SIA-C

Self & Dual Powered Overcurrent & Earth Fault Protection Relay

DNP3.0 PROTOCOL MANUAL

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1. INTRODUCTION

This manual describes the DNP 3 interoperability Slave profile integrated in SIA-C devices.

- Configurable Version (Firmware version since M04.03.00)

The information included in this document is reviewed regularly, so any correction or improvement will be included in the following revisions.

2. DNP3.0 PROTOCOL COMMUNICATION PARAMETERS

As communication parameters are common for all the protocols, they can be adjusted on General Settings of the relay, on the following menus:

Description	Minimun	Maximun	Step	Unit	Default
Rear Serial Communications (for DNP 3.0 Serial)					
Protocol	-	-	Modbus RTU, IEC 60870-5-103 or DNP3.0	-	Modbus RTU
Baudrate	-	-	4800, 9600, 19200, 38400, 57600, 115200	-	19200
Parity	-	-	8-N-1, 8-E-1, 8-O-1, 9-N-1, 8-N-2, 8-E-2, 8-O-2, 9-N-2	-	8-N-1

Inside protocol:

Description	Minimun	Maximun	Step	Unit	Default
DNP3 Serial					
Slave Address	0	65519	1	-	4
DNP3 Master Address	0	65519	1	-	1
Self Address	-	-	Yes/No	-	No
MultiMaster	-	-	Yes/No	-	No
Pre Transmition Delay	0	250	1	ms	5
Clock Synchronization Enable	-	-	Yes/No	-	No
Unsolicited Responses Enable	-	-	Yes/No	-	Yes
Unsolicited Responses Retries	1	10	1	-	3
Unsolicited Responses Timeout	0	60000	1	ms	2000
Solicited Responses Timeout	0	60000	1	ms	2000
Select Timeout	1	300	1	s	15

3. DEVICE PROFILE DOCUMENT

DNP V3.00

DEVICE PROFILE DOCUMENT

This document must be accompanied by : **Implementation Table** and **Point List**.

Vendor Name: **FANOX Electronic, S.L.**

Device Name: **SIA-C**

Highest DNP Level Supported:	Device Function:
For Requests **2** For Responses **2**	☐ Master ☒ **Slave**

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

Static object requests sent with qualifiers 06, will be responded with qualifiers 00.
32-bit and Analog Change Events with Time may be requested.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted **255** Received **255**	Transmitted **768** Received **216**

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☒ **None** ☐ Fixed at _____ ☐ Configurable.	☐ None ☐ Fixed at 10. ☒ **Configurable**

Requires Data Link Layer Confirmation:

☒ **Never**
☐ Always
☐ Sometimes. If 'Sometimes', when? _____
☐ Configurable as Never, Only for multi-frame messages, or Always. Default Never

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always (not recommended)
- ☒ **When reporting Event Data (Slave devices only)**
- ☐ When sending multi-fragment responses (Slave devices only)
- ☐ Sometimes. If 'Sometimes', when?
- ☐ Configurable as: "Only when reporting event data", or "When reporting event data or multi-fragment messages."

Timeouts while waiting for:

Data Link Confirm	☒ **None**	☐ Default at 5000ms	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at 2s	☐ Variable	☒ **Configurable**
Complete Appl. Response	☒ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable

Others

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT (3) / OPERATE (4)	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE (5)	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK (6)	☐ Never	☒ **Always**	☐ Sometimes	☐ Configurable
Count > 1	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse Off	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒**Always**	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒**Always**	☐ Sometimes	☐ Configurable
Queue	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ **Never**	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation:

All points support the same Function Codes: Select Before Operate (SBO) and Direct Operate (DO).
All points support the same Control Codes: Latch ON, Latch OFF.

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:	
Reports Binary Input Change Events when no specific variation requested: ☐ Never ☒ **Only time-tagged** ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☒ **Binary Input Change with Time** ☐ Binary Input Change with Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☐ Configurable ☐ Only certain objects (Class 1) ☐ Sometimes (attach explanation) ☒ **ENABLE / DISABLE UNSOLICITED Function codes supported**	Sends Static Data in Unsolicited Responses: ☒ **Never** ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ **Default Object 20** **Default Variation 01** ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☒ **32 Bits** ☐ Other Value _____ ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ☐ Yes ☒ No	

QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS

Function Codes

1	Read
2	Write
3	Select
4	Operate
5	Direct Operate
6	Direct Operate-No ACK
13	Cold Start
14	Warm Start
20	Enable Unsol. Messages
21	Disable Unsol. Messages
23	Delay Measurement
129	Response
130	Unsolicited Message

