

# IEC 60870-5-101 Protocol RTU IED Server Simulator User Manual

Stack Version: 21.05.008

[IEC 60870-5-101 Protocol](#)

## FreyrSCADA Embedded Solution

FreyrSCADA



Embedded Solution

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CIN: U72900TN2018PTC120601

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## **Download Free Demo Evaluation Kit - IEC 101 Development Bundle**

New updated Version of IEC 101 Simulator & SDK (Software Development Kit) is available now.

In the Development Bundle, We included IEC 104 Server & Client Simulator, Windows and Linux SDK, C# projects, Doxygen documentation and Raspberry Pi, BeagleBone Demo library.

# 1. Introduction

IEC 60870-5-101 (IEC101) is a standard for power system monitoring, control & associated communications for telecontrol, tele protection, and associated telecommunications for electric power systems. This is completely compatible with IEC 60870-5-1 to IEC 60870-5-5 standards and uses standard asynchronous serial tele-control channel interface between DTE and DCE. The standard is suitable for multiple configurations like point-to-point, star, multidrop etc.

## Features

- Supports unbalanced (only master initiated message) & balanced (can be master/slave initiated) modes of data transfer.
- Link address and ASDU (Application Service Data Unit) addresses are provided for classifying the end station and different segments under the same.
- Data is classified into different information objects and each information object is provided with a specific address.
- Facility to classify the data into high priority (class-1) and low priority (class-2) and transfer the same using separate mechanisms.
- Possibility of classifying the data into different groups (1-16) to get the data according to the group by issuing specific group interrogation commands from the master & obtaining data under all the groups by issuing a general interrogation.
- Cyclic & Spontaneous data updating schemes are provided.
- Facility for time synchronization
- Schemes for transfer of files- Example: IED's will store disturbance recorder file in the memory, when electrical disturbance is occurred in the field. This file can be retrieved through IEC103 protocol for fault analysis

FreyrSCADA IEC 60870-5-101 Server Simulator was originally developed to test the IEC 60870-5-101 stack.

We tested this simulator with multiple test software available in the market.

The interoperability list focused only for our Stack. If you have any specific requirement to implement new Type id ASDU, Please contact to us.

Our support team has young, dynamic and professional team of engineers. And they will provide the quick and accurate solution as per customer requirement.

