14 IEC 60870-5-10X

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14.1 Introduction

IEC 60870 part 5 is one of the IEC 60870 set of standards which define systems used for telecontrol (supervisory control and data acquisition) in electrical engineering and power system automation applications. Part 5 provides a communication profile for sending basic telecontrol messages between two systems, which uses permanent directly connected data circuits between the systems. The IEC Technical Committee 57 (Working Group 03) has developed a protocol standard for telecontrol, teleprotection, and associated telecommunications for electric power systems. The result of this work is IEC 60870-5. Five documents specify the base IEC 60870-5:

- IEC 60870-5-1 Transmission Frame Formats
- IEC 60870-5-2 Data Link Transmission Services
- IEC 60870-5-3 General Structure of Application Data
- IEC 60870-5-4 Definition and Coding of Information Elements
- IEC 60870-5-5 Basic Application Functions
- IEC 60870-5-6 Guidelines for conformance testing for the IEC 60870-5 companion standards
- IEC TS 60870-5-7 Security extensions to IEC 60870-5-101 and IEC 60870-5-104 protocols (applying IEC 62351)

The IEC Technical Committee 57 has also generated companion standards:

- IEC 60870-5-101 Transmission Protocols - companion standards especially for basic telecontrol tasks
- IEC 60870-5-102 Transmission Protocols - Companion standard for the transmission of integrated totals in electric power systems (this standard is not widely used)
- IEC 60870-5-103 Transmission Protocols - Companion standard for the informative interface of protection equipment
- IEC 60870-5-104 Transmission Protocols - Network access for IEC 60870-5-101 using standard transport profiles
- IEC TS 60870-5-601 Transmission protocols - Conformance test cases for the IEC 60870-5-101 companion standard
- IEC TS 60870-5-604 Conformance test cases for the IEC 60870-5-104 companion standard

IEC 60870-5-101/102/103/104 are companion standards generated for basic telecontrol tasks, transmission of integrated totals, data exchange from protection equipment & network access of IEC101 respectively.

Source: https://en.wikipedia.org/wiki/IEC_60870-5

14.2 IEC 60870-5-101 Master

The IEC 60870-5-101 protocol is a companion standard for power system monitoring, control associated communications for telecontrol, teleprotection and associated telecommunications for electric power systems. Standard IEC 60870-5-101 was prepared by IEC technical committee 57 (Power system control and associated communications).

