



IEC-60870-5-104 OPC Device Driver

IEC-60870-5-104 OPC Device Driver Manual

Table of Contents

OVERVIEW	3
RELAB IEC-60870-5-104 OPC DEVICE DRIVER	3
OPERATING SYSTEM AND HARDWARE REQUIREMENTS	3
OPERATING SYSTEM (OS)	3
HARDWARE	3
CONFIGURING RL60870-5-104 OPC DEVICE DRIVER	4
DRIVER CONFIGURATION DIALOG	5
CONNECTION TAB OPTIONS	5
INITIALIZATION TAB OPTIONS	6
TIME SETTINGS TAB OPTIONS.....	7
FIELD SIZES TAB OPTIONS	8
GROUP POLLING TAB OPTIONS.....	9
COUNTER POLLING TAB OPTIONS.....	10
LOG TAB OPTIONS	11
IMMEDIATE IO TAB OPTIONS	12
OPC TAG TYPES	13
SYSTEM TAGS	14
ACQUISITION TAGS.....	14
COMMAND TAGS	15
<i>CMD and CMD_WithTs Tags</i>	15
<i>CMD_SBO and CMD_SBO_WithTs Tags</i>	16
PARAMETER TAGS	16
ATTRIBUTE TAGS	18
GLOBAL TAGS	20
CAUSE OF TRANSMISSION (COT)	21
SELECT BEFORE OPERATE (SBO) COMMANDS.....	22
MAPPING RL60870-5-104 ITEMS TO RELAB OPC SERVER	25

IEC-60870-5-104 OPC Device Driver Manual

Overview

IEC-60870 is a Substation Automation design standard - part of the IEC reference architecture for electric power systems.

ReLab IEC-60870-5-104 OPC Device Driver

ReLab OPC Server has an advanced architecture with ability to plug-in multiple drivers supporting multiple protocols into one instance of the OPC Server.

ReLab's IEC-60870-5-104 OPC device driver fully addresses the need of collecting, processing and analyzing IEC-60870 data.

This manual will assist you in configuring communications between IEC-60870 compliant devices (IED's) and ReLab's IEC-60870-5-104 OPC Device Driver.

Operating System and Hardware Requirements

Operating System (OS)

- Windows® 7
- Windows 8, 8.1
- Windows® Server 2003
- Windows® Server 2008, 2008 R2

Hardware

- CPU – 1GHz (minimum)
- Memory – 500MB (minimum)
- Hard Drive Storage – 500MB (minimum)

Configuring RL60870-5-104 OPC Device Driver

Follow these steps to configure the IEC-60870-5-104 OPC Device Driver (RL60870-104):

1. Open ReLab OPC Console and navigate to the main menu item **Configure | Load Driver**

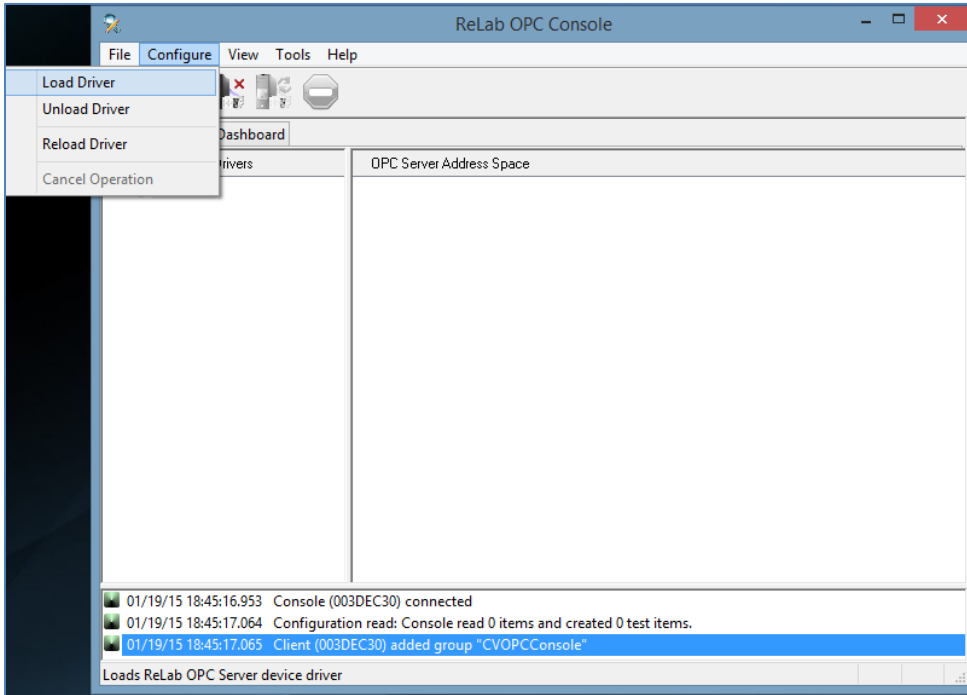


Figure 1

2. Select IEC-60870 Device Driver

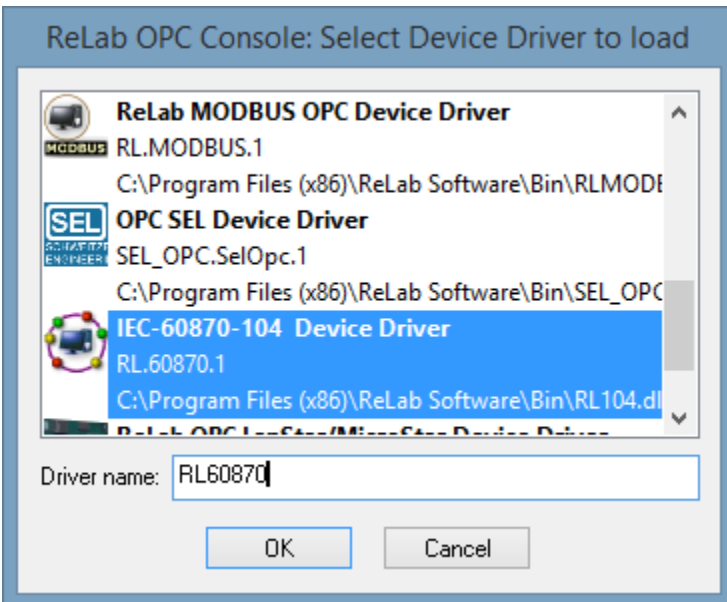


Figure 2

3. Specify **Driver name** and click **OK**
4. The **Driver Configuration** dialog will appear

Driver Configuration Dialog

The following options can be configured for the Driver:

