

# IEC 870-5-104 Server

## IEC 870-5-104 Server communication protocol

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### Supported device types and versions

Communication supports reading and writing data by means of the IEC870-5-104 communication protocol operating on the basis of TCP network communication. D2000 system works in the mode IEC 870-5-104 server (slave), that is enable to communicate with N clients (masters). Implementation is according to the standard IEC870-5-104 as follows:

- initial Originator ASDU address is 1 byte, it is defined as line number.
- ASDU address is 2 bytes, it is defined as station address. For each station on one line, there must be defined different ASDU address.
- 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.
- There are implemented the following ASDU types in the direction of logging (from D2000 system to control station and also vice-versa in balanced mode):

Table nr. 1

ASDU type	I/O tag type
1 - Single-point information	Dout
2 - Single-point information with time tag	Dout
3 - Double-point information	Dout,Cout
4 - Double-point information with time tag	Dout,Cout
5 - Step position information	Cout
6 - Step position information with time tag	Cout
7 - Bitstring of 32 bits	Cout
8 - Bitstring of 32 bits with time tag	Cout
9 - Measured value, normalized value	Ao
10 - Measured value, normalized value with time tag	Ao
11 - Measured value, scaled value	Cout
12 - Measured value, scaled value with time tag	Cout
13 - Measured value, short floating point value	Aout
14 - Measured value, short floating point value with time tag	Aout
15 - Integrated totals	Cout
16 - Integrated totals with time tag	Cout
20 - Packed single-point information with status change detection	Cout *
21 - Measured value, normalized value without quality descriptor	Ai
30 - Single-point information with time tag CP56Time2a	Dout
31 - Double-point information with CP56Time2a tag	Dout,Cout
32 - Step position information with CP56Time2a tag	Cout
33 - Bitstring of 32 bits with CP56Time2a tag	Cout
34 - Measured value, normalized value with CP56Time2a tag	Aout
35 - Measured value, scaled value with CP56Time2a tag	Cout
36 - Measured value, short floating point value with time tag CP56Time2a	Aout
37 - Integrated totals with time tag CP56Time2a	Cout
241 - 64-bit floating point value (Ipssoft & URAP implementation)	Ao
243 - 64-bit floating point value with time tag CP56Time2a (Ipssoft & URAP implementation)	Ao

251 - Archive data values (Ipssoft's implementation)	none **
252 - <a href="#">D2000 Unival</a> (Ipssoft's implementation)	all

**Note:** For setting individual bites of the byte that inform us on quality (SIQ for ASDU 1,2,30; DIQ for ASDU 3,4,31; QDS for ASDU 5..14,20,32..36), there are used the flags FLA (0.bit),FLB (1.bit) ..FLH (7.bit).

**For example:**

- for ASDU 4: FLA=DPI bit 0, FLB=DPI bit 1, FLC=0, FLD=0, FLE=BL bit, FLF=SB bit, FLG=NT bit, FLH=IV bit.
- for ASDU 16: FLA..FLE Sequence number bites 0..4, FLF=CY bit, FLG=CA bit, FLH=IV bit

Except the bites, which are set directly by a value (e.g. for ASDU 1, the 0.bit is not set by the flag FLA but by the value of output I/O tag). If there is the attribute *Invalid* is set to a new value, the higher bit (IV) will be set in the status byte of all ASDU (except ASDU 21 not containing it).

\* - *Status* is taken as low 2 bytes, *Status change detection* is taken as high 2 bytes of 32-bit integer.

There are implemented the following ASDU types in the direction of control (from control station to D2000, also the opposite direction in balanced mode):

**Table nr. 2**

ASDU type	I/O tag type
45 - Single command	Di, Qi
46 - Double command	Qi
47 - Regulating step command	Di, Qi
48 - Set point command, normalised value	Ai
49 - Set point command, scaled value	Ci
50 - Set point command, short floating point value	Ai
51 - Bitstring of 32 bit	Ci
58 - Single command with time tag CP56Time2a	Di, Qi
59 - Double command with time tag CP56Time2a	Qi
60 - Regulating step command with time tag CP56Time2a	Di, Qi
61 - Set point command, normalised value with time tag CP56Time2a	Ai
62 - Set point command, scaled value with time tag CP56Time2a	Ci
63 - Set point command, short floating point value with time tag CP56Time2a	Ai
64 - Bitstring of 32 bit with time tag CP56Time2a	Ci
250 - Archive data request command (Ipssoft's implementation)	none **
252 - <a href="#">D2000 Unival</a> (Ipssoft's implementation)	all (except Qi)

