1KGT151132, MAY 26TH, 2020

Application Note
Converting IEC-101 to IEC-104 using serial attached RTU520 and EDS500
Table of Content

1 Introduction ........................................................................................................................................3
   1.1 Motivation .................................................................................................................................3

2 Configuration .....................................................................................................................................4
   2.1 Setup ........................................................................................................................................4
   2.2 RTU520 Configuration ..............................................................................................................5
   2.3 Configuration Summary for RTU520 .....................................................................................10
   2.4 500NMD Configuration ..........................................................................................................12
   2.5 Configuration File for 500NMD ............................................................................................14

3 Verifying operation .........................................................................................................................15
   3.1 Verification of configuration and operation on EDS500 ......................................................15

4 Ordering Information ...................................................................................................................16

5 References .....................................................................................................................................17
1 Introduction

This document describes the settings required to enable transparent protocol conversion from station side balanced IEC 60870-5-101 to control center side IEC 60870-5-104 via an EDS500 managed Ethernet switch, namely 500NMD and 560NMS series of DIN rail and rack mount Ethernet products.

The station side RTU is a RTU500 based device, in this example a RTU520 with Release 12.6.

1.1 Motivation

In some applications the serial data path on RTU500 is required for security measures (in example separation of SCADA and Management traffic) or redundancy.

With a consequently Ethernet based networking infrastructure a conversion to IEC 60870-5-104 is required at some point in the network to ensure connectivity to SCADA control systems or intermediate RTUs.

With its’ optional transparent protocol conversion capability EDS500 can be used for direct connection of IEC 60870-5-101 based equipment to the communication device. The transparency of the conversion ensures ease of use due to the fact, that changes on information objects only need to be done in the attached RTU. A reconfiguration of the converter is not required.
2 **Configuration**

Chapter 0 describes the configuration steps to configure the transparent conversion for a 500NMD01 EDS500 managed Ethernet Switch and shows the corresponding settings for the attached RTU520.

Chapter 2.1 illustrates the setup while chapters 2.2 to 2.5 describe the settings and configuration steps.

### 2.1 Setup

A RTU520 is directly connected to a 500NMD01 managed switch via a 500CAB10 serial cable. The RTU uses the IEC 60870-5-101 protocol in balanced mode.

![Setup Diagram](image)

**Figure 1: Setup**

On the other side the 500NMD01 connects to a communication network and finally to a redundant control center.

The IEC 60870 settings below are used for the serial (IEC 60870-5-101) respectively Ethernet (IEC 60870-5-104) side.

**IEC 60870 Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>IEC-101 (RTU520)</th>
<th>IEC-104 (Control Center)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of link address</td>
<td>1 byte (8 bits)</td>
<td>-</td>
</tr>
<tr>
<td>Length of ASDU (station) address</td>
<td>2 bytes (16 bits)</td>
<td>2 bytes (16 bits)</td>
</tr>
<tr>
<td>Length of information object addresses</td>
<td>3 bytes (24 bits)</td>
<td>3 bytes (24 bits)</td>
</tr>
<tr>
<td>Information object address structure</td>
<td>8-8-8</td>
<td>8-8-8</td>
</tr>
</tbody>
</table>
2.2 RTU520 Configuration

The example below shows the configuration of a RTU520 520CMD01 to connect to an EDS500 based managed switch via IEC 60870-5-101. The corresponding EDS500 configuration can be found in chapter 2.4.

The main parameters are balanced mode IEC 60870-5-101, 16 bit ASDU (station) addresses, 24 bit object addresses structured as 8-8-8.

The communication port used at the RTU520 is CP1.

Configuration is done via the RTUtil500 configuration tool.
Tasks – Network Tree

Description

CLI command

Select ‘Network Tree’ View

Add a new item to the (existing) RTU520 device.

Add a node ‘Host Activity’ – ‘Line T101’.
Select the IEC 60870-5-101 tab and set transmission mode to balanced.

Change ASDU address length/structure to ‘16’ and Information object address length/structure to 8-8-8.

Disable Gap supervision time.
### Tasks – Hardware Tree

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLI command</strong></td>
</tr>
</tbody>
</table>

Select ‘Hardware Tree’ View.

Select the 520CMD01 CMU/AD device.

Right click ‘Link item’.
Select ‘Line T101’ and ‘CP1’. Click Link.

