Protocol Specific

- Modbus
- IEC 60870-5-101
- IEC 60870-5-103
- IEC 60870-5-104

Modbus

Modbus is a communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). Simple and robust, it has since become a de facto standard communication protocol, and it is now a commonly available means of connecting industrial electronic devices.

Info about protocol

Address:

- **IP address** - every device in Ethernet have physical address (only for Ethernet)
- **Station address** - every slave (client) device have a logical address.
- **Function** - function type
- **Address** - information object address.

Telegram Structure

Modbus RTU

Request

Name	Bytes	Function
Station	0	Station address
Function	1	Function code
Address Hi	2	Starting address
Address Lo	3	
Quantity Hi	4	Quantity
Quantity Lo	5	
CRC	6	CRC check

Response

Name	Bytes	Function
Station	0	Station address
Function	1	Function code
Bytes	2	Data bytes
Data	3...	Data
CRC	Depending of data	CRC check

Modbus RTU/ASCII

Request

Name	Char	Function

Start	0	: 0x3A
Station	1	Station address
Function	2	Function code
Address Hi	3	Starting address
Address Lo	4	
Quantity Hi	5	Quantity
Quantity Lo	6	
LRC	7	LRC check
End	8	ASCII values of 0x0D & 0x0A
End	9	

Response

Name	Char	Function
Start	0	: 0x3A
Station	1	Station address
Function	2	Function code
Bytes	3	Data bytes
Data	4...	Data
LRC	Depending of data	LRC check
End	Depending of data	ASCII values of 0x0D & 0x0A

Modbus TCP

Request

Name	Bytes	Function
Transaction Identifier	0	For synchronization
Transaction Identifier	1	
Protocol Identifier	2	Zero for Modbus/TCP
Protocol Identifier	3	
Length	4	Number of remaining bytes in this frame
Length	5	
Station	6	Station address
Function	7	Function code
Address Hi	8	Starting address
Address Lo	9	
Quantity Hi	10	Quantity
Quantity Lo	11	

Response

Name	Bytes	Function

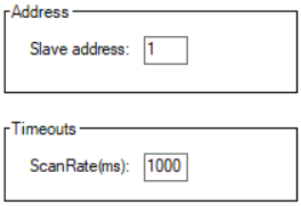
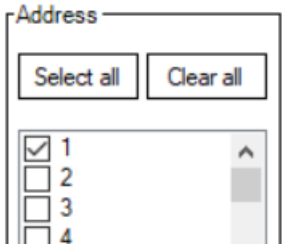
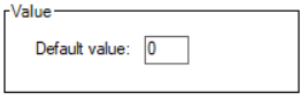
Transaction Identifier	0	For synchronization
Transaction Identifier	1	
Protocol Identifier	2	Zero for Modbus/TCP
Protocol Identifier	3	
Length	4	Number of remaining bytes in this frame
Length	5	
Station	6	Station address
Function	7	Function code
Bytes	8	Data bytes
Data	9...	Data

Functions

Standard MODBUS functions

Dec	Description	Direction	Support
1	Read Coils	Monitor	Yes
2	Read Discrete Inputs	Monitor	Yes
3	Read Holding Registers	Monitor	Yes
4	Read Input Registers	Monitor	Yes
5	Write Single Coil	Control	Yes
6	Write Single Register	Control	Yes
7	Read Exception Status	Monitor	No
8	Diagnostic	Monitor	No
11	Get Com Event Counter	Monitor	No
12	Get Com Event Log	Monitor	No
15	Write Multiple Coils	Control	Yes
16	Write Multiple Registers	Control	Yes
17	Report Slave ID	Monitor	No
20	Read File Record	Monitor	No
21	Write File Record	Control	No
22	Mask Write Register	Control	No
23	Read/Write Multiple Registers	Both	No
24	Read FIFO Queue	Monitor	No
43	Read Device Identification	Monitor	No
43	Encapsulated Interface Transport	Monitor	No

Settings

MASTER			
		*Modbus TCP*	*Modbus Serial (ASCII included)*
	Slave address	Address of the device which data is read from	Address of the device which data is read from
	Scan Rate(ms)	Interval between requests to data	Interval between requests to data
SLAVE			
	**Address**	Select addresses of slaves to simulate	Select addresses of slaves to simulate
	**Value**	Default value which slaves will return from all registers.	Default value which slaves will return from all registers.

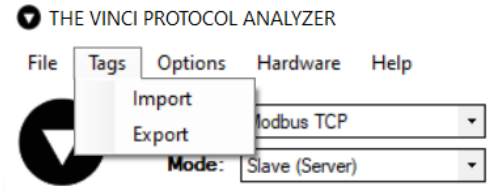
Default values are overridden by created Tags.

Functions

Tags

This function allows user to created named points. After points created, user can send it manually or set reply checkbox to automatic reply.

- To export Tags to csv file: **Tags -> Export -> Save file dialog appear**
- To import Tags from csv file: **Tags -> Import -> Open file dialog appear**

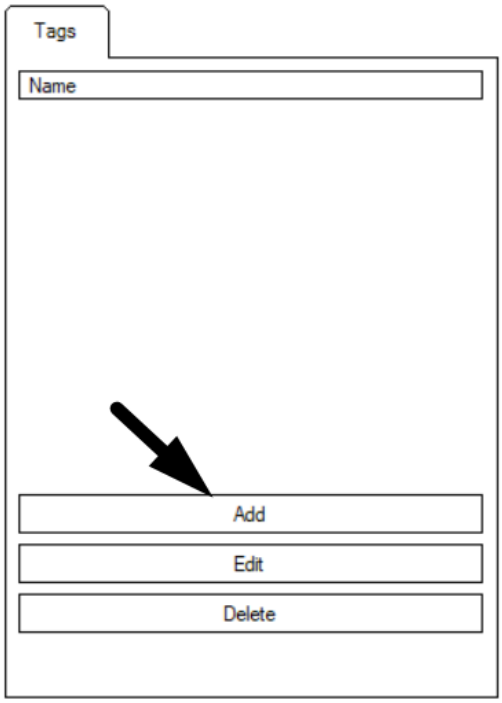


Creating Tag

In Modbus protocol tags are mostly used for Slaves to simulate specific data registers, although they can be used in Master to write data to slave registers or format received data from Slave devices.

There are two ways of creating tags:

1. Add button in the tag menu.

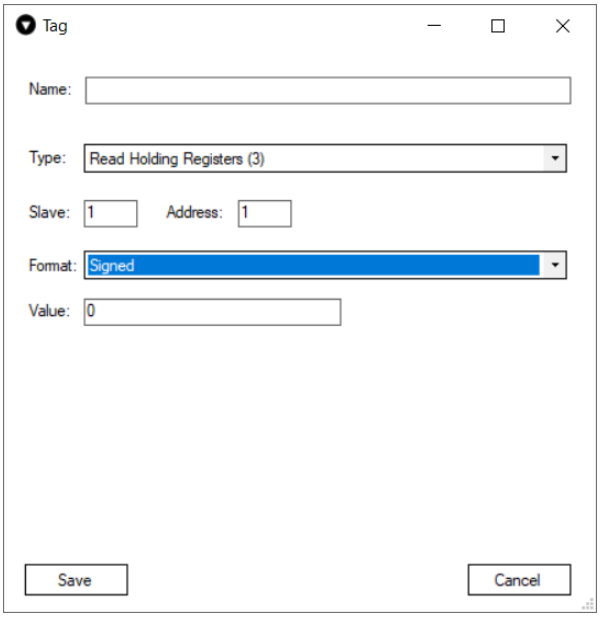


2. Left mouse button double click value in statistic tab.

Slave

If the simulation mode is **Slave** a modbus tag creation window should look like this and have these parameters.

