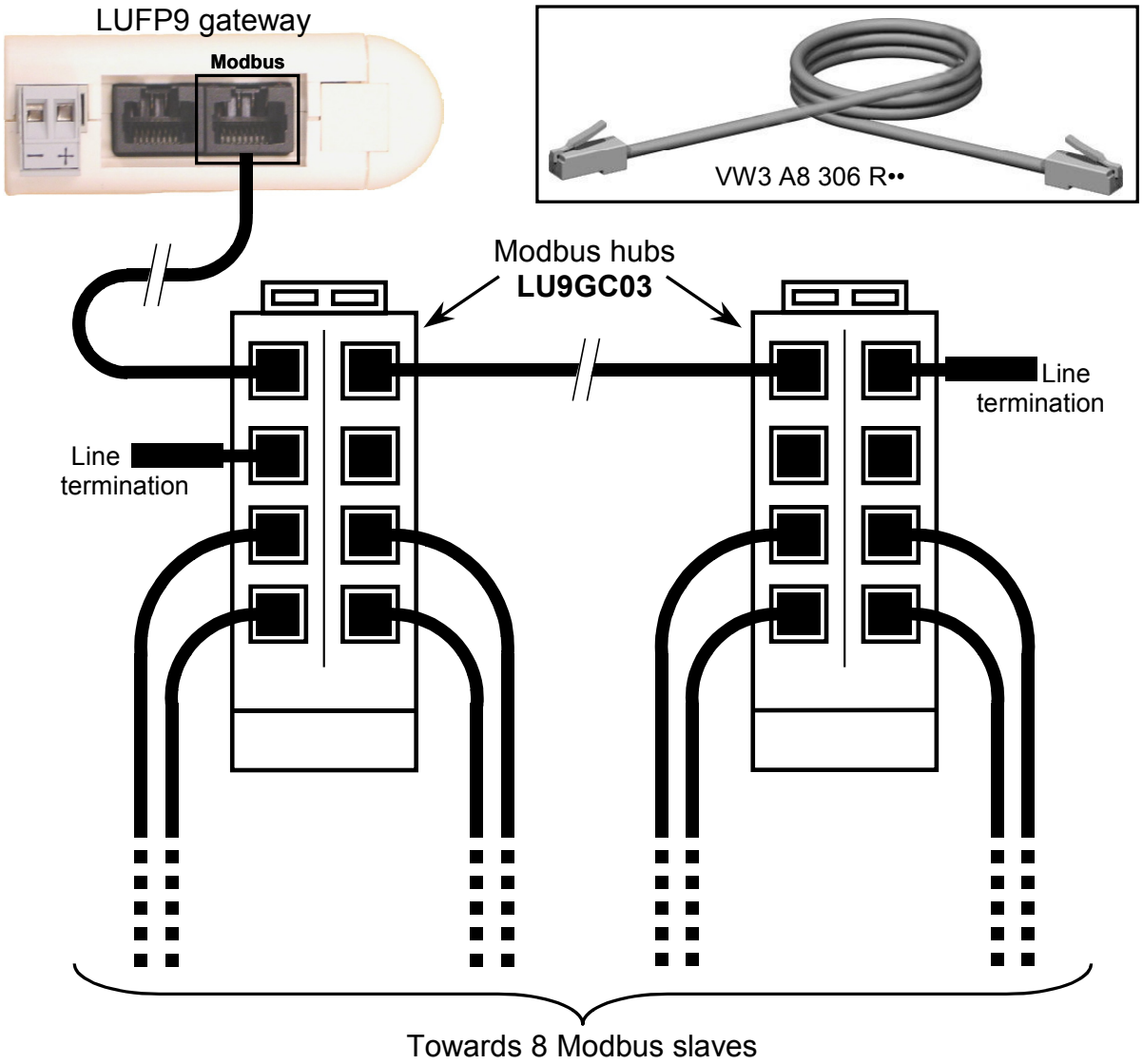
2.5. Connecting the Gateway to the Modbus Network

Three typical examples of Modbus connection for the gateway and its slaves are shown below. There are many other possible Modbus connections, but they are not covered in this document.

2.5.1. Examples of Modbus connection topologies

- **"Star" topology:** This topology uses LU9GC03 Modbus hubs, which have 8 female RJ45 connectors. These hubs should be placed close to the Modbus slaves to which they are connected using VW3 A8 306 R•• cables. On the other hand, the nature of the cable connecting the LUFP9 gateway to one of these hubs will depend on the network architecture, so long as there is a male RJ45 connector at each end. If necessary, one or two line terminations may be directly connected to the hubs.

  The connections are shown below:



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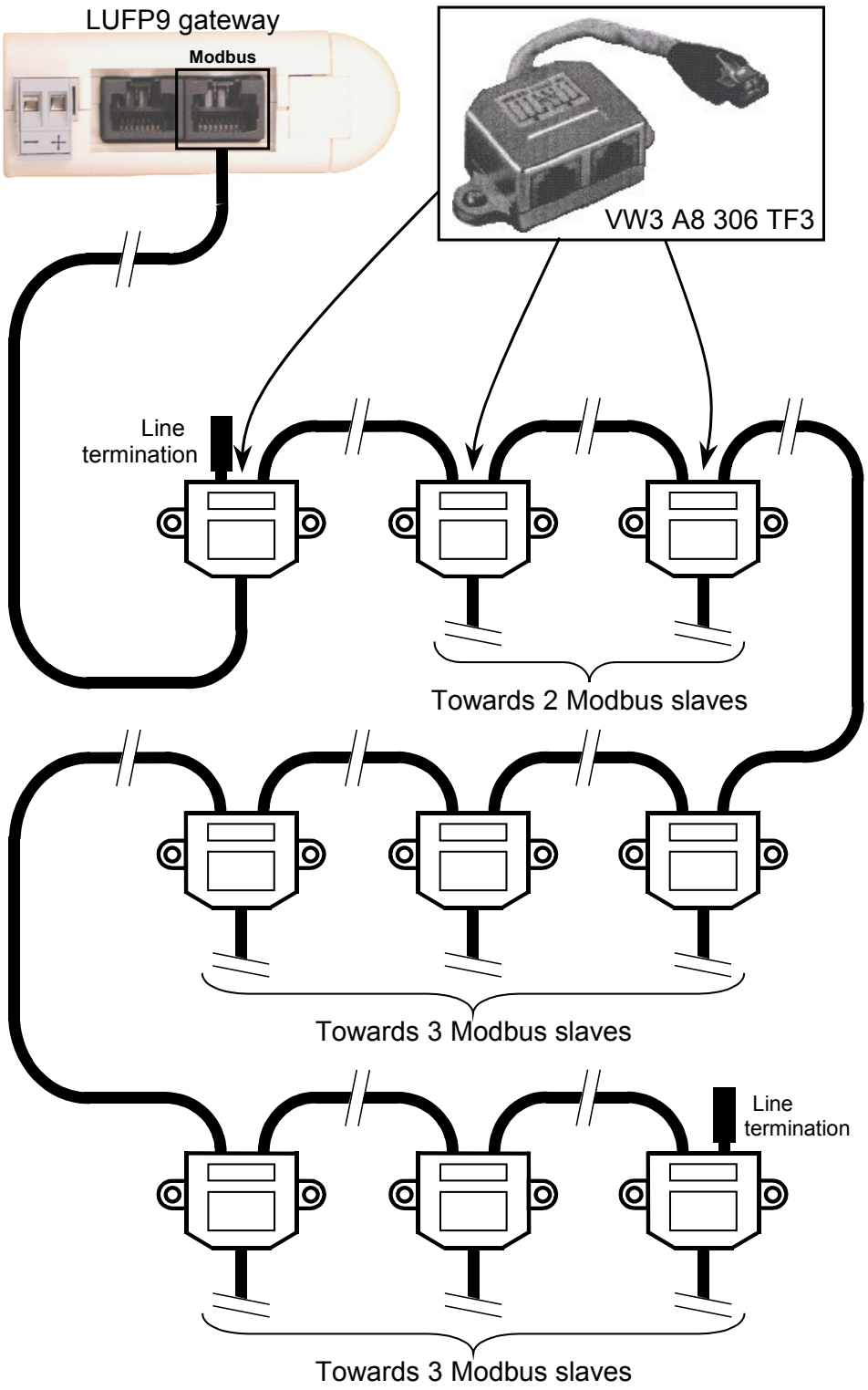
2. Hardware Implementation of the LUFP9 Gateway

- **"Bus" topology with VW3 A8 306 TF3 drop boxes:** This topology uses VW3 A8 306 TF3 drop boxes to connect each of the Modbus slaves to the main section of the Modbus network. Each box should be placed in the immediate vicinity of the Modbus slave it is associated with. The cable for the main section of the Modbus network must have male RJ45 connectors (like the VW3 A8 306 R•• cable used for the "star" topology). The lead between the drop box and the slave or the Modbus gateway is an integral part of this box. The connections are shown below:



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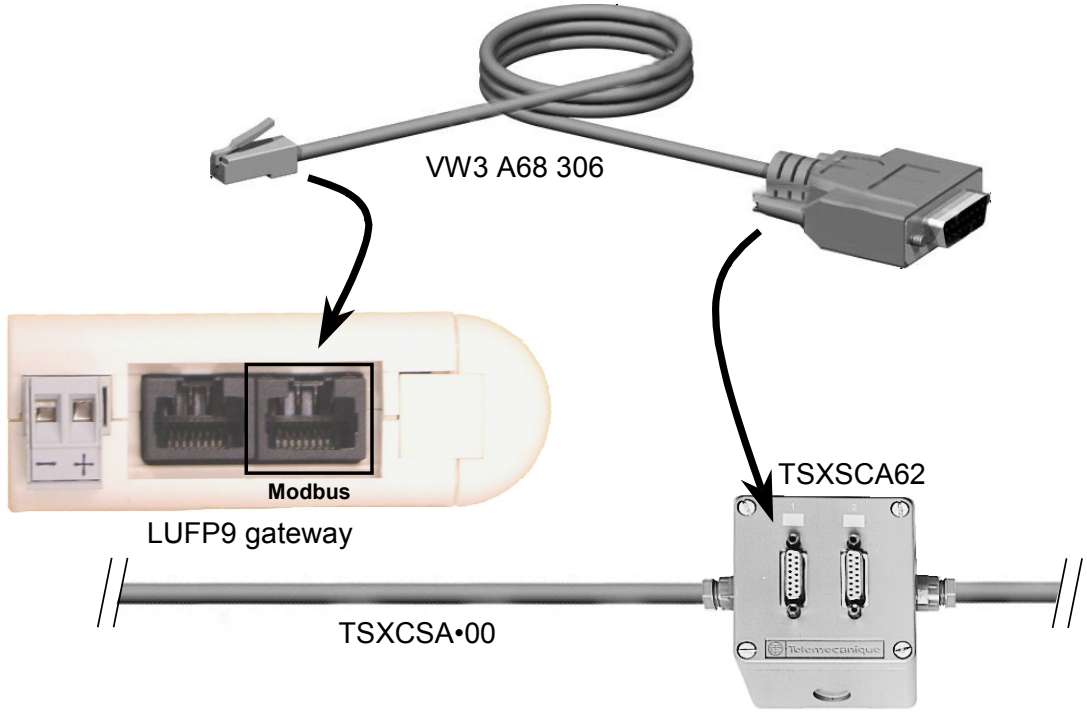
2. Hardware Implementation of the LUFP9 Gateway

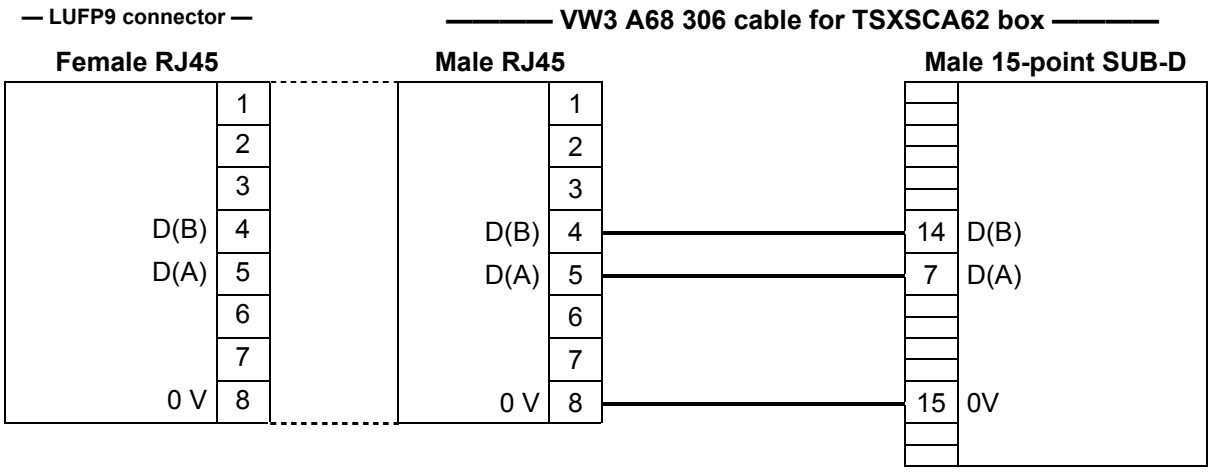
- **"Bus" topology with tap boxes:** This topology is similar to the previous one, except that it uses TSXSCA62 subscriber connectors and/or TSXCA50 subscriber connectors. We recommend using a VW3 A68 306 connection cable and the TSXCSA•00 Modbus cables. Connect the RJ45 connector on the VW3 A68 306 cable to the Modbus connector on the LUFP9 gateway.

  The connections are shown below:



2.5.2. Pin outs

In addition to the pin out for the connector on the gateway, the one on the VW3 A68 306 cable is also shown below, as it is the only Modbus cable which does not exclusively use RJ45 connections.



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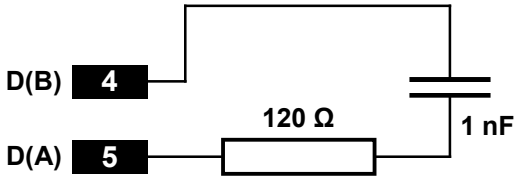
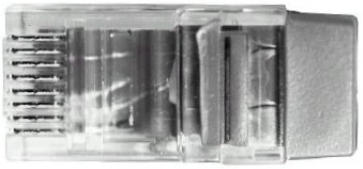
2. Hardware Implementation of the LUFP9 Gateway

2.5.3. Wiring recommendations for the Modbus network

- Use a shielded cable with 2 pairs of twisted conductors,
- connect the reference potentials to one another,
- maximum length of line: 1,000 metres
- maximum length of drop line / tap-off: 20 metres
- do not connect more than 9 stations to a bus (slaves and one LUFP9 gateway),
- cable routing: keep the bus away from power cables (at least 30 cm), make crossings at right angles if necessary, and connect the cable shielding to the earth on each unit,
- adapt the line at both ends using a line terminator (see diagram and VW3 A8 306 RC termination below).



— Line termination recommended at both ends of the line —



— VW3 A8 306 RC line termination —

To make it easier to connect the units using the topologies described in chapter 2.5.1 Examples of Modbus connection topologies, page 15, various accessories are available in the *Schneider Electric* catalogue:

1) Hubs, drops, taps, and line terminations:

☐ LU9GC03 hub..... (“star” topology)	This passive box has 8 female RJ45 connectors. Each of these connectors can be connected to a Modbus slave, to a Modbus master, to another Modbus hub, or to a line termination.
☐ VW3 A8 306 TF3 drop box..... (“bus” topology with VW3 A8 306 TF3 drop boxes)	This passive box includes a short lead with a male RJ45 connector allowing it to be connected directly to a Modbus slave, without having to use a different cable. It is fitted with 2 female RJ45 connectors for the connection of two Modbus cables of the VW3 A8 306 R•• type.
☐ 2-way TSXSCA62 subscriber connector. (“bus” topology with branch boxes)	This passive box has a printed circuit fitted with screw terminals and allows the connection of 2 subscribers to the bus (2 female 15 point SUB-D connectors). It includes the line termination when the connector is located at the end. It is fitted with 2 screw terminals for the connection of two double twisted pair Modbus cables.
☐ TSXCA50 tap box..... (“bus” topology with tap boxes)	This passive box allows a Modbus unit to be connected to a screw terminal. It includes the line termination when the connector is located at the end. It is fitted with 2 screw terminals for the connection of two double twisted pair Modbus cables.
☐ VW3 A8 306 RC double termination ..... (all topologies)	Each of these two red passive boxes is a male RJ45 connector 3 cm long containing an RC line termination (see diagram and illustration above). Only the abbreviation “RC” is shown on these boxes.

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2. Hardware Implementation of the LUFP9 Gateway

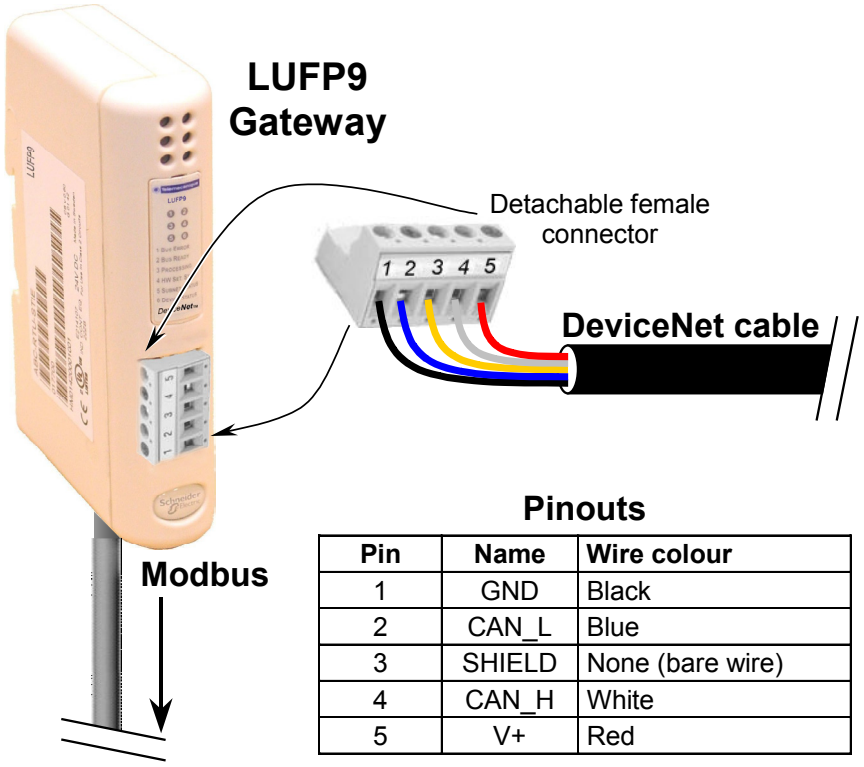
2) Cables:

- VW3 A8 306 R•• Modbus cable ..... Shielded cable with a male RJ45 connector at each end.
  ("star" topology / "bus" topology with tap boxes)
- VW3 A68 306 Modbus cable..... Shielded cable with a male RJ45 connector and a male 15-point SUB-D connector. It is used to connect a Modbus subscriber (slave or master) to a TSXSCA62 or TSXCA50 box.
  ("bus" topology with tap boxes)
- Shielded double twisted pair Modbus cable..... Bare cable (without connectors) used to make up the main section of the Modbus network. There are three items available: TSXCSA100 (100 m), TSXCSA200 (200 m), and TSXCSA500 (500 m).
  ("bus" topology with branch boxes)

2.6. Connecting the LUFP9 gateway to the DeviceNet network

If the LUFP9 gateway is physically located either end of the DeviceNet network, you will need to connect a line termination to the terminals on its DeviceNet connector.

The resistance of this line termination should be equal to 121 Ω and it should be connected between pins 2 and 4 on the gateway connector, that is to say between the CAN_L and CAN_H signals.



Pinouts

Pin	Name	Wire colour
1	GND	Black
2	CAN_L	Blue
3	SHIELD	None (bare wire)
4	CAN_H	White
5	V+	Red

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2. Hardware Implementation of the LUFP9 Gateway

2.7. Configuring DeviceNet Communication Features

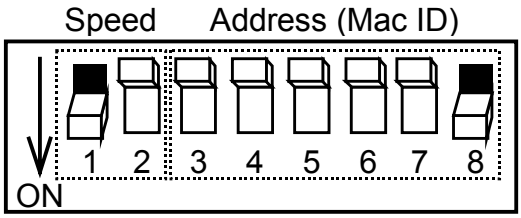
This configuration should be carried out when the gateway is powered off.

The block of selector switches allowing you to configure the DeviceNet communication functions is hidden behind the gateway cover ⑤ (see illustration in chapter 2.2 Introduction to the LUFP9 Gateway, page 13). To remove this cover, all you have to do is slide the end of a small screwdriver between the top of the cover and the gateway box, then carefully remove it.

The power supply of the gateway must be turned off before opening the cover.

Once the cover has been removed, make sure that you touch neither the electrical circuits nor the electronic components.

The block of selector switches is shown in the diagram below, each switch being shown in its factory set position:



A selector switch is in the 0 state when it is in the OFF position and in the 1 state when it is in the ON position.

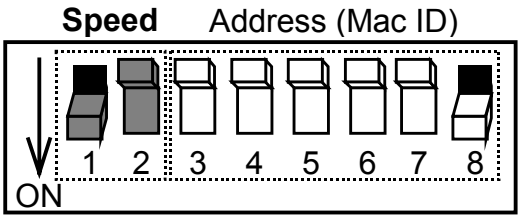
Any change to the gateway's communication functions will not be effective until the next time that the gateway is powered on.

2.7.1. Encoding DeviceNet Speed

The gateway's communication speed on the DeviceNet network must be identical to that of the DeviceNet master.

The factory setting is 500 kbits/s.

This speed value depends on the position of selector switches 1 and 2.



Selector switches 1 2 3 4 5 6 7 8	DeviceNet speed
0 0 x x x x x x	125 kbits/s
0 1 x x x x x x	250 kbits/s
1 0 x x x x x x	500 kbits/s
1 1 x x x x x x	Invalid configuration

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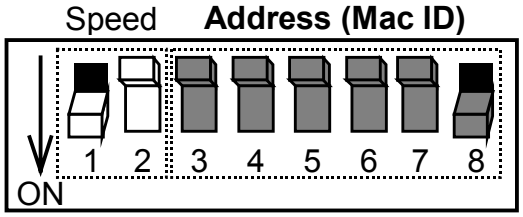
2. Hardware Implementation of the LUFP9 Gateway

2.7.2. Encoding the Gateway Address

The LUFP9 gateway is identified on the DeviceNet bus by its address (or “Mac ID”), which is between 0 and 63.



The gateway’s DeviceNet address depends on the position of selector switches 3 to 8. It corresponds to the binary number given by the ON (1) or OFF (0) position of these 6 selector switches.

Selector switches 1 2 3 4 5 6 7 8	DeviceNet address
x x 0 0 0 0 0 0	0
x x 0 0 0 0 0 1	1
x x 0 0 0 0 1 0	2
x x 0 0 0 0 1 1	3
x x 0 0 0 1 0 0	4
x x 0 0 0 1 0 1	5
x x 0 0 0 1 1 0	6
x x 0 0 0 1 1 1	7
x x 0 0 1 0 0 0	8
x x 0 0 1 0 0 1	9
x x 0 0 1 0 1 0	10
x x 0 0 1 0 1 1	11
x x 0 0 1 1 0 0	12
x x 0 0 1 1 0 1	13
x x 0 0 1 1 1 0	14
x x 0 0 1 1 1 1	15
x x 0 1 0 0 0 0	16
x x 0 1 0 0 0 1	17
x x 0 1 0 0 1 0	18
x x 0 1 0 0 1 1	19
x x 0 1 0 1 0 0	20
x x 0 1 0 1 0 1	21

Selector switches 1 2 3 4 5 6 7 8	DeviceNet address
x x 0 1 0 1 1 0	22
x x 0 1 0 1 1 1	23
x x 0 1 1 0 0 0	24
x x 0 1 1 0 0 1	25
x x 0 1 1 0 1 0	26
x x 0 1 1 0 1 1	27
x x 0 1 1 1 0 0	28
x x 0 1 1 1 0 1	29
x x 0 1 1 1 1 0	30
x x 0 1 1 1 1 1	31
x x 1 0 0 0 0 0	32
x x 1 0 0 0 0 1	33
x x 1 0 0 0 1 0	34
x x 1 0 0 0 1 1	35
x x 1 0 0 1 0 0	36
x x 1 0 0 1 0 1	37
x x 1 0 0 1 1 0	38
x x 1 0 0 1 1 1	39
x x 1 0 1 0 0 0	40
x x 1 0 1 0 0 1	41
x x 1 0 1 0 1 0	42
x x 1 0 1 0 1 1	43

Selector switches 1 2 3 4 5 6 7 8	DeviceNet address
x x 1 0 1 1 0 0	44
x x 1 0 1 1 0 1	45
x x 1 0 1 1 1 0	46
x x 1 0 1 1 1 1	47
x x 1 1 0 0 0 0	48
x x 1 1 0 0 0 1	49
x x 1 1 0 0 1 0	50
x x 1 1 0 0 1 1	51
x x 1 1 0 1 0 0	52
x x 1 1 0 1 0 1	53
x x 1 1 0 1 1 0	54
x x 1 1 0 1 1 1	55
x x 1 1 1 0 0 0	56
x x 1 1 1 0 0 1	57
x x 1 1 1 0 1 0	58
x x 1 1 1 0 1 1	59
x x 1 1 1 1 0 0	60
x x 1 1 1 1 0 1	61
x x 1 1 1 1 1 0	62
x x 1 1 1 1 1 1	63

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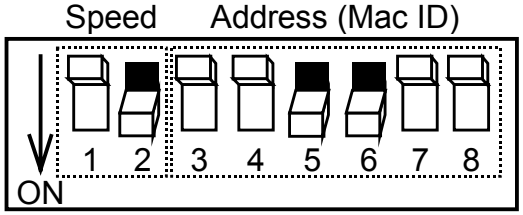
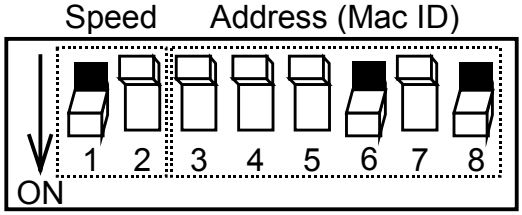
2.7.3. Sample Gateway Configurations

Speed = 250 kbits/s
Address = 12

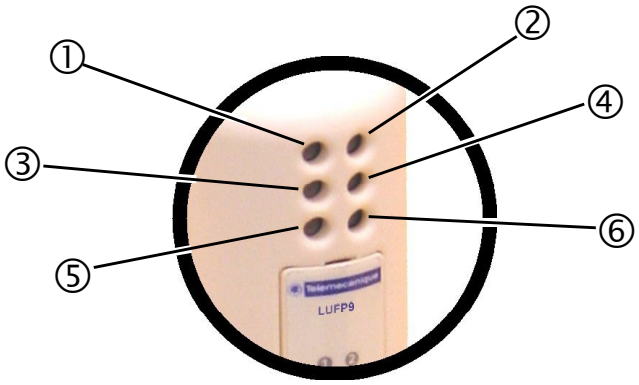


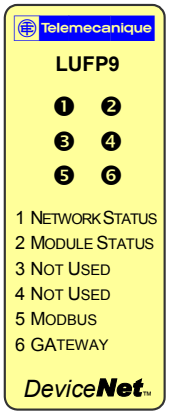
Speed = 500 kbits/s
Address = 5



3. Signalling

The gateway's 6 LEDs and the descriptive label on the removable cover which hides its block of selector switches allow you to diagnose the status of the gateway:





LED	LED → Gateway state
❶ NETWORK STATUS	Off: Gateway not connected to the DeviceNet bus
	Green: Gateway connected to the DeviceNet bus: Connection established
	Red: Fatal error on connection to the DeviceNet bus
	Flashing (green): Gateway connected to the DeviceNet bus: Connection not established
	Flashing (red):Timeout in connection to the DeviceNet bus ↳*The length of this timeout is defined by the DeviceNet master*
❸ NOT USED	**Off: —**
❺ MODBUS	Off: No power
	Flashing (green): No Modbus communications
	Green: Modbus communications OK
	Red: Loss of communication with at least one Modbus slave (1)

LED	LED → Gateway state
❷ MODULE STATUS	Off: No power
	Red: Unrecoverable failure
	Green: Gateway is operational
	Flashing (red): Minor fault
❹ NOT USED	**Off: —**
❻ GATEWAY	Off: No power
	Flashing (red/green): Configuration absent / not valid ↳*Use AbcConf to load a valid configuration*
	Green: Gateway currently being initialized and configured
	Flashing (green): Gateway is in running order: Configuration OK

(1) The LED ❺ MODBUS becomes red whenever you use incorrect values in the outputs corresponding to the queries of the two aperiodic services designed to read/write the value of any parameter of a Modbus slave (see chapter 4.2.8 Description of Services Assigned to Gateway Inputs/Outputs, page 31). This LED will only revert to its former green state if you reuse these very same services, but with correct values. More generally, this LED becomes red, then reverts to a green state, on loss and recovery of the communications with any Modbus slave.

N.B. If the DEVICE STATUS LED ❻ is flashing following a sequence beginning with one or more red flashes, we advise that you note down the order of this sequence and give this information to the *Schneider Electric* support service.

In some cases, all you need to do is power the gateway off then back on again to solve the problem.

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4. Software Implementation of the Gateway

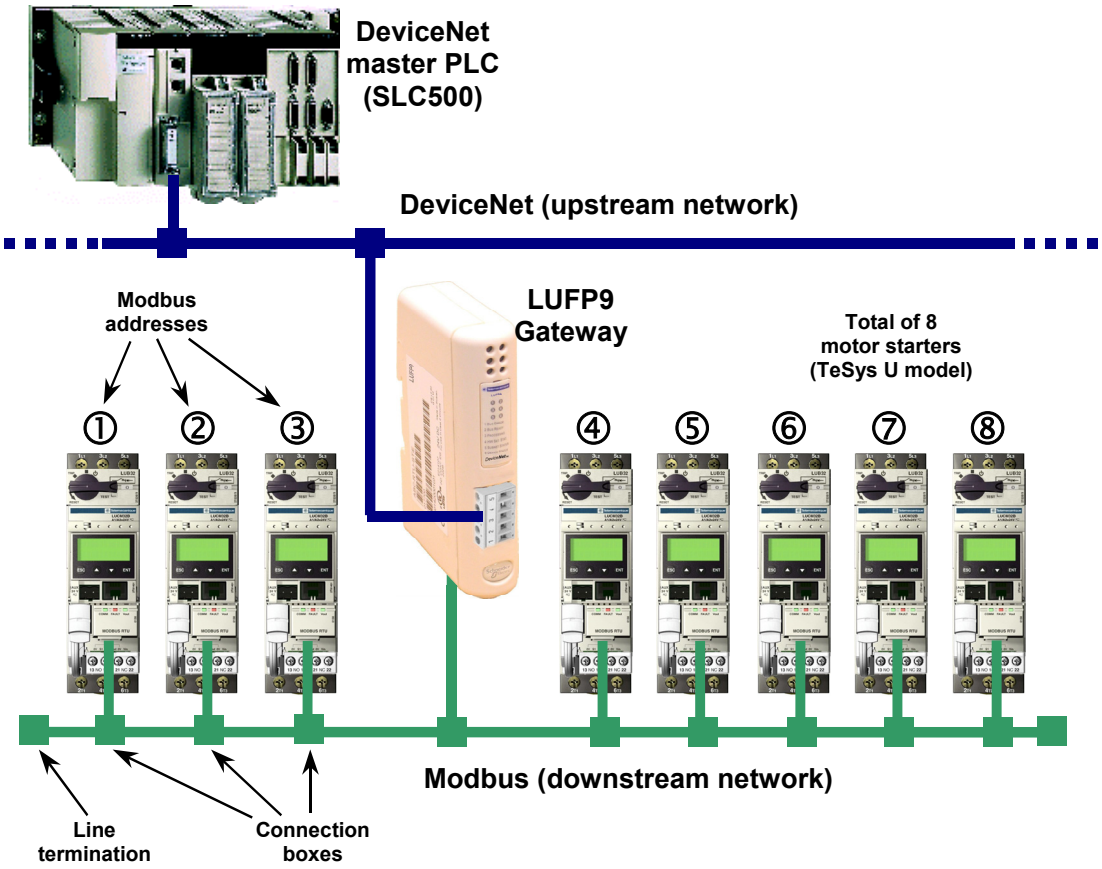
4.1. Introduction

This chapter gives an introduction to a quick implementation of the LUFP9 gateway, using its default configuration. All LUFP9 gateways ship pre-configured.

This pre-configuration means that the user does not have to configure the LUFP9 gateway using AbcConf. This configuration is described in order to allow the gateway to be used with a configuration tool for DeviceNet master PLCs. As an example this implementation will use RsNetWorx, the PLC configuration tool marketed by *Allen Bradley* (e.g. SLC500).

4.1.1. System Architecture

The default configuration for an LUFP9 gateway allows it to control, monitor and configure 8 TeSys U motor starters:



Please see chapter 2 Hardware Implementation of the LUFP9 Gateway, page 13, for the hardware implementation of the default configuration.

If you are using fewer than 8 TeSys U motor starters, you will need to adapt the gateway configuration using the “ABC-LUFP Configurator” software (see chapter 6 Configuring the Gateway, page 40, and chapter 6.6 Deleting a Modbus Slave, page 45).

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4. Software Implementation of the Gateway

4.1.2. Configuring the Motor Starters

Each motor starter should be configured as follows:

Protocol:	Modbus RTU slave
Modbus address	1 to 8
Bitrate	19,200 bits/s
Data bits	8

Start bits	1
Parity	None
Parity bit	0
Stop bits	1

When using a TeSys U motor starter with a Modbus communication module (LULC031 module), the configuration parameters for the RS485 connection are automatically detected, only the Modbus address needs to be configured.

4.1.3. Modbus cycle time

The LUFP9 gateway's default configuration sets a cycle time of 300 ms on Modbus commands for each of the 8 TeSys U motor starters.

4.1.4. Managing degraded modes

The default management for degraded modes is described below, but it takes no account of the PLC used or of the DeviceNet scanner. Please see chapter 6.11.2.1 Managing Degraded Modes, page 65, if you would like to change the way that degraded modes for one or more Modbus commands are managed.

<table>
<tr><th colspan="2" rowspan="2">Desired behaviour</th><th colspan="4">Event</th></tr>
<tr><th>DeviceNet PLC: CPU stop or failure</th><th>Disconnection of the upstream DeviceNet network</th><th>Failure of the LUFP9 gateway</th><th>Disconnection of the downstream Modbus RTU network</th></tr>
<tr><td rowspan="2">Outputs</td><td>Reset</td><td rowspan="2">Depending on the configuration of the DeviceNet master</td><td>Yes</td><td colspan="2" rowspan="2">Depending on the configuration of the TeSys U motor starters (1)</td></tr>
<tr><td>Hold</td><td>——</td></tr>
<tr><td rowspan="2">Inputs</td><td>Reset</td><td rowspan="2">——</td><td colspan="2" rowspan="2">Depending on the configuration of the DeviceNet master</td><td>Yes</td></tr>
<tr><td>Hold</td><td>——</td></tr>
</table>

(1) The desired behaviour with regard to the outputs should be directly configured on each of the TeSys U motor starters.

You can also read the user manuals for your master and your DeviceNet scanner to obtain further details about how to process degraded modes.

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4. Software Implementation of the Gateway

4.2. Configuring the Gateway in RsNetWorx

The DeviceNet master PLC must be configured so that it has access to all of the data described in chapters 8.2.1 Input Data Memory Area, page 84 et 8.2.2 Output Data Memory Area, page 85.

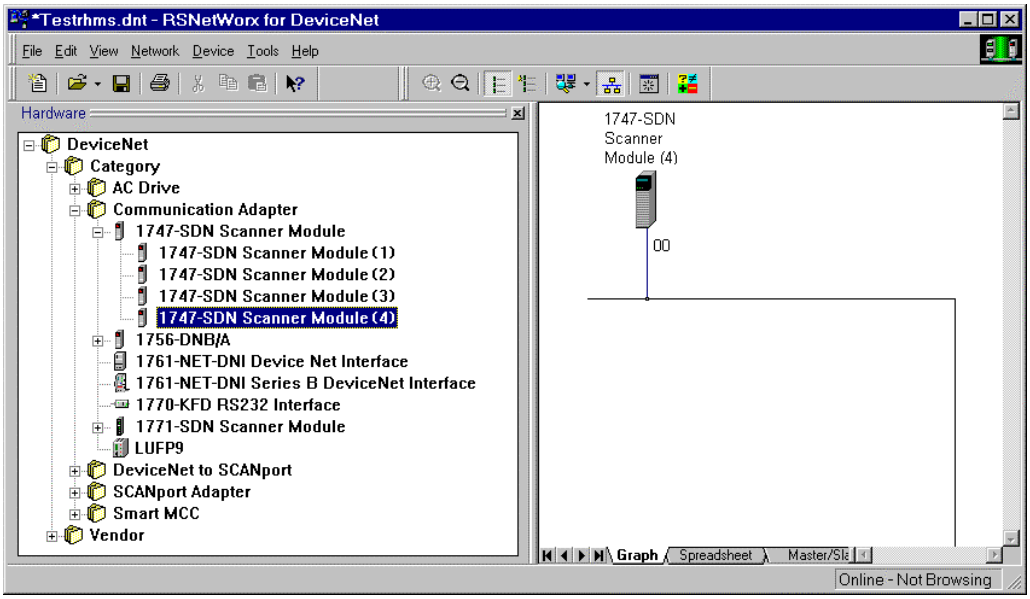
The following chapters describe the steps in RsNetWorx which you will need to go through so that the gateway is correctly recognised by the DeviceNet master PLC.

The DeviceNet network which is described in the following chapters only includes one master and one slave (LUFP9 gateway). So you will need to adapt the addressing of the inputs and outputs shown below (%IW and %QW) according to any other slaves on the DeviceNet network which you need to configure.

4.2.1. Selecting and adding the master PLC's DeviceNet scanner

In RsNetWorx, select the type of scanner you have and add it to the DeviceNet network topology.

In our example, this scanner is a "1747-SDN Scanner Module (4)" and its Mac ID address is set to 00.



4.2.2. Installing the Gateway Description File

The EDS file describing the gateway must be placed on the PC's hard disk so that RsNetWorx has access to it at all times. The best thing is to place this file in the directory which holds all of the EDS files used by RsNetWorx.

This file can be found on the CD LUF9CD1 : "`LUFP9_100.eds`".

➔ Once you are inside RsNetWorx, see the documentation to read how to import an EDS file. This procedure should then be applied to the file "`LUFP9_100.eds`". It uses the "EDS wizard", which is accessible from the "Tools" menu.

The following two entries are then added to the tree structure for recognised DeviceNet products:

- DeviceNet / Category / Communication Adapter / LUFP9
- DeviceNet / Vendor / Schneider Automation / LUFP9

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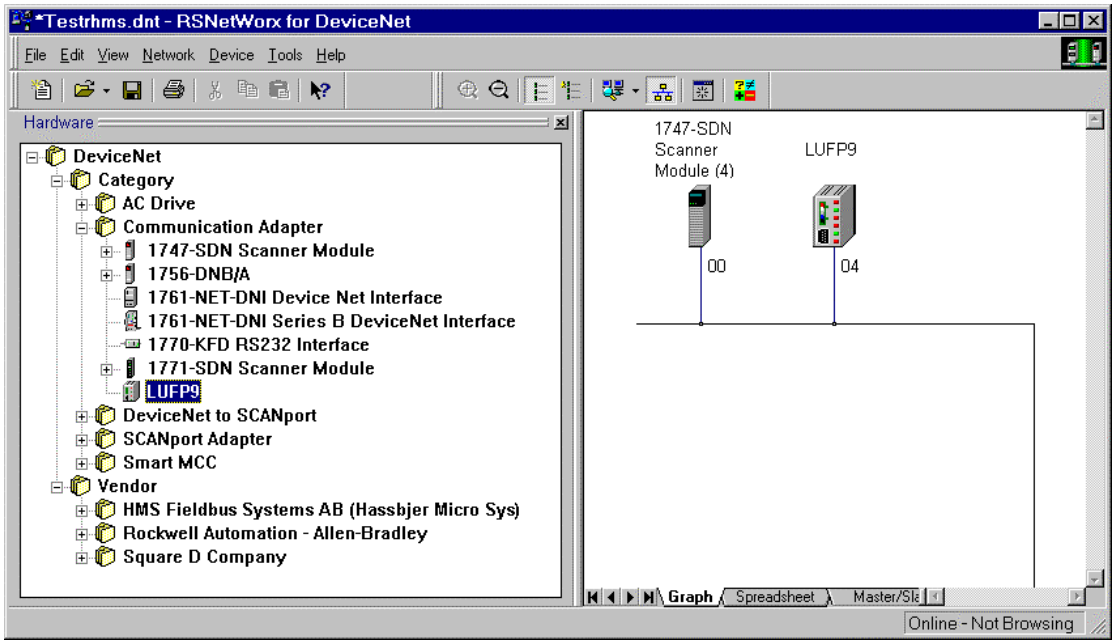
4. Software Implementation of the Gateway

4.2.3. Selecting and Adding the Gateway to the DeviceNet Network

Select “LUFP9” from the list on the left, then add it to the DeviceNet network topology.

