IEC-60870-5-101
Master Communication Protocol

Summary

1. GENERAL INFORMATION

1.1 Summary

Communication Driver Name: IEC8705101
Current Version: 1.0
Implementation DLL: T.ProtocolDriver.IEC8705101.dll
Protocol: IEC-870-5-101 Master standard protocol
Interface: TCP/IP or Serial
Description: The Action.Net IEC870-5-101 protocol driver implements comunication with IEDs(intelligent Eletronic Devices), RTUs(Remote Terminal Units) and IO devices compatible with this protocol, playing role as master station.
IEDs types supported: Any IED compatible with IEC-60870-5-101.

Communication block size: Maximum 250 bytes, FT 1.2 format
Protocol Options: Number of octects used by link layer and application layer, data objects and transmission cause.
Multi-threading: User defined, fiev threads per node by default.
Max number of nodes: User defined
PC Hardware requirements: Standard PC Ethernet interface board, RS485 or RS232 port
PC Software requirements: Action.Net system.

1.2 Supported Objects (ASDUs)

M_SP_NA: 1 - Single-point information ;
M_DP_NA: 3 - Double-point information ;
M_ST_NA: 5 - Step position;
M_BO_NA: 7 - Bitstring with 32 bits ;
M_ME_NA: 9 - Measured value, normalized ;
M_ME_NB: 11 - Measured value, scaled value ;
M_ME_NC: 13 - Measured value Float;
M_IT_NA: 15 - Integrated totals ;
M_EP_TA: 17 - Equipment protection with Time;
C_SC_NA: 45 - Single command ;
C_DC_NA: 46 - Double command ;
C_RC_NA: 47 - Regulating step command ;
C_SE_NA: 48 - Set point command, normalized value ;
C_SE_NC: 50 - Set point command, 32 bits floating point ;

On Action.Net, each type of Object Data listed above has three variants: the first one, without timestamp; the others, with timestamp (24 bits and 56 bits). On Action.Net, by default, user do not have to specify the variants intended to be used, this is processed in a transparent way.

1.3 General Operation

The protocol IEC-60870-5-101 is implemented in Master mode in which it communicates with IEDs that implement the protocol IEC-870-5-101 slave. The frame used for data exchange is FT 1.2, non-balanced (slave don´t send unsolicited data). There is a large range of settings options for matching different usage profiles.

Master has the following operating sequence:

On start or communication failure
- As first step, start initialization procedures on the Slave(s);
- Send schedule, if time different from zero;
- Do cycle readings, according to preset sample times (all classes);

Infinity Loop
- If received a request to send command, sends the command, as according to parameter details;
- If the sampling time of some group has expired, do the reading;
- If periodic time for sending schedule has expired. And if time its value is different from zero, sends schedule;
- On receiving data request if there is indication for new events, do events request (class 1);
- On receiving an error frame or occurrence of request timed out, restarts communication procedure (goes to the first step);

2. CHANNEL SETTINGS

2.1 Protocol Options

CommonAddress Num Octets – Number of bytes used for application layer address in slave station targeted. It could be 1 or 2 bytes.

LinkAddress Num Octets – Number of bytes used for link layer layer address in slave station targeted. It could be 1 or 2 bytes.

ObjectAddress Num Octets – Number of bytes used for data object address. It could be 1, 2 or 3 bytes.

CauseOfTransmission Num Octets – Number of bytes used to inform the cause of data transmission. It could be 1 or 2 bytes.

2.2 Settings

Serial:

DataBits: 8
StopBits: 1 or 2
Extra port settings accordingly to remote IED slave.

TCP/IP channels:
- NodeConnections: Defines the maximum number of parallel requests that can be sent to each node (asynchronous communication)

3. NODES SETTINGS

Each node is a Server station (IED). For each channel could be associated many nodes.

3.1 TCP/IP Communication

Endereço IP – IED IP address
Port – Port Number

3.2 Serial Communication

The settings were those prior exposed on Channel Settings Section.

3.3 Common Parameters

Common Address – IED application layer address

LinkAddress – IED link layer address

Synchronism sample time – Period of time, in milliseconds, between two consecutives submissions of Date and Time to remote IEDs. Zero is used to indicate that there is no need for synchronization. Note that IEDs synchronized by GPS should not be synchronized by the master.