Bites of "status" byte (SCO fro ASDU 45,58; DCO for ASDU 46,59; RCO for ASDU 47,60; QOS for ASDU 48..50,61..63) causes setting the flags FLA (0. bit),FLB (1.bit) ..FLH (7.bit) with exception for the bites, which are directly set by the value of a variable ( SCO bit 0, DCO a RCS bity 0-1). After receiving an response (positive/negative), the flags FLA..FLH are set according the bites of "status" byte.

When writing values, the value of 6 [Activation] is waited as CauseOfTransmission. Response of control station depends on the setting of the parameter **C MDC**. *Originator ASDU address* will be used the same as in the received command.

## Establishing connection:

- process [D2000 KOM](#) is waiting on TCP port and, after establishing a connection, is waiting for sending the U-frame StartDT Act from the client. It is waiting for StartDT Con as a response (it is possible to send TestFrame before StartDT Act)
- if the parameter [EOI](#) is set for the process [D2000 KOM](#), there is sent ASDU 70 [End of initialization], the initial address (set a line number) is used as *Originator ASDU address*
- if the parameter **Synchronisation period** (the tab **Time parameters**) for some station is different from 0, ASDU 103 [Clock synchronisation command] with CauseOfTransmission= 6 [Activation] is sending in given period. The initial address (set as line number) or Originator ASDU of the last received ASDU 1000 or 101 is used as *Originator ASDU address*.
- process [D2000 KOM](#) sends new values acquired from the process [D2000 Server](#) for variables with ASDU 1..14, 20, 21, 30 .. 36 to a client, which sent ASDU 100 [Interrogation Command] and new values for variables with ASDU 15,16,37 to a client, which sent ASDU 101 [Counter Interrogation Command]
- process [D2000 KOM](#) accepts time synchronisation using ASDU of 103 type [Clock synchronisation command] with CauseOfTransmission=6 [Activation] or 3 [Spontaneous]. If CauseOfTransmission= 6, it responds in dependence on setting the parameter **C MDC**, if CauseOfTransmission= 3, it does nOt response.
- process [D2000 KOM](#) responses to received commands (ASDU 45..51, 58..64) with CauseOfTransmission= 6 [Activation] in dependence on setting the parameter **C MDC**.

**Originator ASDU address (OA):** initial OA is set as TCP line number in the configuration. The address will be used for optimum sending the ASDU 70 [End of initialization] at the beginning of connection and always when sending new values.

After receiving ASDU 100 or 101, there are sent current values of all output I/O tags (with no attribute *Invalid* set) with the same OA as contained in ASDU 100 or 101.

As responses to received commands (ASDU 45..51, 58..64), there are sent confirmations with the same ASDU as contained in the received command.

D2000 system also supports the **balanced mode**. In the mode, the task of controlled and control stations is changed. That time, D2000 system sends commands and ASDU 100/101. The balanced mode may be used only when is supported by partner station. An advantage is that D2000 system sends ASDU 100 [Interrogation Command] a 101 [Counter Interrogation Command] and gets the status of output I/O tags (configured as ASDU 1-40) after disconnection and re-establishing the connection. It is suitable to configure single-shot commands as ASDU 45 - 64; they are not repeated after re-establishing the connection.

Writing an output I/O tag:

When writing IEC 104 values (ASDU 1-40), there are valid the rules of [server protocols](#).

When writing IEC 104 values (ASDU 45-64) in the balanced mode, ASDU is considered to be confirmed (away from the state *Transient*) in dependence on the parameter [CMDC](#). If the connection to a client is lost when writing, the writing success depends on the parameter [PW](#).

## Communication line configuration

- Communication line category: [TCP/IP-TCP](#)
- TCP Parameters
  - Required to define the server parameters
  - Host: string containing at most 80 characters – name of the network interface in form of INET (name or numerical address a.b.c.d, e.g. 192.168.0.1) using of which the process [D2000 KOM](#) will receive clients. If the name is *ALL*, the process [D2000 KOM](#) will wait on all network interfaces of the computer, where is running.
  - Port: TCP port number (0..65535), where the process [D2000 KOM](#) is waiting.
  - Line number: will be used as Originator ASDU address (1 byte, 0-255).