Connection Tab Options

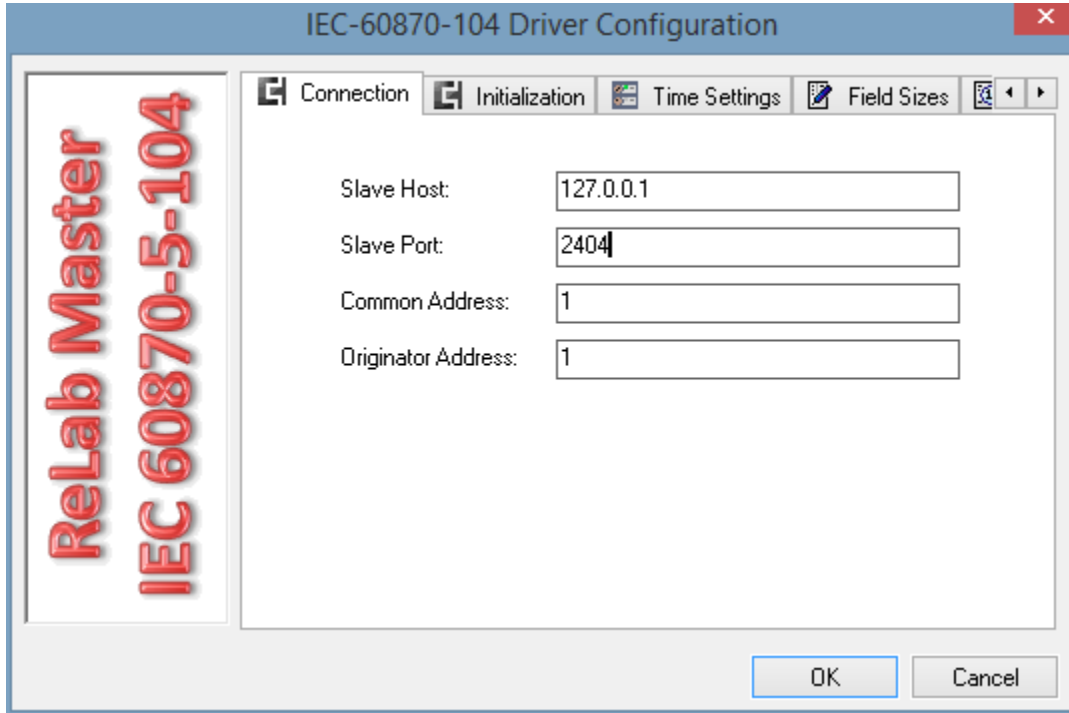


Figure 3

Option	Description	Type	Default
Slave Host	The IP address of the Slave device.	IP Address	127.0.0.1
Slave Port	The port of the Slave device.	Integer	2404
Common Address	The address of a particular sector of a physical device. The valid range is 0 to 254 or 0 to 65534, depending on whether the Common Address (ASDU) size setting is set to one or two octets.	Integer	1
Originator Address	Transmitter's address.	Integer	1

Table 1

Initialization Tab Options

On initialization tab a user can specify the sequence of optional command the Driver will send to a Slave on an initialization. The Initialization sequence will be executed on the driver start-up and on every connection to a Slave.

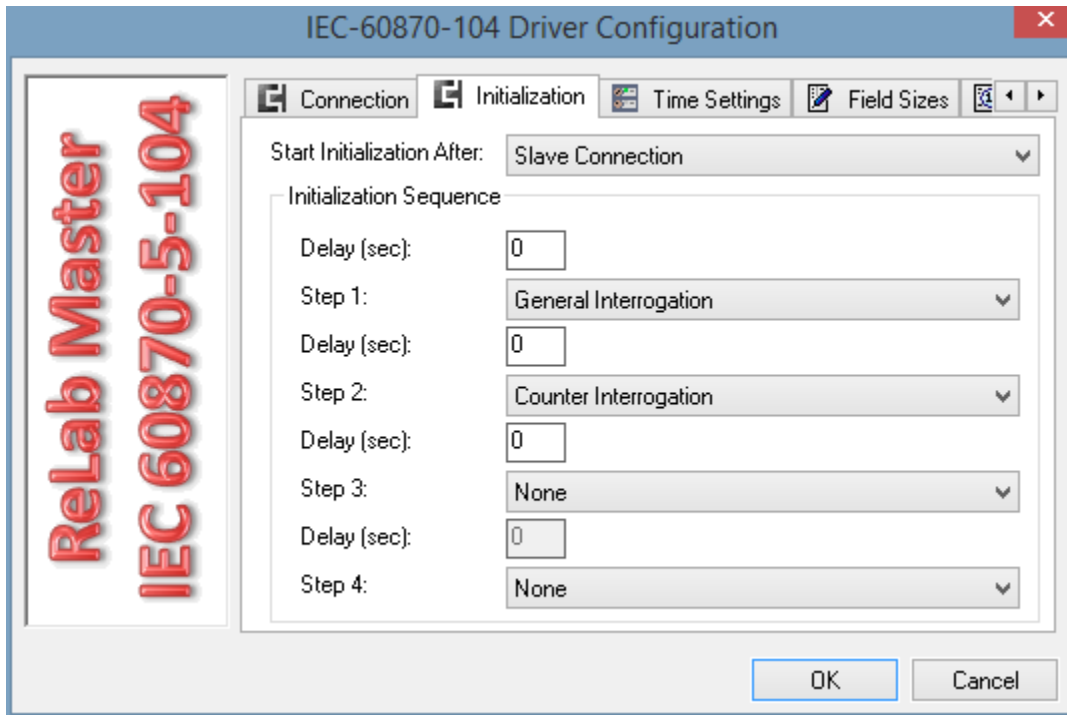


Figure 4

Option	Description	Type	Default
Start Initialization after	Start initialization after a connection to a Slave is established or after Slave's Initialization is completed	Dropdown String	Slave Connection
Delay (sec)	Delay in seconds between Initialization steps	Textbox Integer	0 seconds
Step	Steps from 1 to 4, each step containing one of: General Interrogation Clock Synchronization Counter Interrogation Test Procedure	Dropdown String	Default for: Step1: Clock Synchronization Step2: General Interrogation Step3: Counter Interrogation Step4: None