Select the communication port 1 (CP1) tab under ‘CMU/AD device: 520CMD01’ and adjust the baud rate to 9600 bits/sec and the link type to ‘Direct link (TxD/RxD only)’. 
2.3 Configuration Summary for RTU520

The image below represents the sample settings for the RTU520.

Interface settings

Figure 2: RTU520 interface settings
Figure 3: RTU520 IEC 60870-5-101 settings
2.4 500NMD Configuration

The example below outlines the configuration steps required to connect an EDS500 managed switch 500NMD to a RTU500 device via serial communication using the IEC 60870-5-101 protocol. The serial interface used at the 500NMD is ‘Console0’.

The configuration must be performed by using CLI commands via a serial connection, Telnet or SSH access or the integrated webserver. The example below lists the appropriate CLI commands.

The IEC configuration is performed by configuring virtual interfaces ‘iec101 interface 1’ and ‘iec104 interface 1’.

Tasks – Serial Interface

<table>
<thead>
<tr>
<th>Description</th>
<th>CLI command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set baud rate to 9600 baud.</td>
<td>set interface console0 baudrate 9600</td>
</tr>
<tr>
<td>Set number of data bits to 8 (this is default)</td>
<td>set interface console0 databits 8</td>
</tr>
<tr>
<td>Set parity to ‘even’.</td>
<td>set interface console0 parity even</td>
</tr>
<tr>
<td>Set number of stop bits to 1 (this is default)</td>
<td>set interface console0 stopbits 1</td>
</tr>
<tr>
<td>Disable handshake line.</td>
<td>set interface console0 cts off</td>
</tr>
<tr>
<td>Disable carrier detection signal.</td>
<td>set interface console0 dcd off</td>
</tr>
<tr>
<td>Set serial interface mode to IEC-101.</td>
<td>set interface console0 mode iec101</td>
</tr>
</tbody>
</table>

Tasks – Virtual IEC 60870-5-10x Interfaces

<table>
<thead>
<tr>
<th>Description</th>
<th>CLI command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attach IEC-101 to interface ‘console0’ in balanced mode</td>
<td>set iec101 interface 1 attach console0 balanced</td>
</tr>
<tr>
<td>Set IEC-101 to master mode (RTU is slave).</td>
<td>set iec101 interface 1 function master</td>
</tr>
<tr>
<td>Set IEC-101 length of link address to 1 byte (8 bits).</td>
<td>set iec101 interface 1 length link-address 1</td>
</tr>
<tr>
<td>Set IEC-101 length of object addresses to 3 bytes (24 bits).</td>
<td></td>
</tr>
</tbody>
</table>
Set IEC-101 length of ASDU (station) addresses to 2 bytes (16 bits). This is the default setting.

Optional: Set IEC-101 object address structure to 8-8-8. The settings is only relevant for the user interface, there is no technical relevance within 500NMD for this setting.

Enable use of single-character acknowledgements ('E5') in receive direction for IEC-101.

Link IEC-101 interface 1 to the corresponding IEC-104 interface.

Optional: Limit IEC-104 connection to the control center IP addresses.

Optional: Enable multiple IEC-104 connections simultaneously (in example required for redundancy in an active/active configuration).

Disable conversion of IEC-104 acknowledges to IEC-101. The setting is required unless systemwide IEC-104 parameters ‘w’ and ‘k’ are set to ‘1’. This potentially falsely suggests the RTU in a communication error condition that a signal has reached the control center. If the corresponding status is retransmitted after the connection is restored (in example via a general interrogation command) this is usually not a problem.

Disable conversion of ASDU types for IEC-104.

EDS500 managed switches can act as IEC-104 station providing link state and several other parameters via IEC-104 to a control center. It is best practice to disable this feature in a converter application.

Optional: Set IEC-104 object address structure to 8-8-8. The settings is only relevant for the user interface, there is no technical relevance within 500NMD for this setting.

Link IEC-104 interface 1 to the corresponding IEC-101 interface.

Enable IEC-101 interface.

Enable IEC-104 interface.
2.5 Configuration File for 500NMD

The listing below represents a sample configuration file for the conversion from IEC 60870-5-101 to IEC 60870-5-104.