support@freyrscada.com

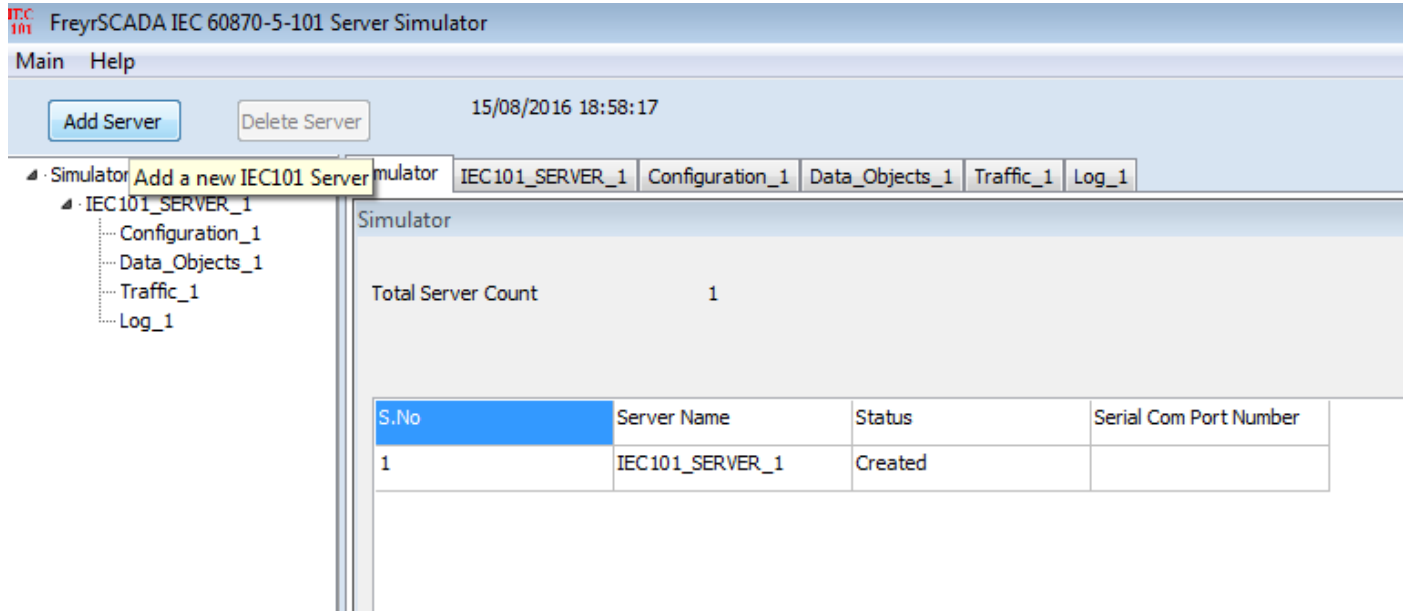
Thanks

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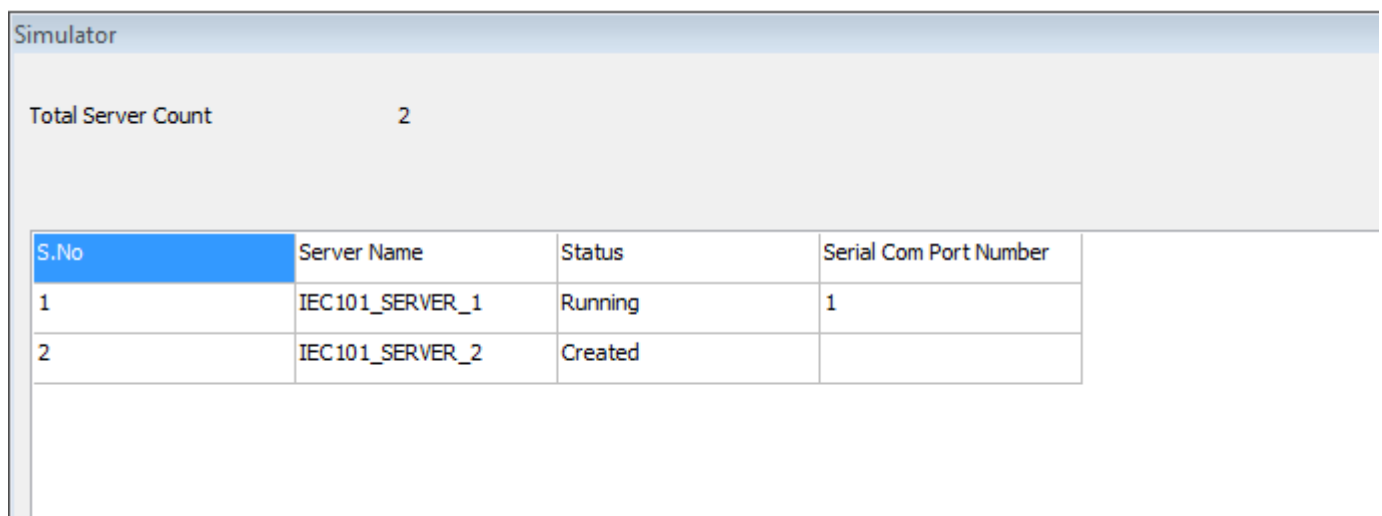
## 2. Add and Delete Server

We can add upto 50 server node in the simulator. Every server node will work independently.

And also we can delete the server.

