IEC 870-5-104 Sinaut

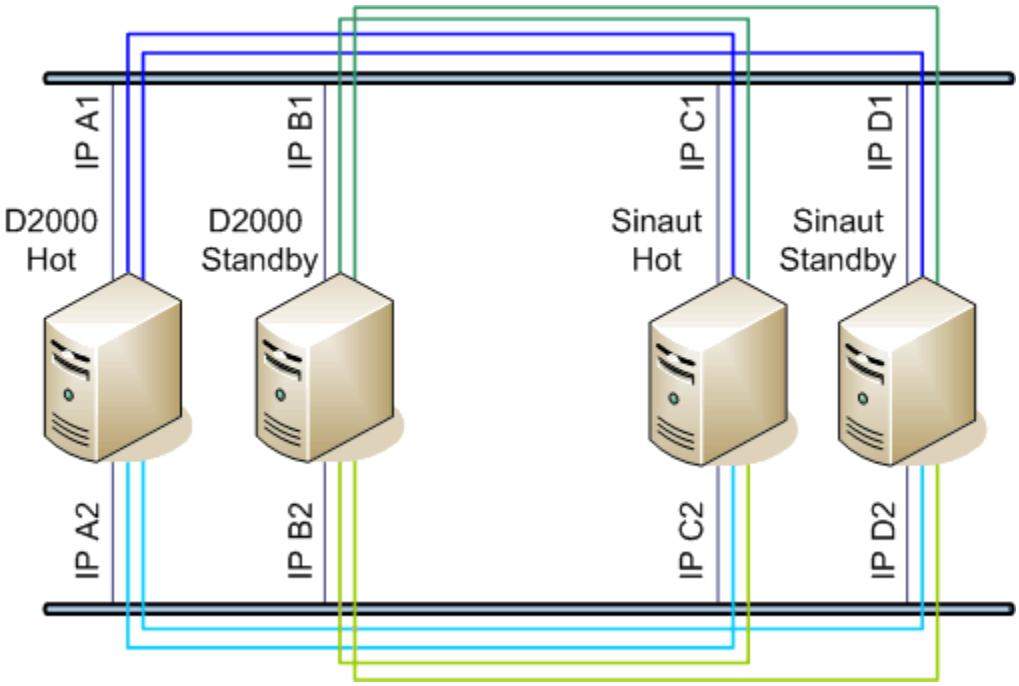
IEC 60870-5-104 Sinaut communication protocol

Supported device types and versions
Communication line configuration
Communication station configuration
Station protocol parameters
I/O tag configuration
Tell commands
Literature
Document revisions

Supported device types and versions

The protocol is a modification of the IEC 870-5-104 protocol working on the basis of TCP network communication. The protocol has been modified specifically for redundant communication with the **Siemens Sinaut Spectrum** system. It supports the balanced mode and both active and passive establishment of the communication (a connecting party and a listening party) according to the station protocol parameters and therefore allows to interconnect not only the D2000 system with the Sinaut system but also two D2000 systems.

Picture: the D2000 redundant system communicating with Sinaut redundant system in a redundant network



The picture above shows TCP connections - each process D2000 KOM (D2000 Hot, D2000 StandBy) with each Sinaut (Sinaut Hot, Sinaut StandBy)

Implementation according to the standard IEC870-5-104 is following:

- **Originator ASDU address -** is 1 byte, it is defined as a line number.
- **ASDU address -** is 2 bytes, it is defined as station address. For each station on one line, a different ASDU address must be defined.
  Note: Because of the Sinaut data model, the low and high address bytes are exchanged (in contrast to the standard IEC 104 implementation), i.e. a big-endian instead of a little-endian is used.
  Example:
  station address=1, ASDU address is sent as bytes 0, 1
  station address=513 (2*256+1), ASDU address is sent as 2, 1 bytes
  For better orientation, station address may be defined in the form of ByteHI, ByteLO, i.e. address **2,1** is the same as **513**
- **Cause of transmission** - is 2 bytes (it also contains Originator ASDU address)
- **Information object address** - 3 bytes, it is defined as I/O tag address
  Note: Because of the Sinaut data model, the low and high address bytes are exchanged (in contrast to the standard IEC 104 implementation), i.e. a big-endian instead of a little-endian is used.
  Example:
  I/O tag address=1, ASDU address is sent as bytes 0, 0, 1.
  I/O tag address=66051(1*65536+2*256+3), ASDU address is sent as bytes 1, 2, 3.
  For better orientation, the I/O tag address may be defined in the form of ByteLO, ByteMIDDLE, ByteHI, i.e. address **1,2,3** is sent as bytes 1, 2, 3.

