IEC 870-5-104

IEC 60870-5-104 communication protocol

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Supported device types and versions

The protocol (known also as IEC 870-5-104 or IEC-104) allows reading and writing data, operating on the basis of TCP network communication. Implementation is, according to the IEC 60870-5-104 standard, as follows:

- **Originator ASDU address** is 1 byte, it is defined as the line number.
- **ASDU address** is 2 bytes, it is defined as the station address. ASDU addresses of all stations on one line must be different.
- **Cause of transmission** is 2 bytes (contains also Originator ASDU address).
- **Information object address** is 3 bytes, it is defined as an I/O tag address.
- The following ASDU types are implemented in the monitoring course (from controlled station to the D2000 system and also vice-versa in balanced mode):

Table 1

ASDU type	I/O tag type
1 - Single-point information	Di, Qi (On/Off), Ai, Ci
2 - Single-point information with time tag	Di, Qi (On/Off), Ai, Ci
3 - Double-point information	Qi, Ai, Ci
4 - Double-point information with time tag	Qi, Ai, Ci
5 - Step position information	Ci, Ai *
6 - Step position information with time tag	Ci, Ai *
7 - Bitstring of 32 bits	Ci, Ai
8 - Bitstring of 32 bits with 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 ***
241 - 64-bit floating-point value (Ipesoft & URAP implementation)	Ao
243 - 64-bit floating-point value with time tag CP56Time2a (Ipesoft & URAP implementation)	Ao
251 - Archive data values (Ipesoft's implementation)	none ****
252 - D2000 Unival (Ipesoft's implementation)	all (except Qi)

Note: Single bits of the byte, which informs us on quality (SIQ for ASDU 1,2,30; DIQ for ASDU 3,4,31; QDS for 5..14,20,32..36) are mapped into the A (0. bit), B (1.bit) .. H (7.bit) flags except the bits that are directly set by the value of the variable (SCO bit 0, DCO and RCS bits 0-1). After receiving the answer (a positive/negative one), the A .. H flags are set according to bits of "status" byte.

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

* - T-bit of the value of these ASDU types is in the I flag, a number within -64 .. +63 is in a variable of Ci/Ai type.
** - ASDU 17 and 38: SEP byte is in the flags A (0.bit), B (1.bit) .. H (7.bit), the 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).

*** - ASDU 18, 39 and 40: SPE(ASDU 18,39) byte respectively OCI (ASDU 40) byte is in the flags I (0.bit), J (1.bit) .. P (7.bit), QDP byte is in the flags A (0. bit), B (1.bit) .. H (7.bit), the 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.

The following ASDU types are implemented in the control course (from D2000 system to controlled station and also vice-versa in balanced mode):

Table 2

ASDU type	I/O tag type
45 - Single command	Dout
46 - Double command	Dout
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
250 - Archive data request command (Ipesoft's implementation)	none ****
252 - D2000 Unival (Ipesoft's implementation)	all

To set the bits of "status" byte (SCO for ASDU 45,58; DCO for ASDU 46,59; RCO for ASDU 47,60; QOS for ASDU 48..50,61..63), the flags A (0.bit), B (1. bit) .. 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 (ASDU 45-64), the value of 6 [Activation] is sent as a CauseOfTransmission. The expected response from the controlled station depends on the Command Confirm parameter. There are the following possibilities:
- writing is successful if the packet with RSN confirming the SSN packet with the write command
- writing is finished, if there is a response with CauseOfTransmission=7 [Activation Confirmation] and/or with 10 [Activation Termination]. Success/failure depends on the setting of the P/N bit in CauseOfTransmission.

**** - ASDU 250 can be used for communication with Ipesoft 870-5-104 Server. The command will ask for historical values (within specified interval) from the server, which will arrive as ASDU 251 (or newer ASDU 249 that use 64-bit values for improved precision, if the protocol parameter D2H64 is enabled on the server). The reading of the archive values can be executed by means of the GETOLDVAL command with the parameter containing the name of the I /O tag or station (in this case, the values of all I/O tag are read gradually, i.e. reading of the next tag starts after the reading of current tag is done). Response for ASDU 250 is again ASDU 250 (with CauseOfTransmission=7) and with the return code:

- 0 - the successful start of reading the history
- 1 - the history for the required tag doesn't exist
- 2 - the history for the required tag is not available (the archive does not run)

Next (is the return code was 00) the ASDU 251 with archive data will be sent and the termination ASDU 250 with CauseOfTransmission=10.

Establishing a connection:

The D2000 KOM process is connecting to the TCP port and sends a StartDT Act U-frame, then a StartDT Con U-frame is expected as a reply.

For all the stations with a defined synchronization (see the article below), an ASDU type 103 [Clock synchronisation command] with CauseOfTransmission=6 [Activation] is sent, and a reply (depending on the Command Confirm parameter) is expected.

Then a sequence of 0 up to N I-frames with ASDU 100 [Interrogation Command] and ASDU 101 [Counter Interrogation Command] is sent, both with CauseOfTransmission=6 [Activation]. The I-frames are sent for each station with at least one input I/O tag (i.e. Ai, Di, Qi, Ci). The expected response (in any order) is:

- reception of frames with ASDU 100 [Interrogation Command] and with CauseOfTransmission=7 or 10 (depending on the Command Confirm parameter)
- reception of frames with ASDU 101 [Counter Interrogation Command] and with CauseOfTransmission=7 or 10 (depending on the Command Confirm parameter)
- reception of current values of all I/O tags.