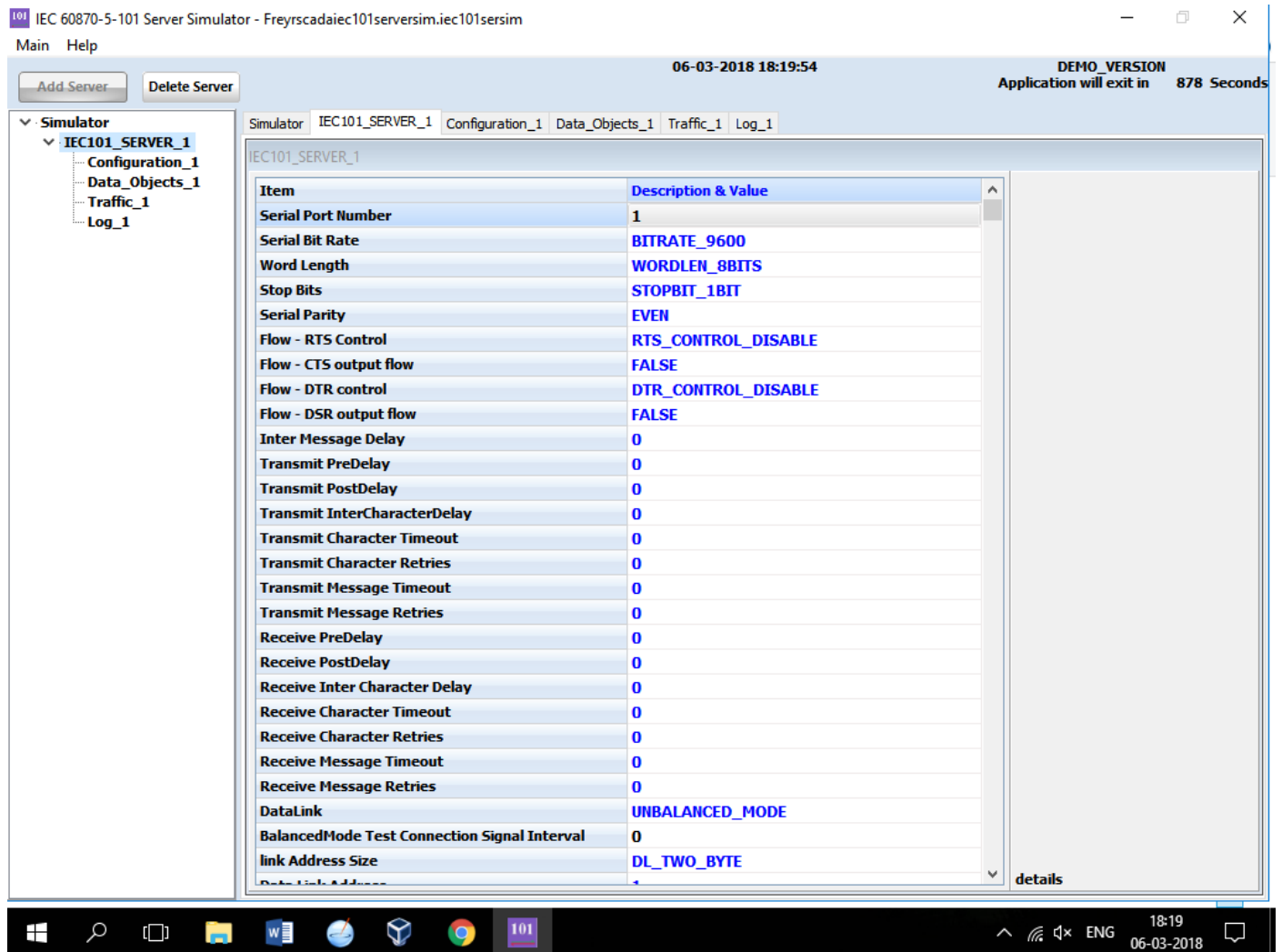


Simulator window shows the status & connected Serial com Port Number.



### 3. Server Configuration

Server Protocol Configuration window shows the actual protocol settings.



Configuration Parameters as follows:

1. **Serial Port Number** – Serial COM port number
2. **Serial Bit Rate** - Serial Bit/Baud Rate
3. **Word Length** - Serial Word Length
4. **Stop Bits** - Serial Stop Bits
5. **Serial Parity** - Serial Parity
6. **Flow Control** - Flow Control

7. **Inter Message Delay** - Time between sending and receiving of message only applies after transmitting the message
8. **Transmit PreDelay** - Transmit Delay before send
9. **Transmit PostDelay** - Delay after send
10. **Transmit InterCharacterDelay** - Delay between characters during send
11. **Transmit Character Timeout** - Timeout if the character is not being sent
12. **Transmit Character Retries** - Number of retries to send
13. **Transmit Message Timeout** - Message Timeout if entire message is not sent
14. **Transmit Message Retries** - Transmit - Message Retries to retry the entire message
15. **Receive PreDelay** - Delay before receive
16. **Receive PostDelay** - Delay after receive
17. **Receive Inter Character Delay** - Delay between characters during receive
18. **Receive Character Timeout** - Timeout if the character is not being received
19. **Receive Character Retries** - Number of retries to receive a character
20. **Receive Message Timeout** - Message Timeout if entire message is not received
21. **Receive Message Retries** - Receive - Message Retries to retry the entire message
22. **DataLink** - Data link transmission - Unbalanced mode , Balanced mode
23. **BalancedMode Test Connection Signal Interval** - in seconds, in balanced mode , nothing received, after this interval, server will send the test link function to master 60 seconds to 3600 seconds
24. **link Address Size** - Data Link address size
25. **Data Link Address** - Data link address
26. **COT Size** - Cause of Transmission Size
27. **IOA Size** - Information Object Address Size
28. **Common Address Size** - Common Address Size
29. **Positive ACK** - Positive ACK Format
30. **Negative ACK** - Negative ACK Format
31. **Class 1 Event Buffer Size** - High Priority - Class 1 Event Buffer Size
32. **Class 2 Event Buffer Size** - Class 2 Event Buffer Size
33. **Class 1 Buffer OverFlow Percentage** - High Priority - Class 1 Buffer OverFlow Percentage
34. **Class 2 Buffer OverFlow Percentage** - Class 2 Buffer OverFlow Percentage
35. **Maximum APDU Size** - Monitoring Information - Maximum APDU Size
36. **Clock Sync Period** - in milliseconds. If 0 than Clock Synchronisation command is not expected from Master. If the time elapsed, and did not receive the time sync command , in the events, cp56time21 time stamp, the invalid bit will set.

37. **Short Pulse Time** - in milliseconds default 5000. For Certain Command points have Pulse Duration, so after actconform, the actterm signal will be triggered according to this pulse time
38. **Long Pulse Time** - in milliseconds 10000, For Certain Command points have Pulse Duration, so after actconform, the actterm signal will be triggered according to this pulse time.
39. **Generate ACTTERM Respond** - if Yes , Generate ACTTERM responses for operate commands.
40. **Enable Double Transmission** - enable double transmission.
41. **Total number of stations** - In a single physical device/ server, we can run many stations – Total number of stations in iec104 server ,according to common address (1-5).
42. **Station Address - 1 (CommonAddress 1)** - station address 1- Common Address 1 , 1-65534 , 65535 = global address (only master can use this).
43. **Station Address - 2(CommonAddress 2) - station address 2-** Common Address 2 , 1-65534 , 65535 = global address (only master can use this).
44. **Station Address - 3 (CommonAddress 3)** - station address 3- Common Address 3 , 1-65534 , 65535 = global address (only master can use this).
45. **Station Address - 4 (CommonAddress 4)** - station address 4- Common Address 4 , 1-65534 , 65535 = global address (only master can use this).
46. **Station Address - 5(CommonAddress 5)** - station address 5- Common Address 5 , 1-65534 , 65535 = global address (only master can use this).
47. **Enable File Transfer** - Enable FILE transmission.- in demo version, file transfer disabled
48. **File Transfer Directory Path** - File Transfer Directory Path – location of file to list in directory command & transfer to iec104 master.
49. **Max Files In Directory** - Maximum Number of Files in Directory (default 25).
50. **Transmit Spontaneous Measured Value** - transmit M\_ME measured values as COT – spont ,spontaneous message.
51. **Transmit Measured Values in Interrogation** - Transmit M\_ME measured values in General interrogation.
52. **Transmit Measured Values in Background scan** - transmit M\_ME measured values in background Scan message.
53. **Enable UTC** - Enable UTC time / local time for update the monitoring information & initial database time initialization.
54. **Update Check Timestamp** - if it is true ,the timestamp change also generate event during the iec101update for Monitoring information.