7	6	5	4	3	2	1	0
	Index Size			Qualifier Code			

Index Size

0- No Index, Packed
1- 1 Byte Index
2- 2 Byte Index
3- 4 Byte Index
4- 1 Byte Object Size
5- 2 Byte Object Size
6- 4 Byte Object Size

Qualifier Code

0- 8-Bit Start and Stop Indices
1- 16-Bit Start and Stop Indices
2- 32-Bit Start and Stop Indices
3- 8-Bit Absolute Address Ident.
4- 16-Bit Absolute Address Ident.
5- 32-Bit Absolute Address Ident.
6- No Range Field (All)
7- 8-Bit Quantity
8- 16-Bit Quantity
9- 32-Bit Quantity
11-(0xB) Variable array

4. IMPLEMENTATION TABLE

The following implementation table identifies which object groups and variations, function codes and qualifiers the device supports in both requests and responses. The *Requests* columns identify all requests that may be sent by a master, or all requests that must be parsed by an outstation. The *Response* columns identify all responses that must be parsed by a Master, or all responses that may be sent by an outstation.

In the table below, text shaded as (example) indicates subset Level 3 functionality (beyond Subset Level 2).
In the table below, text shaded as (example) indicates functionality beyond Subset Level 3.

OBJECT			REQUEST (BCD will parse)		RESPONSE (BCD will respond)		
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**	**Notes**
0	216	Device Attributes - Max Number of Binary Output Per Request	1 (read)	00	129 (Response)	00	
	222	Device Attributes - Support for Binary Output Events	1 (read)	00	129 (Response)	00	
	223	Device Attributes - Max Binary Output Index	1 (read)	00	129 (Response)	00	
	224	Device Attributes - Number of Binary Outputs	1 (read)	00	129 (Response)	00	
	226	Device Attributes - Support for Frozen Counters	1 (read)	00	129 (Response)	00	
	227	Device Attributes - Support for Counter Events	1 (read)	00	129 (Response)	00	
	228	Device Attributes - Max Counter Index	1 (read)	00	129 (Response)	00	
	229	Device Attributes - Number of Counter Points	1 (read)	00	129 (Response)	00	
	231	Device Attributes - Support for Analog Input Events	1 (read)	00	129 (Response)	00	
	232	Device Attributes - Maximum Analog Input index	1 (read)	00	129 (Response)	00	
	233	Device Attributes - Number of Analog Input Points	1 (read)	00	129 (Response)	00	
	237	Device Attributes - Support for Binary Input Events	1 (read)	00	129 (Response)	00	
	238	Device Attributes - Max Binary Input Index	1 (read)	00	129 (Response)	00	
	239	Device Attributes - Number of Binary Input Points	1 (read)	00	129 (Response)	00	
	240	Device Attributes - Max Transmit Fragment Size	1 (read)	00	129 (Response)	00	
	241	Device Attributes - Max Receive Fragment Size	1 (read)	00	129 (Response)	00	
	242	Device Attributes - Device Manufacturer's Software Version	1 (read)	00	129 (Response)	00	
	247	Device Attributes - User-Assigned Device Name	1 (read)	00	129 (Response)	00	
	248	Device Attributes - Device Serial Number	1 (read)	00	129 (Response)	00	
	249	Device Attributes - DNP3 Subset and Conformance	1 (read)	00	129 (Response)	00	