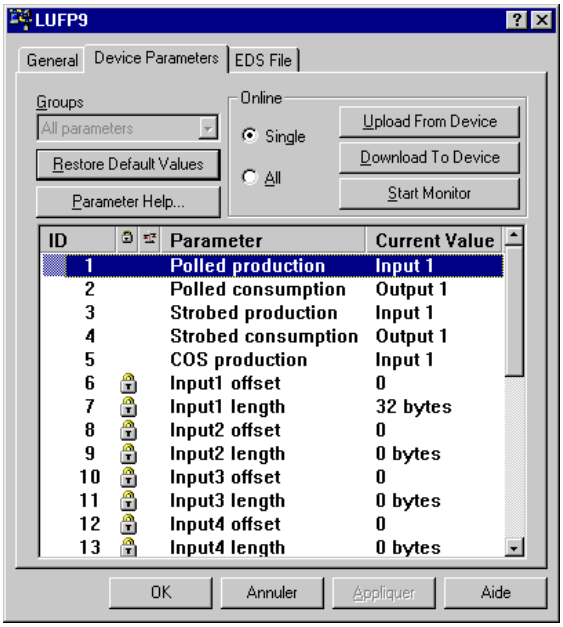
In our example, we have assigned the Mac ID address 04 to the gateway (the configuration of the address for a gateway is described in chapter 2.7.2 Encoding the Gateway Address, page 21).

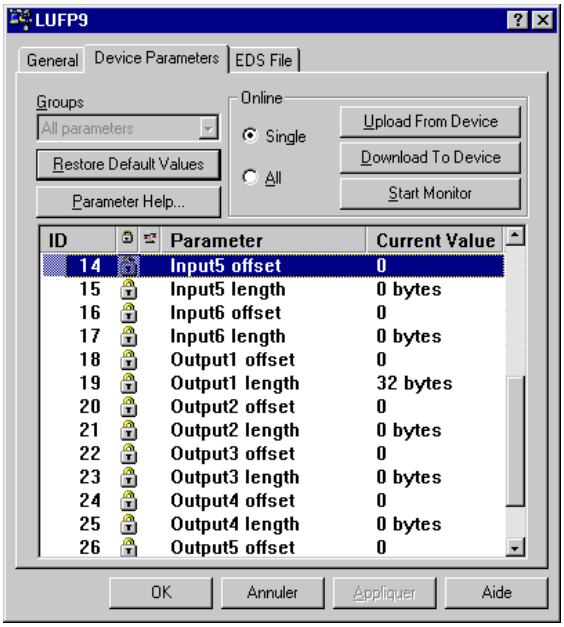


4.2.4. Editing gateway parameters

Double-click on the icon which corresponds to the gateway, in the frame on the right.

In the window which then appears, select the “Device Parameters” tab and check that the values for the parameters correspond to those for the parameters shown below. If necessary, change them (only parameters 1 to 5 are accessible to the user in write mode), then click on the “Download To Device” button to send these changes to the gateway.





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4. Software Implementation of the Gateway

If you are in any doubt over what is displayed, click on the "Upload From Device" button, then on "Start Monitor". The RsNetWorx application then starts to read from the gateway the values of the parameters currently displayed. Click on the "Stop Monitor" button to stop this reading process.

The most important parameters, in the case of the default gateway configuration, are parameters 1 and 2 (periodic transfers between the PLC and the gateway via a periodic connection known as "polled"), 6 and 7 (offset and size of the input data area in the gateway's input memory), and 18 and 19 (offset and size of the output data area in the gateway's output memory).

If you create or change a configuration using AbcConf (see chapter 6 Configuring the Gateway, page 40), you should be aware that the values of these parameters should correspond to the configuration of the data in the gateway's memory, as defined in AbcConf. This data corresponds to all of the bytes exchanged with the Modbus slaves via the "Data" or "Preset Data" fields in the Modbus frames.

You should only check the parameters related to "Input1" and "Output1" areas. The other parameters, related to "Input2" to "Input6" or to "Output2" to "Output6" areas, are intended for an advanced use of the gateway, and *Schneider Electric* refuses to accept responsability for their use. The operations needed to set the values of these parameters will not be described in the current guide.

N.B. If a connection is not used, the corresponding EDS parameters are not used by the gateway. This is the case with "Strobed" and "COS" connections (and EDS parameters nos. 3 to 5) when the default gateway configuration is used. You can then retain the initial assignment of parameters nos. 1 to 5 to the two default input and output areas (areas no. 1), because only the "Polled" connection (parameters nos. 1 and 2) will be activated by the DeviceNet master.

N.B. The value of each "offset" type parameter refers to an offset from the start of the gateway's input data memory area or from the start of its output data memory area and not from the start of its physical memory.

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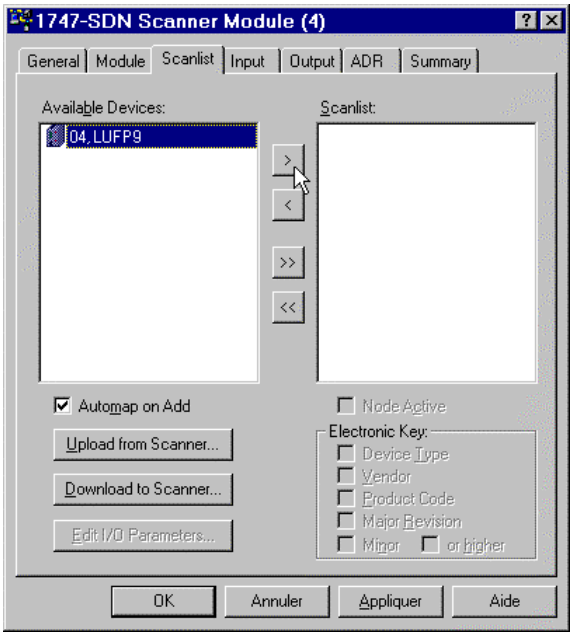
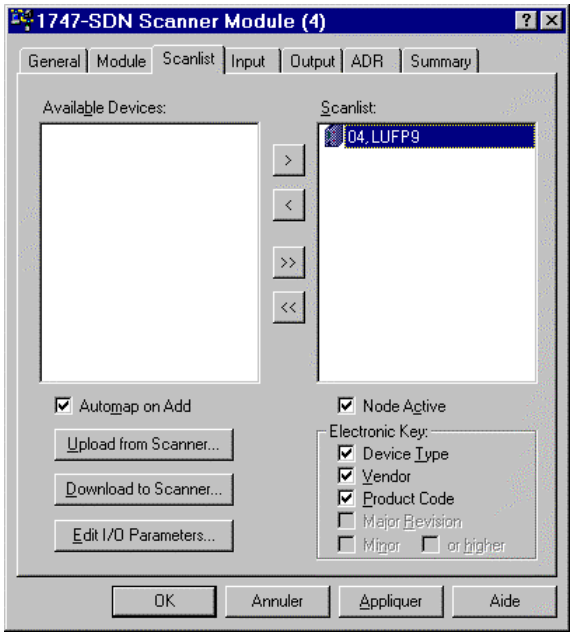
4. Software Implementation of the Gateway

4.2.5. Configuring the DeviceNet Scanner

Double-click on the icon which corresponds to the DeviceNet scanner.

A window then appears allowing you to configure the exchanges carried out by the scanner. Select the “Scanlist” tab and add the “LUFP9” gateway to the “Scanlist” (**>** or **>>** buttons). After selecting the gateway from this list, the “Edit I/O Parameters…” button becomes accessible.

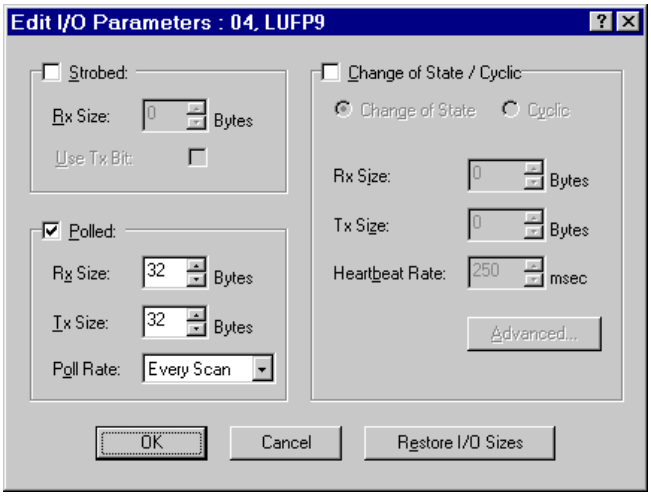




Click on the “Edit I/O Parameters…” button.

In the window that appears, check the “Polled:” box, then configure the size of the data received (Rx = 32 bytes) and the size of the data transmitted (Tx = 32 bytes) by the scanner.

With the LUFP9 gateway’s default configuration, these values allow you to exchange all of the data shown in chapters 8.2.1 Input Data Memory Area, page 84, et 8.2.2 Output Data Memory Area, page 85.



If you create or change a configuration using AbcConf (see chapter 6 Configuring the Gateway, page 40), the sizes of the data exchanged via one of these connections must correspond to the sizes of the “Input1” and “Output1” areas which have been assigned to it using EDS parameters nos. 1 to 5 (see previous chapter).

Please see chapter 10.8 Connection Object (Class 16#05), page 99 for further information about DeviceNet connections for the LUFP9 gateway. Please also see the documentation that came with your DeviceNet master PLC.

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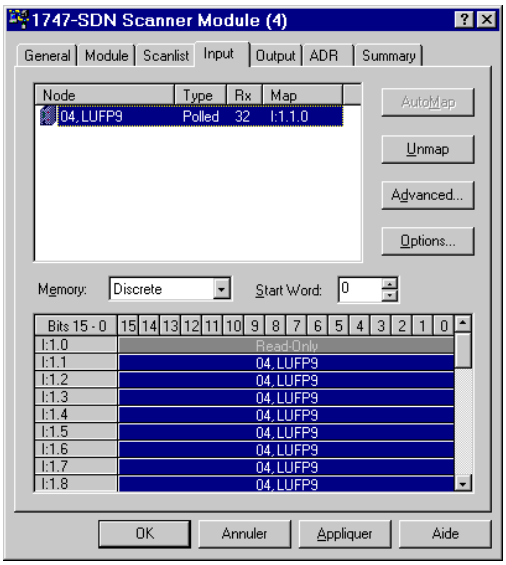
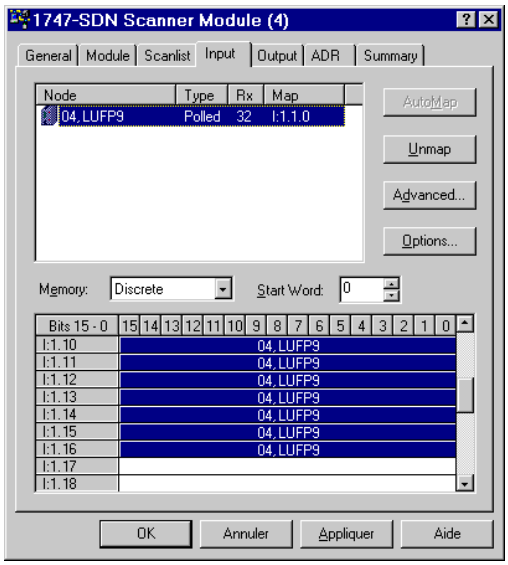
4.2.6. Configuring Inputs from the Gateway

On the “Input” tab, select the “LUFP9” gateway, then click on the “AutoMap” button. RsNetWorx then automatically establishes the correspondence between the 32 data bytes (8-bit format) from the gateway and the corresponding 16 PLC inputs “I:1.1” to “I:1.16” (16-bit format).

Please check that a correspondence between all of the data from the gateway and the PLC inputs “I:1.1” to “I:1.16” has been established.





The correspondence between the contents of the gateway’s input memory (see chapter 8.2.1 Input Data Memory Area, page 84) and PLC inputs “I:1.1” to “I:1.16” is given in the following table:

Service	PLC input	Description	
		Bit 0.....Bit 7	**Bit 8 .....Bit 15**
Managing the downstream Modbus network	**I:1.1**	LUFP9 gateway status word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Monitoring of TeSys U motor starters	**I:1.2**	Value of the motor starter ① status register	
	I:1.3	Value of the motor starter ② status register	
	I:1.4	Value of the motor starter ③ status register	
	I:1.5	Value of the motor starter ④ status register	
	I:1.6	Value of the motor starter ⑤ status register	
	I:1.7	Value of the motor starter ⑥ status register	
	I:1.8	Value of the motor starter ⑦ status register	
	I:1.9	Value of the motor starter ⑧ status register	
Aperiodic communications — Reading the value of a motor starter parameter (RESPONSE)	**I:1.10**	Memory location free	Slave no. (16#01-16#08)
	I:1.11	Function number (16#03)	Number of bytes read (16#02)
	I:1.12	Value of the parameter read (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications — Writing the value of a motor starter parameter (RESPONSE)	**I:1.13**	Slave no. (16#01-16#08)	Function no. (16#06)
	I:1.14	Address of the parameter written (MSB → 16#xx••)	(LSB → 16#••xx)
	I:1.15	Value of the parameter written (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications (“Trigger bytes” for the responses)	**I:1.16**	Read parameter response counter	Write parameter response counter

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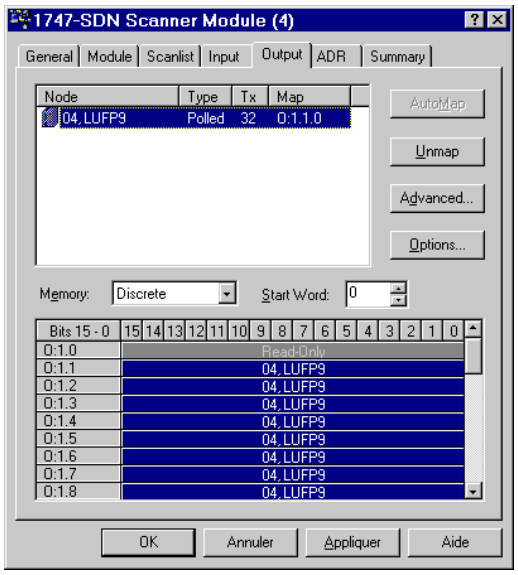
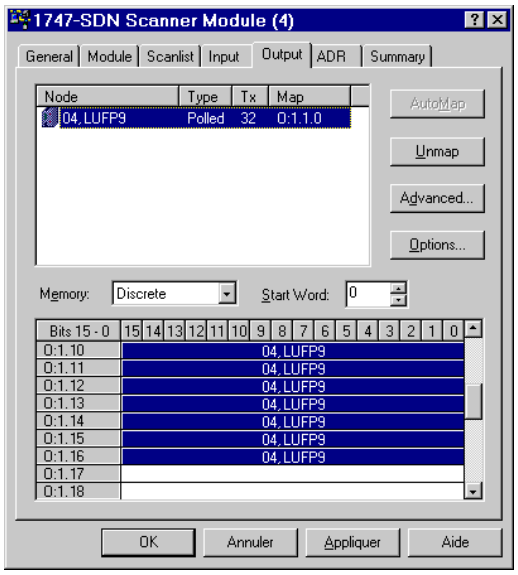
4. Software Implementation of the Gateway

4.2.7. Configuring Outputs Intended for the Gateway

On the “Output” tab, select the “LUFP9” gateway, then click on the “AutoMap” button. RsNetWorx then automatically establishes the correspondence between the 32 data bytes (8-bit format) to be sent to the gateway and the corresponding 16 PLC outputs “O:1.1” to “O:1.16” (16-bit format).

Please check that a correspondence between all of the data sent to the gateway and the PLC outputs “O:1.1” to “O:1.16” has been established.





The correspondence between the contents of the gateway’s output memory (see chapter 8.2.2 Output Data Memory Area, page 85) and PLC outputs “O:1.1” to “O:1.16” is given in the following table:

Service	PLC output	Description	
		Bit 0 ..... Bit 7	Bit 8 .....Bit 15
Managing the downstream Modbus network	**O:1.1**	DeviceNet master command word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Controlling TeSys U motor starters	**O:1.2**	Value of the motor starter ① command register	
	O:1.3	Value of the motor starter ② command register	
	O:1.4	Value of the motor starter ③ command register	
	O:1.5	Value of the motor starter ④ command register	
	O:1.6	Value of the motor starter ⑤ command register	
	O:1.7	Value of the motor starter ⑥ command register	
	O:1.8	Value of the motor starter ⑦ command register	
	O:1.9	Value of the motor starter ⑧ command register	
Aperiodic communications — Reading the value of a motor starter parameter (QUERY)	**O:1.10**	Slave no. (16#01-16#08)	Function no. (16#03)
	O:1.11	Address of the parameter to be read (MSB → 16#xx••)	(LSB → 16#••xx)
	O:1.12	Number of parameters to be read (MSB → 16#00••)	(LSB → 16#••01)
Aperiodic communications — Writing the value of a motor starter parameter (QUERY)	**O:1.13**	Slave no. (16#01-16#08)	Function no. (16#06)
	O:1.14	Address of the parameter to be written (MSB → 16#xx••)	(LSB → 16#••xx)
	O:1.15	Value of the parameter to be written (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications (“Trigger bytes” for the queries)	**O:1.16**	Read parameter query counter	Write parameter query counter

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4. Software Implementation of the Gateway

4.2.8. Description of Services Assigned to Gateway Inputs/Outputs

Managing the downstream Modbus network: Please see chapter 5.2 Diagnostic only, page 37, for a detailed description of this service. The example described in chapter 9.1 Main Program: "LAD 2 - MAIN_LUFP9", page 86, only automatically acknowledges gateway diagnostics, that is to say it does not exploit the data from these diagnostics. In the case of the gateway's default configuration, under AbcConf, the "Control/Status Byte" field of the "ABC" element is equal to "Enabled but no startup lock."

Periodic communications (inputs): The value of each of the 8 words for this service corresponds to the value of the status register of a TeSys U motor starter (register located at address 455).

Periodic communications (outputs): The value of each of the 8 words for this service corresponds to the value to be sent to the command register for a TeSys U motor starter (register located at address 704).

Please see chapter 9.2 Controlling/Monitoring Sub-Program for a TeSys U Motor Starter: "LAD 3 - CMD_MON", page 87, for an example of the simplified use of these "periodic communications" services.

Aperiodic communications: Please see chapter 9.3 Sub-Program for Reading a Parameter in all TeSys U Motor Starters: "LAD 4 - RD_PAR", page 89, and chapter 9.4 Sub-Program for Writing a Parameter on a Single TeSys U Motor Starter: "LAD 5 - WR_PAR", page 91, for an example of how to use the "aperiodic communications" services.

These aperiodic communications services offer functions similar to those of "parameter area PKW", which can be found on certain *Schneider Electric* products, such as some ATV drives.

The 16-bit inputs and outputs for which the MSB and LSB order is specified must be used by the DeviceNet master inverting the LSB / MSB order so as to restore the value of the corresponding item of Modbus data.

- ***Sample reading of a motor starter parameter:***
  Reading of the 1st fault register (address = 452 = `16#01C4`) on "TeSys U n°5" motor starter. The initial values of O:1.16 and I:1.16 are equal to `16#1306`. The result of the reading is `16#0002` (magnetic fault).

Output	Value	Meaning (MSB + LSB)
O:1.10	`16#0305`	Function no. + Slave no.
O:1.11	`16#C401`	Parameter address (MSB↔LSB)
O:1.12	`16#0100`	Number of parameters (MSB↔LSB)
O:1.16	`16#1307`	"Trigger byte" for the query (Pf)

Input	Value	Meaning (MSB + LSB)
I:1.10	`16#0500`	Slave no. + (not used)
I:1.11	`16#0203`	Number of bytes + Function no.
I:1.12	`16#0200`	Value read (MSB↔LSB)
I:1.16	`16#1307`	"Trigger byte" for the response (Pf)

- ***Sample writing of a motor starter parameter:***
  Writing of the 2nd command register (address = 705 = `16#02C1`) on "TeSys U n°7" motor starter at the value `16#0006` (clear statistics + reset thermal memory). The initial values of O:1.16 and I:1.16 are equal to `16#1307`. The result of the writing is a command echo, that is to say that the values of the "address parameter" and "value to be written" fields are identical in both the query and the response.

Output	Value	Meaning (MSB + LSB)
O:1.13	`16#0607`	Function no. + Slave no.
O:1.14	`16#C102`	Parameter address (MSB↔LSB)
O:1.15	`16#0600`	Value to be written (MSB↔LSB)
O:1.16	`16#1407`	"Trigger byte" for the query (PF)

Input	Value	Meaning (MSB + LSB)
I:1.13	`16#0607`	Function no. + Slave no.
I:1.14	`16#C102`	Parameter address (MSB↔LSB)
I:1.15	`16#0600`	Value to be written (MSB↔LSB)
I:1.16	`16#1407`	"Trigger byte" for the response (PF)

Avoid writing incorrect values in outputs which correspond to the aperiodic communication services described above, as they would lead to the transmission of an incoherent Modbus frame. In fact there is no check on the data used by these services and so it is up to the DeviceNet master PLC application to manage them.

In addition, do not ever use these services in "Broadcast" mode (Modbus address = 0).

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4.2.9. Transferring the DeviceNet Scanner Configuration

Once you have finished the operations described above, make sure that the changes made have been transmitted to the DeviceNet scanner. To do this, click on the "Download to Scanner…" button on each of the "Module" and "Scanlist" tabs in the DeviceNet scanner properties window.

If necessary, please see the RsNetWorx documentation for further details on this subject.

4.2.10. Developing a DeviceNet Application

The DeviceNet master PLC used as an example is a SLC500, marketed by *Allen Bradley*. An example of a PLC application, developed in RSLogix 500, is shown in chapter 9 Appendix C: Practical Example (RSLogix 500), page 86. This example uses the PLC, the gateway and the 8 TeSys U motor starters shown in the Software Implementation of the Gateway.

5. Gateway Initialization and Diagnostics

Each of the three sub-chapters 5.1, 5.2 and 5.3 describes the principle used to initialize and carry out diagnostics on the gateway using each of the three options offered by the gateway. These options can be configured via AbcConf, by changing the assignment of the “Control/Status Byte” field for the “ABC” element (see chapter 6.12.2 “ABC” Element, page 76). The links between these sub-chapters and these options are as follows:

The option chosen in the default configuration is “Enabled but no startup lock.”

5.1. Full Management

Until it receives an order to start up the Modbus exchanges from the DeviceNet master, the LUFP9 gateway does not transmit any queries on the Modbus network. The DeviceNet master can then deactivate these exchanges by inverting this startup order. Subsequently these two orders may be reiterated by the DeviceNet master.

The Modbus exchange startup order is located in a 16-bit register occupying the addresses 16#0200 and 16#0201 in the gateway’s memory (outputs). A second 16-bit register, located at the addresses 16#0000 and 16#0001 (inputs), allows the gateway to send diagnostics to the DeviceNet master.

So you must configure your DeviceNet master so that it has access to the first two bytes of the gateway’s output data area, as well as to the first two bytes of the gateway’s input data area (see chapter 4.2 Configuring the Gateway in RsNetWorx, page 25).

5.1.1. DeviceNet Master Command Word

The output word located at addresses 16#0200 (MSB) and 16#0201 (LSB) in the gateway’s output memory constitutes the DeviceNet master command word. Its structure is described below:

Bits	Description
15	**FB_HS_CONFIRM: Acknowledgement bit of a gateway diagnostic** The DeviceNet master must compare the value of the FB_HS_CONFIRM bit to the value of the ABC_HS_SEND bit (bit 15 in the gateway’s status word). If these two values are different, this means that the gateway has transmitted a new diagnostic to the DeviceNet master. To tell the gateway that it has read a diagnostic, the DeviceNet master must copy the value of the ABC_HS_SEND bit to the FB_HS_CONFIRM bit. This allows the gateway to issue a new diagnostic. **Summary:** • If (FB_HS_CONFIRM = ABC_HS_SEND) → The gateway’s status word contains a diagnostic which has already been acknowledged by the DeviceNet master. So the gateway is free to use this status word to place another diagnostic there. • Else → A new diagnostic is available in the gateway’s status word. The DeviceNet master can read this diagnostic, but must also copy the value of ABC_HS_SEND to FB_HS_CONFIRM in order to allow the gateway to generate new diagnostics.

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Bits	Description
14	**FB_HS_SEND: New command from the DeviceNet master** Before changing the value of FB_DU, the DeviceNet master must compare the values of FB_HS_SEND and ABC_HS_CONFIRM (bit 14 of the gateway's status word). If these two values are different, this means that the gateway has not yet acknowledged the previous DeviceNet master command. Else, the DeviceNet master can issue a new command, updating the FB_DU bit according to the nature of its command (shutdown or activation of Modbus exchanges), then toggling the value of the FB_HS_SEND bit to inform the gateway that it has sent it a new command. **Summary:** • If (FB_HS_SEND ≠ ABC_HS_CONFIRM) → The DeviceNet master command word still contains a command which has not yet been acknowledged by the gateway. So the DeviceNet master cannot use this word to place a new command in it. • Else → The previous command of the DeviceNet master has been acknowledged by the gateway, which allows it to transmit a new command. In this case, it changes the value of the FB_DU bit, then toggles the value of the FB_HS_SEND bit.
13	**FB_DU: Modbus exchange startup** The setting of this bit to one by the DeviceNet master allows communications between the gateway and the Modbus slaves. Resetting it to zero is used to inhibit them. When the DeviceNet master sets this bit to one, it is preferable for all of the output data it has placed in the gateway's output memory to be up-to-date ("FB_DU" means "FieldBus – Data Updated"). If they are not, this data will be transmitted to the Modbus slaves "as it".
0-12	Reserved.

Due to the inversion of the LSB and the MSB for this register between the gateway and the DeviceNet master, the structure of the corresponding output word ("O:1.1" in the case of the default configuration) is as follows:

Bits	Description
8-15	Reserved.
7	**FB_HS_CONFIRM: Acknowledgement bit of a gateway diagnostic**
6	**FB_HS_SEND: New DeviceNet master command word**
5	**FB_DU: Modbus exchange startup**
0-4	Reserved.

e.g. If the O:1.1 output word is set to 16#00A0, the DeviceNet master command word will be set to 16#A000.

The correct use of this command word by the DeviceNet master, to transmit a new command to the gateway, goes through the following steps:

- Checking of (FB_HS_SEND = ABC_HS_CONFIRM).
- ↳ The command, that is to say the value of the FB_DU bit, is updated.
- ↳ The value of the FB_HS_SEND bit is inverted.

N.B. It is possible to simplify this use as follows:

- The FB_DU and FB_HS_SEND bits are set to one to activate the Modbus communications.
- The FB_DU and FB_HS_SEND bits are reset to halt Modbus communications.

On the other hand, **do not write directly in 16-bit format** in the DeviceNet master command word, because this would disrupt the operation of the transfer of the gateway diagnostics (undesired change to FB_HS_CONFIRM). However, during some debug or test phase, you could, for instance, write 16#6000 in the DeviceNet master command word (that is to say 16#0060 in the O:1.1 output word) in order to activate the Modbus communications, and 16#0000 to stop them.

5. Gateway Initialization and Diagnostics

5.1.2. Gateway Status Word

The input word located at addresses 16#0000 (MSB) and 16#0001 (LSB) in the gateway's input memory constitutes the gateway's status word. Its structure is described below:

Bits	Description
15	**ABC_HS_SEND: New gateway diagnostic** (See description of bit 15 of the DeviceNet master command word, FB_HS_CONFIRM.)
14	**ABC_HS_CONFIRM: Acknowledgement bit of a DeviceNet master command** (See description of bit 14 of the DeviceNet master command word, FB_HS_SEND.)
13	**ABC_DU: Modbus exchanges activated** The gateway activates this bit to tell the DeviceNet master that the Modbus data located in its input memory area have **all** been updated at least once since the last activation of FB_DU ("ABC_DU" means "ABC – Data Updated"). These Modbus input data include every data in responses from all Modbus slaves, for both periodic commands and aperiodic commands. This bit is deactivated by the gateway when the FB_DU bit is deactivated, that is to say when the DeviceNet master demands a shutdown of Modbus exchanges. **N.B.** Once it is active, this bit is not deactivated if there are any communication errors with the Modbus slaves. To signal this type of error, the gateway uses bit 12 of its status word.
12	**Periodicity of Modbus exchanges** The gateway activates this bit provided that it is periodically communicating with all of the Modbus slaves. It deactivates it as soon as it loses communication with one of them. The "Reconnect time (10ms)", "Retries" and "Timeout time (10ms)" elements of each of the Modbus queries (see chapter 6.11.2.2 Configuring the Query, page 66) are used to determine whether communication is lost, then restored. **N.B.** If a number of periodic exchanges are configured for the same Modbus slave, only one of them needs to remain active for the periodic communications with this slave to be declared active.
8-11	**EC: Error code associated with the Modbus network** Code for the error detected on the Modbus network by the gateway and transmitted to the DeviceNet master.
0- 7	**ED: Error data item associated with the Modbus network** Data item associated with the EC error code.

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Due to the inversion of the LSB and the MSB for this register between the gateway and the DeviceNet master, the structure of the corresponding input word ("I:1.1" in the case of the default configuration) is as follows:

Bits	Description
8-15	**ED: Error data item associated with the Modbus network**
7	**ABC_HS_SEND: New gateway diagnostic**
6	**ABC_HS_CONFIRM: Acknowledgement bit of a DeviceNet master command**
5	**ABC_DU: Modbus exchanges activated**
4	**Periodicity of Modbus exchanges**
0-3	**EC: Error code associated with the Modbus network**

E.g. If the gateway's status word is set to 16#F031, the input word I:1.1 will be set to 16#31F0.

5. Gateway Initialization and Diagnostics

The correct use of this status word by the DeviceNet master, to read a diagnostic generated by the gateway, goes through the following steps:

- Checking of (ABC_HS_SEND ≠ FB_HS_CONFIRM).
- ↳ Reading of the value of ABC_DU to determine whether all of the Modbus input data are up-to-date.
- ↳ Reading of the value of the “Periodicity of Modbus exchanges” bit to determine whether the periodicity of the Modbus communications has been maintained.
- ↳ Reading of the values of EC and ED to check for any error detected by the gateway on the Modbus network (see table below).
- ↳ Copying of the value of the ABC_HS_SEND bit to the FB_HS_CONFIRM bit.

This last step is essential because it allows the gateway to transmit a future diagnostic! Even if you do not wish to read the content of the gateway’s status word, it is preferable to automate this step in your DeviceNet master software.

The values of the EC and ED fields are described in the table below:

EC	Description of the error	ED	Notes
2#0000	Re-transmissions on the Modbus network	Number of re-transmissions (1)	Total number of re-transmissions carried out on the sub-network, for all slaves.
2#0001	A Modbus slave is missing	Address of the missing Modbus slave	—
2#0010	Several Modbus slaves are missing	—	—
2#0011	Excessive data in a Modbus response	Address of the Modbus slave involved	This error occurs when the gateway receives too much data in the response sent by one of its Modbus slaves.
2#0100	Unknown Modbus error	Address of the Modbus slave involved	—

(1) The re-transmission counter used to signal this error is not reset when the gateway generates this error code. If there are recurrent communication problems on the Modbus network, the gateway will generate this same diagnostic repeatedly, so as to tell the DeviceNet master the total number of re-transmissions carried out as often as possible. This counter is reset when its value exceeds its maximum value (counter modulo 256: 16#FF → 16#00).

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5. Gateway Initialization and Diagnostics

5.2. Diagnostic only

The gateway uses a 16-bit register, located at the addresses 16#0000 and 16#0001 in its memory (inputs), to send diagnostics to the DeviceNet master. A second 16-bit register, located at the addresses 16#0200 and 16#0201 (outputs), allows the DeviceNet to acknowledge each of these diagnostics.

So you must configure your DeviceNet master so that it has access to the first two bytes of the gateway's output data area, as well as to the first two bytes of the gateway's input data area (see chapter 4.2 Configuring the Gateway in RsNetWorx, page 25).

5.2.1. Gateway Status Word

The input word located at addresses 16#0000 (MSB) and 16#0001 (LSB) in the gateway's input memory constitutes the gateway's status word. Its structure is described below:

Bits	Description
15	**ABC_HS_SEND: New gateway diagnostic** (See description of bit 15 of the DeviceNet master command word, FB_HS_CONFIRM.)
14	Reserved.
13	**ABC_DU: Modbus exchanges activated** The gateway activates this bit to tell the DeviceNet master that the Modbus data located in its input memory area have **all** been updated at least once since the last activation of FB_DU ("ABC_DU" means "ABC – Data Updated"). These Modbus input data include every data in responses from all Modbus slaves, for both periodic commands and aperiodic commands. This bit is deactivated by the gateway when the FB_DU bit is deactivated, that is to say when the DeviceNet master demands a shutdown of Modbus exchanges. **N.B.** Once it is active, this bit is not deactivated if there are any communication errors with the Modbus slaves. To signal this type of error, the gateway uses bit 12 of its status word.
12	**Periodicity of Modbus exchanges** The gateway activates this bit provided that it is periodically communicating with all of the Modbus slaves. It deactivates it as soon as it loses communication with one of them. The "Reconnect time (10ms)", "Retries" and "Timeout time (10ms)" elements of each of the Modbus queries (see chapter 6.11.2.2 Configuring the Query, page 66) are used to determine whether communication is lost, then restored. **N.B.** If a number of periodic exchanges are configured for the same Modbus slave, only one of them needs to remain active for the periodic communications with this slave to be declared active.
8-11	**EC: Error code associated with the Modbus network** Code of the error detected on the Modbus network by the gateway and transmitted to the DeviceNet master.
0- 7	**ED: Error data item associated with the Modbus network** Data item associated with the EC error code.

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Due to the inversion of the LSB and the MSB for this register between the gateway and the DeviceNet master, the structure of the corresponding input word ("I:1.1" in the case of the default configuration) is as follows:

Bits	Description
8-15	**ED: Error data item associated with the Modbus network**
7	**ABC_HS_SEND: New gateway diagnostic**
6	Reserved.
5	**ABC_DU: Modbus exchanges activated**
4	**Periodicity of Modbus exchanges**
0-3	**EC: Error code associated with the Modbus network**

E.g. If the gateway's status word is set to 16#B031, the input word I:1.1 will be set to 16#31B0.

The correct use of this status word by the DeviceNet master, to read a diagnostic generated by the gateway, goes through the following steps:

- Checking of (ABC_HS_SEND ≠ FB_HS_CONFIRM).
- ↳ Reading of the value of ABC_DU to determine whether all of the Modbus inputdata are up-to-date.
- ↳ Reading of the value of the "Periodicity of Modbus exchanges" bit to determine whether the periodicity of the Modbus communications has been maintained.
- ↳ Reading of the values of EC and ED to check for any error detected by the gateway on the Modbus network (see table on page 36).
- ↳ Copying of the value of the ABC_HS_SEND bit to the FB_HS_CONFIRM bit.

This last step is essential because it allows the gateway to transmit a future diagnostic! Even if you do not wish to read the content of the gateway's status word, it is preferable to automate this step in your DeviceNet master software.

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5.2.2. DeviceNet Master Command Word

The output word located at addresses 16#0200 (MSB) and 16#0201 (LSB) in the gateway's output memory constitutes the DeviceNet master command word. Its structure is described below:

Bits	Description
15	**FB_HS_CONFIRM: Acknowledgement bit of a gateway diagnostic** The DeviceNet master must compare the value of the FB_HS_CONFIRM bit to the value of the ABC_HS_SEND bit (bit 15 in the gateway's status word). If these two values are different, this means that the gateway has transmitted a new diagnostic to the DeviceNet master. To tell the gateway that it has read a diagnostic, the DeviceNet master must copy the value of the ABC_HS_SEND bit to the FB_HS_CONFIRM bit. This allows the gateway to issue a new diagnostic. **Summary:** • If (FB_HS_CONFIRM = ABC_HS_SEND) → The gateway's status word contains a diagnostic which has already been acknowledged by the DeviceNet master. So the gateway is free to use this status word to place another diagnostic there. • Else → A new diagnostic is available in the gateway's status word. The DeviceNet master can read this diagnostic, but must also copy the value of ABC_HS_SEND to FB_HS_CONFIRM in order to allow the gateway to generate new diagnostics.
0-14	Reserved.

Due to the inversion of the LSB and the MSB for this register between the gateway and the DeviceNet master, the structure of the corresponding output word (“O:1.1” in the case of the default configuration) is as follows:

Bits	Description
8-15	Reserved.
7	**FB_HS_CONFIRM: Acknowledgement bit of a gateway diagnostic**
0-6	Reserved.

E.g. If the O:1.1 output word is set to 16#0080, the DeviceNet master command word will be set to 16#8000.

5.3. Simplified Operation

The two 16-bit registers located at addresses 16#0000-16#0001 (inputs) and 16#0200-16#0201 (outputs) are no longer used for “managing the downstream Modbus network”. These two registers are no longer reserved and so these addresses can be used to exchange data with the Modbus slaves (“Data Location” attribute of “Data” or “Preset Data” type frame fields).

The DeviceNet master’s command word and the gateway’s status word, which we will be talking about in the rest of this document, do not exist anymore. So the two warnings on pages 51 and 55 should be ignored, and the input and output ranges in the gateway’s memory therefore go respectively from 16#0002-16#01FF to 16#0000-16#01FF and from 16#0202-16#03FF to 16#0200-16#03FF.

If the gateway’s default configuration were to be configured in this way, it would clear DeviceNet scanner input “I:1.1” and output “O:1.1”. These two words would then become “free memory locations”.

6. Configuring the Gateway

Each part of this chapter describes a separate step allowing the user to personalize the gateway configuration, according to his own particular needs. Each part gives an introduction to a basic operation isolating it from the rest of the configuration and describing the operations to be carried out using AbcConf (mainly) and RsNetWorx (where necessary), and their implications for the gateway's general behaviour.

In each case, the first two steps are required, as they allow you to establish the dialogue between the gateway and the PC software allowing you to configure it, that is to say AbcConf.