## 4. Server Data Configuration

Server Data Configuration window shows the point list configuration.

The screenshot shows the 'Configuration\_1' window in the IEC 60870-5-101 Server Simulator. The window contains a table with 21 rows of configuration data. The table columns are: S.No, IEC 60870-5 Group to Choose, Event Report Type ID, Starting IOA, Range, IEC870 COT Cause, Cyclic Transmission Time, and Control. The table is populated with various point types such as Single Point, Double Point, Step Position, and Parameters.

S.No	IEC 60870-5 Group to Choose	Event Report Type ID	Starting IOA	Range	IEC870 COT Cause	Cyclic Transmission Time	Control
1	Single Point	M_SP_TB_1 = 30	100	1	INROGEN = 20	0	STATU
2	Single Command	C_SC_TA_1 = 58	1000	1	NOTUSED	0	DIREC
3	Double Point	M_DP_TB_1 = 31	200	1	INROGEN = 20	0	STATU
4	Double Command	C_DC_TA_1 = 59	2000	1	NOTUSED	0	DIREC
5	Step Position	M_ST_TB_1 = 32	300	1	INROGEN = 20	0	STATU
6	Regulating Step Command	C_RC_TA_1 = 60	3000	1	NOTUSED	0	DIREC
7	Measured Normalized	M_ME_TD_1 = 34	400	1	INROGEN = 20	0	STATU
8	Set Point command - Normali...	C_SE_TA_1 = 61	4000	1	NOTUSED	0	DIREC
9	Measured Scaled	M_ME_TE_1 = 35	500	1	INROGEN = 20	0	STATU
10	Set Point command - Scaled ...	C_SE_TB_1 = 62	5000	1	NOTUSED	0	DIREC
11	Measured Short Float	M_ME_TF_1 = 36	600	1	INROGEN = 20	0	STATU
12	Set Point command - Float V...	C_SE_TC_1 = 63	6000	1	NOTUSED	0	DIREC
13	Integrated Totals	M_IT_TB_1 = 37	700	1	REQCOGEN= 37	0	STATU
14	Bitstring	M_BO_TB_1 = 33	800	1	INROGEN = 20	0	STATU
15	Bitstring of 32 bit command	C_BO_TA_1 = 64	8000	1	NOTUSED	0	DIREC
16	Event of Protection Equipment	M_EP_TD_1 = 38	11	1	NOTUSED	0	STATU
17	Packed Start Events of Prote...	M_EP_TE_1 = 39	22	1	NOTUSED	0	STATU
18	Packed Output Circuit Inform...	M_EP_TF_1 = 40	33	1	NOTUSED	0	STATU
19	Parameter	P_ME_NA_1 = 110	44	1	INROGEN = 20	0	STATU
20	Parameter	P_ME_NB_1 = 111	55	1	INROGEN = 20	0	STATU
21	Parameter	P_ME_NC_1 = 112	66	1	INROGEN = 20	0	STATU

### IEC 60870-5 Group & Typeid to choose

- 1) Single Point - Single-point information

M\_SP\_NA\_1 = 1

M\_SP\_TA\_1 = 2

M\_SP\_TB\_1 = 30

- 2) Double Point - Double-point information

M\_DP\_NA\_1 = 3

M\_DP\_TA\_1 = 4

M\_DP\_TB\_1 = 31



3) Step Position - Step position information

M\_ST\_NA\_1 = 5

M\_ST\_TA\_1 = 6

M\_ST\_TB\_1 = 32

4) Bitstring - Bit string of 32 bit

M\_BO\_NA\_1 = 7

M\_BO\_TA\_1 = 8

M\_BO\_TB\_1 = 33

5) Measured Normalized - Measured normalized value

M\_ME\_NA\_1 = 9

M\_ME\_TA\_1 = 10

M\_ME\_TD\_1 = 34

6) Measured Normalized Without Quality - Measured normalized value without quality descriptor

M\_ME\_ND\_1 = 21

7) Measured Scaled - Measured scaled value

M\_ME\_NB\_1 = 11

M\_ME\_TB\_1 = 12

M\_ME\_TE\_1 = 35

8) Measured Short Float - Measured value, normalized value

M\_ME\_NC\_1 = 13

M\_ME\_TC\_1 = 14

M\_ME\_TF\_1 = 36

9) Integrated Totals - Integrated totals

M\_IT\_NA\_1 = 15

M\_IT\_TA\_1 = 16

M\_IT\_TB\_1 = 37

10) Event of Protection Equipment - Event of protection equipment with time tag CP56Time2a

M\_EP\_TD\_1 = 38, Event of protection equipment with time tag CP56Time2a

11) Packed Start Events of Protection Equipment - Packed start events of protection equipment with time tag CP56Time2a

M\_EP\_TE\_1 = 39, Packed start events of protection equipment with time tag CP56Time2a

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12) Packed Output Circuit Information of Protection Equipment - Packed output circuit information of protection equipment with time tag CP56Time2a