- **Name -** user-friendly tag name.
- **Type -** the function to be used. *This means that if The Vinci software gets a request with the 03 function type and there is a tag created with that type and it matches the slave address and data address The Vinci software will respond to the request with the value that is set as the tag value.*
- **Slave -** Slave address of tag.
- **Address** - Address of slave register.
- **Format** - Format to store or read data in.
- **Value** - Value of the register.



Master

If the simulation mode is **Master** a modbus tag creation window should look like the one shown below and have these parameters.

In this case since this is the **Master** tag creation window it has two additional buttons that give the master the ability

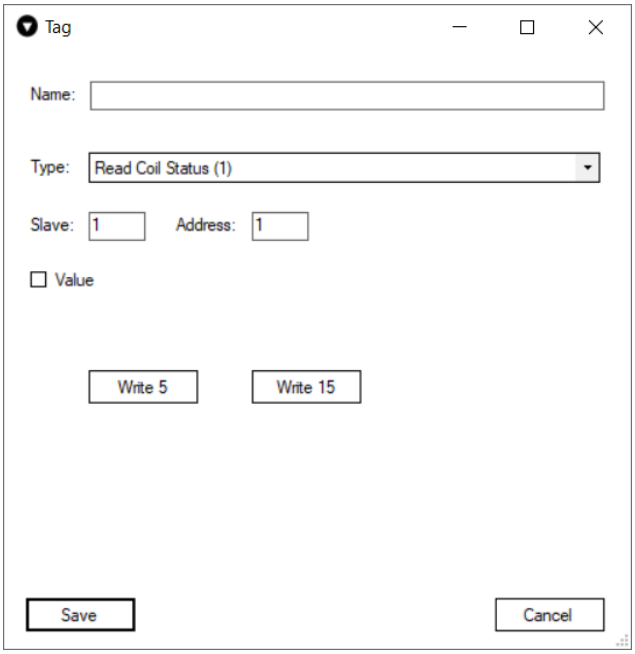
to write data to the Slave device. For the selected type he buttons are **Write 5 and Write 15** correlating to the modbus types.

In **Master** applications tags are mostly used to format data read from Slaves since data reading from devices is done using **Jobs**.

For types 1 and 2 the buttons will be**Write 5 and Write 15.**

For types 3 and 4 the buttons will be**Write 6 and Write 16**

- **Name -** user-friendly tag name.
- **Type -** the type of data.
- **Slave -** Slave address of tag.
- **Address** - Adress of slave register.
- **Format** - Format to store or read data in.
- **Value** - Value of the register.

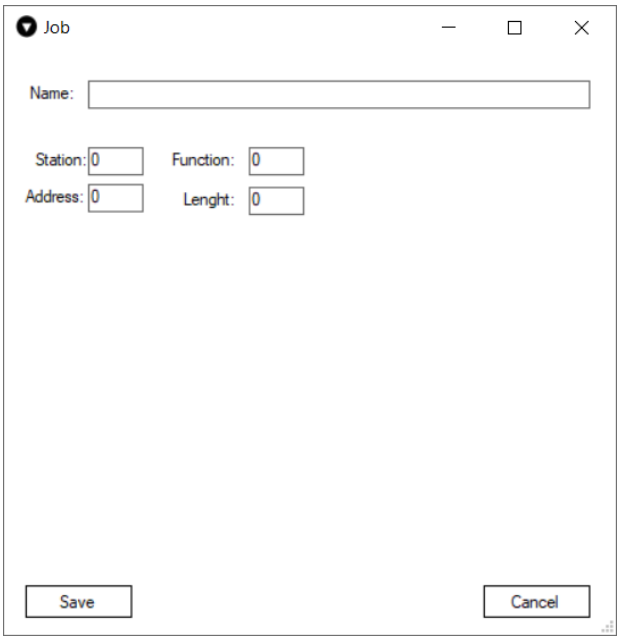


Jobs

Jobs are only available in **Master** simulations. What jobs are meant for is reading data from the Modbus slave device. They can send requests for big chunks of data in a single request. Then the data that slave responds with can be formatted using tags.

Job has these parameters:

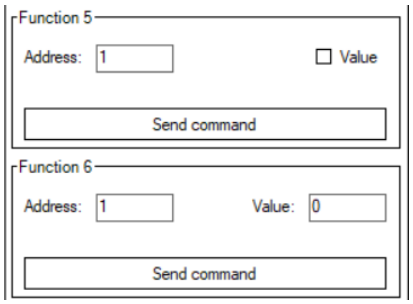
- **Name -** user-friendly job name.
- **Station -** Modbus **Slave address** to read data from.
- **Function -** the function to be used to read data.
- **Address -** slave address to begin reading data from.
- **Length** - how many bytes will be read.



Command

Commands are only available in **Master** simulations. Commands are used to send data to **Slave** devices. They serve the same purpose as **Write 5** and **Write 6** buttons in tags.

Although, commands will send data to the **Slave address** configured in the **Settings** tab whereas tags will send the data to the **Slave address** configured in the tag configuration.

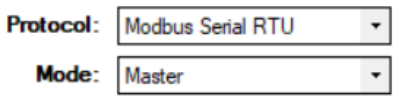


⚠ When using commands make sure to enter the desired Slave Address in the settings tab.

Setup

To setup an Modbus simulation it is fairly straightforward.

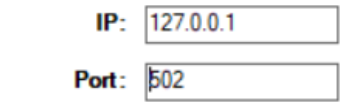
1. Select Modbus and the mode.



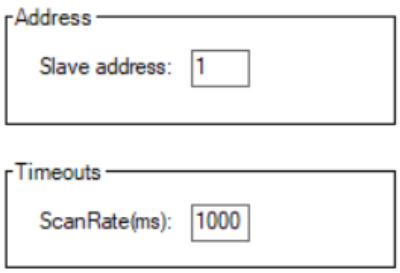
ℹ There are three different Modbus modes: **Modbus TCP, Modbus Serial RTU, Modbus Serial ASCII.**

2. Select Serial Port settings according to your device specification.

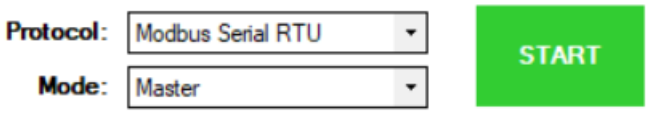
2.1 If **Modbus TCP** is used then the **IP** address and **Port** will have to be selected.



3. Select settings in the settings tab according to your device, preference and selected mode.



4. Press the green **START** button and the simulation should start. If everything was done correctly The Vinci software should establish communication with the Modbus device which you can monitor in the console tab.



IEC 60870-5-101

IEC 60870-5-101 is a protocol for power system monitoring and controlling. Mostly used for communication between substations and control centers over radio.