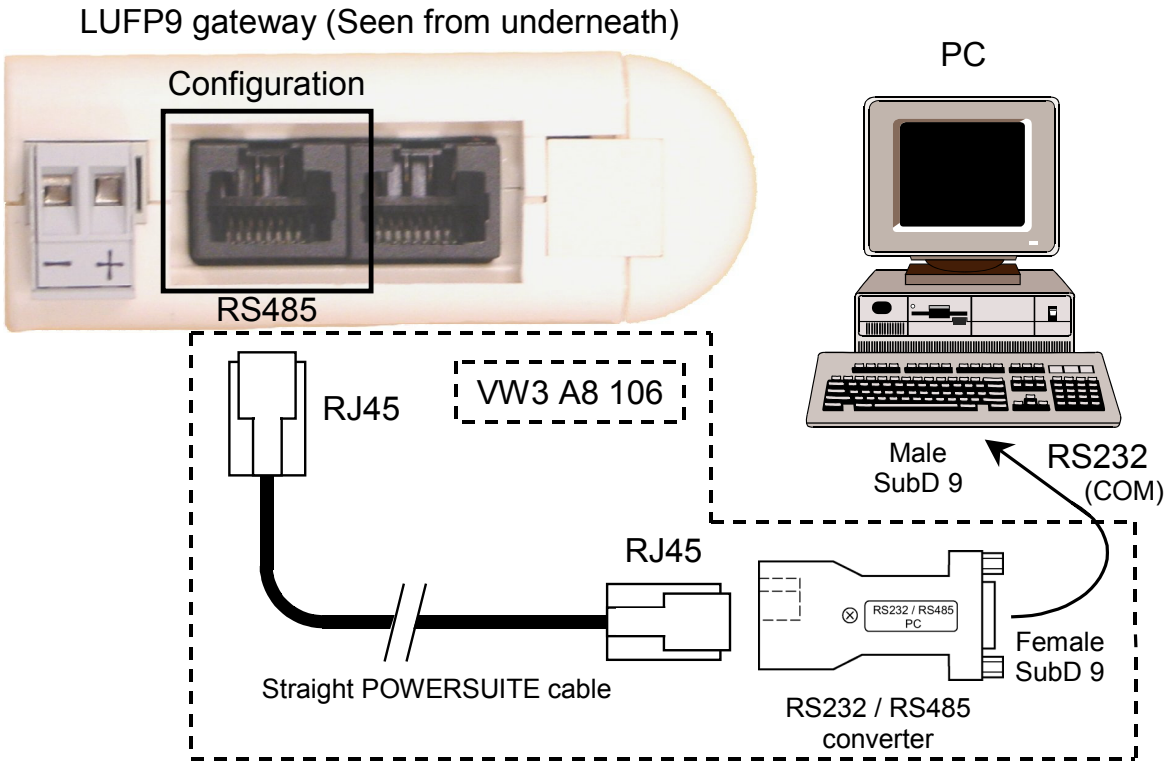
We strongly recommend that you read chapter 4 Software Implementation of the Gateway, page 23, because all of the operations carried out in AbcConf or RsNetWorx are based on the principle that we are using the default configuration of the LUFP9 gateway.

6.1. Connecting the Gateway to the Configuration PC

This step is required when setting up the gateway configuration application, AbcConf.

Connecting the gateway to one of the serial (COM) ports on a PC requires a straight PowerSuite cable and a RS232/RS485 converter. These two items are the same as those allowing dialogue with drives and soft start-soft stop units using the **PowerSuite** application and are both available from the catalogue (ref.: VW3 A8 106).

Ensure that you use the "POWERSUITE" cable and the "RS232 / RS485 PC" converter. An "ATV28 before 09 / 2001" cable and an "ATV 58" converter are also supplied with these items, but they should not be used with the LUFP9 gateway.



Once the gateway has been connected to a PC with the PowerSuite cable and the RS232/RS485 converter, you can change its configuration using "ABC-LUFP Configurator", more generally referred to as "AbcConf". This configurator also allows you to carry out a few diagnostics on the gateway.

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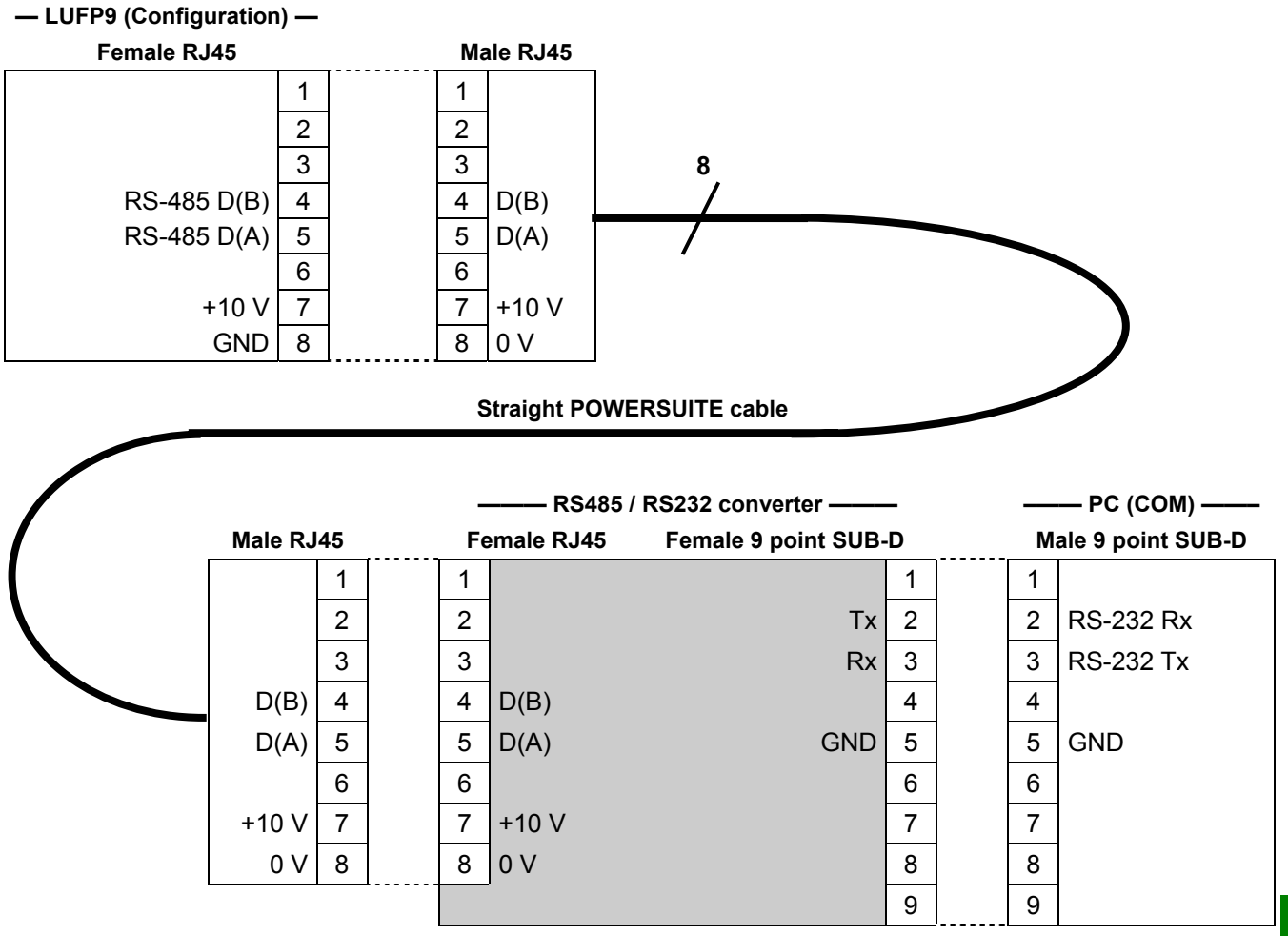
6. Configuring the Gateway

6.1.1. Pin Outs



N.B. The inversion of the Rx and Tx signals between the gateway and the PC is shown on the 9-point SUB-D connectors, because beyond this junction, the RS-232 signals are replaced by the D(A) and D(B) polarisations of the RS-485 signals.

6.1.2. RS-232 link protocol

There is no need to configure the PC's COM port, as AbcConf uses a specific setup which replaces the one for the port being used. This replacement is temporary and is cancelled as AbcConf stops using this serial port, that is to say when AbcConf is closed.

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6. Configuring the Gateway

6.2. Installing AbcConf

The minimum system requirements for AbcConf are as follows:

- Processor.....Pentium 133 MHz
- Free hard disk space .....10 Mb
- RAM..... 8 Mb
- Operating system.....MS Windows 95 / 98 / ME / NT / 2000
- Browser.....MS Internet Explorer 4.01 SP1

The AbcConf installation program can be found on the CD LU9CD1. To install it, run "`ABC-LUFP_Setup.exe`", then follow the on-screen instructions

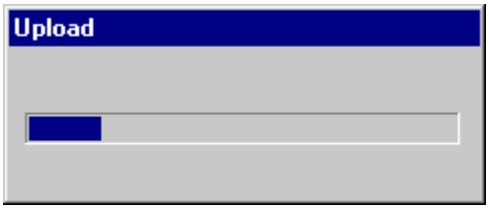
You can read about how to use AbcConf in a user manual entitled **AnyBus Communicator – User Manual** which is also on the CD LU9CD1 : "`ABC_User_Manual.pdf`". We strongly recommend that you read this manual when using AbcConf, because this guide will only describe the various features it provides in relation to using the LUFP9 gateway.

6.3. Importing the Gateway Configuration

Before you can make any changes to the gateway configuration, you will first need to import its current configuration. If you already have this configuration on your hard disk, all you will need to do is open the file corresponding to this configuration.

Check that the gateway has a valid configuration and that it is working properly, that is to say that LED ❻ DEVICE STATUS is flashing green.

In AbcConf, choose "Upload configuration from ABC-LUFP" from the "File" menu or click on the  button, in the AbcConf toolbar. A window called "Upload" will then open and a progress bar shows you the state of progress of the gateway configuration uploading process. This window disappears as soon as the whole configuration has been uploaded successfully.



This step is particularly important if you wish to read details about the content of the gateway's default configuration, after unpacking it. You can then use this configuration as a template for any changes you wish to make subsequently, thus avoiding having to create all of the items and reducing the potential risk of error.

Save this configuration to your hard disk so that it is always available. This will allow you to reconfigure the gateway "cleanly" should the configuration become invalid, if you were to download an invalid configuration, for example.

N.B. The LUFP9 gateway's default configuration can be found on the CD LU9CD1 : "`LUFP9.cfg`".

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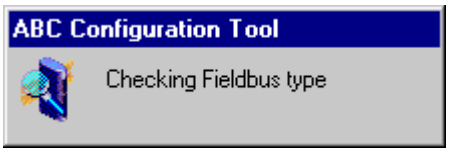
6. Configuring the Gateway

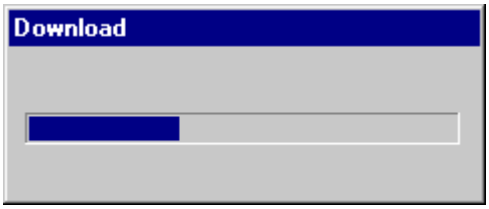
6.4. Transferring a Configuration to the Gateway

When using AbcConf, you can transfer the configuration you are editing to the gateway at any time.

Choose "Download configuration to ABC-LUFP" from the "File" menu or click on the  button, in the AbcConf toolbar.



AbcConf initializes a check test of the gateway type. **During this test, the PC should not carry out any other operations, as this could lead to AbcConf apparently freezing up and slow down the PC's general operation for several minutes!** The test then continues and the PC returns to normal running speed.



Once this test has finished, a window called "Download" opens and a progress bar shows the state of progress for the transfer of the configuration to the gateway. You must never interrupt this operation, otherwise you will have to start it again from the beginning.

Check that the transfer has been correctly carried out: LED ❻ DEVICE STATUS should be flashing green.

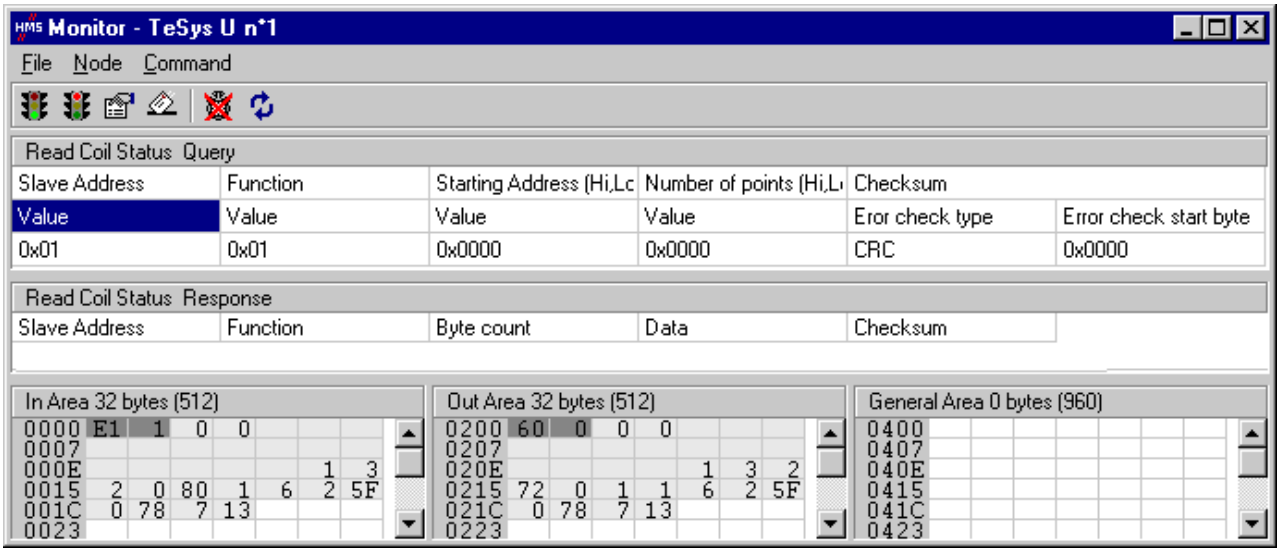
If this LED is flashing red/green, save the configuration you were editing, open the file containing the default configuration for LUFP9 gateways, then transfer it to the gateway. This will restore it to a known initial state. You can then continue with the configuration you were transferring, and make any corrections which may be necessary.

6.5. Monitoring the Content of the Gateway's Memory

One of the main commands that you will need to use when setting up the gateway is the command allowing you to read the contents of the gateway's memory and to display it in a window used for this purpose. This will be particularly useful when you are working on your PLC configurations and applications. However, it only shows data from the "Data" and "Preset Data" fields configured in the "Query" and "Response" elements of just one of the Modbus slaves, plus the content of the gateway's two reserved registers, located at memory addresses 16#0000-16#0001 (gateway status word) and 16#0200-16#0201 (DeviceNet master command word).

To monitor the content of the gateway's memory, start by selecting the node corresponding to the Modbus slave whose data you wish to view, then choose "Monitor" from the menu whose name corresponds to the name of the previously selected node. A monitoring window then appears. The sample window shown at the top of the next page corresponds to a view of the contents of the memory exchanged, using the gateway's default configuration, with the "TeSys U n°1" motor starter.

6. Configuring the Gateway



The upper part of this window allows you to choose a Modbus command, to edit its contents, then to send it to the Modbus network ("Command" menu). The response will then be displayed in this same part. Please see chapter 2.10 Node monitor in the AbcConf user manual, entitled **AnyBus Communicator – User Manual**, for further information about how to use this window. This manual can be found on the CD LU9CD1 : "ABC_User_Manual.pdf".

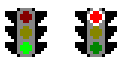
The lower part of this window allows you to view the content of the gateway's memory, but only the bytes used in queries and responses frames for commands and transactions configured for the selected node. The values of the gateway's two reserved words (addresses 16#0000-16#0001 and 16#0200-16#0201) are also shown, whichever node is selected.

In the window shown above, the data displayed correspond to the values at the memory locations designated by the "Data" fields in the commands and transactions configured for the "TeSys U no. 1" node, that is to say the following commands: "Read Holding Registers", "Preset Multiple Registers", "Transactions 1", and "Transactions 2".

N.B. The data exchanged with the Modbus slave previously selected are displayed LSB-first, that is in the LSB / MSB order (as read from left to right, with growing memory addresses), provided that the "Byte Swap" option from the "Data" or "Preset Data" element of the corresponding Modbus command was set to "Swap 2 bytes" (see chapter 6.11.2.5 Configuring the Content of the Response Frame, page 72). For the two reserved words dedicated to the management of the downstream Modbus network, it is the contrary: MSB-first.

However, but only as far as the "TeSys U n°1" node is concerned, the data beginning at addresses 16#0013, 16#0018, 16#0212, and 16#0218 (see chapter 8.2 Content of the Gateway's DPRAM Memory, page 84) follow the same byte order than the content of the frames they are related to (see Appendix E: Modbus Commands, page 113), from first to last byte (checksum excluded), and following growing adresses in the memory of the gateway. Finally, bytes 16#001E, 16#001F, 16#021E, and 16#021F correspond to the reception and emission counters for these frames ("Trigger bytes" from Transactions 1 and 2). But *all these bytes* are swapped two by two between the gateway and the DeviceNet master.

A brief description of the toolbar buttons of this window is given below:


Stop / Start communications with the selected node.


Select / Send the Modbus command shown in the upper part of the window


Stop / Resume refreshing the data displayed in the lower part of the window

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6. Configuring the Gateway

6.6. Deleting a Modbus Slave

This step allows you, for instance, to free up a location on the downstream Modbus network, known as the "Sub-Network" in AbcConf, in order to replace one Modbus slave with another.

In fact the gateway's default configuration already allows it to communicate with eight TeSys U motor starters, whereas the maximum number of Modbus slaves with which it can communicate is limited to eight.

If the gateway is used to manage exchanges on a Modbus network with fewer than eight TeSys U motor starters, it is preferable to delete the redundant TeSys U motor starters from the gateway configuration. In fact, the deterioration in performances linked to the absence of one or more TeSys U motor starters is such that it is preferable to carry out this operation using AbcConf.

If you wish to retain the read/write aperiodic services for the value of a motor starter parameter, **never delete the first configured TeSys U motor starter**, because the two transactions associated with these services are configured for this motor starter.

In fact, these two transactions are sent to any Modbus slave, because the value of the "slave number" field in the Modbus queries associated to them is fully managed wholly by the DeviceNet master PLC software (bits 0 to 7 of outputs O:1.10 and O:1.13).

Procedure for deleting a Modbus slave

1) Select the node corresponding to the Modbus slave you wish to delete from the configuration. If this is the only node remaining in the configuration, you will not be able to delete it, as the downstream Modbus network must include at least one slave.

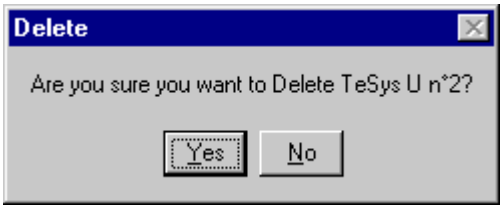
2) Right click on the icon or the name of this Modbus slave. A menu pops up underneath the mouse cursor.

   or

   In the AbcConf main menu, pull down the menu whose name corresponds to the name of the previously selected node.

3) On this menu, click on "Delete". The confirmation window shown below then appears, asking you to either confirm that you want to delete the selected node ("TeSys U no. 2" in the example shown here) or cancel the operation.

4) If you confirm that you want to delete the node, the menu disappears, along with the previously selected node. Otherwise, the node will still be there once the window disappears.



Keyboard shortcut: "Del" key.

Adjusting the gateway's memory (optional step):

The data previously exchanged between the gateway and the Modbus slave which has just been deleted will free up locations in the gateway's memory. If you want to optimize the exchanges between the gateway's memory and the master PLC DeviceNet scanner inputs/outputs, you will need to change the configuration of all the other Modbus slaves in order to adjust the content of the gateway's memory.

However, these operations are not necessary when deleting a single slave. Conversely, they become almost essential when most of the Modbus slaves are deleted, because these deletions divide up the gateway's memory.

Please see chapter 6.11 Adding and Setting Up a Modbus Command, page 62, which describes all of the changes you can make to the configuration of each of the Modbus commands.

6.7. Adding a Modbus Slave

This operation allows you to add a Modbus slave whose type is different from those of the other Modbus slaves in the configuration. On the other hand, if the slave type is the same as one of the previously configured slaves, it is preferable to copy this slave rather than to create a new one.

An additional import/export feature also allows you to individually save the complete configuration of a Modbus slave, in order to have access to it in AbcConf, from any configuration and at any time.

These two features are only available provided that there are less than 8 Modbus slaves declared, which is not the case in the default configuration, as it comprises 8 TeSys U motor starters.

Adding a new type of Modbus slave:

Use one of the two methods shown below:

a) Select "Sub-Network", then choose "Add Node" from the "Sub-Network" menu. A new node is added after all the other configured nodes. By default, its name is "New Node".

b) Select one of the nodes located under the "Sub-network" element, then choose "Insert New Node" from the menu whose name corresponds to the name of the selected node. A new node is added just before the selected node. By default, its name is "New Node".

All of the steps in configuring the new node are described in chapter 6.10 Changing a Modbus slave Configuration, page 60.

Copying a previously configured Modbus slave:

Select the node corresponding to the slave whose configuration you want to copy, then choose "Copy" from the menu whose name corresponds to the name of the selected node. **Keyboard shortcut:** "`Ctrl C`".

Then use one of the two methods shown below:

a) Select "Sub-Network", then choose "Paste" from the "Sub-Network" menu. A new node is added after all the other configured nodes. Its name and its whole configuration are identical to that of the node you copied. **Keyboard shortcut:** "`Ctrl V`".

b) Select one of the "Sub-Network" nodes, then choose "Insert" from the menu whose name corresponds to the selected node. A new node is added just before the one which is selected. Its name and the whole of its configuration are identical to that of the node you copied.

As the new node and the original node are identical in every way, you will need to change (1) the name of the node, (2) the address of the corresponding Modbus slave and (3) the location of the data exchanged between the gateway's memory and this Modbus slave. All of these operations are described in chapter 6.10 Changing a Modbus slave Configuration, page 60, and in chapter 6.11 Adding and Setting Up a Modbus Command, page 62.

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Importing/exporting a Modbus slave configuration:

AbcConf offers the possibility of independently saving and loading the configuration of a node on the downstream “Sub-Network”. For instance, this will allow you to build a library of Modbus slave templates, so that you can use them in any configuration.

To save the configuration of a Modbus slave, select the node it corresponds to, then choose “Save Node” from the menu whose name corresponds to the name of the selected node. A dialog box will then appear asking you to save the configuration (export in XML format).

To insert a node using the XML file containing a Modbus slave configuration as a template, use one of the two methods shown below:

a) Select “Sub-Network”, then choose “Load Node” from the “Sub-Network” menu. A dialog box asks you to choose a file containing a Modbus slave configuration (import in XML format). A new node is added after all the other configured nodes. Its name and its whole configuration are identical to those of the Modbus slave, as it was configured when it was saved.

b) Select one of the “Sub-Network” nodes, then choose “Insert from File” from the menu whose name corresponds to the name of the selected node. A new node is added just before the selected node. Its name and its whole configuration are identical to those of the Modbus slave, as it was configured when it was saved.

You will then change (1) the name of the node, (2) the address of the corresponding Modbus slave and (3) the location of the data exchanged between the gateway’s memory and this Modbus slave. All of these operations are described in chapter 6.10 Changing a Modbus slave Configuration, page 60, and in chapter 6.11 Adding and Setting Up a Modbus Command, page 62.

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6.8. Changing the Periodic Data Exchanged With a Modbus Slave

This operation consists of replacing, adding or deleting periodic data exchanged with one of the Modbus slaves. With each of these operations, we shall take the default configuration of the LUFP9 gateway as an example, that is to say that any changes previously made will have been cancelled at the start of each operation. In addition, the operations to be carried out are shown as part of a targeted example.

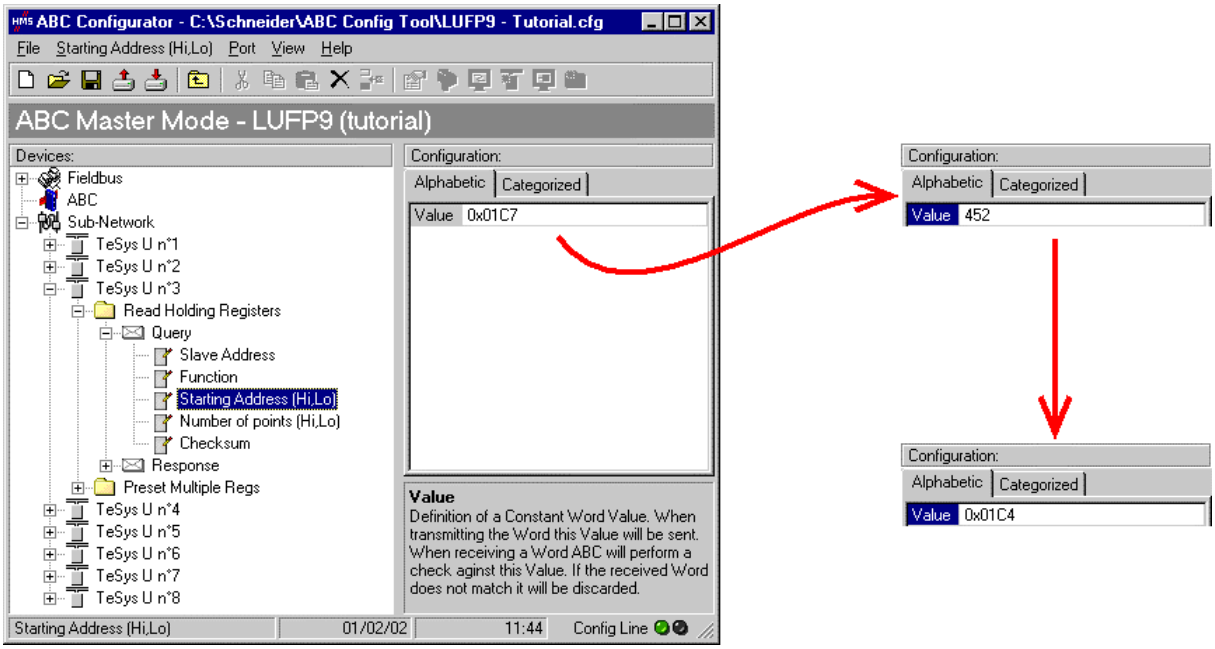
You must never forget to save the changes you have made, or to transfer the whole configuration to the gateway. This will allow you to check that the configuration is valid.

6.8.1. Replacing a Periodic Input Data Element

E.g. “TeSys U n°3” motor starter. We are trying to replace the monitoring of the “TeSys U Status Register” (address 455 = 16#01C7) with the monitoring of the “1st Fault Register” (address 452 = 16#01C4).

The operation is a very simple one and consists purely of changing the value of the “Starting Address (Hi, Lo)” element of the “Query” from the “Read Holding Registers” command (Modbus command for reading the values of a number of registers).

Select this element, then change its value as shown below. You can enter the address of the parameter in decimal format. AbcConf will automatically convert it to hexadecimal.



This operation in no way changes the content of the gateway’s memory, because we do not need to change the values of the “Data length” and “Data location” fields of the “Data” element of the “Response” to the aforementioned command. So no additional operations will be necessary, either in AbcConf, or in RsNetWorx.

On the other hand, the DeviceNet master PLC software will have to take account of the change in the nature of the corresponding input. In the chapter 8.2.1 Input Data Memory Area, page 84, the description of the word located at address 16#0006 becomes “value of the motor starter ③ 1st default register.” This word corresponds to the PLC input word I:1.4 (see chapter 4.2.6 Configuring Inputs from the Gateway, page 29).

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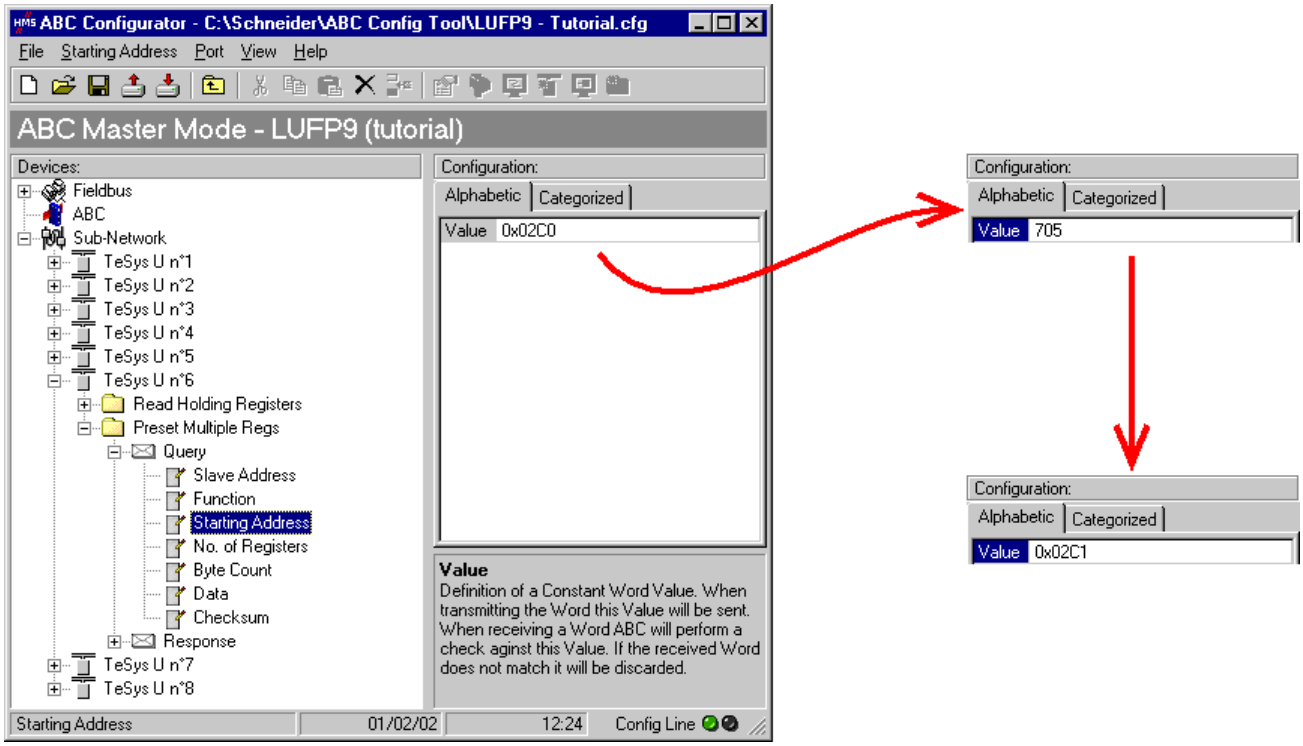
6.8.2. Replacing an Output Periodic Data Element

E.g. “TeSys U n°6” motor starter. We are trying to replace the control of the “Command Register” (address 704 = 16#02C0) with the control of the “2nd Command Register” (address 705 = 16#02C1).

The operation consists of changing the value of the “Starting Address” in the “Query” and in the “Response” for the “Preset Multiple Registers” command (Modbus command for writing values from a number of registers).

Select “Starting Address” from the “Query”, then change its value as shown below. You can enter the address of the parameter in decimal format. AbcConf will automatically convert it to hexadecimal. **Do the same for the “Starting Address” element of the “Response”** because the gateway checks the value of this field when it receives each Modbus response. If the value does not correspond to that of the query, the gateway will ignore the response.



This operation in no way changes the content of the gateway’s memory, because we do not need to change the values of the “Data length” and “Data location” fields of the “Data” element of the “Query”. So no additional operations will be necessary, either in AbcConf, or in RsNetWorx.

On the other hand, the DeviceNet master PLC software will have to take account of the change in the nature of the corresponding output. In chapter 8.2.2 Output Data Memory Area, page 85, the description of the word located at address 16#020C becomes “value of the motor starter ⑥ 2nd command register.” This word corresponds to PLC output word O:1.7 (see chapter 4.2.7 Configuring Outputs Intended for the Gateway, page 30).

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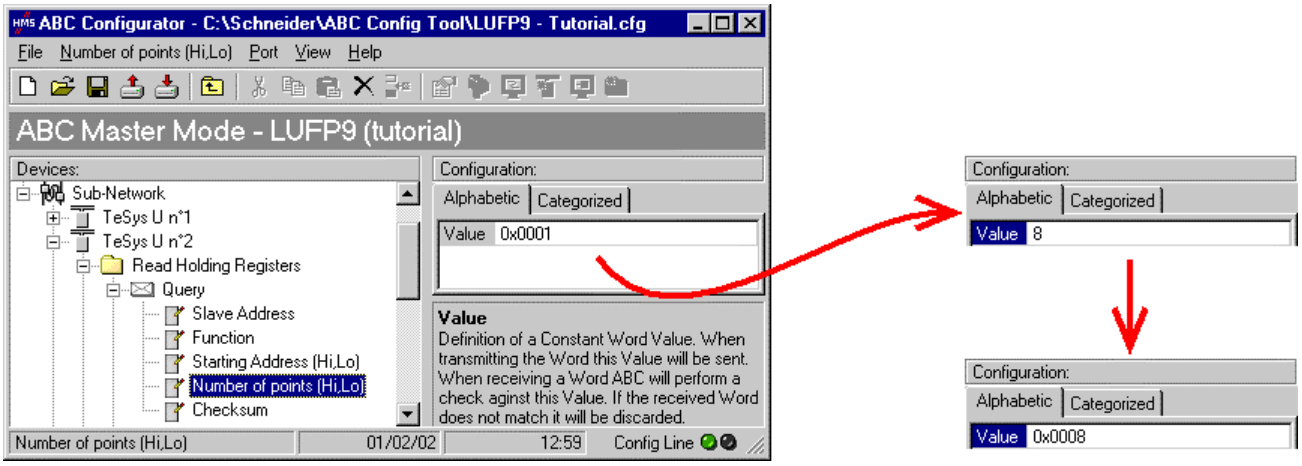
6.8.3. Increasing the Amount of Periodic Input Data

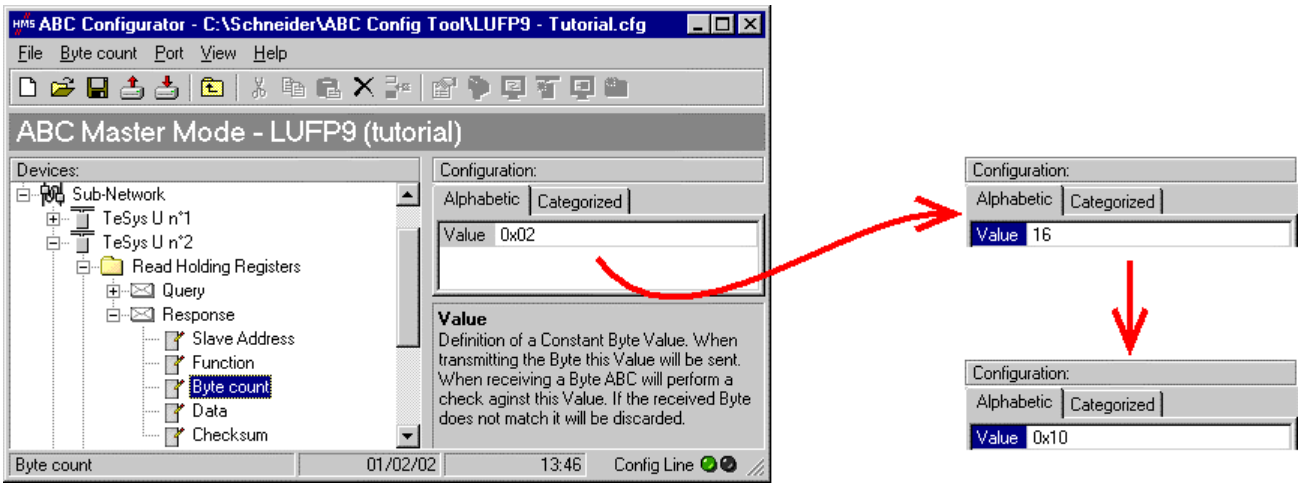
E.g. “TeSys U no. 2” motor starter. We are trying to complete the monitoring of this motor starter starting from the currently monitored register, that is to say “TeSys U Status Register” (address 455 = 16#01C7), and going as far as the “Reserved: 2nd Warning Register” (address 462 = 16#01CE). The number of registers monitored is therefore increased from 1 to 8.

In this case, there are quite a lot of operations to be carried out. They are described in order below:

1) Changing the number of registers monitored: This step consists of changing the value of “Number of points (Hi, Lo)” element of the “Query” from the “Read Holding Registers” command (Modbus command for reading the values of a number of registers). Select this element, then change its value as shown below. AbcConf will automatically convert any value entered in decimal to hexadecimal.



2) Changing the number of data bytes in the Modbus response: The number of bytes read from the “TeSys U n°2” motor starter memory increases from 2 to 16, as the number of registers monitored has increased from 1 to 8. Select the “Byte count” element from the “Response” and change its value as shown below. AbcConf will automatically convert any value entered in decimal to hexadecimal.



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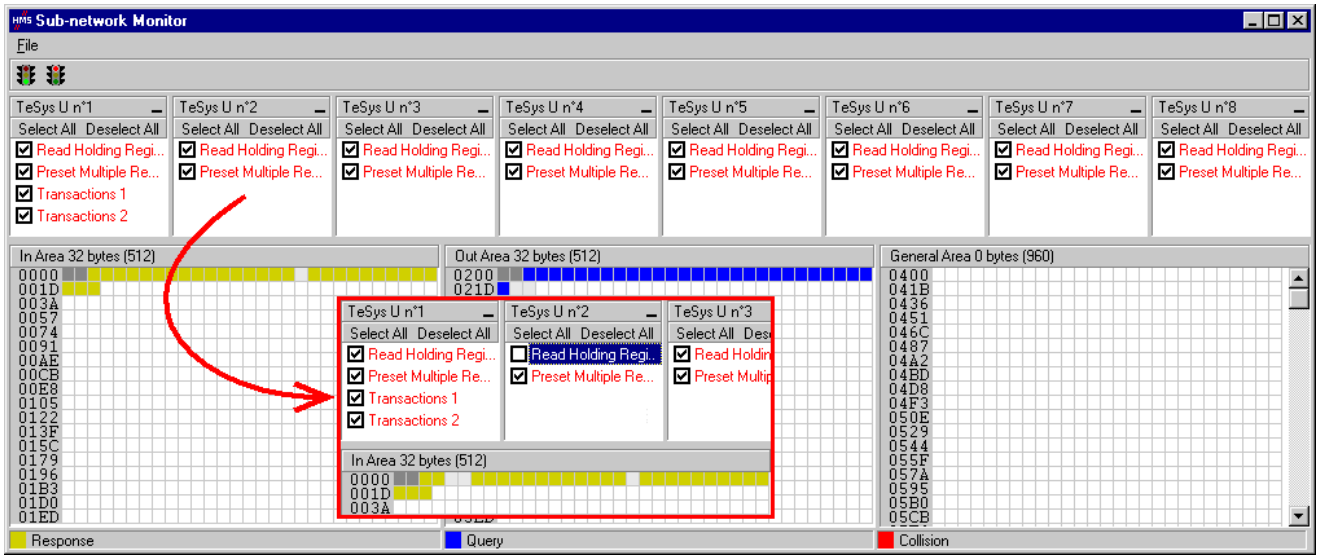
3) Changing the location of the Modbus data received in the gateway's memory: As the number of bytes read (see previous step) has increased from 2 to 16, the Modbus data received must be placed at a different location in the gateway's memory, and the size of the memory occupied must also be adjusted appropriately.

   If you are not certain how much of the gateway's memory is currently occupied, select "Sub-Network" and choose "Monitor" from the "Sub-Network" menu. The following window appears, allowing you to see how much of the gateway's memory is occupied.



   To see which memory locations are occupied by data from the command you are interested in, all you have to do is uncheck the box corresponding to the "Read Holding Registers" command from the "TeSys U n°2" node, as shown above. We can see that the Modbus data received in response to this command occupy 2 bytes located from address 16#0004.

   The memory locations 16#0000 and 16#0001 are reserved (see chapter 5 Gateway Initialization and Diagnostics, page 33). So you will not be able to place any Modbus data in these locations.

   The sizes displayed above the graphics areas of this window ("In Area 32 bytes" and "Out Area 32 bytes") correspond to the total input and ouput sizes you must check under RsNetWorx (see point 6) on next page) and configure for the DeviceNet scanner (see point 7)).

If you wish to place the 16 bytes of Modbus data which will be received by the gateway for this command into memory, once the changes have been made, we will have to move all the other input data by 14 bytes, which may be tedious, or change the memory location of the block of data received. In the example described here, we will be using the second solution, although the first solution is actually preferable, in principle, as it avoids leaving any "holes" in the gateway's memory, thus optimising the transfer of all of the data to the DeviceNet master PLC. Furthermore, the 1747-SDN scanner can only exchange 32 input words with the master PLC. Leaving "holes" of this sort in the gateway's memory is therefore not recommended in cases of large configurations.

So we will be placing the 16 bytes of data from address 16#0020 (32 in decimal), that is to say directly after the input data for the gateway's default configuration.

Close the "Sub-network Monitor" window, then once you are back in the main AbcConf window, select the "Data length" and "Data location" fields of the "Data" element from the "Response" one after another and change their values as shown at the top of the next page. AbcConf will automatically convert any value entered in decimal to hexadecimal.