The other side can also send frames with ASDU TypeIdentificator=100 and CauseOfTransmission=10 [Activation Termination]. However, the D2000 KOM process does not consider it to be an error if such no frames are received. The order of sending ASDU 100 and 101 as well as disabling their sending is defined by the Order of IC and Order of Counter IC parameters.

Clock synchronisation: Sending ASDU type 103 [Clock synchronisation command] is performed during initialization (after sending StartDT and before sending Interrogation Command). The synchronization is sent for the stations, with the **Enable** parameter checked in the Time parameters tab. ASDU type 103 is sent regularly with a defined period.

Forced disconnection: If all stations on the line are in the simulation mode or the communication is stopped for them, the line will be disconnected (the communication socket will be closed). If the simulation is disabled for at least one station and the communication is not stopped for it (the Parameters tab of *Station* type object), the line will be connected again (and Interrogation Command and/or Counter Interrogation Command will be sent to the active station). After enabling communication for further stations, Interrogation Command and/or Counter Interrogation Command will be sent to these stations, see the next paragraph.

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

The D2000 system also supports a **balanced mode**. In this mode, the task of controlled and control stations is symmetrical. In this mode, the D2000 system receives commands and confirms them. The balanced mode may be used only when it is supported by the partner station. An advantage is that the D2000 system sends the current status of output I/O tags (defined as ASDU 1-40) as a reply to ASDU 100 [Interrogation Command] and 101 [Counter Interrogation Command] requests. It is still suitable to configure single-shot commands as ASDU 45 - 64; they are not repeated after re-establishing the connection.
As the protocol supports the balanced mode (partly it is a server), the rules of server protocols apply to it.
The output tags, which are configured as ASDU 1-40, do not go through the *Transient* status (i.e. they are considered as if in the configuration of I/O tag, *Output control tab*, the I/O tag output mode is set to *Command*). The writing is considered to be successful if there is a connection with the server at the time of writing, otherwise, the writing is unsuccessful.

Communication partners

- **ABB MicroScada**. Note: The value of the parameter *Maximum message length* in the ABB MicroScada settings must be changed from 253 similar to 230 (+/- a few bytes). Default value of the parameter causes rewriting the communication buffer and it is expressed by sending a corrupted message.
- **PLC Bernecker & Rainer**, protocol implementation: URAP-AUTOMATIZÁCIA s.r.o. (Ltd.)
- **LFC terminals of Slovenské Elektrárne, a.s. (Inc.)**, protocol implementation: Energodata/ABB
- **RS Unicon 4**, UniControls

Communication line configuration

- Communication line category: TCP/IP-TCP or TCP/IP-TCP Redundant.
- TCP parameters - server parameters are mandatory:
  - Host: string containing at most 80 characters – server name in form of INET (name or numerical address a.b.c.d). In the case of redundant systems, multiple names/addresses separated by commas can be entered.
  - Port: TCP port number (0..65535)
  - Line number: is to be used as the Originator ASDU address (1 byte, 0-255)

Communication station configuration

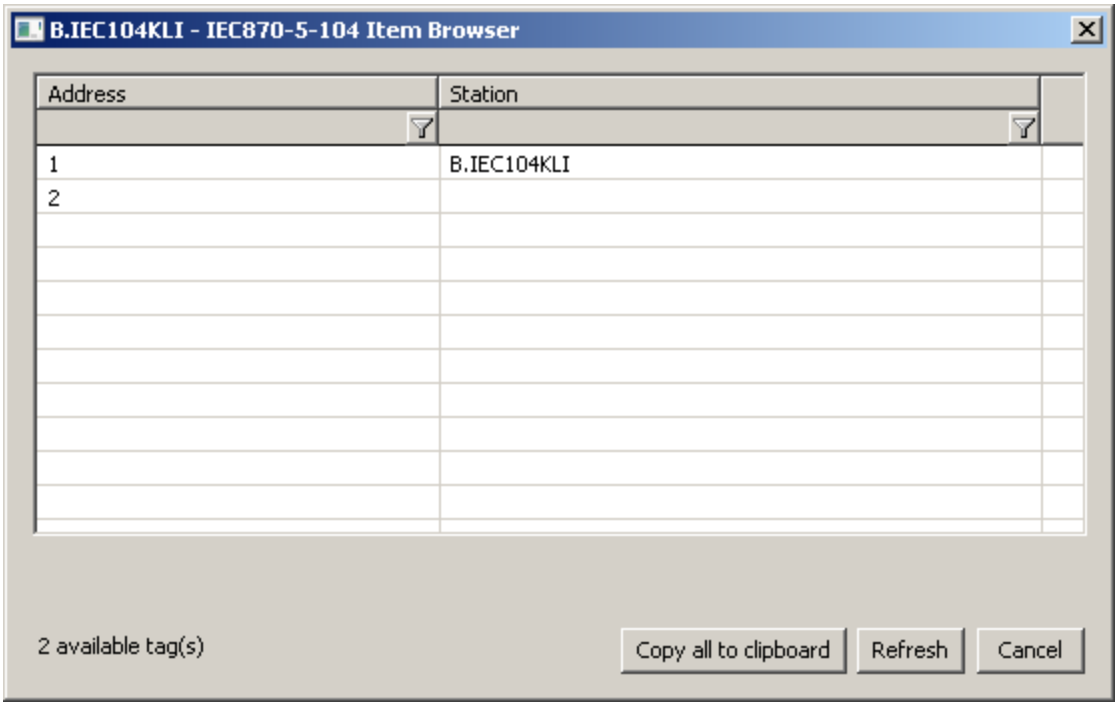
- Communication protocol: **IEC870-TCP**.
- Station address: a number within the range of 0..65535 defines the ASDU address. It can be specified as a decimal number or as a hexadecimal number with a hash at the beginning (e.g. #0A).

