IEC 60870-6 ICCP/TASE.2

IEC 60870-6 ICCP/TASE.2 communication protocol

Description

IEC 60870 part 6 belongs to the IEC 60870 set of standards that are used for remote control, monitoring and telemetry in both the telecommunication networks of electric (power) systems and the applications for control of energy centers. IEC 60870-6 standard is based on the functional-profile theory. A description of the functional profiles, their classification and defining is taken from IEC 60870-6-1.

A profile for the Telecontrol Application Service Element 2 (TASE.2) is known as ICCP - Inter-Control Centre Communications Protocol. TASE.2 in application layer is defined in the IEC 60870-6-503 standard. This standard defines the protocol of application layer so that it accomplish the requirements for functional cooperation. It also defines the requirements for both the presentation and relation layers that provides TASE.2.

TASE.2 protocol is based on MMS (Manufacturing Message Specification). The basic functions of ICCP are specified as set of so-called "Conformance Blocks".

In D2000 System, ICCP protocol supports the functions of block 1 and 2:

1. Periodic System Data: Status points, analogue points, quality flags, time stamp, change of value counter. Association objects to control ICCP sessions.
2. Extended Data Set Condition Monitoring: Provides report by exception capability for the data types that block 1 is able to transfer periodically.

There is implemented a transmission layer ISO over TCP/IP according to RFC 1006 specification.

Communication line configuration

- Communication line category: TCP/IP-TCP
- TCP Parameters:
  - Host: string max. 80 characters – server name in INET format (a name or numerical address a.b.c.d) or the text "ALL"
  - Port: TCP port number (0 to 65535), port 102 is used by default.
  - Line number: not used, set 1

If ICCP connection is initiate by D2000 (the address parameter Initiate), you must enter a valid host name of ICCP server according to above mentioned rules. If, on the contrary, D2000 accepts the received request for ICCP connection, you must enter the text "ALL" to *Host* field. It means, D2000 System will listen on all interfaces that belongs to the particular server (with running D2000 KOM). If the listening is required only on the particular interface, enter the IP address of this server interface in INET format.

If D2000 System initiate this connection (the address parameter Initiate), you must also enter the port number on which a target ICCP server listens. The protocol ISO over TCP/IP uses the port 102. If D2000 System only accepts the incoming connections, the port number is not used (enter for example 1). The number of bound TCP port is defined by the line protocol parameter "Bind TCP port". This feature enables the operation of ICCP protocol as a client and server simultaneously.

For redundant systems, user may set more names/addresses separated by comma. When the connection has failed, the communication process tries to reconnect to the server on the given address. If it failed again, the process tries to establish the connection with the next address. It repeats this action cyclically until it establishes the connection with one of the servers.

Communication line protocol parameters

Communication lines - configuration dialog box - tab **Protocol parameters**.
These parameters influence some optional parameters of protocol. You can define the following parameters:

Table 1

Parameter	Meaning	Unit	Default value
Bilateral Table ID	Name of the bilateral table. The basic data for identification of connection between centers.	-	
Max MMS Message Size	Maximum size of MMS messages.	bytes	32000