Standard IEC 60870-5-101 defines an **Application Service Data Unit** (**ASDU** Figure below). In ASDU there is an ASDU identifier (with the type of ASDU in it) and information objects.
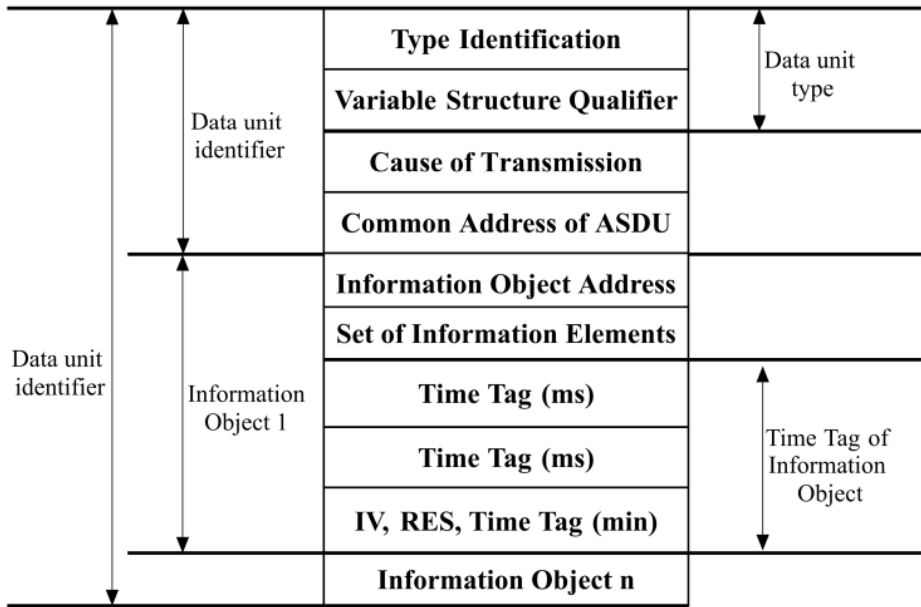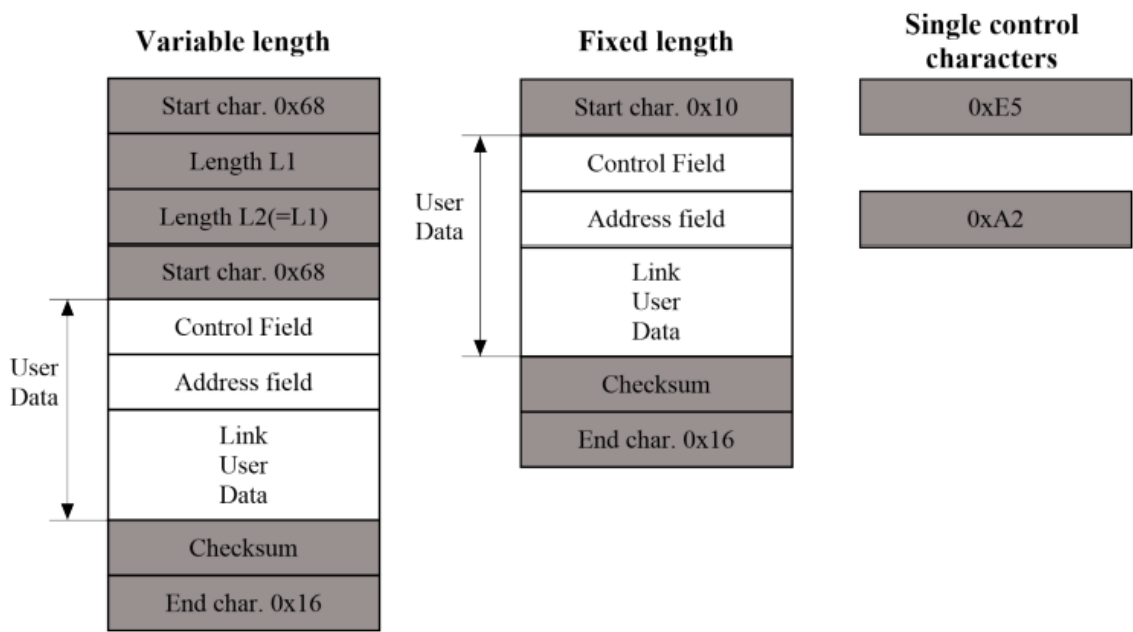

IEC 60870-5-101 ASDU structure

Common Address of ASDU Defines the stations' address and can be configured in Devices asdu_address field for source and *Signals* common_address field for the destination.

Information Object Address Used as destination object address in the control direction and as source object address in monitor direction can be configured in Signals info_address field.

Standard IEC 60870-5-101 transmission frames are separated into 3 different types: **frame with variable length**, **frame with fixed length,** and **single control characters**

IEC 60870-5-101 ASDU structure

Control field provides information about the message direction, type of service, and checksum.

Address field specifies the link address which points to the message's destination. WCC Lite supports IEC 60870-5--

101 Master protocol over a serial link (according to EIA RS485). Its full functionality list can be found in an IEC 60870-5-101 PID Interoperability List which can be downloaded separately from this user manual.

Configuring datapoints (master)

To use IEC 60870-5-101 Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-101 master parameters for *Devices* tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-101 master	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed (bauds/s)	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535

link_size	integer	Link address size in bytes	No	1	1	2
asdu_address	integer	Application Service Data Unit address	Yes		0	65535
asdu_size	integer	Common address size in bytes	No	1	1	2
ioa_size	integer	Information object address (IOA) size in bytes	No	2	1	3
cot_size	integer	Cause of transmission (COT) size in bytes	No	1	1	2
time_sync_interval_sec	integer	Defines how often (in seconds) slave will request time synchronization. **If greater than 0** - slave will request synchronizations, will reset the timer if the master did it earlier. **If 0** slave won't request timesyncs, but will allow them. **If 1** - timesyncs are not supported - requests will be dropped.	No	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds, if 0 requests are disabled	No	300		
scan_rate_ms	integer	Polling interval in milliseconds. Time frame between two telegrams from master	Yes	100		
timeout_ms	integer	Response timeout in milliseconds	Yes	1000		
retry_count	integer	Number of retries of failed requests before announcing that device is in Error state	Yes	1		