Time Settings Tab Options

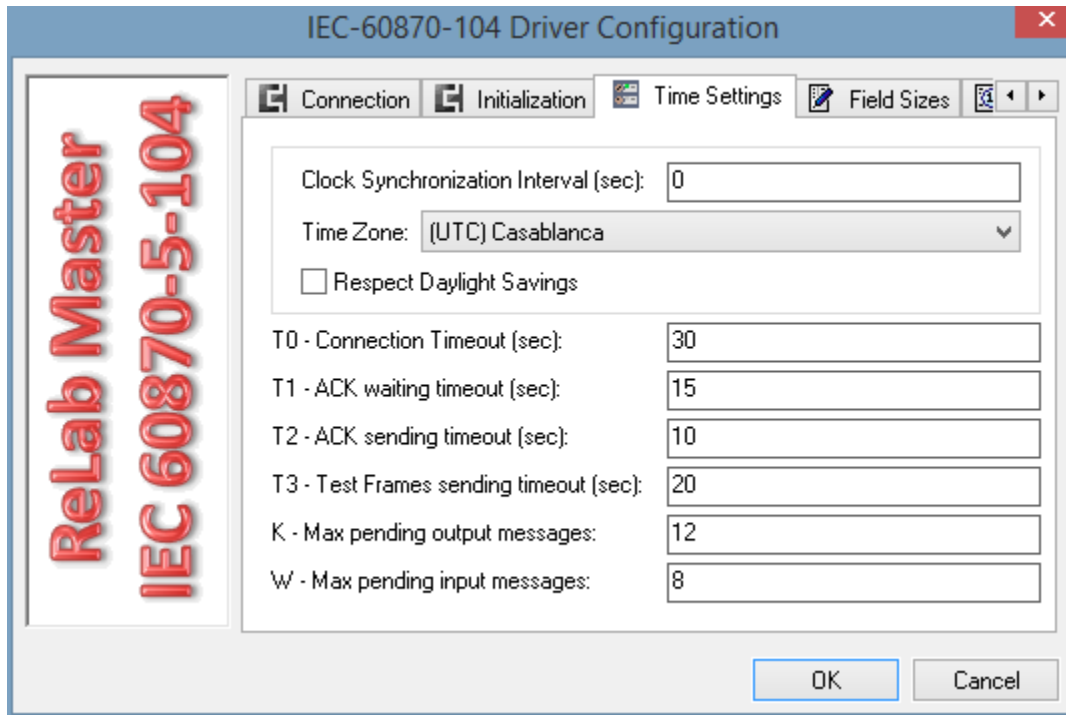


Figure 5

Option	Description	Type	Default
Clock Synchronization Interval	Time-out in seconds of sending of clock synchronization messages.	Textbox Integer	0 – clock synchronization messages are not sent
Time Zone	Specifies the device's time zone	Dropdown list	UTC time
Respect Daylight Savings	If checked then the driver will respect Daylight Saving Time when synching the device time.	Checkbox	Unchecked
T0 – Connection Timeout	Time-out of the next reconnect attempt.	Textbox Integer	30 seconds
T1 – ACK waiting timeout	Timeout in seconds to wait for an acknowledgement (ACK) to a transmitted APDU. If this time expires, the master will actively disconnect and reconnect to a Slave.	Textbox Integer	15 seconds
T2 – ACK sending timeout	Timeout in seconds for acknowledgements in case of no data messages. T2 < T1.	Textbox Integer	10 seconds

IEC-60870-5-104 OPC Device Driver Manual

Option	Description	Type	Default
T3 – TestFrames sending timeout	Time-out in seconds for sending test frames in case of a long idle state. When enabled (interval is greater than 0), the driver periodically sends a test command ASDU. $T3 > T1$.	Textbox Integer	20 seconds
K	Max pending output messages	Textbox Integer	12
W	Max pending input messages	Textbox integer	8

Table 2

Maximum range for timeouts T0 to T2: 1 s to 255 s, accuracy 1 s.

Recommended range for timeout T3: 1 s to 48 h, resolution 1 s.

Long timeouts for T3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Field Sizes TAB Options

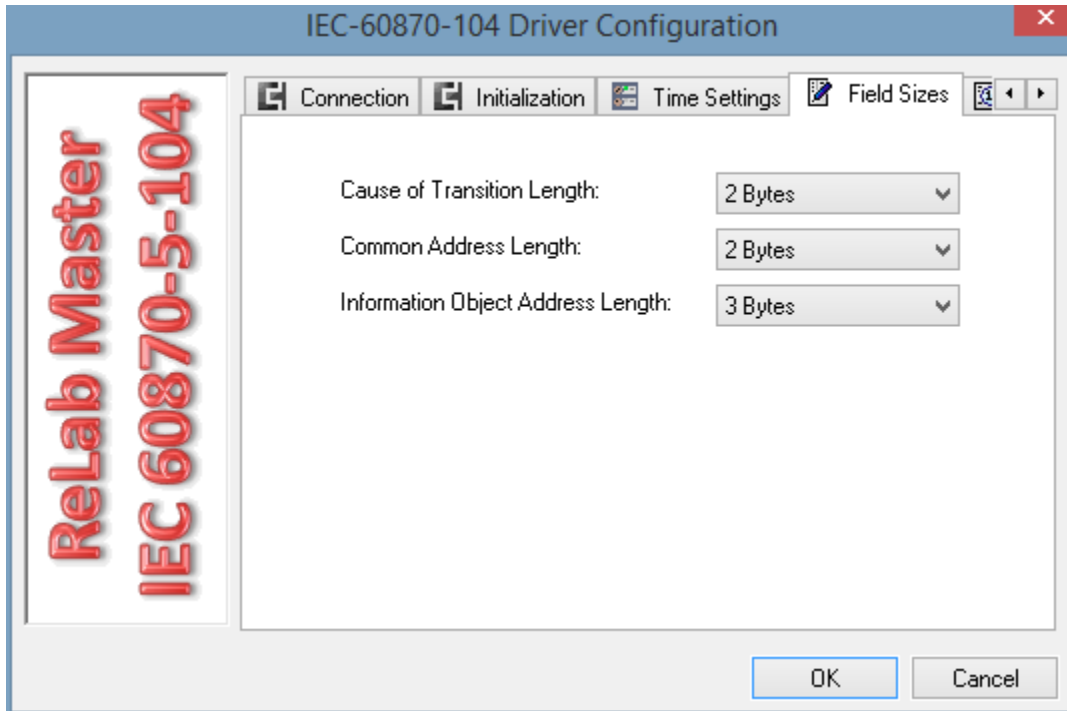


Figure 6

IEC-60870-5-104 OPC Device Driver Manual

Option	Description	Type	Default
Cause of Transmission Length	The Cause of Transmission data length, can be 1 or 2 octets (Bytes).	Dropdown list	2 Bytes
Common Address Length	Common Address of ASDU, can be 1 or 2 octets (Bytes).	Dropdown list	2 Bytes
Information Object Address Length	Information Object Address length, can be 1, 2 or 3 octets (Bytes).	Dropdown list	3 Bytes

Table 3

Group Polling Tab Options

Group Polling Tab specifies how often the General Interrogation and Group Interrogation commands will be executed.

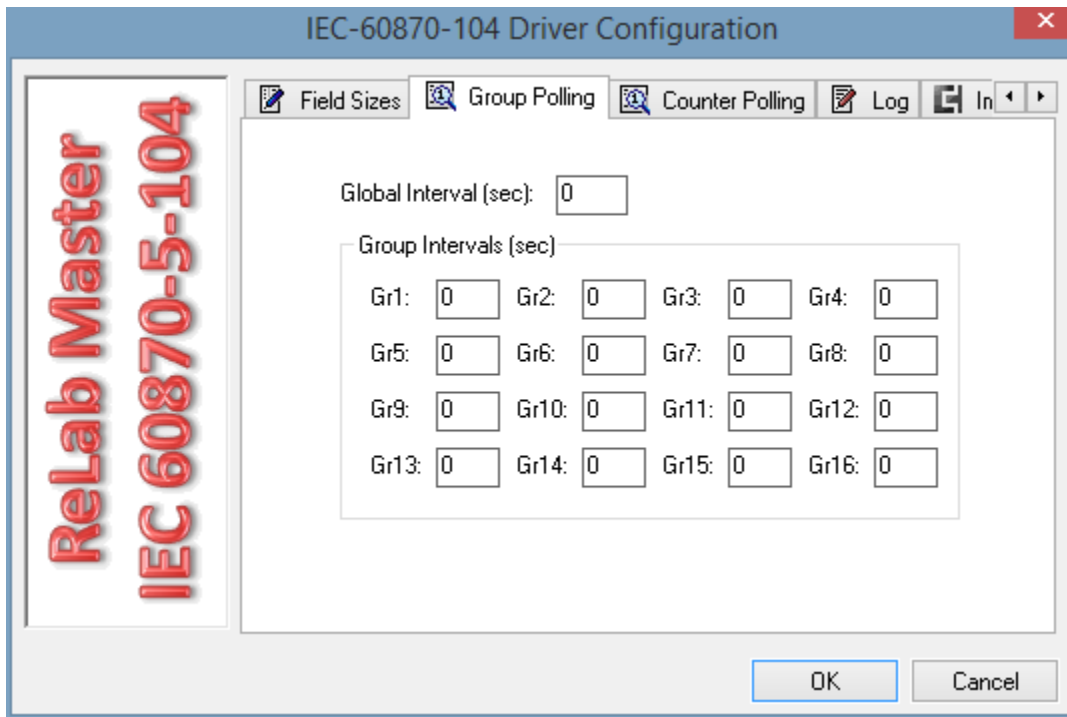


Figure 7

Option	Description	Type	Default
Global Interval	Specifies in seconds how often the Driver will send periodic General Interrogation (GI) commands to a Slave	Integer	0 – disables periodic GI commands
Group Intervals	Specifies in seconds how often the Driver will send a periodic Group Interrogation command to a Slave	Integer	0 – disables sending periodic Group Interrogation commands

IEC-60870-5-104 OPC Device Driver Manual

Table 4

Counter Polling Tab Options

Counter Polling Tab specifies how often the Counter Interrogation and Group Counter Interrogation commands will be executed. The commands are executed with the Freeze option. If Reset Counters is set, the command will be executed with Freeze and Reset option.