! version 2.0
! common
set iec101 interface 1 attach console0 balanced
set iec101 interface 1 convert to iec104 interface 1
set iec101 interface 1 function master
set iec101 interface 1 length link-address 1
set iec101 interface 1 length object-address 3
set iec101 interface 1 length station-address 2 (default)
set iec101 interface 1 object structure 8-8-8 (optional)
set iec101 interface 1 single-character rx
set iec104 interface 1 attach remote-ip 192.168.99.10 (optional)
set iec104 interface 1 attach remote-ip 192.168.99.11 (optional)
set iec104 interface 1 control-center multiple-active
set iec104 interface 1 convert no acknowledge
set iec104 interface 1 convert no asdu-types
set iec104 interface 1 convert to iec101 interface 1
set iec104 interface 1 local-station no enable
set iec104 interface 1 object structure 8-8-8 (optional)
set interface console0 baudrate 9600
set interface console0 cts off
set interface console0 databits 8 (default)
set interface console0 dcd off
set interface console0 mode iec101
set interface console0 parity even
set interface console0 stopbits 1 (default)
set system gateway 192.168.16.1
set system ip 192.168.16.13
! interface state
set iec101 interface 1 no shutdown
set iec104 interface 1 no shutdown
set interface ds11 no shutdown
set switch port1 no shutdown
set switch port2 no shutdown
set switch port3 no shutdown
set switch port4 no shutdown
3 Verifying operation

There are several commands to verify the operation of the IEC conversion.

3.1 Verification of configuration and operation on EDS500

<table>
<thead>
<tr>
<th>Description</th>
<th>CLI command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display the configuration.</td>
<td>show running-configuration</td>
</tr>
<tr>
<td>Display IEC 60870-5-101 information.</td>
<td>show iec101</td>
</tr>
<tr>
<td>Display IEC 60870-5-104 information.</td>
<td>show iec104</td>
</tr>
<tr>
<td>Display IEC 60870-5-101 converter information.</td>
<td>show iec101 converter</td>
</tr>
<tr>
<td>Display IEC 60870-5-104 converter information.</td>
<td>show iec104 converter</td>
</tr>
<tr>
<td>Display IEC 60870-5-101 traffic. The additional command ‘terminal monitor’ is required.</td>
<td>debug iec101</td>
</tr>
<tr>
<td>Display IEC 60870-5-104 traffic. The additional command ‘terminal monitor’ is required.</td>
<td>debug iec104</td>
</tr>
</tbody>
</table>
# Ordering Information

For order numbers regarding 500NMDxx the table below can be used.

<table>
<thead>
<tr>
<th>Product</th>
<th>Ident no</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>500NMD01</td>
<td>R0002 1KHW025096R0002</td>
<td>4xRJ-45, 1xSHDSL, 1xRS-232</td>
</tr>
<tr>
<td>500NMD02</td>
<td>R0002 1KHW025097R0002</td>
<td>4xRJ-45, 2xSHDSL, 2xRS-232</td>
</tr>
<tr>
<td>500NMD11</td>
<td>R0002 1KHW027869R0002</td>
<td>4xRJ-45, 1xSHDSL, 1xSFP, 2xRS-232</td>
</tr>
<tr>
<td>500NMD20</td>
<td>R0002 1KHW025098R0002</td>
<td>4xRJ-45, 2xSFP, 2xRS-232</td>
</tr>
<tr>
<td>500NMD30</td>
<td>R0002 1KGT038890R0002</td>
<td>4xRJ-45, 1xRS-232</td>
</tr>
<tr>
<td>500CAB10</td>
<td>R0001 1KGT038924R0001</td>
<td>Connection cable 500NMDxx to RTU500 CP</td>
</tr>
<tr>
<td>520CMD01</td>
<td>R0001 1KGT031900R0001</td>
<td>RTU520, 3xRS-232, 1xRJ-45</td>
</tr>
<tr>
<td>520CMD01</td>
<td>R0002 1KGT031900R0002</td>
<td>RTU520, 1xRS-232, 2xRS-485, 1xRJ-45</td>
</tr>
</tbody>
</table>
5 References

<table>
<thead>
<tr>
<th>Product</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDS500 IEC-Conversion</td>
<td>Application Note</td>
</tr>
<tr>
<td>500NMDxx</td>
<td>Presentation</td>
</tr>
<tr>
<td>500NMDxx</td>
<td>Brochure</td>
</tr>
<tr>
<td>500CAB10</td>
<td>Datasheet</td>
</tr>
<tr>
<td>RTU520</td>
<td>Presentation</td>
</tr>
<tr>
<td>RTU520</td>
<td>Brochure</td>
</tr>
</tbody>
</table>

Contact

Technical questions: de-eds-sales-support@abb.com
Commercial topics, orders: substationautomation-products@de.abb.com