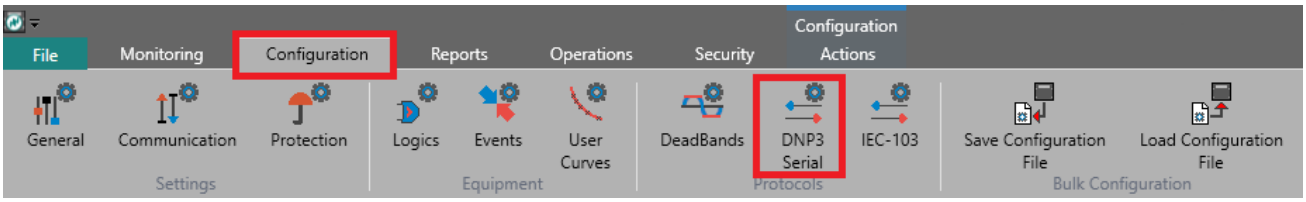
OBJECT			REQUEST (BCD will parse)		RESPONSE (BCD will respond)		
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**	**Notes**
	250	Device Attributes - Device Manufacturer's Product Name and Model	1 (read)	00	129 (Response)	00	
	255	Device Attributes – List of Attribute Variations	1 (read)	00,06	129 (Response)	00	
1	1	Binary Input - Packed Format **(Default)**	1 (read)	00, 01, 06	129 (response)	00	Assigned to Class 0
	2	Binary Input - With Flags	1 (read)	00, 01, 06	129 (response)	00	
	2	Binary Input - With Flags	1 (read)	00, 01, 06	129 (response)	00	
2	0	Binary Input Event - Any variation	1 (read)	06, 07, 08			
	1	Binary Input Event – Without Time	1 (read)	06, 07, 08	129 (response), 130 (unsolicited)	17, 28	
	2	Binary Input Event – With Absolute Time **(Default)**	1 (read)	06, 07, 08	129 (response), 130 (unsolicited)	17, 28	Assigned to Class 1
	3	Binary Input Event – With Relative Time	1 (read)	06, 07, 08	129 (response), 130 (unsolicited)	17, 28	
10	0	Binary Output – Any variation	1 (read)	00, 01, 06			
	1	Binary Output – Packed Format	1 (read)	00, 01, 06	129 (response)	00	
	2	Binary Output – Output status with flags **(Default)**	1 (read)	00, 01, 06	129 (response)	00	Assigned to Class 0
11	0	Binary Output Event – Any Variation	1 (read)	06, 07, 08			
	1	Binary Output Event – Without Time	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
	2	Binary Output Event – Status with Time **(Default)**	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	Assigned to Class 1
12	1	Binary Command – Control Relay Output Block (CROB)	3 (Select) 4 (Operate) 5 (Direct Operate)	17, 28	129 (response)	Echo of request	
	1	Binary Command – Control Relay Output Block (CROB)	6 (Dir. Op., no ack)	17, 28			
20	0	Counter – Any Variation	1 (read)	00, 01			
	1	Counter – 32 Bit with flag **(Default)**	1 (read)	00, 01	129 (response)	00	Assigned to Class 0
	2	Counter – 16 Bit with flag	1 (read)	00, 01	129	00	

OBJECT			REQUEST (BCD will parse)		RESPONSE (BCD will respond)		
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**	**Notes**
	5	Counter – 32 Bit without flag	1 (read)	00, 01	(response)	00	
	6	Counter – 16 Bit without flag	1 (read)	00, 01	129	00	
20	0	Counter – Any Variation	7 (Inm. Freeze), 8 (Inm. Freeze no ack) 9 (Freeze & clear) 10 (Freeze & clear- no ack)	00, 01, 06	129 (response)	00	
21	0	Frozen Counter – Any Variation	1 (read)	00, 01, 06			
	1	Frozen Counter – 32 Bit with flag **(Default)**	1 (read)	00, 01, 06	129 (response)	00	
	2	Frozen Counter – 16 Bit with flag	1 (read)	00, 01, 06	129 (response)	00	
	9	Frozen Counter – 32 Bit without flag	1 (read)	00, 01, 06	129 (response)	00	
	10	Frozen Counter – 16 Bit without flag	1 (read)	00, 01, 06	129 (response)	00	
22	0	Counter Event – Any Variation	1 (read)	06, 07, 08			
	1	Counter Event – 32 Bit with flag	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
	2	Counter Event – 16 Bit with flag	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
	5	Counter Event – 32 Bit with time and flag **(Default)**	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	Assigned to Class 3
	6	Counter Event – 16 Bit with time and flag	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
30	0	Analog Input – Any Variation	1 (read)	00, 01, 06			
	1	Analog Input – 32-Bit with flag **(Default)**	1 (read)	00, 01, 06	129 (response)	00	Assigned to Class 0
	2	Analog Input – 16-Bit with flag	1 (read)	00, 01, 06	129 (response)	00	
	3	Analog Input – 32-Bit without flag	1 (read)	00, 01, 06	129 (response)	00	
	4	Analog Input – 16-Bit without flag	1 (read)	00, 01, 06	129 (response)	00	
32	0	Analog Input Event – Any variation	1 (read)	06, 07, 08			

OBJECT			REQUEST (BCD will parse)		RESPONSE (BCD will respond)		
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**	**Notes**
	1	Analog Input Event – 32-Bit without Time	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	Assigned to Class 2
	2	Analog Input Event – 16-Bit without Time	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
	3	Analog Input Event – 32-Bit with Time **(Default)**	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
	4	Analog Input Event – 16-Bit with Time	1 (read)	06, 07, 08	129 (response) 130 (unsolicited)	17, 28	
50	0	Time and Data – Any Variation	1 (read) 2 (write)	07 (limited qty = 1)			
	1	Time and Data – Absolute time **(Default)**	1 (read) 2 (write)	07 (limited qty = 1)	129 (response)	07	
51	1	Time and Date CTO – Absolute Time, synchronized			129 (response) 130 (unsolicited)	07	
	2	Time and Date CTO – Absolute Time, unsynchronized			129 (response) 130 (unsolicited)	07	
60	1	Class Objects – Class 0 Data	1 (read)	06	129 (response)	00	
	2	Class Objects – Class 1 Data	1 (read)	06, 07, 08	129 (response)	17, 28	
	3	Class Objects – Class 2 Data	1 (read)	06, 07, 08	129 (response)	17, 28	
	4	Class Objects – Class 3 Data	1 (read)	06, 07, 08	129 (response)	17, 28	
80	1	Internal Indications – Packed Format	1 (read)	00, 01			
	1	Internal Indications – Packed Format	2 (write)	00			