Note 1: After saving a station in process D2000 CNF, the process D2000 KOM automatically sends ASDU 100 and ASDU 101 (Interrogation and Counter Interrogation Commands) to this station, if enabled.

Note 2: The protocol supports sending long time stamps (CP56Time2a tag) in local time or UTC time with defined offset (see the parameter Use monotonic UTC time +).

Note 3: Starting with D2000 version 7.02.004 if a **TCP Redundant** line category is used, the C and D flags are used in the value of communication stations for an indication of the functionality of primary (C) and secondary (D) communication paths. If these flags are set, the respective communication path is non-functional. For example, if the value of the communication station is StON and the C flag is set it means that only the secondary communication path is functional.
For lower versions of D2000 only partial detection of a broken communication path is available when using the Strict Redundancy Connection Signalisation parameter.

The **Browse** button opens a browsing dialogue for the station address. If the communication is functional, a dialogue with the ASDU addresses received so far is displayed. The **Refresh** button can be used to clear the list of received ASDU addresses.



Station protocol parameters

Table 3

Full name	Meaning	Unit	Default value
Asymmetric Redundancy Mode Periodicity	The parameter can be used for a *TCP Redundant* line with defined backup servers (see the parameters AS1, AP1, BS1, BP1 ..). The non-zero value of *ARMP* parameter means that if this number of ASDUs is received (after a successful reconnect), both connections are checked whether they're not going through the same network (IPs and ports defined in the line settings or ASx:APx and BSx:BPx). If they do, the connection to the standby server (see the Asymmetric Redundancy Mode Slave Detection parameter) will be closed and an attempt to establish a connection through another network will be made. If unsuccessful, the next IP address will be tried (i.e. Alternate Server 1, Alternate Server 2, line IP, Alternate Server 1, etc). **Note:** When the parameter *Asymmetric Redundancy Mode Periodicity* is enabled, the second connection is established to "B-Alternate Server 1":"B-Alternate Port 1" and not to the IP address and port defined for the line after running the D2000 KOM process (so that it wouldn't be immediately closed).	-	0
Asymmetric Redundancy Mode Slave Detection	The detection method of standby server for Asymmetric Redundancy Mode Periodicity: • 0 - no detection: the first connection, that detects it is working via the same network, is to be disconnected • 1 - if ASDU contains the bit 0 of the 3rd Control Field byte set to 1 • 2 - if ASDU in CauseOfTransmission contains the bit 7 set to 1	-	0
Alternate Server 1/ Alternate Port 1/ Alternate Server 2/ Alternate Port 2/	Extension for redundant systems: besides the IP address defined in the configuration of the Line, it is possible to define 2 alternative IP addresses. In case of a connection failure, the D2000 KOM process is attempting to connect to the next address in the list. **Note 1**: All IP addresses and ports must be defined gradually for one station (i.e. at first "Alternate Server 1", "Alternate Port 1" and then "Alternate Server 2", "Alternate Port 2"). **Note 2**: These parameters are obsolete since it's possible to define several IP addresses in the configuration of the line (separated by comma or semicolon, e.g. 10.0.0.1;10.0.0.2).	-	-
B-Alternate Server 1/ B-Alternate Port 1/ B-Alternate Server 2/ B-Alternate Port 2/	Can be used when the protocol IEC 870-5-104 is configured for a TCP redundant line. The meaning of the parameters is the same as for the primary connection, but they are valid for the backup connection. **Note 1**: All IP addresses must be defined stepwise for one station (i.e. at first "Alternate Server 1", "Alternate Port 1" and then "Alternate Server 2", "Alternate Port 2"). **Note 2**: These parameters are obsolete since it's possible to define several IP addresses in the configuration of the line (separated by comma or semicolon, e.g. 10.0.0.1;10.0.0.2).	-	-
Command Confirm	Confirmation of control ASDU. If Command Confirm=0, the D2000 KOM process is not waiting for confirmation of control ASDU from the partner station using a reply ASDU with a different CauseOfTransmission. ASDU is considered to be confirmed when a packet containing the corresponding ReceiveSequenceNumber is received. If Command Confirm=1, the D2000 KOM process is waiting for confirmation with CauseOfTransmission=7 (Activation Confirmation). If Command Confirm=2, the D2000 KOM process is waiting for confirmation with CauseOfTransmission=10 (Activation Termination). If Command Confirm=3, the D2000 KOM process waiting for confirmation with CauseOfTransmission=7 or 10 (if both of them are received, only the first of them is taken into account). Having received corresponding confirmation means that writing is finished (the *Transient* attribute of written value is cleared and the "*Wait Timeout Tn*" timeout stops elapsing). If a confirmation with a *CauseOfTransmission* different from the one the D2000 KOM process expects, is received, it will be ignored. Writing is successful if the received ASDU contains the P/N bit set to 0. Otherwise, writing is unsuccessful. Value from received ASDU is written back into a particular I/O tag and 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) as a response, then the value will be sent to the D2000 system by the D2000 KOM process.	-	1
These parameters are intended for the configuration of a communication station for communication between two D2000 systems using ASDU 252 - D2000 Unival (Ipesoft's implementation). more ...			
Debug Input	A mask for debug levels of input data. The meaning of bits is as follows: • 0.bit - displays a number of incoming values during General Interrogation • 1.bit - displays all incoming values • 2.bit - balanced mode: requesting Interrogation command was received	-	0
Debug Output	A mask for debug levels of output data. The meaning of bits is as follows: • 0.bit - balanced mode: displays a number of outgoing values during General Interrogation • 1.bit - displays all outgoing values	-	0
End of initialization	Extension for ABB MicroScada: If *End of initialization*=1, having received ASDU 70 (End of initialisation) resends Interrogation Command and/or Counter Interrogation Command.	-	0