IEC 60870-5-101 master parameters for Signals tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			

source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes	1		
info_address	integer	Information object address	Yes			
data_type	integer	ASDU type identifier	Yes			1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 30, 31, 32, 34, 35, 36, 45, 46, 47, 48, 49, 50

Device status signals

IEC 60870-5-101 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal for IEC 60870-5-101 protocol, job_todo and tag_job_todo fields with string values are required. For IEC 60870-5-101 master required parameters for status signal will be: **signal_name device_alias, signal_alias, common_address, info_address, data_type, job_todo** and **tag_job_todo**. Job_todo value must be *device_status* and for tag_job_todo there are 4 variations: communication_status, device_running, device_error, uknown_error. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Debugging a IEC 60870-5-101 Master application

If configuration for IEC 60870-5-101 devices is set up, handler for protocol will start automatically. If the configuration is missing parameters or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

If IEC 60870-5-101 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop *iec101-master* process and run *iec101-master* command with respective flags as shown in the table below.

Procedure for IEC 60870-5-101 master service debugging:

- **Step 1**: Service must be stopped by entering the following command into the WCC Lite: **/etc/init.d/iec101-master stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7:**iec101-master -c /etc/iec101-master/iec101master.json -d7**
Additional output forming options described here: Command line arguments.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec101-master start**

IEC 60870-5-101 command line debugging options

```
-h [ —help ] Display help information
-V [ —version ] Show version
-d<debug level> Set debugging level
-c [ —config ] Config path
-r [ —raw ] Show raw telegram data
-f [ —frame ] Show frame data
-R [ —readyfile ] Ready notification file
```

14.3 IEC 60870-5-101 Slave

Configuring datapoints (slave)

To use IEC 60870-5-101 Slave in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in *Devices* and *Signals.*

IEC 60870-5-101 slave parameters for Devices tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-101 slave	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed (bauds/s)	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535
link_size	integer	Link address size in bytes	No	1	1	2
asdu_size	integer	Common address size in bytes	No	1	1	2

					Range	
ioa_size	integer	Information object address (IOA) size in bytes	No	2	1	3
cot_size	integer	Cause of transmission (COT) size in bytes	No	1	1	2
time_sync	boolean	Allow time synchronization, 1 to enable and 0 to disable	No	0	0	1
message_size	integer	Maximum length of a message	Yes	253	0	255
cache_size	integer	Maximum number of events to store in a buffer	No	100	0	1000
respond_delay	integer	Time in microseconds to wait before sending responses	Yes	100	0	1000000
single_byte_ack	boolean	Use single character acknowledge, 1 to enable and 0 to disable	No	0	0	1
keep_alive_timeout	integer	Time interval in seconds before serial connection is considered offline	No	60		

keep_alive_timeout timer is used for connection tracker to display protocol status. This parameter has no effect on protocol functionality and is only used to track it's status in connection tracker.

IEC 60870-5-101 slave parameters for Signals tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		

gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
info_address	integer	Information object address	Yes			
data_type	integer	ASDU type identifier	Yes			1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 30, 31, 32, 34, 35, 36, 45, 46, 47, 48, 49, 50, 58, 59, 60, 61, 62, 63

Device status signals

IEC 60870-5-101 has an additional signal which can be configured to show communication status. It is used to indicate if the master device has disconnected from slave (WCC Lite). To configure such signal for IEC 60870-5-101 protocol, job_todo and tag_job_todo fields with string values are required. For IEC 60870-5-101 slave required parameters for status signal will be: **signal_name device_alias, signal_alias, common_address, info_address, data_type, job_todo** and **tag_job_todo**. Job_todo value must be *device_status* and for tag_job_todo there are 4 variations: communication_status, device_running, device_error, uknown_error. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Debugging an IEC 60870-5-101 slave application

If the configuration for IEC 60870-5-101 devices is set up, the handler for the protocol will start automatically. If the configuration is missing parameters or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-101 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from the command-line interface and find out why the link is not functioning properly. To launch a debugging session, a user should stop the *iec101-slave* process and run the *iec101-slave* command with respective flags as shown in the table below.