M\_EP\_TF\_1 = 40, Packed output circuit information of protection equipment with time tag CP56Time2a

13) Single Command - Single command

C\_SC\_NA\_1 = 45

C\_SC\_TA\_1 = 58

14) Double Command - Double command

C\_DC\_NA\_1 = 46

C\_DC\_TA\_1 = 59

15) Regulating Step Command - Regulating step command

C\_RC\_NA\_1 = 47

C\_RC\_TA\_1 = 60

16) Set Point command - Normalized Value - Set point command, normalized value

C\_SE\_NA\_1 = 48

C\_SE\_TA\_1 = 61

17) Set Point command - Scaled Value - Set point command, scaled value

C\_SE\_NB\_1 = 49

C\_SE\_TB\_1 = 62

18) Set Point command - Float Value - Set point command, short floating point value

C\_SE\_NC\_1 = 50

C\_SE\_TC\_1 = 63

19) Bitstring of 32 bit command - Bitstring of 32 bit command

C\_BO\_NA\_1 = 51

C\_BO\_TA\_1 = 64

20) Parameter - Parameter

P\_ME\_NA\_1 = 110

P\_ME\_NB\_1 = 111

P\_ME\_NC\_1 = 112

The selection of following parameters based on the typeid selection.

Consider for the following items

	<b>Monitoring information</b>	<b>Control / Command Point</b>	<b>Parameter Value</b>
IEC 60870-5 Group to Choose	Single Point	Single Command	Parameter
Event Report Type Id	M_SP_NA_1 = 1	C_SC_NA_1 = 45	P_ME_NA_1 = 110
Starting IOA	<b>10</b>	<b>100</b>	<b>2000</b>
Range	<b>5</b>	<b>5</b>	<b>5</b>
IEC870 COT Cause	INROGEN = 20	NOTUSED	INROGEN = 20
Cyclic Transmission time	<b>0</b>	<b>0</b>	<b>0</b>
Control Model Configuration	status only	direct operate	status only
SBO TimeOut	<b>0</b>	<b>0</b>	<b>0</b>
Kind of Parameter - KPA	PARAMETER_NONE	PARAMETER_NONE	PARAMETER_THRESHOLDVALUE
Common Address	<b>1</b>	<b>1</b>	<b>1</b>
Background Scan time	<b>0</b>	<b>0</b>	<b>0</b>
Event Class to Report	<b>IEC_CLASS1</b>	<b>IEC_NO_CLASS</b>	<b>IEC_NO_CLASS</b>