Force Master Time	If *Force Master Time*=True, then the D2000 KOM process will accept ASDU 103 (Clock synchronisation command) with *CauseOfTransmission*=6 [Activation] or 3 [Spontaneous] from the server and it will save the time difference between the server's time and its time. If *CauseOfTransmission*=6, it replies with *CauseOfTransmission*=7 [Activation Confirmation]. Then the time of all values, which are received with timestamps, is decreased by this difference, i.e. a correction to the time of D2000 is made. The parameter allows solving the problem when some values from the server are received with the timestamps and others without timestamps and times from D2000 and server differ. In this case, without parameter *Force Master Time*=True the values received without timestamps are tagged by D2000 time and the values with the timestamps are tagged by the server time. With parameter *Force Master Time*=True the time, sent by the server, is corrected to D2000 time using the time difference, which is computed from the received ASDU 103 (Clock synchronisation command).	-	False
Force Slave Time	Extension for ABB MicroScada: If *Force Slave Time*=True, then the D2000 KOM process will accept ASDU 103 (Clock synchronisation command) with *CauseOfTransmission*=6 [Activation] or 3 [Spontaneous] from the server and saves the time difference between server time and its time. If *CauseOfTransmission*=6, it replies with *CauseOfTransmission*=7 [Activation Confirmation]. Then all values, which are received with no timestamps, are to be marked by the current time plus time difference (if the station is not configured to use the communication computer time). The *Force Slave Time* parameter allows solving the problem, that after receiving ASDU 100 or 101, the ABB MicroScada sends "interrogated" values without timestamps. However, during the communication, the values are sent with the timestamps - which may cause problems if the times of the MicroScada and the D2000 system are not synchronized.	-	False
GI Send New	If *GI Send New*=True, then the D2000 KOM process, after receiving the *General Interrogation* command, sends also values with more recent times than the time when the command was received. The value of the *GI Send New* parameter must be True to send values with future times as a reply to the *General Interrogation* command.	-	False
Ignore Control Field 3 bit 0	Determines behavior, when ASDU contains Control Field with the lowest bit (0) of the 3rd-byte set to 1. • if *Ignore Control Field 3 bit 0*=False (default), ASDU content is to be processed • if *Ignore Control Field 3 bit 0*=True, ASDU content is to be ignored The feature can be used when creating a redundant TCP connection (TCP Redundant line + IEC 870-5-104 protocol). The active server should send ASDU with the lowest bit of the 3rd Control Field byte set to 0, the passive server should send ASDU with the lowest bit of the 3rd Control Field byte set to 1.	-	False
Ignore Invalidson Interrogation	Balanced mode: if this parameter is set on a station, the D2000 KOM process will not send as a reply for ASDU 100 and 101 (Interrogation / Counter interrogation command) values of I/O tags which are Invalid or Unknown. The parameter can be used e.g. when controlling if sending Invalid values causes a breakdown of control.	-	False
Ignore Tests	Determines behavior, when ASDU contains the highest 7th bit (Test) set in CauseOfTransmission. • if *Ignore Tests*=0 (default), ASDU content is to be processed • if *Ignore Tests*=1, ASDU content is to be ignored • if *Ignore Tests*=2, a *Weak* attribute is to be set The feature can be used for creating a redundant TCP connection (TCP Redundant line + IEC 870-5-104 protocol). An active server should send ASDU with the Test bit=0, a passive server should send ASDU with the Test bit=1.	-	0
Ignore Unknown Addresses	If *Ignore Unknown Addresses*=TRUE, the D2000 KOM process will not show an error on its console or write it into log files in case that incoming value has the address not matching any of the addresses of I/O tags defined in the D2000 system.	-	False
Implicit Interrogation	Balanced mode: After connecting to the IEC104 server, the D2000 KOM process sends the values of all variables without waiting for ASDU 100 or 101 [Interrogation/Counter Interrogation Command] requests.	-	False
Interrogation Covers Counter Interrogation	Balanced mode: As a reply to Interrogation, also values of I/O tags configured as ASDU 15, 16, 37 (Integrated Totals) are sent. (They are normally requested by ASDU 101 [Counter Interrogation].)	-	False
Interrogation WithOut Timestamps	If *Interrogation WithOut Timestamps*=True, then values sent as a response to ASDU 100 [Interrogation Command] in balanced mode will be sent as ASDUs without timestamps. For example instead of ASDU 2 (Single-point information with time tag) or ASDU 30 (Single-point information with time tag CP56Time2a) ASDU 1 (Single-point information) will be sent. This behavior is suitable in the situation when the values have been invalidated as a result of communication error and after the communication is reestablished the values come with old timestamps which causes problems in the archive (if the values change only rarely, calculated archives depending on them will be also invalid till a new value arrives). At the same time, this behavior is strictly according to the IEC standard, which says that the response to Interrogation should not use ASDUs with time stamps.	-	False
K	Sending window size i.e. number of I-frames 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