**Note:** Starting from D2000 version 7.02.004 [the flags](#) FLA to FLP are used during setting of [the value of communication line](#) to inform about connected active clients. Active client is a client who after establishing the connection sent U-frame StartDT Act, i.e. asked for sending the data. The first connected active client will cause change of flag FLA to TRUE, the second flag FLB etc upto flag FLP and continuing with the flag FLA. If the client sends U-frame StopDT Act (requesting the server to stop sending data) or disconnects, the value of its flag will be changed to FALSE.

## Communication station configuration

- Communication protocol: [IEC870-TCP Server](#).
- Station address is a decimal number within the range 0...65535, defines the ASDU address.

**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 +](#)).

## Station protocol parameters

The following parameters can be defined as station protocol parameters:

Table nr. 3

Keyword	Full name	Meaning	Unit	Default value
CMDC	Command Confirm	Confirmation of control ASDU. If CMDC=0, the process <a href="#">D2000 KOM</a> does not confirm any control ASDU from the partner station using backward sending ASDU with other CauseOfTransmission. If CMDC=1, the process <a href="#">D2000 KOM</a> confirms control ASDU with CauseOfTransmission=7 (Activation Confirmation). If CMDC=2, the process <a href="#">D2000 KOM</a> confirms control ASDU with CauseOfTransmission=10 (Activation Termination). If CMDC=3, the process <a href="#">D2000 KOM</a> confirms control ASDU with CauseOfTransmission=7 and CauseOfTransmission=10.	-	1
<a href="#">D2CLS</a> <a href="#">D2CPA</a> <a href="#">D2VCO</a>	The parameters are intended for configuration of communication station for communication between two D2000 systems with using ASDU 252 - D2000 Unival (Ipsosoft's implementation). <a href="#">more ...</a>			
D2H64	D2000 64-bit Historical Values	When sending the historical values (as an answer to <a href="#">request</a> for historical data), it uses ASDU 249, which uses 64-bit representation of floating points (the same as D2000 internally), instead of ASDU 251 (which encodes the values as 32-bit floating points) to improve precision. <b>Note:</b> Before enabling this parameter, you should verify that also the client supports ASDU 249. This support was implemented in November, 2011 for D2000 v8.00.011.	-	False
DBGI	Debug Input	A mask for debug levels of input data. The meaning of bits is as follows: <ul style="list-style-type: none"><li>• 1.bit - displays a number of incoming values during General Interrogation</li><li>• 2.bit - displays all incoming values</li><li>• 3.bit - balanced mode: requesting Interrogation command was received</li></ul>	-	0

