IEC 60870-5-101 and 104

Connects to IEDs, RTUs and control centers over IEC 60870-5-101 (serial or TCP/IP) and IEC 60870-5-104 (TCP/IP), as master or as slave.

- Names: **IEC8705101**, **IEC8705101S**, **IEC8705104**, **IEC8705104S**
- Protocol: IEC 60870-5-101 and IEC 60870-5-104, master and slave
- Interface: Serial or TCP/IP (101), TCP/IP (104)
- Configuration:
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Overview

The Electrical Pack includes four connectors for the IEC 60870-5 telecontrol companion standards. The 101 connectors exchange FT 1.2 frames on a serial line, and can also carry the same frames over TCP/IP. The 104 connectors use the 104 network profile over TCP/IP. Each standard has a master connector, which polls or receives data from field stations and sends commands, and a slave connector, which publishes solution tags to an upper-level master and executes the commands it receives.

Driver name	Assembly Name	Role	Interface	Nodes per channel	Maximum block size
IEC8705101	T.ProtocolDriver.IEC8705101	101 master (client) station	Serial (RS-232 or RS-485) or TCP /IP	Several	250 bytes, FT 1.2 frame
IEC8705101S	T.ProtocolDriver. IEC8705101S	101 slave (server) station	Serial or TCP/IP	One	250 bytes, FT 1.2 frame
IEC8705104	T.ProtocolDriver.IEC8705104	104 master (client) station	TCP/IP	Several	253 bytes
IEC8705104S	T.ProtocolDriver. IEC8705104S	104 slave (server) station	TCP/IP	One	253 bytes

This page has information about the connection settings and the address syntax of each connector. For further information, see:

- Devices Module
- Devices Module Reference

Common Concepts

The four connectors share the data objects, the address syntax and the command model described in this section. The sections for each connector list the settings that differ.

Supported Data Objects (ASDUs)

Points are registered with the type codes below. The connectors also handle the time-tagged variants of the monitoring types: the 101 connectors use the 24-bit variants (even codes 2 to 16) and the 56-bit variants (codes 30 to 37); the 104 connectors use the 56-bit variants. A master that receives a time-tagged variant writes the received value, quality and time to the tag registered with the base type. A slave sends the time-tagged variants when it reports changes, and the base types in answer to general and counter interrogations.

Monitoring direction

Type	Code	Description	Time-tagged variants	101 Master	101 Slave	104 Master	104 Slave
M_SP_NA	1	Single-point information. Value 0 or 1.	M_SP_TA (2), M_SP_TB (30)	Yes	Yes	Yes	Yes
M_DP_ NA	3	Double-point information. States 0 to 3, normally used for breaker and switch positions.	M_DP_TA (4), M_DP_TB (31)	Yes	Yes	Yes	Yes
M_ST_NA	5	Step position. Range -64 to +63, mainly used for transformer tap position.	M_ST_TA (6), M_ST_TB (32)	Yes	Yes	Yes	Yes
M_BO_ NA	7	Bitstring of 32 bits, handled as a long number.	M_BO_TA (8), M_BO_TB (33)	Yes	Yes	Yes	Yes
M_ME_ NA	9	Measured value, normalized. Signed 16-bit value (-32768 to 32767) converted to a normalized real number. Use Scaling on the point to show engineering units.	M_ME_TA (10), M_ME_TD (34)	Yes	Yes	Yes	Yes
M_ME_ NB	11	Measured value, scaled. Signed 16-bit value, -32768 to 32767.	M_ME_TB (12), M_ME_TE (35)	Yes	Yes	Yes	Yes

M_ME_NC	13	Measured value, short floating point (32-bit IEEE 754).	M_ME_TC (14), M_ME_TF (36)	Yes	Yes	Yes	Yes
M_IT_NA	15	Integrated totals (counters). Signed 32-bit integer.	M_IT_TA (16), M_IT_TB (37)	Yes	Yes	Yes	Yes
M_EP_TA	17	Event of protection equipment with a 24-bit time tag. The state is in the 2 least significant bits of the quality byte.	None	Yes	No	No	No
M_ME_ND	21	Measured value, normalized, without quality descriptor.	None	No	Yes	No	Yes