LFC History	The parameter may be used to read historical values for communication with LFC terminals or other devices that support ASDU 250 defined by Ipesoft. Unlike the primary use of ASDU 250, the LFC terminal can only transmit one value for interval begin time, while the end time is ignored. The value will not be received as ASDU 251 but as one of the standard ASDU with a timestamp. Moreover, the values (with the same timestamp) of other tags may be received along with the value of the required tag. LFC terminal does not send ASDU 250 (with *CauseOfTransmission*=7, 10) as part of the response to ASDU 250 and the D2000 KOM process considers the reading done as soon as it gets the value of the required I/O tag. If the value is not received within the time defined by the *Wait Timeout T1* parameter, the reading of historical value is considered unsuccessful, however, the connection to the LFC terminal is not closed. If the values of other I/O tags are received along with the value of the required I/O tag, they must be received before the value of the required tag is received, otherwise, they are not considered as historical values (because reading is considered to be done after the value of required I/O tag is received). *Example*: After the request for the values of I/O tags with the addresses of 1,2..16, the LFC terminal always sends the values of all the tags in the order of 1,2..16, therefore we must ask for the value of the I/O tag with the address of 16. If the parameter is not defined or *LFC History*=0, reading of historical data is defined by Ipesoft (D2000 IEC104 Server partner is assumed). If *LFC History*=1, then the value is considered to be historical (it will go to the archive but not to the I/O tag, etc.) if its timestamp belongs to the time interval specified by the GETOLDVAL action (and is received as ASDU 250). If *LFC History*=2 then the behavior is as for *LFC History*=1 except if the timestamp of the received value is newer than the timestamp of the current value of the I/O tag, the received value will be sent into the D2000 Server process as a new one and not as a historical one. ***Note*:** When reading historical data of the LFC terminal, the **GETOLDVAL** action may not contain the station name (the *statIdent* parameter) but the I/O tag name. If the action contains a station name, ASDU 250 will be sent for one I/O tag only.	-	0
Maximum Time Difference	Maximum acceptable time difference (in hours) between the time of received data and the time of the D2000 KOM process. If the partner station sends a value with a timestamp older or later than MDT hours, the value will be ignored and an error log will be written into the line's trace file. If the *Maximum Time Difference* parameter is a negative value (e.g. *Maximum Time Difference*=-5), its absolute value is used and the system alarm SystemError will be generated as well. If the parameter's value is zero, the time difference will not be checked.	hrs	0
No Flags	If the parameter is True, then the status byte of incoming ASDUs is ignored and not saved into the A .. H flags. Flags of output I/O tags are also ignored and they are not written to the status byte.	-	False
Order of IC	Order of sending ASDU 100 [Interrogation Command] during connection initialization. If *Order of IC* < *Order of Counter IC*, ASDU 100 will be sent before ASDU 101. If *Order of IC*=0, ASDU 100 will not be sent. The parameter can be set extra for each station.	-	1
Order of Counter IC	Order of sending ASDU 101 [Counter Interrogation Command] during connection initialization. If *Order of Counter IC* < *Order of IC*, ASDU 101 will be sent before ASDU 100. If *Order of Counter IC*=0, ASDU 101 will not be sent. The parameter can be set extra for each station.	-	2
Ping Count	The number of repetitions, after which the IP address not responding to the ping is considered non-functional. See the Ping TimeOut parameter.	-	3
Ping TimeOut	If the parameter is non-zero, it defines the timeout (in milliseconds) of server response for ping (ICMP echo) packet. In the background, the D2000 KOM process sends ping packets to all defined IPs - Line IP address and Alternate Server 1, Alternate Server 2, B-Alternate Server 1, B-Alternate Server 2. If some of the addresses do not respond Ping Count-times, it is designated as non-functional. If the line is connected to this IP address, the connection is terminated. A new connection is established only to a functional IP address. If the parameter *Ping TimeOut*=0, sending the ping packet to IP addresses is disabled.	ms	0
Post start delay	A delay between receiving StartDT Con response and sending Interrogation Command and/or Counter Interrogation Command in the initialization phase.	ms	0
Pre Reconnect Delay	A delay before connecting or reconnecting (after starting the D2000 KOM process and after communication break-up).	ms	0
Send sequence number	The initial *Send sequence number* after the TCP connection is established. According to the standard, having established the connection the *Send sequence number* is set to 0, other than zero could be appropriate e.g. for testing.	-	0
Smart Redundancy Minimum	The number of values that must be identical in the Smart Redundancy Minimum mode to consider the connections synchronized. The following parameters are taken into account: • I/O tag and station addresses • value • time • flags (A .. H)	-	5
Smart Redundancy Mode	Can be used for TCP Redundant line as an alternative to Ignore Tests=1 or Ignore Control Field 3 bit 0=1. The D2000 KOM process assumes that identical values go via the both connection of the TCP Redundant line in the same order. The D2000 KOM process is attempting to synchronize the connections. If a number of identical values defined by the Smart Redundancy Minimum parameter are received, data are synchronized. After synchronization is done, the value that comes earlier is taken into account, the same value via the other connection is ignored. When the TCP connection is broken or two different values come, the synchronization is broken. Compared to the detection of active/passive partner by means of "*Ignore Tests*"/"*Ignore Control Field 3 bit 0*", an advantage is that after communication failure with the active server, there is no data loss because the communication is still working with the passive partner and the D2000 KOM process is attempting to recover the connection with the active server. Having recovered the connection (if the second connection is working), there are ignored the values which are acquired by the command *General Interrogation*.	-	False