Info about protocol

Telegram Structure

Teleram format with fixed length

	7	6	5	4	3	2	1	0
0	Start byte							
1	RES	PRM	FCB ACD	FCV DFC	Function code			
2	Link address (1-2 bytes)							
3	Checksum							
4	Stop byte							

Telegram format with variable length

	7	6	5	4	3	2	1	0
0	Start byte							
1	Length							
2	Length							
4	Start byte							
5	RES	PRM	FCB ACD	FCV DFC	Function code			
6	Link address (1-2 bytes)							
7...	ASDU							

- **RES** - Reserved
- **PRM** - 1 if master, 0 if slave

PRM = 1

- **FCB** - alternating bit for successive services per station
- **FCV** - (if FCV=1 FCB enabled)

PRM = 0

- **ACD** - access demand (if ACD=1 there are class 1 data)
- **DFC** - data flow control (if DFC=1 further messages may cause data overflow)

ASDU - Application Service Data Unit

Function Code

PRM=1

Dec	Frame type	Service function	FCV
0	SEND/CONFIRM expected	Reset of remote link	0
1	SEND/CONFIRM expected	Reset of user process	0
2	SEND/CONFIRM expected	Reserved	-
3	SEND/CONFIRM expected	User data	1
4	SEND/REPLY expected	User data	0
5		Reserved	-
6		Reserved	-
7		Reserved	-
8	REQUEST for access demand	Expected response specifies access demand	0
9	REQUEST/RESPOND expected	Request status of link	0
10	REQUEST/RESPOND expected	Request user data class 1	1
11	REQUEST/RESPOND expected	Request user data class 2	1
12		Reserved	-
13		Reserved	-
14		Reserved	-
15		Reserved	-

PRM=0

Dec	Frame type	Service function
0	CONFIRM	ACK: positive acknowledgment
1	CONFIRM	NACK: message not accepted, link busy
2		Reserved
3		Reserved
4		Reserved
5		Reserved
6		Reserved
7		Reserved
8	RESPOND	User data
9	RESPOND	Requested data not available
10		Reserved
11	RESPOND	Status of link
12		Reserved

13		Reserved
14		Reserved
15		Reserved

Type identification

Standard IEC 60870-5-101 data types[1-255]

•[1-127] - standard definition

•[128-135] - reserved for routing of messages

•[136-255] - for special use

Dec	Type	Description	Direction	Support
Process information				
1	M_SP_NA_1	Single-point information	Monitor	Yes
2	M_SP_TA_1	Single-point information with time tag	Monitor	Yes
3	M_DP_NA_1	Double-point information	Monitor	Yes
4	M_DP_TA_1	Double-point information with time tag	Monitor	Yes
5	M_ST_NA_1	Step position information	Monitor	Yes
6	M_ST_TA_1	Step position information with time tag	Monitor	Yes
7	M_BO_NA_1	Bit string of 32 bit	Monitor	Yes
8	M_BO_TA_1	Bit string of 32 bit with time tag	Monitor	Yes
9	M_ME_NA_1	Measured value, normalized value	Monitor	Yes
10	M_ME_TA_1	Measured value, normalized value with time tag	Monitor	Yes
11	M_ME_NB_1	Measured value, scaled value	Monitor	Yes
12	M_ME_TB_1	Measured value, scaled value wit time tag	Monitor	Yes
13	M_ME_NC_1	Measured value, short floating point number	Monitor	Yes
14	M_ME_TC_1	Measured value, short floating point number with time tag	Monitor	Yes
15	M_IT_NA_1	Integrated totals	Monitor	Yes
16	M_IT_TA_1	Integrated totals with time tag	Monitor	Yes
17	M_EP_TA_1	Event of protection equipment with time tag	Monitor	Yes
18	M_EP_TB_1	Packed start events of protection equipment with time tag	Monitor	Yes
19	M_EP_TC_1	Packed output circuit information of protection equipment with time tag	Monitor	Yes
20	M_PS_NA_1	Packed single point information with status change detection	Monitor	Yes
21	M_ME_ND_1	Measured value, normalized value without quality descriptor	Monitor	Yes
30	M_SP_TB_1	Single-point information with time tag CP56Time2a	Monitor	Yes

31	M_DP_TB_1	Double-point information with time tag CP56Time2a	Monitor	Yes
32	M_ST_TB_1	Step position information with time tag CP56Time2a	Monitor	Yes
33	M_BO_TB_1	Bit string of 32 bit with time tag CP56Time2a	Monitor	Yes
34	M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	Monitor	Yes
35	M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	Monitor	Yes
36	M_ME_TF_1	Measured value, short floating point number with time tag CP56Time2a	Monitor	Yes
37	M_IT_TB_1	Integrated totals with time tag CP56Time2a	Monitor	Yes
38	M_EP_TD_1	Event of protection equipment with time tag CP56Time2a	Monitor	Yes
39	M_EP_TE_1	Packed start events of protection equipment with time tag CP56Time2a	Monitor	Yes
40	M_EP_TF_1	Packed output circuit information of protection equipment with time tag CP56Time2a	Monitor	Yes
45	C_SC_NA_1	Single command	Control	Yes
46	C_DC_NA_1	Double command	Control	Yes
47	C_RC_NA_1	Regulating step command	Control	Yes
48	C_SE_NA_1	Set-point Command, normalized value	Control	Yes
49	C_SE_NB_1	Set-point Command, scaled value	Control	Yes
50	C_SE_NC_1	Set-point Command, short floating point number	Control	Yes
51	C_BO_NA_1	Bit string 32 bit command	Control	Yes
58	C_SC_TA_1	Single command with time tag CP56Time2a	Control	Yes
59	C_DC_TA_1	Double command with time tag CP56Time2a	Control	Yes
60	C_RC_TA_1	Regulating step command with time tag CP56Time2a	Control	Yes
61	C_SE_TA_1	Measured value, normalized value command with time tag CP56Time2a	Control	Yes
62	C_SE_TB_1	Measured value, scaled value command with time tag CP56Time2a	Control	Yes
63	C_SE_TC_1	Measured value, short floating point number command with time tag CP56Time2a	Control	Yes
64	C_BO_TA_1	Bit string of 32 bit command with time tag CP56Time2a	Control	Yes
System information				
70	M_EI_NA_1	End of Initialization	Monitor	Yes
100	C_IC_NA_1	Interrogation command	Control	Yes
101	C_CI_NA_1	Counter interrogation command	Control	Yes
102	C_RD_NA_1	Read command	Control	Yes
103	C_CS_NA_1	Clock synchronization command	Control	Yes
104	C_TS_NA_1	Test command	Control	Yes
105	C_RP_NA_1	Reset process command	Control	Yes

106	C_CD_NA_1	Delay acquisition command	Control	No
107	C_TS_TA_1	Test command with time tag CP56Time2a	Control	No
Parameter				
110	P_ME_NA_1	Parameter of measured values, normalized value	Control	No
111	P_ME_NB_1	Parameter of measured values, scaled value	Control	No
112	P_ME_NC_1	Parameter of measured values, short floating point number	Control	No
113	P_AC_NA_1	Parameter activation	Control	No
File transfer				
120	F_FR_NA_1	File ready	File transfer	No
121	F_SR_NA_1	Section ready	File transfer	No
122	F_SC_NA_1	Call directory, select file, call file, call section	File transfer	No
123	F_LS_NA_1	Last section, last segment	File transfer	No
124	F_FA_NA_1	ACK file, ACK section	File transfer	No
125	F_SG_NA_1	Segment	File transfer	No
126	F_DR_TA_1	Directory	File transfer	No

Cause of transmission

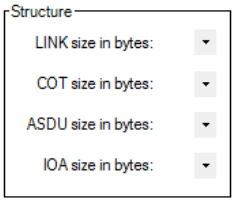
Standard IEC 60870-5-101 cause of transmission [0-63]

Dec	Description
1	Periodic, cyclic
2	Background interrogation
3	Spontaneous
4	Initialized
5	Interrogation or interrogated
6	Activation
7	Confirmation activation
8	Deactivation
9	Confirmation deactivation
10	Termination activation
11	Return information caused by a remote command
12	Return information caused by a local command
13	File transfer
20	Interrogated by general interrogation
21	Interrogated by interrogation group 1
22	Interrogated by interrogation group 2
23	Interrogated by interrogation group 3
24	Interrogated by interrogation group 4
25	Interrogated by interrogation group 5
26	Interrogated by interrogation group 6
27	Interrogated by interrogation group 7
28	Interrogated by interrogation group 8
29	Interrogated by interrogation group 9
30	Interrogated by interrogation group 10
31	Interrogated by interrogation group 11
32	Interrogated by interrogation group 12