Control direction

Type	Code	Description	101 Master	101 Slave	104 Master	104 Slave
C_SC_NA	45	Single command (1 bit).	Yes	Yes	Yes	Yes
C_DC_NA	46	Double command (2 bits), for switches and breakers with two-bit signalling.	Yes	Yes	Yes	Yes
C_RC_NA	47	Regulating step command, normally raise or lower pulses to a transformer tap changer.	Yes	Yes	Yes	Yes
C_SE_NA	48	Set point command, normalized value (16 bits).	Yes	Yes	Yes	Yes
C_SE_NB	49	Set point command, scaled value (16-bit integer).	No	Yes	No	Yes
C_SE_NC	50	Set point command, short floating point (32-bit IEEE 754).	Yes	Yes	Yes	Yes
C_BO_NA	51	Bitstring of 32 bits, handled as an unsigned long number. Map it to an Integer or Long tag.	No	Yes	Yes	Yes

For set point commands, the value sent is the current value of the tag mapped to the command point. The 104 Slave also accepts the commands with a 56-bit time tag, codes 58 to 64 (see **Commands Received by a Slave**). The 104 Master sends commands with a 56-bit time tag when the channel option **Use commands with timetag** is enabled.

System Commands

Type	Code	Use
C_IC_NA	100	General interrogation. Sent by both masters at the GI sample time; answered by both slaves.
C_CI_NA	101	Counter interrogation. Sent by both masters at the counter sample time; answered by the 101 Slave.
C_CS_NA	103	Clock synchronization. Sent by both masters when a synchronization interval is set; accepted by both slaves.
C_TS_NA	104	Test command. Accepted by the 101 Slave.
C_TS_TA	107	Test command with a 56-bit time tag. Sent by the 104 Master at the test command interval; answered by the 104 Slave.
C_RP_NA	105	Reset process command. Accepted by the 101 Slave.

Quality and Timestamps

- Both masters handle the quality descriptor (QDS) of each object and write it to the tag Quality. When a time-tagged object arrives, its time is written to the tag Timestamp.
- All timestamps are stored internally in UTC. When an IED sends local time, set the IED time bias in hours: for an IED that sends local time 3 hours behind UTC, enter -3. The default is 0. The 101 Master has this setting in the Protocol Options; the 104 Master has it in each node.
- Both slaves read the value, quality and timestamp of each tag and send them as they are. The 104 Slave sends timestamps in UTC unless **Bi as time from GMT** is set.
- The 104 Master option **Quality changes timestamp** updates the tag timestamp when a new reading arrives with a different quality, even if the value is unchanged.

Point Address Syntax

The Address column holds the point type, the information object address (IOA) and, for commands, the command parameter, separated by colons. Click the Address cell to open a window where you choose the Type from the list of supported types and enter the Address and, for commands, the Command Parameter.

- Monitoring point: ***<Type>:<Address>***, for example `M_DP_NA:400`.
- Command point: ***<Type>:<Address>:<Command parameter>***, for example `C_SC_NA:510:1`.
- Slave analog point with a deadband: `M_ME_NC:9:DeadbandABS=5:ZeroDrift=2`. The window offers the Deadband Mode (absolute, DeadbandABS, or percentage, DeadbandPCT), the Deadband value and the Zero Drift value. Zero Drift sets a range above zero inside which percentage variations are ignored. When no deadband is set, a slave uses a 1% deadband and a zero drift of 1 unit.

The IOA is assigned by the device manufacturer and is unique in a station, whatever the point type. Its size is set per connector: see the Point Settings of each connector.

Command Parameter and Select / Execute

Each command point carries a fixed command parameter, so a device usually needs one point to open and another to close, or one point to raise and another to lower. The parameter is the sum of an action code (A) and a detail code (B). If you know the code, type it in the field. Otherwise, use the Command and Details tabs of the address window: choose the action (Trip or Close) and the mode (Execute, Select, or Select and Execute), and choose the output signal type in Details. The arrow button loads the resulting code into the Command Parameter field.