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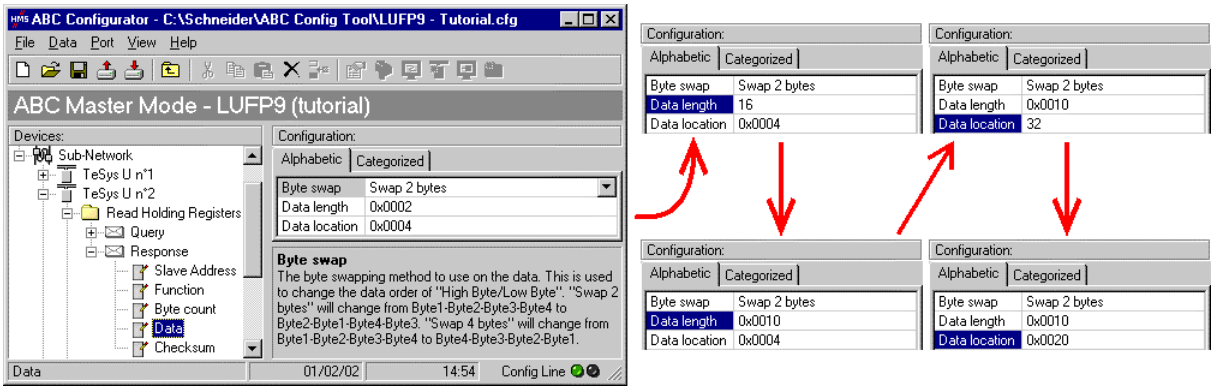
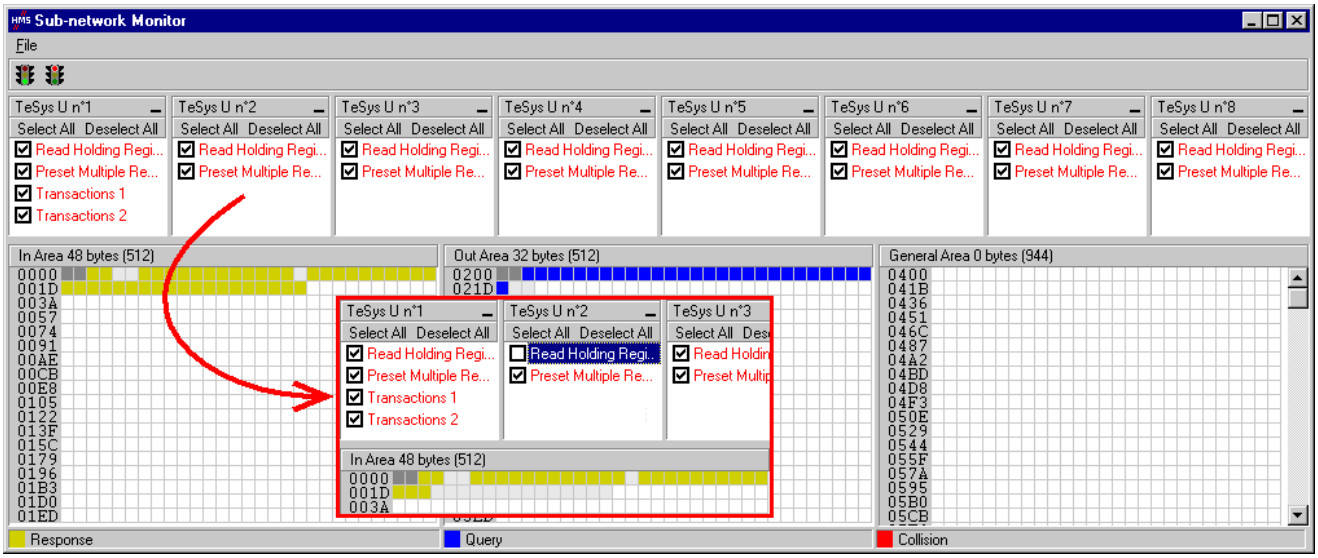


To check that these changes have been entered into the configuration, choose "Monitor" from the "Sub-Network" menu again:



In point 6), you shall make sure the values of the displayed parameters are the same as the exchange sizes displayed in the "Sub-network Monitor." In the current example, "In Area 48 bytes" imply that the "Input1" area begins at offset 0 (physical address 16#0000) and that its length is equal to 48 bytes. Also, "Out Area 32 bytes" imply that the "Output1" area begins at offset 0 (physical address 16#0200) and that its length is equal to 32 bytes.

4) Transferring this configuration to the gateway Please see chapter 6.4 Transferring a Configuration to the Gateway, page 43. Check that the configuration is valid (LED ❻ DEVICE STATUS flashing green).

5) Saving this configuration to your PC's hard disk.

6) Checking the gateway setup: In RsNetWorx, check the values of the gateway parameters (see chapter 4.2.4 Editing gateway parameters, page 26). Only the value of parameter no. 7, "Input1 length", should have changed, from "32 bytes" to "48 bytes".

7) Changing the amount of data received by the DeviceNet scanner: Still in RsNetWorx, change the value for the amount of periodic data received by the DeviceNet scanner (see chapter 4.2.5 Configuring the DeviceNet Scanner, page 28). Change the value of the "Rx Size:" field from 32 to 48, in the "Polled:" section.

8) Configuring the DeviceNet master PLC inputs: In RsNetWorx, establish a new correspondence between the data from the gateway and the PLC inputs, according to the requirements of your application (see chapter 4.2.6 Configuring Inputs from the Gateway, page 29). The various possibilities offered by RsNetWorx for establishing a correspondence between the data from a DeviceNet subscriber and the PLC inputs will not be covered here. Please see the documentation for this software application to find out more about this step in setting up a DeviceNet master PLC.

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6. Configuring the Gateway

In this guide, we will be using the "AutoMap" command to establish a "raw" correspondence with all of the data from the LUFP9 gateway. We then get the correspondence shown below, derived from the one used with the gateway's default configuration. The changes in relation to the default configuration are shown by a greyed-out background, like the "free memory locations".

Service	PLC input	Description	
		Bit 0.....**Bit 7**	**Bit 8** .....**Bit 15**
Managing the downstream Modbus network	**I:1.1**	LUFP9 gateway status word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Monitoring of TeSys U motor starters	**I:1.2**	Value of the motor starter ① status register	
	I:1.3	Free memory location	
	I:1.4	Value of the motor starter ③ status register	
	I:1.5	Value of the motor starter ④ status register	
	I:1.6	Value of the motor starter ⑤ status register	
	I:1.7	Value of the motor starter ⑥ status register	
	I:1.8	Value of the motor starter ⑦ status register	
	I:1.9	Value of the motor starter ⑧ status register	
Aperiodic communications — Reading the value of a motor starter parameter (RESPONSE)	**I:1.10**	Free memory location	Slave no. (16#01-16#08)
	I:1.11	Function number (16#03)	Number of bytes read (16#02)
	I:1.12	Value of the parameter read (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications — Writing the value of a motor starter parameter (RESPONSE)	**I:1.13**	Slave no. (16#01-16#08)	Function no. (16#06)
	I:1.14	Address of the parameter written (MSB → 16#xx••)	(LSB → 16#••xx)
	I:1.15	Value of the parameter written (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications ("Trigger bytes" for the responses)	**I:1.16**	Read parameter response counter	Write parameter response counter
Periodic communications — Monitoring of TeSys U motor starter ②	**I:1.17**	Value of the "TeSys U Status Register"	
	I:1.18	Value of the "Complementary Status Register"	
	I:1.19	Value of the "K7 Status Register"	
	I:1.20	Value of the "K7 Status Register 2 (free format)"	
	I:1.21	Value of the "K7 Status Register 3 (free format)"	
	I:1.22	Value of the "Warning Number" register	
	I:1.23	Value of the "Warning Register"	
	I:1.24	Value of "Reserved : 2nd Warning Register"	

9) Transferring the DeviceNet scanner configuration: Following the changes made to the list of DeviceNet scanner exchanges, it needs to be transferred to the DeviceNet scanner. Please see chapter 4.2.9 Transferring the DeviceNet Scanner Configuration, page 32.

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6.8.4. Increasing the amount of periodic output data

E.g. "TeSys U n°4" motor starter. We are attempting to complete the control for this motor starter whilst retaining the currently controlled "Command Register" (address 704 = 16#02C0), and adding the following next register, that is to say "2st Command Register" (address 705 = 16#02C1). The number of registers controlled is therefore increased from 1 to 2.

There are quite a lot of operations to be carried out. They are described in order below:

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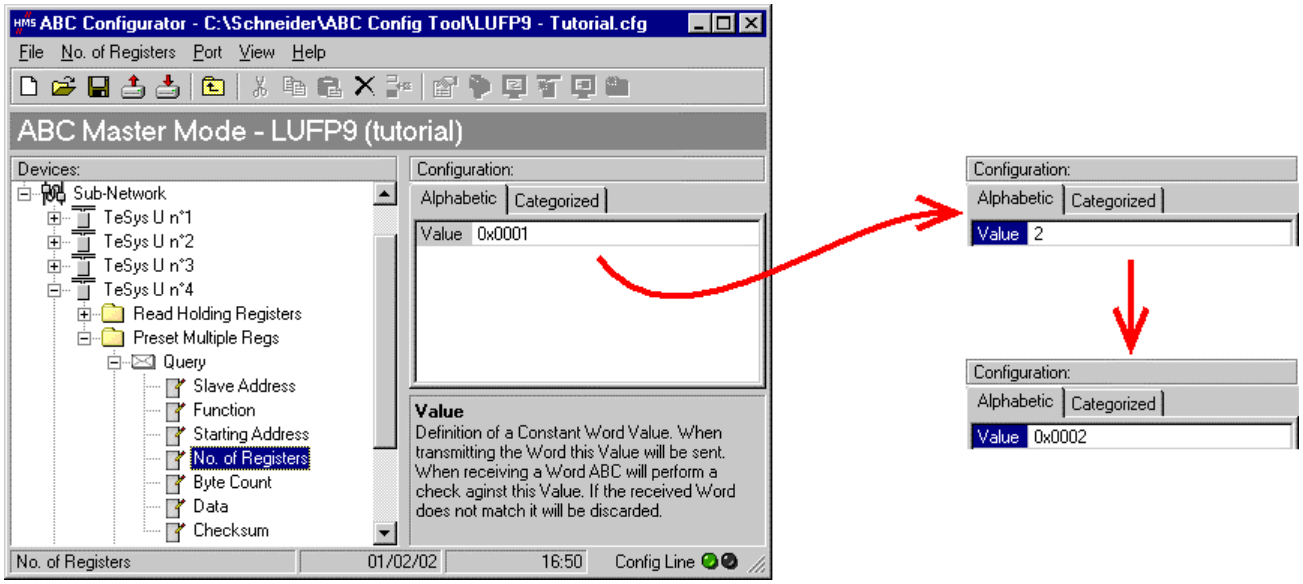
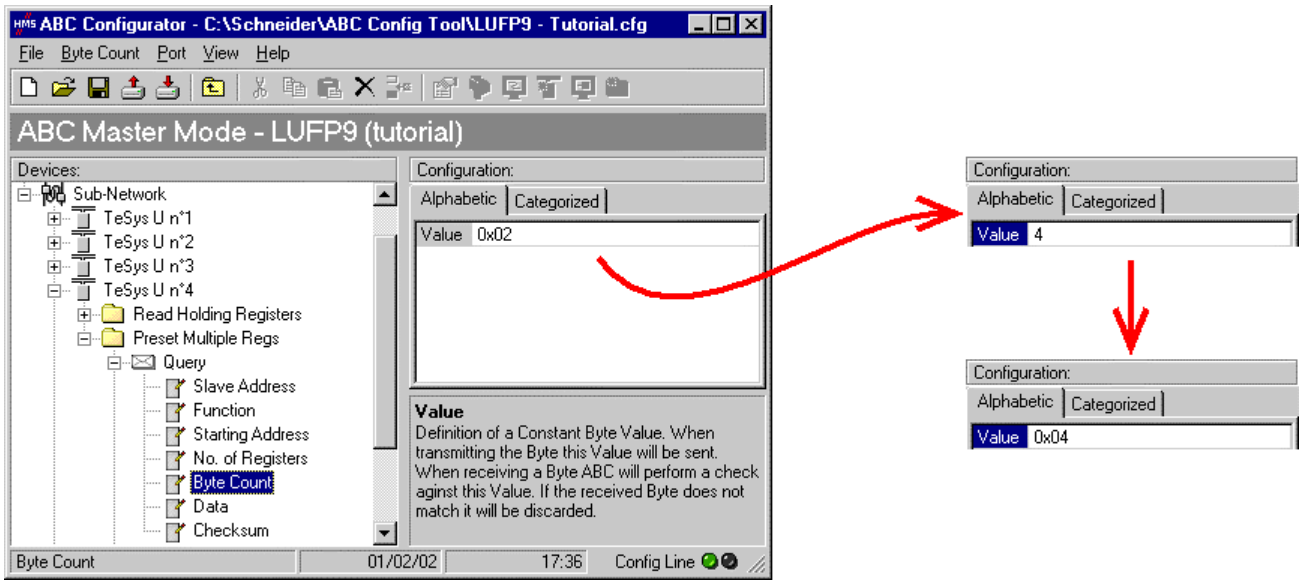
1) Changing the number of registers controlled: This step consists of changing the value of the “No. of Registers” in the “Query” and in the “Response” for the “Preset Multiple Registers” command (Modbus command for writing values of a number of registers). Start by selecting “Starting Address” from the “Query”, then change its value as shown below. AbcConf will automatically convert any value entered in decimal to hexadecimal. **Do the same for the “Starting Address” element of the “Response”** because the gateway checks the value of this field when it receives each Modbus response. If the value does not correspond to that of the query, the gateway will ignore the response.



2) Changing the number of data bytes in the Modbus query: The number of bytes written into the memory of the “TeSys U n°4” motor starter memory increases from 2 to 4, as the number of registers controlled has increased from 1 to 2. Select the “Byte count” element from the “Query” and change its value as shown below. AbcConf will automatically convert any value entered in decimal to hexadecimal.



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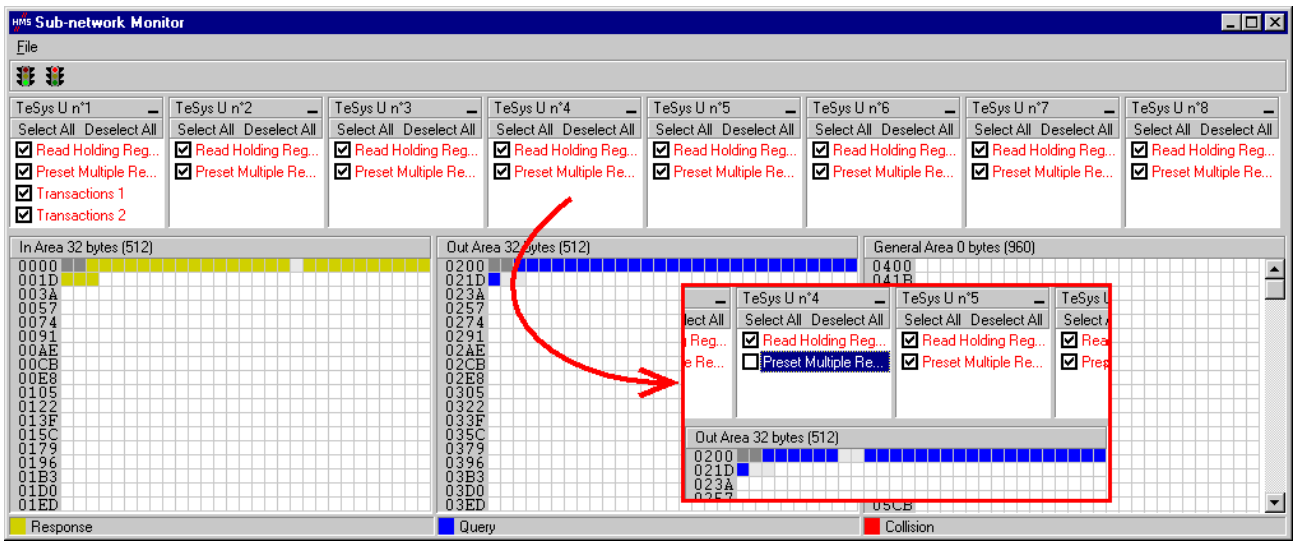
3) Changing the location of the Modbus data transmitted into the gateway's memory: As the number of bytes written (see previous step) has increased from 2 to 4, the Modbus data to be transmitted to the "TeSys U n°4" motor starter must be placed at a different location in the gateway's memory, and the size of the memory occupied must also be adjusted appropriately.

If you are not certain how much of the gateway's memory is currently occupied, select "Sub-Network" and choose "Monitor" from the "Sub-Network" menu. The window shown below appears, allowing you to see how much of the gateway's memory is occupied.



To see which memory locations are occupied by data from the command you are interested in, all you have to do is uncheck the box corresponding to the "Preset Multiple Registers" command from the "TeSys U n°4" node, as shown above. We can see that the Modbus data transmitted with the query corresponding to this command occupy 2 bytes located from address 16#0208.

Memory locations 16#0200 and 16#0201 are reserved (see chapter 5 Gateway Initialization and Diagnostics, page 33). So you will not be able to place any Modbus data in these locations.

The sizes displayed above the graphics areas of this window ("In Area 32 bytes" and "Out Area 32 bytes") correspond to the total input and ouput sizes you must check under RsNetWorx (see point 6) on next page) and configure for the DeviceNet scanner (see point 7)).

If you wish to place the 4 bytes of Modbus data which will be transmitted by the gateway for this command into memory, once the changes have been made, we will have to move all the other output data by 2 bytes, which may be tedious, or change the memory location of the block of data transmitted. In the example described here, we will be using the second solution, although the first solution is actually preferable, in principle, as it avoids leaving any "holes" in the gateway's memory, thus optimising the transfer of all of the data from the DeviceNet master PLC. Furthermore, the 1747-SDN scanner can only exchange 32 output words with the master PLC. Leaving "holes" of this sort in the gateway's memory is therefore not recommended in cases of large configurations.

We will place the 4 bytes of data from address 16#0220 (544 in decimal). **N.B.** As far as possible, place the data at even addresses in order to align the Modbus data (in 16-bit format) on the O:1.x outputs of the 1747-SDN DeviceNet scanner.

Close the "Sub-network Monitor" window, then once you are back in the main AbcConf window, select the "Data length" and "Data location" fields of the "Data" element from the "Query" one after another and change their values as shown at the top of the next page. AbcConf will automatically convert any value entered in decimal to hexadecimal.

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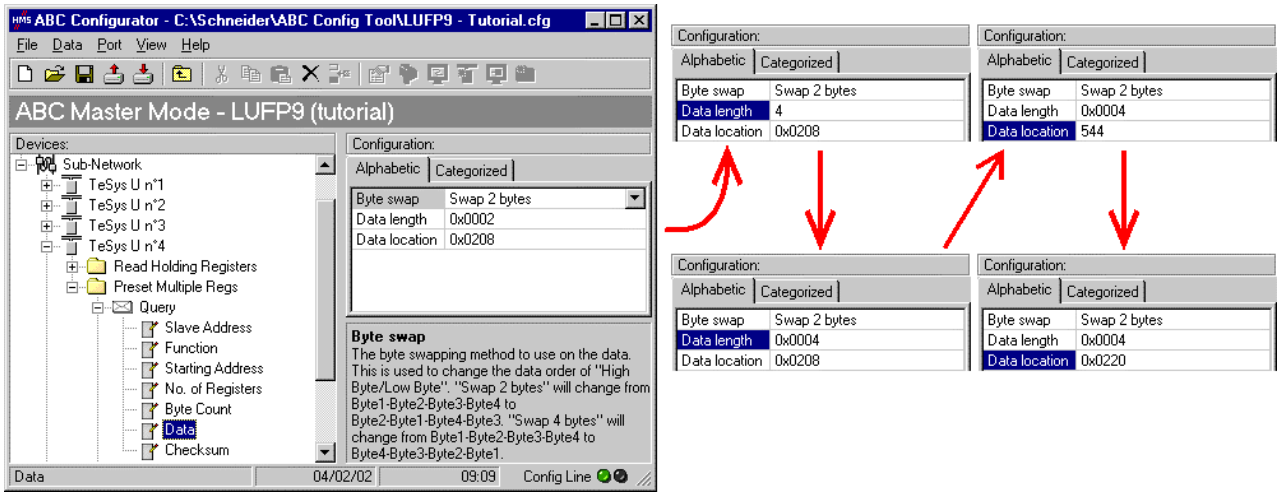
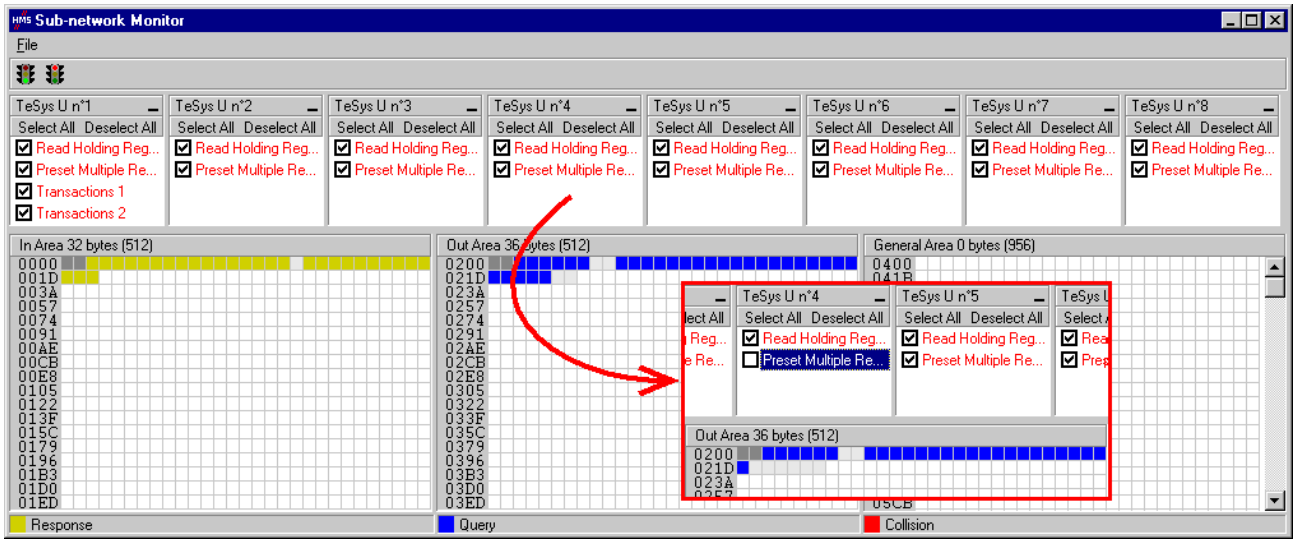


To check that these changes have been entered into the configuration, choose "Monitor" from the "Sub-Network" menu again:



In point 6), you shall make sure the values of the displayed parameters are the same as the exchange sizes displayed in the "Sub-network Monitor." In the current example, "In Area 32 bytes" imply that the "Input1" area begins at offset 0 (physical address 16#0000) and that its length is equal to 32 bytes. Also, "Out Area 36 bytes" imply that the "Output1" area begins at offset 0 (physical address 16#0200) and that its length is equal to 36 bytes.

4) Transferring this configuration to the gateway Please see chapter 6.4 Transferring a Configuration to the Gateway, page 43. Check that the configuration is valid (LED ❻ DEVICE STATUS flashing green).

5) Saving this configuration to your PC's hard disk.

6) Checking the gateway setup: In RsNetWorx, check the values of the gateway parameters (see chapter 4.2.4 Editing gateway parameters, page 26). Only the value of parameter no. 19, "Output1 length", should have changed, from "32 bytes" to "36 bytes".

7) Changing the amount of data transmitted by the DeviceNet scanner: Still in RsNetWorx, change the value for the amount of periodic data transmitted by the DeviceNet scanner (see chapter 4.2.5 Configuring the DeviceNet Scanner, page 28). Change the value of the "Tx Size:" field from 32 to 36, in the "Polled:" section.

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8) Configuring the DeviceNet master PLC outputs: In RsNetWorx, establish a new correspondence between the data transmitted to the gateway and the PLC outputs, according to the requirements of your application (see chapter 4.2.7 Configuring Outputs Intended for the Gateway, page 30). The various possibilities offered by RsNetWorx for establishing a correspondence between the data transmitted to a DeviceNet subscriber and the PLC outputs will not be covered here. Please see the documentation for this software application to find out more about this step in setting up a DeviceNet master PLC.

   In this guide, we will be using the "AutoMap" command to establish a "raw" correspondence with all of the data transmitted to the LUFP9 gateway. We then get the correspondence shown below, derived from the one used with the gateway's default configuration. The changes in relation to the default configuration are shown by a greyed-out background, like the "free memory locations".

Service	PLC output	Description	
		Bit 0.....Bit 7	**Bit 8 .....Bit 15**
Managing the downstream Modbus network	**O:1.1**	DeviceNet master command word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Controlling TeSys U motor starters	**O:1.2**	Value of the motor starter ① command register	
	O:1.3	Value of the motor starter ② command register	
	O:1.4	Value of the motor starter ③ command register	
	O:1.5	Free memory location	
	O:1.6	Value of the motor starter ⑤ command register	
	O:1.7	Value of the motor starter ⑥ command register	
	O:1.8	Value of the motor starter ⑦ command register	
	O:1.9	Value of the motor starter ⑧ command register	
Aperiodic communications — Reading the value of a motor starter parameter (QUERY)	**O:1.10**	Slave no. (16#01-16#08)	Function no. (16#03)
	O:1.11	Address of the parameter to be read (MSB → 16#xx••)	(LSB → 16#••xx)
	O:1.12	Number of parameters to be read (MSB → 16#00••)	(LSB → 16#••01)
Aperiodic communications — Writing the value of a motor starter parameter (QUERY)	**O:1.13**	Slave no. (16#01-16#08)	Function no. (16#06)
	O:1.14	Address of the parameter to be written (MSB → 16#xx••)	(LSB → 16#••xx)
	O:1.15	Value of the parameter to be written (MSB → 16#xx••)	(LSB → 16#••xx)
Aperiodic communications ("Trigger bytes" for the queries)	**O:1.16**	Read parameter query counter	Write parameter query counter
Periodic communications Monitoring of TeSys U motor starter ④	**O:1.17**	Value of the "Command Register"	
	O:1.18	Value of the "2nd Command Register"	

9) Transferring the DeviceNet scanner configuration: Following the changes made to the list of DeviceNet scanner exchanges, it needs to be transferred to the DeviceNet scanner. Please see chapter 4.2.9 Transferring the DeviceNet Scanner Configuration, page 32.

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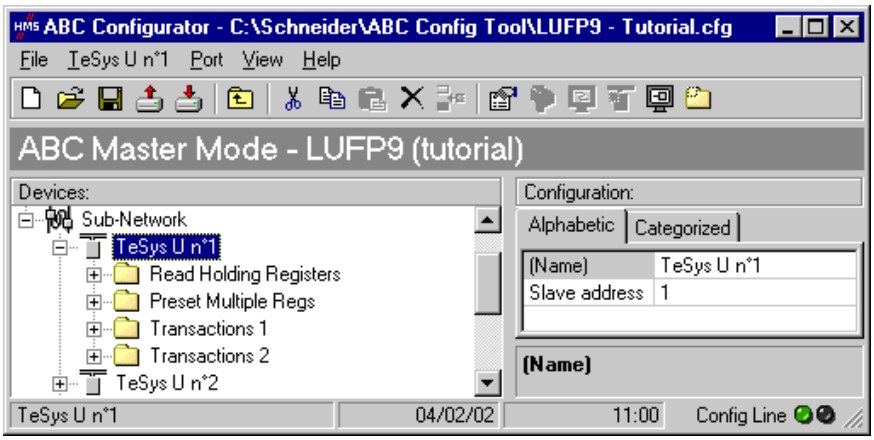
6.9. Deleting Aperiodic Parameter Data

If your PLC application does not need the aperiodic service for reading/writing parameter data on Modbus slaves, you can delete the associated commands. If you also intend to add Modbus data, and therefore use new locations in the gateway's memory, it is preferable to delete the aperiodic commands from the start, so that you can reuse the memory locations.

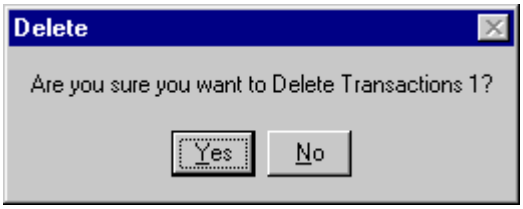
On the other hand, if the only configuration operation you wish to carry out on the LUFP9 gateway consists of not using the aperiodic service for parameter data, you can simply not use this service in RsNetWorx. Go straight on to step 8). In fact the Modbus exchanges associated with this setup will not be carried out if the associated data is not changed by the DeviceNet master PLC. So deleting associated Modbus commands becomes optional.

The operations you will need to carry out are described in order below:

1) Displaying parameter data commands: Select the very first node of the downstream Modbus network, "TeSys U n°1", and expand the tree structure showing its commands and transactions. The screen should look like the one below:



2) Deleting the read command for a parameter: Select the personalized "Transactions 1" command and delete it with the "Del" key (or "Delete" from the menu whose name corresponds to the name of the selected node). A request for confirmation appears, asking you whether or not to proceed deleting the "Transactions 1" command. In this case confirm with the "Yes" button.



3) Deleting the write command for a parameter: Back in the main AbcConf window, the "Transactions 1" command has been deleted. The second personalised command, "Transactions 2" is automatically renamed "Transactions 1", but retains all of its setup. Now delete this one in the same way as you did with the previous command.

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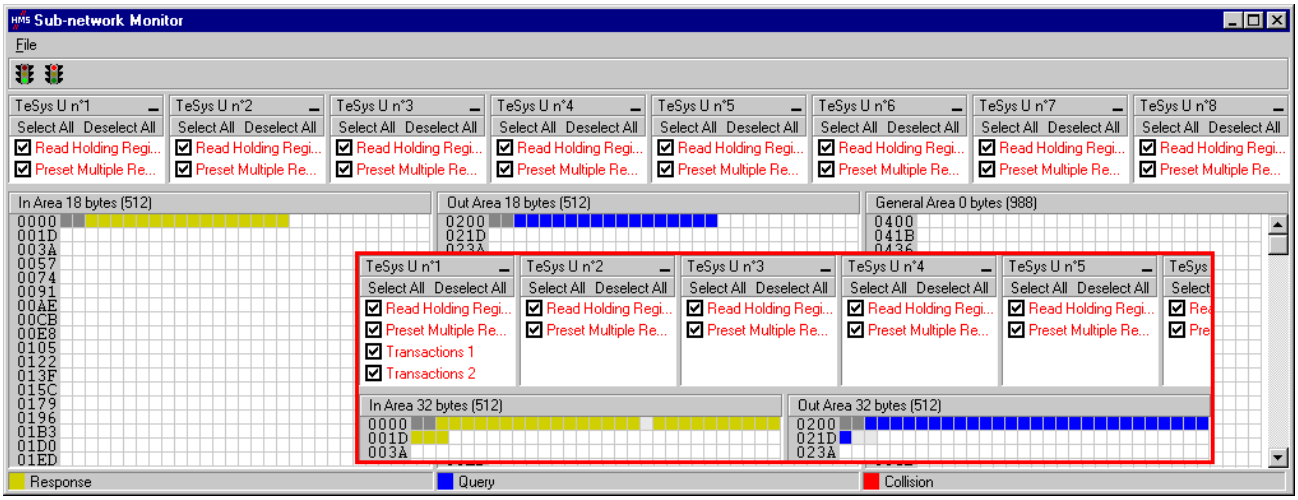
4) Checking the new memory occupation: If you wish to check how much of the gateway's memory is now occupied, select "Sub-Network" and choose "Monitor" from the "Sub-Network" menu. The following window appears, allowing you to see how much of the gateway's memory is occupied by Modbus data. The part framed in red represents the memory occupation before the deletion of the two setup commands. It has been inlaid in the illustration below so that you can see the effects of the deletion operations we have just carried out.



You will note that the "TeSys U n°1" section now only has the two Modbus commands common to the eight TeSys U motor starters, and that the memory locations which corresponded to the two personalised commands are now free.

N.B. The free memory location at address 16#0012 in the gateway's memory is no longer part of the gateway's inputs, because there is no input data used beyond this address.

5) Transferring this configuration to the gateway Please see chapter 6.4 Transferring a Configuration to the Gateway, page 43. Check that the configuration is valid (LED ❻ DEVICE STATUS flashing green).

6) Saving this configuration to your PC's hard disk.

7) Checking the gateway setup: In RsNetWorx, check the values of the gateway parameters (see chapter 4.2.4 Editing gateway parameters, page 26). The value of parameter no. 7, "Input1 length", should have changed, from "32 bytes" to "18 bytes". The value of parameter no. 19, "Output1 length", should have changed, from "32 bytes" to "18 bytes".

8) Changing the amount of data received and the amount of data transmitted by the DeviceNet scanner: Still in RsNetWorx, change the value for the amount of periodic data received and the amount of periodic data transmitted by the DeviceNet scanner (see chapter 4.2.5 Configuring the DeviceNet Scanner, page 28). In the "Polled:" section, change the value of the "Rx Size:" field from 32 to 18 and the value of the "Tx Size:" field from 32 to 18.

9) Configuring the DeviceNet master PLC inputs and outputs: In RsNetWorx, establish a new correspondence between the data from the gateway and the PLC inputs (see chapter 4.2.6 Configuring Inputs from the Gateway, page 29). Do the same for the correspondence between the data transmitted to the gateway and the PLC outputs (see chapter 4.2.7 Configuring Outputs Intended for the Gateway, page 30).

We then get the two correspondences shown on the next page, derived from those used with the gateway's default configuration.

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6. Configuring the Gateway

Service	PLC input	Description	
		Bit 0 ..... Bit 7	Bit 8 .....Bit 15
Managing the downstream Modbus network	I:1.1	LUFP9 gateway status word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Monitoring of TeSys U motor starters	I:1.2	Value of the motor starter ① status register	
	I:1.3	Value of the motor starter ② status register	
	I:1.4	Value of the motor starter ③ status register	
	I:1.5	Value of the motor starter ④ status register	
	I:1.6	Value of the motor starter ⑤ status register	
	I:1.7	Value of the motor starter ⑥ status register	
	I:1.8	Value of the motor starter ⑦ status register	
	I:1.9	Value of the motor starter ⑧ status register	

Service	PLC output	Description	
		Bit 0 ..... Bit 7	Bit 8 .....Bit 15
Managing the downstream Modbus network	O:1.1	DeviceNet master command word (MSB → 16#xx••)	(LSB → 16#••xx)
Periodic communications — Controlling TeSys U motor starters	O:1.2	Value of the motor starter ① command register	
	O:1.3	Value of the motor starter ② command register	
	O:1.4	Value of the motor starter ③ command register	
	O:1.5	Value of the motor starter ④ command register	
	O:1.6	Value of the motor starter ⑤ command register	
	O:1.7	Value of the motor starter ⑥ command register	
	O:1.8	Value of the motor starter ⑦ command register	
	O:1.9	Value of the motor starter ⑧ command register	

10) Transferring the DeviceNet scanner configuration: Following the changes made to the list of DeviceNet scanner exchanges, it needs to be transferred to the DeviceNet scanner. Please see chapter 4.2.9 Transferring the DeviceNet Scanner Configuration, page 32.

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6.10. Changing a Modbus slave Configuration

Configuring a Modbus slave itself remains very simple because it only involves the name and the Modbus address of the node to which it corresponds. On the contrary, configuring Modbus commands is much more complete and is the subject of a separate object of its own (see chapter 6.11 Adding and Setting Up a Modbus Command, page 62).

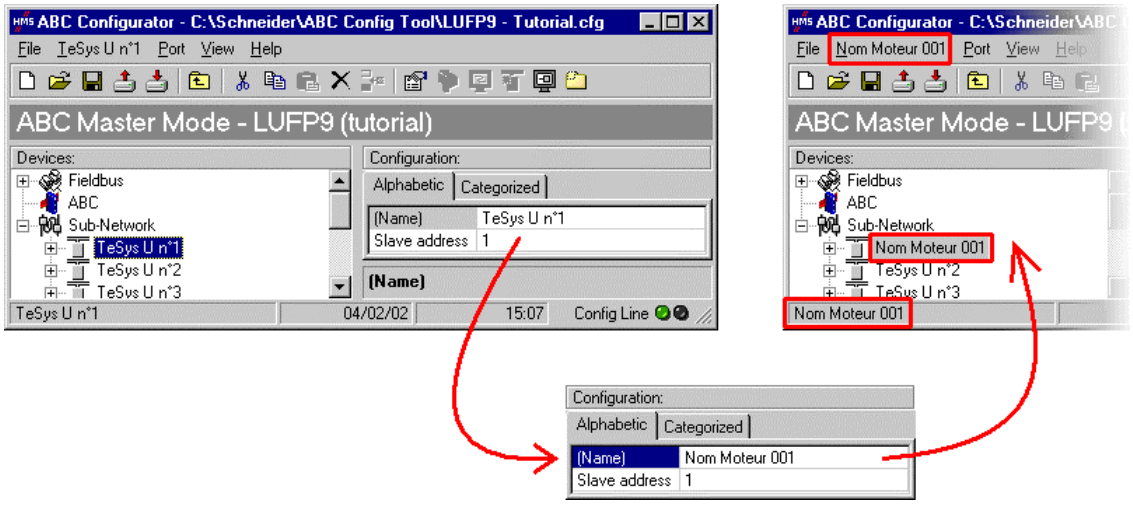
You will need to change the configuration of a Modbus slave when you add a new Modbus unit (see chapter 6.7 Adding a Modbus Slave, page 46), using any method.

Changing the name of the node which corresponds to a Modbus slave is used to distinguish it from the other nodes when the configuration of its Modbus commands has been changed, for instance.

6.10.1. Changing the Name of a Modbus Slave

To carry out this operation, all you have to do is select the node which corresponds to the Modbus slave involved ("Devices:" section), click on the current name (value of the "(Name)" field, in the "Configuration:" section), then change it. After confirming the new name ("Enter" key or click outside the name's data entry field), this will become effective in AbcConf, and the name of the node will be automatically updated in the "Devices:" section. An example is given at the top of the next page. The three red frames shown in this example show the consequences of the change made.

6. Configuring the Gateway



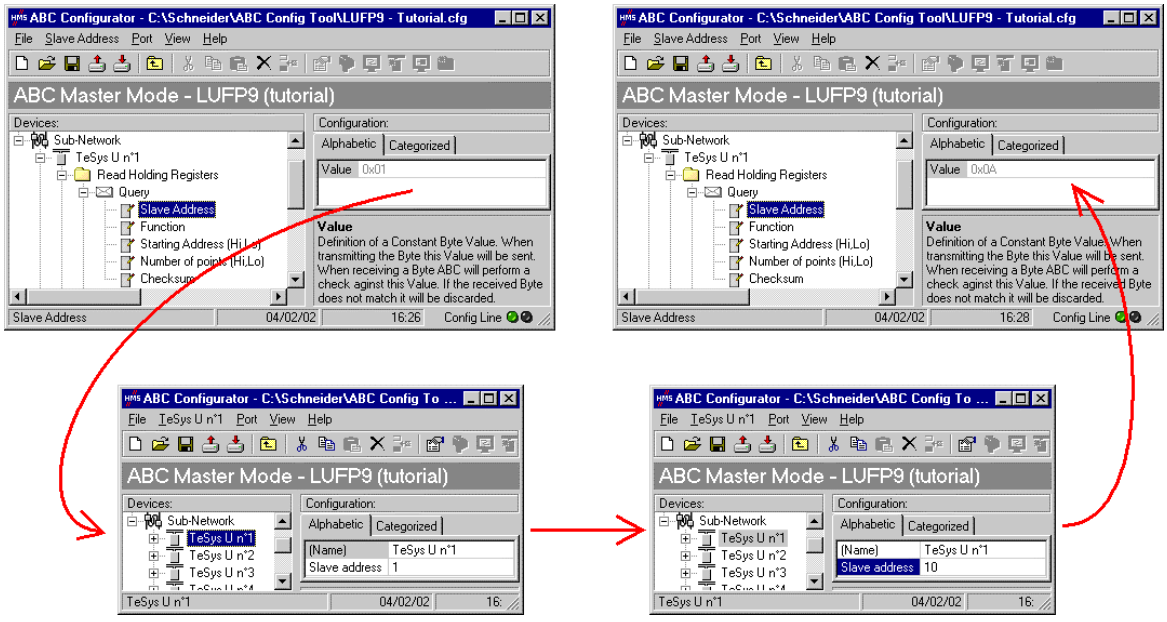
6.10.2. Changing the Address of a Modbus Slave

To carry out this operation, all you have to do is select the node which corresponds to the Modbus slave involved ("Devices:" section), click on the value of the current address (value of the "Slave address" field, in the "Configuration:" section), then change it.