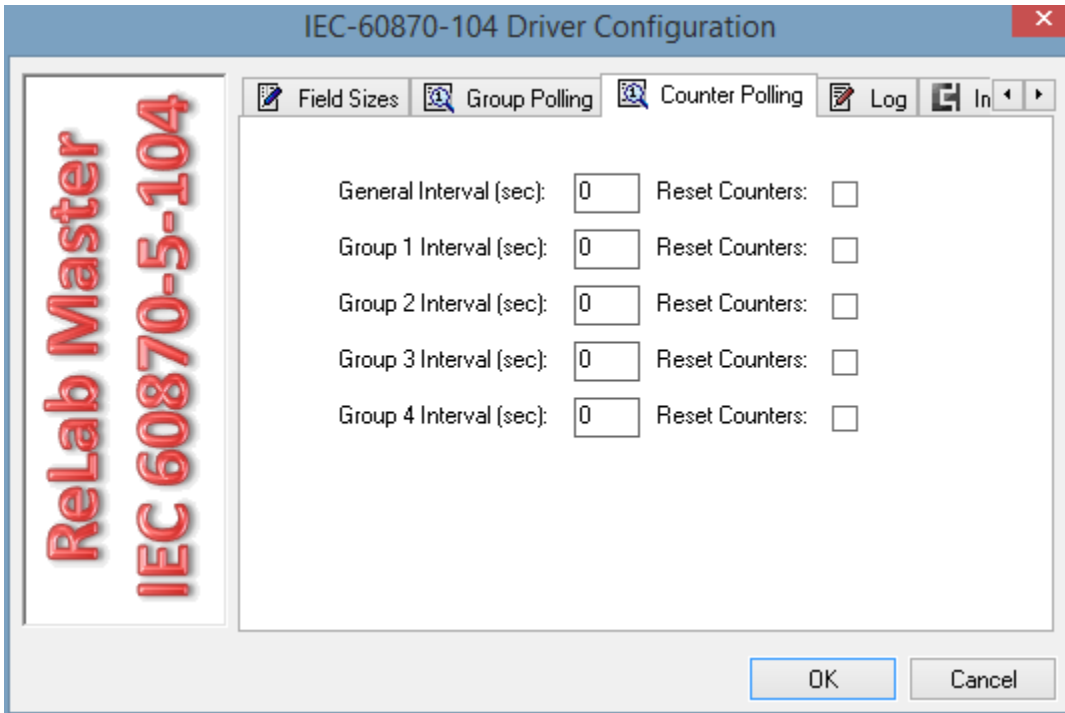


Figure 8

Option	Description	Type	Default
General Interval	Specifies in seconds how often the Driver will send a periodic Counter Interrogation (CI) command to a Slave	Textbox	0 – disables periodic CI commands
Group N Interval	Specifies in seconds how often the Driver will send a periodic Counter Group Interrogation command to a Slave	Textbox	0 – disables periodic Group Interrogation commands
Reset Counters	Specifies if the counters will be reset with the Counters Interrogation Command	CheckBox Boolean	False

Table 5

Log Tab Options

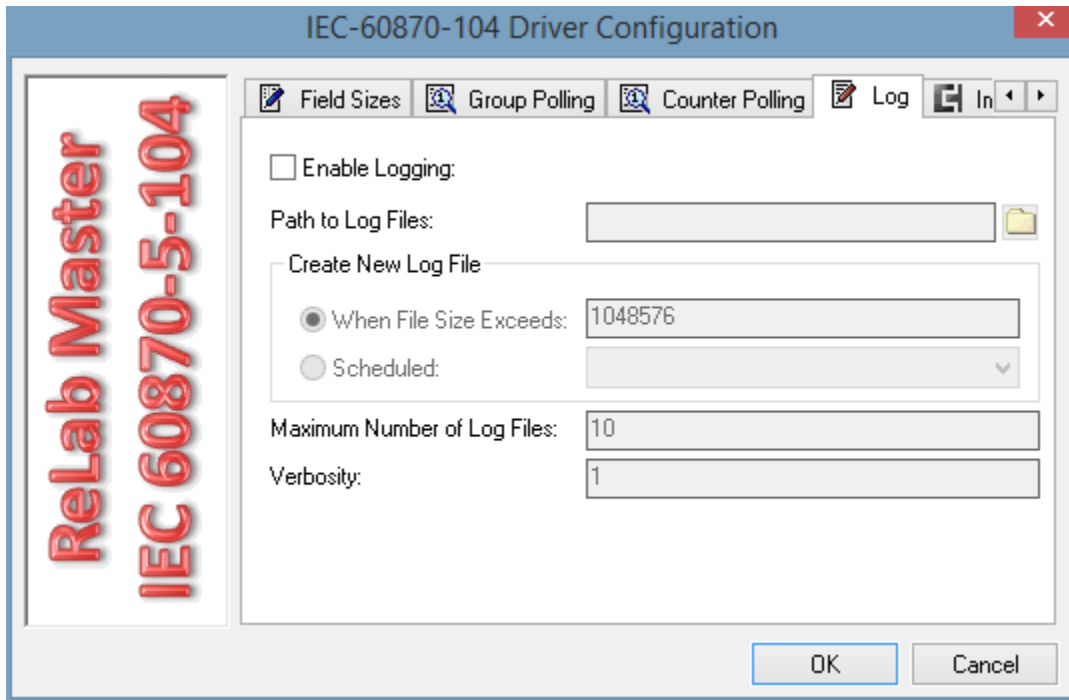


Figure 9

Options	Description	Type	Default
Enable logging	Enables or disables driver logging	Boolean Checkbox	False
Path to log file(s)	Specifies location of the log file(s)	String Textbox	Empty
When file size exceeds	Specifies when the new file will be created based on file size entered (in bytes)	Long Textbox	1048576
Scheduled	Specifies when the new file will be created based on user selectable schedule Daily (every 24 hours) Every 12 hours Every 8 hours Every 6 hours Every 4 hours Every 2 hours Hourly	Enumeration Dropdown	Empty
Maximum number of log files	Specifies maximum number of log files before the files are overwritten	Integer Textbox	10
Verbosity	Specifies verbosity level of the log files (Valid entry is 1 – 9)	Integer Textbox	1