Command	Action (A)	Details (B)
Single command, C_SC_NA	0 = Off 1 = On	0 = No additional detail 4 = Short pulse 8 = Long pulse 12 = Persistent output
Double command, C_DC_NA	1 = Off 2 = On	
Regulating step command, C_RC_NA	1 = Lower 2 = Raise	

The mode is added to A + B:

- **Execute:** add nothing. The command acts on the device.
- **Select:** add 128. The command only selects the device.
- **Select and Execute** (masters only): add 300. The master sends a Select (with 128 added) and, after the select confirmation, the Execute.

For example, 9 (1 + 8) in a single command is a long pulse to switch the device On; 137 is the Select for the same action, and 309 is Select and Execute. Set point commands use only the mode: 0 for Execute, 128 for Select, 300 for Select and Execute.

Command Signalling (CMDSIGN)

The 104 Master offers the internal point type CMDSIGN, which links a command to the input point that signals its result. Add CMDSIGN rows on the tag of the signalling point. When Type is CMDSIGN, the address window shows these fields: Address, the IOA of the command point; Command Parameter, the command code; Expected state, the state the signalling point must reach; and Timeout.

For example, a breaker has a position tag Breaker52.Position (M_DP_NA:400) and two command tags, Breaker52.Open (C_SC_NA:510:0) and Breaker52.Close (C_SC_NA:510:1). Add two CMDSIGN rows on Breaker52.Position, one for each command code at address 510. These rows create no runtime points. When the connector loads, it builds a list of the command and signalling pairs of each node and uses it to check each command it sends. No further configuration is needed. Command signalling applies to the C_SC_NA and C_DC_NA commands with M_SP_NA or M_DP_NA signalling points.

Command Results Tag (CMDRES)

While a master processes a command, it runs checks, sends the protocol messages and receives the responses. It writes the progress to an integer results tag, so displays can show it. The results tag name is the **Tag for comm status** name of the node with its last part replaced by CMDRES. For example, with the status tag Substation1/IED1.Comm.State, the results tag is Substation1/IED1.Comm.CMDRES. If no tag has that name, the master does not report results.

Code	Meaning
0	Command received
1	Command not accepted
7	Activation confirmed
9	Deactivation confirmed
10	Activation terminated
44	Unknown type identification
45	Unknown cause of transmission
46	Unknown IED (common) address
47	Unknown point (information object) address
99	Command requested
100	Command sent
101	Discarded by the timestamp check
102	Invalid password
103	Write not allowed

104	No response to the activation

Command Security Checks

A master sends a command when the value of the tag mapped to a command point changes. Two checks protect against unintended commands:

- **Password for commands.** A number of up to 9 digits (0 to 999999999), set in the channel Protocol Options. When it is not zero, the master compares it with the current value of the EstimatedValue attribute of the command tag. A display or script that sends a command must first write the password to that attribute. After the command, the master sets EstimatedValue back to zero. The default, 0, turns the check off.
- **Timestamp check.** The master checks the timestamp of the command tag, which is the time of its last value change. The change must be at most 30 seconds old when the master receives the request.

On a slave, **Password for commands** holds the password that the master connector forwarding the command to the field expects. Use the same value as that master channel.

Commands Received by a Slave

A slave executes a received command only when it finds a point with the same address, type and command parameter. Otherwise it discards the command and sends a negative activation confirmation to the master.

- **Select:** no change in memory. The slave writes a SELECT message to the trace when the point exists, and the message "POINT NOT FOUND!" when it does not.
- **Execute:** the slave executes the command and writes an EXECUTE message to the trace.

The detail code (B) sets what the slave writes to the destination tag:

- **0, no additional detail:** toggles the tag (0 becomes 1, 1 becomes 0), whatever the action code.
- **4, short pulse:** writes 0, then 1, holds it for 300 ms, and writes 0 again.
- **8, long pulse:** writes 0, then 1, holds it for 800 ms, and writes 0 again.
- **12, persistent output:** writes the action code (A) to the tag and keeps it.

> ⚠ When a slave forwards pulsed commands to a tag that another connector sends to the field, set WriteEvent = ChangedUp in the AccessType of that destination point, so that each pulse generates one command.

The 104 Slave compares the time tag of a time-tagged command with the clock of its computer. When the difference is greater than the **t1** timeout, it does not execute the command and sends no response, as the standard defines for commands with a time tag.

