

Communication System Interface

Communication System Interface for Ekip Touch trip unit on circuit breaker Tmax XT7-XT5-XT4-XT2 + Ekip Com modules in all the available versions:

- Ekip Com Modbus TCP
- Ekip Com EtherNet/IP™
- Ekip Com Profinet
- Ekip Com IEC 61850
- Ekip Com Modbus RTU
- Ekip Com Profibus DP
- Ekip Com DeviceNet™



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1. INTRODUCTION

The documents refer to the communication interface available with Tmax XT circuit breaker.

The aim of this document is to indicate the addresses of all measures, parameters and information available on Tmax XT with external and internal communication modules, connected to Ekip Touch trip unit, or with Stand Alone modules, available to take some CB information without a connection to a trip unit.

Moreover it explains the procedure to read information and to program the parameters of the above mentioned trip units.

1.1 Applicability

This document applies to communication module Ekip Com in all the available versions:

Module / Protocol	External version	Internal version ⁽¹⁾	Stand alone version (STA) ^{(1) (3)}
Ekip Com Modbus RTU	✓ ⁽²⁾	✓	✓
Ekip Com Modbus TCP	✓ ⁽²⁾	✓	✓
Ekip Com Profibus DP	✓ ⁽²⁾		
Ekip Com DeviceNet™	✓ ⁽²⁾		
Ekip Com EtherNet/IP™	✓ ⁽²⁾	✓	
Ekip Com Profinet	✓ ⁽²⁾	✓	
Ekip Com IEC 61850	✓ ⁽²⁾	✓	

NOTES:

(1) Modules available on XT5-XT4-XT2 circuit breaker

(2) Modules available also in Redundant version (e.g.: Ekip Com Modbus RTU and Ekip Com R Modbus RTU)

(3) Stand Alone modules have STA included in name (e.g. Ekip Com STA Modbus RTU)

1.2 Bibliography

Schneider Automation Inc., 'Modicon Modbus protocol reference guide'.

Modbus IDA, 'Modbus messaging on TCP/IP implementation guide'.

The New Rapid Way to PROFIBUS DP" di Manfred Popp .

1.3 Acronym and definition

1.3.1. Acronym

CB	Circuit Breaker	WORD	Word (IEC 61131-3)
		DWORD	Double word (IEC 61131-3)
AI	Analog Input	LWORD	Long Word (IEC 61131-3)
AO	Analog Output	SINT	Short Integer (IEC 61131-3)
LSb	Least Significant Bit	USINT	Unsigned Short Integer (IEC 61131-3)
LSB	Least Significant Byte	INT	Single Integer (IEC 61131-3)
MSb	Most Significant Bit	UINT	Unsigned Integer (IEC 61131-3)
MSB	Most Significant Byte	DINT	Double Integer (IEC 61131-3)
		UDINT	Unsigned Double Integer (IEC 61131-3)
ADU	Application Data Unit	LINT	Long Integer (IEC 61131-3)
PDU	Protocol Data Unit	ULINT	Unsigned Long Integer (IEC 61131-3)
		STRING	Text String (IEC 61131-3)
BOOL	Bit or Boolean (IEC 61131-3)	UNICODE	Unicode (IEC 61131-3)
BYTE	Byte (IEC 61131-3)		

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1.3.2. Definitions

ALARM:

There are two types of alarm:

Alarm Type	Definition
Alarm	It's similar to a status. A Trip Reset is NOT necessary to reset it. Ex. L Pre-Alarm, S Alarm, ...
Trip	Only a command can reset it, i.e. a new alarm won't be signalled until the reset. Ex. L Tripped, S Tripped, ...

CB RESET:

Event (Any Trip) /alarm reset of any information related to the (last) trip

DEVICE:

Trip unit

EVENT:

Information that signals a normal (foreseen) device behaviour; typically, the producer of an event is the device, while the consumer is the system

PARAMETER:

Information that allows configuration of device functionality (e.g. a protection algorithm)

PROTECTION TRIPS:

Sum of real protection trips. 'Real' means 'not caused in a test session'

TRIP UNIT:

Touch electronic device that implements protection algorithms

REGISTER:

The least analogue information container (one word = 2 bytes)

STATUS:

Information that represents the dynamics of a functionality (e.g. the CB or a protection algorithm); it can be managed (i.e. set/reset) only by the device itself

TRIP COMMAND FAIL:

After a protection trip, with relevant opening command to the release, CB stays in CLOSED state: in this case, the device tries to open the CB by starting a back-up procedure; meanwhile, the device tries also to open the CB using the opening coil

TRIP RESET:

Command equal to CB Reset

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2. COMMUNICATION MAP

Complete information about specific communication maps for devices threatened in this document are available in the file:
1SDH002031A1101-System Interface XT.xlsx

2.1 Legend for communication map document

Communication map document is in MS Excel format and is made of different sheets:

- 1) [Legend](#): it contains introduction and application note.
- 2) [Revision history](#): it contains the differences introduced into every version
- 3) [Tables](#) and [Events](#): it contains tables to define fields described into 'Protocol' sheet
- 4) [Protocol](#) sheets:

Protocol sheet	Proper protocol addresses column	Detail of addresses
Modbus	Modbus Address (DEC) and functions	Address or register address to put into PDU (decimal format) and available functions (X= function available for the parameter to put into PDU)
Devicenet	Devicenet™	Address for parameters and command configuration
	Cyclic Data Offset	Register offset (of cyclic data) in PLC memory
Profibus	Profibus Legacy and Dataset access + Cyclic Data offset	Address reference for parameters and command configuration
Profinet	Profinet Legacy and Dataset access + Cyclic Data offset	Address reference for parameters and command configuration
IEC 61850	IEC 61850 References	Address reference for parameters and command configuration
	IEC 61850 Data set	Data set reference for parameters and command configuration
	GOOSE, report	Message type to use for data reading
EtheNet/IP™	Ethernet/IP™ Class ID + Cyclic Data offset	Address for parameters and command configuration

Table 1 protocol sheet

NOTE: information available with Stand Alone modules (Ekip Com STA Modbus RTU and Ekip Com STA Modbus TCP) are reported in dedicated sheets of document

Each protocol sheet contains information available on the device and how to interface to it:

Column	Name of the register/parameter
Modbus Address (DEC) and functions	Address or register address to put into PDU (decimal format) and available functions (X= function available for the parameter to put into PDU)
Nr of registers	Number of registers that composed the data
Bit field (B = YES)	Show if the register is handled as a bit field, and value for each bit
Events	Show if the information is checked by event log section and how (See Legend sheet for details)
Range	Allowable range for the parameter
Description	A short description of the parameter
Units	Unit of measure of the parameter
Multiplier	Coefficient to convert data from protocol format to user format Example: data = 40; multiplier = 0.1 ⇒ user format = 0.4
Data type	Define the data type (See Legend sheet for details)
Access	R = Read only; RW = Read-Write
Sw Ver x.xx	Show change details with previous SW version (see comments of the column to check single code meanings)

Table 2 Legend for communication maps

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3. MODBUS PROTOCOL

The Modbus protocol defines a simple 'Protocol Data Unit' (**PDU**) independent of the underlying communication layers. The mapping of Modbus protocol on specific buses or networks can introduce some additional fields on the 'Application Data Unit' (**ADU**).

3.1 Data management

3.1.1. ADU on Modbus RTU

ADU		
Slave device address	PDU	Error check (CRC)

Table 3 Modbus RTU General frame

3.1.2. ADU on Modbus TCP

ADU	
MBAP header	PDU

Table 4 Modbus TCP request/response

A dedicated header is used on TCP/IP to identify the Modbus 'Application Data Unit' (ADU). It's called the 'Modbus Application Protocol' header (**MBAP**).