33	Interrogated by interrogation group 13
34	Interrogated by interrogation group 14
35	Interrogated by interrogation group 15
36	Interrogated by interrogation group 16
37	Interrogated by counter general interrogation
38	Interrogated by interrogation counter group 1
39	Interrogated by interrogation counter group 2
40	Interrogated by interrogation counter group 3
41	Interrogated by interrogation counter group 4
44	Type Identification unknown
45	Cause unknown
46	ASDU address unknown
47	Information object address unknown

Settings

Structure

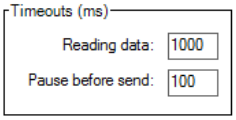


	Monitor	Master	Slave
LINK size in bytes	LINK size in bytes	LINK size in bytes	LINK size in bytes
COT size in bytes	COT size in bytes	COT size in bytes	COT size in bytes
ASDU size in bytes	ASDU size in bytes	ASDU size in bytes	ASDU size in bytes
IOA size in bytes	IOA size in bytes	IOA size in bytes	IOA size in bytes

Address

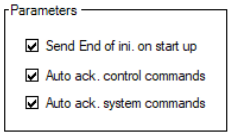
	Monitor	Master	Slave
Link address	Not used	Remote device address	Own system address

Timeouts (ms)



	Monitor	Master	Slave
Reading data	Waiting data in serial port buffer	Waiting data in serial port buffer	Waiting data in serial port buffer
Pause before send	Not used	Pause before send data	Pause before send data

Parameters



	Monitor	Master	Slave
Send End of ini.	Not used	Not used	Send end of initialization TI 70 (M_EI_NA_1)

	Auto ack. control commands	Not used	Not used	Auto acknowledge system commands (TI: 100, 103)
	Auto ack. system commands	Not used	Not used	Auto acknowledge commands

System

For all system functions user can set custom address:

General Interrogation

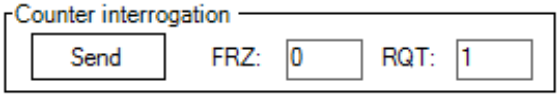
This function will send telegram Type-identification = 100 (C_IC_NA_1)

QOI - qualifier of interrogation [0...255]

- 20 - Station interrogation
- 21 - Interrogation of group 1
- 22 - Interrogation of group 2
- 23 - Interrogation of group 3
- 24 - Interrogation of group 4
- 25 - Interrogation of group 5
- 26 - Interrogation of group 6
- 27 - Interrogation of group 7
- 28 - Interrogation of group 8
- 29 - Interrogation of group 9
- 30 - Interrogation of group 10
- 31 - Interrogation of group 11
- 32 - Interrogation of group 12
- 33 - Interrogation of group 13
- 34 - Interrogation of group 14
- 35 - Interrogation of group 15
- 36 - Interrogation of group 16

Counter Interrogation

This function will send telegram Type-identification = 101 (C_CI_NA_1)



FRZ - freeze[0..3]

- 0 - Station interrogation
- 1 - Interrogation of group 1
- 2 - Interrogation of group 2
- 3 - Interrogation of group 3

RQT - request[0..63]

- 1 - Counter group 1
- 2 - Counter group 2
- 3 - Counter group 3
- 4 - Counter group 3
- 5 - General request

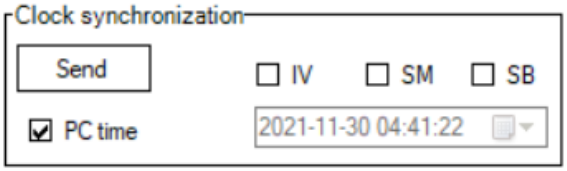
Commands

Read command will send telegram Type-identification = 102 (C_RD_NA_1)

Test command will send telegram Type-identification = 104 (C_TS_NB_1)

Clock synchronization

This function will send telegram Type-identification = 103 (C_CS_NA_1)



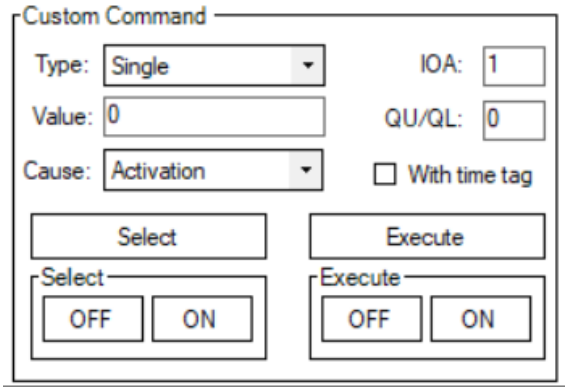
If "PC time" checkbox is checked, then the PC time will be sent. If it's not checked user can set time manually.

Time tag status bits:

- **IV** - invalid time
- **SM** - Summer/Winter
- **SB** - Substitute

Custom Commands

This function allows user to send commands to the slave device.



Tags

This function allows user to created named points. After points created user can send it manually or set reply checkbox to automatic reply.

- To export Tags to csv file:**Tags -> Export -> Save file dialog appear**
- To import Tags from csv file:**Tags -> Import -> Open file dialog appear**

There are two ways of creating tags:

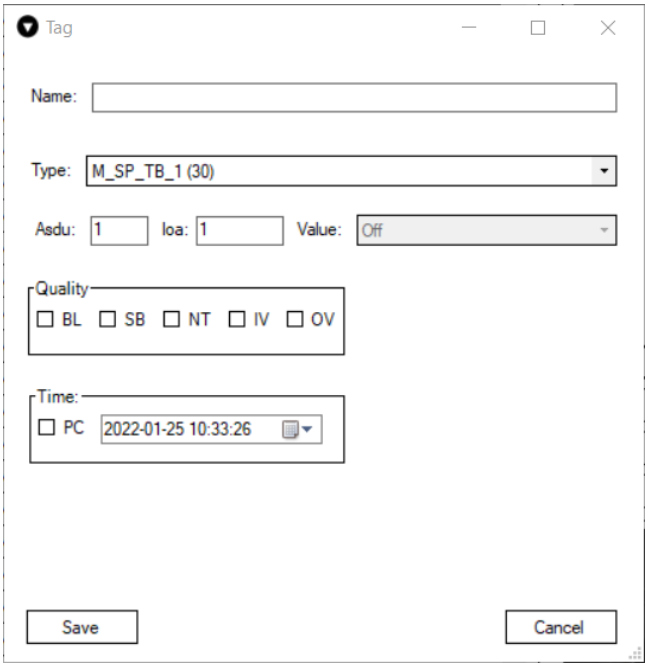
1. Create tag button.
2. Double click a signal with the left mouse button in the statistic tab.

Main parameters:

- **Name** - user-friendly tag name
- **Asdu** - Identifier of the device
- **Ioa** - Identifier of values from the device.
- **Type** - the type of value.

Here is an example image of the tag window with the**M_SP_TB_1 (30)** type selected. Each type has different options that can be configured when sending data. For example this type depicted in the picture below can send a value **Off** or

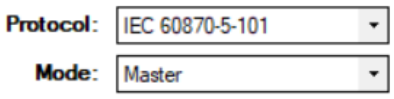
On and it also is time-tagged. The user in this case can either select a specific time that they have in mind or just mark the PC checkbox and The Vinci software will automatically send the current PC time. As you can see the Value box in this example is greyed out that is because this tag is created on a **master** simulation, and this type doesn't support writing to slave.



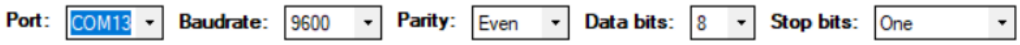
Setup

To setup an IEC 60870-5-101 simulation it is fairly straightforward.