IEC 60870-5-101 Master

The IEC8705101 connector is a 101 master station. It communicates with IEDs, RTUs and I/O devices that implement the 101 slave. It uses the unbalanced FT 1.2 frame, so the IED sends data only when the master asks for it.

Operation

At startup and after a communication failure, the master:

1. Runs the station initialization sequence.
2. Sends clock synchronization, if a synchronization interval is set.
3. Runs a general interrogation of all classes.

Then, in a continuous loop, the master:

- Sends each command requested, according to its command parameter.
- Sends a general interrogation, a status (class 1 and class 2) request or a counter interrogation when each sample time expires.
- Sends clock synchronization at the synchronization interval.
- Requests class 1 data when a response indicates that events are waiting.
- Returns to the initialization sequence after a response timeout or a frame error.

Class 1 data are priority events, always with a time tag. Class 2 data come from cyclic reads, without a time tag. The class is not a property of the point: a change of a point can generate a class 1 event, and the next cyclic read of the same point is class 2. The tag value follows the cyclic reads, so that it stays consistent after the event is handled. The 101 groups of points are not used: each read covers all point types, or all counters.

Channel Settings

Protocol Options

Option	Default	Range	Description
CommonAddress Num Octets	1	1 to 2	Size of the station address at the application layer.

LinkAddress Num Octets	1	1 to 2	Size of the station address at the link layer.
ObjectAddress Num Octets	2	1 to 3	Size of the information object address.
CauseOfTransmission Num Octets	1	1 to 2	Size of the cause of transmission field.
Password for commands	0	0 to 999999999	See **Command Security Checks**. 0 turns the check off.
Timeout(ms)	4000	1000 to 120000	Time to wait for a response after any request. It is a functional check of the channel: it does not depend on the request or response type.
Logging Level	Error	Debug, Info, Warning, Error	See **Diagnostic Tools**.
IED time bias from GMT	0	Hours	Offset of the time sent by the IEDs from UTC. See **Quality and Timestamps**.

Settings

- **Serial:** the defaults are COM1, 9600 baud, 8 data bits, 1 stop bit, Even parity. Use 8 data bits and 1 or 2 stop bits; set the other port settings to match the IED.
- **TCP/IP:** NodeConnections sets the maximum number of parallel requests to each node. The default is 1.

Node Settings

Each node is one IED. A channel can have several nodes.

Setting	Default	Description
IP	192.168.1.1	TCP/IP channels only. IP address of the IED.
Port	8000	TCP/IP channels only. TCP port of the IED.
CommonAddress	1	Address of the IED at the application layer.
LinkAddress	1	Address of the IED at the link layer.
Synchronism sample time	0	Interval between two clock synchronization messages to the IED. 0 means no synchronization. Do not synchronize from the master an IED that has its own GPS time source.
GI sample time	60000	Interval, in ms, between two general interrogations. The IED answers with as many messages as it needs to send all its points.
Status sample time	1000	Interval, in ms, between two requests for class 1 and class 2 changes. Use a short interval, for example 1000 ms.
General counter sample time	0 on serial channels, 2000 on TCP/IP channels	Interval, in ms, between two counter interrogations.
Clock adjust	False	True sets the clock of this computer to the time the IED returns. Use it only when the IED has a GPS time source. This setting changes the computer clock.
Tag for comm status	Empty	Name of an existing tag that receives 1 while the IED answers and 0 when no response arrives within the channel Timeout. It also names the results tag, see **Command Results Tag**.

A node can also define a backup station for a redundant IED. Use the same addresses and sample times as the primary station.

Point Settings

The address is ***<Type>:<Address>*** for monitoring points and ***<Type>:<Address>:<Command parameter>*** for commands. The IOA has the size set in **ObjectAddress Num Octets**; with the default of 2 octets, the range is 0 to 65535. Supported types: monitoring 1, 3, 5, 7, 9, 11, 13, 15 and 17; commands 45, 46, 47, 48 and 50.

