SIR-A

Feeder Protection and Recloser Control Relay



DNP3.0 PROTOCOL MANUAL

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1. INTRODUCTION

This manual describes the DNP 3 interoperability Slave profile integrated in SIR-A devices.

- Configurable Version (Firmware version after M01.12.00)

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

The communication can be serial or TCP/IP.

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

Description	Minimun	Maximun	Step	Unit	Default
Rear TCP Communications (for DNP 3.0 TCP/IP)					
Protocol	-	-	Modbus TCP, IEC 60870-5-104 or DNP3.0 TCP	-	Modbus TCP
IP Address	1.0.0.1	223.255.255.254	-	-	192.168.200.100
Subnet	255.0.0.0	255.255.255.252	-	-	255.255.255.0
Gateway	1.0.0.1	223.255.255.254	-	-	192.168.200.1
DNS – 1	0.0.0.0	255.255.255.255		-	0.0.0.0
DNS – 2	0.0.0.0	255.255.255.255		-	0.0.0.0
SNTP	-	-	0.es.pool.ntp.org	-	0.es.pool.ntp.org

Inside each protocol:

Description	Minimun	Maximun	Step	Unit	Default
DNP3 Serial					
Slave Address	0	65519	1	-	3
DNP3 Master Address	0	65519	1	-	1
MultiMaster	-	-	Yes/No	-	No
Unsolicited Retries	1	255	1	s	10
Unsolicited TimeOut	0,02	300	1	s	2

Description	Minimun	Maximun	Step	Unit	Default
DNP3 TCP					
Slave Address	0	65519	1	-	3
DNP3 Master Address	0	65519	1	-	1
TCP Port	1	65535	1	-	20000
MultiMaster	-	-	Yes/No	-	No
Unsolicited Retries	1	255	1	s	10
Unsolicited TimeOut	0,02	300	1	s	2

  - Activity timeout (by default 5min).

3. DEVICE PROFILE DOCUMENT

DNP V3.00

DEVICE PROFILE DOCUMENT

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

Vendor Name: FANOX **FANOX Electronic, S.L.**	
Device Name: **SIR-A**	
Highest DNP Level Supported: For Requests **2** For Responses **2**	Device Function: ☐ 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): Transmitted **255** Received **255**	Maximum Application Fragment Size (octets): Transmitted **768** Received **216**
Maximum Data Link Re-tries: ☒ **None** ☐ Fixed at _____ ☐ Configurable.	Maximum Application Layer Re-tries: ☐ 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 must be parsed 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**
1	0	Binary Input - Any variation	1 (read)	00, 01, 06			
	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	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			

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**
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	
	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 response)	00, 01, 06	129 (response)	00	
	1	Counter – 32 Bit with flag **(Default)**	7 (Inm. Freeze), 8 (Inm. Freeze no response)	00, 01, 06	129 (response)	00	
	2	Counter – 16 Bit with flag	7 (Inm. Freeze), 8 (Inm. Freeze no response)	00, 01, 06	129 (response)	00	
	5	Counter – 32 Bit without flag	7 (Inm. Freeze), 8 (Inm. Freeze no response)	00, 01, 06	129 (response)	00	
	6	Counter – 16 Bit without flag	7 (Inm. Freeze), 8 (Inm. Freeze no response)	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	

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**
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			
	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	

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**
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

5.1. BINARY INPUT CONFIGURATION.

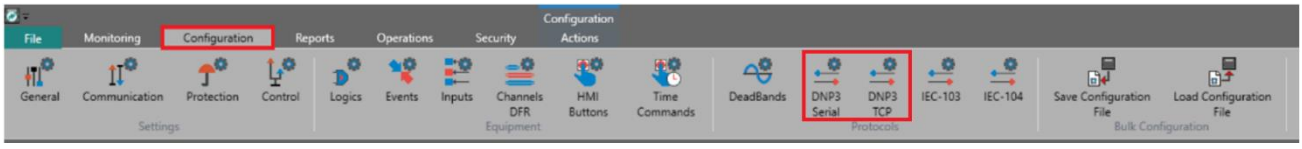
BINARY INPUT (OBJECT 1) -> Assigned to Class 0

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

The configurable point list is available with memory for up to 256 configurable binary inputs.