Max Requests Pending	Maximum proposed transactions that could be sent and unacknowledged. The value can be reduced if a co-center suggests lower value at negotiation.	1 .. 32	5
Max Indications Pending	Maximum proposed transactions that could be received without sending an acknowledge. The value is sent to a partner.	1 .. 32	5
Max Nesting Level	Maximum level of nesting for MMS data structures.	1 .. 10	5
Bind TCP Port	TCP port number where KOM process accepts the incoming requests for connection from the external centers. If the value is 0, KOM process does not accept external requests for connection.	0 .. 65535	102
ISO TPDU Size	The maximum packet size for "ISO over TCP" protocol level (according to RFC 1006)	8192/4096 /2048 /1024/512 /256/128 bytes	1024 bytes
Heartbeat	Timer, which permits the sending ICCP message I*dentify request* to *Remote control center* to find out the validity of TCP/IP connection. To enable the timer a nonzero value must be specified. If the connection was aborted on TCP/IP level, the fast detection ensures its faster restoring. This parameter is recommended in situations when transmitting data via large networks, when the less data are transmitted via the active connection or there are high timeouts for transmission of Reports (e.g. value of Interval parameter). The value 0 (implicit) turns out *HeartBeat timer*. Other positive values means the seconds to send Heartbeat message. If any message is sent, the Heartbeat timer is reset and Heartbeat message is sent only after timeout elapses without any communication between partners.	sec	0
Retry Delay	Delay inserted before repeated attempt to establish the connection after it has been broken (if D2000 System activated this connection). If the connection should be restored as fast as possible, set the low value or 0 seconds.	sec	10 sec
Inter Read Timeout	Maximum waiting time to receive TCP data. After this timeout elapses, the possible requirements (data) for sending to a partner center are checked. As the communication with the partner center is executed via one thread, the high value can reduce speed of interaction between centers. The recommended value is 50 to 150 milliseconds.	msec	100 msec
Supported Features	Hexadeciml number (0000-80FF) defining a bitmask for declaration of supported protocol functionality, which is divided into blocks (Conformance Blocks). Default value of 00C0 (binary 1100_0000 i.e support for blocks 1 and 2). Bits are numbered from lowest (1st bit) to highest (8th bit). • **Lower byte** • 8.bit - block 1 - Basic Services • 7.bit - block 2 - Extended Data Set Condition Monitoring • 6.bit - block 3 - Blocked Transfers • 5.bit - block 4 - Information Message • 4.bit - block 5 - Device Control • 3.bit - block 6 - Programs • 2.bit - block 7 - Events • 1.bit - block 8 - Accounts • **Higher byte** • 8.bit - block 9 - Time Series • 7-1.bit - unused A specific client (SISCO AX-S4 ICCP) required setting the parameter to value D8 (i.e. support of blocks 1,2,4,5) - otherwise it closed the connection.	-	00C0
Read Mode	A mode of reading values of I/O tags for *Remote Control Center* station: • **Subscribe**: on-change reading of values by defining a list of variables (message DefineNamedVariableList-Request) followed by sending of changed values (message InformationReport) • **Read**: perioding polling of values of all variables. Time parameters (periode/delay) are defined on a station Optimal mode of reading values is *Subscribe*, usage of *Read* is recommended only in case of communication problems with *Subscribe*. Periodic polling burdens both communicating parties.	Subscribe /Read	Subscribe
Map ICCP flags	The way ICCP flags are mapped into D2000 flags FA..FH. ICCP protocol has following quality flags mapped into 8 bits of Quality attribute: • unused [8.bit] * • unused [7.bit] * • Validity_hi [6.bit] • Validity_lo [5.bit] • CurrentSource_hi [4.bit] • CurrentSource_lo [3.bit] • NormalValue [2.bit] • TimeStampQuality [1.bit] Note (*): in case of state values (State, StateQ, StateQTimeTag and StateExtended) the highest 2 bits are used to encode a state value (State_hi [8.bit] and State_lo [7.bit]). Mapping can be: • *None* - flags FA .. FH are not set • *Simple* - Quality attribute directly maps to flags FA .. FH • *Sinaut* - a mapping compatible with Sinaut Spectrum system. The *Sinaut* mapping is based on following ICCP flags: • *Validity*: can have values VALID (0), HELD (1), SUSPECT (2), NOTVALID (3) • *CurrentSource*: can have values TELEMETERED (0), CALCULATED (1), ENTERED(2), ESTIMATED (3)	None / Simple / Sinaut	None

Validity \ CurrentSource	TELEMETERED (0)	CALCULATED (1)	ENTERED (2)	ESTIMATED (3)
VALID (0)	Actual (FA)	Calcul (FB)	Manual (FC)	Calcul (FB)
HELD (1)	Blocked (FD)	BlCalcul (FE)	BlManual (FF)	BlCalcul (FE)
SUSPECT (2)	Suspect (FG)	Suspect (FG)	Suspect (FG)	Suspect (FG)
NOTVALID (3)	NotValid (FH)	NotValid (FH)	NotValid (FH)	NotValid (FH)

Note 1: after the change of this parameter we recommend a restart of KOM process or communication partner so that all values come into the system with properly set flags.
Note 2: unlike None/Simple mappings, the Sinaut mapping does not change the attribute VLD, only the FH flag.