Access Type

Point types	Access Type settings

Monitoring: M_SP_NA (1), M_DP_NA (3), M_ST_NA (5), M_BO_NA (7), M_ME_NA (9), M_ME_NB (11), M_ME_NC (13), M_IT_NA (15), M_EP_TA (17)	ReadOnStartup = True ReadPolling = Always ReadPollingRate = 500 ms WriteEvent = Changed AcceptUnsolicited = True
Commands: C_SC_NA (45), C_DC_NA (46), C_RC_NA (47), C_SE_NA (48), C_SE_NC (50)	ReadPolling = Never WriteEventEnabled = True WriteEvent = Changed

IEC 60870-5-101 Slave

The IEC8705101S connector is a 101 slave (server) station. It publishes solution tags to a 101 master and executes the commands it receives. It uses the unbalanced FT 1.2 frame, so it sends data only when the master asks for it. The connector:

- Answers general interrogations with the single-point, double-point and analog points.
- Answers the class 1 and class 2 requests with the changes of digital points and the analog changes outside the deadband.
- Accepts general interrogation, counter interrogation, clock synchronization, test and reset process commands.
- Sends 24-bit or 56-bit time tags (see **Use CP56Timetag**).
- Accepts direct commands and select before operate, for digital points and set points.
- Sends the quality descriptor (QDS) of each point.

Channel Settings

When you create the channel, choose the medium: Serial, which uses the CustomSerial interface, or TCP/IP, which uses the CustomTCPIP interface.

Protocol Options

Option	Default	Range	Description
CommonAddress Num Octets	1	1 to 2	Size of the station address at the application layer.
LinkAddress Num Octets	1	1 to 2	Size of the station address at the link layer.
ObjectAddress Num Octets	2	1 to 3	Size of the information object address.
CauseOfTransmission Num Octets	1	1 to 2	Size of the cause of transmission field.
Password for commands	0	0 to 999999999	See **Command Security Checks**.
Timeout(ms)	4000	1000 to 120000	Time to wait for a request after a response. Any request restarts it. It is a functional check of the channel.
Use CP56Timetag	True	True, False	True sends time-tagged objects with the 56-bit time tag. False uses the 24-bit time tag of the original 101 standard.
Maximum analog changes to send msg	30	0 to 100	Number of analog changes collected in one message. Used when the changes arrive as write events (WriteEventEnabled = True).
Maximum time to send analog changes(ms)	3000	1000 to 30000	Maximum wait before the slave sends the analog changes collected so far. With **Get analog changes by sampling**, it is the sampling interval.
Get analog changes by sampling	Disabled	Enabled, Disabled	Enabled makes the slave compare the current tag values with the last values sent, at each sampling interval, and send only the values that changed by more than the deadband. Analog points that use sampling need WriteEventEnabled = False in their AccessType.
Logging Level	Error	Debug, Info, Warning, Error	See **Diagnostic Tools**.
Listening Port	2404	1 to 20000	TCP/IP only. TCP port where the slave waits for the master connection.
Allowed client Ips	Empty	Text	TCP/IP only. IP addresses of the masters allowed to connect, separated by semicolons. Empty allows any master. Connections from other addresses are refused.

⚠ Slave connectors need periodic calls to keep their timing. If no point uses write events, or if periodic calls are not certain, create an auxiliary tag, change it periodically with a script, and map it to a point whose AccessType triggers a call to the connector.

Settings

- **Serial:** the defaults are COM1, 19200 baud, 8 data bits, 1 stop bit, Even parity. Use 8 data bits and 1 or 2 stop bits; set the other port settings to match the master.
- **Timeouts:** on Serial and TCP/IP, the RxStart value, in ms, is the timeout for each attempt to read received data.

Node Settings

Each channel has one node, which is this slave station.

Setting	Default	Description
Ip Address, Port	Not used	TCP/IP channels show these fields, but the slave does not use them.
CommonAddress	1	Address of this station at the application layer.
LinkAddress	1	Address of this station at the link layer.
Clock adjust	False	True sets the clock of this computer to the time of each clock synchronization received from the master. This setting changes the computer clock.
Tag for comm status	Empty	Name of an existing tag that receives 1 while requests arrive and 0 when no request arrives within the channel Timeout.

Point Settings

The IOA has the size set in **ObjectAddress Num Octets**. Supported types: monitoring 1, 3, 5, 7, 9, 11, 13, 15 and 21; commands 45, 46, 47, 48, 49, 50 and 51. For analog points, set the deadband in the address window (see **Point Address Syntax**). For command points, see **Commands Received by a Slave**.