3.2 Format management

Data format LINT (Acronym 1.3.1) (4 bytes = 2 words = 2 registers) is transferred with low significant part at lower Modbus address (LOW-HIGH)

Register i	LS word
Register i + 1	MS word

Instead within WORD data the most significant byte is transferred first (according to Modbus RTU standard)

MS byte	LS byte
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3.3 Framing management

3.3.1. Device RTU Framing

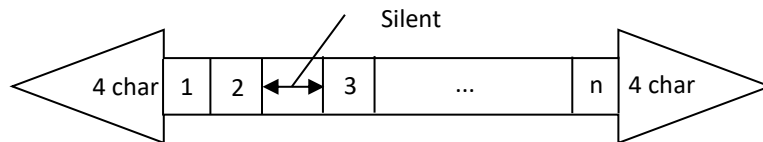
The allowed inter-character silent interval has been relaxed from 'at least 2 characters' to 'at least 4 characters' (the same silent interval to recognize the end of a message). This means:

Silent interval < 4 char between two characters inside the message

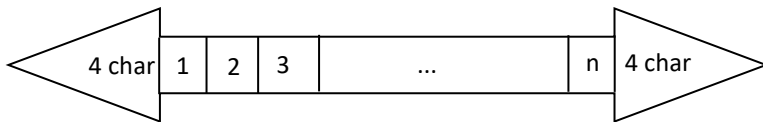
In this case the receiver filters the silent interval and the following characters will be appended to those already received. The difference from the protocol specification is:

1. Silent interval < 2 char between two characters inside the message.

Transmitter



Receiver

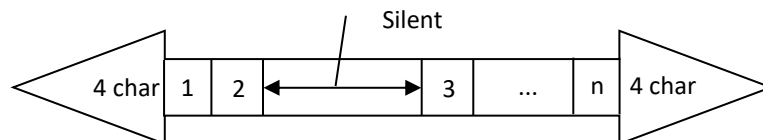


The behaviour is exactly as specified by the protocol.

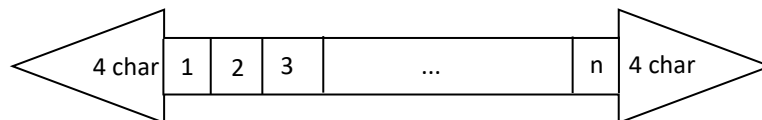
2. Silent interval ≥ 2 char and < 4 char between two characters inside the message.

The received characters are NOT flushed and the following ones will be appended.

Transmitter



Receiver



Note that after flushing, the standard protocol specification allows:

- reception of the remaining characters of a partially received message.
- reception of a completely new message.

The device behaviour **doesn't cover the second case** because it always appends new incoming characters to the previous ones, leading to a CRC error.

So the behaviour is exactly the same if and only if the incoming characters are NOT a new message. In this case the received packet will lead to a CRC error and the CRC error counter will be incremented.

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Silent interval ≥ 4 char between two characters inside the message

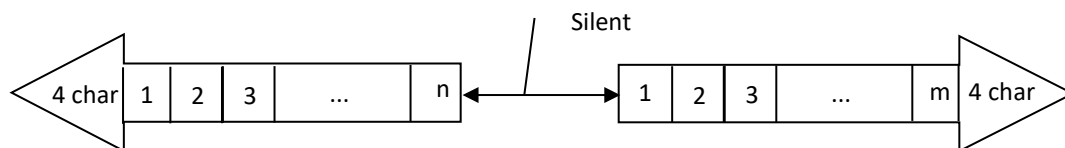
If the message transmission is NOT ended, all the previously received characters are managed as a message because this is exactly the protocol specification regarding the end of a message.

New frame before 4 character silent interval at the end of a frame.

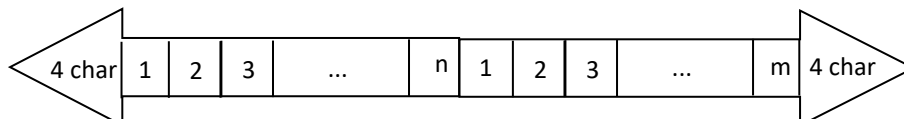
In this case the receiver filters the silent interval and the following characters (of the new frame) will be appended to those already received.

This will lead to a CRC error.

Transmitter



Receiver



So the CRC error counter will count both the 'real' CRC errors and the inter-character errors.

3.4 Communication Parameters

3.4.1. Communication Parameters on Modbus RTU

Available communication parameters are:

Baud rate	Slave device address	Physical protocol
9600/19200/38400 bit/s	1 ÷ 247	E, 8, 1 / O, 8, 1 N, 8, 2 / N, 8, 1

Table 5 Modbus RTU Communication Parameters

The default parameters configuration is:

Baud rate	Slave device address	Physical protocol
19200 bit/s	247 (Ekip Com Modbus RTU -external, internal, STA-) 246 (Ekip Com R Modbus RTU)	E, 8, 1

Table 6 Modbus RTU Default parameters

3.4.2. Communication Parameters on Modbus TCP

Available communication parameters are:

Baud rate	Slave device address (MBAP header field)
10/100 Mbit/s	1, mandatory

Table 7 Modbus TCP Communication Parameters

3.4.3. Network Parameters on Modbus TCP

Network parameters IP Address, Subnet mask and Gateway address can be set statically directly on the unit. Alternatively, a dynamic configuration can also be chosen, and in this case two different sources can be selected to determine the device network parameters:

- DHCP server.
- AutoIP (in absence of a DHCP server) , in the range 169.254.x.x, where the 2 LSBs are calculated based on the device MAC address and are thus identical between successive operations.

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3.5 Unit identification

Unit	Slave ID
Ekip Touch	0xA2

Table 8 Modbus Unit ID

3.6 Available Modbus functions

Function Code	Name	Applicable to
03 (03h)	Read Holding Registers	AO
04 (04h)	Read Input Registers	AI
06 (06h)	Write Single Register	AO
08 (08h) + Subf Code 00 (00H)	Diagnostic Loop back	---
16 (10h)	Write Multiple Registers	AO
17 (11h)	Report Slave ID	---
70 (46h)	Read Extended Registers	Extended Reg.

Table 9 Modbus functions

NOTE: All queries must respect the limitation of maximum Modbus message length of 256 byte

3.7 PDU Structure

3.7.1. Function 03 (03h) - Read Holding Registers

Query	<table><tr><th colspan="5">PDU</th></tr><tr><th>Function</th><th colspan="2">Starting address</th><th colspan="2">Number of registers</th></tr><tr><td>03h</td><td>High</td><td>Low</td><td>High</td><td>Low</td></tr></table> <p>NOTE: Number of registers ≤ 125</p>	PDU					Function	Starting address		Number of registers		03h	High	Low	High	Low						
PDU																						
Function	Starting address		Number of registers																			
03h	High	Low	High	Low																		
Response	<table><tr><th colspan="7">PDU</th></tr><tr><th>Function</th><th>Byte count</th><th colspan="2">Register value</th><th>...</th><th colspan="2">Register value</th></tr><tr><td>03h</td><td>nn</td><td>High</td><td>Low</td><td>...</td><td>High</td><td>Low</td></tr></table>	PDU							Function	Byte count	Register value		...	Register value		03h	nn	High	Low	...	High	Low
PDU																						
Function	Byte count	Register value		...	Register value																	
03h	nn	High	Low	...	High	Low																


Table 10 Modbus Function 03

3.7.2. Function 04 (04h) - Read Input Registers

Query	<table><tr><th colspan="5">PDU</th></tr><tr><th>Function</th><th colspan="2">Starting address</th><th colspan="2">Nr of input registers</th></tr><tr><td>04h</td><td>High</td><td>Low</td><td>High</td><td>Low</td></tr></table> <p>NOTE: Number of registers ≤ 125</p>	PDU					Function	Starting address		Nr of input registers		04h	High	Low	High	Low						
PDU																						
Function	Starting address		Nr of input registers																			
04h	High	Low	High	Low																		
Response	<table><tr><th colspan="7">PDU</th></tr><tr><th>Function</th><th>Byte count</th><th colspan="2">Input register</th><th>...</th><th colspan="2">Input register</th></tr><tr><td>04h</td><td>nn</td><td>High</td><td>Low</td><td>...</td><td>High</td><td>Low</td></tr></table>	PDU							Function	Byte count	Input register		...	Input register		04h	nn	High	Low	...	High	Low
PDU																						
Function	Byte count	Input register		...	Input register																	
04h	nn	High	Low	...	High	Low																