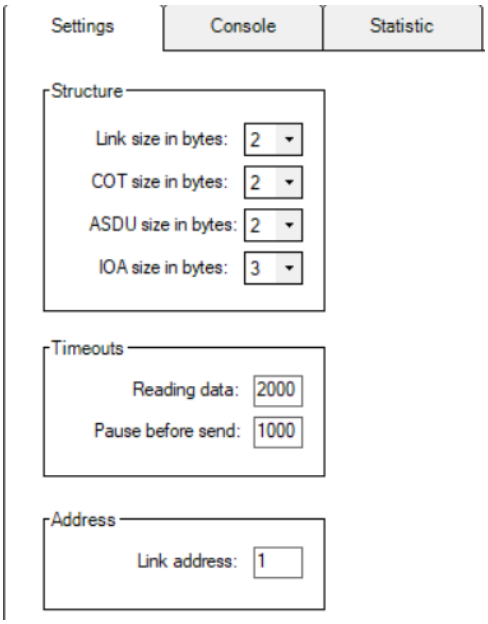
1. Select IEC 60870-5-101 and the mode.



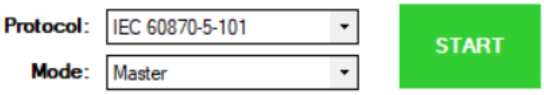
2. Select Serial Port settings according to your device specification.



3. Select settings in the settings tab according to your device and preference.



4. Press the green **START** button and the simulation should start. If everything was done correctly The Vinci software should establish communication with the IEC 60870-5-101 device which you can monitor in the console tab.



IEC 60870-5-103

IEC 60870-5-103 is a protocol for power system monitoring and controlling. Mostly used for communication between protection devices and devices of a control system in a substation (RTU) over fiber optics.

Info about protocol

Telegram Structure

Telegram format with fixed length

	7	6	5	4	3	2	1	0
0	Start byte							
1	RES	PRM	FCB ACD	FCV DFC	Function code			
2	Link address (1-2 bytes)							
3	Checksum							
4	Stop byte							

Telegram format with variable length

	7	6	5	4	3	2	1	0
0	Start byte							
1	Length							
2	Length							
4	Start byte							
5	RES	PRM	FCB ACD	FCV DFC	Function code			
6	Link address							
7	Type identification							
8	SQ	Number of objects						
9	Cause of transmission							
10	ASDU address							
11	Function type							
12	Information number							
13...	Information elements...							
x	Checksum							
x	Stop byte							

- **RES** - Reserved
- **PRM** - 1 if master, 0 if slave

PRM = 1

- **FCB** - alternating bit for successive services per station

- **FCV** - (if **FCV**=1 **FCB** enabled)

PRM = 0

- **ACD** - access demand (if **ACD**=1 there are class 1 data)
- **DFC** - data flow control (if **DFC**=1 further messages may cause data overflow)

Function Code

PRM=1

Dec	Frame type	Service function	FCV
0	SEND/CONFIRM expected	Reset of remote link	0
1	SEND/CONFIRM expected	Reset of user process	0
2	SEND/CONFIRM expected	Reserved	-
3	SEND/CONFIRM expected	User data	1
4	SEND/REPLY expected	User data	0
5		Reserved	-
6		Reserved	-
7		Reserved	-
8	REQUEST for access demand	Expected response specifies access demand	0
9	REQUEST/RESPOND expected	Request status of link	0
10	REQUEST/RESPOND expected	Request user data class 1	1
11	REQUEST/RESPOND expected	Request user data class 2	1
12		Reserved	-
13		Reserved	-
14		Reserved	-
15		Reserved	-

PRM=0

Dec	Frame type	Service function
0	CONFIRM	ACK: positive acknowledgment
1	CONFIRM	NACK: message not accepted, link busy
2		Reserved
3		Reserved
4		Reserved
5		Reserved
6		Reserved

7		Reserved
8	RESPOND	User data
9	RESPOND	NACK: requested data not available
10		Request user data class 1
11	RESPOND	Request user data class 2
12		Reserved
13		Reserved
14		Reserved
15		Reserved

Type identification

Standard IEC 60870-5-103 data types[1-255]

- [1-31] - standard definition
- [32-255] - for special use

Dec	Description	Direction	Support
1	Time-tagged message	Monitor	Yes
2	Time-tagged message with relative time	Monitor	Yes
3	Measurands I	Monitor	Yes
4	Time-tagged measurands with relative time	Monitor	Yes
5	Identification	Monitor	Yes
6	Clock synchronization	Both	Yes
7	General interrogation	Control	Yes
8	End of general interrogation	Monitor	Yes
9	Measurands II	Monitor	Yes
10	Generic data	Both	No
11	Generic identification	Monitor	No
20	General command	Control	Yes
21	Generic command	Control	No
23	List of recorded disturbances	Monitor	No
24	Order for disturbance data transmission	Control	No
25	Acknowledgment for disturbance data transmission	Control	No
26	Ready for transmission of disturbance data	Monitor	No
27	Ready for transmission of a channel	Monitor	No
28	Ready for transmission of tags	Monitor	No
29	Transmission of tags	Monitor	No
30	Transmission of disturbance values	Monitor	No
31	End of transmission	Monitor	No

Cause of transmission

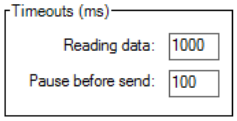
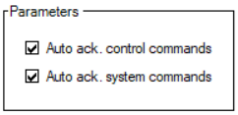
Standard IEC 60870-5-103 cause of transmission [0-255]

- [0] - not used
- [1-63] - standard definition
- [64-255] - for special use

Dec	Description

1	Spontaneous
2	Cyclic
3	Reset frame count bit (FCB)
4	Reset communication unit (CU)
5	Start/ restart
6	Power ON
7	Test mode
8	Time synchronization
9	General interrogation
10	End of general interrogation
11	Return information caused by a remote command
12	Return information caused by a local command
20	Command "ACK positive"
21	Command "ACK negative"
31	Transmission disturbance data
40	Generic write command with ACK positive
41	Generic write command with ACK negative
42	Generic read command data valid
43	Generic read command data invalid
44	Generic write conformation

Settings

Timeouts (ms)				
		**Monitor**	**Master**	**Slave**
	Reading data	Waiting data in serial port buffer	Waiting data in serial port buffer	Waiting data in serial port buffer
	Pause before send	Not used	Pause before send data	Pause before send data
Address				
		**Monitor**	**Master**	**Slave**
	Link	Not used	Remote device address	Own system address
	ASDU	Not used	Remote device address	Own system address
Commands ack.				
		**Monitor**	**Master**	**Slave**
	Auto ack. system commands	Not used	Not used	Auto acknowledge system commands

	Auto ack. control commands	Not used	Not used	Auto acknowledge commands

System

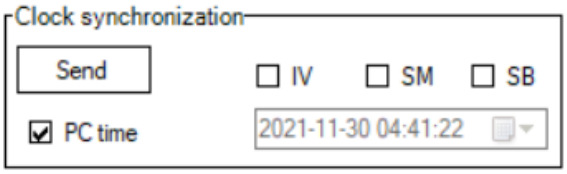
For all system functions user can set custom address:

General Interrogation

This function will send telegram Type-identification = 7

Clock synchronization

This function will send telegram Type-identification = 103 (C_CS_NA_1)



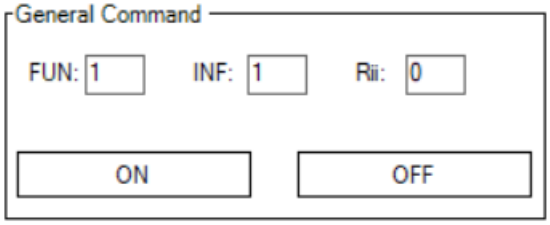
If "PC time" checkbox is checked, then the PC time will be sent. If it's not checked user can set time manually.