Debug I/O binary packets info	Enables debug information on the level of binary packets. See Note 1.	YES/NO	NO
Debug ISO packet level info	Enables debug information on ISO OSI layer. See Note 1.	YES/NO	NO
Debug MMS level info	Enables debug information on MMS data level. See Note 1.	YES/NO	NO
Full TASE2 level info	Enables debug information on the top level of TASE.2 data. See Note 1.	YES/NOO	NO
Incoming values info	Enables a detail debug information about incoming values (data values). See Note 1.	YES/NO	NO
Outgoing values info	Enables a detail debug information about outgoing values (data values). See Note 1.	YES/NO	NO

Note 1

If all debug info are enabled, it could cause an overload of communication workstation and decrease of data transfer rate between the centers. After setting and debugging the communication we recommend you minimize the amount of debug information.

Communication station configuration

- Communication protocol "**IEC 60870-6 ICCP/TASE.2**".
- Polling parameters are not used.
- Protocol does not support time synchronization between the control centers.

Station address

Img. No. 1, Station address

Station address configuration (in ICCP terminology - Control Centre) requires to set the following data:

- **Control Center type**
    - **Local Control Center (LCC)**
      In LCC, there are only data values that are transmitted to the partner centers. It means, that only the output I/O tags (Ao, Co, Dout) are relevant for this station. If the I/O tag value is changed, by the control objects, data are then published outward of D2000 System. In the opposite direction - to LCC, the values can be transmitted by the commands. These objects could be the input values (Ai, Ci, Di, Qi). Exactly one station of LCC type must be configured on the line.
    - **Remote Control Center (RCC)**
      In RCC, there are only data values that are transmitted form the partner centers to D2000 System. It means, that only the input I/O tag values (Ai, Ci, Di, Qi) are relevant for this station. The values of output I/O tags are transmitted as commands via RCC from D2000 System.
      One or more stations of RCC type can be configured on the line.
- **Domain**
    - For LCC - **Local Domain**
      It is a domain name that executes *Local Control Center* for the remote client (center). The text string is max. 32 characters. It consists of alphanumeric characters ("a…z", "A…Z", and "0…9"), underscore ("_") or dollar sign ("$"). The first sign must be a letter.
    - For RCC - **Remote Domain**
      It is a domain name that executes *Remote Control Center* for a local client (D2000). The text string is max. 32 characters. It consists of alphanumeric characters ("a…z", "A…Z", and "0…9"), underscore ("_") or dollar sign ("$"). The first sign must be a letter.

  The **Browse** button, which is enabled only for RCC, enables (if a KOM process is running and if a communication is established) to obtain a list of domains from a remote control center. For browsing functionality to work, the remote control centre must support handling of getNameList request with parameter ObjectClass=DOMAIN.

- **Remote Control Centre Parameters**
  Permitted only for *RCC*.
    - **Initiate**
      It enables an active initiation of TCP connection to the remote control center. It means, D2000 System initiates this connection.

- **Role**
  The parameter *Service Role* belongs to *Bilateral Table Agreement*. It indicates the ICCP activity that is required for *Remote Control Center* - Client, Server, or Client & Server. The value is set according to an agreement with the partner local center. Usually, when enabling the parameter *Initiate*, you should set a pro-active communication, i.e. *Client* or *Client & Server* value.
  If the *Initiate* parameter is on, a handler task is created for every RCC with *Client* or *Client & Server* role and connects to the ICCP server according to the line configuration.
  If the *Initiate* parameter is off, the KOM process is waiting for ICCP client to connect, and according to the station's protocol parameters (TSEL, SSEL, PSEL, AP Title, AE Qualifier) is matching an ICCP client to a RCC with *Server* or *Client & Server* roles.