Standby Keep Open	If True, after changing the status of the D2000 Server process (the D2000 KOM process is connected to) from Hot into Standby state (in a redundant system), connection with the IEC104 server will not be closed.	-	False
Standby Set Control Field	If TRUE, after changing the status of the D2000 Server process (the D2000 KOM process is connected to) from Hot to Standby state (in a redundant system), the lowest bit of the 3rd Control Field byte of information APDUs (APDU containing data or commands) will be set to 1 instead of the standard value of 0. The behavior does not strictly follow the standard and we recommend using the *Standby Set Test Bit* parameter instead of this parameter if it is possible.	-	False
Standby Set Test Bit	If True, the *Cause Of Transmission* will have a Test bit set if the D2000 KOM process is connected to the Standby server (in a redundant system) or is a passive instance.	-	False
Standby Write Values	If True, after changing the status of the D2000 Server process (the D2000 KOM process is connected to) from Hot into Standby state (in a redundant system), the new values will be sent to the IEC104 server.	-	False
Station Communication Error	The number of unsuccessful connection attempts after the communication failure after which the station status is changed to St_CommErr. For redundant lines, the communication must be either failed on both TCP connections or only a TCP connection to a passive server is established (see the parameters Ignore Control Field 3 bit 0 and Ignore Tests), i.e. data from such a server are ignored.	-	2
Station Hard Error	The status of all stations on the line is changed into the St_HardErr state if the following conditions are met: • number of unsuccessful connection attempts reaches the value of *Station Hard Error* or higher, • an attempt to restore the communication lasts at least the time defined by the Time filter parameter (maximum value of all stations on the line is taken into account), • for redundant lines, the communication must be either failed for both TCP connections or only a TCP connection to a passive server is established (see the parameters Ignore Control Field 3 bit 0 and Ignore Tests), i.e. data from such a server are ignored.	-	5
Stop Data Confirm Ignored	*Workaround* for the MetsoDNA server error: after connecting to the IEC870-5-104 server from the Metso company, the server sends a StopDT Con U-frame (thereby confirming the end of sending data). If the *Stop Data Confirm Ignored* parameter is True, this frame will be ignored and the communication will continue. Without the *Stop Data Confirm Ignored* parameter set, the connection will be aborted.	-	False
Strict Redundancy Connection Signalisation	Determines behavior, when the protocol is used for TCP Redundant line • if *Strict Redundancy Connection Signalisation*=False, the line is ok (TRUE), if at least 1 connection is working • if *Strict Redundancy Connection Signalisation*=True, the line is in an error state (FALSE), if both connections are working	-	False
Tcp Keep Init	The parameter is implemented for use on OpenVMS platforms only. If it is other than zero, then defines the timeout (in seconds) for opening a new connection to the IEC104 server. For OpenVMS, the default value is 75 seconds, for Windows, it is 20 seconds. When the timeout expires, the connect procedure returns an error.	-	0
Tcp No Delay	Setting *Tcp No Delay* parameter causes low-level socket option TCP_NODELAY to be set, thus turning off the default packet coalesce feature.	-	False
W	The number of received I-frames, after which the D2000 KOM process sends an S-frame confirmation. According to the standard, the default value is 8. The relation W < K must be true, the standard recommends W = 2/3 * K.	-	8
Wait Timeout T1	Timeout for receiving the confirmation of a sent I-frame (either confirmation within the I-frame or the S-frame itself) or a U-frame. If the D2000 KOM process does not receive the confirmation within *Wait Timeout T1* time, it closes the TCP connection. According to the standard, the *Wait Timeout T1* default value is 15000 ms.	ms	15 000
Wait Timeout T2	Timeout for sending the confirmation of a received I-frame. *Wait Timeout T2* < *Wait Timeout T1*. If another I-frame (which confirms the received I-frame) is not sent within *Wait Timeout T2* time since the I-frame was received, the D2000 KOM process sends an S-frame confirming the received I-frame to the partner. According to the standard, the *Wait Timeout T2* default value is 10000 ms.	ms	10 000
Wait Timeout T3	Timeout for sending test frames (TEST ACT U-frame). If no data are sent in any direction for a long time, a TEST ACT U-frame will be sent after the expiration of the *Wait Timeout T3* time by the D2000 KOM process, and a TEST CON U-frame is expected (within *Wait Timeout T1* time after sending). If the *Wait Timeout T3* on the partner side is set to a lower value, it sends the test frames, and the D2000 KOM process replies to them. According to the standard, the *Wait Timeout T2* default value is 20000 ms. Setting the value to 0 disables sending test frames.	ms	20 000
Wait Timeout No answer	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 *Wait Timeout No answer* time interval, the D2000 KOM process waits for receiving the response (e.g. after sending ASDU with TypeIdentificator=45 [Single Command] with CauseOfTransmission=6 [Activation], the receiving of Single Command with CauseOfTransmission=7 [Activation Confirmation] is expected. After the expiration of the *Wait Timeout Tn*, the D2000 KOM process closes the TCP connection.	ms	60 000

Defined parameters, except for *Order of IC*, *Order of Counter IC,* and *Force Slave Time*, are valid for the **entire** line - i.e. it is enough to define them for one station on the line.