5. POINT LIST CONFIGURATION

The configuration of the signals is done from the SICom software on **Configuration Menu/DNP3 Serial**



Once the desired protocol is selected, a new window appears with the different types of signals to be configured:

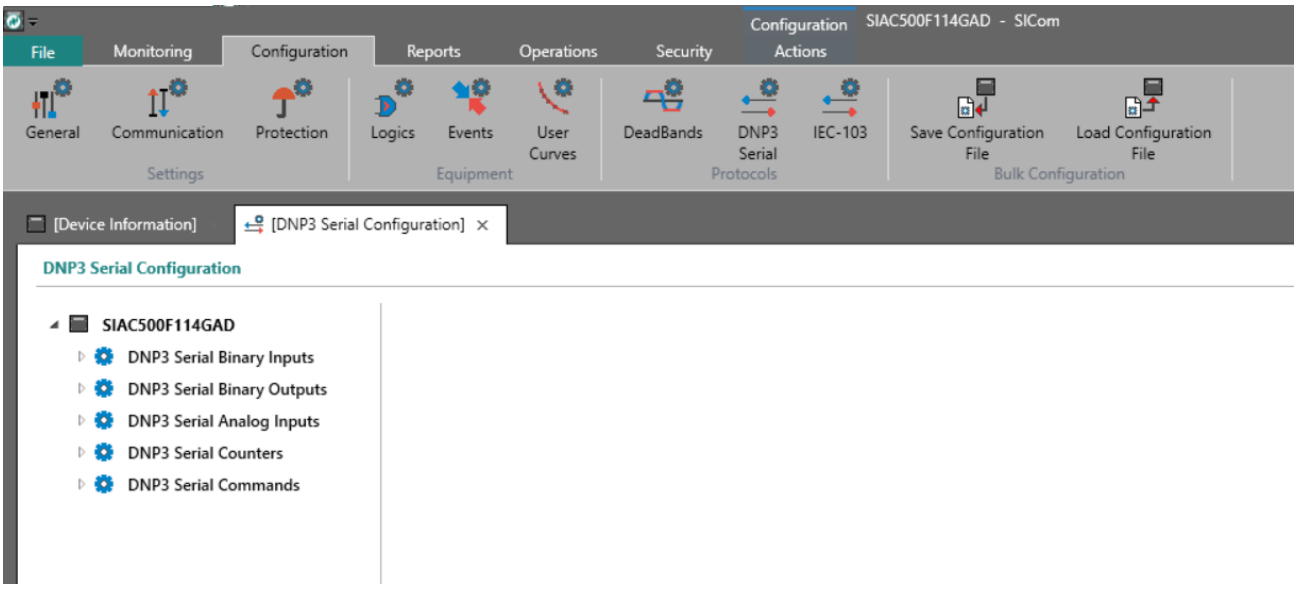
-Binary Inputs

-Binary Outputs

-Analog Inputs

-Counters

-Commands



5.1. BINARY INPUT CONFIGURATION.

BINARY INPUT (OBJECT 1) -> Assigned to Class 0

BINARY INPUT EVENT (OBJECT 2) -> Assigned to Class 1

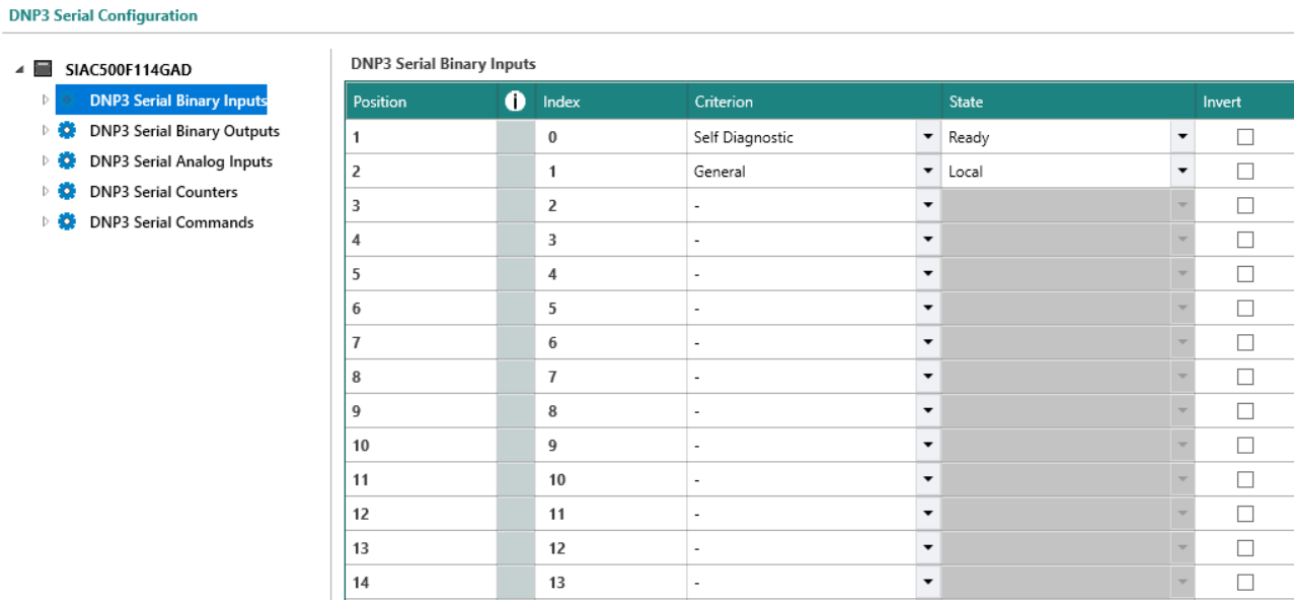
The configurable point list is available with memory for up to 32 binary input objects.

We recommend configuring only the necessary binary inputs, it is not necessary to configure all 32 signals. Gaps in the configuration are accepted, non-configured signals will report "0" value and “off-line” flag when requested.

To configure select:

- DNP3 Serial Binary Inputs

It will open the entire database table of binary input signals.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the signal address starting from 1
Information	Relevant information (configuration not saved, configuration load from file…) Readable overing the mouse over the image in the field
Index	Informative numeral to show the DNP3 Index starting from 0
Criteria	Group of signals according to the relay model, selectable from a list
States	Signal available in each group, selectable from a list
Invert	Inverts the value of the incoming signal

5.2. BINARY OUTPUT

BINARY OUTPUT (OBJECT 10) -> Assigned to Class 0.

BINARY OUTPUT CHANGE (OBJECT 11) -> Assigned to Class 1.

The Binary Output map is configurable up to 8 binary output objects.

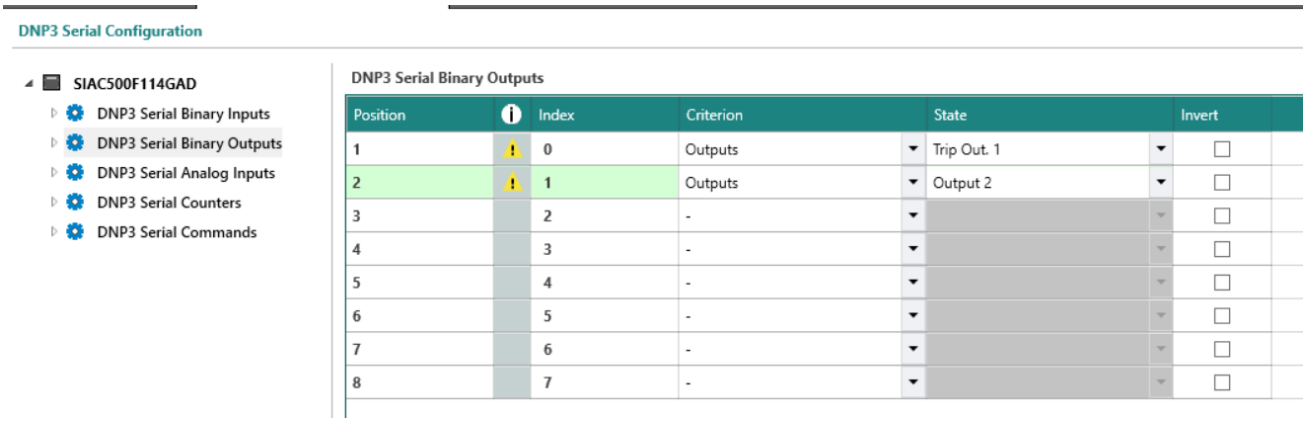
The number of physical outputs to be mapped will depend on the selected model:

SIACxxxxxx2xxx Signaling outputs	SIACxxxxxx3xxx Signaling outputs	SIACxxxxxx4xxx Signaling outputs
Output 1: trip output 1	Output 1: trip output 1	Output 1: trip output 1
Output 2	Output 2: trip output 2	Output 2
Output 3	Output 3: trip output 3	Output 3
Output 4	Output 4	Output 4
Output 5	Output 5	Output 5
-	-	Output 6
-	-	Output 7
-	-	Output 8

To configure the outputs, select:

- DNP3 Serial Binary Outputs

It will open the entire database table of binary output signals.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the signal address starting from 1
Information	Relevant information (configuration not saved, configuration load from file…) Readable overing the mouse over the image in the field
Index	Informative numeral to show the DNP3 Index starting from 0
Criteria	Group of signals according to the relay model, selectable from a list
States	Signal available in each group, selectable from a list
Invert	Inverts the value of the outcoming signal

5.3. ANALOG INPUT CONFIGURATION.

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0

ANALOG INPUT CHANGE (OBJECT 32) -> Assigned to Class 2

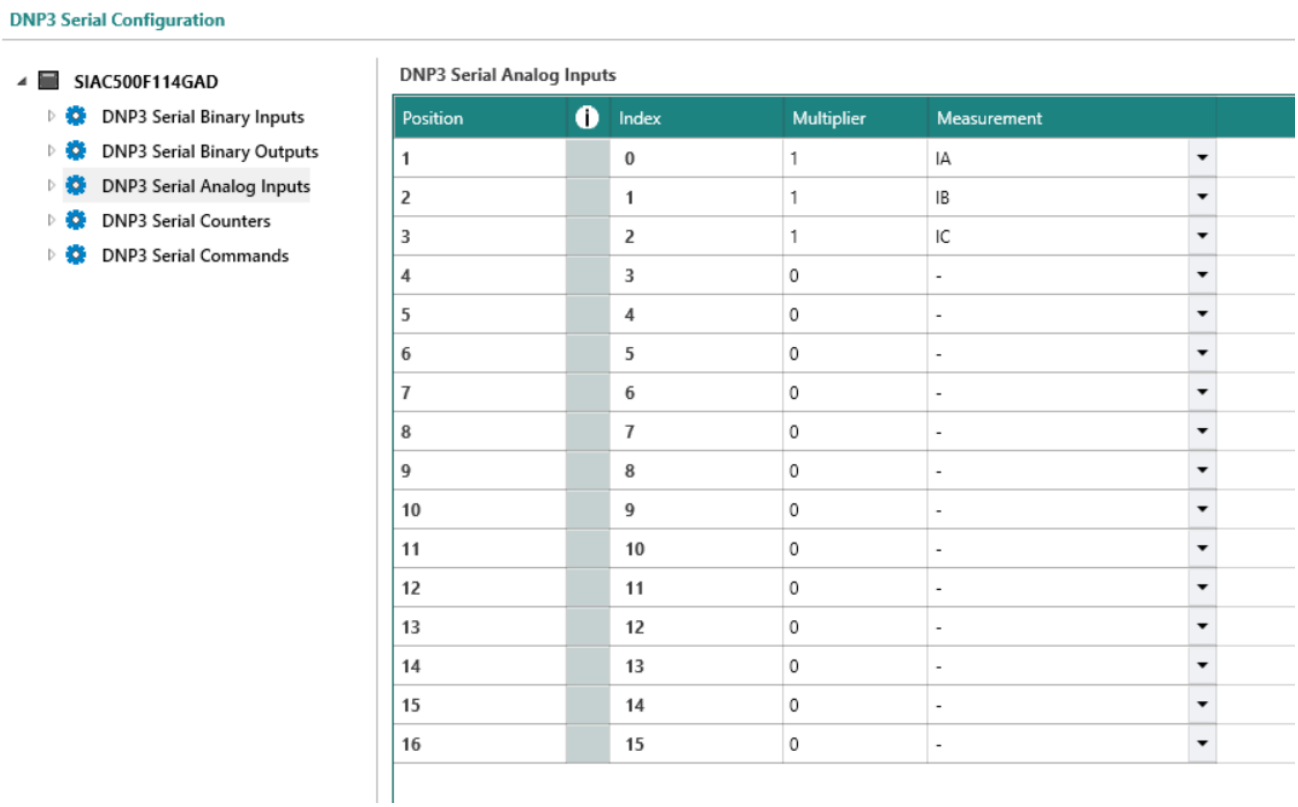
Configurable point list is available with memory for 16 analog input objects.

We recommend configuring only the necessary analog inputs, it is not necessary to configure all 16 signals. Gaps in the configuration are accepted; non-configured signals will report "0" value and “off-line” flag when requested.

To configure the signals, select:

- DNP3 Serial Analog Inputs

It will open the entire database table of analog signals.