Access Type

Point types	Access Type settings
Monitoring: M_SP_NA (1), M_DP_NA (3), M_ST_NA (5), M_BO_NA (7), M_ME_NA (9), M_ME_NB (11), M_ME_NC (13), M_IT_NA (15)	ReadOnStartup = True ReadPolling = Always ReadPollingRate = 500 ms WriteEventEnabled = True WriteEvent = Changed AcceptUnsolicited = True
Commands: C_SC_NA (45), C_DC_NA (46), C_RC_NA (47), C_SE_NA (48), C_SE_NC (50), C_BO_NA (51)	ReadPolling = Never WriteEventEnabled = True WriteEvent = Changed

IEC 60870-5-104 Master

The IEC8705104 connector is a 104 master station. It communicates over TCP/IP with IEDs, RTUs and I/O devices that implement the 104 slave. The IED sends changes spontaneously, without polling.

Operation

At startup and after a communication failure, the master:

1. Sends the start of data transfer message (STARTDT).
2. Sends clock synchronization, if a synchronization interval is set.
3. Runs a general interrogation, at the GI sample time.

Then, in a continuous loop, the master:

- Receives the spontaneous data messages that the IED sends when a value changes.

- Acknowledges the received messages after **w** messages, or after **t2** without new messages, with the sequence number of the last message received.
- Sends a test frame when no message arrives for **t3**.
- Sends each command requested, according to its command parameter.

Channel Settings

Protocol Options

Option	Default	Range	Description
t0 Timeout of Connection establishment(s)	30	1 to 255	After a disconnection or a command response failure, the master reconnects at once, starting with STARTDT. If that fails, it tries again after t0 seconds.
t1 Timeout of send or test APDUs(s)	15	1 to 255	Maximum time for the IED to answer any request. When it expires, the master closes the TCP/IP connection and reconnects, following t0.
t2 Timeout for ack in case of no Data (s)	10	1 to 255	Maximum time after a received message before the master acknowledges it when no new message arrives. t2 must be less than t1.
t3 Timeout for send test frames(s)	20	1 to 255	Idle time on an open connection after which the master sends a TEST frame.
Password for commands	0	0 to 999999999	See **Command Security Checks**. 0 turns the check off.
Logging Level	Error	Debug, Info, Warning, Error	See **Diagnostic Tools**.
Maximum changes per minute	0	0 to 240	Maximum number of changes per minute considered normal for a digital input point. The limit is set on the channel and applies to all its nodes. 0 turns the check off.
Unactivate Node if tag maximum changes	NO	YES, NO	YES deactivates the whole node when one of its points exceeds the limit. NO sets the Locked attribute of that point to 1, and the point stops changing until an operator sets Locked back to 0. In both cases the connector reports the event.
Time to reactivate node(min)	0	0 to 1440	Time after which the connector reactivates a node it deactivated. 0 means no automatic reactivation.
Quality changes timestamp	Disable	Enable, Disable	Enable updates the tag timestamp when a reading arrives with a different quality, even if the value is unchanged.
Use commands with timetag	Disable	Enable, Disable	Enable sends the commands with a 56-bit time tag (CP56Time2a).

Settings

NodeConnections sets the maximum number of parallel requests to each node. The default is 1.

Node Settings

Each node is one IED. A channel can have several nodes.

Setting	Default	Description	
IP	192.168.0.0	IP address of the IED.	
Port	2404	TCP port of the IED. The standard port is 2404; other ports can be used.	
CommonAddress	1	Address of the IED at the application layer.	
Date sample time(ms)	0	Interval between two clock synchronization commands (C_CS_NA, 103) with the time of this computer. 0 means no synchronization. Do not synchronize from the master an IED that has its own GPS time source.	
General Interrogation sample time (ms)	60000	Interval between two general interrogations (C_IC_NA, 100). The IED answers with as many messages as it needs to send all its points.	
w Send ack after received w IFormat APDUs	8	Number	Number of information messages received after which the master sends an acknowledgement with the sequence number of the last one. The standard recommends that w is at most two thirds of k.