Station protocol parameters

Communication station - configuration dialog box - tab **Protocol parameters**.
These parameters influence some optional parameters of protocol. You can set the following station parameters:

Table 2

Object group	Parameter	Meaning	Unit / size	Default value
Address parameters	TSEL (hex)	Octet string that represents the Transport Selector. It identifies the Transport SAP. The maximum size is 32 octets (64 ASCII encoded hexadecimal digits).	octet string	00 01
	SSEL (hex)	Octet string that represents the Session Selector. It identifies the Session SAP. The maximum size is 16 octets (32 ASCII encoded hexadecimal digits).	octet string	00 01
	PSEL (hex)	Octet string that represents the Presentation Selector. It identifies the Presentation SAP. The maximum size is 16 octets (32 ASCII encoded hexadecimal digits).	octet string	00 00 00 01
	AP Title	Application Process Title is an identifier that is assigned by an address manager. It represents a specific application process.	string	1.3.9999.1
	AE Qualifier	Integer value used to identify the local Application Entity.	string	1
Data Set parameters (only for *RCC*)	Data Set Name	Data Set (DS) name. Data set is a group of all I/O tags, i.e. data values, which are configured on RCC station. You can create only one data set within the RCC station.	string	
	Transfer Set Name in Inf. Report	It enables the transmission of DS Name in each message with Information report. The reserved MMS object name is "Transfer_Set_Name".	YES /NO	YES
	Transfer Set Time Stamp in Inf. Report	It enables the transmission of DS Time Stamp in each message with data Information report. A time stamp is a time, when the Information report was generated. The reserved MMS object name is "Transfer_Set_Time_Stamp".	YES /NO	YES
	DS Conditions Detected in Inf. Report	It enables the transmission of conditions of data report creation in each Information report. The reserved MMS object name is "DS_Conditions_Detected".	YES /NO	YES
Data Set Transfer Set parameters (only for *RCC*)	Start Time	Time parameter for TASE.2 server that defines a delay of data monitoring. If Start Time is 0, then TASE.2 server starts the data monitoring immediately.	sec	0
	Interval	Required time interval between Data Set Transfer Reports. The Interval starts after Start Time. If RBE is set on NO, the current status of all objects in data set is sent every time after "Interval". If RBE = YES, the current status of objects, which were changed since the last sending the Data Set Transfer Report, is sent. If one object was changed several times during the "Interval", only the last value is sent. See Note 2.	sec	10
	TLE	Time Limit for Execution (in seconds). It is used for TASE.2 server. It is a timeout during which TASE.2 server tries to send Data Set Transfer Report TASE.2 to a client. If TASE.2 server founds out that it cannot send Data Set Transfer Report TASE.2 to the client till TLE timeout, it could remove these data. It means, the client cannot receive data older then TLE. If the problem is the communication line, the connection probably breaks up and must be restored. There is no reason to decrease this timeout under limit of 60 seconds in TCP/IP communication.	sec	60
	Buffer Time	Time interval for data buffering if "ObjectChange condition" occurs before sending them to TASE.2 client. Buffer Time starts when the first condition "ObjectChange condition" occurs. If RBE = NO, the current status of all objects in Data Set is sent after "Buffer Time". If RBE = YES, the values of objects, which were changed till the expiration of "Buffer Time", are sent. If "Buffer Time" is 0, the report is generated for each value change. If one object was changed several times during the "Buffer Time", only the last value is sent. Warning: When the parameter "Buffer Time" is 0 seconds, it can cause the overload of system or communication line because of the large number of messages (reports). See Note 2.	sec	2
	Integrity Timeout	Time interval for "integrity check", if "DS Conditions - Integrity Timeout" and RBE are set on YES. See Note 2.	sec	30
	DS Conditions - Interval Timeout	Enables TASE.2 server to send reports after elapsing the "Interval". See Note 2.	YES /NO	YES