We recommend configuring only the necessary binary inputs, it is not necessary to configure all 256 signals. Gaps in the configuration are accepted. Non-configured signals will report "0" value and “off-line” flag when requested.

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



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

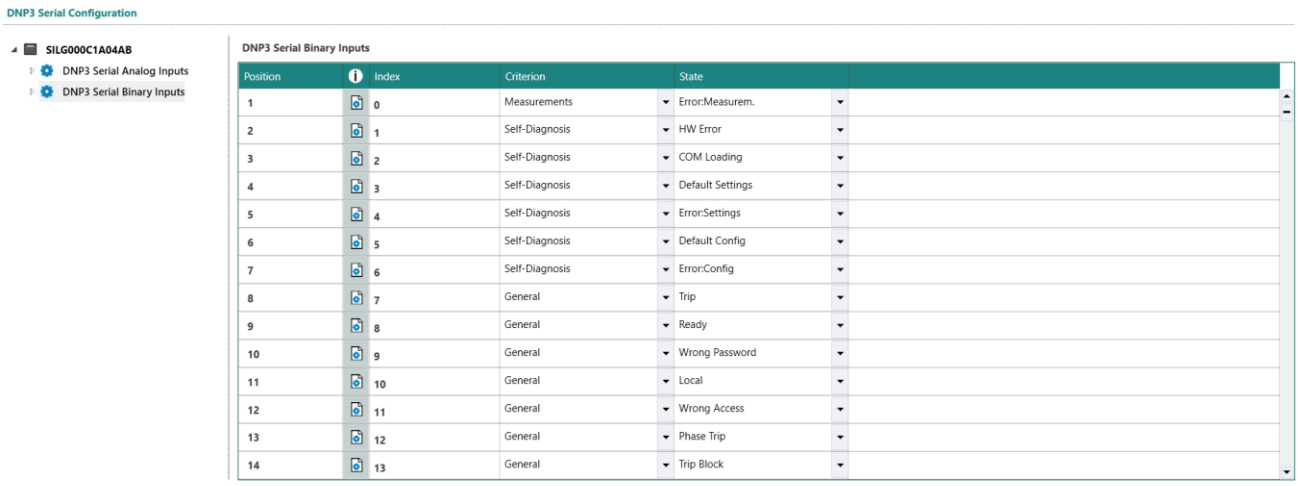
DNP3 Serial:

- DNP3 Serial Binary Inputs

DNP3 TCP:

- DNP3 TCP Binary Inputs

It will open the entire database table of binary signals.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the DNP3 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

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 not configurable.

The map of the binary outputs is created according to the number of outputs of the relay, to optimize the data transfer.

Index	SIR-Axxxxxx0xxx SIR-Axxxxxx5xxx	SIR-Axxxxxx7xxx	SIR-Axxxxxx6xxx	SIR-AxxxxxxAxxx SIR-AxxxxxxBxxx
1	Output 1	Output 1	Output 1	Output 1
2	Output 2	Output 2	Output 2	Output 2
3	Output 3	Output 3	Output 3	Output 3
4	Output 4	Output 4	Output 4	Output 4
5	Output 5	Output 5	Output 5	Output 5
6	Output 6	Output 6	Output 6	Output 6
7	Output 7	Output 7	Output 7	Output 7
8	-	Output 8	Output 8	AFD Output 1
9	-	Output 9	Output 9	AFD Output 2
10	-	Output 10	Output 10	AFD Output 3
11	-	Output 11	Output 11	AFD Output 4
12	-	-	Output 12	-
13	-	-	Output 13	-
14	-	-	Output 14	-
15	-	-	Output 15	-
16	-	-	Output 16	-
17	-	-	Output 17	-
18	-	-	Output 18	-