TELL commands

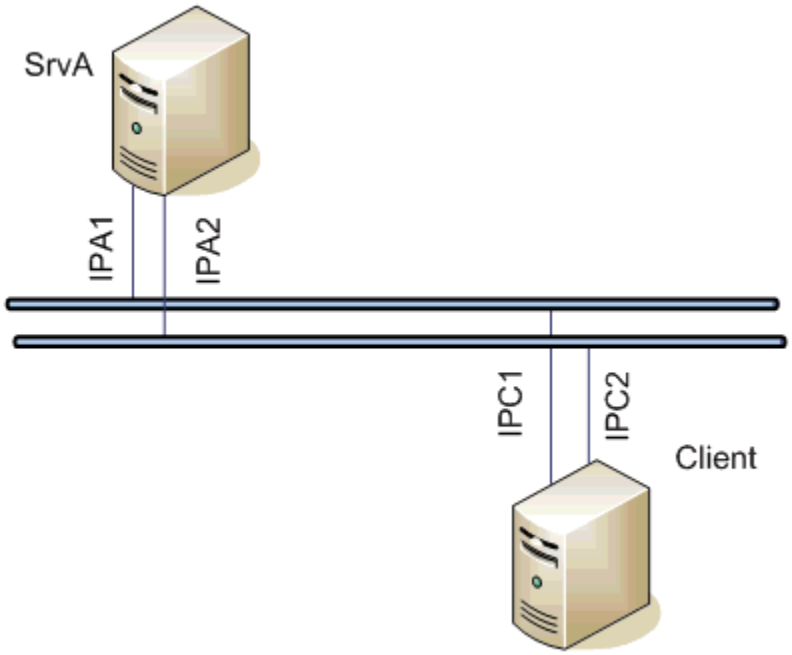
Table 4

Command	Syntax	Description

STCOMMAND	STCOMMAND StationName DISCONNECT	TELL command closes immediately the active TCP connections of the communication line (a parent of "StationName"). Then the connection is restarted and reconnected.
STWATCH	STWATCH StationName	TELL command sends Interrogation Command and/or Counter Interrogation Command to the station (depending on station parameters).

Examples of configurations

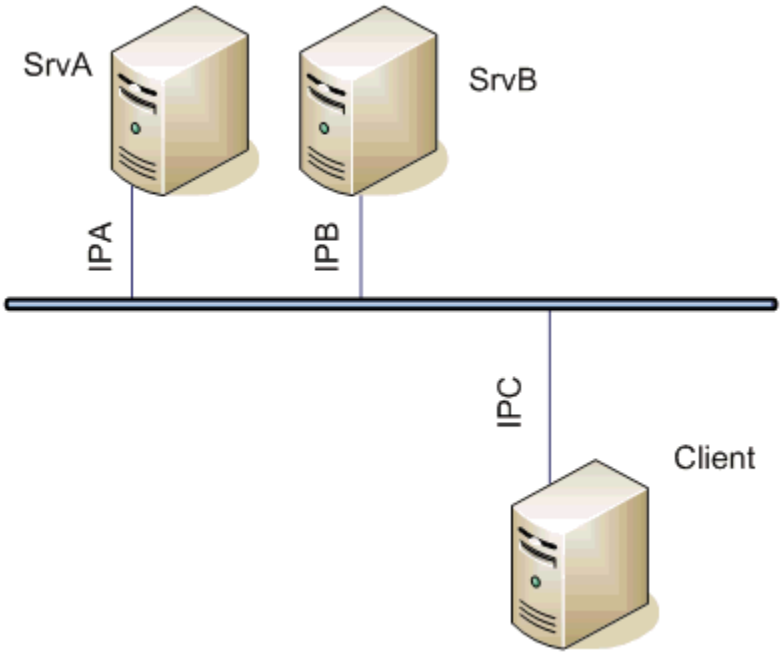
Example 1: Client communicating with the server SrvA on a redundant network.



Server settings	Client settings
• line: TCP/IP-TCP (Host *ALL*, port *2404*) • protocol: IEC 870-5-104 Server • parameters: none	• line: TCP (Host *IPA1, IPA2*, port *2404*) • protocol: IEC 870-5-104 • parameters: none

If a communication segment drops out (e.g. IPA1 failure) the client establishes a connection with the server **SrvA** using the address IPA2.

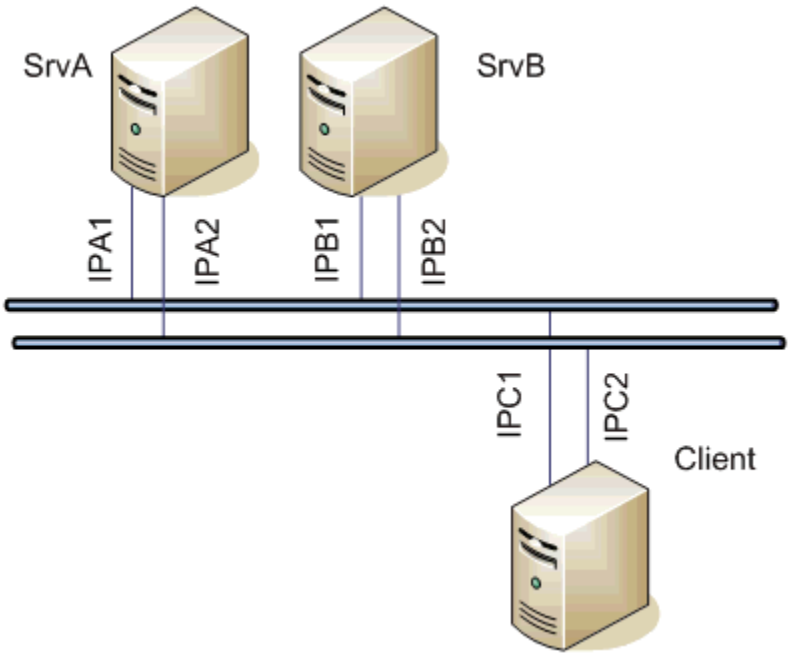
Example 2: Client communicating with the redundant servers SrvA, SrvB.



Servers' settings	Client settings
• line: TCP/IP-TCP (Host *myName* or *ALL*, port *2404*) • protocol: IEC 870-5-104 Server • parameters: SKO=TRUE; SWV=False; SSCF3=True;	• line: TCP/IP-TCP Redundant (Primary host *IPA*, Secondary host *IPB*, both ports *2404*) • protocol: IEC 870-5-104 • parameters: SKO=True;ICF3=True;

The client communicates both with the active and passive server, connection with the passive server continues to be open, but new values are sent by the active server only.
Note: If a symbolic name *myName* is used in the configuration of the IEC104 Server, it should be defined as IPA in the *hosts* file of the 1-st server and as IPB in the *hosts* file of the 2-nd server.