The following ASDU types in the monitoring direction (from Sinaut system to D2000 system and also vice-versa in balanced mode) are implemented:

Table 1

ASDU type	I/O tag types
1 - Single-point information	Di, Qi (On/Off), Ai, Ci
2 - Single-point information with a time tag	Di, Qi (On/Off), Ai, Ci
3 - Double-point information	Qi, Ai, Ci
4 - Double-point information with a time tag	Qi, Ai, Ci
5 - Step position information	Ci, Ai *
6 - Step position information with a time tag	Ci, Ai *
7 - Bitstring of 32 bits	Ci, Ai
8 - Bitstring of 32 bits with a time tag	Ci, Ai
9 - Measured value, normalized value	Ai
10 - Measured value, normalized value with time tag	Ai
11 - Measured value, scaled value	Ci, Ai
12 - Measured value, scaled value with time tag	Ci, Ai
13 - Measured value, short floating point value	Ai
14 - Measured value, short floating point value with time tag	Ai
15 - Integrated totals	Ci, Ai
16 - Integrated totals with time tag	Ci, Ai
17 - Event of protection equipment with time tag	Ci, Ai, TiR **
18 - Packed start events of protection equipment with time tag	Ci, Ai, TiR ***
20 - Packed single-point information with status change detection	Ci, Ai
21 - Measured value, normalized value without quality descriptor	Ai
30 - Single-point information with time tag CP56Time2a	Di, Qi (On/Off), Ai, Ci
31 - Double-point information with CP56Time2a tag	Qi, Ai, Ci
32 - Step position information with CP56Time2a tag	Ci, Ai *
33 - Bitstring of 32 bits with CP56Time2a tag	Ci, Ai
34 - Measured value, normalized value with CP56Time2a tag	Ai
35 - Measured value, scaled value with CP56Time2a tag	Ci, Ai
36 - Measured value, short floating point value with time tag CP56Time2a	Ai
37 - Integrated totals with time tag CP56Time2a	Ci, Ai
38 - Event of protection equipment with time tag CP56Time2a	Ci, Ai, TiR **
39 - Packed start events of protection equipment with time tag CP56Time2a	Ci, Ai, TiR ***
40 - Packed output circuit information of protection equipment with time tag CP56Time2a	Ci, Ai, TiR ***

Note: Individual bits of the quality byte (SIQ for ASDU 1,2,30; DIQ for ASDU 3,4,31; QDS for 5..14,20,32..36) are mapped to the flags A (bit 0), B (bit 1) .. H (bit 7).
For example:
for ASDU 4: A=DPI bit 0, B=DPI bit 1, C=0, D=0, E=BL bit, F=SB bit, G=NT bit, H=IV bit.
for ASDU 16: A..E = Sequence number bits 0..4, F=CY bit, G=CA bit, H=IV bit

Moreover:

- if *IV* (Invalid) bit is set, the value status will be *Invalid*
- if any of NT (Not topical), SB (Substituted), BL (Blocked), OV (Overflow), CA (Counter adjusted), CY (Counter overflow) bits are set for corresponding ASDU types, the value status will be *Weak*.

* - T-bit of the value of these ASDUs is mapped to the I flag, a number in range -64 .. +63 goes to a variable of Ci/Ai type

** - **ASDU 17** and **38**: SEP byte is in the flags A (bit 0), B (bit 1) .. H (bit 7), following 2 bytes (CP16Time2a) are in a variable of Ci/Ai type as a positive number (0-60 000) or they are in a variable of TiR type as a relative time (0-60 seconds)

The following ASDU types are implemented in the control direction (from D2000 system to Sinaut system and vice-versa in balanced mode):

Table 2

ASDU type	I/O tag type
45 - Single command	Dout
46 - Double command	Dout, Co
47 - Regulating step command	Dout
48 - Set point command, normalised value	Ao
49 - Set point command, scaled value	Co
50 - Set point command, short floating point value	Ao
51 - Bitstring of 32 bit	Co
58 - Single command with time tag CP56Time2a	Dout
59 - Double command with time tag CP56Time2a	Dout, Co
60 - Regulating step command with time tag CP56Time2a	Dout
61 - Set point command, normalised value with time tag CP56Time2a	Ao
62 - Set point command, scaled value with time tag CP56Time2a	Co
63 - Set point command, short floating point value with time tag CP56Time2a	Ao
64 - Bitstring of 32 bit with time tag CP56Time2a	Co