Procedure for IEC 60870-5-101 slave service debugging:

- **Step 1**: Service must be stopped by entering the following command into the WCC Lite:
  /etc/init.d/iec101-slave stop
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7:**iec101-slave-c /etc/iec101-slave/iec101slave.json -d7**
  Additional output forming options described here: Command line arguments.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec101-slave start**

IEC 60870-5-101 command line debugging options

```
-h [ —help ] Display help information
-V [ —version ] Show version
-d<debug level> Set debugging level
-c [ —config ] Config path
-r [ —raw ] Show raw telegram data
-f [ —frame ] Show frame data
-R [ —readyfile ] Ready notification file
```

14.4 IEC 60870-5-103 Master

The IEC 60870-5-103 protocol is a companion standard for the informative interface of protection equipment. Standard IEC 60870-5-103 was prepared by IEC technical committee 57 (Power system control and associated communications). It is a companion standard for the basic standards in series IEC 60870-5:

Standard IEC 60870-5-103 defines communication between protection equipment and devices of a control system (supervisor or RTU) in a substation.

Standard IEC 60870-5-103 defines a multipoint communication protocol via which information can be exchanged between a control system (supervisor or RTU) and one or more protection devices. The control system is the master and the protection devices are the slaves. Each slave is identified by a unique address between 1 and 254. Address 255 is reserved for broadcast frames.

IEC 60870-5-103 Master

Configuring datapoints

WCC Lite supports IEC 60870-5-103 Master protocol over a serial link (according to EIA RS-485). Its full functionality list can be found in an IEC 60870-5-103 PID Interoperability List.

To use IEC 60870-5-103 Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals.

IEC 60870-5-103 parameters for Devices tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-103 master	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed (bauds/s)	No	9600	600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	8	

stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535
asdu_address	integer	Application Service Data Unit address	Yes		0	65535
time_sync_interval_sec	integer	Time frame between Time Synchronization requests in seconds	No	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds, if 0 requests are disabled	Yes	300		
scan_rate_ms	integer	Polling interval in milliseconds. Time frame between two telegrams from master	No	100		
timeout_ms	integer	Response timeout in milliseconds	No	1000		
serial_delay	integer	Communication device's serial delay in milliseconds. Time frame in which master station is not TX'ing after last RX byte	No	50		
retry_count	integer	Number of retries of failed requests before announcing that device is in Error state	No	3		
retry_delay_ms	integer	Time before the next retry in milliseconds	No	500		

IEC 60870-5-103 master parameters for Signals tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max

signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_ali as	string	device_alias of a source device	For commands			
source_signal_alia s	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excludin g (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
function	integer	Function number	No	0		
info_address	integer	Information object address	Yes			
info_number	integer	Information number	Yes			
data_type	integer	ASDU type identifier	No	0	0, 1, 2, 3, 4, 9, 20	
fleeting	boolean	Mark signal as fleeting type (1 or 0). Fleeting signals have go to DPI::OFF after defined time	No		0	1
normalise_time_m s	integer	Time in milliseconds between station receiving DPI::ON and automatically switching to DPI::OFF	If fleeting is used	100		

Device status signals

IEC 60870-5-103 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal for IEC 60870-5-103 protocol, job_todo and tag_job_todo fields with string values are required. For IEC 60870-5-103 master required parameters for status signal will be: **signal_name device_alias, signal_alias, common_address, info_address, info_number, job_todo** and **tag_job_todo**. Job_todo value must be *device_status* and for tag_job_todo there are 4 variations: communication_status, device_running, device_error, uknown_error. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Debugging an IEC 60870-5-103 Master application

If the configuration for IEC 60870-5-103 devices is set up, the handler for the protocol will start automatically. If a configuration is missing parameters or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-103 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from the command-line interface and find out why the link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the iec103-master process and run the iec103-master command

with respective flags.