Time tag status bits:

- **IV** - invalid time
- **SM** - Summer/Winter
- **SB** - Substitute

General Command

This function allows user to send command to slave device.



Tags

This function allows user to created named points. After points created user can send it manually or set reply checkbox to automatic reply.

- To export Tags to csv file:**Tags -> Export -> Save file dialog appear**
- To import Tags from csv file:**Tags -> Import -> Open file dialog appear**

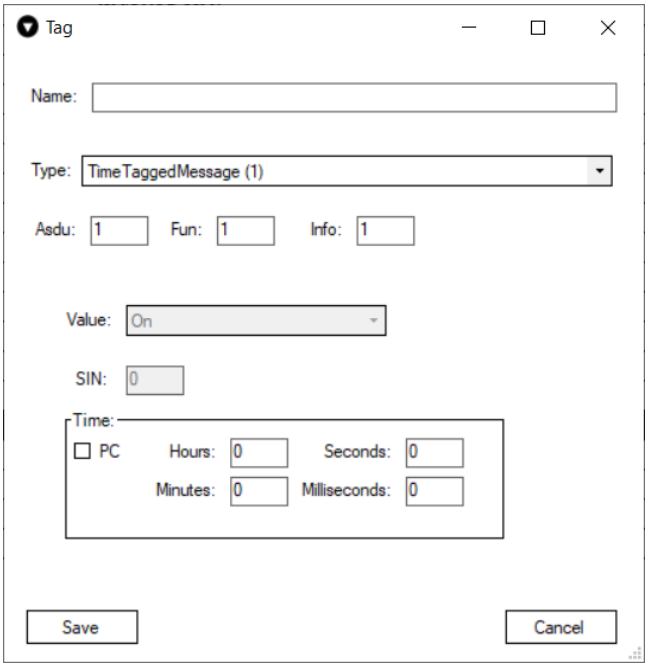
There are two ways of creating tags:

1. Create tag button.
2. Double click a signal with the left mouse button in the statistic tab.

Main parameters:

- **Name** - user-friendly tag name
- **Type** - the type of value.
- **Asdu** - Identifier of the device
- **Fun -** function number
- **Info**- Identifier of values from the device.

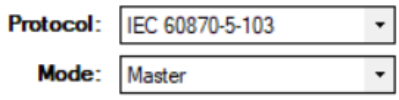
Here is an example image of the tag window with the**TimeTaggedMessage(1)** type selected. Each type has different options that can be configured when sending data. For example this type depicted in the picture below can send a value **Off** or **On** and it also is time-tagged. The user in this case can either select a specific time that they have in mind or just mark the PC checkbox and The Vinci software will automatically send the current PC time. As you can see the **Value** box in this example is greyed out that is because this tag is created on a**master** simulation, and this type doesn't support writing to slave.



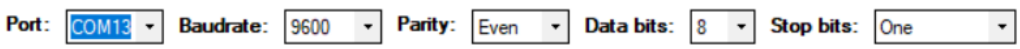
Setup

To setup an IEC 60870-5-103 simulation it is fairly straightforward.

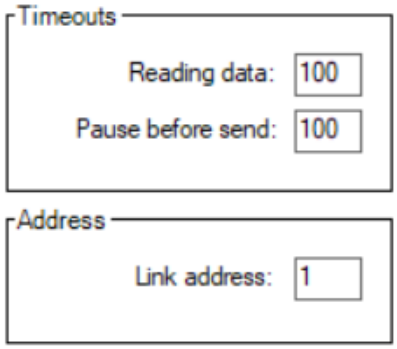
1. Select IEC 60870-5-103 and the mode.



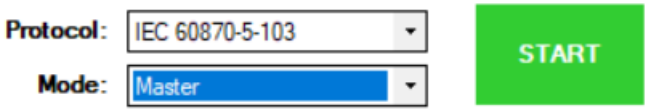
2. Select Serial Port settings according to your device specification.



3. Select settings in the settings tab according to your device and preference.



4. Press the green **START** button and the simulation should start. If everything was done correctly The Vinci software should establish communication with the IEC 60870-5-103 device which you can monitor in the console tab.



IEC 60870-5-104

IEC 60870-5-104 is a protocol for power system monitoring and controlling. Mostly used to communication between substations and control centers over Ethernet (Fiber optics, 2/3/4G, ...).IEC 60870-5-104 protocol is an extension of IEC 60870-5-101 protocol with the changes in transport, network, link and physical layer services to suit the complete network access.

Info about protocol

Telegram Structure

Teleram format with fixed length

	7	6	5	4	3	2	1	0
0	Start byte							
1	Length of APDU							
2	Control field 1							
3	Control field 2							
4	Control field 3							
5	Control field 4							

Telegram format with variable length

	7	6	5	4	3	2	1	0
0	Start byte							
1	Length of APDU							
2	Control field 1							
3	Control field 2							
4	Control field 3							
5	Control field 4							
6...	ASDU							

- **APCI** - Application Protocol Control Information (First 6 bytes)
- **APDU** - Application Protocol Data Unit (All variable length telegram)
- **ASDU** - Application Service Data Unit

Type identification

Standard IEC 60870-5-104 data types[1-255]

- [1-127] - standard definition
- [128-135] - reserved for routing of messages
- [136-255] - for special use

Dec	Type	Description	Direction	Support
Process information				
1	M_SP_NA_1	Single-point information	Monitor	Yes
2	M_SP_TA_1	Single-point information with time tag	Monitor	Yes
3	M_DP_NA_1	Double-point information	Monitor	Yes
4	M_DP_TA_1	Double-point information with time tag	Monitor	Yes
5	M_ST_NA_1	Step position information	Monitor	Yes
6	M_ST_TA_1	Step position information with time tag	Monitor	Yes
7	M_BO_NA_1	Bit string of 32 bit	Monitor	Yes
8	M_BO_TA_1	Bit string of 32 bit with time tag	Monitor	Yes
9	M_ME_NA_1	Measured value, normalized value	Monitor	Yes
10	M_ME_TA_1	Measured value, normalized value with time tag	Monitor	Yes
11	M_ME_NB_1	Measured value, scaled value	Monitor	Yes
12	M_ME_TB_1	Measured value, scaled value wit time tag	Monitor	Yes
13	M_ME_NC_1	Measured value, short floating point number	Monitor	Yes
14	M_ME_TC_1	Measured value, short floating point number with time tag	Monitor	Yes
15	M_IT_NA_1	Integrated totals	Monitor	Yes
16	M_IT_TA_1	Integrated totals with time tag	Monitor	Yes
17	M_EP_TA_1	Event of protection equipment with time tag	Monitor	Yes
18	M_EP_TB_1	Packed start events of protection equipment with time tag	Monitor	Yes
19	M_EP_TC_1	Packed output circuit information of protection equipment with time tag	Monitor	Yes
20	M_PS_NA_1	Packed single point information with status change detection	Monitor	Yes
21	M_ME_ND_1	Measured value, normalized value without quality descriptor	Monitor	Yes
30	M_SP_TB_1	Single-point information with time tag CP56Time2a	Monitor	Yes