Table 6

Immediate IO Tab Options

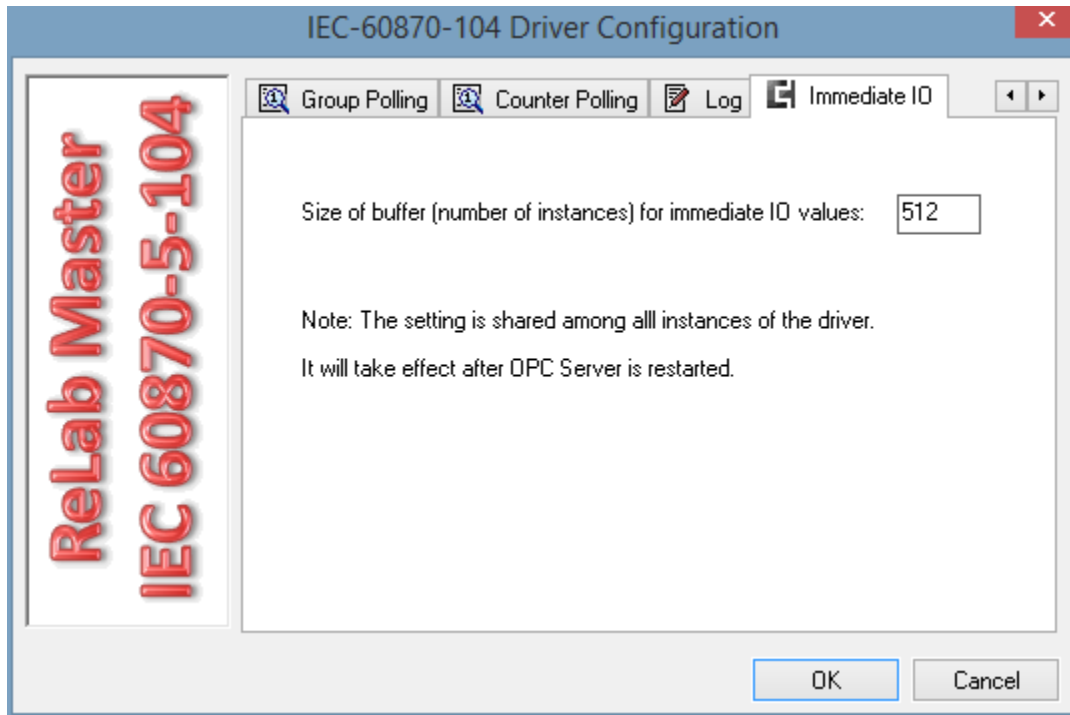


Figure 10

Option	Description	Type	Default
Size of the buffer for immediate IO values	Specifies the receiving buffer size. If the number of values exceeds the buffer size the older values will be discarded.	Textbox	512

Table 7

OPC Tag Types

The following tag types are supported by the Driver.

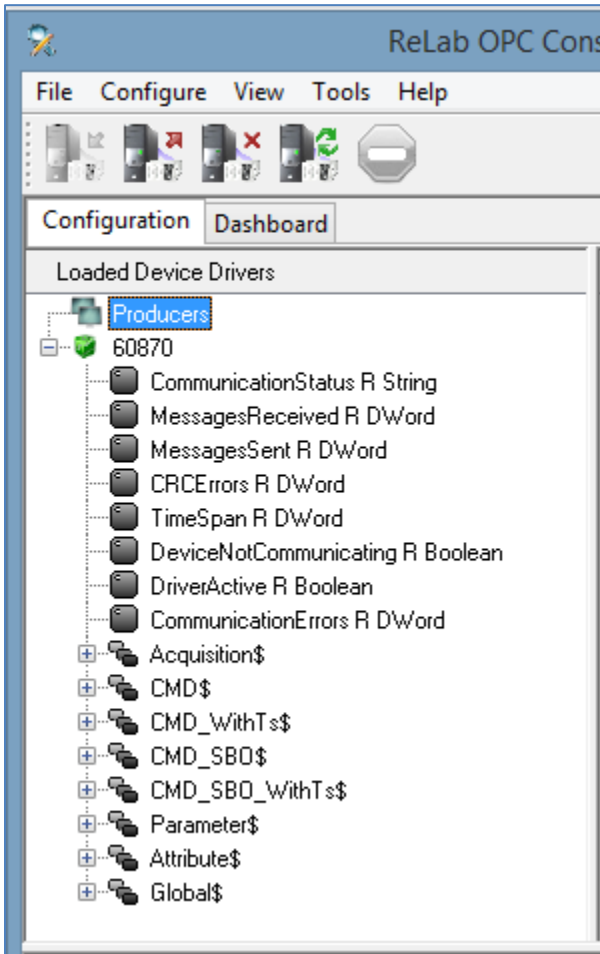


Figure 11

Tag Type	Description
System	Tags that reflect the driver's communication status
Acquisition	Tags associated with Monitor ASDUs, read only
CMD	Direct commands
CMD_WithTs	Direct Commands with time tag
CMD_SBO	Commands that require Select before Operate

IEC-60870-5-104 OPC Device Driver Manual

CMD_SBO_WithTs	Commands that require Select before Operate with time tag
Parameter	Parameters are used to change the configuration of a device, for example, to change a parameter such as a threshold value or the lower/upper limit for an alarm.
Attribute	Tags that serve as attributes for the complex commands like SBO, complementary tags for parameters, etc. See Attribute Tags description below.
Global	Tags for the Commands like General Interrogation, Counter Interrogation, etc., that are not associated with a particular Information Object Address but have a global scope.

Table 8

System Tags

Tag	Description	Data Type
Communication Status	<p>CommunicationStatus tag can take one of the following values:</p> <ol style="list-style-type: none"> 1. Initializing - this status is entered when driver's method Start is called by the OPC Server 2. Connecting - this status is entered when "opensocket" is called 3. Online - this status means normal operation of the driver. 4. Failed – connection to a Slave failed, waiting for the next reconnection attempt. The timeout for the next connection attempt is set by the TO configuration option. 	String
MessagesReceived	The number of messages received from the device	DWord
MessagesSent	The number of messages sent to the device	DWord
TimeSpan	Time in seconds after driver's initialization	DWord
DeviceNotCommunicating	True means that the Device is not connected	Boolean
CommunicationErrors	Communication Errors, the number of disconnects	Boolean

Table 9

Acquisition Tags.

Acquisition Tags should be mapped to Monitor ASDUs addresses. The driver will convert data between ASDU type and Tag type. In cases if conversion is not feasible the corresponding Tag(s) will have bad quality. Recommended mapping between Monitor ASDU types and Tag types are in the table below.

IEC-60870-5-104 OPC Device Driver Manual

Tag type	Data type	Monitor ASDU	
Boolean	Single bit	1, 30	
Byte	Unsigned 8 bit value	To any Monitor ASDU that can be converted to Byte.	
Short	Signed 16 bit value	11, 35	
Int	Signed 32 bit value	15, 37	
Float	32 bit floating-point value	9, 13, 21, 34, 36	
Double	64 bit floating-point value	To any Monitor ASDU that can be converted to Double.	
Word	Unsigned 16 bit data	To any Monitor ASDU that can be converted to Word.	
DWord	Unsigned 32 bit data	7, 33	
Char	Signed 8 bit data	3, 5, 31, 32	

Table 10

Command Tags

Command tags trigger a command on the address they are mapped to.