Table 11 Modbus Function 04

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3.7.7. Function 70 (46h) Read Extended Registers

Query	<table><tr><th colspan="8">PDU</th></tr><tr><th>Function</th><th>Byte count</th><th>Ref type</th><th colspan="2">File number</th><th colspan="2">Starting address</th><th colspan="2">Number of registers</th></tr><tr><td>46h</td><td>07h</td><td>06h</td><td>High</td><td>Low</td><td>High</td><td>Low</td><td>High</td><td>Low</td></tr></table>								PDU								Function	Byte count	Ref type	File number		Starting address		Number of registers		46h	07h	06h	High	Low	High	Low	High	Low
	PDU																																	
	Function	Byte count	Ref type	File number		Starting address		Number of registers																										
	46h	07h	06h	High	Low	High	Low	High	Low																									
	NOTE:																																	
<ul style="list-style-type: none">- <i>File number ≤ 3</i>- <i>Starting address ≤ 65535</i>- <i>Number of registers ≤ 125</i>																																		
Response	<table><tr><th colspan="8">PDU</th></tr><tr><th>Func</th><th>Byte count</th><th>Ref type</th><th colspan="2">Reg value</th><th>...</th><th colspan="2">Reg value</th></tr><tr><td>46h</td><td>Nn</td><td>06h</td><td>High</td><td>Low</td><td>...</td><td>High</td><td>Low</td></tr></table>								PDU								Func	Byte count	Ref type	Reg value		...	Reg value		46h	Nn	06h	High	Low	...	High	Low		
	PDU																																	
	Func	Byte count	Ref type	Reg value		...	Reg value																											
46h	Nn	06h	High	Low	...	High	Low																											

Table 16 Modbus Function 70

3.8 Command

Each command are formed by 2 field:

Field name	
Command type	MS word
Command parameter	LS word

Table 17 Modbus Command

To execute a command it's requested to write together the 'Command type' and the 'Command parameter' fields.

Write into 'Command type' field the number desired and into 'Command parameter' field the optional parameter value, equal to 0 if not needed, with Modbus function 16 (10h) also if the parameters value is not necessary.

Example 1.

To send 'Trip reset' command, write '01' as 'Command type' field and '00' as 'Command parameter' field (parameter not necessary for this command).

Query

PDU									
Funct	Starting addr		Num of registers		Byte count	Command type		Command parameter	
10	00	00	00	02	04	00	01	00	00

Response

PDU				
Function	Starting address		Number of register	
10	00	00	00	02

Example 2.


To send 'Harmonics acquisition start' command on L2 phase, write '16' at 'Command type' field and '01' at 'Command parameter' field.

Query

PDU									
Funct	Starting addr		Num of registers		Byte count	Command type		Command parameter	
10	00	00	00	02	04	00	10	00	01

Response

PDU				
Function	Starting address		Number of register	
10	00	00	00	02

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3.9 Exception responses

3.9.1. Illegal function

PDU	
Function	Exception code
Function + 80h	01h

3.9.2. Illegal data address

PDU	
Function	Exception code
Function + 80h	02h

3.9.3. Illegal data value

PDU	
Function	Exception code
Function + 80h	03h

3.9.4. Slave device failure

PDU	
Function	Exception code
Function + 80h	04h

3.9.5. Slave device busy

PDU	
Function	Exception code
Function + 80h	06h

3.9.6. Gateway Problem Path

PDU	
Function	Exception code
Function + 80h	0Ah

Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. Usually means that the gateway is misconfigured or overloaded.

3.9.7. Gateway Problem Device

PDU	
Function	Exception code
Function + 80h	0Bh

Specialized use in conjunction with gateways, indicates that no response was obtained from the target device. Usually means that the device is not present on the network.

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3.9.8. Exception occurrences

		Exception				
		01 Illegal function	02 Illegal data address	03 Illegal data value	04 Slave device failure	06 Slave device busy
QUERY FUNCTION	03		Starting address not valid	<ul style="list-style-type: none"> - Invalid query length - Requested number of register too large - Address out of modbus map 		
	04		Starting address not valid	<ul style="list-style-type: none"> - Invalid query length - Requested number of register too large - Address out of modbus map 		Reading attempt of busy non-volatile memory at present
	06		<ul style="list-style-type: none"> - Starting address not valid - Write of TIME information not allowed with this function 	Invalid query length		<ul style="list-style-type: none"> - Local state - Programming session already open - Programming session not open
	08			<ul style="list-style-type: none"> - Sub function ≠ 00 00 - Invalid query length 		
	16		Starting address not valid	<ul style="list-style-type: none"> - Invalid query length - Number of register too large - Address out of modbus map - Command not available - Command parameter filed not valid - Wrong Time 	Parameters error check after a stop programming session command	<ul style="list-style-type: none"> - Local state - Programming session already open - Programming session not open - Command acceptance conditions not verified
	17			Invalid query length		
	70		Starting address not valid	<ul style="list-style-type: none"> - Invalid query length - Requested number of register too large - Address out of modbus map - Field Ref Type not correct - Field Byte count not correct 		Reading attempt of busy data logger
	Other	Function not available				

Table 18 Modbus Exception occurrences

3.10 Trouble shooting

When using Ekip Com Modbus TCP as a gateway, the Slave ID field must be always set to 1.

Ekip Com Modbus TCP only provides support for registers functions, and not for coils functions:

- Read Input Register (4).
- Read Holding Registers (3).
- Write Single Register (6).
- Write Multiple Registers (16).

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4. PROFIBUS PROTOCOL

Ekip Com Profibus DP implements the Decentralized Periphery version of the protocol that meets fast data exchange and easy automation requirements.

4.1 Class and SAP functions

Ekip Com Profibus modules support:

- DPV0 connection (MS0 communication) that means cyclic data exchange between the device and a Class 1 master.
- DPV1 connection that means acyclic data exchange with:
 - Class 1 master (MS1 communication).
 - Class 2 master (MS2 communication).
- All MS0, MS1 and MS2 SAP functions (except SAP 0x37, Change Station Address -Set_Slave_Add-).

NOTE: Ekip Com Profibus modules do not support:

- "Synch" and "Freeze" commands.
- Extended diagnostic.

4.2 File GSD

The most recent GSD files for Ekip Com Profibus modules are available on ABB library or in Profibus Website (www.profibus.com), in section Product finder searching for: SACE Emax 2 Ekip Com Profibus-DP.

At the moment of publication, the latest version is **ABBS0E7F.gsd** and contains both Custom and Legacy information for the interface configuration.

4.2.1. Custom modules

GSD file with version ≥ 2.20 used on Ekip Com Profibus with FW version ≥ 2.16 allows to create a custom profile composed by one or more single blocks (up to 70 blocks, maximum 200byte); the list of available blocks is contained into the GSD file.

To help the making of custom profile, the document **Profibus - Custom GSD guide** and **Profibus - Custom modules.xlsx** are available.

NOTE: it's not possible to mix Legacy modules with Custom modules

4.2.2. Legacy modules

GSD file allows 5 different fixed modules:

- Emax 2 basic status.
- Emax 2 full status.
- Emax 2 status + current measures.
- Emax 2 status + current measures + voltage measures.
- Emax 2 status + current measures + voltage measures + power measures + energy measures.