- Step 1: Service must be stopped by entering the following command into the WCC Lite:
/etc/init.d/iec103-master stop
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec103-master -c /etc/iec103-master/iec103-master.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec103-master start**

IEC 60870-5-103 command line debugging options

```
-h [ —help ] Display help information
-V [ —version ] Show version
-d<debug level> Set debugging level
-c [ —config ] Config path
-r [ —raw ] Show raw telegram data
-f [ —frame ] Show frame data
-R [ —readyfile ] Ready notification file
```

- Step 1: Service must be stopped by entering the following command into the WCC Lite:
/etc/init.d/iec103-master stop
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec103-master -c /etc/iec103-master/iec103-master.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec103-master start**

14.5 IEC 60870-5-104 Master

IEC 60870-5-104 protocol (in short IEC 104) is a part of IEC Telecontrol Equipment and Systems Standard IEC 60870-5 that provides a communication profile for sending basic telecontrol messages between two systems in electrical engineering and power system automation. Telecontrol means transmitting supervisory data and data acquisition requests for controlling power transmission grids.

IEC 104 provides network access to IEC 60870-5-101 (in short IEC 101) using standard transport profiles. In simple terms, it delivers IEC 101 messages as application data (L7) over TCP, usually port 2404. IEC 104 enables the communication between the control station and a substation via a standard TCP/IP network. The communication is based on the client-server model.

> ℹ️ To set up TLS connection for both IEC104 Master and Slave, refer to sections Excel configuration and Certificates. All keys and certificates should be provided in the PEM format.

> ⚠️ If no configuration is set up, IEC104 Master and Slave services are not started.

Configuring IEC 104 Master datapoints

To use IEC 60870-5-104 Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-104 Master parameters for *Devices* tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-104 master	
asdu_address	integer	Application Service Data Unit address	Yes		0	65535
asdu_size	integer	Common address size in bytes	No	2	1	2
time_sync_interval_sec	integer	Time frame between Time Synchronization requests in seconds	Yes	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds. If 0 requests are disabled	Yes	300		
port	integer	TCP port	Yes		0	65535

				Default value	Min	Max
ioa_size	integer	Information object address (IOA) size in bytes	No	3	1	3
swt	integer	Send window (k)	Yes			
rwt	integer	Receive window (w)	Yes			
cot_size	integer	Cause of transmission (COT) size in bytes	No	2	1	3
ip	string	Host IP address (ipv4)	Yes			
t1*	integer	Acknowledge timeout t1 (sec)	Yes	15	1	255
t2*	integer	Connection ACKRSN clock t2 (sec)	Yes	10	1	254
t3*	integer	Connection TESTFR clock t3 (sec)	Yes	20	1	172800
originator	integer	Provides a means for a controlling station to explicitly identify itself	No	0	0	255

* - t1, t2 and t3 parameters must meet the inequality: t2<t1<t3.

IEC 60870-5-104 Master parameters for *Signals*

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
function	integer	Function number	No	0		

info_address	integer	Information object address	Yes		
data_type	integer	ASDU type identifier	Yes		1, 3, 5, 9, 11, 13, 21, 30, 31, 32, 34, 35, 36, 45, 46, 47, 48, 49, 50, 58, 59, 60, 61, 62, 63
select_ms	integer	Time limit in milliseconds for command execution. Command select has to be performed before execution if this parameter is specified. Direct command execution can be performed only if this field is left empty or set to zero.	No	0	

Device status signals

IEC 60870-5-104 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal for IEC 60870-5-104 protocol, job_todo and tag_job_todo fields with string values are required. For IEC 60870-5-104 master required parameters for status signal will be: **signal_name device_alias, signal_alias, common_address, info_address, data_type, job_todo** and **tag_job_todo**. Job_todo value must be *device_status* and for tag_job_todo there are 4 variations: communication_status, device_running, device_error, uknown_error. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Debugging an IEC 60870-5-104 Master application

If the configuration for IEC 60870-5-104 devices is set up, the handler for the protocol will start automatically. If a configuration is missing parameters or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-104 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from the command-line interface and find out why the link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the *iec104-master* process and run the *iec104-master* command with respective flags.

- Step 1: Service must be stopped by entering the following command into the WCC Lite:
  /etc/init.d/iec104-master stop
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec104-master -c /etc/iec104-master/iec104-master.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command:
  /etc/init.d/iec104-master start

IEC 60870-5-104 command-line debugging options

```
-h [ —help ] Display help information
-V [ —version ] Show version
-d<debug level> Set debugging level
-c [ —config ] Config path
-r [ —raw ] Show raw telegram data
-f [ —frame ] Show frame data
-e [ —redis ] Show redis message
-R [ —readyfile ] Ready notification file
```

14.6 IEC 60870-5-104 Slave

IEC 60870-5-104 Slave is designed not to lose data acquired from Master protocols. The data that arrives from Master protocols is stored in the cache. This data is checked every second to manage further data sending. The data that leaves IEC 60870-5-104 Slave has output caches. They're built to provide switching between multiple sessions (redundant SCADA). If a new connection arrives, the old one is dropped, but data, that is stored in a cache, not sent and not confirmed by SCADA is transferred to the new connection.