Reminder: The address of a Modbus slave must be between 1 and 247.

If you use Modbus slaves belonging to the *Schneider Electric* Speed Variation range, such as Altistarts or Altivars, do not configure ANY slaves at the addresses 65, 126 or 127 on the same Modbus network as these products, because these addresses are reserved when using these products.

After confirming the new address ("Enter" key or click outside the data entry field of the address of the Modbus slave), this will become effective in AbcConf, and the values of the "Slave Address" elements of the queries and responses in the Modbus commands for the selected node will be automatically updated. An example is given below, but the updating of a single "Slave Address" element is shown:



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6.11. Adding and Setting Up a Modbus Command

6.11.1. With TeSys U Motor Starters

With TeSys U motor starters, the main use of adding a Modbus command consists of allowing you to control or monitor additional registers, without having to change the elements in the default configuration. So, the operation of the periodic and aperiodic communication services remains the same as for the default configuration, unlike the operations described in the various parts of chapter 6.8 Changing the Periodic Data Exchanged With a Modbus Slave, page 48.

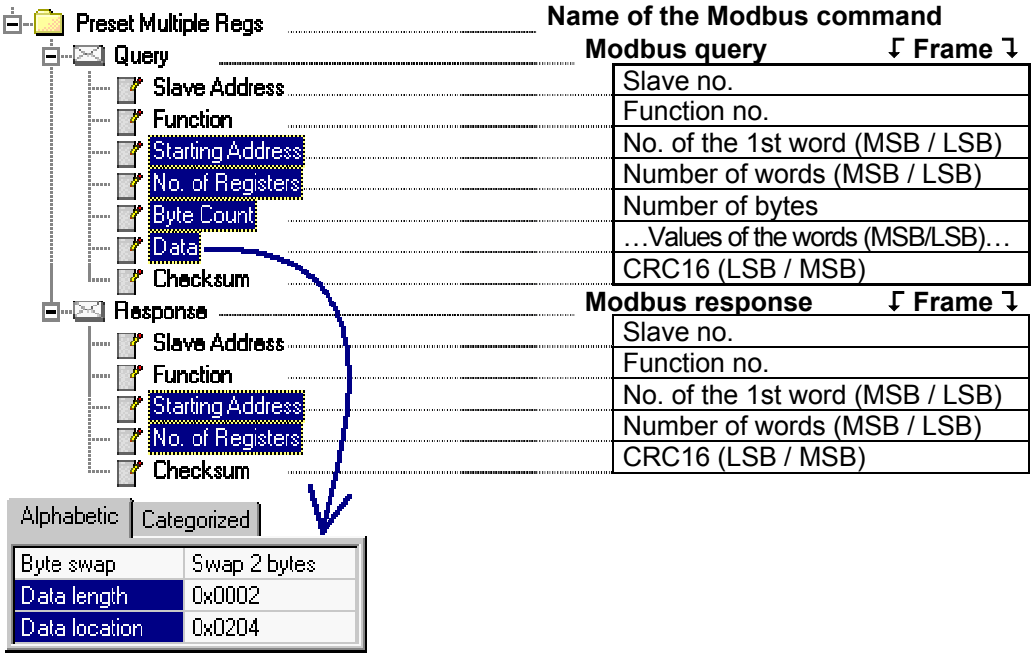
Instead of adding a command and fully configuring it, it is a better idea to copy one of the two default commands for TeSys U motor starters, “Read Holding Registers” (reading/monitoring) or “Preset Multiple Registers” (writing/controlling), and to paste it into the list of Modbus commands for the appropriate node.

To copy an already configured Modbus command, select it, then choose “Copy” from the menu whose name corresponds to the name of the selected command. **Keyboard shortcut:** “`Ctrl C`”. Then continue using one of the two methods shown below:

a) Select the node corresponding to the Modbus slave for which you wish to add this command (e.g. “TeSys U n°4”), then choose “Paste” from the menu whose name corresponds to the selected node. A new command is added after all the other configured commands for this node. The whole of its configuration is identical to that for the previously copied command. **Keyboard shortcut:** “`Ctrl V`”.

b) Select one of the commands for the node involved, then choose “Insert” from the menu whose name corresponds to the selected command. A new command is added just before the one which is selected. The whole of its configuration is identical to that for the previously copied command.

As the new Modbus command and the original Modbus command are identical, you will need to make changes to the fields highlighted in blue in one of the two following diagrams, depending on whether this is the “Preset Multiple Registers” command or a “Read Holding Registers” command (see chapter 6.8 Changing the Periodic Data Exchanged With a Modbus Slave, page 48). The correspondence between the various elements which appear in these tree structures and the standard Modbus terminology is located to their right:



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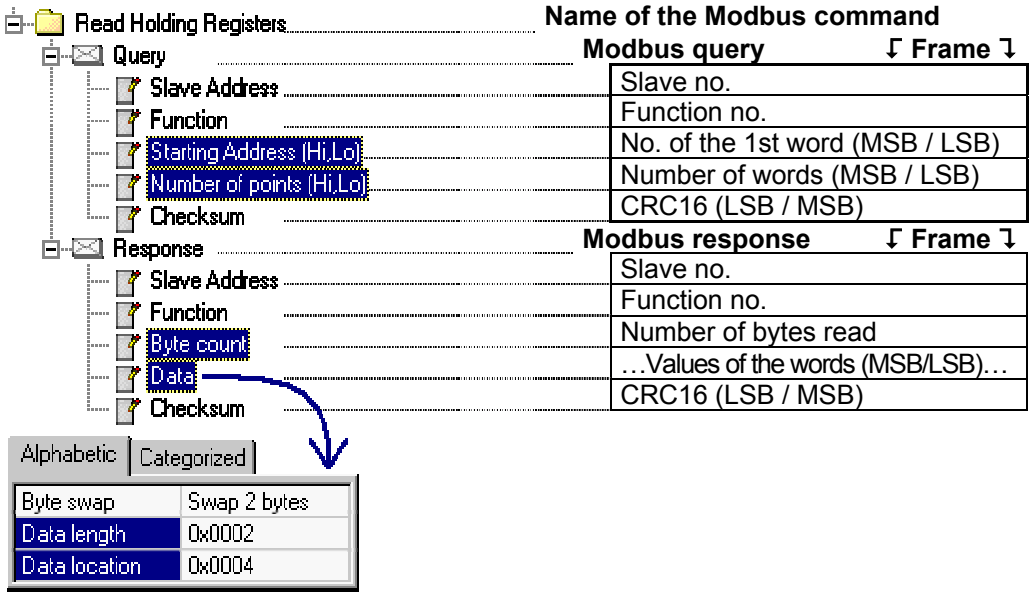

N.B. In all cases, the “Query / Slave Address” and “Response / Slave Address” elements are automatically updated by AbcConf according to the node in which the command is located. Their values cannot be changed by the user. In the same way, the “Query / Function” and “Response / Function” fields depend on the nature of the Modbus command and cannot be changed by the user.

The operations to be carried out are more or less the same as those consisting of changing the default commands. For the “Read Holding Registers” command, please see chapter 6.8.1 Replacing a Periodic Input Data Element, page 48, and chapter 6.8.3 Increasing the Amount of Periodic Input Data, page 50. For the “Preset Multiple Registers” command, please see chapter 6.8.2 Replacing an Output Periodic Data Element, page 49, and chapter 6.8.4 Increasing the amount of periodic output data, page 53.

6.11.2. With a Generic Modbus Slave

Unlike the previous chapter, here we will be looking at adding and setting up a Modbus command which is different from those configured by default with the LUFP9 gateway. We will benefit from this occasion to exhaustively describe the fields allowing you to set up the management of communications for a command of this sort.

Please see chapter 11 Appendix E: Modbus Commands, page 113, for a list of the Modbus functions supported by the LUFP9 gateway. If you need to use a command which is not supported by the gateway, you can configure one. A command of this sort is included in a specific element called “Transactions” or becomes a new Modbus command in its own right. Please see the next chapter, § 6.11.3 Adding a Special Modbus Command, page 73, for further details on this subject.

E.g. To illustrate the various operations to be carried out and the explanations given, we will be taking the example of a Altistart starter, the ATS48, and a Modbus command recognised both by the gateway and the ATS48. This is the “Preset Single Register” command, whose function code is 6 and which allows you to write the value of a unique output word. This function will be used to periodically write the value of the ATS48’s CMD command register, located at address W400 (address 400 = 16#0190).

Since the gateway’s default configuration already has 8 Modbus slaves, you will need to delete one of them, such as the “TeSys U n°2” node, for example, and to add a new node in its place (see chapter 6.6 Deleting a Modbus Slave, page 45, and chapter 6.7 Adding a Modbus Slave, page 46). **Reminder:** We strongly advise you not to delete the “TeSys U n°1” node, as it contains the commands corresponding to the read and write services for a parameter in a Modbus slave.

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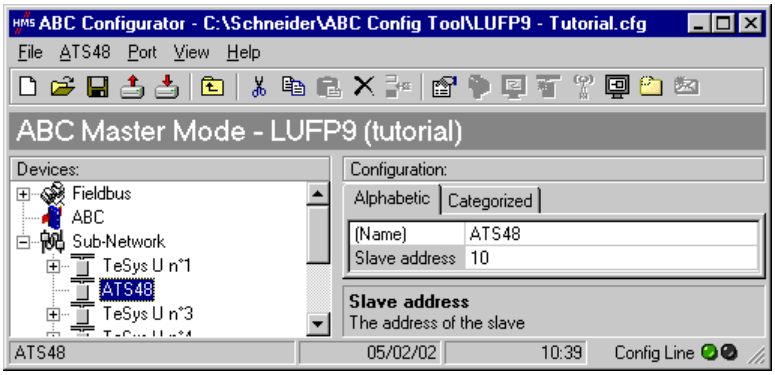
We rename the “New Node”, which has just been created, in “ATS48”, and we assign it the Modbus address 10, as shown here:

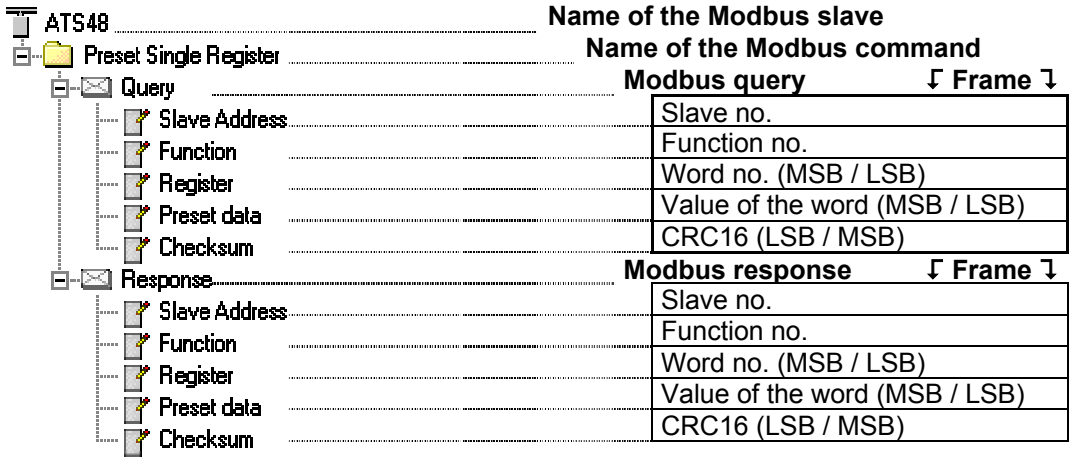


We then proceed to add the “Preset Single Register” command by choosing “Add Command” from the “ATS48” menu.

In the window which appears (shown opposite), select the “0x06 Preset Single Register” command and choose “Select” from the “File” menu.

Back in the main AbcConf window, the “Preset Single Register” command now appears in the list of Modbus commands for the “ATS48” node.

Expand the full tree structure for this command, shown below. The correspondence between the various elements which appear in this tree structure and the standard Modbus terminology is located to its right.



These elements can be configured using AbcConf. There is a description of them in the following chapters. We will then return to the example of the ATS48 to illustrate how to use these elements.

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6.11.2.1. Managing Degraded Modes

Due to the number of hardware elements and software tools used, the following table shows a summary of the various degraded modes in a DeviceNet application. In this case, this application includes an LUFP9 gateway, but we will not be including either the master PLC or its scanner:

<table>
<tr><th colspan="2" rowspan="2">Desired behaviour</th><th colspan="4">Event</th></tr>
<tr><th>DeviceNet PLC: CPU stop or failure</th><th>Disconnection of the upstream DeviceNet network (1)</th><th>Failure of the LUFP9 gateway (2)</th><th>Disconnection of the downstream Modbus RTU network (1) (2)</th></tr>
<tr><td rowspan="3">Outputs</td><td>Reset</td><td rowspan="2">Depending on the configuration of the DeviceNet master</td><td>“Offline options for fieldbus” = “Clear”</td><td colspan="2" rowspan="2">Depending on the configuration of the Modbus slaves</td></tr>
<tr><td>Hold</td><td>“Offline options for fieldbus” = “Freeze”</td></tr>
<tr><td>Stop refresh</td><td>——</td><td>“Offline options for fieldbus” = “No Scanning”</td><td colspan="2">——</td></tr>
<tr><td rowspan="2">Inputs</td><td>Reset</td><td>——</td><td colspan="2" rowspan="2">Depending on the configuration of the DeviceNet master</td><td>“Offline options for sub-network” = “Clear”</td></tr>
<tr><td>Hold</td><td>——</td><td>“Offline options for sub-network” = “Freeze”</td></tr>
</table>

(1) The “Offline options for fieldbus” and “Offline options for sub-network” are described in the next chapter.

(2) The behaviour desired with regard to the outputs should be directly configured on each of the Modbus slaves. In the case of drives marketed by *Schneider Electric*, for instance, resetting the outputs is configured by setting the NTO bit to 0 (communication control), and they are held by setting NTO to 1 (suppression of communication control).

You can also read the user manuals for your master and your DeviceNet scanner to obtain further details about how to process degraded modes.

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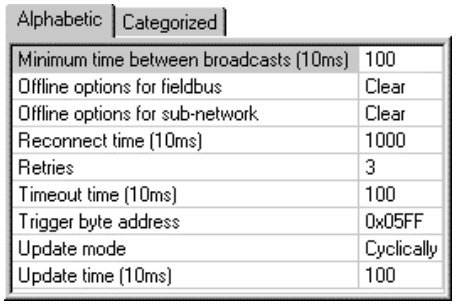
6. Configuring the Gateway

6.11.2.2. Configuring the Query

Select the “Query” element from the Modbus command. The various elements of the configuration of the query for this command are shown opposite. The values displayed correspond to the default values for any new command.



These elements allow you to configure how the whole command is managed, including how degraded modes are managed (number of re-transmissions, for example).

Each of these elements is described, in order, in the table below. When a unit is assigned to an element, it is shown in brackets after the name of the element:

Configuration element	Description
Minimum time between broadcasts (10ms)	This element is only relevant if you have added a “Broadcaster” node (see chapter 6.13 Adding a Broadcaster Node, page 79). This parameter then allows you to specify a waiting time following the transmission of the selected broadcast command. The next Modbus message, whatever it is, will only be transmitted by the gateway once this time has elapsed. So it needs to be long enough to allow the slowest Modbus slave to process the command which has been broadcast. This parameter is not used by commands which do not belong to a broadcaster node. With the LUFP9 gateway’s default configuration, this feature has not been used, so as to control the Modbus slaves individually.
Offline options for fieldbus	This element affects the data ***sent to the Modbus slave***, but only in the query to which this element belongs to, whenever the gateway is disconnected from the DeviceNet network. This element takes one of the following three values: - Clear ..... From now on all data sent to the Modbus slave using this query is set to 16#0000 (resetting of the output data in the gateway’s memory). - Freeze..... All data sent to the Modbus slave using this query retains its current values (the output data in the gateway’s memory is frozen). - NoScanning .. The query is no more transmitted to the Modbus slave by the gateway.
Offline options for sub-network	This element affects the data ***sent to the DeviceNet master PLC*** whenever the query to which this element belongs to has not been answered with a response by the Modbus slave (no response). This element takes one of the following two values: - Clear ..... From now on the data sent to the DeviceNet master PLC is set to 16#0000 (resetting of the input data in the gateway’s memory). - Freeze..... From now on the data sent to the DeviceNet master PLC retains its current values (the input data in the gateway’s memory is frozen). **N.B.** exception responses issued by the Modbus slaves do not trigger the use of these “Offline options!”
Reconnect time (10ms)	If there is no response from the Modbus slave to a query, or following the receipt of an incorrect response, the gateway uses the “Retries” and “Timeout time (10ms)” elements to carry out re-transmissions. If the Modbus slave has still not responded correctly following these re-transmissions, the gateway stop sending it the corresponding query for a period of time which can be adjusted using “Reconnect time (10ms)”. When this period is over, the gateway attempts to restore communication with the Modbus slave.

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6. Configuring the Gateway

Configuration element	Description
Retries	This element indicates the number of re-transmissions carried out by the gateway if there is no response from the Modbus slave to a query, or if the response is incorrect. This re-transmission process ceases as soon as the gateway gets a correct response within a given time. If none of the re-transmissions has allowed the gateway to obtain a correct response, the Modbus slave is deemed to be off-line, but only in relation to the command in question. The gateway then uses the “Offline options for sub-network” and “Reconnect time (10ms)” elements and the LED ❺ MODBUS becomes red. This LED will only revert to a green state if the Modbus command is answered with a correct response, once the reconnection has started (see element “Reconnect time (10ms)”). If the number of re-transmissions is set to 0, the process described above will not be run.
Timeout time (10ms)	This element represents the time that the Modbus slave will wait for a response. If a response has not reached the gateway within the given time, configured using the “timeout time (10ms)” element, the gateway proceeds to a re-transmission. This process continues until it reaches the last re-transmission allowed (see “Retries”), then the gateway declares the Modbus slave off-line, but only for the command to which the “timeout time (10ms)” belongs to.
Trigger byte address	This element is only used by the gateway if “Update mode” is set to “Change of state on trigger”. In this case, it specifies the address, in the gateway’s output memory (16#0202 to 16#03FF), of an 8-bit counter managed by the DeviceNet master. When the value located at this address is changed by the DeviceNet master but *different from zero*, the query configured with a “Change of state on trigger” related to this address is transmitted to the Modbus slave. So the DeviceNet master must have access to this counter in the same way as for the periodic output registers sent to TeSys U motor starters. In comparison to the “On data change” mode, this mode allows you to send a command on a specific order from the DeviceNet master if, for example, the latter is unable to update all data of any given query at the same time. **N.B.** In the specific case of the gateway’s default configuration, the “Transactions 1” and “Transactions 2” personalized command mode for the “TeSys U n°1” node is set to “Change of state on trigger”. These aperiodic commands are respectively used to read and write the value of a parameter for one of the Modbus slaves. The “Trigger byte address” elements of the “Query” elements for these two commands are configured at addresses 16#021E and 16#021F. These are the “parameter read/write request counters”. Considered under DeviceNet and RSNetWorx, these two data are configured the same way as the other outputs (see chapter 4.2.7 Configuring Outputs Intended for the Gateway, page 30) and both correspond to the O:1.16 output. To transmit one of these two commands, the DeviceNet master PLC must first of all update all of the data to be transmitted on the Modbus network for this command (addresses 16#0212 to 16#0217 or addresses 16#0218 to 16#021D), then change the value of the associate counter (address 16#021E or 16#021F). The gateway will then transmit the query corresponding to the command. **N.B.** The “trigger byte” does not have to be an item of output data updated by the DeviceNet master. In fact it is quite possible that it may be an input between 16#0002 and 16#01FF. In this case, the Modbus slave which updates this byte will condition the exchanges of the command you’re currently configuring.

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Configuration element	Description
Update mode	This element is used to specify the transmission mode for the query on the Modbus network. It takes one of the following four values: - Cyclically ..... Default communication mode. The query is transmitted **periodically** on the Modbus network (see "Update time"). - On data change ..... The gateway transmits the query on the Modbus network when at least one item of data from this query is changed by the DeviceNet master. So this is an **aperiodic** communication mode. - Single Shot ..... This transmission mode only allows a single Modbus exchange for the whole of the time that the gateway is operating. This exchange takes place just after the initialization of the gateway. - Change of state on trigger ..... With this **aperiodic** communication mode, the Modbus query is sent every time that the DeviceNet master changes the value of an 8-bit counter designated by the "Trigger byte address" element. For instance, this is the case with the queries associated with "Transactions 1" and "Transactions 2" personalized commands for the "TeSys U n°1" node of the gateway's default configuration. These queries are transmitted when the values of the related "trigger bytes" (addresses 16#021E and 16#021F) are changed by the DeviceNet master. Please see the description of this element for further information about how to use this communication mode.
Update time (10ms)	This element is only used by the gateway if "Update mode" is set to "Cyclically". In this case, it specifies the query's transmission period on the Modbus network.

e.g. With the ATS48, we will be using the configuration shown opposite. The most notable points of this configuration are:

- On disconnection the data is reset on one of the two networks.
- 3 re-transmissions with a 100 ms timeout.
- Periodic communications with a cycle time set to 300 ms.

Alphabetic | Categorized

Minimum time between broadcasts (10ms)	100
Offline options for fieldbus	Clear
Offline options for sub-network	Clear
Reconnect time (10ms)	1000
Retries	3
Timeout time (10ms)	10
Trigger byte address	0x05FF
Update mode	Cyclically
Update time (10ms)	30

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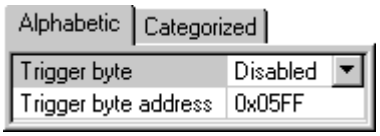
6.11.2.3. Configuring the Response

Next select the “Response” element from the Modbus command. The various elements of the configuration of the response for this command are shown opposite. The values displayed correspond to the default values for any new command.



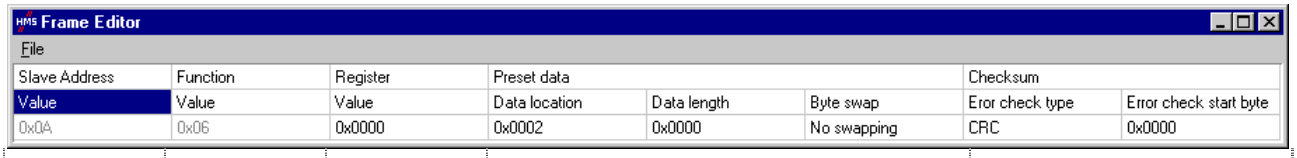
These elements allow you to configure a single aspect of managing the command, described at the top of the page on the right. Each of these elements is described, in order, in the table below.

Configuration element	Description
Trigger byte	This element is used by the gateway to activate the unitary incrementation of an 8-bit counter in order to notify the DeviceNet master of the receipt of a new response to the associated Modbus command. It takes one of the following two values: - Disabled..... Default configuration. The gateway does not increment any counter on receipt of the Modbus response. - Enabled ..... Each time that the gateway receives a new response to the associated Modbus command, it increments the value of an 8-bit counter designated by the “Trigger byte address” element (see below). If used, this counter allows the DeviceNet master, for example, to only consider the response’s corresponding data when this counter’s value is incremented.
Trigger byte address	This element is only used by the gateway if the element “Trigger byte” is set to “Enabled”. In this case, it specifies the address, in the gateway’s input memory (16#0002 to 16#0002), of an 8-bit counter managed by the gateway. When the gateway receives a response to the associated Modbus command, it increments the value of this counter in a unitary manner (value = value+1). So the DeviceNet master must have access to this counter in the same way as for the periodic input registers from the TeSys U motor starters. This mode allows the DeviceNet master to be informed that a new response is available. This can be useful, for example, if it is possible that the data from two consecutive responses may be identical. **N.B.:** In the specific case of the gateway’s default configuration, the “Trigger byte” element for responses to the “Transactions 1” and “Transactions 2” personalized commands of the “TeSys U n°1” node is set to “Enabled”. Hence, the management of responses to read and write commands for parameters is **event driven**. The “Trigger byte address” elements of the “Response” elements for these two commands are configured at addresses 16#001E and 16#001F. These are the “parameter read/write response counters”. Considered under DeviceNet and RSNetWorx, these two data are configured the same way as the other inputs (see chapter 4.2.6Configuring Inputs from the Gateway, page 29) and both correspond to the I:1.16 input. The DeviceNet master PLC will be able to detect the receipt of a response from a Modbus slave by comparing the previous value and the current value of the associated counter (address 16#001E or 16#001F). If there is a *unitary incrementation* of this counter, the PLC may, for example, read all of the data from the response (addresses 16#0013 to 16#0017 or addresses 16#0018 to 16#001D) and allow the transmission of a new query for reading or writing the value of a parameter (using a “Trigger byte” for the queries). Contrarily to the counter one can associate to the queries of any command, a response’s “Trigger byte” is a true modulo 256 counter, *i.e.* zero must be managed (… 254, 255, 0, 1, 2 …).

E.g. With the ATS48, we do not want the response to be event driven. So we will be retaining the default configuration.

6.11.2.4. Configuring the Content of the Query Frame

The window shown below is obtained using "Edit Frame" from the "Query" menu. Unlike the tree structure in the main AbcConf window, this display has the advantage of showing all of the frame's fields at the same time as well as their values. The values displayed below correspond to the values assigned by default to the Modbus command query we have created. The correspondence with the content of the corresponding Modbus frame has been added underneath this window.



Slave no.	Function no.	Word number (MSB / LSB)	Value of the word (MSB / LSB)	CRC16 (LSB / MSB)

Edit the values which are not greyed out, one after another. There is a description of them below.

The nature of a frame's fields depends on the Modbus command to which it corresponds. However, a certain number of these fields are common to all frames, whereas others are common to a number of them. Here is a description of those shown above, for the example described at the beginning of the chapter 6.11.2:

Field in the frame	Size in the frame	Description
Slave Address	1 byte	This field cannot be changed by the user and its value is greyed out to inform him of the fact. AbcConf updates the value of this field automatically using the address of the Modbus slave corresponding to the current node. **N.B.** This field is common to queries for all Modbus commands. E.g. The value of this field is set to the address of the Modbus slave which corresponds to the "ATS48" node, that is to say 16#0A.
Function	1 byte	This field cannot be changed by the user and its value is greyed out to inform him of the fact. AbcConf updates the value of this field automatically using the function code for the corresponding Modbus command. **N.B.** This field is common to queries for all Modbus commands. E.g. The value of this field is set to the code for the "Preset Single Register" command (writing the value of an output word), that is to say 16#06.
Register	2 bytes	Address of an output word, or of a register, in the Modbus slave's memory. So this field designates the memory object to which the command relates. **N.B.** This field is common to queries for all Modbus commands whose purpose is to access one or more locations in the memory of a Modbus slave. When accessing several memory locations, the "Register" field designates the address of the first word affected by the command. E.g. The value of this field should be changed by entering the address of the CMD command register, that is to say 400 (16#0190). This value will be automatically converted to hexadecimal if the user enters it in decimal.

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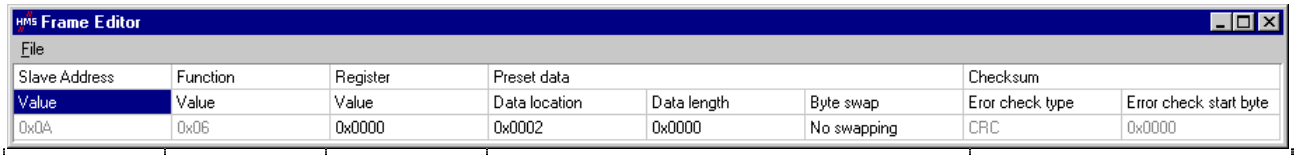
Field in the frame	Size in the frame	Description
Preset Data	2 bytes or more for a block of data	Data Location: Address, in the gateway's output data memory (16#0202 to 16#03FF), of the item of data to be transmitted in the "Preset Data" field for the query's frame. **N.B.** The "Data location" field is used for each frame that allows you to exchange some data between the Modbus slaves and the DeviceNet master. In this case it designates the starting address of the block of data to be transmitted. **N.B.** As far as possible, ensure that the data is located at even addresses in order to align the Modbus data (in 16-bit format) on the O:1.x outputs of the DeviceNet scanner. E.g. The value to be assigned to the ATS48's CMD register should be placed in the gateway's output data memory area. We will be using the first free location starting at an even address, that is to say the one located at 16#0220, with the gateway's default configuration.
		Data length: Length of the block of output data, in the gateway's memory, whose values must be transmitted in the "Preset Data" field of the query's frame. It is expressed in number of bytes. **N.B.** The "Data length" field is always used together with the "Data location" field, described above. E.g. Since the "Preset Single Register" command is used to write the value of a single register (16-bit), the value of the "Data length" field must be set to 2. See the documentation for each Modbus slave to find out the maximum amount of 8-bit data which can be placed in "Data" type fields in queries and responses for this slave. With the ATS48, for instance, it is limited to 30 16-bit words.
		Byte swap: Specifies whether the output data bytes to be transmitted to the Modbus slave must be swapped before being placed in the Modbus frame or not. The three possible values are as follows: - No swapping ..... Default configuration. The data is sent in the same order as they appear in the gateway's memory. - Swap 2 bytes ..... The bytes to be transmitted are swapped two by two. **This is the case which must be used by default**, because for an item of 16-bit data, the most significant byte is placed first in the Modbus frame, whereas it is always written into the gateway's memory by a DeviceNet master with the least significant byte first. - Swap 4 bytes ..... The bytes to be transmitted are swapped four by four. This is rarely used, as it only relates to 32-bit data. The principle is similar to that of the previous case, "Swap 2 bytes". E.g. We will be using the "Swap 2 bytes" value, because the two bytes of the value to be written into the ATS48's CMD register, as transmitted by the SLC500 PLC, are placed into the gateway's memory in least significant / most significant order.

Field in the frame	Size in the frame	Description
Checksum	2 bytes	Error check type: Type of error check for the frame. - CRC.....Default method. This is the method adopted for the Modbus RTU protocol. - LRC .....This method relates to the Modbus ASCII protocol. So it should not be used in this case. - XOR.....Simple "OR Exclusive" applied to the frame's bytes. E.g. The LUFP9 gateway is specifically designed for the Modbus protocol RTU mode. **The default value, "CRC", should not be changed.**
		Error check start byte: Indicates the number of the byte, in the frame, from which the calculation of the "checksum" should begin. The first byte in each frame carries the number 0. E.g. The calculation of a frame's checksum should always begin with the first byte. **The value of this field should therefore remain set to zero.**

6.11.2.5. Configuring the Content of the Response Frame

The window shown below is obtained using "Edit Frame" from the "Response" menu. The values shown in it correspond to the values assigned by default to the Modbus command response we have created. The correspondence with the content of the corresponding Modbus frame has been added underneath this window.



Slave no.	Function no.	Word number (MSB / LSB)	Value of the word (MSB / LSB)	CRC16 (LSB / MSB)

Edit the values which are not greyed out, one after another.

There is a description of them on the next page, but also see the previous chapter, as the nature of the content of response frames is very similar to that of the fields in Modbus query frames.

If the value of a field from the response of a Modbus slave is different from that configured via AbcConf, the response will be rejected by the gateway. It will then proceed to a re-transmission of the query, provided that at least one re-transmission has been configured for this command (see chapter 6.11.2.2 Configuring the Query, page 66). Of course, this remark does not relate to the data itself, that is to say the Modbus frame fields configured using the "Data location," "Data length," and "Byte swap" elements.

Field in the frame	Size in the frame	Description
Slave Address	1 byte	Identical to that of the query's "Slave Address" field.
Function	1 byte	Identical to that of the query's "Function" field.
Register	2 bytes	Identical to that of the query's "Register" field, since the Modbus response of any "Preset Single Register" command is an echo to the corresponding query. Here you should also enter the address of the memory object to which the command relates. E.g. Enter the value 400, converted to 16#0190 by AbcConf.
Preset Data	2 bytes or more for a block of data	Data Location: Address, in the gateway's input data memory (16#0002 to 16#01FF), of the item of data received in the "Preset Data" field for the response's frame. **N.B.** As far as possible, ensure that the data is located at even addresses in order to align the Modbus data (in 16-bit format) on the I:1.x inputs of the DeviceNet scanner. E.g. The value sent back as an echo to the command must be placed in the gateway's input data memory area. We will be using the first free location, that is to say the one located at 16#0020, with the gateway's default configuration.
		Data length: Length of the block of input data received in the "Preset Data" field of the response frame. It is expressed in number of bytes. E.g. The value of the "Data length" field must be set to 2.
		Byte swap: Identical to that of the query's "Byte swap" field. E.g. We will also be using the "Swap 2 bytes" value, for the same reasons as with the query.
Checksum	2 bytes	Error check type: Identical to that of the query's "Error check type" field.
		Error check start byte: Identical to that of the query's "Error check start bype" field.
		However, these two fields cannot be changed by the user and their values are greyed out to reflect this. AbcConf updates the values of these fields automatically using those of the query's "Error check type" and "Error check start byte" fields.

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6.11.3. Adding a Special Modbus Command

Apart from the standard Modbus commands covered in the previous chapter, it is possible to create two types of special Modbus commands: Modbus commands using the same template as standard commands and Modbus commands whose nature and frame content can be completely changed by the user.

6.11.3.1. Modbus Commands Based on Standard Commands

You create a command of this type from the "Select Command" window (see chapter 6.11.2 With a Generic Modbus Slave, page 63), by choosing "Add Command" from the "Command" menu. The window shown at the top of the next page appears. It shows the structure of the future command's query and response frames, which will then be added to the list of available Modbus commands. This structure includes the standard elements, that is to say the "Slave Address", "Function" and "Checksum" fields, described in previous chapters.

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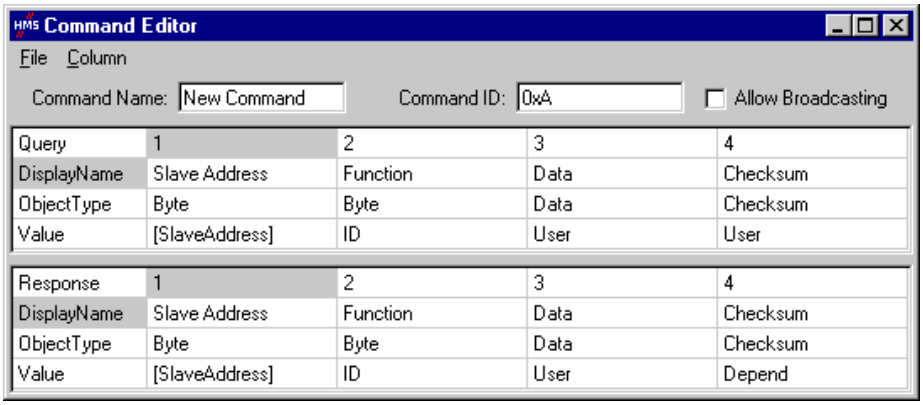

Please see chapter 2.12 Command editor in the AbcConf user manual, entitled **AnyBus Communicator – User Manual**, for further information about creating standard Modbus commands. This manual can be found on the CD LU9CD1 : "ABC_User_Manual.pdf".

6.11.3.2. Modbus Commands which Can Be Completely Changed by the User

In AbcConf, these commands are known as "Transactions". Unlike in the previous case, the whole structure of the query and response frames associated with these commands correspond to an association of input or output data in the gateway's memory ("Data" fields), constants in Byte, Word or DWord format and a final "Checksum" field.

All of the data contained in the query and response "Data" fields of a "Transactions" command are managed by the DeviceNet master, including the "Slave address" and "Function" fields if these are placed in a "Data" field. For instance, this allows you to manage all of the Modbus frame fields from the DeviceNet master if all of the query and response fields of a "Transactions" element (excluding "Checksum") are "Data" type fields.

N.B. You must *not* place more than one "Data" field in any Modbus frame. This guarantees that all of the data involved will be processed by the gateway at the same time.

Constants in Byte, Word or DWord format allow you to relieve the DeviceNet master by placing the values of these constants in Modbus query frames (constants in "Query" elements) or by comparing them to the values located in the Modbus responses (constants in "Response" elements). These comparisons are used to accept (identical values) or reject (different values) the Modbus responses in the same way as for standard Modbus commands. The DeviceNet master does not have access to these constants. They are mainly used to replace fields such as "Slave address", "Function", "Starting Address," etc.

Please see the section on "Actions on query/response" in chapter **2.6.4 Transaction** and in chapter **2.6.6 Frame objects** in the AbcConf user manual, entitled **AnyBus Communicator – User Manual**, for further information about how to handle "Transaction" commands. This manual can be found on the CD LU9CD1 : "ABC_User_Manual.pdf".

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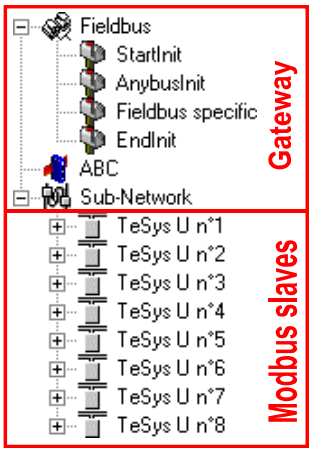
The LUFP9 gateway's default configuration includes two "Transaction" commands. These are aperiodic commands used for reading and writing the value of a Modbus slave parameter (necessarily a TeSys U motor starter with the default configuration). They are configured solely for the "TeSys U n°1" node, as the address of the slave is controlled by the DeviceNet master via the first byte of the "Data" field, which corresponds to the "Slave Address" field in standard Modbus commands. This allows the DeviceNet master to send this command to all of the Modbus slaves, slave by slave, through the first byte of the "Data" field. The remaining fields of the frames used by these two commands are also placed in the same "Data" field. So the DeviceNet master has access to all of the content of the frames in these two commands, excluding the checksum.

6.12. Configuring the General Characteristics of the Gateway

This operation relates to the gateway's general characteristics ("Fieldbus" to "Sub-Network" elements), whereas the previous chapters described the configuration of the Modbus slaves (elements located under the "Sub-Network" element).



The "Fieldbus" element describes the upstream network, that is to say the DeviceNet network in the case of the LUFP9 gateway.

The "ABC" and "Sub-Network" elements describe the downstream network, that is to say the Modbus RTU network in the case of the LUFP9 gateway, and allow you to identify the software version in the gateway.

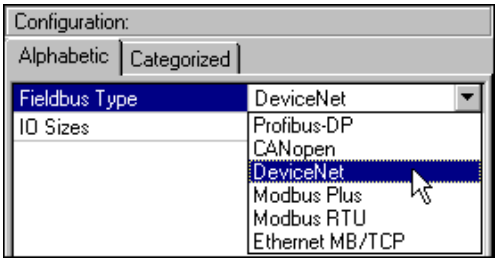
The configuration of these three elements, plus the commands they give access to, are described in the next three chapters.

6.12.1. "Fieldbus" element

Below this element there is a list of the mailboxes configured by default. These elements are not described here, as they are only designed for the internal management of the gateway. These mailboxes can neither be changed nor deleted. Both their number and their nature depend on the type of upstream network.

When the "Fieldbus" element is selected, you can select the type of upstream network. With the LUFP9 gateway, you must select the "DeviceNet" network.

When the "DeviceNet" network is selected, you have access to an additional field, known as "IO Sizes". ***Its value, "Automatic," must not be changed!***



If your PC is connected to the gateway using the PowerSuite cable and you are using AbcConf in "on-line" mode when AbcConf starts up, the type of upstream network will be automatically detected.

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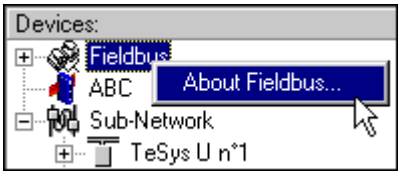
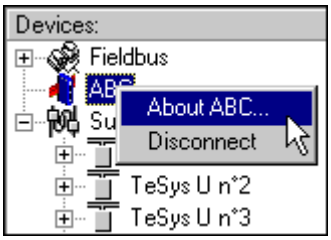
The only command accessible from the “Fieldbus” menu is “About Fieldbus…”.