31	M_DP_TB_1	Double-point information with time tag CP56Time2a	Monitor	Yes
32	M_ST_TB_1	Step position information with time tag CP56Time2a	Monitor	Yes
33	M_BO_TB_1	Bit string of 32 bit with time tag CP56Time2a	Monitor	Yes
34	M_ME_TD_1	Measured value, normalized value with time tag CP56Time2a	Monitor	Yes
35	M_ME_TE_1	Measured value, scaled value with time tag CP56Time2a	Monitor	Yes
36	M_ME_TF_1	Measured value, short floating point number with time tag CP56Time2a	Monitor	Yes
37	M_IT_TB_1	Integrated totals with time tag CP56Time2a	Monitor	Yes
38	M_EP_TD_1	Event of protection equipment with time tag CP56Time2a	Monitor	Yes
39	M_EP_TE_1	Packed start events of protection equipment with time tag CP56Time2a	Monitor	Yes
40	M_EP_TF_1	Packed output circuit information of protection equipment with time tag CP56Time2a	Monitor	Yes
45	C_SC_NA_1	Single command	Control	Yes
46	C_DC_NA_1	Double command	Control	Yes
47	C_RC_NA_1	Regulating step command	Control	Yes
48	C_SE_NA_1	Set-point Command, normalized value	Control	Yes
49	C_SE_NB_1	Set-point Command, scaled value	Control	Yes
50	C_SE_NC_1	Set-point Command, short floating point number	Control	Yes
51	C_BO_NA_1	Bit string 32 bit command	Control	Yes
58	C_SC_TA_1	Single command with time tag CP56Time2a	Control	Yes
59	C_DC_TA_1	Double command with time tag CP56Time2a	Control	Yes
60	C_RC_TA_1	Regulating step command with time tag CP56Time2a	Control	Yes
61	C_SE_TA_1	Measured value, normalized value command with time tag CP56Time2a	Control	Yes
62	C_SE_TB_1	Measured value, scaled value command with time tag CP56Time2a	Control	Yes
63	C_SE_TC_1	Measured value, short floating point number command with time tag CP56Time2a	Control	Yes
64	C_BO_TA_1	Bit string of 32 bit command with time tag CP56Time2a	Control	Yes

System information				
70	M_EI_NA_1	End of Initialization	Monitor	Yes
100	C_IC_NA_1	Interrogation command	Control	Yes
101	C_CI_NA_1	Counter interrogation command	Control	Yes
102	C_RD_NA_1	Read command	Control	Yes
103	C_CS_NA_1	Clock synchronization command	Control	Yes
104	C_TS_NA_1	Test command	Control	Yes
105	C_RP_NA_1	Reset process command	Control	Yes
106	C_CD_NA_1	Delay acquisition command	Control	No
107	C_TS_TA_1	Test command with time tag CP56Time2a	Control	No
Parameter				
110	P_ME_NA_1	Parameter of measured values, normalized value	Control	No
111	P_ME_NB_1	Parameter of measured values, scaled value	Control	No
112	P_ME_NC_1	Parameter of measured values, short floating point number	Control	No
113	P_AC_NA_1	Parameter activation	Control	No
File transfer				
120	F_FR_NA_1	File ready	File transfer	No
121	F_SR_NA_1	Section ready	File transfer	No
122	F_SC_NA_1	Call directory, select file, call file, call section	File transfer	No
123	F_LS_NA_1	Last section, last segment	File transfer	No
124	F_FA_NA_1	ACK file, ACK section	File transfer	No
125	F_SG_NA_1	Segment	File transfer	No
126	F_DR_TA_1	Directory	File transfer	No

127	F_SC_NB_1	Request archive file	File transfer	No

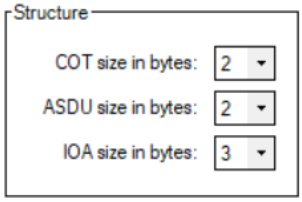
Cause of transmission

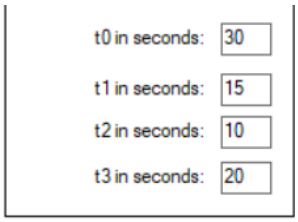
Standard IEC 60870-5-101 cause of transmission [0-63]

Dec	Description
1	Periodic, cyclic
2	Background interrogation
3	Spontaneous
4	Initialized
5	Interrogation or interrogated
6	Activation
7	Confirmation activation
8	Deactivation
9	Confirmation deactivation
10	Termination activation
11	Return information caused by a remote command
12	Return information caused by a local command
13	File transfer
20	Interrogated by general interrogation
21	Interrogated by interrogation group 1
22	Interrogated by interrogation group 2
23	Interrogated by interrogation group 3
24	Interrogated by interrogation group 4
25	Interrogated by interrogation group 5
26	Interrogated by interrogation group 6
27	Interrogated by interrogation group 7
28	Interrogated by interrogation group 8

29	Interrogated by interrogation group 9
30	Interrogated by interrogation group 10
31	Interrogated by interrogation group 11
32	Interrogated by interrogation group 12
33	Interrogated by interrogation group 13
34	Interrogated by interrogation group 14
35	Interrogated by interrogation group 15
36	Interrogated by interrogation group 16
37	Interrogated by counter general interrogation
38	Interrogated by interrogation counter group 1
39	Interrogated by interrogation counter group 2
40	Interrogated by interrogation counter group 3
41	Interrogated by interrogation counter group 4
44	Type Identification unknown
45	Cause unknown
46	ASDU address unknown
47	Information object address unknown

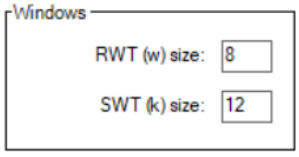
Settings

Structure			
		**Master, Slave, Monitor**	
	COT size in bytes	COT size in bytes	
	ASDU size in bytes	ASDU size in bytes	
	IOA size in bytes	IOA size in bytes	
Timeouts (ms)			
		**Master**	**Slave**
	t0 in seconds	Timeout for the establishment of the connection with the server.	Not used



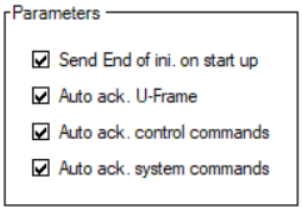
t1 in seconds	This parameter defines the time in seconds that Master waits maximum for an acknowledge from the slave.	This parameter defines the time in seconds that slave waits maximum for an acknowledge from the master.
t2 in seconds	A S-format frame will be sent at the latest after this time starting from the last received telegram from the slave.	A S-format frame will be sent at the latest after this time starting from the last received telegram from the master.
t3 in seconds	A Test frame will be sent at the latest after this time starting from the last received telegram from the slave.	A Test frame will be sent at the latest after this time starting from the last received telegram from the master

Windows



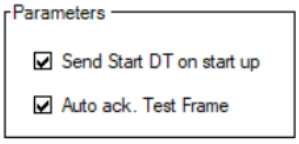
	Master	**Slave**
w size	This parameter indicates the number of received I frames after the S-Frame will be send.	This parameter indicates the number of received I frames after the S-Frame will be send
k size	Maximum I-frames send until acknowledgment.	Not used

SLAVE Parameters



	Slave
Send End of ini. on start up	Send end of initialization TI 70 (M_EI_NA_1)
Auto ack. U-Frame	Auto ack. U-Frame.
Auto ack. control commands	Auto acknowledge commands
Auto ack. system commands	Auto acknowledge system commands (TI: 100, 103)

MASTER Parameters



	Master
Send Start DT on start up	Send Start DT on startup
Auto ack. Test Frame	Auto ack. Test frame

System

For all system functions user can set custom address:

General Interrogation

This function will send telegram Type-identification = 100 (C_IC_NA_1)

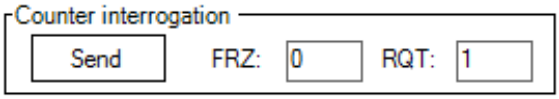
QOI - qualifier of interrogation [0...255]