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4.3 ADU

Profibus standard support 4 main kinds of telegrams:

4.3.1. Frames with variable data field length

Request frame										
SYN	SD2	LE	LEr	SD2	DA	SA	FC	DATA	FCS	ED
Reply frame										
SD2	LE	LEr	SD2	DA	SA	FC	DATA	FCS	ED	

4.3.2. Fixed length frames with data field

Request frame							
SYN	SD3	DA	SA	FC	DATA_UNIT	FCS	ED
Reply frame							
SD3	DA	SA	FC	DATA_UNIT	FCS	ED	

4.3.3. Fixed length frames without data field

Request frame						
SYN	SD1	DA	SA	FC	FCS	ED
Reply frame						
SD1	DA	SA	FC	FCS	ED	
Fast reply frame						
SC						

4.3.4. Token frame

Token frame			
SYN	SD4	DA	SA

4.3.5. Frame legend

SYN:	Synchronization field, (33 idle bits all "1").
SD2:	Start Delimiter, hexadecimal value set to 68H.
LE:	Length, number of bytes from DA (included) to FCS (excluded); range = 4...249.
LEr:	Length repetition
DA:	Destination Address; range = 0...127.
SA:	Source Address; range = 0...126.
FC:	Function Code.
DATA:	User Data; range 1...244 bytes
FCS:	Frame Checking Sequence.
ED:	End Delimiter, hexadecimal value set to 16H.
SD3:	Start Delimiter, hexadecimal value set to A2H.
DATA_UNIT:	User Data with fixed length = 8 byte
SD1:	Start Delimiter, hexadecimal value set to 10H.
SC:	Single Character, hexadecimal value set to E5H.
SD4:	Start Delimiter, hexadecimal value set to DCH.

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4.4 Format management

Data format LINT (Acronym 1.3.1) (4 bytes = 2 words = 2 registers) is transferred with low significant part at lower Profibus address (LOW-HIGH):

Register i	LS word
Register i + 1	MS word

Instead within WORD data the most significant byte is transferred first (according to Profibus standard)

MS byte	LS byte
---------	---------

4.5 Communication Parameters

Available communication parameters are:

Slave device address
1 ÷ 125

Table 19 Profibus Communication Parameters

The default parameters configuration is:

Slave device address
125 (Ekip Com Profibus -external, internal-)
124 (Ekip Com R Profibus)

Table 20 Profibus Default Parameters

Master configuration can set other parameters, compliant with Profibus standard:

Transfer rate	Watchdog	Watchdog timeout
9.6kbit/s - 19.2 kbit/s - 45.45 kbit/s - 93.75 kbit/s - 187.5 kbit/s - 500 kbit/s - 1.5 Mbit/s - 3 Mbit/s - 6 Mbit/s - 12 Mbit/s -	Enable / Disable	0 / 65535

Table 21 Profibus Other Parameters

NOTE:

- The device does not support 31.25Kbit/s baudrate.
- Transfert rate 3 Mbit/s - 6 Mbit/s - 12 Mbit/s are supported by Ekip Com Profibus modules, but not certified.

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4.6 Command

Each command are formed by 2 field:

Field name	
Command type	MS word
Command parameter	LS word

Table 22 Profibus Command

To execute a command it's requested to write together the 'Command type' and the 'Command parameter' fields.

Write into 'Command type' field the number desired and into 'Command parameter' field the optional parameter value, equal to 0 if not needed.

Example.

To send 'Trip reset' command, write '01' as 'Command type' field and '00' as 'Command parameter' field (parameter not necessary for this command).

PDU			
Command type		Command parameter	
00	01	00	01

4.7 Diagnosis

Standard diagnostic is supported as requested by, and in the limit of, Profibus standard.

Grayed fields set by Master not by Profibus Slave.

Bit	DIAGNOSTIC	Description
0	Diag.Station_Non_Existent	Set to 1 by the master if slave cannot be reached over the line. Slave sets this bit to 0
1	Diag.Station_Not_Ready	Set by slave if slave is not ready for data transfer
2	Diag.Cfg_Fault	Set by slave if it detects a mismatch in config data
3	NOT USED	
4	Diag.Not_Supported	Set by slave if requested function/service is not supported
5	Diag.Invalid_Slave_Response	Slave sets this bit to 0. Set to 1 by the master if it receives an implausible response from the slave
6	Diag.Prm_Fault	Set by slave if last parameter frame was faulty (wrong parameterization, bad length, bad ident_number, etc.)
7	Diag.Master_Lock	Set by a class 1 master to indicate slave has been parameterized by another master (if address in DU byte 4 is not 255 and differs from its own address). Set to 0 by slave

Table 23 Profibus Diagnostic Byte 1

Bit	DIAGNOSTIC	Description
0	Diag.Prm_Req	Set by a slave if it needs to be parameterized and cleared once parameterization is complete
1	Diag.Stat_Diag	Static diagnostics. Slave sets this bit to cause the master to retrieve diagnostic information until this bit is cleared
2	Slave sets this bit to 1	
3	Diag.WD_ON	Set by slave to indicate Watchdog is active
4	Diag.Freeze_Mode	Set by slave after it has received the Freeze control command. (Freeze NOT supported)
5	Diag.Sync_Mode	Set by slave after it has received a Sync command (Synch NOT supported)
6	Reserved	
7	Diag.Deactivated	Set by the master if slave has been marked inactive within the slave parameter set and is removed from cyclic processing. Slave sets this bit to 0

Table 24 Profibus Diagnostic Byte 2

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5. PROFINET PROTOCOL

PROFINET represents the systematic union of:

- PROFIBUS DP fieldbus
- Industrial Ethernet

Ekip Com Profinet modules support standard PNIO Version V2.2, based on standard Ethernet Port 100BASETX.

5.1 Class functions

Ekip Com Profinet modules support Real time Class RT_CLASS_1. Isochronous Mode is not supported.

5.2 Protocols

Ekip Com Profinet supports the following protocols in the Profinet family

- PROFINET I/O (based on PROFINET RT, Ethertype 0x8892)
- PROFINET Discovery and basic Configuration Protocol (DCP). DCP_Hello is not supported.
- Link Layer Discovery Protocol (LLDP)

5.3 File GSDML

NOTE! The change of configuration (Legacy to Dataset and vice versa) is possible with parameter Dataset for Acyclic data, available from test bus (with unit Ekip T&P and application Ekip Connect) of from the external bus of all the com modules except for the Profinet one.

The configuration change needs a restart of the Profinet module.

The most recent GSDML files for Ekip Com Profinet modules are available on ABB library or in Profibus Website (www.profibus.com), in section Product finder searching for: SACE Emax 2 Ekip Com Profinet.

At the moment of publication, the latest versions are:

- **GSDML-V2.35-ABBsace-EkipCOMProfinet-20200330.xml**, compatible with Ekip Com Profinet with FW version ≥ 4.25 ; see sect.5.3.1 for the file features
- **GSDML-V2.35-ABBsace-EkipCOMProfinet (Legacy)-20200330.xml**, compatible with Ekip Com Profinet with FW version $\geq 2.xx$; see sect.5.3.2 for available modules

NOTE: on Profibus Website is available the Legacy file version only

5.3.1. Custom modules

Allows to create a custom profile composed by one or more single blocks; the list of available blocks is contained into the GSDML file.

See file **Profinet - Custom modules.xls** attached to the .zip file for the list of the available blocks.

5.3.2. Legacy modules

Fixed, pre-allocated modules provide the required functionalities as displayed below:

Module	Name	Information	Fixed in slot
ID_Mod_11	Status, Measures	200 bytes I (overall consistency) - ModuleIdNumber:0x30 - SubmoduleIdNumber:0x0001 - API:0x00	1
ID_Mod_12	Commands	4 bytes O (overall consistency) - ModuleIdNumber:0x31 - SubmoduleIdNumber:0x0001 - API:0x00	2
ID_Mod_13	Device Parameters	Protections, General settings	3

Table 25 Profinet Modules

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5.4 Format management

Data format LINT (Acronym 1.3.1) (4 bytes = 2 words = 2 registers) is transferred with low significant part at lower Profinet address (LOW-HIGH):

Register i	LS word
Register i + 1	MS word

Instead within WORD data the most significant byte is transferred first (according to Profinet standard)

LS byte	MS byte
---------	---------

5.5 Features and Parameters

DNS Compliant Name and IP addresses are performed by the master through DCP protocol. Default name is "emax2"

Features	Data
Maximum Input Length	1440 Bytes
Maximum Output Length	1440 Bytes
Physical Slots	0..3
Minimum Device Interval	1 ms

Table 26 Profinet Communication features

5.6 Command

Each command are formed by 2 fields:

Field name	
Command type	MS word
Command parameter	LS word

Table 27 Profinet Command

To execute a command it's requested to write together the 'Command type' and the 'Command parameter' fields.