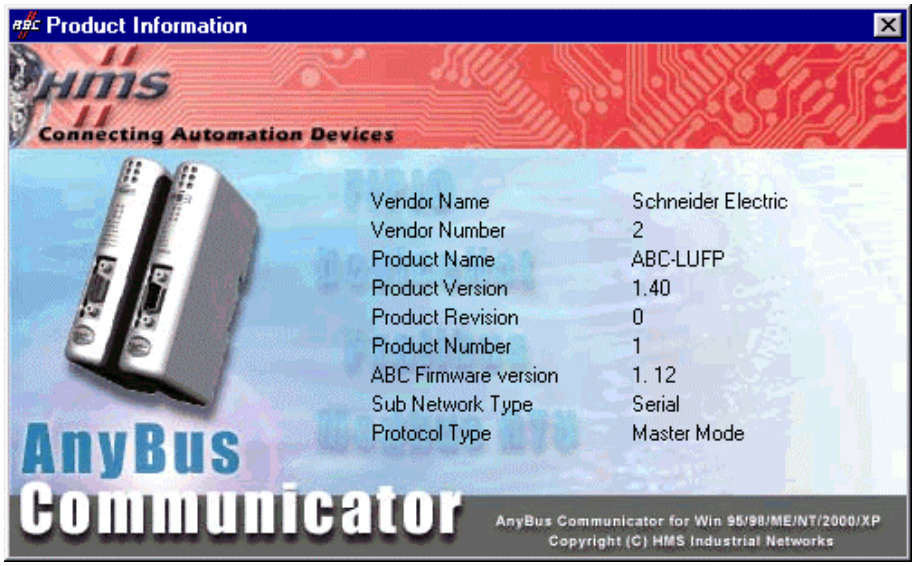


In “on-line” mode (see chapter 6.12.2 “ABC” Element, page 76), the window shown opposite will be displayed. In “off-line” mode the word “Unknown” will replace “DeviceNet” to show that the type of upstream network cannot be identified.

6.12.2. “ABC” Element

The two commands accessible from the “ABC” menu are “About ABC…” and “Disconnect” (or “Connect” if you are in “off-line” mode).





- Running “About ABC…” allows AbcConf to upload and display information showing the software version on the PC and the software version in the gateway.

An example is shown opposite.

When you run “About ABC…” in “off-line” mode, the last three fields are replaced by “Unknown” to show that the gateway software version cannot be identified.

N.B. Only the software version in the gateway’s Modbus card is displayed. This software is common to several types of gateway marketed by *Schneider Electric*. The gateway’s DeviceNet card software version is only accessible using the appropriate DeviceNet object (see chapter 10.4 Identity Object (class 16#01), page 95).

- The “Disconnect” command allows you to go from “on-line” to “off-line” mode. It is only available in “on-line” mode. It is replaced by “Connect” once you are in “off-line” mode.

Apart from these two exclusive commands, the transition to “on-line” mode is requested by AbcConf when certain events do occur (AbcConf is launched, use of “Upload” and “Download” commands, etc.).

AbcConf’s connection mode is displayed to the right of its status bar:

Config Line	“On-line” mode (the LED on the left is green)
Config Line	“Off-line” mode (the LED on the right is red)

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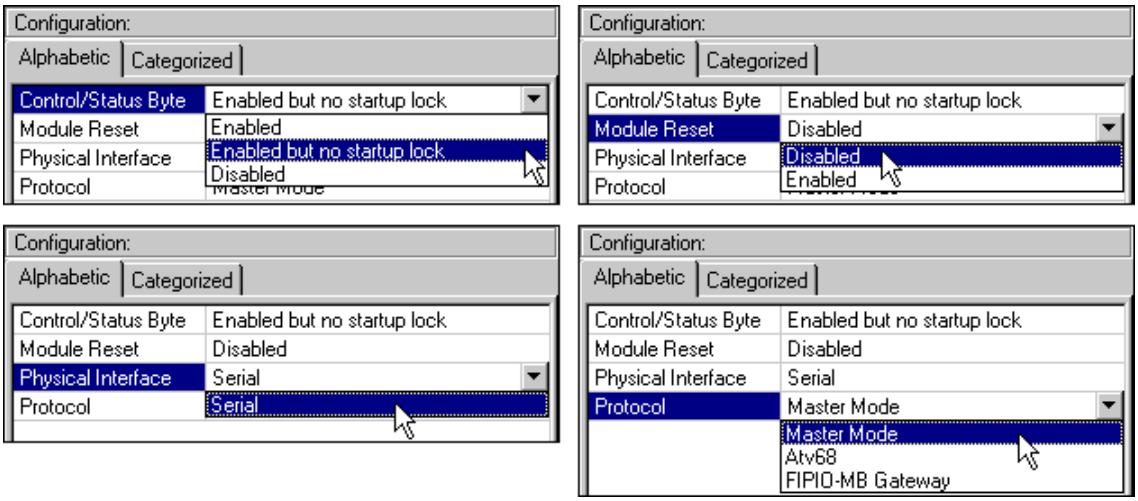
Apart from the “Control/Status Byte” and “Module Reset” options, the configuration of the LUFP9 gateway’s “ABC” element should not be changed. Out of the four options shown below, the last two should therefore retain the values shown: “Serial” and “Master Mode”.

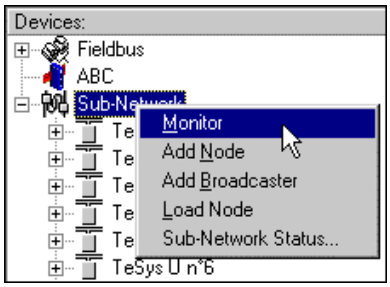


These four options allow you to configure certain of the gateway’s system aspects:

- Control/Status Byte: The three possibilities available for this option are described in chapter 5 Gateway Initialization and Diagnostics, page 33.
- Module Reset: By default, this option prevents the gateway from reinitializing itself when there is an internal operation problem. Changing this option is mainly intended for “laboratory” type use.
- Physical Interface: The only possibility offered by this option shows that the physical interface of the network downstream of the gateway is a serial link.
- Protocol: This option should not be changed, because it indicates the type of protocol used on the downstream network of the gateway. With the LUFP9 gateway, “Master Mode” must be selected. The other possibilities available are reserved for other products from the same family as this gateway.

6.12.3. “Sub-Network” Element

The five commands accessible from the “Sub-Network” menu are:



- “Monitor”: Allows you to view the correspondence between the data from Modbus commands and the content of the gateway’s memory. Examples of how to use this command are shown in chapters 6.8.3 (page 50), 6.8.4 (page 53) and 6.9 (page 58).
- “Add Node”: Allows you to add a new node on the downstream Modbus network. Each node corresponds to a different Modbus slave. This command is not available if there are already 8 Modbus slaves, which is the case with the gateway’s default configuration.
- “Add Broadcaster”: Allows you to add a broadcaster node (see chapter 6.13 Adding a Broadcaster Node, page 79).
- “Load Node”: Allows you to add a pre-configured node on the downstream Modbus network. The configuration for this node is contained in an XML file (see the section on “Importing/Exporting a Modbus slave configuration” in chapter 6.7 Adding a Modbus Slave, page 46). This command is not available if there are already 8 Modbus slaves, which is the case with the gateway’s default configuration.

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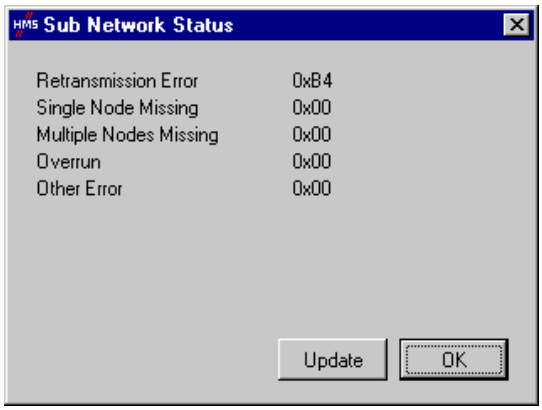
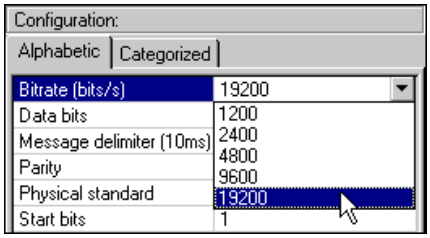
- “Sub-Network Status…”: In “on-line” mode (see chapter 6.12.2 “ABC” Element, page 76), this command displays a window summarizing the values of the gateway’s error counters. These counters are also used by the gateway to update the value of its status word (see chapter 5.1.2 Gateway Status Word, page 35). The “Update” button allows you to refresh the values of these counters.

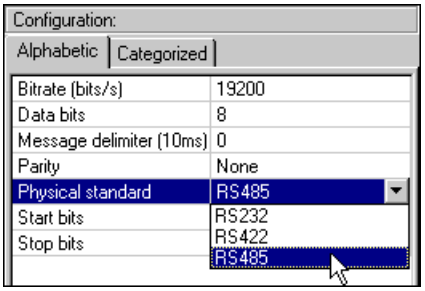
  When you run this command in “off-line” mode, all of the values displayed are replaced by the word “Unknown” to show that they cannot be read on the gateway. The “Update” button then becomes inaccessible.

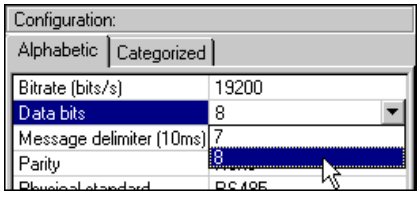


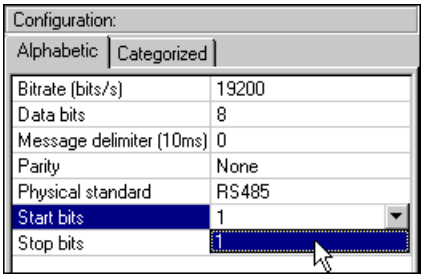
When the “Sub-Network” element is selected, you have access to all of the options allowing you to configure the gateway’s communication protocol format on the Modbus network. The various settings you can make are described below. All of the Modbus slaves present must support this configuration and be configured appropriately.

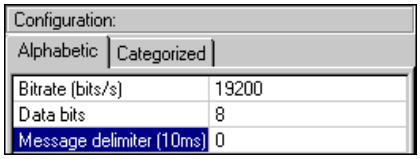
- Bitrate (bits/s): The gateway supports a limited number of communication speeds. Choose the speed that suits your Modbus network.
- Data bits: 8 bits (required).
- Message delimiter (10ms): Period of silence added to the normal period of silence between the end of one message and the start of the next message. The normal period of silence corresponds to the time taken to transmit 3.5 characters.
- Parity: Choose the parity according to the format chosen for communications on your Modbus network.
- Physical standard: RS485 (required).
- Start bits: 1 bit (required).
- Stop bits: 1 or 2 bits.

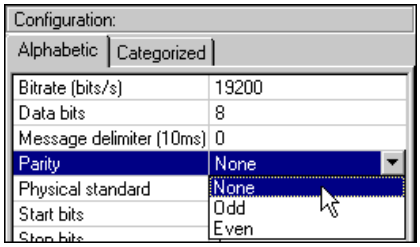


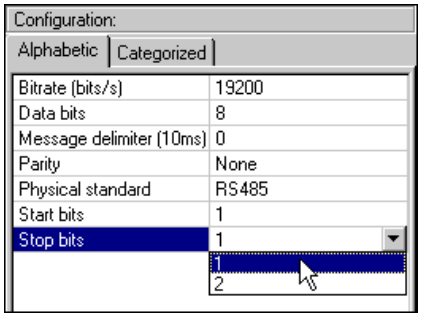












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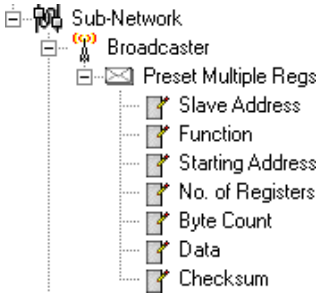
6.13. Adding a Broadcaster Node

A broadcaster node does not correspond to any Modbus slave in particular, as it applies to **all** Modbus slaves. All the commands which will be configured for this node will be transmitted with the “Slave Address” field set to 16#00. This means that all of the slaves will run the command, but that none of them will respond to it.

To add a broadcaster node, select “Sub-Network”, then choose “Add Broadcaster” from the “Sub-Network” menu. The broadcaster node created in this way does not count in the limit on the number of configurable nodes. A simple example is shown opposite:



The addition and configuration of a Modbus command in the list of broadcaster node commands is done in the same way as for other nodes, but with the following differences:

- The list of standard Modbus commands which can be used in broadcast is considerably smaller. Only functions 16#06 and 16#10 can be used (see list in chapter 6.11.2, page 63).
- The command is made up of a query, but does not include any response. The query bears the name of the command itself, instead of the name “Query”. Also, each broadcast command only consumes one of the 50 queries and responses allowed by the gateway, as there is no possible response for such a command.
- The value of the query’s “Minimum time between broadcasts (10ms)” field must be changed if the default value (1 second) is not suitable.
- The value of the query frame’s “Slave Address” field is set to 16#00.

Please see chapter 6.11.2.2 Configuring the Query, page 66, for further details on how to configure a Modbus query.

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7. Appendix A: Technical Characteristics

7.1. Environment

Dimensions (excluding connectors)	Height: 120 mm Width: 27 mm Depth: 75 mm
External appearance	Plastic case with device for fixing to a DIN rail.
Torque	PSU connector: between 5 and 7 lbs.-in.
Power supply	⎓ 24V insulated ±10% Maximum consumption: Around 95 mA Maximum internal consumption for all of the gateway's electronic cards, relating to the internal 5V PSU: 450 mA
Maximum relative humidity	95% without condensation or seepage, according to IEC 68-2-30
Ambient air temperature around the device, in a dry environment	According to IEC 68-2-1 Ab, IEC 68-2-2 Bb and IEC 68-2-14 Nb: • Storage: –25°C (±3) to +85°C (±2) • Operation: – 5°C (±3) to +70°C (±2)
UL	E 214107 certificate "open type" category The product should be installed in an electrical cabinet or in an equivalent location.
EC	Certified as complying with European standards, unless otherwise stated.
Electromagnetic compatibility (EMC): Transmission	Complies with the EN 50 081-2:1993 (industrial environment) standard Tested according to class A radiation under the EN 55011:1990 standard
Electromagnetic compatibility (EMC): Immunity	Complies with the EN 50 082-2:1995 and EN 61 000-6-2:1999 (industrial environment) standard Tested according to the ENV 50 204:1995, EN 61000-4-2:1995, EN 61000-4-3:1996, EN 61000-4-4:1995, EN 61000-4-5:1995 and EN 61000-4-6:1996 standards.

7.2. Communication Characteristics

"Upstream" network	DeviceNet
"Downstream" network	Modbus RTU
DeviceNet characteristics	• Network topology: Multipoint linear topology (bus) with suitable line terminations (impedance of 121 Ω ±1% ¼W). • Physical media: Four types of specific DeviceNet cables, with built-in 24V ⎓ PSU: ① Thick double twisted pair cylindrical cable ③ Flat cable ② Thin double twisted pair cylindrical cable ④ "KwikLink" cable • Communication speed: 125, 250, or 500 kbits/s • Total maximum length of the network: 500 m at 125 kbits/s 250 m at 250 kbits/s 100 m at 500 kbits/s • Maximum number of subscribers: 64 • Transactions: Up to 8 bytes of data per frame. • Possibility of connecting or disconnecting a subscriber without affecting communications between other subscribers.

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7. Appendix A: Technical Characteristics

<table>
<tr><td>Specific DeviceNet features of the LUFP9 gateway</td><td>• The LUFP9 gateway is a “group two only server” DeviceNet subscriber (cf. DeviceNet Specifications).
• Fragmentation support for transactions requiring more than 8 bytes of data.
• Connections supported: 1 “Explicit Connection”
1 “Polled Command/Response” connection
1 “Bit Strobed Command/Response” connection
1 “Change-of-State / Cyclic” connection
• Communication speed configured using 2 selector switches.
• Gateway’s DeviceNet address (Mac ID) configured using 6 selector switches (address between 0 and 63).
• Configuration facilitated by the use of a specific EDS file.</td></tr>
<tr><td>Modbus RTU characteristics</td><td>• Physical media: RS485 serial link
• Network topology: Multipoint linear topology with adapted line terminations (impedance of 120 Ω in parallel with a capacity of 1 nF)
• Communication speed: 1,200 to 57,600 kbits/s
• Data bits: 8
• Subscriber addresses: 1 to 247. Address 0 reserved for broadcasting. Addresses 65, 126 and 127 reserved if drives and/or starters from Schneider Electric are used on the same Modbus network.
• Period of silence: Equivalent to the transmission of 3.5 characters.</td></tr>
<tr><td>Specific Modbus RTU features of the LUFP9 gateway</td><td>• Maximum number of subscribers (excluding gateway): 8 Modbus slaves.
• Maximum number of commands configured: Up to 50 Modbus queries and responses configured for the same gateway using AbcConf.
• Communication speed: 1,200, 2,400, 4,800, 9,600, or 19,200 bits/s, configured using AbcConf.
• Period of silence: Possibility of increasing the gateway’s period of silence, in 10 ms steps, using AbcConf.
• Parity: None, even or uneven, configured using AbcConf.
• Start bits: 1 bit, configuration using AbcConf.
• Stop bits: 1 or 2 bits, configuration using AbcConf.</td></tr>
<tr><td>Structure of the LUFP9 gateway’s memory:

Inputs</td><td>• 2 bytes for the diagnostics of errors on the downstream network by the gateway (see chapter 5 Gateway Initialization and Diagnostics, page 33).
• 510 bytes accessible by the DeviceNet master in the form of input data (see chapter 8.2.1 Input Data Memory Area, page 84, for the default use of this input data).

<table>
<tr><th>Addresses</th><th>Input data area</th></tr>
<tr><td>16#0000
16#0001</td><td>Gateway status word
(unless “Control/Status Byte” = “Disabled”)</td></tr>
<tr><td>16#0002
:
16#01FF</td><td>Inputs accessible through the DeviceNet master
510 bytes
1 input data area</td></tr>
</table>
</td></tr>
</table>

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7. Appendix A: Technical Characteristics

<table>
<tr>
<td>Structure of the LUFP9 gateway's memory:

Outputs</td>
<td>
• 2 bytes for the activation or inhibition of the downstream network by the gateway (see chapter 5 Gateway Initialization and Diagnostics, page 33).
• 510 bytes accessible by the DeviceNet master in the form of output data (see chapter 8.2.2 Output Data Memory Area, page 85, for the default use of this output data).
<table>
<tr><th>Addresses</th><th>Output data area</th></tr>
<tr><td>16#0200
16#0201</td><td>DeviceNet master command word
(unless "Control/Status Byte" = "Disabled")</td></tr>
<tr><td>16#0202
:
16#03FF</td><td>Outputs accessible through the DeviceNet master
510 bytes
1 output data area</td></tr>
</table>
</td>
</tr>
<tr>
<td>Structure of the LUFP9 gateway's memory:

General data</td>
<td>
• 1,024 bytes inaccessible through the DeviceNet master.
<table>
<tr><th>Addresses</th><th>General data area</th></tr>
<tr><td>16#0400
16#051F</td><td>Input area reserved for the Mailboxes
(288 bytes)</td></tr>
<tr><td>16#0520
16#063F</td><td>Output area reserved for the Mailboxes
(288 bytes)</td></tr>
<tr><td>16#0640
. . . . . .
16#07BF</td><td>Internal area reserved for the management of the upstream network (384 bytes)
(input area / output area / bi-directional area)</td></tr>
<tr><td>16#07C0
. . . . . .
. . . . . .
16#07FD</td><td>Internal area reserved for the control registers
(62 bytes / MSB first for 16-bit data)
(data accessible via instance 16#01 of class 16#AA: "Diagnostic Object")</td></tr>
<tr><td>16#07FE
16#07FF</td><td>Gateway status / DeviceNet master control
(2 bytes)</td></tr>
</table>

You can use the general data area for Modbus input data (from Modbus responses) if you do not want the DeviceNet master to have access to them. In this case, always use 16{#4000 as the starting address. If you use multiple times the same addresses in this area, the corresponding memory locations will be displayed in red in the "General Area" section of the "Sub-network Monitor" window (see page 51 for an example). However, this will have no consequences on the gateway during run-time.
</td>
</tr>
<tr>
<td>Data transfer order (swapping)</td>
<td>
• DeviceNet network: LSB first and MSB last.
• Modbus RTU network: MSB first and LSB last.
• LUFP9 gateway: MSB stored in the lowest memory address.

→ In most cases, the option which should be chosen for Modbus data stored in the gateway's memory is "Swap 2 bytes". This option relates to all "Data" fields for Modbus queries and responses frames.
</td>
</tr>
</table>

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8. Appendix B: Default Configuration

The configuration described below corresponds to the LUFP9 gateway's default configuration.

This chapter mainly gives the user information about the performances obtained on the downstream Modbus network. It allows the user to decide whether, for example, he should change the period for cyclical exchanges with one or more of the TeSys U motor starters (see chapter 6 Configuring the Gateway, page 40).

8.1. Configuring Modbus exchanges

The LUFP9 gateway carries out four types of exchanges with each of the 8 TeSys U motor starters. The first two exchanges are cyclical and allow you to control and monitor the motor starter. The last two exchanges are aperiodic (only when there is a change in the values of the data to be transmitted to the motor starter) and allow you to read and change the value of any motor starter parameter.

Function	Modbus function	Number of bytes (1)	Exchange between the LUFP9 gateway and the TeSys U motor starter
16#03	Read Holding Registers	11,5 + 10,5	Periodic reading (300 ms period) of the TeSys U motor starter's status register (address 455 = 16#01C7) only
16#10	Preset Multiple Registers	14,5 + 11,5	Periodic writing (300 ms period) of the TeSys U motor starter's status register (address 704 = 16#02C0) only
(16#03)	(Read Holding Register)	11,5 + 10,5	Aperiodic reading of the value of a single parameter, for a single TeSys U motor starter at a time (function and address supplied by the user)
(16#06)	(Preset Single Register)	11,5 + 11,5	Aperiodic writing of the value of a single parameter, for a single TeSys U motor starter at a time (function and address and value supplied by the user)

(1) Number of bytes in the Query + number of bytes in the Response, plus a period of silence of 3.5 characters for each of these two frames (see description of the "Message delimiter (10ms)" parameter in chapter 6.12.3 "Sub-Network" Element, page 77). Each byte will be transmitted in the form of a group of 10 bits (8 data bits, 1 start bit and 1 stop bit). These values allow you to calculate the approximate amount of traffic on the downstream Modbus network as follows:

Volume of periodic traffic (300 ms period)..... *[(11.5 + 10.5) + (14.5 + 11.5)] × (8 + 1 + 1) = 480 bits*

For 1 TeSys U motor starter ..... *1 × 480 × (1,000 ÷ 300) = 1,600 bits/s*
For 8 TeSys U motor starters ..... *8 × 480 × (1,000 ÷ 300) = 12,800 bits/s*

As a result, on a network operating at 9,600 bits/s, you will need to considerably increase the cycle time for all or part of the periodic Modbus commands. On the other hand, at a speed of 19,200 bits/s (default speed), the available bandwidth is sufficient to allow proper communications, even in occasional degraded mode (frames re-transmission), and to allow the use of aperiodic setup exchanges.

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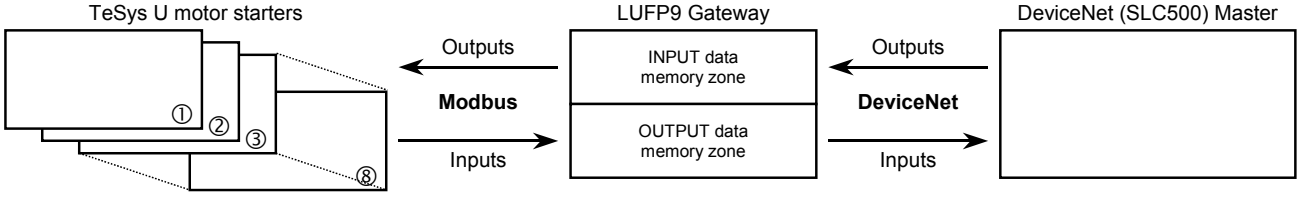
8. Appendix B: Default Configuration

8.2. Content of the Gateway's DPRAM Memory

The LUFP9 gateway's DPRAM memory contains all of the data exchanged between the gateway and the 8 TeSys U motor starters, as well as two special registers only exchanged between the gateway and the DeviceNet master (words used for managing the downstream Modbus network).

The flow of data exchanged between the TeSys U motor starters, the gateway and the DeviceNet master is shown below, in order to highlight the role of the gateway's memory in these exchanges:



8.2.1. Input Data Memory Area

The gateway has 512 input bytes. Only the first 32 bytes are used. All of these 32 bytes make up the gateway's input area, referenced as "Input 1" in the RsNetWorx configurator.

Service	Address	Size	Description
Managing the downstream Modbus network	16#0000	1 word	Gateway status word
Periodic communications — Monitoring of TeSys U motor starters	16#0002	1 word	Value of the motor starter ① status register
	16#0004	1 word	Value of the motor starter ② status register
	16#0006	1 word	Value of the motor starter ③ status register
	16#0008	1 word	Value of the motor starter ④ status register
	16#000A	1 word	Value of the motor starter ⑤ status register
	16#000C	1 word	Value of the motor starter ⑥ status register
	16#000E	1 word	Value of the motor starter ⑦ status register
	16#0010	1 word	Value of the motor starter ⑧ status register
——	16#0012	1 byte	Memory location free
Aperiodic communications — Reading the value of a motor starter parameter (RESPONSE)	16#0013	1 byte	Slave no. (16#01 to 16#08)
	16#0014	1 byte	Function number (16#03)
	16#0015	1 byte	Number of bytes read (16#02)
	16#0016	1 word	Value of the parameter read (16#xxxx)
Aperiodic communications — Writing the value of a motor starter parameter (RESPONSE)	16#0018	1 byte	Slave no. (16#01 to 16#08)
	16#0019	1 byte	Function number (16#06)
	16#001A	1 word	Address of the parameter written (16#xxxx)
	16#001C	1 word	Value of the parameter written (16#xxxx)
Aperiodic communications ("Trigger bytes" for the responses)	16#001E	1 byte	Read parameter response counter
	16#001F	1 byte	Write parameter response counter
——	16#0020 … 16#01FF	1 byte … 1 byte	Free input area (480 bytes)

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8. Appendix B: Default Configuration

8.2.2. Output Data Memory Area

The gateway has 512 output bytes. Only the first 32 bytes are used. All of these 32 bytes make up the gateway's output area, referenced as "Output 1" in the RsNetWorx configurator.

Service	Address	Size	Description
Managing the downstream Modbus network	16#0200	1 word	DeviceNet master command word
Periodic communications — Controlling TeSys U motor starters	16#0202	1 word	Value of the motor starter ① command register
	16#0204	1 word	Value of the motor starter ② command register
	16#0206	1 word	Value of the motor starter ③ command register
	16#0208	1 word	Value of the motor starter ④ command register
	16#020A	1 word	Value of the motor starter ⑤ command register
	16#020C	1 word	Value of the motor starter ⑥ command register
	16#020E	1 word	Value of the motor starter ⑦ command register
	16#0210	1 word	Value of the motor starter ⑧ command register
Aperiodic communications — Reading the value of a motor starter parameter (QUERY)	16#0212	1 byte	Slave no. (16#01 to 16#08)
	16#0213	1 byte	Function number (16#03)
	16#0214	1 word	Address of the parameter to be read (16#xxxx)
	16#0216	1 word	Number of parameters to be read (16#0001)
Aperiodic communications — Writing the value of a motor starter parameter (QUERY)	16#0218	1 byte	Slave no. (16#01 to 16#08)
	16#0219	1 byte	Function number (16#06)
	16#021A	1 word	Address of the parameter to be written (16#xxxx)
	16#021C	1 word	Value of the parameter to be written (16#xxxx)
Aperiodic communications ("Trigger bytes" for the queries)	16#021E	1 byte	Read parameter query counter
	16#021F	1 byte	Write parameter query counter
——	16#0220 … 16#03FF	1 byte … 1 byte	Free output area (480 bytes)

8.2.3. Total Number of Modbus Queries and Responses

The total number of Modbus queries and responses is equal to 36 (2 periodic queries and 2 periodic responses for each of the 8 TeSys U motor starters, plus 2 aperiodic queries and 2 aperiodic responses for all of these motor starters). Since the total number of the Modbus queries and responses one can configure for a single gateway is limited to 50, there is only 14 spare Modbus queries and responses (that is to say the equivalent of 7 Modbus commands).

So this reserve does not allow the addition of any single Modbus command for each of the TeSys U motor starters, as this would require the use of 16 Modbus queries and responses (1 query and 1 response for each of the 8 motor starters).

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9. Appendix C: Practical Example (RSLogix 500)

A practical example can be found on the CD LU9CD1. It is made up of two files. The first of these, "SLC_Guide_LUFP9.dnt", shows the configuration of the DeviceNet scanner in RsNetWorx, described in the previous chapters. The second, "SLC_Guide_LUFP9_EN.rss", is an RSLogix 500 file and so this is the example itself.

As the configuration of the RsNetWorx file corresponds exactly to that shown in the previous chapters, we will not be repeating its content here. On the other hand, the RSLogix 500 file is described below, based on the structure of the sub-programs used.

9.1. Main Program: "LAD 2 - MAIN_LUFP9"

The role of the main program is to activate the DeviceNet and Modbus communications, and to call the other sub-programs, described in later chapters. The processes carried out in the main program are described below, in the order in which they are run:

- Validation of the scanner's DeviceNet exchanges by activation of bit O:1.0/0.
- Activation of the gateway's Modbus communications using bits 13 (FB_DU) and 14 (FB_HS_SEND) of the DeviceNet master's command word (see chapter 5 Gateway Initialization and Diagnostics, page 33). These two bits correspond to DeviceNet scanner bits O:1.1/5 and O:1.1/6. **N.B.** This process is only relevant provided that the "Control/Status Byte" option is set to "Enabled". With the LUFP9 gateway's default configuration ("Control/Status Byte" = "Enabled but no startup lock"), this process is irrelevant but may still be kept. *Finally, this example should not be used when this option is set to "Disabled", because words I:1.1 and O:1.1 are no longer reserved for "managing the downstream Modbus network".* Please see chapter 5 Gateway Initialization and Diagnostics, page 33, for further information on this subject.
- Automatic acknowledgement of the gateway diagnostics by the DeviceNet master. All you have to do is copy the value of bit 15 (ABC_HS_SEND) of the gateway's status word to bit 15 (FB_HS_CONFIRM) of the DeviceNet master's command word (see chapter 5 Gateway Initialization and Diagnostics, page 33). This automatic acknowledgement is mainly designed not to halt the mechanism for feeding diagnostics back from the gateway to the DeviceNet master.
- Controlling/monitoring the "TeSys U n°1" motor starter by using sub-program U:3, that is to say the "LAD 3 - CMD_SURV" sub-program. This sub-program uses local variables as parameters. The word N7:0 is used to index both the output register and the input register used to control and monitor the "TeSys U n°1" motor starter. So before calling the sub-program, the value of this word is set to 2 in order to access the words O:1.2 and I:1.2. N7:0 is also used to index one of the bits of each of the registers N7:32, 33, 34 and 35 (registers handled by the user).
- Controlling/monitoring motor starter "TeSys U n°2": *Ditto*, but setting the value of N7:0 to 3 (O:1.3 and I:1.3).
- Controlling/monitoring motor starter "TeSys U n°3": *Ditto*, but setting the value of N7:0 to 4 (O:1.4 and I:1.4).
- Controlling/monitoring motor starter "TeSys U n°4": *Ditto*, but setting the value of N7:0 to 5 (O:1.5 and I:1.5).
- Controlling/monitoring motor starter "TeSys U n°5": *Ditto*, but setting the value of N7:0 to 6 (O:1.6 and I:1.6).
- Controlling/monitoring motor starter "TeSys U n°6": *Ditto*, but setting the value of N7:0 to 7 (O:1.7 and I:1.7).
- Controlling/monitoring motor starter "TeSys U n°7": *Ditto*, but setting the value of N7:0 to 8 (O:1.8 and I:1.8).
- Controlling/monitoring motor starter "TeSys U n°8": *Ditto*, but setting the value of N7:0 to 9 (O:1.9 and I:1.9).
- Reading the value of a single parameter out of all of the TeSys U motor starters, by using the U:4 sub-program, that is to say the "LAD 4 - LECT_PAR" sub-program.
- Writing the value of a parameter in a single TeSys U motor starter at a time, by using the U:5 sub-program, that is to say the "LAD 5 - LECT_PAR" sub-program.
- Updating output 0:1.16 using the two counters N7:36 and N7:37. This output corresponds to the two "Trigger bytes" that trigger the emission of both the parameter reading request (LSB) and the parameter writing request (MSB). These two counters are independantly updated in the following sub-programs: "LAD 4 – RD_PAR", for N7:36, and "LAD 5 – WR_PAR", for N7:37.

N.B. You can read a parameter on all the motor starters and write a parameter on one of them at the same time as these services use different Modbus commands.

9. Appendix C: Practical Example (RSLogix 500)

The various data used by the main program are shown in the following table:

Address	Symbol	Description
I:1.1/ 7 → I:1/23	ABC_HS_SEND	Flip flop indicating that there is a new gateway diagnostic
O:1.0/ 0 → O:1/ 0	SCAN_VALIDATION	Enable DeviceNet communications: this bit must be set to 1 to validate the exchanges
O:1.1/ 5 → O:1/21	FB_DU	Activation of Modbus communications by the gateway
O:1.1/ 6 → O:1/22	FB_HS_SEND	Flip flop telling the gateway that there is a new command
O:1.1/ 7 → O:1/23	FB_HS_CONFIRM	Bit used by the DeviceNet master to acknowledge diagnostics of the gateway
N7:0	MODULE	Parameter giving access (index) to the motor starter (called "module" to simplify things)
O:1.16	TRIGGER_OUT_RD_WR	"Trigger bytes" used to trigger the emission of the read parameter request (LSB) or of the write parameter request (MSB)
N7:36	————	Local counter related to the "trigger byte" of the read parameter request
N7:37	————	Local counter related to the "trigger byte" of the write parameter request

9.2. Controlling/Monitoring Sub-Program for a TeSys U Motor Starter: "LAD 3 - CMD_MON"

The role of this sub-program consists of exercising very simple control over one of the TeSys U motor starters, depending on its current status and the user's commands. The processes carried out in this sub-program are described below, in the order in which they are run:

- Control of the motor to run forward / in reverse / to stop. Register N7:0 is used as a parameter. It contains the number of both the input word and the output word used to control and monitor the TeSys U motor starter. This same number is used to index one of the bits of each register for registers N7:32 to N7:35. The input word used is located between I:1.2 and I:1.9 (motor starters nos. 1 to 8), and the output word used is located between O:1.2 et O:1.9 (*ditto*). So the value of N7:0 must be between 2 and 9, according to the number of the motor starter currently controlled.

  The user controls the motor starter's running mode using bits 2 to 9 (motor starters nos. 1 to 8) of registers N7:32 (Run (1) / Stop (0)) and N7:33 (Run Forwards (0) / Reverse (1)).

  The forward, reverse and stop commands for the TeSys U motor starter are carried out under the following conditions:
  - Bit 14 of a TeSys U status word = 0 ..... The motor starter is not in local mode.
  - Bit 2 of a TeSys U status word = 0 ..... There is no fault on the motor starter.
  - Bit 0 of a TeSys U status word = 1 ..... The motor starter is in the "Ready" or "Switched on" state.

  When all of these conditions are met, registers N7:32 and N7:33 (bit 2 to 9, depending on the value of N7:0) are used to control either the motor starter running forwards / in reverse, or to stop it by means of braking. The user updates these two registers bit by bit, according to the commands he wishes to undertake.

- The faults on the TeSys U motor starter are reset. Register N7:0 is used in the same way as above and the input and output words are the same as for controlling the motor starter.

  When there is a fault on the motor starter (bit 2 of the monitoring register equal to 1), this fault is copied to one of the bits 2 to 9 (one bit per motor starter) in register N7:34 (Faulty device (1) / Motor starter OK (0)), simply to show this state together with the user command which allows you to reset motor starter faults. This user command corresponds to one of the bits 2 to 9 of register N7:35 (fault reset (1)) and is used to activate bit 3 of the command register of the corresponding TeSys U motor starter ("Reset" bit), that is to say bit O:1.[N7:0]/3.

  This fault reset user command is then cancelled by the program when the TeSys U motor starter no longer shows that there is a fault.

9. Appendix C: Practical Example (RSLogix 500)

The various data used by this sub-program are shown in the following table:

Address	Symbol	Description
I:1.[N7:0]/ 0	—	Bit 0 “Ready” of the TeSys U status register
I:1.[N7:0]/ 1	—	Bit 1 “On” of the TeSys U status register
I:1.[N7:0]/ 2	—	Bit 2 “Fault” of the TeSys U status register
I:1.[N7:0]/14	—	Bit 14 “Reserved: Local control” of the TeSys U motor starter status register
N7:32/[N7:0]	CMD_RUN [MODULE]	**User command:** Start (1) / Stop (0) on the motor starter whose number is N7:0
N7:33/[N7:0]	CMD_REVERSE [MODULE]	**User command:** Run forwards (0) / Reverse (1) on the motor starter whose number is N7:0
N7:34/[N7:0]	MON_FAULTY_DEV [MODULE]	**User monitoring:** Fault (1) / No fault (0) on the motor starter whose number is N7:0
N7:35/[N7:0]	CMD_RESET [MODULE]	**User command:** Fault reset (1) on the motor starter whose number is N7:0
O:1.[N7:0]/ 0	—	Bit 0 “Reserved: Run Forward” of the TeSys U command register addressed with N7:0
O:1.[N7:0]/ 1	—	Bit 1 “Reserved: Run Reverse” of the TeSys U command register addressed with N7:0
O:1.[N7:0]/ 2	—	Bit 2 “Reserved (brake)” of the TeSys U command register addressed with N7:0
O:1.[N7:0]/ 3	—	Bit 3 “Reset” of the TeSys U command register addressed with N7:0
N7:0	MODULE	Parameter for accessing the motor starter (index between 2 and 9, for TeSys U motor starters nos. 1 to 8)

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The example includes a personalized data monitoring screen, known as “CDM 0 - CMD_MON”, in order to simplify the use of this example. The content of this screen is shown below:

Address	Symbol	Display
O:1/ 0	SCAN_VALIDATION	Binary
O:1/21	FB_DU	Binary
O:1/22	FB_HS_SEND	Binary
N7:0	MODULE	Decimal
N7:32	CMD_RUN	Binary
N7:33	CMD_REVERSE	Binary
N7:34	MON_FAULTY_DEV	Binary
N7:35	CMD_RESET	Binary
I:1.2	MON_TESYS_U_1	Binary
O:1.2	CMD_TESYS_U_1	Binary
I:1.3	MON_TESYS_U_2	Binary
O:1.3	CMD_TESYS_U_2	Binary

Address	Symbol	Display
I:1.4	MON_TESYS_U_3	Binary
O:1.4	CMD_TESYS_U_3	Binary
I:1.5	MON_TESYS_U_4	Binary
O:1.5	CMD_TESYS_U_4	Binary
I:1.6	MON_TESYS_U_5	Binary
O:1.6	CMD_TESYS_U_5	Binary
I:1.7	MON_TESYS_U_6	Binary
O:1.7	CMD_TESYS_U_6	Binary
I:1.8	MON_TESYS_U_7	Binary
O:1.8	CMD_TESYS_U_7	Binary
I:1.9	MON_TESYS_U_8	Binary
O:1.9	CMD_TESYS_U_8	Binary

9. Appendix C: Practical Example (RSLogix 500)

9.3. Sub-Program for Reading a Parameter in all TeSys U Motor Starters: “LAD 4 - RD_PAR”

The role of this sub-program is to read the value of a single parameter on all TeSys U motor starters. As they are read, the results are placed into an array starting at N7:4 (motor starter no. 1) and ending at N7:11 (motor starter no. 8). Index N7:2 is used to access these various addresses. The processes carried out on this sub-program are described below, in the order in which they are run:

- If the user changes the number (or address) of the parameter to be read (N7:1) this causes the data used by the sub-program to be reinitialized, but only if the previous reading process is finished (B3:0/0 = 0). The comparison between N7:1 (new address) and O:1.11 (address in the last command used) is made through a scratch variable, N9:0, in which the LSB and the MSB of the new address are swapped. The initializations are summarised below:
  - B3:0/0 = 1 ..... A parameter is read on all TeSys U motor starters: In progress.
  - Reset (C5:0) ..... The number of motor starters polled counter is reinitialized.
  - Reset (T4:0)..... The timer associated with the timeout for a parameter’s read response is reinitialized.
  - N7:2 = 4 ..... Index in the array of results → No. of the 1st element in the array = N7:4.
  - N7:3 = 1 ..... Address of the Modbus slave polled → Address of the first TeSys U motor starter, that is to say 1.
  - N7:[4..11] = 0 ..... The contents of the array of results is reset.
  - B3:0/5 = 0 ..... Enables the update of the “trigger byte” that will trigger the emission of the query.
- The output data corresponding to the read query is updated (O:1.10 to O:1.12) and the N7:36 counter (“trigger byte”) is increased by one. This update is only done once (bit B3:0/5 used for this pupose). **Reminder:** In the LUFP9 gateway’s default configuration, this output data corresponds to the personalized Modbus command “Transactions 1” of the “TeSys U n°1” node. The query frame for this personalized command is sent when the “trigger byte” located in bits 0-7 of O:1.16 is changed (“Update mode” = “Change of state on trigger”). As a result, increasing the N7:36 counter, then updating O:1.16 using N7:36 (in “LAD 2 – MAIN_LUFP9”), causes this query to be sent. On the other hand, the output data O:1.10 to O:1.12 must be valid so that the content of the Modbus query remains coherent!
- The data from the Modbus response which corresponds to this read command is checked. The values of inputs I:1.10 and I:1.11 are compared to those of output O:1.10 and the value 16#02xx (AND mask set to 16#FF00) in order to determine whether the response to the command has arrived or not. If the slave number and the function number correspond to those of the query (see above) and the number of bytes of data received is correct, bit B3:0/1 is activated in order to tell the rest of the sub-program that the response has arrived and that it is correct. The N9:0 scratch variable is used to compare the inputs and the outputs in the same format.
- The value of the read parameter is copied into the array of results. So the value of I:1.12 is transferred to the location reserved for the result of the motor starter currently being polled (use of index N7:2). This transfer only takes place if the response has arrived and its content is correct (bit B3:0/1 is active). The LSB and the MSB for this value are then swapped in this array so as to restore the value of the read parameter. The timer for the response timeout (T4:0) is reinitialized to allow the process of reading the same parameter on the next motor starter.
- Management of the response timeout (TON block on variable T4:0). Until the response arrives or if its content is incorrect (bit B3:0/1 = 0), a 3-second timer is set. When this timeout (T4:0/DN = 1) is triggered, the related timer is reinitialized and a result set to –1 is placed in the array of results, at the location normally reserved for the motor starter being polled.
- On receipt of the response, or after the timeout has been triggered, the internal data used by this sub-program is updated to allow the same parameter to be read on the next motor starter, up to the last of the 8 motor starters (addresses 1 to 8). Counter C5:0 is used to count the number of motor starters which have been polled so far.
- When the reading of the 8th motor starter is finished (counter C5:0 reaching its preset value), the reading process is halted (bit B3:0/0 is reset). However, until the reading of the parameter for the 8th motor starter has finished, the sub-program restarts the next PLC cycle from the beginning (moving onto the next motor starter or continuing to wait for a response for the motor starter currently being polled).