CMD and CMD_WithTs Tags

Tag	Description	Control TypeID	ASDU	Data Type
SngPoint	Single Command. By default the command is executed in the Persistent mode. To issue a ShortPulse or LongPulse command a user needs to map a complimentary CmdOption tag to the same address as the command. See Table 14 below.	C_SC	45, 58	Boolean
DblPoint	Double Command	C_DC	46, 59	Int
StepPos	Regulating Step Command	C_RC	47, 60	Int

IEC-60870-5-104 OPC Device Driver Manual

NormVal	Measured Value, Normalized Value	C_SE_NV	48, 61	Float
ScaleVal	Set Point Command, Scaled Value	C_SE_SV	49, 62	Short
FloatVal	Set Point Command, Short Floating Point Value	C_SE_FV	50, 63	Float
BitStr	Bit String	C_BO	51, 64	DWord

Table 11

CMD_SBO and CMD_SBO_WithTs Tags

Tag	Description	Control TypeID	ASDU	Data Type
SngPoint	Single Command	C_SC	45, 58	Boolean
DblPoint	Double Command	C_DC	46, 59	Int
StepPos	Regulating Step Command	C_RC	47, 60	Int
NormVal	Measured Value, Normalized Value	C_SE_NV	48, 61	Float
ScaleVal	Set Point Command, Scaled Value	C_SE_SV	49, 62	Short
FloatVal	Set Point Command, Short Floating Point Value	C_SE_FV	50, 63	Float

Table 12

Parameter Tags

Parameter Tags are used to modify the configuration of a device, for example - to change a parameter such as a threshold value or the lower/upper limit for an alarm.

Parameter loading for all parameters except the Activate parameter requires two steps.

1. Specifying the type of the parameter (threshold value, filter factor, lower limit or upper limit). This is accomplished by writing the corresponding value to a ParType Tag associated with the Parameter. To associate a ParType Tag with a Parameter Tag a user must map the ParType Tag to the same address as the Parameter Tag.
2. Sending the parameter loading command to the device with the desired value for the parameter. This is accomplished by writing the desired value to the Parameter Tag.

Once a parameter loading operation has been successfully completed, the new value for the parameter is received from the device and transmitted to the OPC client that performed the operation.

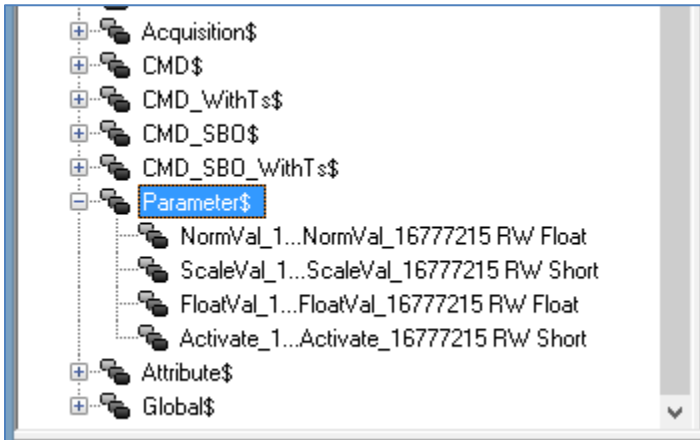


Figure 12

Tag	Description	Data Type
NormVal	Parameter for the Measured Value, Normalized value. ParType Tag must be mapped to the same address as the NormVal Parameter Tag.	Float
ScaleVal	Parameter for the Measured Value, Scaled value. ParType Tag must be mapped to the same address as the ScaleVal Parameter Tag.	Short
FloatVal	Parameter for the Measured Value, Short Floating Point number value. ParType Tag must be mapped to the same address as the FloatVal Parameter Tag.	Float
Activate	Activates/deactivates of persistent cyclic or periodic transmission of the addressed object. Activation parameter types are loaded directly by writing the activation value (0: Activation, 1: Deactivation) to the tag representing the device parameter. There is no complementary Attribute Tag attached to this parameter type.	Short

Table 13

Attribute Tags

Attribute tags are the complementary tags that can be mapped to the same address as the main tag to specify the type of the operation that is performed when the main tag is changed (like for ParType tags) or to provide extra information about the operation (like CauseOfTrans or CmdOption tags).

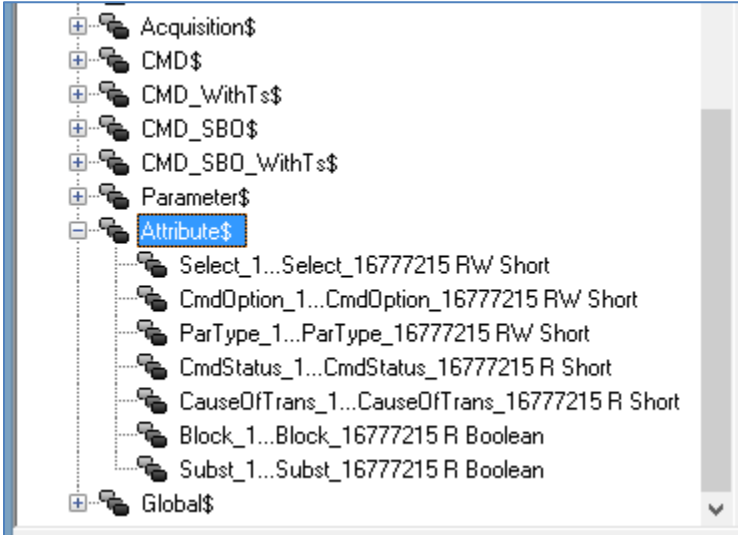


Figure 13

Tag	Description	Data Type
Select	<p>The Tag is used in Manual SBO mode, see Select Before Operate (SBO) commands for more details.</p> <p>When mapped to the same address as an SBO command the value of the Select tag the message the Master will send to a Slave.</p> <p>If Select Tag is set to:</p> <ul style="list-style-type: none"> 1 – the Driver will send Select message 0 – the Driver will send Execute message 2 – the Driver will send Cancel message. The message will cancel previous Select. 	Short
CmdOption	<p>An optional complementary tag for a Single (SngPoint) command. Specifies the command type.</p> <ul style="list-style-type: none"> 1 - short pulse duration (circuit-breaker), duration determined by a system parameter in the outstation 2 - long pulse duration, duration determined by a system parameter in the outstation 3 - persistent output 	Short

IEC-60870-5-104 OPC Device Driver Manual

Tag	Description	Data Type
ParType	<p>ParType is a complementary tag that must be associated with a respective Parameter Tag by mapping it to the same address as the Parameter Tag.</p> <p>To load a Parameter it is necessary to specify the Parameter Type by writing the corresponding value to the Tag, and then – writing the Parameter Value to the Parameter tag itself.</p> <p>The Parameter Type tag can take one of the following values:</p> <ul style="list-style-type: none"> 1 - threshold value 2 - smoothing factor (filter time constant) 3 - low limit for transmission of measured values 4 - high limit for transmission of measured values 	Short
CmdStatus	<p>The CmdStatus attribute can be used with SBO command to show the detailed status of SBO command.</p> <p>If mapped to the same address as SBO command the CmdStatus tag will have the following values:</p> <ul style="list-style-type: none"> 0- Undefined, 1- Select message sent, 2- Select message response is “OK”, 3- Select message response is “fail”, 4- Execute message sent, 5- Execute message response is “Ok”, 6- Execute message response is “fail”, 7- Cancel message sent, 8- Cancel message response is “OK” 	Short
CauseOfTrans	<p>CauseOfTrans tag can be associated with Acquisition tag by mapping it to the same address as the Acquisition tag. The CauseOfTrans possible values are listed in the Table 16 below.</p>	Short
Block	<p>The value of IEC quality, bit 0x10 (Blocked/Not Blocked) of 8 high-order bits. The value of the Information Object is blocked for transmission; the value remains in the state in which it was acquired before it was blocked. Blocking and unblocking may be initiated by a local lock or a local automatic cause, for example.</p>	Boolean
Trans	<p>The value of IEC quality, bit 0x20 (Substituted / Not Substituted) of 8 high-order bits. The value of the Information Object is provided through operator input (dispatcher) or by an automatic source.</p>	Boolean

Table 14

Global Tags

Global Tags are used to send the commands like General Interrogation, Counter Interrogation, etc., that are not associated with a particular Information Object Address but rather work globally for the driver. The command is sent when the appropriate value is written to a global tag, see Table 15 below.