To set the bits of the "status" byte (SCO for ASDU 45,58; DCO for ASDU 46,59; RCO for ASDU 47,60; QOS for ASDU 48..50,61..63), flags A (bit 0), B (bit 1) .. H (7.bit) are used except the bits, which are directly set by the variable value (SCO bit 0, DCO and RCS bits 0-1). Having received a response (positive/negative), the A .. H flags are set according to the bits of the "status" byte.

When sending commands (ASDUs 45-64), the value of 6 [Activation] is used as CauseOfTransmission. Whether a response is expected from the controlled station depends on the CMDC parameter. These options are available:

- Writing is considered successful if a packet with RSN confirming the SSN packet with the write command is received.
- Writing is considered finished if a response with CauseOfTransmission=7 [Activation Confirmation] and/or 10 [Activation Termination] is received. Success/failure depends on the setting of the P/N bit in received CauseOfTransmission.

Redundant communication with Siemens Sinaut system - basic features:

- One communication line of a TCP/IP-TCP Redundant type communicates with two redundant Sinaut partners, one of them is HOT, the other is STANDBY.
- Communication with each of the partners is performed via two redundant networks (i.e. two TCP connections are created for each Sinaut, so altogether there are four TCP connections by every D2000 KOM process).
- Only the HOT partner (D2000 or Sinaut) is allowed to send new values and reply to ASDU 100 [Interrogation Command]. Having established the connection, the STANDBY partner only sends confirmations (S-frames) and test frames. However, the STANDBY partner may also send ASDU 100 [Interrogation Command].
- Each participant communicates with a partner through a single TCP connection. It sends new values, command confirmations, ASDU 100, and replies to ASDU 100 through this connection. The second connection is not used (except for sending test frames) and it is only used when a failure on the first connection is detected.

Establishing a connection:

- In the active mode, the D2000 KOM process connects to specified TCP ports. It sends a StartDT Act U-frame to each of the ports and waits for a StartDT Con reply.
- In the passive mode, the D2000 KOM process waits on a specified TCP port (see the SP, SH parameters). When the clients are connected, the process waits for a StartDT Act U-frame and sends a StartDT Con reply.
- Further communication is completely symmetrical. Both partners can send ASDU 100 [Interrogation Command] in order to read all current values and then the partners receive and send changed values and commands.

Having established the connection, a partner may send I-frame with ASDU 100 [Interrogation Command] with CauseOfTransmission=6 [Activation] and with ASDUAddres=FFFF, whereby it requests the values of I/O tags for all stations. As a replay, the partner waits for:

- receiving an I-frame with ASDU 100 [Interrogation Command] and with CauseOfTransmission=7 and ASDU Address=FFFF
- receiving the current values of all I/O tags
- receiving an I-frame with ASDU 100 [Interrogation Command] and with CauseOfTransmission=10 and ASDU Address=FFFF

Forced disconnection: If all communication stations on the line are in the simulation mode or the communication is stopped for them, the communication line will be disconnected (communication sockets will be closed). When the simulation mode is turned off or the communication is enabled for at least one station (the Parameters tab of the Station type object), the line will be reconnected (and Interrogation Command and/or Counter Interrogation Command will be sent to this active station). Then, when other stations are enabled, the Interrogation Command and/or Counter Interrogation Command is sent to this station; see the next point.

Forced sending of Interrogation Command or Counter Interrogation Command: If a station is not in the simulation mode and the communication is not disabled (the Parameters tab of the Station type object), the D2000 KOM process sends Interrogation Command and/or Counter Interrogation Command (see the OIC and OCIC parameters).

The IEC870-5-104 Sinaut protocol supports the **balanced mode** described in the communication protocol IEC 870-5-104 - it is partly a server, so it must comply with the rules of server protocols.