## 5. Map controlling point to Monitoring Point

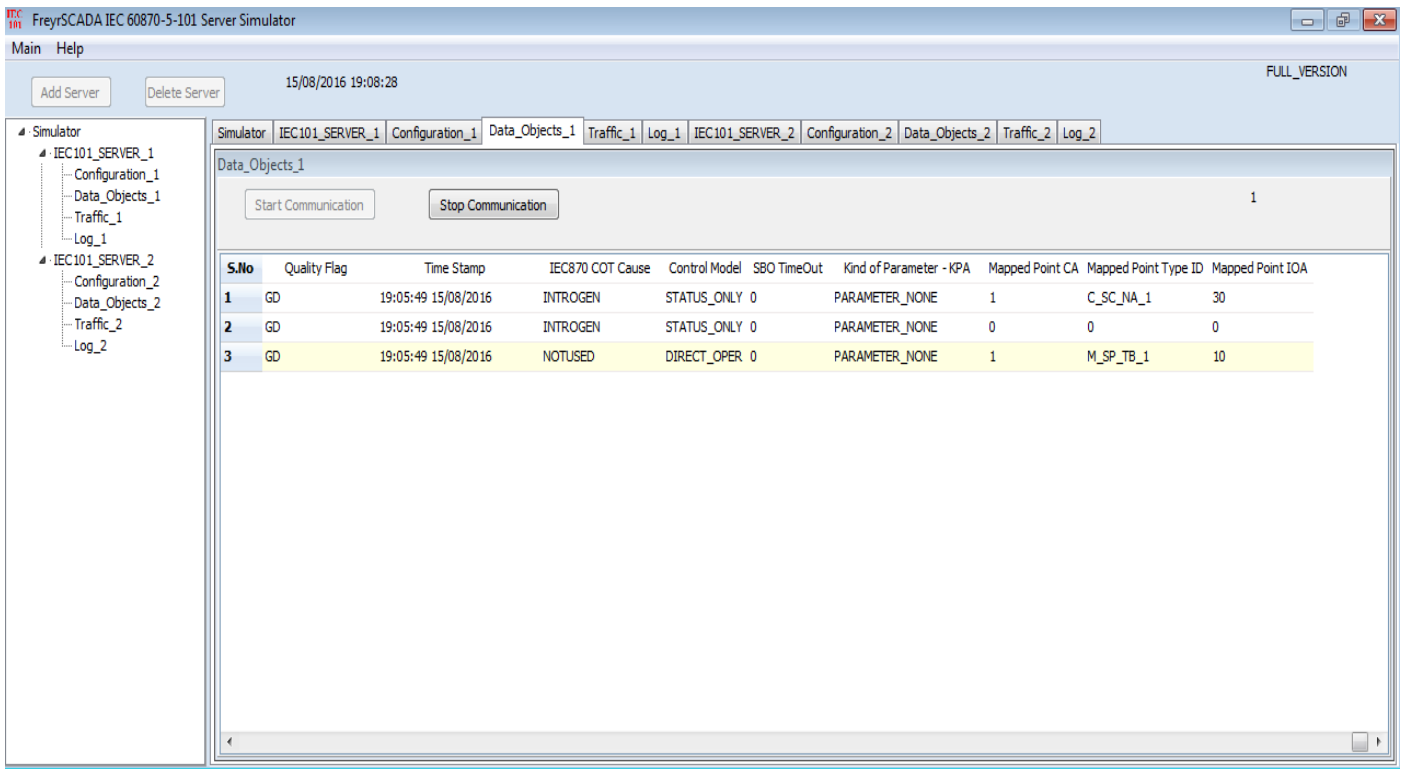
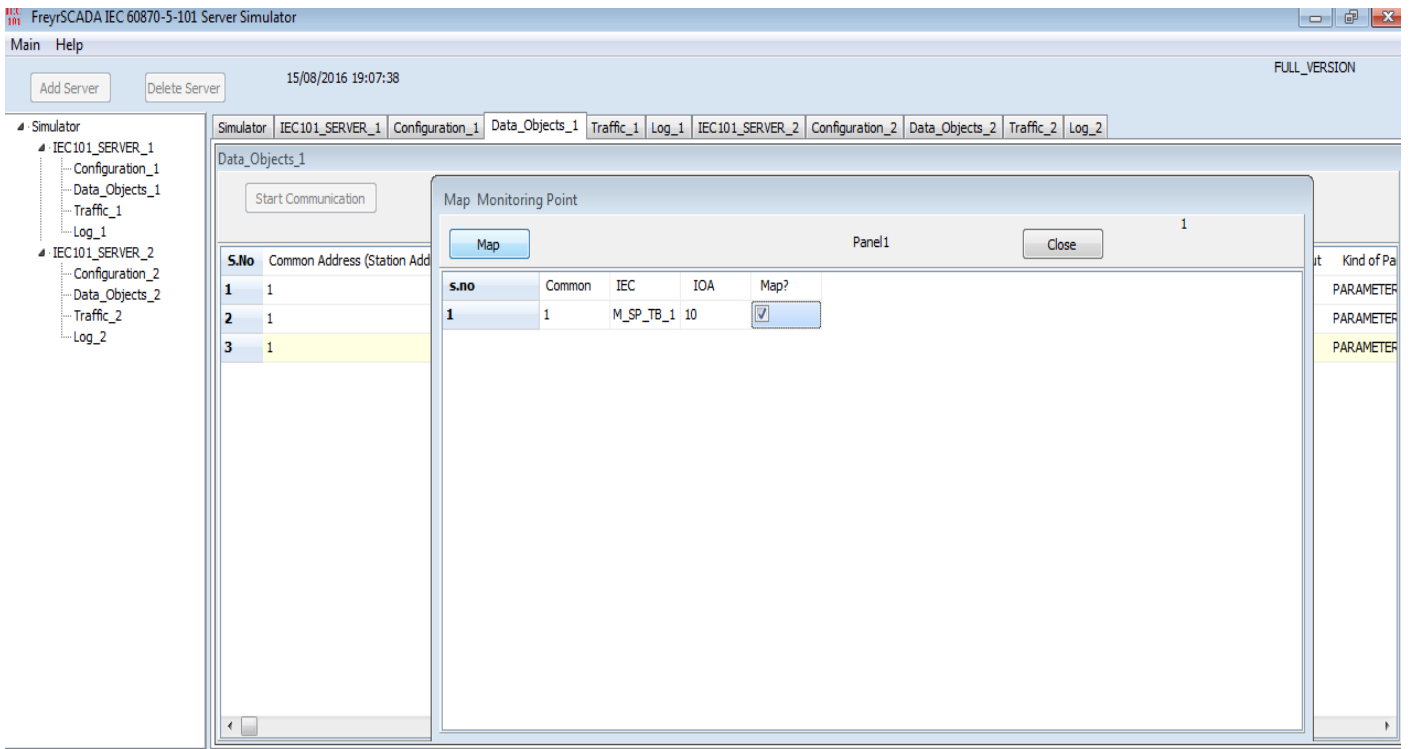
In the simulator, Data object window, We can map the controlling point to a monitoring point individually,

Consider a point (C\_SC, IOA 1), can map to a monitoring information point (M\_SP, IOA 1),

Right click the command point-> map, a new window will show the available monitoring point, and select the point and map it. If a control point receive the command, the command value will reflect in the monitoring point

The screenshot shows the IEC 60870-5-101 Server Simulator interface. The main window displays the 'Data\_Objects\_1' configuration. A table lists various data objects with columns for S.No, Common Address, Event Report Type ID, IOA, Value, Quality Flag, and Time Stamp. A context menu is open over the entry for 'C\_SC\_TA\_1' (S.No 2), showing options: 'Update', 'Map', and 'unmap'. The 'Map' option is highlighted. The interface also includes a 'Start Communication' button and a 'Stop Communication' button. The top status bar shows the date and time as '06-03-2018 18:22:46' and a 'DEMO\_VERSION' warning that the application will exit in 706 seconds.