5.3. ANALOG INPUT CONFIGURATION.

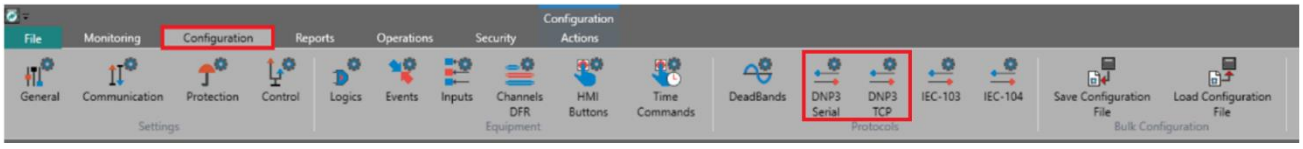
ANALOG INPUT (OBJECT 30) -> Assigned to Class 0

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

Configurable point list is available with memory for 32 configurable analog inputs.

We recommend configuring only the necessary analog 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.

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



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

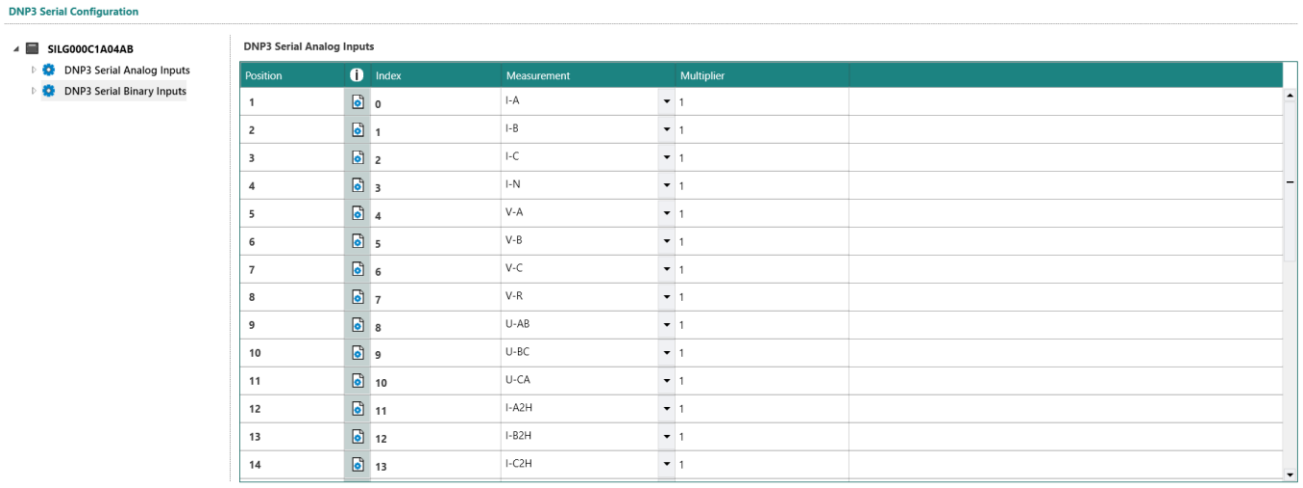
DNP3 Serial:

- DNP3 Serial Analog Inputs

DNP3 TCP:

- DNP3 TCP Analog Inputs

Click on DNP3 Serial/TCP Analog Inputs, it will open the entire database table of analog signals.