Communication line configuration

- Communication line category: TCP/IP-TCP Redundant
- TCP parameters:
  - Host: string containing at most 80 characters – two comma-separated server IP addresses in the form of a.b.c.d
    In the active mode, they are the addresses of the server, to which the D2000 KOM process is connecting.
    In the passive mode (see the parameters SP, SH), they are the IP addresses of clients, which are accepted by the D2000 KOM process (if the client is connecting from other IP address, it will be disconnected).
  - Port: TCP port number (0...65535)
    In the active mode, it is the server port, where the D2000 KOM process is connecting to.
    In the passive mode (see the SP, SH parameters), the parameter will be ignored (however it must be specified, set it e.g. to 0).
  - Line number: it is used as *Originator ASDU address* (1 byte, 0-255).

Communication station configuration

- Communication protocol: **IEC870-TCP Sinaut**.
- The station address is a decimal number within the range of 0 až 65535, it defines the ASDU address.
  For better orientation, the station address may be defined in the form of ByteHI, ByteLO, i.e. address **2,1** is the same as **513** (2*256 + 1). See a note about the ASDU address.

Note: The protocol supports sending long timestamps (CP56Time2a tag) in local time or UTC time with defined offset (see the Use monotonic UTC time+ parameter).

Station protocol parameters

Station configuration dialog box - tab **Protocol parameters**.
They influence some of the optional protocol parameters. The following station protocol parameters can be defined:

Table 3

Full name	Meaning	Unit	Default value
Command Confirm	Confirmation of control ASDUs. If CMDC=0, the D2000 KOM process is not waiting for confirmation of control ASDUs from the partner station using a reply ASDU with a different CauseOfTransmission. The ASDU is considered to be confirmed when a packet containing the corresponding ReceiveSequenceNumber is received. If CMDC=1, the D2000 KOM process is waiting for confirmation with CauseOfTransmission=7 (Activation Confirmation). If CMDC=2, the D2000 KOM process is waiting for confirmation with CauseOfTransmission=10 (Activation Termination). If CMDC=3, the D2000 KOM process is waiting for confirmation with CauseOfTransmission=7 or 10 (if both of them are received, just the first of them is taken into account). Having received the corresponding confirmation means that writing is finished (the *Transient* attribute of written value is cleared and the *WTn* timer is reset). If a confirmation is received with a different CauseOfTransmission from the one that the D2000 KOM process is expecting, it will be ignored. Writing is successful if the received ASDU contains the P/N bit set to 0. Otherwise, writing is unsuccessful. The value from a received ASDU is written into the corresponding I/O tag and it is sent to the system. E.g. if an ASDU of type 50 (short floating point) with the value of 1200.0 is sent and the partner station sends an ASDU of type 50 as a reply, P/N bit=0, the value of 999.0 (e.g. due to physical limitations of the given parameter), then this value will be sent to the system by the D2000 KOM process.	-	3
Debug Input	A mask for a debug level of the input data. Meaning of individual bits: • 0. bit - information about the number of points received within General Interrogation • 1. bit - information about received values of I/O tags • 2. bit - balanced mode: information about received Interrogation command • 3. bit - information about discarded values due to the setting of the Ignore Flagged parameter	0 .. 255	0
Debug Output	A mask for a debug level of the output data. Meaning of individual bits: • 0.bit - balanced mode: information about the number of points sent within General Interrogation • 1.bit - information about sent values of I/O tags	0 .. 255	0