k Messages received to send state variable	12	Number	Maximum number of messages the IED sends without an acknowledgement. When it reaches k, the IED stops sending and waits for the acknowledgement.
Clock adjust	False	True sets the clock of this computer to the time the IED returns in response to clock synchronization. Use it only when the IED has a GPS time source. This setting changes the computer clock.	
IED time bias from GMT	0	Offset, in hours, of the time sent by the IED from UTC. See **Quality and Timestamps**.	
Tag for comm status	Empty	Name of an existing tag that receives 1 while the IED communicates and 0 on a communication failure. It also names the results tag, see **Command Results Tag**.	
Test Command with time tag56(ms)	5000	Interval between two test commands with a 56-bit time tag. It keeps activity on the connection and checks that the IED is active.	
Counters Interrogation sample time (ms)	0	Interval between two counter interrogations (C_CI_NA, 101).	

A node can also define a backup station for a redundant IED, with the same settings as the primary station.

Point Settings

The address is ***<Type>:<Address>*** for monitoring points and ***<Type>:<Address>:<Command parameter>*** for commands. The 104 standard fixes the IOA at 3 octets, so there is no octet option on the channel. Supported types: monitoring 1, 3, 5, 7, 9, 11, 13 and 15; commands 45, 46, 47, 48, 50 and 51; and the internal type CMDSIGN (see **Command Signalling**).

Access Type

Point types	Access Type settings
Monitoring: M_SP_NA (1), M_DP_NA (3), M_ST_NA (5), M_BO_NA (7), M_ME_NA (9), M_ME_NB (11), M_ME_NC (13), M_IT_NA (15)	ReadOnStartup = True ReadPolling = Always ReadPollingRate = 500 ms WriteEvent = Changed AcceptUnsolicited = True
Commands: C_SC_NA (45), C_DC_NA (46), C_RC_NA (47), C_SE_NA (48), C_SE_NC (50), C_BO_NA (51)	ReadPolling = Never WriteEventEnabled = True WriteEvent = Changed

Keep ReadOnStartup = True on monitoring points, so that the connector reads all values when it starts.

IEC 60870-5-104 Slave

The IEC8705104S connector is a 104 slave (server) station. It publishes solution tags to a 104 master over TCP/IP and executes the commands it receives.

Operation

1. At startup, and after the connection closes, the slave waits for a master to connect on the listening port.
2. When a master connects, the slave neither answers nor sends messages until it receives STARTDT.
3. The slave confirms STARTDT and starts to exchange data.
4. The slave sends the changes of its points spontaneously: the digital changes, and the analog changes outside the deadband.
5. After sending **k** messages, or after a period without sending, the slave waits for the acknowledgement of the master. If it does not arrive, the slave stops sending.
6. The slave always confirms test frames.

The slave also answers general interrogations, accepts clock synchronization, sends 56-bit time tags and the quality descriptor (QDS) of each point, and accepts direct commands and select before operate.

Channel Settings

Protocol Options

Option	Default	Range	Description
t0 Timeout of Connection establishment(s)	30	1 to 255	Time to wait for a master to connect. When it expires, the slave closes the socket and opens it again to wait.
t1 Timeout of send or test APDUs(s)	15	1 to 255	Maximum time for sent or test messages to be confirmed after STARTDT. The slave also uses t1 to reject commands with an old time tag.
t2 Timeout for ack in case of no Data (s)	10	1 to 255	Maximum time after a message before the master must acknowledge it when no new message arrives. t2 must be less than t1.
t3 Timeout for send test frames (s)	20	1 to 255	Idle time on an open connection after which a TEST frame is sent.
Maximum changes to send a msg	30	1 to 80	Number of analog changes collected in one message. Used when the changes arrive as write events (WriteEventEnabled = True).
Max time to send analog changes (ms)	3000	500 to 60000	Maximum wait before the slave sends the analog changes collected so far. With **Get analog changes by sampling**, it is the sampling interval.
Password for commands	0	0 to 999999999	See **Command Security Checks**.
Logging Level	Error	Debug, Info, Warning, Error	See **Diagnostic Tools**.
Get analog changes by sampling	Disabled	Enabled, Disabled	Enabled makes the slave compare the current tag values with the last values sent, at each sampling interval, and send only the values that changed by more than the deadband. Analog points that use sampling need WriteEventEnabled = False in their AccessType.
Set all quality good on start	Disabled	Enabled, Disabled	The slave normally reads the value and quality of each tag without changing them. Enabled sets the quality of all its tags to Good when the slave starts.
Bias time from GMT	0	Hours	The slave sends timestamps in UTC, as the standard defines. To send local time, enter the offset of the local time from UTC, for example -3 for a local time 3 hours behind UTC.
Delay before start working(s)	0	0 to 1200	Time between the start of the connector and the start of its operation. The usual value is 0.
Use timestamp for Analog	Disabled	Enabled, Disabled	Sets whether the slave sends analog points with their time tag.