Error handling:

After the value is written to a Global command tag the value of the tag is set to 0 and the corresponding command is sent to the slave:

- In case of success the value of the tag will be subsequently changed to the desired value.
- In case of failure the tag's value will be changed to (-1).
- If wrong value is written to the tag the command is not sent to the slave and the tag value is immediately changed to (-2).

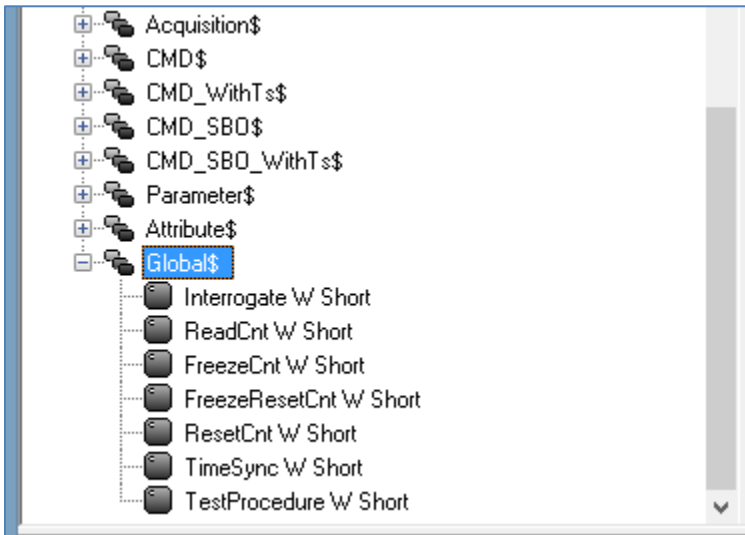


Figure 14

Tag	Description	Data Type
Interrogate	Writing a value to this tag will send the Interrogation command to a Slave. Values from 1 to 16 will trigger the corresponding Group Interrogation command. Value 32 will trigger the General Interrogation command.	Short
ReadCnt	Writing a value to this tag will send the Read Counters command to a Slave. Values from 1 to 4 will trigger the corresponding Group Read Counters command. Value 16 will trigger the Read All Counters command.	Short
FreezeCnt	Writing a value to this tag will send the Freeze Counters command to a Slave. Values from 1 to 4 will trigger the corresponding Group Freeze Counters command.	Short

IEC-60870-5-104 OPC Device Driver Manual

Tag	Description	Data Type
	Value 16 will trigger the Freeze All Counters command.	
FreezeResetCnt	Writing a value to this tag will send the Freeze and Reset Counters command to a Slave. Values from 1 to 4 will trigger the corresponding Group Freeze and Reset Counters command. Value 16 will trigger the Freeze and Reset All Counters command.	Short
ResetCnt	Writing a value to this tag will send the Reset Counters command to a Slave. Values from 1 to 4 will trigger the corresponding Group Reset Counters command. Value 16 will trigger the Reset All Counters command.	Short
TimeSync	Writing 1 to this tag will send the Time Synchronization command to a Slave.	Short
TestProcedure	Writing 1 to this tag will send the Test Procedure command to a Slave.	Short

Table 15

Cause of Transmission (COT)

The Cause of Transmission field is based on the IEC 60870-5-104 specification and is enumerated according to the table below.

COT Value	Cause
0	Not used
1	Periodic, cyclic
2	Background scan
3	Spontaneous
4	Initialized
5	Request or requested
6	Activation
7	Activation confirmation
8	Deactivation
9	Deactivation confirmation

IEC-60870-5-104 OPC Device Driver Manual

COT Value	Cause
10	Activation termination
11	Return information caused by a remote command
12	Return information caused by a local command
13	File transfer
14-19	Reserved for further compatible definitions
20	Interrogated by station interrogation
21-36	Interrogated by group 1-16 interrogation
37	Requested by general counter request
38-41	Requested by group 1-4 counter request
42-43	Reserved for further compatible definitions
44	Unknown type identification
45	Unknown Cause of Transmission
46	Unknown Common Address (ASDU)
47	Unknown Information Object Address (IOA)
48-63	For special use (private range)

Table 16

Select Before Operate (SBO) commands.

Select Before Operate Commands, also known as Select and Execute require two messages to be sent from Master to a Slave.

The first "Select" message reserves Master's right to write to the selected address, if "Select" was successful the Master then sends a write (Operate) command to the address.

ReLab's Driver supports two modes for SBO commands: Automatic and Manual

The Automatic mode is the default mode. A write request to SBO command tag will automatically execute the SBO command:

1. Send the Select request to a Slave
2. Analyze Select results
3. In case of success - Send the Operate request to the Slave

IEC-60870-5-104 OPC Device Driver Manual

For the Manual mode a user need to map a "Select" tag from the Attribute tags to the same address as the SBO Command.

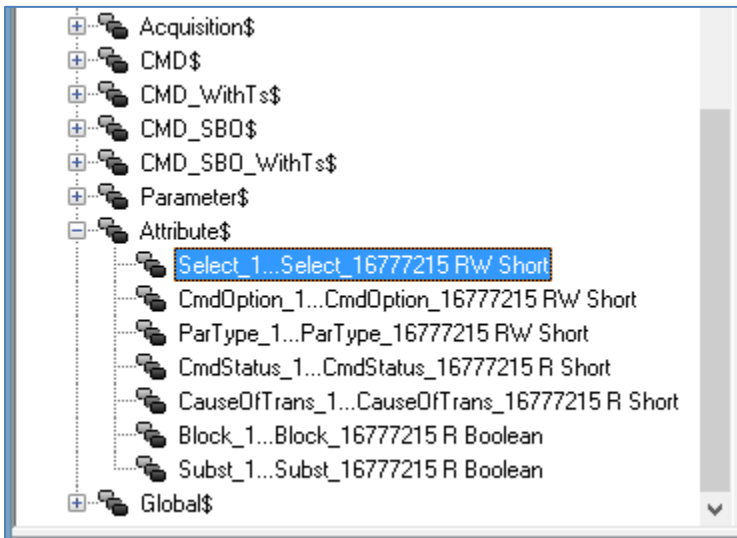


Figure 15

The values of the Select tag will determine which message the Master will send to a Slave.

User has first to write value to a Select tag and then write a required value to the Command tag.

If Select Tag is set to:

- 1 – the Driver will send Select message
- 0 – the Driver will send Execute message
- 2 – the Driver will send Cancel message. The message will cancel previous Select.

Note: The driver will send the above messages only upon writing to the corresponding Command tag.

The same Select tag indicates the result of Select and Operate actions.

Depending on the result of the Select or Operate action the Select tag will change it's value to:

- 0 – the action was successful
- 2 – the action generated an error.

CmdStatus attribute.

The CmdStatus attribute can be used with SBO command to show the detailed status of SBO command.