	DS Conditions - Integrity Timeout	Enables TASE.2 server to send a complete Data Set of all objects after elapsing "Integrity Timeout". It is relevant only if RBE is set on YES. See Note 2.		YES /NO	YES
	DS Conditions - Object Change	Enables TASE.2 server to send the report after the value of any object has changed in Data Set. It involves the change of value, status or quality flags. See Note 2.		YES /NO	YES
	DS Conditions - Operator Request	Enables TASE.2 server to send the report when an operator on TASE.2 server control center sends a request.		YES /NO	NO
	DS Conditions - External Event	Enables TASE.2 server to send the report, if an external incident occurs.		YES /NO	NO
	Critical	Control type of Transfer Report. The setting on YES means that Transfer Report is critical and needs an acknowledgement from TASE.2 client back to TASE.2 server.		YES /NO	NO
	RBE	A flag that controls the mechanism of "Report By Exception". See Note 2.		YES /NO	YES
Interpretation of quaternary values	QERR Value	Interpretation of Quaternary value Error from the received integer value or from 2-bit State value.		0, 1, 2, 3	3 (11 binary)
	QOFF Value	Interpretation of Quaternary value Off from the received integer value or from 2-bit State value.		0, 1, 2, 3	2 (10 binary)
	QON Value	Interpretation of Quaternary value On from the received integer value or from 2-bit State value.		0, 1, 2, 3	1 (01 binary)
	QTRANS Value	Interpretation of Quaternary value Transient/Moving from the received integer value or from 2-bit State value.		0, 1, 2, 3	0 (00 binary)

Note 1

The identification of incoming client is executed according to all address parameters, i.e. TSEL, SSEL, PSEL, AP Title and AE Qualifier. If the connected ICCP client provides different address parameters which do not match parameters configured on any RCC-type station configured in D2000 system, the connection is rejected.

Note 2

So many parameters needed for setting the "Data Set Transfer Set" can seem complicated. To set RBE (Report By Exception) parameter (i.e. the functionality of "Conformance Block" No. 2, "Extended Data Set Condition Monitoring") is, however, very important.

1. RBE = **NO**
   Report All object values from Data Set are sent in each Report. After elapsing the "Start Time", the Reports are sent with a period "Interval". The parameter "DS Conditions - Interval Timeout" must be enabled.
2. RBE = **YES**
   More effective data transmission. Only the changed values are transmitted. After elapsing the "Start Time" timeout, a complete Report with all object values of Data Set are sent. Thereafter Report is sent after elapsing the "Buffer Time", which contains only changed object values of Data Set. Report with all object values of Data Set is sent with period "Integrity Timeout". The parameters "DS Conditions - Integrity Timeout", "DS Conditions - Object Change" must be enabled. The parameter "DS Conditions - Interval Timeout" must be set on NO.

I/O tag configuration

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

I/O address

mg. No. 2, I/O tag address (Data Value)

The configuration of Data Values (according to ICCP terminology) requires the following data:

Name

A unique text string which identify Data Value. Maximum size is 32 characters.
Note: if I/O tag's address is specified as **%IGNORE**, such an I/O tag will be ignored.