Configuring IEC 104 Slave datapoints

To use IEC 60870-5-104 Slave in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-104 Slave parameters for *Devices* tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-104 slave	
asdu_size	integer	Common address size in bytes	No	2	1	2
time_sync	boolean	Enable/disable (1 or 0) time synchronization	Yes			
port	integer	TCP port	No	2404	0	65535
ioa_size	integer	Information object address (IOA) size in bytes	No	3	1	3
swt	integer	Send window (SWT)	No	12		
rwt	integer	Receive window (RWT)	No	8		
cot_size	integer	Cause of transmission (COT) size in bytes	No	2	1	3
host	string	Space-separated remote host IP addresses (ipv4)	Yes			
bind_address	string	Bind to local IP address (ipv4)	No	0.0.0.0		
t1	integer	Acknowledge timeout t1 (sec)	Yes	15	1	255
t2	integer	Connection ACKRSN clock t2 (sec), t2 should be less than t1	Yes	10	1	254

t3	integer	Connection TESTFR clock t3 (sec)	Yes	20	1	172800
message_size	boolean	The maximum length of a message	Yes	253	0	255
cache_size	integer	Amount of data to be cached	Yes	100	0	1000
tls	boolean	Enable/disable the use of TLS	No	0	0	1
tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	No			
tls_private_key	string	A file consisting of the private key for TLS connection	No			
command_timeout_ms	integer	Time to execute a command before responding negatively.	No	30000	0	
command_age_ms	integer	The amount of time shift allowed for the command to still be executed.	No	0	0	

IEC 60870-5-104 Slave parameters for *Signals* tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0	0	1
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
info_address	integer	Information object address	Yes			

data_type	integer	ASDU type id.	Yes		1, 3, 5, 9, 11, 13, 21, 30, 31, 32, 34, 35, 36, 45, 46, 47, 48, 49, 50, 58, 59, 60, 61, 62, 63
select_ms	integer	Time limit in milliseconds for command execution. Command select has to be performed before execution if this parameter is specified. Direct command execution can be performed only if this field is left empty or set to zero.	No	0	

Device status signals

IEC 60870-5-104 has an additional signal which can be configured to show communication status. It is used to indicate if the master device has disconnected from slave (WCC Lite). To configure such signal for IEC 60870-5-104 protocol, job_todo and tag_job_todo fields with string values are required. For IEC 60870-5-104 slave required parameters for status signal will be: **signal_name device_alias, signal_alias, common_address, info_address, data_type, job_todo** and **tag_job_todo**. Job_todo value must be *device_status* and for tag_job_todo there are 4 variations: communication_status, device_running, device_error, uknown_error. Each signal has 4 possible values and are based on the same logic. If signal returns value of 0, it means unknown error has appeared, 1 – device or protocol connection is on and working properly, 2 – device is off or protocol is disconnected, 3 – error or service is down.

Debugging an IEC 60870-5-104 Slave application

If the configuration for IEC 60870-5-104 devices is set up, the handler for the protocol will start automatically. If a configuration is missing parameters or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-104 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from the command-line interface and find out why the link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the *iec104-slave* process and run the *iec104-slave* command with respective flags.

- Step 1: Service must be stopped by entering the following command into the WCC Lite:
  /etc/init.d/iec104-slave stop
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec104-slave-c /etc/iec104-slave/0_0_0_0_502.json -d7;** (0_0_0_0 - bind_address, 502 - port)
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command:
  /etc/init.d/iec107-slave start

IEC 60870-5-104 command-line debugging options

```
-h [ —help ] Display help information
-V [ —version ] Show version
-d<debug level> Set debugging level
-c [ —config ] Config path
-r [ —raw ] Show raw telegram data
-f [ —frame ] Show frame data
-e [ —redis ] Show redis message
-R [ —readyfile ] Ready notification file
```