Position	Index	Multiplier	Measurement
1	0	1	IA
2	1	1	IB
3	2	1	IC
4	3	0	-
5	4	0	-
6	5	0	-
7	6	0	-
8	7	0	-
9	8	0	-
10	9	0	-
11	10	0	-
12	11	0	-
13	12	0	-
14	13	0	-
15	14	0	-
16	15	0	-

For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the signal address starting from 1
Information	Relevant information (configuration not saved, configuration load from file…) Readable overing the mouse over the image in the field
Index	Informative numeral to show the DNP3 Index starting from 0
Multiplier	Parameter to multiply the measured value before communicating it
Measurement	Measure to be configured. Selectable from a list

5.4. COUNTERS

COUNTER (OBJECT 20) -> Assigned to Class 0.

COUNTER EVENT (OBJECT 22) -> Assigned to Class 1.

FROZEN COUNTER (OBJECT 21)

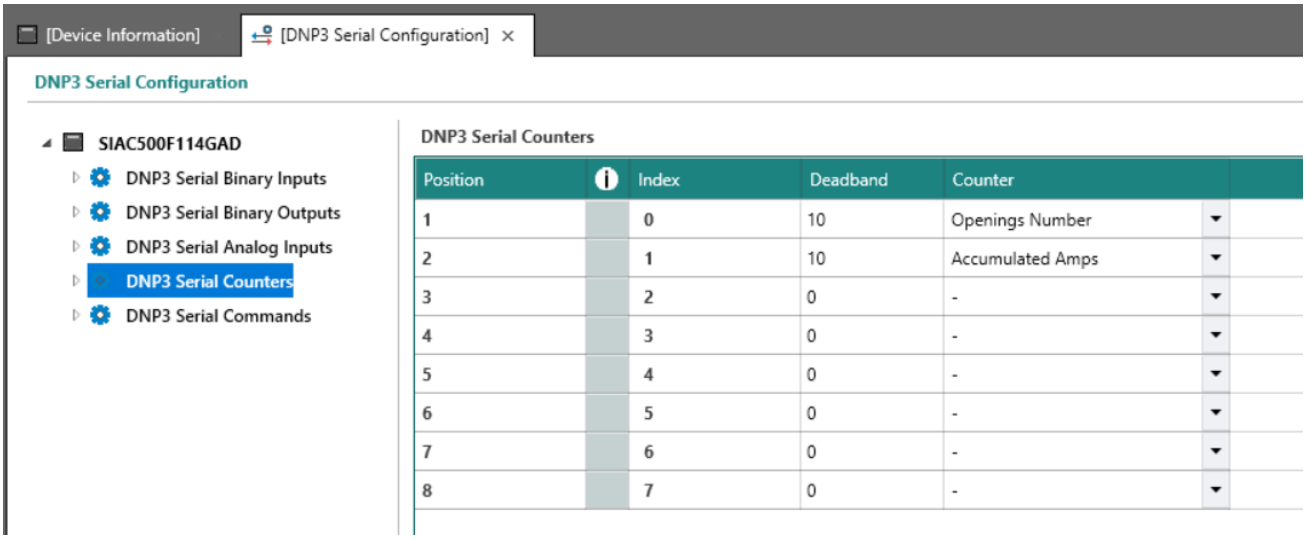
Configurable point list is available with memory for 8 counter objects.

Gaps in the configuration are accepted; non-configured signals will report "0" value and “off-line” flag when requested.

To configure the signals, select:

- DNP3 Serial Counters

It will open the entire database table of counters.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the signal address starting from 1
Information	Relevant information (configuration not saved, configuration load from file…) Readable overing the mouse over the image in the field
Index	Informative numeral to show the DNP3 Index starting from 0
Deadband	Indicates how much the signal must change before it is transmitted.
Counter	Signal to be configured. Selectable from a list

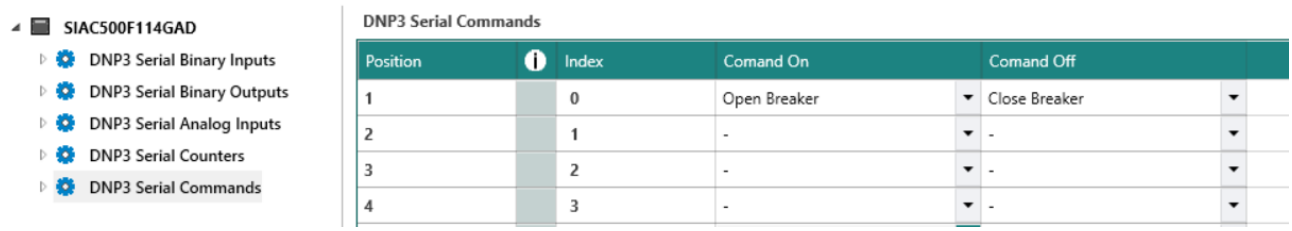
5.5. CONTROL RELAY OUTPUT BLOCK (OBJECT 12)

Configurable point list is available with memory for 16 CROB objects.