Data Type

The list of permitted data types:

Data Type	Meaning
State	Discrete 2-bit value
StateQ	Discrete 2-bit value + ICCP Validity
StateQTime Tag	Discrete 2-bit value + ICCP Validity + Time stamp
StateExtend ed	Discrete 2-bit value + ICCP Validity + Current Source + Extended time stamp
Discrete	Integer 32-bit value signed
DiscreteQ	Integer 32-bit signed value + ICCP Validity
DiscreteQTi meTag	Integer 32-bit signed value + ICCP Validity + Time stamp
DiscreteExt ended	Integer 32-bit signed value + ICCP Validity + Current Source + Extended time stamp
Real	Float 32
RealQ	Float 32 + ICCP Validity
RealQTime Tag	Float 32 + ICCP Validity + Time stamp
RealExtend ed	Float 32 + ICCP Validity + Current Source + Extended time stamp

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Autodetect
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	For I/O tags on a _Local Control Center_ station the Data Type will be derived from the Value Type:
	
	    • DiscreteQTimeTag for Integer output (Cout)
	    • RealQTimeTag for Analog output (Ao)
	    • StateQTimeTag for Logical output (Dout)
	
	For I/O tags on a _Remote Control Center_ station the Data Type will be queried by a GetVariableAccessAttributes-Request message after the conection establishment.
	Note 1: information is currently stored only in KOM process memory, therefore after its restart and the first connection establishment the data type detection is performed for all Autodetect I/O tags.
	Note 2: data types State and StateQ are undistinguishable by this mechanism, therefore objects of these types are detected as StateQ.
	Note 3: the same mechanism for data type detection is used in browsing.

ICCP Validity is converted to D2000 UniVal as follows:

Valid = Normal, Held, Suspect = Weak, NotValid = Invalid.

A quality flag _CurrentSource_ is ignored when data receiving. When data sending, it is always set on CurrentSource = Telemetered.

Scope

Scope of definition for a Data Value.

- _VMD Specific_ - Data Value is defined on a Virtual Manufacturing Device level
- _Domain Specific_ - Data Value is defined on inside a specific domain inside a device

Read Only

Enables only the reading of Data Value, the writing by command is disabled.

Browse

For I/O tags on a [Remote Control Center](#) station it is possible to query a list of objects and their data types from ICCP server, if a KOM process is running and if a communication is established.
After a *Browse* button is clicked, an ICCP Browser window is opened and the KOM process starts to query a list of objects using a message GetNameList-Request and thereafter their data types using GetVariableAccessAttributes-Request messages.

Img. No. 3, ICCP Item Browser window
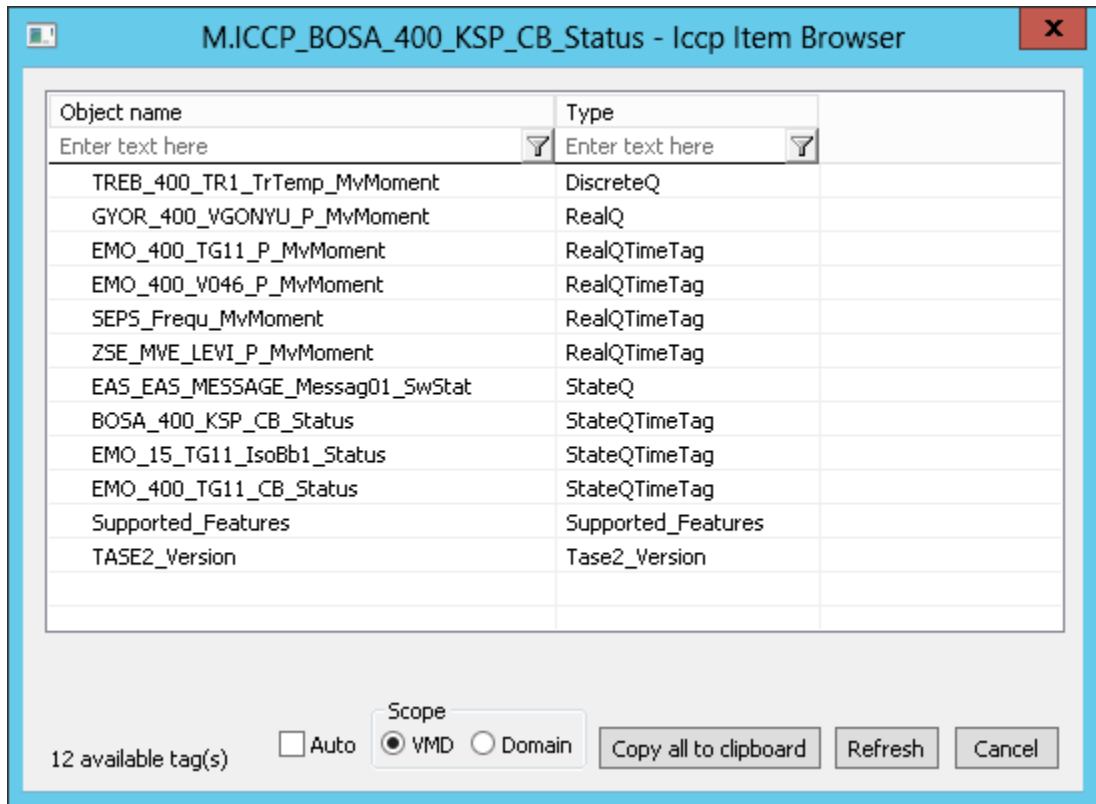
Meaning of individual choices and buttons:

Auto

If this choice is active, the Data Type will be set to [Autodetect](#), otherwise to value discovered during browsing , e.g. StateQ, StateQTimeTag ..

Scope

Sets the [scope](#) of browsing - *VMD Specific* or *Domain specific* objects will be browsed (the domain is defined in configuration of [RCC](#)).

Copy all to clipboard

Copies the displayed objects and their respective data types into the Windows Clipboard.

Refresh

By pressing the Refresh button it is possible to enforce re-querying of the list of objects from the ICCP server. By default the KOM process reads the list of objects and their respective data types only during the first browse request (once for *VMD Specific* and once for *Domain specific* objects) and stores them in memory. This reading can take a longer time, depending on number of ICCP objects and speed of ICCP server. These cached lists are sent to CNF process(es), so that consecutive filling of the Browse window is fast.

Filtering in the list of objects

The browse windows enables filtering by the object name and data type. Tt is not necessary to enter the full text in filter field. Notation "*FILTERED EXPRESSION*" is supported. The symbol * represents any text before and after the expression (e.g. *momen*).

Note

Besides the user-defined objects with supported data types (StateQ, StateQTimeTag .. RealExtended) a list of objects can contained pre-defined protocol objects with different types (Bilateral_Table_ID, DSConditionDetected, DSEventCodeDetected, DSTransferSetName, DSTransferSetTimestamp, NextDSTransferSet, Supported_Features, Tase2_Version, Transfer_Report_ACK, Transfer_Report_NACK). These objects cannot be used in I/O tag configuration and they are listed only due to a completeness and verification that browsing is functional even when there are no user-defined object configured on ICCP server.

Literature

- RFC 1006 (ISO Transport Service on top of the TCP, Version: 3)
- International Standard ISO/IEC 8073 (Open Systems Interconnection — Protocol for providing the connection-mode transport service)
- International Standard ISO/IEC 8327-1 (Open Systems Interconnection — Connection-oriented Session protocol: Protocol Specification)
- International Standard ISO/IEC 8823-1 (Open Systems Interconnection — Connection-oriented Presentation protocol: Protocol Specification)
- International Standard ISO/IEC 8650-1 (Open Systems Interconnection — Connection-oriented protocol for the Association Control Service Element: Protocol Specification)
- International Standard ISO/IEC 60870-6-503 (Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Services and protocol)
- International Standard ISO/IEC 60870-6-505 (Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 User guide)
- International Standard ISO/IEC 60870-6-702 (Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Functional profile for providing the TASE.2 application service in end systems)
- International Standard ISO/IEC 60870-6-802 (Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 Object models)

Changes and modifications

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Document revisions

- Ver. 1.0 - March 26, 2012 - Creation of document.
- Ver. 1.1 - May 2, 2017 - Browsing support, Autodetect addresses.

ⓘ **Related pages:**

Communication protocols