Write into 'Command type' field the number desired and into 'Command parameter' field the optional parameter value, (0 if not needed).

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6. DEVICENET™ PROTOCOL

Ekip Com DeviceNet™ according to ODVA standard, Volume 3, edition 1.14.

6.1 File EDS

The most recent EDS file for Ekip Com DeviceNet™ modules is available on ABB library.

6.2 Communication Parameters

Available communication parameters are:

Slave MAC ID	Transfer rate
0 ÷ 63	125 kbit/s - 250 kbit/s - 500 kbit/s

Table 28 DeviceNet™ Communication Parameters

The default parameters configuration is:

Slave MAC ID	Transfer rate
63 (Ekip Com DeviceNet™ -external, internal-) 62 (Ekip Com DeviceNet™ Redundant)	125 kbit/s

Table 29 DeviceNet™ Default Parameters

6.3 Data management

All communication data must be managed considering 3 parameters:

- Class: see *communication maps*
- Instance: see *communication maps*
- Attribute : fixed to 3.

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7. ETHERNET/IP™ PROTOCOL

Ekip Com EtherNet/IP™ according to ODVA standard, Volume 2, edition 1.16.

7.1 File EDS

The most recent EDS file for Ekip Com EtherNet/IP™ modules is available on ABB library.

7.2 Communication Parameters

Available communication parameters are:

Baud rate
10 / 100Mbit/s

Table 30 EtherNet/IP™ Communication Parameters

7.2.1. Network Parameters on EtherNet/IP™

Network parameters IP Address, Subnet mask and Gateway address can be set statically directly on the unit. Alternatively, a dynamic configuration can also be chosen, and in this case two different sources can be selected to determine the device network parameters:

- DHCP server
- AutoIP (in absence of a DHCP server) , in the range 169.254.x.x, where the 2 LSBs are calculated based on the device MAC address and are thus identical between successive operations.

7.3 Data management

All communication data must be managed considering 3 parameters:

- Class: see *communication maps*
- Instans: see *communication maps*
- Attribute : fixed to 3.

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8. IEC 61850 PROTOCOL

8.1 Supportindg documents

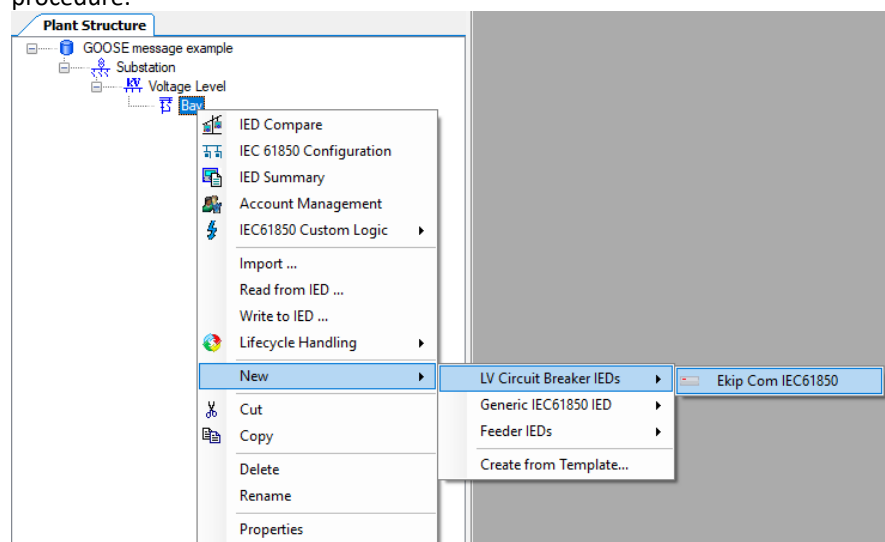
Attached to the zip file of this guide, is included the ABB official documentation for IEC 61850 protocol:

Model Implementation Conformance Document (MICS)
Protocol Implementation Conformance Statement (PICS) - 7.2
Protocol Implementation Conformance Statement (PICS) - 8.1
Protocol Implementation Extra Information for Testing (PIXIT)
Technical Issues Conformance Statement (TICS) Ed. 1

8.2 Module Integration with PCM600

ATTENTION: to integrate the Ekip Com IEC 61850 in the PMC600 application, the Connectivity package of the module must be installed; the Connectivity package is available on ABB library (search key: Connectivity package)

To add communication module Ekip Com IEC 61850 on a net, user can use the software PCM600, as described in the following procedure:



Follow the indication that appears on automatic pop to set Configuration mode, IED protocol, IP address and IEC 61850 version

8.3 ICD File

To load the .icd file on module (for example to use the standard setting configuration), two ways are possible:

- Directly from module Ekip Com IEC 61850, with a client TFTP software.
NOTE: file .icd on module refers to Ed.1 of the standard.
- With the .icd file downloaded from ABB library.
NOTE: On ABB library can be present more versions of .icd file, one for each FW version of the module and of the reference standard (Ed.1 / Ed. 2).
ATTENTION: Any further adjustments to particular tool will be indicated with an additional suffix.

To read the module SW version, it's possible to use frontal connection and Ekip connect software, or directly from display menu.

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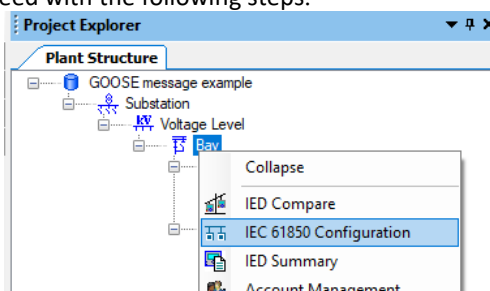
8.4 IP Address and Technical Key configuration

Make a check and, if necessary, set the two parameters as wished:

▼ [000] Appearance	
Caption	Ekip Com IEC61850
Description	Low Voltage Air Circuit Breaker
▼ [020] Addresses	
IP Address	192.168.1.55
IP-GATEWAY	0.0.0.0
IP-SUBNET	255.255.255.0
▼ [030] Communication Control	
Connection Type	Fixed
▼ [080] Authentication	
Is Authentication Disabled	True
Is Password used	False
Password	
▼ [100] SCL Information	
Configuration Version	1.0
IED Type	Generic IED
Manufacturer	ABB
SCL data model	IEC61850-1
Technical Key	AA1J1Q01A1
▼ [300] Configuration Version	
Last modified	08-Apr-21 12:23
System	IT-L-7270603
Version	2

8.5 GOOSE configuration

To use the GOOSE module output, proceed with the following steps:



Set the MAC address to obtain the output GOOSE.

NOTE:

- With default GOOSE MAC Address, no GOOSE message is generated by the unit.
- Default MAC address is different depending on Ekip Com IEC 61850 SW version:
 - For SW version < 2.05: default value of MAC address is 00:00:00:00:00:00.
 - For SW version ≥ 2.05: default value of MAC address is 01:0C:CD:01:00:00.