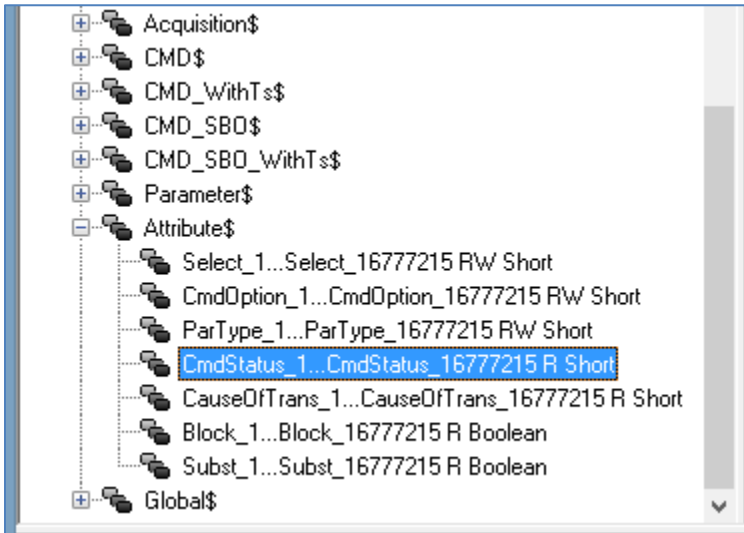


Figure 16

If mapped to the same address as SBO command the CmdStatus tag will have the following values:

- 0- Undefined,
- 1- Select message sent,
- 2- Select message response is "OK",
- 3- Select message response is "fail",
- 4- Execute message sent,
- 5- Execute message response is "Ok",
- 6- Execute message response is "fail",
- 7- Cancel message sent,
- 8- Cancel message response is "OK"

Mapping RL60870-5-104 Items to ReLab OPC Server

To create an OPC group right-click the OPC Server Address Space and Click “Create Group”.

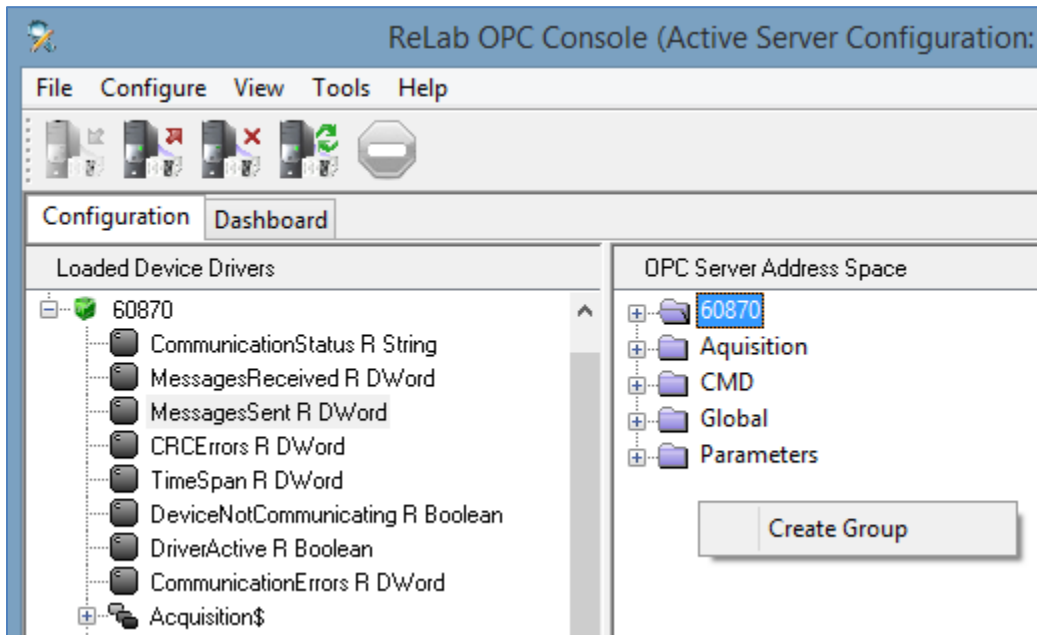


Figure 17

To map System or Global Tags select one or more Tags, right click on the selected tags, and choose either “Map Register to” or “Auto Map” from the context menu.

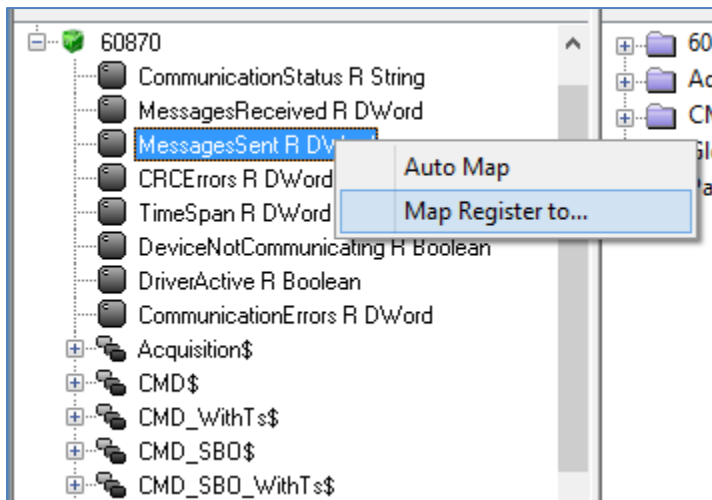


Figure 18

Choosing “Map Register to” will show a dialog to choose one of previously created OPC groups.

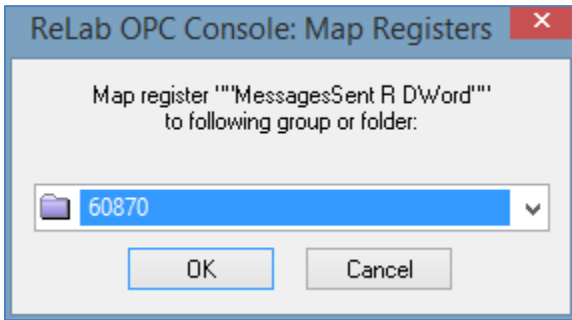


Figure 19

Choosing “Auto Map” will create the corresponding OPC group(s) and map the items to the group. To map the tags other than System or Global tags right-click on the needed tag type and click “Map Register to”.

Use the following dialog to choose the address or the address range and the group you want the tags to belong to.

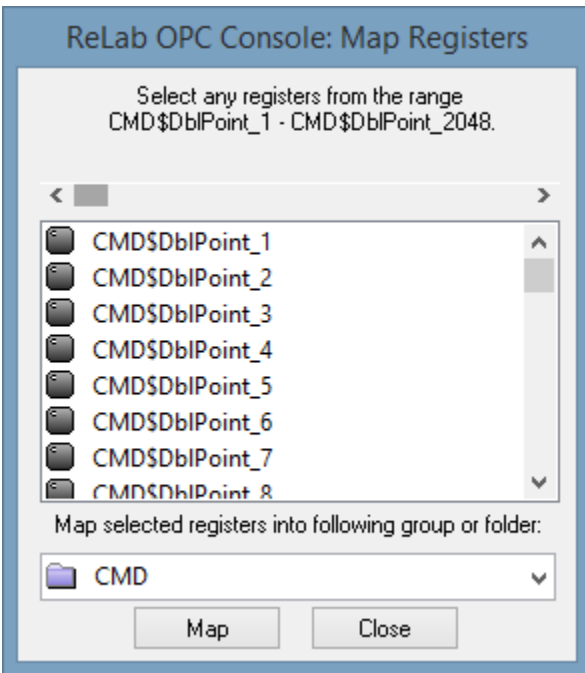


Figure 20

If the range of the addresses is selected the Console will map multiple tags of the chosen type to the range of selected addresses, one tag per each address.

Note that to navigate to the addresses higher than 2048 you can use the scroll bar at the top of the address window. Keyboard buttons: Up, Dn, PgUp, PgDn, Home, End can also be used to navigate the address space.