General Interrogation (GI) sample time – Period of time in milliseconds between two consecutive submissions of general interrogation requests to an IED. The IED responds by sending blocks of information, as many as are required to send all points.

Status sample time – Length of time, in milliseconds, between two consecutive requests for changes occurred in class 1 and class 2 points. IED responds by sending blocks of information, as many as are needed to inform changes occurred. Normally, this period should be set to a short value, 1000 milliseconds for example.

General Counters Sample Time – General timer for counters request, in milliseconds. IED responds with information blocks, as many as necessary.

Clock Adjust – This should be enabled if the Master Station should be synchronized by remote/slave IED date/hour. This is useful if the remote/slave IED is GPS synchronized.

Backup Station – The same settings made to the main station can be made to one backup workstation (alternative IED) if the there is one in the facility.

4. POINT SETTINGS

4.1 General

The points can be input or output. The input points, i.e. points that are acquired by the protocol have basically two main parameters: The point type and address. The output points are used for remote controls, and have an additional parameter, used to specify the type of output operation. In a given IED, points addresses are unique.

4.2 Grouping

O IEC870-5-101 provides groups of points feature. In this implementation, they are not considered. Instead, there is a general read considering all points, and a general counters read considering all timers.

This implementation supports 2 classes listed in the standard:

• Class 1: Priority, captured from events occurrences, always with timestamp (even ASDU's).

• Class 2: Non priority, captured from cycle readings, without timestamp (odd ASDU's);

Note that the concepts of class and point differ from each other. Thus, given a point, if its state has changed, it could generate a class 1 event, that should be processed before next class 2 reading. By design, only cyclical readings, class 2, of point triggers points state change on Action.Net, to avoid inconsistencies. Class 1 events solely generate Action.Net events.

4.3 Point Types

Master communication mode, implements:

• Single digital or Double digital readings;
• Analog points readings;
• Counters readings;
• 24 or 56 bits time tags;
• Single digital or Double digital commands;
• Link Layer address length variation, IED address length variation and point address length variation;
• Select before operate command;
• Point quality analysis (QDS);
• Zero and one sequence messages analysis (SQ)

The point types were implemented as their respective object defined in the standard (see list bellow).

M_SP_NA: 1 - Single-point information
Simple binary input point, assuming 0 or 1. The variants with "timetag" M_SP_TA (= 2) and M_SP_TB (= 30) are also considered in this type.
M_DP_NA: 3 - Double-point information ;

Double input point, which can assume states 0 to 3, is usually used for signaling states of switches and circuit breakers. The variants with "timetag" M_DP_TA (= 4) and M_DP_TB (= 31) are also considered in this type.

M_ST_NA: 5 - Step position;

Step value, ranges from -64 to +63, mainly used for transformer step position or other position information. The variants with "timetag" M_ST_TA (= 6) and M_ST_TB (= 32) are also considered in this type.

M_BO_NA: 7 - Bitstring with 32 bits ;

Status information as a binary string of 32 bits. Action.Net makes no manipulation at all. The configuration is treated as a long number. The variants with "timetag" M_BO_TA (= 8) and M_BO_TB (= 33)) are also considered in this type.

M_ME_NA: 9 - Measured value, normalized ;

Standard Analog measurement using 16-bit signal. Value between -32768 and + 32767. It is calculated as a real number between 0 and 1 before being assigned to the tag in real time. Should be used "scalling"if it´s intended to reproduce the value in engineering units. The variants with "timetag" M_ME_TA (= 10) and M_ME_TD (= 34)) are also considered in this type.

M_ME_NB: 11 - Measured value, scaled value ;

Scalar Analog measurement used for transmission of analog quantities. Also 16-bit value between -32768 and 32767. The variants with "timetag" M_ME_TB (= 12) and M_ME_TE (= 35) are also considered in this type.

M_ME_NC: 13 - Measured value short floating point;

Analog Measurement on fractional real number format, used for transmission of analog quantities. The measurements are 32-bit fields in the format IEEE STD 754, which implements floating-point numbers. The variants with "timetag" M_ME_TC (= 14) and M_ME_TF (= 36) are also considered in this type.

M_IT_NA: 15 - Integrated totals ;

Integer analog measurement signal. Measurements with 32-bit integer. The variants with "timetag" M_IT_TB (= 16) and M_ME_TC (= 37) are also considered in this type.