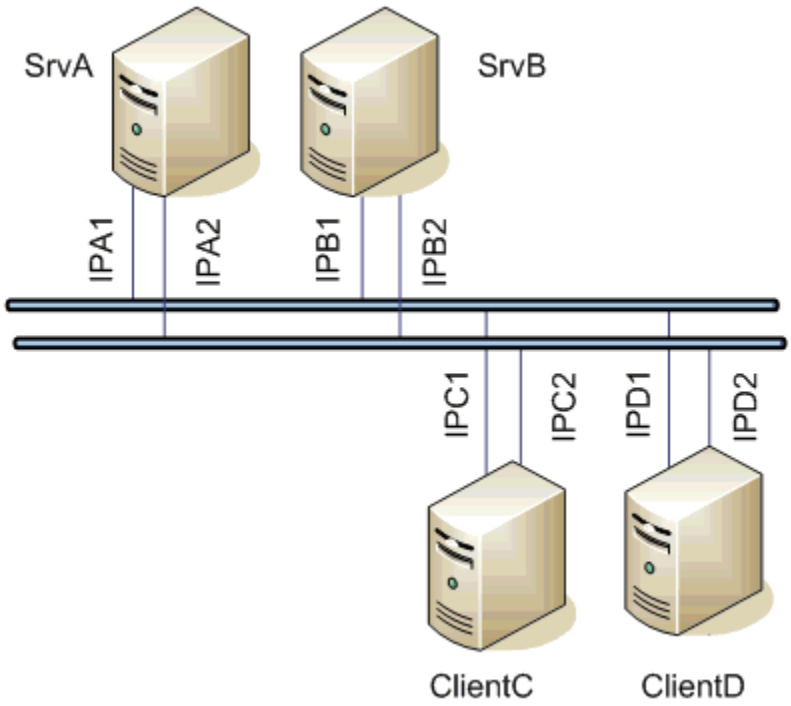
Example 3: Client communicating with the redundant servers SrvA, SrvB on a redundant network.



Servers' settings	Client settings
• line: TCP/IP-TCP (Host *ALL*, port *2404*) • protocol: IEC 870-5-104 Server • parameters: SKO=True; SWV=False; SSCF3=True;	• line: TCP/IP-TCP Redundant (Primary host *IPA1, IPA2*, Secondary host *IPB1, IPB2*, both ports *2404*) • protocol: IEC 870-5-104 • parameters: ICF3=True

The client communicates with both servers. If one network segment drops out (e.g. IPA1 failure), the client establishes a connection with the SrvA server using the IPA2 address.

Example 4: The redundant clients ClientC, ClientD communicating with the redundant servers SrvA, SrvB on a redundant network.



Servers' settings	Clients' settings
• line: TCP/IP-TCP (Host *ALL*, port *2404*) • protocol: IEC 870-5-104 Server • parameters: SKO=True; SWV=False; SSCF3=True;	• line: TCP/IP-TCP Redundant (Primary host *IPA1, IPA2*, Secondary host *IPB1, IPB2*, both ports *2404*) • protocol: IEC870-5-104 • parameters: SKO=True; SWV=False;ICF3=True

The clients communicate with both servers. If one network segment drops out (e.g. IPA1 failure), the clients establish a connection with the SrvA server using the IPA2 address. After switching the active/passive statuses of the ClientC and ClientD clients, they keep communicating with the servers, however, only the active client sends commands. New values are sent by the active server.

I/O tag configuration

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

- I/O tag address is mapped to the *Information object address*, i.e. it has 3 bytes and must be within the range of 0..16777215. It can be specified as a decimal number or as a hexadecimal number with a hash at the beginning (e.g. #0A).
  The I/O tag with an address starting with *%IGNORE* will be ignored.
- Input tags must be of particular types (Ai, Ci, Di, Qi) for received ASDU, see table 1 and also table 2 in the balanced mode.
- For a particular type of output tag (Ao, Dout, Co), it is necessary to set an ASDU type, that has to be used, see table 2.
- Archive for providing historical values: if the client asks for historical values through ASDU 250, the server sends:
  1. the values of the historical value specified by this input entry field,
  2. if the input entry field is not filled, then the values of the historical value that archives the I/O tag,
  3. if the specified historical value does not exist, then the values of the I/O tag that archives the control object of the specified I/O tag,
  4. if the control object does not exist (or the archive is not available), the server returns an error.

  Specification of a historical value allows configuring e.g. sending 10-minutes averages instead of sending all changes of given I/O tag.

- 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).

Literature

Blogs

You can read blogs about the IEC 870-5-104 protocol (for now, in Slovak language only):

- Communication – protocol IEC 104
- Communication – protocol IEC 104, part 2

Document revisions

- Ver. 1.0 – July 30th, 2003
- Ver. 1.1 – November 19th, 2003: extension of supported ASDU, new parameters
- Ver. 1.2 – March 20th, 2004: added ASDU for reading archive data
- Ver. 1.3 – June 20th, 2004: extension - redundancy support
- Ver. 1.4 – December 1st, 2004: extension - support of balanced mode
- Ver. 1.5 - December 12th, 2012 - updating, TELL commands
- Ver. 1.2 – November 16th, 2023 (support for the Destination Column)

Related pages:

Communication protocols