S.No	Common Address	Event Report Type ID	IOA	Value	Quality Flag	Time Stamp
1	1	M_SP_TB_1	100	0	GD	18:22:31 06-03-2018
2	1	C_SC_TA_1			GD	18:22:31 06-03-2018
3	1	M_DP_TB_1			GD	18:22:31 06-03-2018
4	1	C_DC_TA_1			GD	18:22:31 06-03-2018
5	1	M_ST_TB_1	500	0	GD	18:22:31 06-03-2018
6	1	C_RC_TA_1	3000	0	GD	18:22:31 06-03-2018
7	1	M_ME_TD_1	400	0	GD	18:22:31 06-03-2018
8	1	C_SE_TA_1	4000	0	GD	18:22:31 06-03-2018
9	1	M_ME_TE_1	500	0	GD	18:22:31 06-03-2018
10	1	C_SE_TB_1	5000	0	GD	18:22:31 06-03-2018
11	1	M_ME_TF_1	600	0	GD	18:22:31 06-03-2018
12	1	C_SE_TC_1	6000	0	GD	18:22:31 06-03-2018
13	1	M_IT_TB_1	700	0	GD	18:22:31 06-03-2018
14	1	M_BO_TB_1	800	0	GD	18:22:31 06-03-2018
15	1	C_BO_TA_1	8000	0	GD	18:22:31 06-03-2018
16	1	M_EP_TD_1	11	0;Elapsed Time:0	GD	18:22:31 06-03-2018
17	1	M_EP_TE_1	22	0;Elapsed Time:0	GD	18:22:31 06-03-2018
18	1	M_EP_TF_1	33	0;Elapsed Time:0	GD	18:22:31 06-03-2018
19	1	P_ME_NA_1	44	0	GD	18:22:31 06-03-2018
20	1	P_ME_NB_1	55	0	GD	18:22:31 06-03-2018
21	1	P_ME_NC_1	66	0	GD	18:22:31 06-03-2018



## 6. Update Monitoring Information

The user can update the monitoring Point information .The following parameters can change

Value, quality bits and according to event report typeid , the change reported to end client system by spontaneous.

Data\_Objects\_1

Start Communication      Stop Communication      1

S.No	Common Address (Station Address)	Event Report Type ID	IOA	Value	Quality Flag	Time Stamp	IEC870 COT Cause	Control Model	SBO TimeOut
1	1	M_SP_T		0	GD	19:05:49 15/08/2016	INTROGEN	STATUS_ONLY	0
2	1	M_ME_T		0	GD	19:05:49 15/08/2016	INTROGEN	STATUS_ONLY	0
3	1	C_SC_N		0	GD	19:05:49 15/08/2016	NOTUSED	DIRECT_OPER	0

Update  
Map  
unmap

IEC 101 Update Monitoring Information      1

M\_ME Float

Common Address      1

Information Object Address      20

Value      31.000

Quality Bits

IV       NT       SB       BL       OV

Time Quality -Invalid       Time - IV

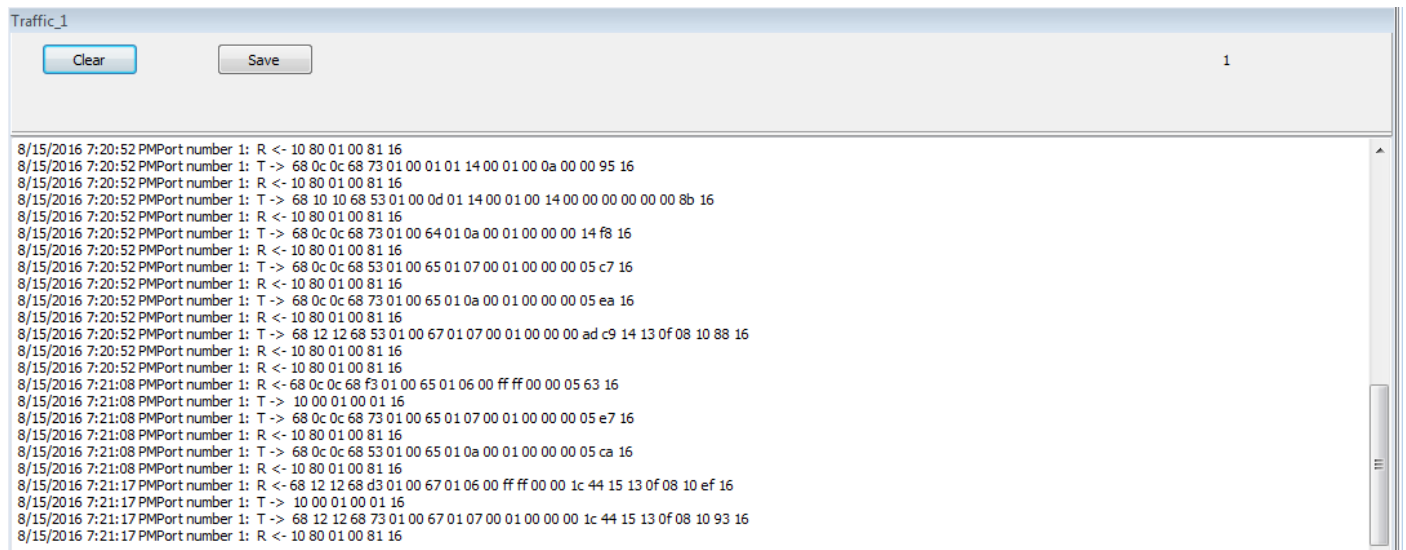
Update Measured Float Point

Close

## 7. Traffic window

In this we can monitor the traffic of iec104 communication.