To configure the signals, select:

- DNP3 Serial Commands

It will open the entire database table of commands.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the signal address starting from 1
Information	Relevant information (configuration not saved, configuration load from file…) Readable overing the mouse over the image in the field
Index	Informative numeral to show the DNP3 Index starting from 0
Command On	Action executed when the latch-on control code is sent.
Command off	Action executed when the latch-off control code is sent.

Note: when the relay is in local control mode, for safety reasons, it is not possible to put it in remote mode through remote communications.

6. EXAMPLE OF TIME AND DATE SYNCHRONIZATION

Unix time is a system for describing a point in time. It is the number of miliseconds that have elapsed since 00:00:00 Thursday, 1 January 1970.

Example of date:
07/15/2019 @ 08:58:35 am (UTC)

Is equivalent to:
1563173915 in seconds → 1563173915000 in miliseconds → 016B F46D 0978 in HEX

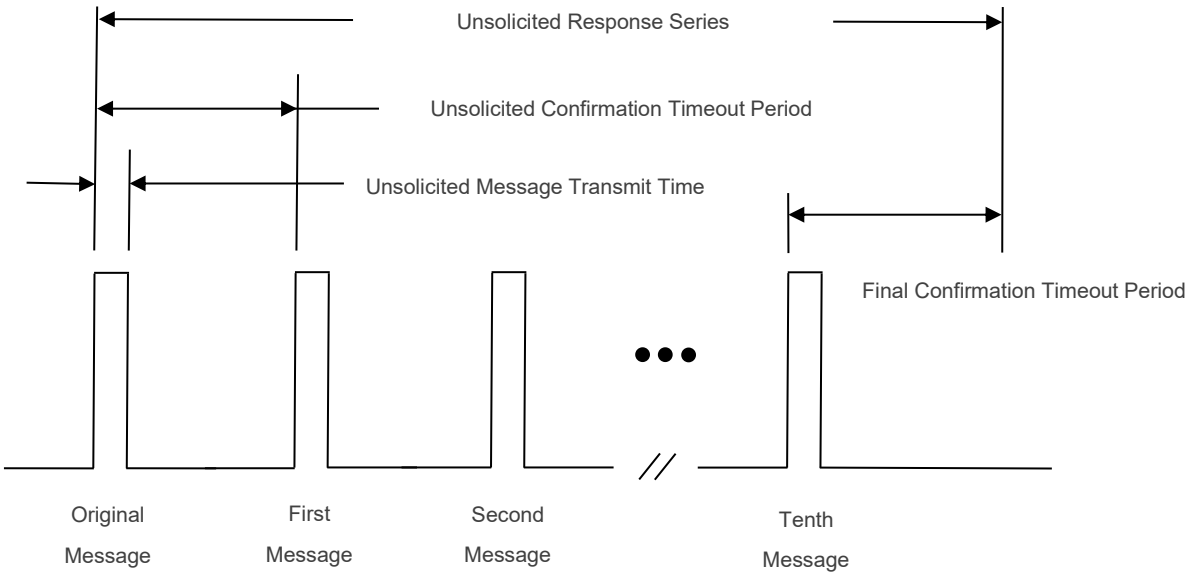
This date shall be sent inside the frame as follows (less to more singinficative octect):
78 09 6D F4 6B 01

7. UNSOLICITED RESPONSES

Unsolicited responses are messages spontaneously sent from SIA-C without a specific request from a master station when something of significance occurs.

The SIA-C relay supports the functions code 20 (Enable Unsolicited Responses) and 21 (Disable Unsolicited Responses). The SIA-C default configuration has the unsolicited responses disable, if the user wants to start using these messages must perform the function code 20. After the function code 20 is sent, the user must open the communication port. This communication port is set to 20000 as default.

The unsolicited responses behavior follows the procedure described in the standard and it is illustrated in the following diagram:



After the original message in sent, the relay waits, by default, two seconds for the master confirmation, this time is shown as the *Unsolicited Confirmation Timeout Period* in the figure. If the relay does not receive any confirmation from the master, then the relay retries the original message in a series of, by default, three messages.

The timeout period and number of retries are configurable since version 4.03.00 of the firmware.

All the Binary Inputs, Outputs and Counter changes described previously in this document are available to be sent in an Unsolicited Response message.

The measurements sent via Analog Input objects are available to be sent in an Unsolicited response considering the deadband variation previously explained in this document.

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