Slave connectors need periodic calls to keep their timing. If no point uses write events, or if periodic calls are not certain, create an auxiliary tag, change it periodically with a script, and map it to a point whose AccessType triggers a call to the connector.

Settings

- **Listening Port:** TCP port where the slave waits for the master. The default and standard port is 2404; other ports can be used. To listen on one network adapter only, enter its IP address before the port, separated by a colon, for example 192.168.0.222:2404.
- **NodeConnections:** maximum number of parallel requests to each node. The default is 1.

Node Settings

Each channel has one node, which is this slave station.

Setting	Default	Description
IP, Port	Not used	These fields are shown but not used.
CommonAddress	1	Address of this station at the application layer.
w Send ack after received w IFormat APDUs	8	Number of messages sent after which the master must send an acknowledgement with the sequence number of the last message received. The standard recommends that w is at most two thirds of k.

k Messages received to send state variable	12	Maximum number of messages the slave sends without an acknowledgement. When it reaches k, the slave stops sending and waits for the acknowledgement.
Clock Adjust	**True**	True sets the clock of this computer to the time of each clock synchronization command received from the master. **Th is is the default: a new 104 Slave channel changes the clock of the computer it runs on.** Set it to False when the computer clock comes from another source, such as a domain time server or GPS.
Tag for comm status	Empty	Name of an existing tag that receives 1 while the master communicates and 0 on a communication failure.
Allowed Clients IPs	Empty	IP addresses of the masters allowed to connect, separated by slashes (/). Empty allows any master. Connections from other addresses are refused.

Point Settings

The 104 standard fixes the IOA at 3 octets. Supported types: monitoring 1, 3, 5, 7, 9, 11, 13, 15 and 21; commands 45, 46, 47, 48, 49, 50 and 51, and their variants with a 56-bit time tag: C_SC_TA (58), C_DC_TA (59), C_RC_TA (60), C_SE_TA (61), C_SE_TB (62), C_SE_TC (63) and C_BO_TA (64). For analog points, set the deadband in the address window (see **Point Address Syntax**). For command points, see **Commands Received by a Slave**.

Access Type

Point types	Access Type settings
Monitoring: M_SP_NA (1), M_DP_NA (3), M_ST_NA (5)	ReadOnStartup = True ReadPolling = Always ReadPollingRate = 500 ms WriteEventEnabled = True WriteEvent = Changed AcceptUnsolicited = True
Commands: C_SC_NA (45), C_DC_NA (46), C_RC_NA (47), C_SE_NA (48), C_SE_NC (50), C_BO_NA (51)	ReadPolling = Never WriteEventEnabled = False
Analog points that use Get analog changes by sampling: M_BO_NA (7), M_ME_NA (9), M_ME_NB (11), M_ME_NC (13), M_IT_NA (15)	ReadPolling = Never WriteEventEnabled = False

Diagnostic Tools

The Property Watch, the Trace Window and the Module Information help find communication and address errors. The four connectors also offer:

- **Logging Level** (channel Protocol Options): Debug records all messages; Info records Info, Warning and Error messages; Warning records Warning and Error messages; Error, the default, records Error messages only.
- **Tag for comm status** (node): 1 while communication works, 0 on a failure.
- **Command results tag** (masters): the progress code of each command, see **Command Results Tag**.

Module Information

This tool shows the operation of the modules and the communication channels: read groups, error codes and communication events. It helps identify communication blocks and address errors.

Property Watch

This tool reads and writes tags and internal properties of the system. It helps find the cause of errors through negative error codes.

Trace Window

This tool shows system messages in a grid, with the status of reads, writes and communication frames, and lists invalid addresses in the configuration. The slave connectors write their SELECT and EXECUTE messages here.

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