GOOSE Communication - IEC 61850 Configuration			Object Properties
	CBA (LD0)	CBB (LD0)	
CBA.LD0.LD0.LLN0.Bfrtrip	<input type="checkbox"/>	<input type="checkbox"/>	
CBA.LD0.LD0.LLN0.Interlock	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
CBA.LD0.LD0.LLN0.Protection	<input type="checkbox"/>	<input type="checkbox"/>	
CBB.LD0.LD0.LLN0.Bfrtrip	<input type="checkbox"/>	<input type="checkbox"/>	
CBB.LD0.LD0.LLN0.Interlock	<input type="checkbox"/>	<input type="checkbox"/>	
CBB.LD0.LD0.LLN0.Protection	<input type="checkbox"/>	<input type="checkbox"/>	

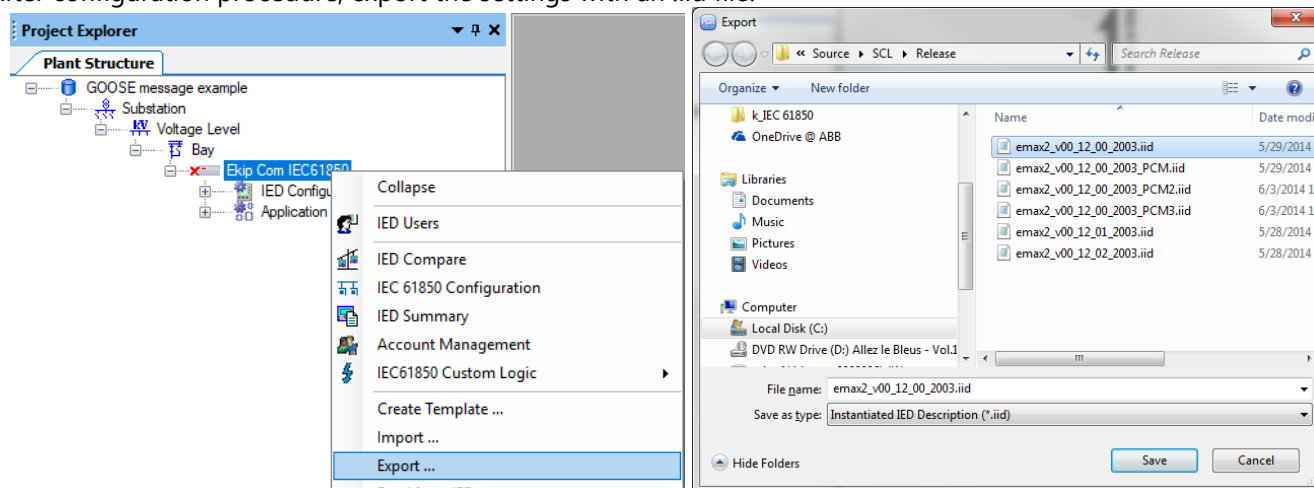
▼ Communication	
Access Point	LD0
App ID	3002
MAC Address	01-0C-CD-01-00-02
Subnetwork	WA1
VLAN ID	001
VLAN Priority	4
▼ Data	
Clients	(Collection)
▼ General	
Application ID	LD0/LLN0.Interlock
Config Revision	10000
Data Set	Interlock
Description	
Max Time	1000
Min Time	4
Name	Interlock
Type	GOOSE
▼ Substation	
IED	CBA
Logical Device	LD0
Logical Node	LLN0

If useful, is possible to set reception of GOOSE generated by the module Ekip Com IEC 61850 for other devices in the net. This operation does not influence the settings of Ekip Com IEC 61850.

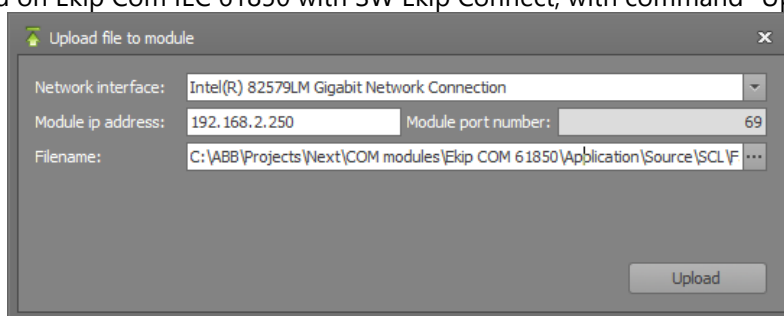
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8.6 Export of configuration on module Ekip Com IEC 61850

After configuration procedure, export the settings with an .iid file:



The .iid file must be load on Ekip Com IEC 61850 with SW Ekip Connect, with command "Upload IEC 61850":



8.7 Data set

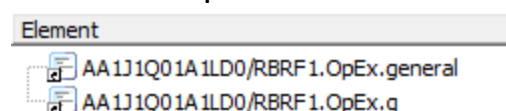
Some of the information available on Ekip Com IEC 61850 module is further grouped in the following data set:

Name	Used by
Brftrip	GOOSE
Interlock	GOOSE
MeasFlt	Report
Protection	GOOSE
Statled	Report
StatNrml	Report
StatUrg	Report
Counters	Report

Table 31 IEC 61850 Data set

NOTE: report = vertical Communication

8.7.1. Brftrip



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8.7.2. Interlock























Element
AA1J1Q01A1LD0/XCBR1.Pos.stVal
AA1J1Q01A1LD0/XCBR1.Pos.q

8.7.3. MeasFlt





Element
AA1J1Q01A1LD0/MMXU1.A.phsA
AA1J1Q01A1LD0/MMXU1.A.phsB
AA1J1Q01A1LD0/MMXU1.A.phsC
AA1J1Q01A1LD0/MMXU1.A.neut
AA1J1Q01A1LD0/MMXU1.A.net
AA1J1Q01A1LD0/MMXU1.PPV.phsAB
AA1J1Q01A1LD0/MMXU1.PPV.phsBC
AA1J1Q01A1LD0/MMXU1.PPV.phsCA
AA1J1Q01A1LD0/MMXU1.PNV.phsA
AA1J1Q01A1LD0/MMXU1.PNV.phsB
AA1J1Q01A1LD0/MMXU1.PNV.phsC
AA1J1Q01A1LD0/MMXU1.PNV.res
AA1J1Q01A1LD0/MMXU1.W.phsA
AA1J1Q01A1LD0/MMXU1.W.phsB
AA1J1Q01A1LD0/MMXU1.W.phsC
AA1J1Q01A1LD0/MMXU1.VAr.phsA
AA1J1Q01A1LD0/MMXU1.VAr.phsB
AA1J1Q01A1LD0/MMXU1.VAr.phsC
AA1J1Q01A1LD0/MMXU1.VA.phsA
AA1J1Q01A1LD0/MMXU1.VA.phsB
AA1J1Q01A1LD0/MMXU1.VA.phsC
AA1J1Q01A1LD0/MMXU1.TotW
AA1J1Q01A1LD0/MMXU1.TotVAr
AA1J1Q01A1LD0/MMXU1.TotVA
AA1J1Q01A1LD0/MMXU1.Hz
AA1J1Q01A1LD0/MMXU1.TotPF

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8.7.4. Protection







Element
 AA1J1Q01A1LD0/PTRC1.Tr.general
 AA1J1Q01A1LD0/PTRC1.Tr.q
 AA1J1Q01A1LD0/PTRC1.Str.general
 AA1J1Q01A1LD0/PTRC1.Str.dirGeneral
 AA1J1Q01A1LD0/PTRC1.Str.q
 AA1J1Q01A1LD0/F50TDPTOC1.Str.general
 AA1J1Q01A1LD0/F50TDPTOC1.Str.q
 AA1J1Q01A1LD0/F67PTOC2.Str.general
 AA1J1Q01A1LD0/F67PTOC2.Str.dirGeneral
 AA1J1Q01A1LD0/F67PTOC2.Str.q
 AA1J1Q01A1LD0/F50NTDPTOC3.Str.general
 AA1J1Q01A1LD0/F50NTDPTOC3.Str.q
 AA1J1Q01A1LD0/F50GTDPTOC4.Str.general
 AA1J1Q01A1LD0/F50GTDPTOC4.Str.q
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind1.stVal
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind1.q
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind2.stVal
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind2.q
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind3.stVal
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind3.q
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind4.stVal
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind4.q

8.7.5. Statled



Element
 AA1J1Q01A1LD0/LPHD1.PhyHealth
 AA1J1Q01A1LD0/LLN0.Mod
 AA1J1Q01A1LD0/LLN0.Beh
 AA1J1Q01A1LD0/LLN0.Health

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8.7.6. StatNrml

Element
 AA1J1Q01A1LD0/PTRC1.Str
 AA1J1Q01A1LD0/PTRC1.Tr
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind1
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind2
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind3
 AA1J1Q01A1LD0/PRGOUTGGIO1.Ind4

8.7.7. StatUrg

Element
 AA1J1Q01A1LD0/CSWI1.Pos
 AA1J1Q01A1LD0/XCBR1.Loc

8.7.8. Counters

Element
 AA1J1Q01A1LD0/MMTR1.TotVAh
 AA1J1Q01A1LD0/MMTR1.TotVArh
 AA1J1Q01A1LD0/MMTR1.TotWh

NOTE: each report can support up to 3 client connections.