ICCP compatible flags	It allows a flag mapping that is compatible with the Sinaut Spectrum ICCP OPC communication. For more information see ICCP compatible flag mapping.	YES /NO	NO
Ignore Flagged	The parameter allows specifying the flags of values (data ASDUs 1-40), which - if set - will cause the incoming value to be discarded. The parameter was implemented when it was necessary to filter out the "Non-topical" flag values that came from the communication partner. The mapping of individual flags from ASDU to A..H flags is as follows: • A - Overflow (OV) - ASDU 5-14, 20, 32-36 • B - no mapping (according to standard this bit should be 0) • C - no mapping (according to standard this bit should be 0) • D - Elapsed Time Invalid (EI): ASDU 17-19, 38-40 • E - Blocked (BL) - ASDU 1-14, 17-20, 30-36, 38-40 • F - Substituted (SB) - ASDU 1-14, 17-20, 30-36; Counter overflow (CY) - ASDU 15, 16, 37 • G - Non-topical (NT) - ASDU 1-14, 17-20, 30-36; Counter adjusted (CA) - ASDU 15, 16, 37 • H - Invalid (IV) - ASDU 1-20, 30-40	A..H	-
Ignore Unknown Addresses	If this parameter is set to True, the D2000 KOM process will not report an error (display an error on its console or write it into the line log file) in case that incoming value has an address that does not match any of the addresses of I/O tags defined in the D2000 system.	-	False
Interrogation Covers Counter Interrogation	As a reply to Interrogation, also values of I/O tags configured as ASDUs 15,16,37 (Integrated Totals) will be sent, which are usually requested by ASDU 101 [Counter Interrogation].	-	True
K (max outstanding I APDUs)	Sending window size i.e. number of packets, which are sent by the D2000 KOM process without receiving a confirmation (S-frame or I-frame). According to the standard, the default value is 12.	-	12
No Flags	If the parameter is True, then the status byte of incoming ASDUs is ignored and not saved into the flags A...H. Flags of output I/O tags are also ignored and they not written to the status byte.	-	False
Order of Counter IC	The order for sending of sending ASDU 101 [Counter Interrogation Command] when the station starts to communicate or when a new station is created. If OCIC<OIC, ASDU 101 will be sent before ASDU 100. If OCIC=0, ASDU 101 will not be sent. The parameter can be set separately for each station.	-	0
Order of IC	The order for sending ASDU 100 [Interrogation Command] when the station starts to communicate or when a new station is created. If OIC<OCIC, ASDU 100 will be sent before ASDU 101. If OIC=0, ASDU 100 will not be sent. The parameter can be set separately for each station.	-	1
Ping Count	A number of repetitions, after which the IP address not responding to ping is to be known as non-functional. See the parameter Ping TimeOut.	-	3
Ping TimeOut	If the parameter is non-zero, it defines the timeout (in milliseconds) of a server response to a ping (ICMP echo) packet. In the background, the D2000 KOM process sends ping packets to all four configured IP addresses. If an IP address repeatedly does not respond for Ping Count-times, it is marked as non-functional and the connection is terminated. If the parameter PTO=0, sending ping packets to IP addresses is disabled.	-	0
Post Start Delay	When the connection is being established, this parameter defines the delay between receiving StartDT Con response and sending Interrogation Command and/or Counter Interrogation Command.	ms	0
Send Sequence Number	Initial SSN. According to the standard, after establishing the connection the SSN is set to 0, values other than zero could be used e. g. for testing.	-	0
Server Port, Server Host	The port number and IP address of the interface where the D2000 KOM process should listen (in a listening mode). If both parameters are defined, the D2000 KOM process works as passive (it is waiting for connecting Sinaut clients). If the process should listen on all network interfaces, *Server Host* must be set *to* ALL or *.	-	
Standby Keep Open	If this parameter is set to True, the connection to the partners will not be closed when the status of the D2000 Server process (the process D2000 KOM is connected to) is changed from Hot to Standby state (in a redundant D2000 system).	-	True
Station Communication Error	The number of unsuccessful attempts to connect, after which the station status is changed into the St_CommErr state. For redundant lines, the communication must fail on both TCP connections.	-	2
Station Hard Error	The number of unsuccessful attempts to connect after a communication error, after which the station status is changed into the St_HardErr state. For redundant lines, the communication must fail on both TCP connections.	-	5
Strict Redundancy Connection Signalisation	The number of TCP connections, which must be opened so that the line could be considered as OK. There are 4 connections (2x Sinaut servers, each of them has 2 network addresses).	-	4
Tcp Keep Init	The parameter is implemented for OpenVMS platforms only. If it is other than zero, then defines the timeout (in seconds) for opening a new connection to the server. For OpenVMS, the default value is 75 seconds, for Windows, it is 20 seconds.	-	0
TCP NoDelay	TND parameter sets a low-level parameter of TCP_NODELAY sockets which disables a default TCP packet coalescing.		