9. Appendix C: Practical Example (RSLogix 500)

The various data used by this sub-program are shown in the following table:

Address	Symbol	Description
B3.0/0	RD_RUNNING	Reading a parameter on all TeSys U motor starters: In progress
B3.0/1	RD_OK_KO	Reading a parameter on all TeSys U motor starters: Reading is correct (OK) or incorrect (KO) for a motor starter (if the response has arrived or when timeout T4:0 is triggered)
B3:0/5	————	The “trigger byte” of the query has been updated: Yes (1) / No (0)
C5:0	CPT_RD_TESYS_U	Reading a parameter on the TeSys U motor starters: Counter. When the value of this counter reaches 9, the process of reading a parameter on all of the TeSys U motor starters is halted.
I:1.10	CR_RDPAR_XXX_SLAVE	Result of reading a parameter: Slave (16#01 to 16#08) as MSB. The value of this field is compared to that of the corresponding field in the query frame. The LSB of this input word is not used.
I:1.11	CR_RDPAR_FCT_BYTES	Result of reading a parameter: Function (always 16#03) as LSB (the value of this field is compared to that of the corresponding field in the query frame) + number of bytes read (16#02) as MSB (value masked and checked).
I:1.12	CR_RDPAR_VALUE	Result of reading a parameter: Value of the parameter read (MSB and LSB are swapped). This value is placed in array N7:[N7:2], then its MSB and its LSB are swapped there in order to restore the correct value of the read parameter.
N7:1	NUMPARAM	**User command:** Number of the read parameter.
N7:2	RD_INDEX	Index in the array of results for the reading of a TeSys U parameter. Value = 4 to 11 (motor starters nos. 1 to 8).
N7:3	ADDRESS	Address of the Modbus slave for which one of the parameters is currently being read. Value = 1 to 8.
N7:[N7:2]	— [RD_INDEX]	Array of results used for the reading of a TeSys U parameter (motor starters nos. 1 to 8). Elements N7:4 to N7:11 (see N7:2). Value = –1 in case of error (response timeout triggered).
N7:36	————	Local counter that corresponds to the “trigger byte” of the read request.
N9:0	VAR_TEMP_1	Temporary scratch variable used to carry out intermediate evaluations.
O:1.10	RDPAR_SLAVE_FCT	Request for the reading of a parameter: Slave (from 16#01 to 16#08) as LSB + function (always 16#03) as MSB.
O:1.11	RDPAR_ADRPAR	Request for the reading of a parameter: Address of the parameter (copied from N7:1, but with MSB and LSB swapped).
O:1.12	RDPAR_NBPARS	Request for the reading of a parameter: Number of parameters to be read (always 16#0001, but with the MSB and LSB swapped, that is to say 16#0100).
T4:0	TIMEOUT_RD_PARAM	Timer for the timeout of the parameter reading command (3 seconds)

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The example includes a personalized screen for monitoring the data, called “CDM 1 - RD_PAR”, in order to simplify the use of this example. The content of this screen is shown below:

Address	Symbol	Display
N7:1	NUMPARAM	Decimal
B3:0/0	RD_RUNNING	Binary
B3:0/1	RD_OK_KO	Binary
N7:2	RD_INDEX	Decimal
N7:3	ADDRESS	Decimal
N7:4	RDPAR1	Decimal
N7:5	RDPAR2	Decimal
N7:6	RDPAR3	Decimal
N7:7	RDPAR4	Decimal
N7:8	RDPAR5	Decimal
N7:9	RDPAR6	Decimal

Address	Symbol	Display
N7:10	RDPAR7	Decimal
N7:11	RDPAR8	Decimal
O:1.10	RDPAR_SLAVE_FCT	Hexadecimal
O:1.11	RDPAR_ADRPAR	Decimal
O:1.12	RDPAR_NBPARS	Hexadecimal
I:1.10	CR_RDPAR_XXX_SLAVE	Hexadecimal
I:1.11	CR_RDPAR_FCT_BYTES	Hexadecimal
I:1.12	CR_RDPAR_VALUE	Hexadecimal
I:1.16	TRIGGER_IN_RD_WR	Hexadecimal
O:1.16	TRIGGER_OUT_RD_WR	Hexadecimal
N7:36	————	Hexadecimal
B3:0/5	————	Binary

9. Appendix C: Practical Example (RSLogix 500)

9.4. Sub-Program for Writing a Parameter on a Single TeSys U Motor Starter: “LAD 5 - WR_PAR”

The role of this sub-program consists of writing the value of a parameter on a single TeSys U motor starter. The user should enter the address of the TeSys U motor starter (N7:12), the address of the parameter (N7:13) and the value to be assigned to the parameter (N7:14). Finally, he should activate bit B3:0/2 to activate the writing process. This bit is automatically reset by the LAD 5 sub-program. When the writing process is finished, the result of the writing (address of the parameter and value of the parameter) is copied in an array starting at N7:16 (for motor starter no. 1) and ending at N7:31 (for motor starter no. 8), using variable N7:15 as an index. Two successive cells of this array are used for each motor starter: The first receives the parameter’s address and the second its value. The processes carried out by this sub-program are described below, in the order in which they are run:

- The sub-program goes into standby mode. The rest of the sub-program is not run until the user has activated bit B3:0/2. This allows the user to enter the values of data N7:12, 13 and 14 one after another beforehand.
- The data the sub-program uses subsequently is initialized, but only if the writing process is finished (B3:0/3 = 0). These initializations are summarised below:
  - B3:0/2 = 0 ..... **User command:** The command for writing a parameter on a TeSys U motor starter is reset.
  - B3:0/3 = 1 ..... A parameter is written on a TeSys U motor starter: In progress.
  - Reset (T4:1) ..... The timer related to the timeout of the parameter write response is reset.
  - N7:15 = (N7:12 × 2) + 14 ..... Index in the array of results.
  - N7:[N7:15] = { 0 ; 0 } ..... The content of the array of results is reset, but only for the motor starter affected by the write query (two successive bytes).
  - B3:0/6 = 0 ..... Enables the update of the “trigger byte” that will trigger the emission of the query.
- The output data corresponding to the write query is updated (O:1.13 to O:1.15) and the N7:37 counter (“trigger byte”) is increased by one. This update is only done once (bit B3:0/6 used for this pupose).. **Reminder:** In the LUFP9 gateway’s default configuration, this output data corresponds to the personalized Modbus command “Transactions 2” of the “TeSys U n°1” node. The query frame for this personalized command is sent when the “trigger byte” located in bits 8-15 of O:1.16 is changed (“Update mode” = “Change of state on trigger”). As a result, increasing the N7:37 counter, then updating O:1.16 using N7:37 (in “LAD 2 – MAIN_LUFP9”), causes this query to be sent. On the other hand, the output data O:1.13 to O:1.15 must be valid so that the content of the Modbus query remains coherent! The LSB and the MSB of outputs O:1.14 and O:1.15 must be swapped. The scratch variable N9:0 is used to carry out this swap between variables N7:13 and N7:14 and outputs O:1.14 and O:1.15.
- The data from the Modbus response which corresponds to this write command is checked. The values of inputs I:1.13 to I:1.15 are compared to those of outputs O:1.13 to O:1.15 to determine whether the response to the command has arrived or not. If the slave number, the function number, the address of the parameter and its value correspond to those of the query (see above) and the number of bytes of data received is correct, bit B3:0/4 is activated in order to tell the rest of the sub-program that the response has arrived and that it is correct.
- The address and the value of the parameter are copied into two successive locations in the array of results (indexing carried out using N7:15), reserved for the motor starter currently being polled and only takes place if the response has arrived and its content is correct (bit B3:0/4 active). The LSB and the MSB for each of these two items of data are then swapped to restore its correct value. The timer for the response timeout (T4:1) is reinitialized to ready the program for a future write command. Bit B3:0/3 is reset to show that the command is finished, thus avoiding having to run the rest of the sub-program.

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- Management of the response timeout (T4:1). Until the response arrives or if its content is incorrect (bit B3:0/4 = 0), a 3-second timer is set. When this timeout (T4:1/DN = 1) is triggered, the timer is reinitialized, the parameter's address (O:1.14, after LSB / MSB have been swapped using scratch variable N9:0) and an erroneous value (N9:1 = –1) are placed in the array of results, into two successive locations, reserved for the motor starter currently being polled. Finally, the write process is halted (bit B3:0/3 is reset).

The various data used by this sub-program are shown in the following table:

Address	Symbol	Description
B3:0/2	WR_COMMAND	**User command:** Writing a parameter on a TeSys U motor starter. This bit is activated by the user and reset by the program.
B3.0/3	WR_RUNNING	Writing a parameter on a TeSys U motor starter: In progress
B3.0/4	WR_OK	Writing a parameter on a TeSys U motor starter: Writing OK (if the response has arrived and is correct)
B3.0/6	————	The "trigger byte" of the query has been updated: Yes (1) / No (0)
I:1.13	CR_WRPAR_SLAVE_FCT	Result of writing the value of a parameter: Slave (16#01 to 16#08) as LSB + function (always 16#06) as MSB. The values of these fields are compared to those of the query
I:1.14	CR_WRPAR_ADRPAR	Result of writing the value of a parameter: Address of the parameter. The value of this field is compared to that of the query (swapping of the MSB and the LSB with each of these two fields)
I:1.15	CR_WRPAR_VALUE	Result of writing the value of a parameter: Value of the written parameter. The value of this field is compared to that of the query (swapping of the MSB and the LSB with each of these two fields)
N7:12	WR_SLAVE	**User command:** Modbus address of the motor starter to which the write request should be sent.
N7:13	WR_ADDRESS	**User command:** Address of the parameter **N.B.** Do not attempt to change the value of register 704 (command register), because it is already controlled by the DeviceNet master (see sub-program "LAD 3 - CMD_MON")!
N7:14	WR_VALUE	**User command:** New value of the parameter
N7:15	WR_INDEX	Index in the array of results for writing TeSys U parameters (motor starters nos. 1 to 8). Value = 16 + 2 × (motor starter no. – 1) = 16 to 30
N7:[N7:15]	— [WR_INDEX]	Array of results for writing TeSys U parameters (motor starters nos. 1 to 8). Elements N7:16 to N7:31 organized by "parameter address" / "parameter value" pairs, each pair occupying two successive addresses. "Parameter value" = –1 if there is an error (response timeout triggered).
N7:37	————	Local counter that corresponds to the "trigger byte" of the read request.
N9:0 N9:1	VAR_TEMP_1 VAR_TEMP_2	Temporary variables used to carry out the intermediate evaluations (primarily LSB / MSB swappings).
O:1.13	WRPAR_SLAVE_FCT	Request for writing the value of a parameter: Slave (copied from N7:12) as LSB + function (always 16#06) as MSB.
O:1.14	WRPAR_ADRPAR	Request for writing the value of a parameter: Address of the parameter (copied from N7:13, but with MSB and LSB swapped).
O:1.15	WRPAR_VALUE	Request for writing the value of a parameter: Value of the parameter (copied from N7:14, but with MSB and LSB swapped).

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Address	Symbol	Description
S:24	INDEX_SYS	Index register used in indexed addressing (prefix: '#')
T4:1	TIMEOUT_WR_PARAM	Timer for the timeout of the parameter writing command (3 seconds)

The example includes a personalized screen for monitoring the data, called "CDM 2 - WR_PAR", in order to simplify the use of this example. The content of this screen is shown below:

Address	Symbol	Display
N7:12	WR_SLAVE	Decimal
N7:13	WR_ADDRESS	Decimal
N7:14	WR_VALUE	Decimal
B3:0/2	WR_COMMAND	Binary
B3:0/3	WR_RUNNING	Binary
B3:0/4	WR_OK	Binary
N7:15	WR_INDEX	Decimal
N7:16	WRPAR_1_ADDRESS	Decimal
N7:17	WRPAR_1_VALUE	Decimal
N7:18	WRPAR_2_ADDRESS	Decimal
N7:19	WRPAR_2_VALUE	Decimal
N7:20	WRPAR_3_ADDRESS	Decimal
N7:21	WRPAR_3_VALUE	Decimal
N7:22	WRPAR_4_ADDRESS	Decimal
N7:23	WRPAR_4_VALUE	Decimal
N7:24	WRPAR_5_ADDRESS	Decimal

Address	Symbol	Display
N7:25	WRPAR_5_VALUE	Decimal
N7:26	WRPAR_6_ADDRESS	Decimal
N7:27	WRPAR_6_VALUE	Decimal
N7:28	WRPAR_7_ADDRESS	Decimal
N7:29	WRPAR_7_VALUE	Decimal
N7:30	WRPAR_8_ADDRESS	Decimal
N7:31	WRPAR_8_VALUE	Decimal
O:1.13	WRPAR_SLAVE_FCT	Hexadecimal
O:1.14	WRPAR_ADRPAR	Hexadecimal
O:1.15	WRPAR_VALUE	Hexadecimal
I:1.13	CR_WRPAR_SLAVE_FCT	Hexadecimal
I:1.14	CR_WRPAR_ADRPAR	Hexadecimal
I:1.15	CR_WRPAR_VALUE	Hexadecimal
I:1.16	TRIGGER_IN_RD_WR	Hexadecimal
O:1.16	TRIGGER_OUT_RD_WR	Hexadecimal
N7:37	————	Hexadecimal
B3:0/6	————	Binary

9.5. Reserves relating to the RSLogix 500 example

This example is perfectible. So, for instance, with an incorrect response (wrong slave number, function number, etc.), the program performs no particular processing and continues to wait for a response until it times out, even though the gateway has not re-transmitted anything because, from its point of view, the response is correct. In fact, as the whole content of the Modbus response is placed in a "Data" field, it will not be checked before being copied into the gateway's memory. Only the frame's Checksum is checked by the gateway.

The two "trigger bytes" located in the input word I:1.16 are not used. You should use them if it is relevant for your application to be notified each time a response related to the two personalized commands "Transactions 1" and "Transactions 2" is received by the gateway.

Compatibility with the various options offered for the "Control/Status Byte" field in "ABC" (see chapter 5 Gateway Initialization and Diagnostics, page 33) is only partially dealt with in this example. The improvements required relate mainly to managing bits 14 and 15 of the DeviceNet master's command word and the gateway's status word (bits 6 and 7 of the corresponding input I:1.1 and output O:1.1). Also, the use of gateway diagnostics (EC and ED fields) still needs to be defined by the user.

10. Appendix D: DeviceNet Objects

10.1. Introduction to the Gateway's DeviceNet Objects

The LUFP9 gateway's software has been developed in accordance with the ***Object Modelling*** from the DeviceNet protocol. This model leads to a method used for addressing the gateway's data, known as *Attributes*, made up of four separate values: ① the *node address* (MAC ID), ② the *Object*'s *class identifier* (Class ID), ③ the *Instance Number* (Instance ID) and ④ the *Attribute Number* (Attribute ID). An address made up in this way is known as a "**Path**". The *Connection by Explicit Messaging*, for example, uses paths of this sort to exchange data from one point to another on a DeviceNet network.

Address	Min. – max.	Description
Node	0 – 63	This field allows you to address one subscriber out of the series of subscribers on a DeviceNet network using its **MAC ID**.
Class	1 – 65 535	All objects sharing the same characteristics belong to the same class, characterized by its **Class ID**.
Instance	0 – 65 535	The instances represent the various objects from one class. All instances from one class share the same behaviours (1) and the same **attributes**, but each of them has its own set of values for these attributes. When a subscriber creates an instance (instantiation), he assigns a unique **Instance ID**, which allows the other DeviceNet subscribers to have individual access to it.
Attribute	1 – 255	Each attribute represents one of the characteristics of the Instances belonging to the same class. It is assigned some sort of value (byte, unsigned integer, character string, etc.) in order to supply information about the subscriber's status or to make settings on the subscriber's behaviours (1). **N.B.** To access the attributes of an object's base class, you need to use Instance 16#00 when entering the full path. *e.g.* To access the "Revision" attribute from the "Identity Object" class for DeviceNet subscriber no. 4, you will need to use the following path: "16#04 • 16#01 • 16#00 • 16#01".

(1) The behaviours designate actions taken by a DeviceNet object in response to particular events.

10.2. List of the Gateway's DeviceNet Objects

Class	ID	Required	Instances	Interfaces
Identity object	16#01	Yes	1	Message router
Message router	16#02	Yes	1	Explicit message connection
DeviceNet object	16#03	Yes	1	Message router
Assembly object	16#04	No	2 (1)	I/O connections or Message router
Connection object	16#05	Yes	4 (2)	I/O connections or Explicit messages
Acknowledge handler object	16#2B	No	1	I/O connections or Message router
I/O data input mapping object	16#A0	No	1	Message router
I/O data output mapping object	16#A1	No	1	Message router
Diagnostic object	16#AA	No	1	Message router

(1) One input area and one output area are created in the gateway's memory.

(2) The four instantiated connections are as follows: ① Explicit Connection, ② Polled Command/Response, ③ Bit Strobed Command/Response and ④ Change-of-State / Cyclic. The last three connections are of the "I/O Connection" type.

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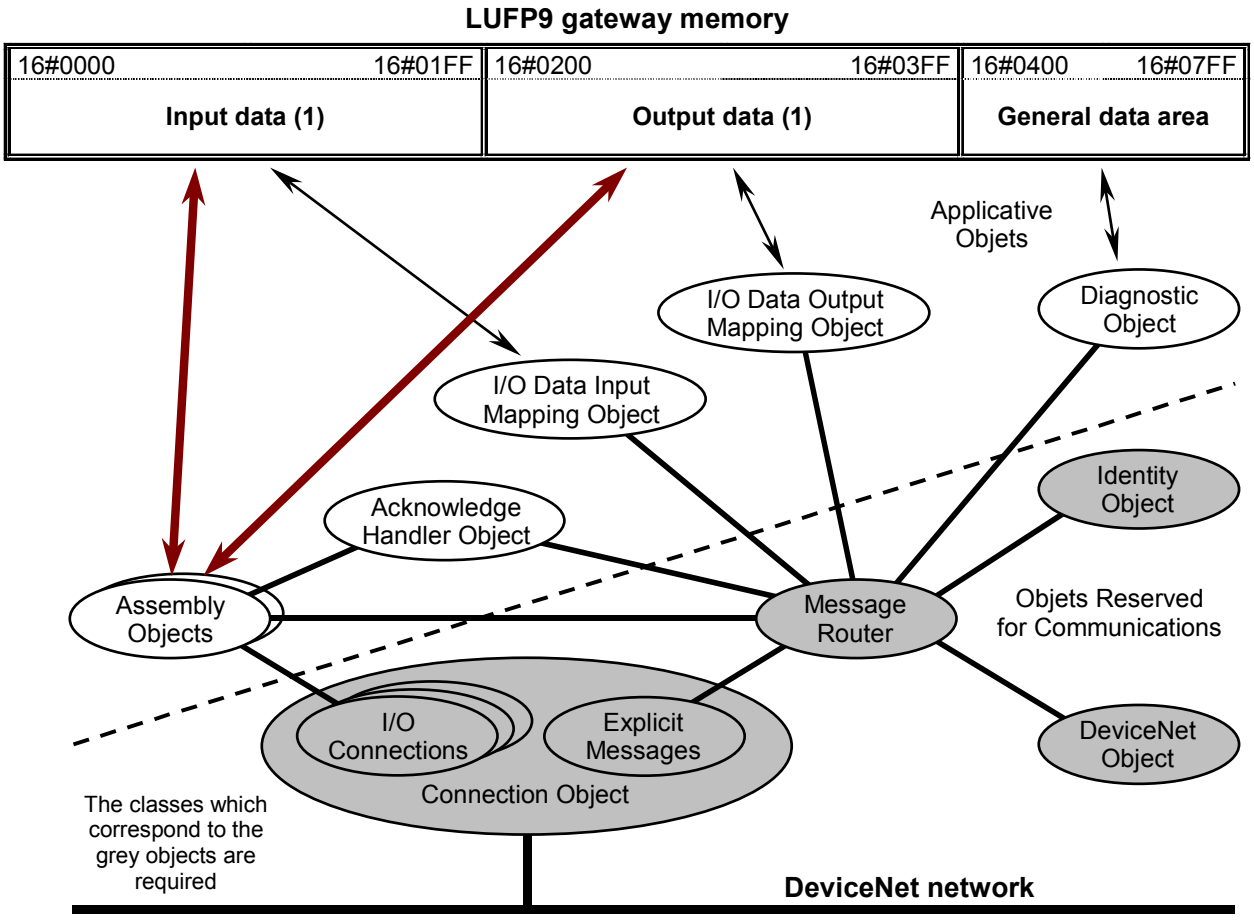
10.3. Graphical Representation of the Gateway's DeviceNet Objects



(1) The input and output data areas can be read or written either using "I/O connections" or using "explicit messages".

10.4. Identity Object (class 16#01)

The "Identity" object only has a single instance (Instance ID = 16#01). This object contains general information allowing you to identify the gateway and diagnose its status. This object is described in chapter 6-2. of volume II of the DeviceNet specifications.

Attributes of class 16#01

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Required	UINT	1	Major and minor indices for the revision of the "Identity Object".

Services in class 16#01

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows the value of one of the attributes of the class to be read.

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Attributes of instance 16#01 of class 16#01

ID	Access	Name	Need	Type	Value
16#01	Get	**Vendor ID**	Required	UINT	90
	All vendor IDs for DeviceNet products are managed by the ODVA. With the LUFP9 gateway, this ID is set to 90 (gateways from *HMS Fieldbus Systems AB (Hassbjer Micro Sys)*).				
16#02	Get	**Device type**	Required	UINT	12
	The list of the various types of DeviceNet products is managed by the ODVA. This attribute allows a DeviceNet subscriber's profile to be identified, and the minimum requirements and options commonly used by the subscribers in this profile to be deduced. The LUFP9 gateway is a "Communication Adapter" product (see chapter 3-7. of volume II of the DeviceNet specifications).				
16#03	Get	**Product code**	Required	UINT	60
	This attribute is managed by the manufacturer of the product, thus allowing him to characterize his own products. He uses it to identify each of his products within the same product family ("device type" attribute). This allows products with differences in terms of their configurations and/or their options to be characterized.				
16#04	Get	**Revision**	Required	USINT, USINT	3 , 1
	Major and minor indices allowing the "Identity Object" to be identified. The value of each of the two members of this attribute may not be null. The conventional representation of the revision indices is "major.minor", with 3 digits for the minor index, completed to the left by zeros if necessary. The major index is limited to 7 data bits. Its 8th bit is reserved and should be set to zero.				
16#05	Get	**Status**	Required	WORD	(16-bit register)
	This attribute is a summary of the product's general status. This is a 16-bit register: Bit 0 ..... Allocated to a master (predefined master/slave connection set). Bit 1 ..... Reserved (value = 2#0). Bit 2 ..... Configured product. Bits 3-7..... Reserved (value = 2#00000). Bit 8.....Minor recoverable fault. Bit 9.....Minor unrecoverable fault. Bit 10.....Major recoverable fault. Bit 11.....Major unrecoverable fault. Bits 12-15.....Reserved (value = 2#0000).				
16#06	Get	**Serial number**	Required	UDINT	(variable)
	The product's serial number is combined with the "vendor ID" attribute to produce a unique identifier for each DeviceNet product. Each manufacturer must take responsibility for guaranteeing that all the DeviceNet products he manufactures have a unique serial number. Sample "serial number:" 16# 23 00 DD 20.				
16#07	Get	**Product name**	Required	SHORT_STRING	"Anybus-C DeviceNet"
	This attribute gives visual identification method and takes the form of an ASCII string. This text gives a short description of the product, or the product family, equivalent to the "product code" attribute (16#03). The byte preceding this ASCII string shows the total length of this string, from first to the last character. With the LUFP9 gateway, the total number of bytes included in the "product name" attribute is set to 24. The "Anybus-C DeviceNet" string has 18 characters (including spaces). The whole content of the "product name" attribute, with the LUFP9 gateway, is therefore equal to: 16# **12** 41 6E 79 62 75 73 2D 43 20 44 65 76 69 63 65 4E 65 74 **00 00 00 00 00**. The bytes which are not shown in bold are the content of the ASCII string (length = 16#12).				
16#09	Get	**Configuration consistency value**	Optional	UINT	(variable)
	The value of this attribute allows the validity of the product's configuration to be checked. The product automatically updates this attribute when the value of any non-volatile attribute is changed. The product's behaviour when an error in the integrity of the configuration is detected is specific to each type of product. In the same way, the method used to calculate the value of this attribute depends entirely on the product: CRC, unit counter, etc. So this attribute allows a DeviceNet master, for instance, to check that the configuration of the DeviceNet product has not been changed. **N.B.** In addition to calculating the value of this attribute, the LUFP9 gateway uses its LED ❻ DEVICE STATUS to warn the user when its configuration is not valid (the LED flashes red/green).				

Services of instance 16#01 of class 16#01

Service code	Name of the service	Requirement	Description
16#05	Reset	Required	This service allows to restart the gateway (power cycle).
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the instance attributes.

10. Appendix D: DeviceNet Objects

10.5. Message Router Object (class 16#02)

The “Message Router” object is the element through which all objects of the “Explicit messages” type go so that they can be routed to the objects they are intended for. It has only one instance (Instance ID = 16#01). This object is described in chapter 6-3. of volume II of the DeviceNet specifications.

Attributes of class 16#02

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of the “Message Router Object” class.

Services in class 16#02

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#02

This instance has no attributes.

10.6. DeviceNet Object (class 16#03)

The “DeviceNet” object has only one instance (Instance ID = 16#01). This object contains the status of the general configuration of the gateway’s node on the DeviceNet network. It is described in chapter 5-5. of volume II of the DeviceNet specifications. The LUFP9 gateway is a “Group 2 only server” type subscriber (see chapter 7-9.of volume I of the DeviceNet specifications).

Attributes of class 16#03

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Required	UINT	2	Revision index of the definition of the class of the “DeviceNet Object” currently used for the implementation of the gateway’s DeviceNet communications functions. (1)

(1) This index must be between 1 and 65,535 and will be incremented if the definition of the class is replaced by a more recent definition.

Services in class 16#03

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Optional	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#03

ID	Access	Name	Need	Type	Value
16#01	Get	**MAC ID**	Required	USINT	0 to 63
	The value of this attribute corresponds to the gateway’s address on the DeviceNet network (MAC ID), that is to say to the address configured using the selector switches described in chapter 2.7.2 Encoding the Gateway Address, page 21.				
16#02	Get	**Baud rate**	Optional	USINT	0 to 2
	The value of this attribute corresponds to the baud rate of the DeviceNet network, as configured on the gateway using the selector switches described in chapter 2.7.1 Encoding DeviceNet Speed, page 20. This speed must be the same for all subscribers on the DeviceNet network. The few possible values for this attribute are as follows: 0 (125 kbits/s), 1 (250 kbits/s) and 2 (500 kbits/s).				

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ID	Access	Name	Need	Type	Value
16#05	Get	**Allocation information**	Required	BYTE , USINT	(variable)
	This attribute supplies general information about the DeviceNet allocation method currently being used. It is made up of the "allocation choice", in BYTE format and the "master's MAC ID", in USINT format and whose value is between 0 and 63. If the "master's MAC ID" is set to 255 (which is the case when the gateway is initialized), this means that there is no allocation when using the "Predefined Master/Slave Connections Set." Please see chapters 3-4., 5-5.4.2., and 7. of volume I of the DeviceNet specifications for further details on this subject. *Example :* 16#03, 16#00.				

Services of instance 16#01 of class 16#03

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Optional	This service allows to read the value of one of the instance attributes.
16#4B	Allocate Master/Slave Connection Set	Optional	This service allows the master/slave connection to be allocated to a DeviceNet master, at the latter's request.
16#4C	Release Master/Slave Connection Set	Optional	This service allows the master/slave connection previously allocated to a DeviceNet master to be cleared, at the latter's request.

10.7. Assembly Objects (Class 16#04)

As a general rule, objects from the "Assembly" class are used to group attributes (data) belonging to different objects within a single attribute. This allows them to be accessed using a single message. With the LUFP9 gateway, this class has only 2 instances, each one being assigned to the input area (Instance ID = 16#64) or to the output area (Instance ID = 16#96) of the gateway. This object is described in chapter 6-5. of volume II of the DeviceNet specifications.

The first instance (Instance ID = 16#64) is assigned to the gateway's input data area. This input area gathers all the memory locations receiving data from a Modbus response and therefore to be relayed to the DeviceNet master. The second instance (Instance ID = 16#96) is assigned to the gateway's output data area. This output area gathers all the memory locations receiving data to be placed in a Modbus query, that is to say all the data transmitted by the DeviceNet master.

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Attributes of class 16#04

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Required	UINT	2	Revision index of the "Assembly Object" class.

Services in class 16#04

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Optional	This service allows to read the value of one of the class attributes.

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Attributes of instance 16#64 of class 16#04 (MODBUS INPUTS)

ID	Access	Name	Need	Type	Value
16#03	Get	**Data**	Required	USINT […]	(array of values)
	The data gathered within this attribute correspond to the data of the attribute 16#01 of instance 16#01 from the "I/O Data Input Mapping Object (Class 16#A0)" described in chapter 10.10 (see page 108). With the default configuration, the size of instance 16#64 (input data area of the gateway) is equal to 32 bytes and the data related to the attribute 16#03 of this instance corresponds to the description given in chapter 8.2.1 Input Data Memory Area, page 84.				

Attributes of instance 16#96 of class 16#04 (MODBUS OUTPUTS)

ID	Access	Name	Requirement	Type	Value
16#03	Get / Set	**Data**	Required	USINT […]	(array of values)
	The data gathered within this attribute correspond to the data of the attribute 16#01 of instance 16#01 from the "I/O Data Output Mapping Object (Class 16#A1)" described in chapter 10.11 (see page 109). With the default configuration, the size of instance 16#96 (output data area of the gateway) is equal to 32 bytes and the data related to the attribute 16#03 of this instance corresponds to the description given in chapter 8.2.2 Output Data Memory Area, page 85.				

Services of instances 16#64 and 16#96 of class 16#04

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the array of values that corresponds to the attribute 16#03 of one of the instances of the "Assembly Object."
16#10	Get_Attribute_Single	Optional	This service allows to write an array of values into the array of the attribute 16#03 of one of the instances of the "Assembly Object."

10.8. Connection Object (Class 16#05)

With the LUFP9 gateway, the "Connection" object has up to four instances (Instance ID = 16#01 to 16#04). Each of these instances represents one of the two ends of a virtual connection established between two nodes on the DeviceNet network, in this case the DeviceNet master node and the gateway node. Each instance of this object belongs to one of the two following types of connection: Explicit connection, allowing *Explicit Messages* to be sent, or implicit connection (*I/O Connections*). This object is described in chapter 5-4. of volume II of the DeviceNet specifications.

Here is a brief description of the four instances of the LUFP9 gateway's "Connection" object, and then details are given in the rest of this chapter:

Instance ID	Type of connection	Connection name
16#01	Explicit Messaging	Explicit Connection
16#02	I/O Connection	Polled Command/Response Connection
16#03	I/O Connection	Bit Strobed Command/Response Connection
16#04	I/O Connection	Change-of-State / Cyclic (Acknowledged) Connection

Each message of an "Explicit Messaging" type connection contains the full addressing path and the values of the attribute involved, as well as the Service Code describing the action to be taken.

Each message of an "I/O Connection" type connection contains only the I/O data. All of the information describing the use of this data is located in the instance of the "Connection Object" associated with this message.

The instance of an "I/O connection" type object is created only if an existing data area has been assigned to it!

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The “Change-of-State / Cyclic Connection” connection (Instance ID 16#04) allows the gateway to produce its data only when their values change or when a timer called “heartbeat rate” times out. A minimum time limit is intended to prevent the connection from monopolizing the DeviceNet network’s bandwidth, should the values of the data it produces change too often. Going into “Cyclic” mode allows the number of exchanges made via this connection to be reduced if the update time (sampling) for the data produced is slow. By adjusting the connection’s cycle time to the value of this time, the produced data corresponds exactly to the data samples, without losing or repeating any sample.

Attributes of class 16#05

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of the “Connection Object” class.
16#64	Get / Set	Polled production	Optional	USINT	0	Index of the input area used by the gateway for production on its “Polled Command/Response” connection. (1)
16#65	Get / Set	Polled consumption	Optional	USINT	0	Index of the output area used by the gateway for consumption on its “Polled Command/Response” connection. (1)
16#66	Get / Set	Strobed production	Optional	USINT	0	Index of the input area used by the gateway for production on its “Bit Strobed Command/Response” connection. (1)
16#67	Get / Set	Strobed consumption	Optional	USINT	0	Index of the output area used by the gateway for consumption on its “Bit Strobed Command/Response” connection. (1)
16#68	Get / Set	COS production	Optional	USINT	0	Index of the input area used by the gateway for production on its “Bit Strobed Command/Response” connection. (1)

(1) All these 5 attributes relate to the first 5 parameters referenced by the EDS file supplied with the gateway. Write access to them (Access = Set) is reserved for DeviceNet configuration tools. You should not use the “Set_Attribute_Single” service with these attributes. An area’s index is necessarily equal to 0 and corresponds to the “Input1” area of the gateway, that is to say to its only one input data area.

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Services in class 16#05

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#05: Explicit Connection

ID	Access	Name	Need	Type	Value
16#01	Get	**State**	Required	USINT	0 to 5
	This attribute represents the status of the “Explicit Connection” object. The LUFP9 gateway supports the following values: 0 (non-existent), 1 (in the process of being configured), 3 (connection established), 4 (timed out) and 5 (deferred deletion). Please see figures 5.16 and 7.4 in volume I of the DeviceNet specifications for further information on this subject.				
16#02	Get	**Instance type**	Required	USINT	0
	This attribute defines the instance’s connection type: Messaging connection (0) or I/O connection (1).				

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ID	Access	Name	Need	Type	Value
16#03	Get / Set	**Transport class trigger**	Required	BYTE	16#83
	This attribute defines the behaviour of the connection. In the case of the LUFP9 gateway's "Explicit Connection" object, this attribute takes the value 16#83, broken down as follows: Bits 0-3 = 2#0011 .... Transport Class = Class 3. Bits 4-6 = 2#xxx..... Value ignored in the case of a data server. Bit 7 = 2#1 ..... The gateway behaves as a data server responding to queries from a DeviceNet client.				
16#04	Get / Set	**Produced connection ID**	Required	UINT	2#11• ••xx xxxx
	The value of this attribute is placed in the CAN protocol's Identifier Field when the connection goes into transmission mode (group 3 messages). The term "xx xxxx" represents the 6 bits of the address of the gateway's DeviceNet node. The term "• ••" represents the message ID. E.g. 16#070A = 2#111 0000 1010 (group 3 messages; ID of the messages = 4; Gateway located at address 10).				
16#05	Get / Set	**Consumed connection ID**	Required	UINT	2#11• ••xx xxxx
	The value of this attribute corresponds to the content of the CAN protocol's Identifier Field for the messages the connection should receive (group 3 messages). The term "xx xxxx" represents the 6 bits of the address of the DeviceNet node. The term "• ••" represents the message ID. E.g. 16#0601 = 2#110 0000 0001 (group 3 messages; ID of the messages = 0; Producer located at address 1).				
16#06	Get / Set	**Initial comm. characteristics**	Required	BYTE	16#21
	This attribute defines the Group or Groups of Messages by which the productions and consumptions associated with the "Explicit Connection" object are carried out. Please see chapters 3-2. et 5-4.3.6. of volume I of the DeviceNet specifications for further details on this subject.				
16#07	Get / Set	**Produced connection size**	Required	UINT	516
	Maximum number of bytes which can be transmitted via this instance's connection.				
16#08	Get / Set	**Consumed connection size**	Required	UINT	516
	Maximum number of bytes which can be received via this instance's connection.				
16#09	Get / Set	**Expected packet rate**	Required	UINT	10,008 (unit = 1 ms, per 10 ms step)
	This attribute allows the gateway to evaluate the values of the *Transmission Trigger Timer* and the *Inactivity / Watchdog Timer* for exchanges made using the "Explicit Connection" object. Please see chapter 5-4.4. in volume I of the DeviceNet specifications for further information on this subject.				
16#0C	Get / Set	**Watchdog timeout action**	Required	USINT	3
	This attribute defines the action taken when the watchdog timer is triggered or when the connection is inactive. The various possible values are as follows: 0 (Transition to timed out), 1 (Auto Delete) et 3 (Deferred Delete).				
16#0D	Get / Set	**Produced connection path length**	Required	UINT	0
	Size of the USINT array of attribute 16#0E (produced connection path).				
16#0E	Get / Set	**Produced connection path**	Required	USINT […]	(empty path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to produce the connection's data. In the case of the current instance, there is no production path for the "Explicit Connection".				
16#0F	Get / Set	**Consumed connection path length**	Required	UINT	0
	Size of the USINT array of attribute 16#10 (consumed connection path).				
16#10	Get / Set	**Consumed connection path**	Required	USINT […]	(empty path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to receive the data consumed by the connection. In the case of the current instance, there is no consumption path for the "Explicit Connection".				