9. FUNCTIONAL DESCRIPTION

9.1 Parameters programming



WARNING: It is allowed to open a programming session only in REMOTE mode.

There is a validity programming session timeout of 5 minutes: once expired, the session is aborted.

To extend it of 5 more minutes more, it is sufficient to send again an open programming session command.

The following flow chart describes the programming session.

White boxes refer to actions requested to the user.

Grey boxes refer to actions made by trip unit.

If during a session a new START PROGRAM SESSION command is sent, any change is flushed away and previous parameters are reloaded. A new session is opened.

If during a session an ABORT PROGRAM SESSION command is sent, any change is flushed away and previous parameters are reloaded. Session is closed.

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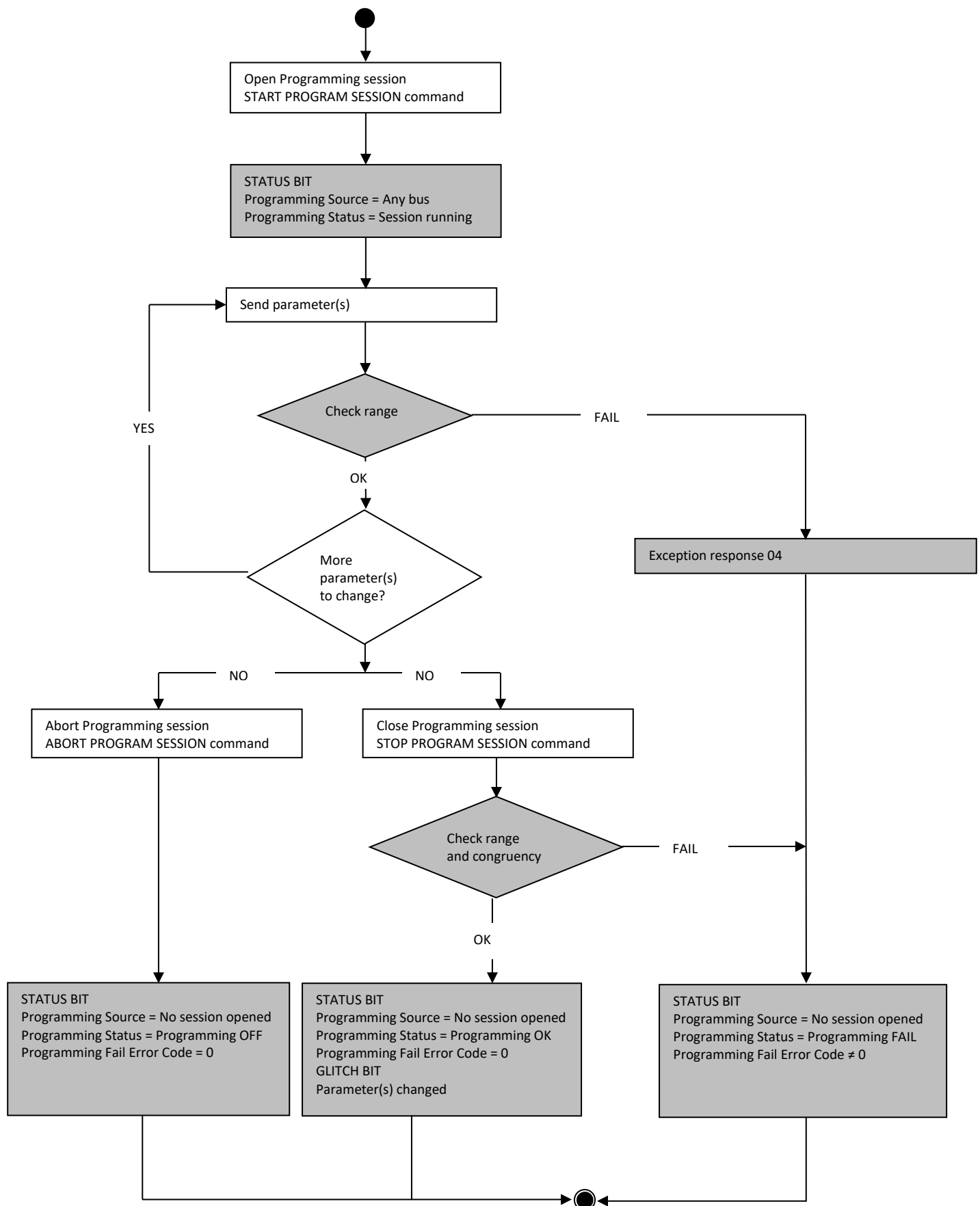


Figure 1. Programming session

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9.2 Minimum and maximum measures

The minimum and maximum values for every measure are stored.

When the device is turned off, data are erased.

It is possible to reset these measures with a command.

9.3 Harmonics and Total Harmonic Distortion

It is possible to obtain the harmonic contents and the total harmonic distortion for one current phase or one voltage, sending the relevant command.

The command (18) requires a parameter to identify the phase:

Parameter	Kind of measure
0	--
1	L1
2	L2
3	L3
4	Ne
5	V12
6	V23
7	V31

When data are available a glitch is set.

9.4 CB status information

Are always available the information about CB position.

- 1) CB open/closed.
- 2) CB tripped.
- 3) CB undefined (Ekip Com detects an invalid CB status).

NOTE: All Ekip Com modules provide also information about CB position, in case of withdrawable version.

- 4) CB isolated/connected.

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9.5 Communication statistical data

NOTE: valid only for Ekip Com Modbus modules

Device produces statistical data relevant to system bus communication.

- 1) number of received messages: counter of total number of messages received by device.
- 2) number of received messages with CRC error: counter of total number of messages received with CRC error.
- 3) number of transmitted messages: counter of total message sent by device.
- 4) number of slave device busy responses: counter of total message sent by device with exception response "Slave Device Busy".
- 5) number of exception responses: counter of total message sent by device with any exception response.

9.6 Circuit breaker statistical data

Device produces statistical data relevant to CB operations.

- 1) number of CB operations: counter of total CB operation.
- 2) number of CB manual operations: counter of total CB operation due to manual opening.
- 3) number of CB protection trips: counter of CB transition to TRIP due to protection trips.
- 4) number of CB protection trips with trip command fail: counter of CB transition to TRIP due to protection trips with trip command fail.
- 5) number of CB test trips: counter of CB transition to TRIP due to electronic trip test.

The following table explains the relationship between CB operations and counters: 'X' shows the counters updated for every CB transitions.

Transition	Condition	Nr of CB operations	Nr of CB manual operations	Nr of CB protection trips	Nr of CB fail trips	Nr of CB test trips
CLOSE TO OPEN	User operation: no trip	X	X			
CLOSE TO TRIP	Trip test					X
	Protection trip			X		
	Trip command fail				X	
TRIP TO OPEN	----	X				

Table 32. CB operations vs. counters

The relationship among counters is:

Number of CB manual operations	+
Number of CB protection trips	+
Number of CB protection trips with trip command fail	+
Number of CB test trips	=
<hr/>	
Number of CB operations	

Table 33. Relationship among counters

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9.7 Commands description and conditions

NOTE: For all commands, it is necessary that the device is in REMOTE operation device mode, otherwise it is refused.