DBGO	Debug Output	<p>A mask for debug levels of output data. The meaning of bits is as follows:</p> <ul style="list-style-type: none"> <li>1.bit - balanced mode: displays a number of outgoing values during General Interrogation</li> <li>2.bit - displays all outgoing values</li> </ul>	-	0
EOI	End of initialization	If EOI=0, the process <b>D2000 KOM</b> doesn't send ASDU 70 (End of initialisation). If EOI=1 and a client sends U-frame StartDT Act, the process <b>D2000 KOM</b> responses StartDT Con and sends ASDU.	-	0
GISN	GI Send New	If GISN=True, then the process <b>D2000 KOM</b> after receiving the command General Interrogation sends also values with more recent times than is the time when the command is received. The value of the parameter GISN must be True to send values with more recent times using the command General Interrogation.	-	False
ICF3	Ignore Control Field 3bit 0	<p>Determines behaviour, if ASDU contains Control Field (Receive set bit 1 (test)) in 3. byte.</p> <ul style="list-style-type: none"> <li>if ICF3=False (default), ASDU content is to be processed</li> <li>if ICF3=True, ASDU content is to be ignored</li> </ul> <p>The feature is usable when creating a redundant TCP connection (TCP Redundant line + IEC 870-5-104 protocol). It is enough to provide, that active (hot) client sends ASDU without the Test bite set and passive (standby) client sends ASDU with the Test bite set.</p>	-	False
III	Ignore Invalids on Interrogation	if this parameter is set on a station, the process <b>D2000 KOM</b> 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. Parameter can be used e.g. when controlling, if sending Invalid values causes breakdown of control.	-	False
IT	Ignore Tests	<p>Determines behaviour, if ASDU contains 1 bite (test) set in CauseOfTransmission.</p> <ul style="list-style-type: none"> <li>if IT=0 (default), ASDU content will be processed</li> <li>if IT=1, ASDU content will be ignored</li> <li>if IT=2, there will be set weak attribute</li> </ul> <p>The feature is usable when creating a redundant TCP connection. It is enough to provide, that active (hot) client sends ASDU without the Test bite set and passive (standby) client sends ASDU with the Test bite set.</p>	-	0
IUA	Ignore Unknown Addresses	If IUA=TRUE, the process <b>D2000 KOM</b> 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
II	Implicit Interrogation	Balanced mode: After connecting the client, there are automatically sent the values of all variables without ASDU 100 and 101 [Interrogation /Counter Interrogation Command] requests.	-	False
ICCI	Interrogation Covers Counter Interrogation	As a reply to Interrogation, there are also sending ASDU 15,16,37 (Integrated Totals), which are by default requested by ASDU 101 [Counter Interrogation].	-	False
IGO	Interrogation Groups Objects	Optimisation of sending values during General Interrogation (answer to Interrogation Command / Counter Interrogation Command). If IGO=True, multiple values will be sent inside a single ASDU (so that the length of ASDU is within maximum defined by standard - 253 Bytes). This parameter does not influence change-based sending of values during normal communication.	-	False
IWOT	Interrogation Without Timestamps	<p>If IWOT=True then values sent as a response to ASDU 100 [Interrogation Command] 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.</p> <p>This behaviour is suitable in situation when the values have been invalidated as a result of communication error and after the communication is re-established the values come with old timestamps which causes problems in archive (if the values change only rarely, calculated archives depending on them will be also invalid till a new value arrives).</p>	-	False
K	K	Sending window size i.e. packet quantity, which is sent by the process <b>D2000 KOM</b> without receiving a confirmation (S-frame or I-frame). According to the standard, the default value is 12.	-	12
MC	Maximum Clients	Maximum number of connected clients. Parameter is needed for D2000 OpenVMS, where a task pool containing 2 * MC tasks for client handling (one task for receiving data, one task for sending data) is created during KOM startup. If a value of parameter Maximum Clients is equal to 0, number of clients is not limited and threads are created dynamically as needed.	-	0
NF	No Flags	If the value of the parameter is True, then the status bit of incoming ASDUs is ignored and not saved into the flags FA...FH. Flags of output I/O tags are also ignored and they not set the status bit.	-	False
OIC	Order of IC	Balanced mode: Sending sequence of ASDU 100 [Interrogation Command] when initializing the connection. If OIC<OCIC, then ASDU 100 is sending before ASDU 101. If OIC= 0, ASDU 100 is not sending. The parameter can be defined and valid specially for each of the stations.	-	0
OCIC	Order of Counter IC	Balanced mode: Sending sequence of ASDU 101 [Counter Interrogation Command] when initializing the connection. If OIC<OCIC, then ASDU 101 is sending before ASDU 100. If OIC= 0, ASDU 101 is not sending. The parameter can be defined and valid specially for each of the stations.	-	0
PW	Pessimistic Write	Defines the evaluation of writing success in case of connection of more than one client. If PW=0, writing a value is consider to be successful, if at least one client confirms it (confirmation method is defined by the parameter <b>CMDC</b> ). If PW= 1, writing must be confirmed by all connected clients. If at least one client doesn't confirm it (e.g. connection failure occurs or the confirmation is negative), writing is consider to be unsuccessful.	-	0
SSN	Send sequence number	Initial SSN. According to the standard, having established the connection the SSN is set to 0, other than zero could be appropriate e.g. for testing.	-	0
SKO	Standby Keep Open	If True - after transition of the process <b>D2000 Server</b> , the process <b>D2000 KOM</b> is connected to, from the HOT status to the STANDBY status (redundant system), connections with clients will not be closed and receiving the clients will not be terminated.	-	False
SSCF3	Standby Set Control Field	If True, - after transition of the process <b>D2000 Server</b> , the process <b>D2000 KOM</b> is connected to, from the HOT status to the STANDBY status (redundant system), there will be sent the value of 1 in the lowest bite of 3.byte of Control Field of Information APDU (APDU containing data) instead the standard value of 0 (according to the standard). The behaviour doesn't strictly follow the standard and if possible, use the parameter SST instead of this.	-	False
SSTB	Standby Set Test Bit	If True - after transition of the process <b>D2000 Server</b> , the process <b>D2000 KOM</b> is connected to, from the HOT status to the STANDBY status (redundant system), there will be sent Test bit set in Cause Of Transmission.	-	False