For each signal there are the following fields:

Name	Description
Position	Informative numeral to show the DNP3 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
Measurement	Measure to be configured. Selectable form a list
Multiplier	Parameter to multiply the measure value before communicating it

5.4. COUNTERS

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

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

FROZEN COUNTER (OBJECT 21)

Index	Description	Event Deadband
0	Openings Number	1
1	Recloses Number	1
2	Accumulated Amperes	1
3	AE+	100.000
4	AE-	100.000
5	RE+	100.000
6	RE-	100.000

5.5. CONTROL RELAY OUTPUT BLOCK (OBJECT 12)

The following command list is available:

Description	Point Number
Open Breaker Command	0 (ON)
Closing Breaker Command	0 (OFF)
79 Block Command	1 (ON)
79 Unblock Command	1 (OFF)
Local Control Command	2 (ON)
Remote Control Command	2 (OFF)
Reset Command	3 (ON)
Thermal Image Command	4 (ON)
Hot Line Tag ON	5 (ON)
Hot Line Tag OFF	5 (OFF)
User Command 1	6 (ON)
User Command 2	7 (ON)
User Command 3	8 (ON)
User Command 4	9 (ON)
User Command 5	10 (ON)
User Command 6	11 (ON)
Setting group 1	12 (ON)
Setting group 2	13 (ON)
Setting group 3	14 (ON)
Setting group 4	15 (ON)

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):

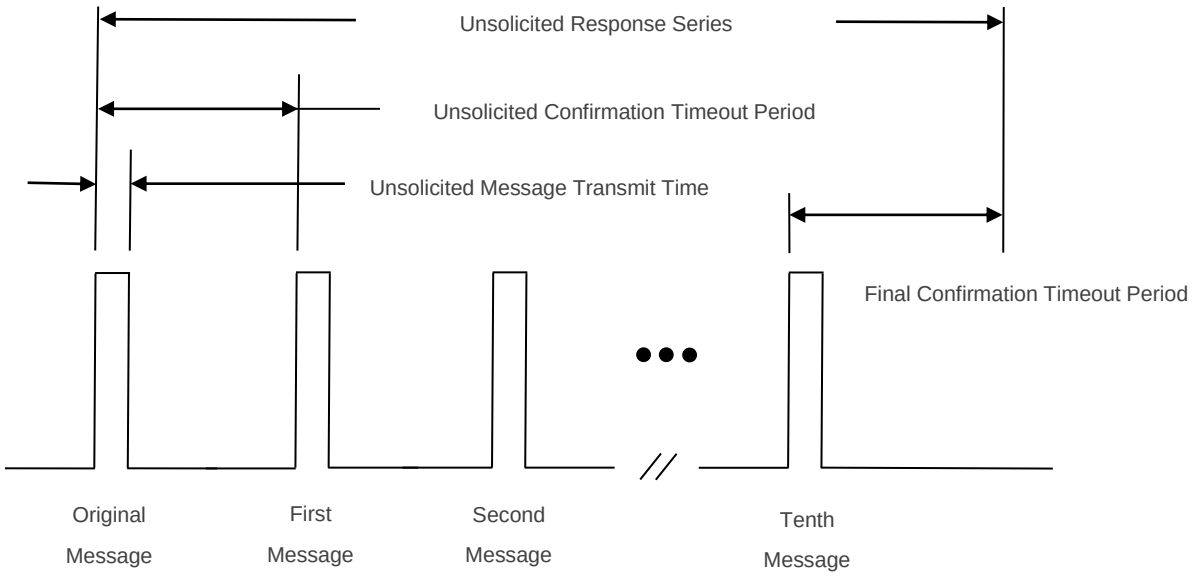
78 09 6D F4 6B 01

7. UNSOLICITED RESPONSES

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

The SIR-A relay supports the functions code 29 (Enable Unsolicited Responses) and 30 (Disable Unsolicited Responses). The SIR-A default configuration has the unsolicited responses disable, if the user wants to start using these messages must perform the function code 29. After the function code 29 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 decribed 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 replies the original message in a serie of, by default, ten messages.

The timeout period and number of retries are configurable since the version 1.02.00 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 regarding the specific data object (Current and Voltage).



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