In this we can save the traffic, and clear the traffic

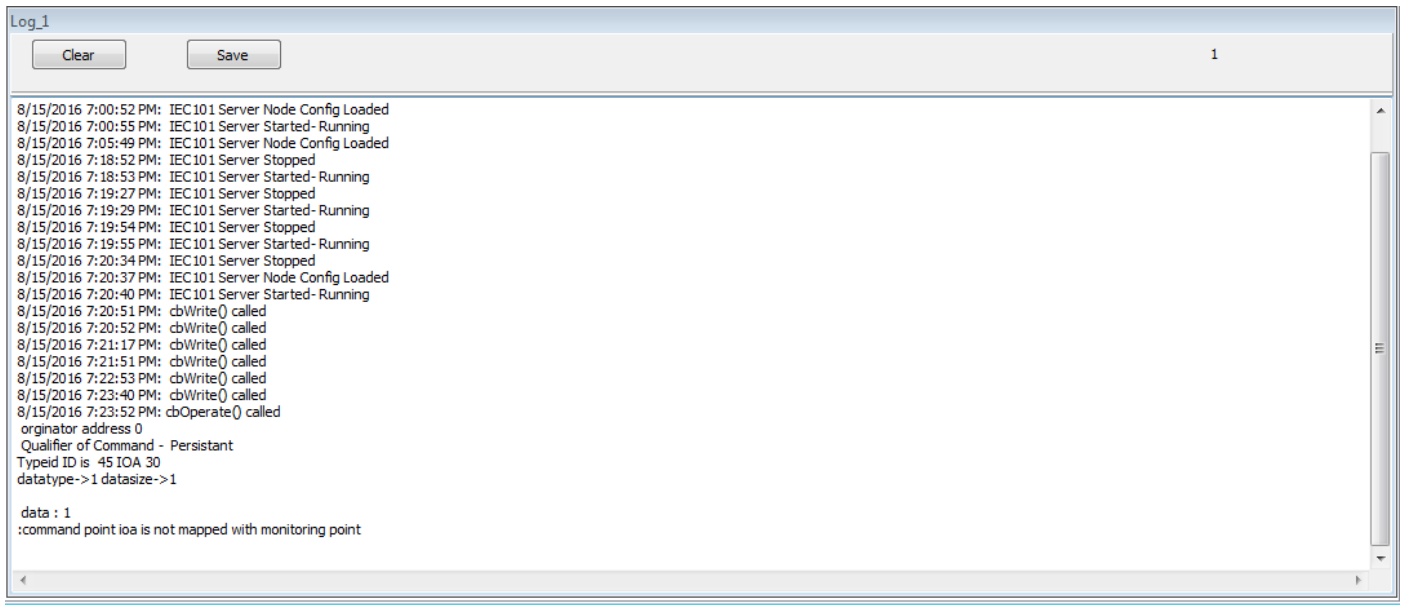


The screenshot shows a window titled "Traffic\_1" with a "Clear" button and a "Save" button. The main area displays a list of traffic packets. Each packet line includes a timestamp, a direction indicator (R for receive, T for transmit), and a hexadecimal representation of the packet data. The packets are as follows:

```
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 0c 0c 68 73 01 00 01 01 14 00 01 00 0a 00 00 95 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 10 10 68 53 01 00 0d 01 14 00 01 00 14 00 00 00 00 00 8b 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 0c 0c 68 73 01 00 64 01 0a 00 01 00 00 00 14 f8 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 0c 0c 68 53 01 00 65 01 07 00 01 00 00 00 05 c7 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 0c 0c 68 73 01 00 65 01 0a 00 01 00 00 00 05 ea 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: T -> 68 12 12 68 53 01 00 67 01 07 00 01 00 00 00 ad c9 14 13 0f 08 10 88 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:20:52 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:21:08 PMPort number 1: R <- 68 0c 0c 68 f3 01 00 65 01 06 00 ff ff 00 00 05 63 16
8/15/2016 7:21:08 PMPort number 1: T -> 10 00 01 00 01 16
8/15/2016 7:21:08 PMPort number 1: T -> 68 0c 0c 68 73 01 00 65 01 07 00 01 00 00 00 05 e7 16
8/15/2016 7:21:08 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:21:08 PMPort number 1: T -> 68 0c 0c 68 53 01 00 65 01 0a 00 01 00 00 00 05 ca 16
8/15/2016 7:21:08 PMPort number 1: R <- 10 80 01 00 81 16
8/15/2016 7:21:17 PMPort number 1: R <- 68 12 12 68 d3 01 00 67 01 06 00 ff ff 00 00 1c 44 15 13 0f 08 10 ef 16
8/15/2016 7:21:17 PMPort number 1: T -> 10 00 01 00 01 16
8/15/2016 7:21:17 PMPort number 1: T -> 68 12 12 68 73 01 00 67 01 07 00 01 00 00 00 1c 44 15 13 0f 08 10 93 16
8/15/2016 7:21:17 PMPort number 1: R <- 10 80 01 00 81 16
```

## 8. Log Window

Log window for internal reference



In the log, we can monitor the command exchange between server & master, and there is an option to save the log & clear log.

For more information, just drop a mail to [support@freyrscada.com](mailto:support@freyrscada.com)