SWV	Standby Write Values	If True - after transition of the process <a href="#">D2000 Server</a> , the process <a href="#">D2000 KOM</a> is connected to, from the HOT status to the STANDBY status (redundant system), the server will send new values to clients.	-	False
W	W	Quantity of received packets, after which the process <a href="#">D2000 KOM</a> sends a S-frame confirmation. According to the standard, the default value is 8. There must be true $w < k$ , the standard recommends $w = 2/3 * k$ .	-	8
WT1	Wait Timeout T1	Timeout for receiving the confirmation of a I-frame sent (either the confirmation within the I-frame or the S-frame itself) or a U-frame. If the process <a href="#">D2000 KOM</a> doesn't get the confirmation in the time WT1, it closes the TCP connection. According to the standard, the WT1 default value is 15000 ms.	ms	15 000
WT2	Wait Timeout T2	Timeout for sending the confirmation of a I-frame received. $WT2 < WT1$ . If another I-frame (which confirms the I-frame received) is not sent in the time WT2 since the I-frame was received, so the process <a href="#">D2000 KOM</a> sends a S-frame confirming the received I-frame to the partner. According to the standard, the WT2 default value is 10000 ms.	ms	10 000
WT3	Wait Timeout T3	Timeout for sending test frames (U-frame TEST ACT). If no data are sent in any direction for a long time, an U-frame TEST ACT will be sent to the process <a href="#">D2000 KOM</a> after expiration of the WT3 time and there is expected (in the WT1 time after sending) receiving a U-frame TEST CON. If the WT3 on the partner side is set to a lower value, it sends the test frames and the process <a href="#">D2000 KOM</a> replies to them. According to the standard, the WT2 default value is 20000 ms. Setting the value to 0 disables sending test frames.	ms	20 000
WTn	Wait Timeout No answer	Balanced mode: Timeout for receiving the confirmation of a sent value for ASDU in the direction of control (ASDU 45 - 64). Receiving e.g. S-frame with RSN (Receive Sequence Number) confirming, that the other party received previous I-frame doesn't mean, that the I-frame was processed. In the WTn time, the process <a href="#">D2000 KOM</a> waits for receiving the response (e.g. after sending ASDU with TypeIdentifier=45 [Single Command] with CauseOfTransmission=6 [Activation] there is expected receiving Single Command with CauseOfTransmission=7 [Activation Confirmation]. After the expiration of the WTn time, the process <a href="#">D2000 KOM</a> closes the TCP connection.	ms	60 000

String containing the protocol parameters is being defined as follows:

Keyword=value;Keyword=value; ...

Example:

WTn=10000;WT3=25000;OCIC=0;

If there is used a keyword with an invalid value in the initialization string, there will be used corresponding default value according the table. Defined parameters, except for OIC, OCIC and FST are valid for the **entire** line - i.e. it is enough to define them for one station on the line.

## I/O tag configuration

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

- I/O tag address is mapped on Information object address, i.e. it has 3 bytes and must within the range of 0..16777215.
- Input tags must be particular types (Ai, Ci, Di, Qi) for received ASDU, see the [table 1](#).
- For particular type of output tag (Ao, Dout, Co) it is necessary to set an ASDU type, that has to be used, see the [table 2](#) and also the [table 1](#) in the balanced mode.
- Archive for providing old values: if client requires archive values using [ASDU 250](#), the server sends:
  - values of archived I/O tag, which are defined in this entry field
  - if the entry field is not defined, values of archived I/O tag, that are directly archived by the I/O tag
  - if the archived I/O tag does not exist, values of the I/O tag, that is archived by the control object of the I/O tag
  - if the object doesn't exist (or the archive is not available), the server returns an error.

Definition of an I/O tag allows e.g. to set sending 10-minute averages instead of sending all changes of the I/O tag.

## Literature

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## Document revisions

- Ver. 1.0 – 5.2.2004
- Ver. 1.1 – December 1st 2004: extension - support of balanced mode



**Related pages:**

[Communication protocols](#)