Command type	Action	Acceptance conditions
Dummy command	No action	-
Trip reset	Reset trip status bits	-
Reset Signalling	Clear Ekip Signalling output latched signal	Ekip Signalling 2K, 4K or 10K present
Start programming session	Open programming session	No protection timings and TC connected
Abort programming session	Abort programming session Restore previous parameters values	Programming session opened
Stop programming session	End programming session	Programming session opened No consistency check errors No protection timings and TC connected
Open CB	Activate the pin to command the CB Opening Coil (Ekip Actuator + YO)	CB open command not in execution CB close command not in execution
Close CB	Activate the pin to command the CB Closing Coil (Ekip Actuator + YC)	CB in open position CB defined CB open command not in execution CB close command not in execution
Reset CB	Reset trip status bits	CB defined CB in trip position CB open command not in execution CB close command not in execution
Wink toggle command	Power LED blinks fast (2Hz)	-
Store event	Store a marker event on Events list	-
Reset measures history	Delete the measures history and store the delete event	-
Hmi wizard reset	Reset the wizard window	-
Reset energies	Delete the energies history and store the delete event	-
Start Datalogger	Start the recording of data in trip unit datalogger area	-
Stop Datalogger	Manual stop of the data recording in trip unit datalogger area	-
Start harm calc	Start the harmonics calculation NOTE: The bus that launch the command gets the priority of the harmonics calculation: the other buses are not allowed to run the same command until the release of the resource (corresponding to the stop command)	Network Analyzer activated Armonics activated
Stop harm calc	Stop the harmonics calculation	Network Analyzer activated Armonics activated
Start waveform	Start the storing of the waveform NOTE: The bus that launch the command gets the priority of the storage of the waveform: the other buses are not allowed to run the same command until the release of the resource (corresponding to the stop command)	-
Stop waveform	Stop the storing of the waveform	-
Load Reactivate	Reset the alarm and make available one of the 15 loads of the power controller function	Power controller on
Clear PC counter	Reset the power controller counters	Power controller on
Clear Pwr Quality Statistics	Reset the Network Analyzer statistics	-
2I Mode ON	Activation command of the 2I protection (see Trip unit user manual)	Protection enabled
2I Mode OFF	Deactivation command of the 2I protection (see Trip unit user manual)	Protection enabled
Reset Absolute Min/Max IV	Reset the storage of minimum and maximum values	-
Open CB Request	Set Trip unit internal bit to be combined with other logic to arrive at open of CB, used with programmable status menu	-
Close CB Request	Set Trip unit internal bit to be combined with other logic to arrive at close of CB, used with programmable status menu,	-
Reset Load Profile Timers	Reset the counters of the Load profile timers	-
Glitch Set Command	Set temporarily on the bit of the Glitch 2 status register (for many works, as not conditioned remote command)	-
Clear LS	Reset the Load Shedding run-time measures	Load shedding on

Table 34 Commands acceptance conditions

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9.8 Measure limits and representation

9.8.1. Floating Measures

Measure	Special value	Description	Data	HMI representation
Currents	Not available	Sensor disconnected	0x7FC00000	— — —
	Too low	$I < I_{min \text{ float}}$	0	● ● ●
	Saturation	$I > I_{max}$	I_{max}	$> I_{max}$
Voltages	Not available	Ekip Measuring module absent	0x7FC00000	— — —
	Too low	$V < V_{min}$	0	● ● ●
	Saturation	$V > V_{max}$	V_{max}	$> [V_{nominal} * 1,25]$
Total cosΦ	Not available	S or P not available $ S $ or $ P < P_{min}$, $ S $ or $ P > P_{max}$	0x7FC00000	— — —

Table 35 Floating Measures

9.8.2. Standard Measures

Measure	Special value	Description	Data	HMI representation
Currents	Not available	Sensor disconnected	0xFFFFFFFF	— — —
	Too low	$I < I_{min}$	0	● ● ●
	Saturation	$I > I_{max}$	I_{max}	$> I_{max}$
Internal ground current	Not available	Sensor disconnected	0xFFFFFFFF	— — —
	Too low	$I_G < I_{Gmin}$	0	● ● ●
	Saturation	$I_G > I_{Gmax}$	I_{Gmax}	$> I_{Gmax}$
External ground current	Not available	External toroid absent, Sensor disconnected	0xFFFFFFFF	— — —
	Too low	$I_{GEXT} < I_{GEXTmin}$	0	● ● ●
	Saturation	$I_{GEXT} > I_{GEXTmax}$	$I_{GEXTmax}$	$> I_{GEXTmax}$
Rc current	Not available	Rc toroid absent, Toroid disconnected	0xFFFFFFFF	— — —
	Too low	$I_{RC} < I_{RCmin}$	0	● ● ●
	Saturation	$I_{RC} > I_{RCmax}$	I_{RCmax}	$> I_{RCmax}$
Maximum current phase	Not available	All sensors disconnected, All current values $< I_{min}$	0	— — —
Voltages	Not available	Ekip Measuring module absent	0xFFFF	— — —
	Too low	$V < V_{min}$	0	● ● ●
	Saturation	$V > V_{max}$	V_{max}	$> [V_{nominal} * 1,25]$
Active, reactive and phase power (P1, P2, P3, Q1, Q2, Q3, S1, S2, S3)	Not available	Ekip Measuring module absent, Sensor disconnected, $I < I_{min}$, $V < V_{min}$	0x7FFFFFFF	— — —
	Too low	$ P < P_{min}$	0	● ● ●
	Saturation	$ P > P_{max}$	P_{max}	$> [P_{nominal} * 1,25]$
Total power (P, Q, S)	Not available	All phase power not available	0x7FFFFFFF	— — —
Active, reactive and apparent energy	Positive saturation	$E > 2^{31}-1$	0x7FFFFFFF	2147483647
	Negative saturation	$E < -2^{31}$	0x80000000	-2147483648
Total cosΦ	Not available	S or P not available $ S $ or $ P < P_{min}$, $ S $ or $ P > P_{max}$	0x7FFF	— — —
Peak factor	Not available	Sensor disconnected, $I < I_{min \text{ Peak}}$	0xFFFF	— — —

Table 36 Standard Measures 1

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Measure	Special value	Description	Data	HMI representation
Frequency	Not available	Ekip Measuring module absent, $V < V_{min}$	0xFFFF	_ _ _
	Too low	$F < \text{minimum frequency}$	Fmin	30
	Too high	$F > \text{maximum frequency}$	Fmax	80
I Harmonic amplitude	Not available	Amplitude < I Harm min	0	_ _ _
	Saturation	Amplitude > I Harm max	I Harm max	> Imax
V Harmonic amplitude	Not available	Amplitude < V Harm min	0	_ _ _
	Saturation	Amplitude > V Harm max	V Harm max	> [V Harm max * 1.25]
Contact wear	Saturation	CW > 100%	65000	100%

Table 37 Standard Measures 2

Measures Minimum / Maximum

$I_{min} = 0,03 I_n$

$I_{min \text{ float}} = 0,004 I_n$

$I_{min \text{ Peak}} = 0,1 I_n$

$I_{max} = 64 I_n$

$I_{Gmin} = 0,08 I_n$

$I_{Gmax} = 64 I_n$

$IGEXT_{min} = 0,08 I_n \text{ (sensor)}$

$IGEXT_{max} = 4 I_n \text{ (sensor)}$

$IRC_{min} = 2 A_{rms}$

$IRC_{max} = 32 A_{rms}$

$V_{min} = 5 V_{rms}$

$V_{max} = 900 V_{rms}$

$P_{min} = (0,5 I_n) * (5 V_{rms})$

$P_{max} = (3) * (16 I_n) * (900V)$

$F_{min} = 30 \text{ Hz}$

$F_{max} = 80 \text{ Hz}$

$I \text{ Harm min} = 0.09 I_n$

$I \text{ Harm max} = 2 I_n$

$V \text{ Harm min} = 5 V_{rms}$

$V \text{ Harm max} = 900 V_{rms}$

10. REVISION HISTORY

Version	Date	Details
B	16/10/2018	New document
C	31/03/2021	4.2.1 Inserted references to guide and sheet for profibus gsd custom profile 8.1 added IEC 61850 files 9.7 updated commands table 9.8 added floating measures table 4.2, 5.3, 8: updated description of supporting files and available configuration options

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