- 20 - Station interrogation
- 21 - Interrogation of group 1

- 22 - Interrogation of group 2
- 23 - Interrogation of group 3
- 24 - Interrogation of group 4
- 25 - Interrogation of group 5
- 26 - Interrogation of group 6
- 27 - Interrogation of group 7
- 28 - Interrogation of group 8
- 29 - Interrogation of group 9
- 30 - Interrogation of group 10
- 31 - Interrogation of group 11
- 32 - Interrogation of group 12
- 33 - Interrogation of group 13
- 34 - Interrogation of group 14
- 35 - Interrogation of group 15
- 36 - Interrogation of group 16

Counter Interrogation

This function will send telegram Type-identification = 101 (C_CI_NA_1)



FRZ - freeze[0..3]

- 0 - Station interrogation
- 1 - Interrogation of group 1
- 2 - Interrogation of group 2
- 3 - Interrogation of group 3

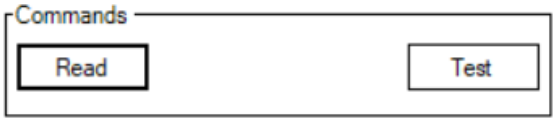
RQT - request[0..63]

- 1 - Counter group 1
- 2 - Counter group 2
- 3 - Counter group 3
- 4 - Counter group 3
- 5 - General request

Commands

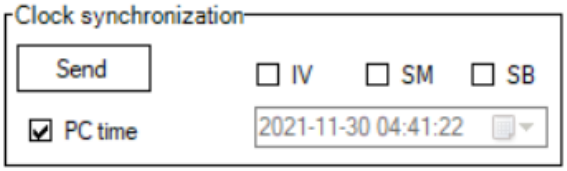
Read command will send telegram Type-identification = 102 (C_RD_NA_1)

Test command will send telegram Type-identification = 104 (C_TS_NB_1)



Clock synchronization

This function will send telegram Type-identification = 103 (C_CS_NA_1)



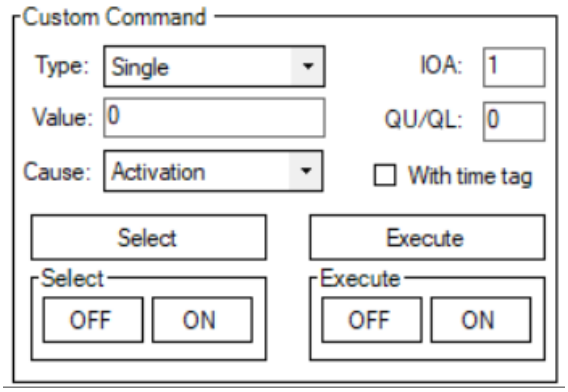
If "PC time" checkbox is checked, then the PC time will be sent. If it's not checked user can set time manually.

Time tag status bits:

- **IV** - invalid time
- **SM** - Summer/Winter
- **SB** - Substitute

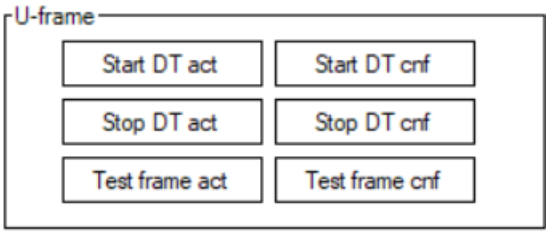
Custom Commands

This function allows user to send commands to the slave device.



Channel

With these functions a user has the ability to send any U or S frame telegram.



- **Start DT act** - Send *Start Data terminal* activation
- **Start DT cnf** - Send *Start Data terminal* confirmation
- **Stop DT act** - Send *Stop Data terminal* activation
- **Stop DT cnf** - Send *Stop Data terminal* confirmation
- **Test Frm act** - Send *Test Frame* activation
- **Test Frm cnf -** Send *Test Frame* confirmation

S-Frame ack - Send S-Frame. User can specify acknowledgment telegram count in text box.

Tags

This function allows user to created named points. After points created user can send it manually or set reply checkbox to automatic reply.

- To export Tags to csv file:**Tags -> Export -> Save file dialog appear**
- To import Tags from csv file:**Tags -> Import -> Open file dialog appear**

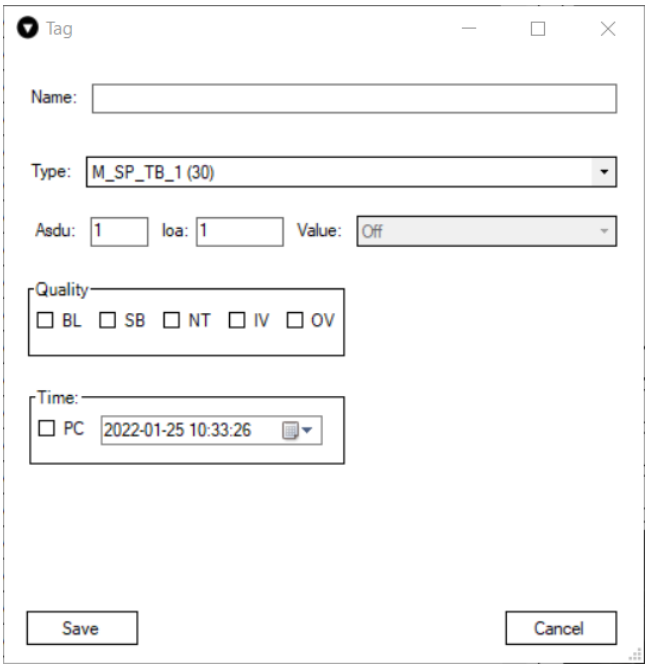
There are two ways of creating tags:

1. Create tag button.
2. Double click a signal with the left mouse button in the statistic tab.

Main parameters:

- **Name** - user-friendly tag name
- **Asdu** - Identifier of the device
- **Ioa** - Identifier of values from the device.
- **Type** - the type of value.

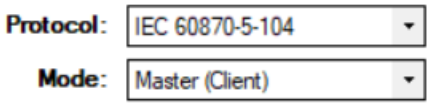
Here is an example image of the tag window with the**M_SP_TB_1 (30)** type selected. Each type has different options that can be configured when sending data. For example this type depicted in the picture below can send a value **Off** or **On** and it also is time-tagged. The user in this case can either select a specific time that they have in mind or just mark the PC checkbox and The Vinci software will automatically send the current PC time. As you can see the Value box in this example is greyed out that is because this tag is created on a **master** simulation, and this type doesn't support writing to slave.



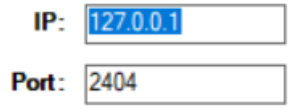
Setup

To setup an IEC 60870-5-104 simulation it is fairly straightforward.

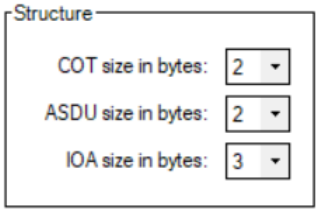
1. Select IEC 60870-5-104 and the mode.

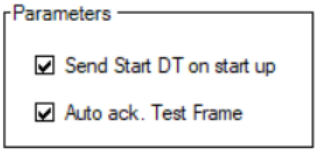


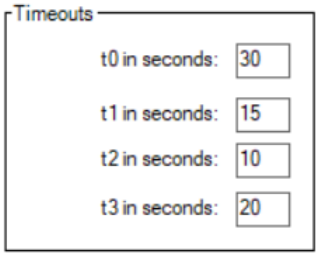
2. Select Ethernet settings to connect to device. Set the **IP** and the **Port.** (Default port: 2404)

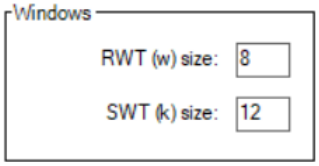


3. Select settings in the settings tab according to your device and preference.









4. Press the green **START** button and the simulation should start. If everything was done correctly The Vinci software should establish communication with the IEC 60870-5-104 device which you can monitor in the console tab.