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Attributes of instance 16#02 of class 16#05: Polled Command/Response Connection

ID	Access	Name	Need	Type	Value
16#01	Get	**State**	Required	USINT	0 to 4
	This attribute represents the status of the "Polled Command/Response Connection" object. The LUFP9 gateway supports the following values: 0 (non-existent), 1 (in the process of being configured), 3 (connection established) and 4 (timed out). Please see figures 5.16 and 7.4 in volume I of the DeviceNet specifications for further information on this subject.				
16#02	Get	**Instance type**	Required	USINT	1
	This attribute defines the instance's connection type: Messaging connection (0) or I/O connection (1).				
16#03	Get / Set	**Transport class trigger**	Required	BYTE	16#82
	This attribute defines the behaviour of the connection. In the case of the LUFP9 gateway's "Polled Command/Response Connection" object, this attribute takes the value 16#82, broken down as follows: Bits 0-3 = 2#0010..... Transport Class = Class 2. Bits 4-6 = 2#xxx ..... Value ignored in the case of a data server. Bit 7 = 2#1..... The gateway behaves as a data server responding to queries from a DeviceNet client.				
16#04	Get / Set	**Produced connection ID**	Required	UINT	2#0•• ••xx xxxx
	The value of this attribute is placed in the CAN protocol's Identifier Field when the connection goes into transmission mode (group 1 messages). The term "xx xxxx" represents the 6 bits of the address of the gateway's DeviceNet node. The term "•• ••" represents the message ID. E.g. 16#03CA = 2#011 1100 1010 (group 1 messages; ID of the messages = 12; Gateway located at address 10).				
16#05	Get / Set	**Consumed connection ID**	Required	UINT	2#10x xxxx x•••
	The value of this attribute corresponds to the content of the CAN protocol's Identifier Field for the messages the connection should receive (group 2 messages). The term "x xxxx x" represents the 6 bits of the address of the DeviceNet node. The term "• ••" represents the message ID. E.g. 16#0455 = 2#100 0101 0101 (group 2 messages; ID of the messages = 5; Producer located at address 10).				
16#06	Get / Set	**Initial comm. characteristics**	Required	BYTE	16#01
	This attribute defines the Group or Groups of Messages by which the productions and consumptions associated with the "Polled Command/Response Connection" object are carried out. Please see chapters 3-2. et 5-4.3.6. of volume I of the DeviceNet specifications for further details on this subject.				
16#07	Get / Set	**Produced connection size**	Required	UINT	(size of the input area)
	Maximum number of bytes which can be transmitted via this instance's connection. The value of this attribute should be set to the size of the input area choosed using attribute 16#0E. With the LUFP9 gateway's default configuration, the value of this attribute is set to 32, that is to say to the size of "Input1" area.				
16#08	Get / Set	**Consumed connection size**	Required	UINT	(size of the output area)
	Maximum number of bytes which can be received via this instance's connection. The value of this attribute should be set to the size of the output area choosed using attribute 16#10. With the LUFP9 gateway's default configuration, the value of this attribute is set to 32, that is to say to the size of "Output1" area.				
16#09	Get / Set	**Expected packet rate**	Required	UINT	80 (unit = 1 ms, per 10 ms step)
	This attribute defines the periodicity of the exchanges made via the connections of this instance.				
16#0C	Get / Set	**Watchdog timeout action**	Required	USINT	0
	This attribute defines the action taken when the watchdog timer is triggered or when the connection is inactive. The various possible values are as follows: 0 (Transition to timed out), 1 (Auto Delete), 2 (Auto Reset) et 3 (Deferred Delete).				
16#0D	Get / Set	**Produced connection path length**	Required	UINT	6
	Size of the USINT array of attribute 16#0E (produced connection path).				

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ID	Access	Name	Need	Type	Value
16#0E	Get / Set	**Produced connection path**	Required	USINT […]	16# 20 04 24 64 30 03
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to produce the connection's data. In the case of the current instance, the default production path for the "Polled Command/Response Connection" designates attribute 16#03 of instance 16#64 of class 16#04, that is to say the data from "Input1" area. **N.B.** Changing the value of attribute 16#64 of instance 16#00 of class 16#04 ("Polled production" EDS parameter) has a direct influence on the value of the attribute presented here, as the corresponding connection path is changed to allow access to the selected input area. These changes should only be made using the EDS file supplied with the gateway.				
16#0F	Get / Set	**Consumed connection path length**	Required	UINT	6
	Size of the USINT array of attribute 16#10 (consumed connection path).				
16#10	Get / Set	**Consumed connection path**	Required	USINT […]	16# 20 04 24 96 30 03
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to receive the data consumed by the connection. In the case of the current instance, the default consumption path for the "Polled Command/Response Connection" designates attribute 16#03 of instance 16#96 of class 16#04, that is to say the data from "Output1" area. **N.B.** Changing the value of attribute 16#65 of instance 16#00 of class 16#04 ("Polled consumption" EDS parameter) has a direct influence on the value of the attribute presented here, as the corresponding connection path is changed to allow access to the selected output area. These changes should only be made using the EDS file supplied with the gateway.				

Attributes of instance 16#03 of class 16#05: Bit Strobed Command/Response Connection

ID	Access	Name	Need	Type	Value
16#01	Get	**State**	Required	USINT	0 to 4
	This attribute represents the status of the "Bit Strobed Command/Response Connection" object. The LUFP9 gateway supports the following values: 0 (non-existent), 1 (in the process of being configured), 3 (connection established) and 4 (timed out). Please see figures 5.16 and 7.4 in volume I of the DeviceNet specifications for further information on this subject.				
16#02	Get	**Instance type**	Required	USINT	1
	This attribute defines the instance's connection type: Messaging connection (0) or I/O connection (1).				
16#03	Get / Set	**Transport class trigger**	Required	BYTE	16#83
	This attribute defines the behaviour of the connection. In the case of the LUFP9 gateway's "Bit Strobed Command/Response Connection" object, this attribute takes the value 16#83, broken down as follows: Bits 0-3 = 2#0011 .... Transport Class = Class 3. Bits 4-6 = 2#xxx..... Value ignored in the case of a data server. Bit 7 = 2#1 ..... The gateway behaves as a data server responding to queries from a DeviceNet client.				
16#04	Get / Set	**Produced connection ID**	Required	UINT	2#0•• ••xx xxxx
	The value of this attribute is placed in the CAN protocol's Identifier Field when the connection goes into transmission mode (group 1 messages). The term "xx xxxx" represents the 6 bits of the address of the gateway's DeviceNet node. The term "•• ••" represents the message ID. E.g. 16#038A = 2#011 1000 1010 (group 1 messages; ID of the messages = 14; Gateway located at address 10).				
16#05	Get / Set	**Consumed connection ID**	Required	UINT	2#10x xxxx x•••
	The value of this attribute corresponds to the content of the CAN protocol's Identifier Field for the messages the connection should receive (group 2 messages). The term "x xxxx x" represents the 6 bits of the address of the DeviceNet node. The term "• ••" represents the message ID. E.g. 16#0400 = 2#100 0000 0000 (group 2 messages; ID of the messages = 0; Producer located at address 0).				
16#06	Get / Set	**Initial comm. characteristics**	Required	BYTE	16#02
	This attribute defines the Group or Groups of Messages by which the productions and consumptions associated with the "Bit Strobed Command/Response Connection" object are carried out. Please see chapters 3-2. et 5-4.3.6. of volume I of the DeviceNet specifications for further details on this subject.				

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ID	Access	Name	Need	Type	Value
16#07	Get / Set	**Produced connection size**	Required	UINT	(size of the input area)
	Maximum number of bytes which can be transmitted via this instance's connection. The value of this attribute should be set to the size of the input area choosed using attribute 16#0E. With the LUFP9 gateway's default configuration, the value of this attribute is set to 0, as no input area is assigned to the "Bit Strobed Command/Response Connection" object. **Maximum size = 8 bytes.**				
16#08	Get / Set	**Consumed connection size**	Required	UINT	(size of the output area)
	The value of this attribute is not significant in the case of the "Bit Strobed Command/Response Connection" object. This value is set to 8. **N.B.** When you configure the "Strobed" connection under RsNetWorx, use **a null size output area** ("Output2" to "Output6") if you do not check the box located after "Use Tx Bit:", or **a 1-byte output area** if you check this box (production of a single bit by the DeviceNet scanner). An area of any other size will generate a configuration which is not valid for the gateway.				
16#09	Get / Set	**Expected packet rate**	Required	UINT	80 (unit = 1 ms, per 10 ms step)
	This attribute defines the periodicity of the exchanges made via the connections of this instance.				
16#0C	Get / Set	**Watchdog timeout action**	Required	USINT	0
	This attribute defines the action taken when the watchdog timer is triggered or when the connection is inactive. The various possible values are as follows: 0 (Transition to timed out), 1 (Auto Delete), 2 (Auto Reset) et 3 (Deferred Delete).				
16#0D	Get / Set	**Produced connection path length**	Required	UINT	0
	Size of the USINT array of attribute 16#0E (produced connection path).				
16#0E	Get / Set	**Produced connection path**	Required	USINT […]	(area path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to produce the connection's data. In the case of the current instance, the production path for the "Bit Strobed Command/Response Connection" corresponds to the input area assigned to the "Polled Command/Response Connection" using the "Strobed production" EDS parameter.				
16#0F	Get / Set	**Consumed connection path length**	Required	UINT	0
	Size of the USINT array of attribute 16#10 (consumed connection path).				
16#10	Get / Set	**Consumed connection path**	Required	USINT […]	(area path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to receive the data consumed by the connection. In the case of the current instance, the consumption path for the "Bit Strobed Command/Response Connection" corresponds to the output area assigned to this connection using the "Strobed consumption" EDS parameter.				

Attributes of instance 16#04 of class 16#05: Change-of-State / Cyclic (Acknowledged) Connection

ID	Access	Name	Need	Type	Value
16#01	Get	**State**	Required	USINT	0 to 4
	This attribute represents the status of the "Change-of-State / Cyclic (Acknowledged) Connection" object. The LUFP9 gateway supports the following values: 0 (non-existent), 1 (in the process of being configured), 3 (connection established) and 4 (timed out). Please see figures 5.16 and 7.4 in volume I of the DeviceNet specifications for further information on this subject.				
16#02	Get	**Instance type**	Required	USINT	1
	This attribute defines the instance's connection type: Messaging connection (0) or I/O connection (1).				
16#03	Get / Set	**Transport class trigger**	Required	BYTE	16#12 or 16#02
	This attribute defines the behaviour of the connection. In the case of the LUFP9 gateway's "Change-of-State / Cyclic (Acknowledged) Connection" object, this attribute takes the value 16#12 or 16#02, broken down as follows: Bits 0-3 = 2#0010..... Transport Class = Class 2. Bits 4-6 = 2#001 or 2#000 ..... "Change-of-State" mode (2#001) or "Cyclic" mode (2#000). Bit 7 = 2#0				

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ID	Access	Name	Need	Type	Value
16#04	Get / Set	**Produced connection ID**	Required	UINT	2#0•• ••xx xxxx
	The value of this attribute is placed in the CAN protocol's Identifier Field when the connection goes into transmission mode (group 1 messages). The term "xx xxxx" represents the 6 bits of the address of the gateway's DeviceNet node. The term "•• ••" represents the message ID. E.g. 16#034A = 2#011 0100 1010 (group 1 messages; ID of the messages = 13; Gateway located at address 10).				
16#05	Get / Set	**Consumed connection ID**	Required	UINT	2#10x xxxx x•••
	The value of this attribute corresponds to the content of the CAN protocol's Identifier Field for the messages the connection should receive (group 2 messages). The term "x xxxx x" represents the 6 bits of the address of the DeviceNet node. The term "• ••" represents the message ID. E.g. 16#0452 = 2#100 0101 0010 (group 2 messages; ID of the messages = 2; Gateway located at address 10).				
16#06	Get / Set	**Initial comm. characteristics**	Required	BYTE	16#01
	This attribute defines the Group or Groups of Messages by which the productions and consumptions associated with the "Change-of-State / Cyclic (Acknowledged) Connection" object are carried out. In this case, it designates groups 1 and 2. Please see chapters 3-2. et 5-4.3.6. of volume I of the DeviceNet specifications for further details on this subject.				
16#07	Get / Set	**Produced connection size**	Required	UINT	(size of the input area)
	Maximum number of bytes which can be transmitted via this instance's connection. The value of this attribute should be set to the size of the input area choosed using attribute 16#0E. With the LUFP9 gateway's default configuration, the value of this attribute is set to 0, as no input area is assigned to the "Change-of-State / Cyclic (Acknowledged) Connection" object.				
16#08	Get / Set	**Consumed connection size**	Required	UINT	0
	Maximum number of bytes which can be received via this instance's connection. As the LUFP9 gateway does not consume any data via this connection, the value of this attribute will remains set to 0.				
16#09	Get / Set	**Expected packet rate**	Required	UINT	0 (unit = 1 ms, per 10 ms step)
	This attribute defines the periodicity of the exchanges made via the connections of this instance.				
16#0C	Get / Set	**Watchdog timeout action**	Required	USINT	0
	This attribute defines the action taken when the watchdog timer is triggered or when the connection is inactive. The various possible values are as follows: 0 (Transition to timed out), 1 (Auto Delete), 2 (Auto Reset) et 3 (Deferred Delete).				
16#0D	Get / Set	**Produced connection path length**	Required	UINT	0
	Size of the USINT array of attribute 16#0E (produced connection path).				
16#0E	Get / Set	**Produced connection path**	Required	USINT […]	(area path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to produce the connection's data. In the case of the current instance, the production path for the "Change-of-State / Cyclic (Acknowledged) Connection" corresponds to the output area assigned to this connection using the "COS production" EDS parameter.				
16#0F	Get / Set	**Consumed connection path length**	Required	UINT	4
	Size of the USINT array of attribute 16#10 (consumed connection path).				
16#10	Get / Set	**Consumed connection path**	Required	USINT […]	(area path)
	This attribute defines the local path (without MAC ID) of the gateway's DeviceNet object used to receive the data consumed by the connection. In the case of the current instance, the consumption path for the "Change-of-State / Cyclic (Acknowledged) Connection" designates instance 16#01 of class 16#2B, that is to say the only object of the "Acknowledge Handler Object" class. **N.B.** The EDS file supplied with the gateway does not contain any parameter whose modification would have had any influence on the value of this attribute.				

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Attributes of instances 16#01 to 16#04 of class 16#05

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the attributes from one of the instances of the "Connection Object."
16#10	Set_Attribute_Single	Optional	This service allows to write the value of one of the attributes from one of the instances of the "Connection Object."

10.9. Acknowledge Handler Object (class 16#2B)

The "Acknowledge Handler" object has only one instance (Instance ID = 16#01). This object is used by connections whose producer needs to know whether its data has been received by its recipient(s) (consumers). This object is described in chapter 6-31. of volume II of the DeviceNet specifications.

Attributes of class 16#2B

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of the "Acknowledge Handler Object" class.
16#02	Get	Max instance	Optional	UINT	1	Maximum number of any instance created within the "Acknowledge Handler Object" class.

Services in class 16#2B

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the attributes of the class.

Attributes of instance 16#01 of class 16#2B

ID	Access	Name	Need	Type	Value
16#01	Get / Set	**Acknowledge timer**	Required	UINT	20 (unit: 1ms)
	The value of this attribute determines the waiting time for acknowledgement of the message from a connection. Once this time has elapsed, the gateway proceeds to re-transmit the message which has just failed to be acknowledged. The value of this attribute ranges from 1 to 65,535, and its default value is 20.				
16#02	Get / Set	**Retry limit**	Required	USINT	1
	This attribute determines the maximum number of times that the acknowledge timeout can be successively triggered for the same message, and therefore the number of re-transmissions allowed for each message. The value of this attribute ranges from 0 to 255, and its default value is 1.				
16#03	Get / Set	**COS producing connection instance**	Required	UINT	4
	The value of this attribute is set to the instance number (Instance ID) of the "Connection Object" class corresponding to the "Change-of-State" connection associated with the "Acknowledge Handler" object. This association allows the latter to transmit the acknowledgements it receives to the corresponding connection if they are addressed to it.				
16#04	Get	**Ack list size**	Optional	BYTE	1
	This attribute represents the maximum number of members which can be placed in the ack list. If the value of this attribute is null, the size of the list is dynamic, which is not the case with the LUFP9 gateway.				
16#05	Get	**Ack list**	Optional	BYTE , USINT […]	0 , (empty list)
	This attribute corresponds to the list of active instances of the "Connection Object" class for which the receipt of an acknowledgement is required. It is made up of two elements: The number of members (BYTE) and the list of the associated instance numbers from the "Connection Object" class (USINT […]). The size of the list is set to the value of the first element. By default, the list is empty (no term of the USINT type […]) and only the BYTE element is created. E.g. "1, 4" for a list comprising a single instance of the "Connection Object" class. This instance (16#04) corresponds to the "Change-of-State / Cyclic (Acknowledged) Connection").				

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ID	Access	Name	Need	Type	Value
16#06	Get	**Data with ack path list size**	Optional	BYTE	1
	This attribute represents the maximum number of members which can be placed in the data with ack path list. If the value of this attribute is null, the size of the list is dynamic, which is not the case with the LUFP9 gateway.				
16#07	Get	**Data with ack path list**	Optional	BYTE , (UINT , USINT, USINT [...]) [...]	(data with ack path list)
	This attribute corresponds to the list of “connection instance / consuming application object” pairs allowing the data received in an acknowledgement to be forwarded. An acknowledgement does not necessarily contain any data and so this attribute is optional. It is made up of the following elements: • The number of members of the list (BYTE). • The list of “connection instance / consuming application object” pairs (UINT , USINT, USINT [...]) [...]. The size of this list is set to the value of the first element, described above, and this list is made up of the following elements: - The acknowledged COS consuming connection instance number (UINT). - The path length of the DeviceNet object intended to receive the acknowledgement data (USINT). - The path of the DeviceNet object intended to receive the acknowledgement data (USINT [...]). E.g. 16# 01 00 04 06 20 04 24 98 30 01. The value of this attribute means that this list only contains a single element (16#01) referring to instance 16#0004 and that the acknowledgement data path (16#06: length 6 bytes) refers to attribute 16#01 of instance 16#98 of class 16#04, that is to say to data from output area no. 1, that is to say “Output1.”				

Services of instance 16#01 of class 16#2B

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of the single instance from the “Acknowledge Handler Object.”
16#10	Set_Attribute_Single	Required	This service allows to write the value of the single instance from the “Acknowledge Handler Object.”

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10.10. I/O Data Input Mapping Object (Class 16#A0)

The “I/O Data Input Mapping Object” has only one instance (Instance ID = 16#01) and is specific to the LUFP9 gateway. It contains all the data from the gateway’s unique input area. The only attribute (Attribute ID = 16#01) of the instance from this object is associated with the “Input1” area. This input area gathers all the memory locations receiving data from a Modbus response.

Attributes of class 16#A0

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of “I/O Data Input Mapping Object” class.
16#64	Get / Set	Input1 offset	Optional	USINT	16#0000	Relative starting address of input area no. 1. (1)
16#6E	Get / Set	Input1 length	Optional	USINT	16#0020	Size, expressed in bytes, of input area no. 1. (1)

(1) These 2 attributes correspond to the “Param6” and “Param7” parameters referenced by the EDS file supplied with the gateway. Write access to them (Access = Set) is reserved for DeviceNet configuration tools, since it allows you to change the location or the size of this input data area. So the “Set_Attribute_Single” service should not be used with these attributes. Changing any one of these two attributes has direct consequences on the attribute 16#01 of instance 16#01 from the “I/O Data Input Mapping Object” (size of the data). This attribute is not created if the size of the gateway’s input area is null. The “Input1 offset” attribute corresponds to an offset from the start of the memory area reserved for the input data (16#0000).

The values located in the “Value” column correspond to the LUFP9 gateway’s default configuration (“Input1” area located at address 16#0000 and made up of 32 bytes).

Services in class 16#A0

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#A0

ID	Access	Name	Need	Type	Value
16#01	Get	**Data**	Optional	USINT […]	(input area no.1)
	This attribute corresponds to the gateway’s “Input1” area. Reading it gives access to the values of all the data located in this area in the form of an array of bytes whose size corresponds to the size of the area. This very same attribute is also involved when using instance 16#64 of the Assembly Objects (Class 16#04) described in chapter 10.7 (voir page 98). **N.B.** With the default configuration, attribute 16#01 corresponds to an array of 32 bytes whose content is described in chapter 8.2.1 Input Data Memory Area, page 84.				

Services of instance 16#01 of class 16#A0

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the array of values corresponding to the sole attribute of the single instance from “I/O Data Input Mapping Object”.

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10.11. I/O Data Output Mapping Object (Class 16#A1)

The “I/O Data Output Mapping Object” has only one instance (Instance ID = 16#01) and is specific to the LUFP9 gateway. It contains all the data from the gateway’s unique output area. The only attribute (Attribute ID = 16#01) of the instance from this object is associated with the “Output1” area. This output area gathers all the memory locations whose values are transmitted to the Modbus slaves via Modbus queries.

Attributes of class 16#A1

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of “I/O Data Output Mapping Object” class.
16#64	Get / Set	Output1 offset	Optional	USINT	16#0000	Relative starting address of output area no. 1. (1)
16#6E	Get / Set	Output1 length	Optional	USINT	16#0020	Size, expressed in bytes, of output area no. 1. (1)

(1) These 2 attributes correspond to the “Param18” and “Param19” parameters referenced by the EDS file supplied with the gateway. Write access to them (Access = Set) is reserved for DeviceNet configuration tools, since it allows you to change the location or the size of this output data area. So the “Set_Attribute_Single” service should not be used with these attributes. Changing any one of these two attributes has direct consequences on the attribute 16#01 of instance 16#01 from the “I/O Data Output Mapping Object” (size of the data). This attribute is not created if the size of the gateway’s output area is null. The “Output1 offset” attribute corresponds to an offset from the start of the memory area reserved for the output data (16#0200).

The values located in the “Value” column correspond to the LUFP9 gateway’s default configuration (“Output1” area located at address 16#0200 and made up of 32 bytes).

Services in class 16#A1

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#A1

ID	Access	Name	Need	Type	Value
16#01	Get / Set	**Data**	Optional	USINT […]	(output area no.1)
	This attribute corresponds to the gateway’s “Output1” area. Reading it gives access to the values of all the data located in this area, and writing it allows to change them. These values take the form of an array of bytes whose size corresponds to the size of the area. This very same attribute is also involved when using instance 16#96 of the Assembly Objects (Class 16#04) described in chapter 10.7 (voir page 98). **N.B.** With the default configuration, attribute 16#01 corresponds to an array of 32 bytes whose content is described in chapter 8.2.2 Output Data Memory Area, page 85.				

Services of instance 16#01 of class 16#A1

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Optional	This service allows to read the array of values corresponding to the sole attribute of the single instance from “I/O Data Output Mapping Object.”
16#10	Set_Attribute_Single	Required	This service allows to write/change all the values corresponding to the sole attribute of the single instance from “I/O Data Output Mapping Object.”

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10.12. Diagnostic Object (Class 16#AA)

The “Diagnostic Object” has only one instance (Instance ID = 16#01) and is specific to the LUFP9 gateway. It contains a large amount of diagnostic data of all levels. As a result, some of these diagnoses should not be used, as these are reserved for maintenance operations carried out on the gateway or when developing its software. However, the attributes to which they correspond are all described below for the sake of completeness.

Attributes of class 16#AA

ID	Access	Name	Need	Type	Value	Description
16#01	Get	Revision	Optional	UINT	1	Revision index of the “Diagnostic Object” class.

Services in class 16#AA

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of one of the class attributes.

Attributes of instance 16#01 of class 16#AA

ID	Access	Name	Need	Type	Value
16#01	Get	**DeviceNet module serial number**	Optional	UDINT	(variable)
	The value of the “DeviceNet module serial number” corresponds to the serial number of the gateway’s *AnyBus-S DeviceNet* card, that is to say the card on which the block of selector switches and the DeviceNet connector are located. *e.g.* 16# 20 DD 00 23.				
16#02	Get	**Vendor ID**	Optional	UINT	16#0001
	The value of this attribute is set to 16#0001 for the LUFP9 gateway. The value 16#0000 cannot be used and values between 16#0002 and 16#FFFF are reserved for the gateway suppliers.				
16#03	Get	**Fieldbus type**	Optional	UINT	16#0025
	With the LUFP9 gateway, this attribute always takes the same value (16#0025), as it characterizes the DeviceNet network. Any other value would be incorrect (e.g. 16#0001 for a Profibus-DP network).				
16#04	Get	**DeviceNet module software version**	Optional	UINT	16#0105
	This attribute shows the software version on the gateway’s *AnyBus-S DeviceNet* card. The major index of this version is given by the most significant byte and its minor index is given by the least significant byte, both in BCD format. *e.g.* 16#0105 corresponds to version 01.05.				
16#05	Get	**Interrupt count**	Optional	UINT	(counter)
	The value of the “interrupt count” is incremented by one every time an interrupt related to the management of the downstream Modbus network do occur.				
16#06	Get	**Watchdog counter in**	Optional	UINT	16#0000
	This counter is not implemented, and using this attribute is pointless. The primary function of this counter is to provide *feedback* from the lifetime counter represented by attribute 16#07, which would allow the *AnyBus-S DeviceNet* card to ensure that the card to which it is connected is working properly by comparing the values of these two attributes.				
16#07	Get	**Watchdog counter out**	Optional	UINT	(counter)
	The value of this counter is incremented by one every millisecond (at least one writing operation every 50 ms) and operates as an internal presence counter, intended to the gateway’s applicative card, that is to say the card on which the *AnyBus-S DeviceNet* card is inserted.				
16#08	Get	**Access method status**	Optional	USINT [4]	16# 40 00 00 80
	This array of 4 USINT elements determines the status of the method used to access the gateway’s memory’s general areas. This attribute is not relevant when using the gateway.				

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ID	Access	Name	Need	Type	Value
16#09	Get	**LED status**	Optional	USINT [6]	(variable)
	The values of the elements of this attribute correspond to the status of the gateway's 6 LEDs (1 byte per LED). The first byte corresponds to LED ①, the second to LED ②, etc., up to LED ⑥. Each byte takes one of the following values to designate the state of the LED to which it corresponds: 16#00 (LED is off), 16#01 (LED is green) or 16#02 (LED is red).				
16#0A	Get	**Module type**	Optional	UINT	16#0101
	The value of this attribute is always equal to 16#0101 with the LUFP9 gateway, as this is an "*AnyBus-S*" module.				
16#0B	Get	**DeviceNet module status**	Optional	USINT	(8-bit register)
	Reading this attribute's bits shows certain information about the state of the gateway's *AnyBus-S DeviceNet* card. The four data bits of these registers are described below: Bit 0: Gateway off-line (0) / on-line (1) on the DeviceNet network. Bit 1: All outputs are zeroed (0) or held (1) in the output memory area if the gateway is off-line on the DeviceNet network. Bit 8: All inputs are zeroed (0) or held (1) in the input memory area if the gateway's application is stopped. Bit 9: The "changed data field" register is inhibited (0) / activated (1).				
16#0C	Get	**Changed data field**	Optional	LWORD	—
	Each bit of this 64-bit register indicates whether the content of 8 consecutive bytes of the output memory area has been changed. Bit 0 relates to bytes 16#0200 to 16#0207, bit 1 relates to bytes 16#0208 to 16#0215, etc., up to bit 63, which relates to bytes 16#03F8 to 16#03FF.				
16#0D	Get	**Interrupt cause**	Optional	BYTE	(8-bit register)
	This register allows you to determine the cause of the last interrupt. Each bit is activated when the associated event occurs, then it is reset by the gateway's interrupt handler. So this register is not intended to be used by the DeviceNet master. Bit 0: The gateway goes on-line on the DeviceNet network. Bit 1: The gateway goes off-line on the DeviceNet network. Bit 2: Data changed.				
16#0E	Get	**Interrupt notification**	Optional	BYTE	(8-bit register)
	This register allows you to determine what types of interrupts are allowed (see description of attribute 16#0D). Its value is set when the gateway is initialized, using a specific mailbox (not described in this guide). Bit 0: Issuing an interrupt when the gateway goes on-line on the DeviceNet network. Bit 1: Issuing an interrupt when the gateway goes off-line on the DeviceNet network. Bit 2: Issuing an interrupt when the data are modified. To do this the "change data field" register should be activated (see description of bit 9 of attribute 16#0B).				
16#0F	Get	**IN cyclic I/O length**	Optional	UINT	16#0020
	This attribute indicates the total size of the cyclic input data (*I/O IN data*), expressed as a number of bytes. This size covers all the gateway's memory space occupied by Modbus input data, free locations also being counted. With the LUFP9 gateway's default configuration, the value of this attribute corresponds to the size of the input area of the gateway, that is to say 32 bytes.				
16#10	Get	**IN DPRAM length**	Optional	UINT	16#0020
	This attribute indicates the total size of the input data and parameters in the gateway's memory (*valid IN bytes in DPRAM*), expressed as a number of bytes. This size covers all of the gateway's memory space occupied by Modbus input data and parameters, free locations also being counted. Since no input parameters are defined, the values of attributes 16#0F and 16#10 are both identical. With the LUFP9 gateway's default configuration, the value of this attribute is equal to 32 bytes.				

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ID	Access	Name	Need	Type	Value
16#11	Get	**IN total length**	Optional	UINT	16#0020
	This attribute indicates the total size of the input data used in the gateway's extended memory (*IN bytes supported*), expressed as a number of bytes. This size is equal to the value of the previous attribute (size of inputs in DPRAM), as it only contains input data. The values of attributes 16#0F, 16#10 and 16#11 are all identical. With the LUFP9 gateway's default configuration, the value of this attribute is equal to 32 bytes. **N.B.** The gateway's extended internal memory is different from the DPRAM memory, dealt with in the rest of this guide. As a result, when using the gateway, you will not have to worry about it.				
16#12	Get	**OUT cyclic I/O length**	Optional	UINT	16#0020
	This attribute indicates the total size of the cyclic output data (*I/O OUT data*), expressed as a number of bytes. This size covers all the gateway's memory space occupied by Modbus output data, free locations also being counted. With the LUFP9 gateway's default configuration, the value of this attribute corresponds to the size of the output area of the gateway, that is to say 32 bytes.				
16#13	Get	**OUT DPRAM length**	Optional	UINT	16#0020
	This attribute indicates the total size of the output data and parameters in the gateway's memory (*valid OUT bytes in DPRAM*), expressed as a number of bytes. This size covers all of the gateway's memory space occupied by Modbus output data and parameters, free locations also being counted. Since no output parameters are defined, the values of attributes 16#12 and 16#13 are both identical. With the LUFP9 gateway's default configuration, the value of this attribute is equal to 32 bytes.				
16#14	Get	**OUT total length**	Optional	UINT	16#0020
	This attribute indicates the total size of the output data used in the gateway's extended memory (*OUT bytes supported*), expressed as a number of bytes. This size is equal to the value of the previous attribute (size of outputs in DPRAM), as it only contains output data. The values of attributes 16#12, 16#13 and 16#14 are all identical. With the LUFP9 gateway's default configuration, the value of this attribute is equal to 32 bytes. **N.B.** The gateway's extended internal memory is different from the DPRAM memory, dealt with in the rest of this guide. As a result, when using the gateway, you will not have to worry about it.				
16#15	Get	**Reserved attribute**	Optional	UINT	16#0000
	This attribute is not used.				
16#16	Get	**Application indication**	Optional	USINT	(8-bit register)
	This 8-bit register is reserved for the gateway's applicative card, that is to say the card on which the *AnyBus-S DeviceNet* card is inserted. The various bits of this register are primarily used when internal commands of the gateway are intended to act on the gateway's memory. These bits are not intended to be used by the DeviceNet master and will not be described here.				
16#17	Get	**AnyBus indication**	Optional	USINT	(8-bit register)
	This 8-bit register is reserved for the gateway's *AnyBus-S DeviceNet* card. The various bits of this register are primarily used when internal commands of the gateway are intended to act on the gateway's memory. These bits are not intended to be used by the DeviceNet master and will not be described here, except for bit 4: Bit 4: This bit is set to one once the gateway's *AnyBus-S DeviceNet* card has been initialized.				

Services of instance 16#01 of class 16#AA

Service code	Name of the service	Need	Description
16#0E	Get_Attribute_Single	Required	This service allows to read the value of the single instance of the "Diagnostic Object."

11. Appendix E: Modbus Commands

Only the Modbus commands shown in the right-hand table are supported by the gateway. The structure of the query and response frames for each of these commands is then described in the following chapters.

Function code		Broadcast (1)	Modbus command
3	16#03	—	Read Holding Registers
6	16#06	Yes	Preset Single Register
16	16#10	Yes	Preset Multiple Registers

(1) The content of this column shows whether the command can be added ("Yes") or not ("—") to the list of a broadcaster node's commands, known as "Broadcaster" in AbcConf.

In the following chapters, each byte of the query and response frames of a Modbus command are described, one after another, with the exception of the fields shown opposite. These are always present in the queries and responses of all Modbus commands.

The "Slave Address" and "Function" fields are the first two bytes of these frames. The two bytes of the "Checksum" are their last two bytes.

Slave Address	- Value cannot be changed (Modbus address: 1 to 247. Addresses 125, 126, and 127 prohibited)
Function	- Value cannot be changed (code of the Modbus command)
… Other fields …	*… Specific features of Modbus commands …*
Checksum (Lo)	- Type of error check
Checksum (Hi)	- Number of the 1st byte checked

The descriptions of the Modbus frames which appear in the following chapters are mainly intended to help you to configure the gateway's Modbus exchanges using AbcConf. Please see the documentation of each Modbus slave to check for any restriction regarding these frames (number of registers which can be read or written in a single Modbus command, for example).

It is a better idea to get hold of a standard Modbus document, such as the guide entitled *Modicon Modbus Protocol Reference Guide* (ref.: PI-MBUS-300 Rev. J), so that you can see the correspondence between the elements displayed in AbcConf and the content of the corresponding Modbus frames. Here is an example of a correspondence for a full frame (including the start and end of frame fields shown above), based on the "Read Holding Registers" Command (16#03) (see chapter 11.1, page 114) :

	Elements under AbcConf		Modbus frame fields	Size
Modbus query	Slave Address		Slave no.	1 byte
	Function		Function no.	1 byte
	Starting Address (Hi, Lo)		No. of the 1st word (MSB / LSB)	2 bytes
	Number of points (Hi, Lo)		Number of words (MSB / LSB)	2 bytes
	Checksum		CRC16 (LSB / MSB)	2 bytes
Modbus response	Slave Address		Slave no.	1 byte
	Function		Function no.	1 byte
	Byte count		Number of bytes read	1 byte
	Data		Value of 1st word (MSB / LSB)	2 bytes
			……	……
			Value of last word (MSB / LSB)	2 bytes
	Checksum		CRC16 (LSB / MSB)	2 bytes

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11. Appendix E: Modbus Commands

Chapter 6.11 Adding and Setting Up a Modbus Command, page 62, also shows a few examples of correspondences between the elements displayed in AbcConf and the corresponding Modbus frame fields.

See also: Chapter 6.11.2 With a Generic Modbus Slave, page 63, and chapter 6.11.3 Adding a Special Modbus Command, page 73, if the implementation of one of these commands would be incompatible with its implementation in the gateway, for example. You then have to create a special Modbus command to compensate for this incompatibility.

N.B. here, the notions of "input" and "output" (and assimilated) are irrelevant, as all Modbus commands have access to all of a Modbus slave's memory. However, these names are retained in order to comply with the terms used in the standard Modbus documentation.

11.1. "Read Holding Registers" Command (16#03)

Frame	Field	Value or properties
Query	Starting Address (MSB)	- Address of the 1st output / internal register
	Starting Address (LSB)	
	Number of points (MSB)	- Number of output / internal registers
	Number of points (LSB)	
Response	Byte count	- Number of data bytes = number of output / internal registers × 2
	Data (first register / MSB)	- Byte swap = "Swap 2 bytes" (or "No swapping") - Data length = Value of the "Byte count" field - Data location = Address in the gateway's input memory
	Data (first register / LSB)	
	……	
	Data (last register / MSB)	
	Data (last register / LSB)	

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11.2. "Preset Single Register" command (16#06)

Frame	Field	Value or properties
Query	Register (MSB)	- Address of the output / internal register
	Register (LSB)	
	Preset data (MSB)	- Byte swap = "Swap 2 bytes" (or "No swapping") - Data length = 16#0002 - Data location = Address in the gateway's output memory
	Preset data (LSB)	
Response	Register (MSB)	- Byte swap = "Swap 2 bytes" (or "No swapping") - Data length = 16#0002 - Data location = Address in the gateway's input memory **N.B.** This data is an echo to the query. So in most cases there is no need to feed them back to the DeviceNet master.
	Register (LSB)	
	Preset data (MSB)	
	Preset data (LSB)	

Instead of creating a link between the echo of the response to the "Preset Single Register" command (16#06) and the memory area dedicated to the DeviceNet inputs (16#0002-16#01FF), you'd better link it with the address 16#0400.

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11.3. “Preset Multiple Registers” Command (16#10)

Frame	Field	Value or properties
Query	Starting Address (MSB)	- Address of the 1st output / internal register
	Starting Address (LSB)	
	Number of Registers (MSB)	- Number of output / internal registers
	Number of Registers (LSB)	
	Byte Count	- Number of data bytes = number of output / internal registers × 2
	Data (first register / MSB)	- Byte swap = “Swap 2 bytes” (or “No swapping”) - Data length = Value of the “Byte count” field - Data location = Address in the gateway’s output memory
	Data (first register / LSB)	
	……	
	Data (last register / MSB)	
	Data (last register / LSB)	
Response	Starting Address (MSB)	- Address of the 1st output / internal register
	Starting Address (LSB)	
	Number of Registers (MSB)	- Number of output / internal registers
	Number of Registers (LSB)	

11.4. Modbus Protocol Exception Responses

When it cannot process a command dictated by a Modbus query, a slave sends an exception response instead of the normal response to the query.

With standard Modbus commands, the LUFP9 gateway considers that all exception responses which it receives from Modbus slaves are incorrect responses. As a result, it will carry out the re-transmissions configured for the queries involved.

If you want the software application for your DeviceNet master to be able to specifically manage exception responses, you can replace the Modbus command, in AbcConf, with a personalized command (see chapter 6.11.3.2 Modbus Commands which Can Be Completely Changed by the User, page 74). This then allows you to feed back the “Slave Address” and “Function” fields to the DeviceNet master.

The structure of an exception response is independent of the Modbus command associated with the “Function” field of the query involved. The whole frame of an exception response is shown below :

Slave Address	Modbus address (1 to 247; addresses 125, 126 and 127 prohibited): The value of this field is identical to that of the “Slave Address” field of the query involved.
Function	Command code, with exception indicator: The value of this field is set to 16#80 + the value of the “Function” field of the query involved.
Exception Code	Code indicating the nature of the error which has caused the exception response (see table on next page).
Checksum (Lo)	Error check
Checksum (Hi)	

11. Appendix E: Modbus Commands

Code	Name of the exception	Description of the exception
16#01	ILLEGAL FUNCTION	The query's "Function" command code is not implemented in the Modbus slave software, or it is unable to process it for the moment.
16#02	ILLEGAL DATA ADDRESS	The combination of the query's "Starting Address" and "No. of Registers" fields (or assimilated fields) gives access to one or more addresses which are not accessible on the Modbus slave.
16#03	ILLEGAL DATA VALUE	The value of one of the Modbus query's fields is outside the authorized limits. This error does not affect the content of the "Data" (or assimilated) fields, as this error only takes account of the fields used for managing the Modbus protocol.
16#04	SLAVE DEVICE FAILURE	An unrecoverable failure has occurred when processing the command.
16#05 (1)	ACKNOWLEDGE	The Modbus slave informs the gateway that it has accepted the command (acknowledgement), but that it will take too long to process it and it cannot afford to wait for the completion of this process before sending a response. The gateway should transmit subsequent queries in order to determine whether the command has finished or not.
16#06 (1)	SLAVE DEVICE BUSY	The Modbus slave informs the gateway that it is already in the process of running a command and therefore it cannot run the one transmitted to it. So the gateway should re-transmit the query subsequently.
16#07 (1)	NEGATIVE ACKNOWLEDGE	The Modbus slave informs the gateway that it cannot process the requested command. This exception only affects commands 13 and 14 (16#0D and 16#0E). These functions are not part of the standard Modbus commands and are not described in this document.
16#08 (1)	MEMORY PARITY ERROR	The Modbus slave informs the gateway that it has detected a parity error on the access to its own memory. This exception only affects standard commands 20 and 21 (16#14 and 16#15) which are not supported by the gateway.

(1) Please see the standard Modbus documentation for further information about these various cases.

ENGLISH

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