M_EP_TA: 17 - Equipment protection with Time;

Change of state event information with timestamp. It uses a byte for quality, with status information in two least significant bits. This type uses 24-bit timestamp.

C_SC_NA: 45 - Single command ;

Simple command to point (1 bit). Details of the command can be selected by clicking in the button that is in the right side of the field. Also can be entered directly the number that is the command code resulting from the choice of details. One point must be configured for opening and another for closing one bit switches.

C_DC_NA: 46 - Double command ;

Double command (2 bits). Details of the command can be selected by clicking the button in the rigth side of the field. Also can be entered directly the number that is the command code resulting from the choice of details. One point must be configured for opening and another for closing two bit switches.

C_RC_NA: 47 - Regulating step command ;

Command for setting step. Normally used to send pulses to step up and down switching transformers. Details of the command can be selected by clicking the button in the rigth side of the field. Also can be entered directly the number that is the command code resulting from the choice of details. One point must be configured to step up and another one to step down the position of the transformer step.

C_SE_NA: 48 - Set point command, normalized value ;
For sending set points of 16-bit normalized for IEDs that support this type of command. The value to be sent is that indicated by the Action.Net "tag" whose address was sent in command.

C_SE_NC: 50 - Set point command, short floating point value ;
For sending set points of 32-bit floating-point format in IEEE STD 764 for IEDs that support this type of command. The value to be sent is that indicated by the Action.Net "tag" whose address was sent in command.

4.4 Point Address

The Address field to be filled in the point registration is what the standard calls "Information Object Address." It is a number with 2 or 3 bytes length, as chosen in the "Protocol Options". In the most common usage two bytes are used for this number, so the range is from 0 to 65535. For a given IED it must be unique. These addresses are set by the IED manufacturer.

4.5 Command Parameter

The command parameter is implemented as a code of one byte, which details the command type to be executed into remote IED. In this implementation, as the user registers a point typed as command output, this field shows up to be filled by the user. If it's already known the code, user may just type it into this field. If not, click on the button on the right side this field for displaying a window with the actions and details available.

The code generated by choosing the items in the parameter setting command window is obtained by calculating the sum of two parts (A and B), first part indicate action, and the second details of the transaction, as defined below:

For Single Command C_SC_NA:
1 = Turn off   (A)
2 = Turn on   (A)
4 = Short Pulse   (B)
8 = Long Pulse   (B)
12= Persistent Signal   (B)

For Double Command C_DC_NA:
1 = Turn off   (A)
2 = Turn on   (A)
4 = Short Pulse   (B)
8 = Long Pulse   (B)
12 = Persistent Signal (B)

For Voltage Regulation C_RC_NA:
1 = Down   (A)
2 = Up   (A)

4 = Short Pulse   (B)
8 = Long Pulse   (B)
12= Persistent Signal   (B)

The remaining options are Select Command - just select the device to be controlled, or Execute Command - send the proper action command. In select command option, is added 128 to the code so far obtained by the sum of the parts A and B.

Exemple: code = 9, in a simple command means *Long Pulse* for *Turn on* the remote device;

4.6 Access Type

Acting on Slave mode, Access type Field should be set as indicated Bellow:

For reading points:

M_SP_NA: 1 - Single-point information;
M_DP_NA: 3 - Double-point information;
M_ST_NA: 5 - Step position;
M_BO_NA: 7 - Bitstring with 32 bits;
M_ME_NA: 9 - Measured value, normalized;
M_ME_NB: 11 - Measured value, scaled value;
M_ME_NC: 13 - Measured value Float;
M_IT_NA: 15 - Integrated totals;
M_EP_TA: 17 - Equipment protection with Time;

The Access Type must be set as:
ReadOnStartup= On;
ReadPooling= Always;
ReadPoolongRate: 500 mili
WriteEvent= Changed;
AccepUnsolictited = On;

For command points:

C_SC_NA: 45 - Single command ;
C_DC_NA: 46 - Double command ;
C_RC_NA: 47 - Regulating step command ;
C_SE_NA: 48 - Set point command, normalized value ;
C_SE_NC: 50 - Set point command, 32 bits floating point ;

The Access Type must be set as:
ReadPooling = Never;
WriteEnable = On
WriteEvent= Changed;