W (ack after receiving W APDUs)	The number of received packets, after which the D2000 KOM process sends an S-frame confirmation. According to the standard, the default value is 8. It must be true that W < K, the standard recommends W = 2/3 * K.	-	8
Wait Timeout T1	The timeout for receiving a confirmation of a sent I-frame (either a confirmation within a received I-frame or an individual S-frame is expected) or a sent U-frame. If the D2000 KOM process does not receive the confirmation within *WT1* limit, it closes the TCP connection. According to the standard, the default value of *WT1* is 15000 ms.	ms	15 000
Wait Timeout T2	The timeout for sending a confirmation of a received I-frame. *WT2* < *WT1*. If another I-frame (which confirms the received I-frame) is not sent within the *WT2* limit since the I-frame was received, then the D2000 KOM process sends an S-frame confirming the received I-frame to the partner. According to the standard, the default value of *WT2* is 10000 ms.	ms	10 000
Wait Timeout T3	The timeout for sending test frames (U-frame TEST ACT). If no data are sent in any direction for a longer time than *WT3*, a TEST ACT U-frame will be sent by the D2000 KOM process and a U-frame TEST CON is expected (within the *WT1* time limit). If the partner's *WT3* is set to a lower value, it sends the test frames and the D2000 KOM process replies to them. According to the standard, the default value of WT3 is 20000 ms. Setting the value to 0 disables sending test frames.	ms	20 000
Wait Timeout N	The timeout for receiving the confirmation of a sent value. Receiving e.g. S-frame with RSN (Receive Sequence Number) confirming that the other party received the previous I-frame doesn't mean that the I-frame was processed. Within the *WTn* time limit, the D2000 KOM process expects a response (e.g. after sending ASDU with TypeIdentificator=45 [Single Command] with CauseOfTransmission=6 [Activation] it expects to receive a Single Command with CauseOfTransmission=7 [Activation Confirmation]. After the expiration of the *WTn* timeout, the D2000 KOM process closes the TCP connection.	ms	60 000

The defined parameters, with the exception of Order of IC and Order of Counter IC, are valid for the entire communication line, i.e. they can have to be set only for a single station on the line.

ICCP compatible flag mapping

Unlike ICCP OPC communication, a status byte of individual ASDUs permits the transmission of a limited group of flags. In Table 4 you can see a conversion of bits of the status byte to the flags which are compatible with ICCP OPC communication (see the ICCP compatible flags parameter).

Table 4

Bits of status byte					**Description**	**ICCP OPC mapping**
8 [IV invalid]	*7 [NT non topical]*	*6 [SB substituted]*	*5 [BL blocked]*	*1 [OV overflow]*		
1	x	x	x	x	INVALID	H (NotValid)
0	x	0	0	x	VALID	A (Actual)
0	x	0	1	x	BLOCKED	D (Blocked)
0	x	1	0	x	SUBSTITUTED	C (Entered)
0	x	1	1	x	SUBSTITUTED + BLOCKED	F (Blocked Manual)

IO tag configuration

Permitted I/O tag types: **Ai, Ao, Ci, Co, Di, Dout, Qi**

- I/O tag address is mapped to the Information Object Address, i.e. contains 3 bytes and must be within the interval of 0...16777215.
  For better orientation, the I/O tag address may be defined in the form of ByteHI, ByteMIDDLE, ByteLO, i.e. address **1,2,3** is the same as **66051** (1*256*256 + 2*256 + 3). See a note about the IOA address.
  The I/O tag with an address starting with *%IGNORE* will be ignored.
- The input I/O tags must have corresponding types (Ai, Ci, Di, Qi) for received ASDU, see table 1.
- For a particular type of output I/O tag (Ao, Dout, Co), it is necessary to set an ASDU type that should be used, see Table 1 and Table 2.
- It is possible to configure one input I/O tag and multiple output I/O tags on the same address, as long as the output I/O tags have different ASDUs. Example:
  - I/O tag M1, Di type, address 1,
  - I/O tag M2, Dout type, address 1, ASDU 1 (single-point information)
  - I/O tag M3, Dout type, address 1, ASDU 45 (single command)

  Configuration on partner's side:
  - I/O tag P1, Dout type, address 1, ASDU 1 (single-point information)
  - I/O tag P2, Di type, address 1

  Writing into the I/O tag P1 from the partner's side results in a new value written to the I/O tag M1. Writing to the I/O tags M2, M3 results in a new value to the I/O tag P2 on the partner's side.
- If the Destination Column is configured, then the values received from the address configured at the I/O tag and above are stored in the corresponding items (e.g. objects with addresses 10, 11, 12 ... according to the number of rows of the destination structure).

Tell commands

Command	**Syntax**	**Description**

STWATCH	STWATCH StationName	Tell command sends Interrogation Command and/or Counter Interrogation Command to the station (based on station parameters).

Literature

-

Document revisions

- Ver. 1.0 – December 15th, 2004
- Ver. 1.1 – February 21st, 2011
- Ver. 1.2 – November 16th, 2023 (support for the Destination Column)

Related pages:

Communication protocols