Data Concentrator TELEM-GW5

User Manual

Martem AS
2009

Contents

1. Main Tasks

The tasks of the Data Concentrator TELEM-GW5 (GW5) include the following:

- To control and monitor the system from the control center using data communication protocols IEC 60870-5-101 and IEC 60870-5-104
- To concentrate data collection from lower level peripheral devices and control them by using different data exchange protocols

2. Possible Applications

- Data acquisition and control of regional and national electricity utilities in SCADA systems for remote control and substation automation
- Comprehensive integration of different devices
- As a communication gateway

3. Features

- Data concentrator with an associated event annunciator performing sub-station level master unit functions in the substation secondary equipment system
- Duplex data communications between the feeder and the equipment level versus the station control level in substations using different communication protocols and cross-referencing between the protocols
- Full scale data exchange between the levels of the substation control system including setting values, measurement values, registered fault parameter values, changes of state with associated time markings etc
- Data concentrator provided with serial interfaces to facilitate the connection between local output devices and external host systems
- All the settings can be changed using software configuration tool
- GW5 is provided with seven serial RS 232 interface ports through which it can be connected to remote control and substation automation systems by using different type of protocols. A SSP interface port to connect to the visual alarm annunciator unit or the additional input-output unit
  A port for connection using interface RS – 485 and a fiber optic port or Ethernet connection port depending on the version
- Output channel to the remote control system can be connected to a leased or a dial-up line using a copper line-, radio- or GSM modem
- Data concentrator GW5 is provided with control input for clock synchronizing purposes using GPS
- Logical operations between digital and analog signals can be described
- Hierarchical connection is possible
- TELEM RTU devices can be remotely configured across TELEM-GW5
- Microsoft Excel direct import and export facilities are in use
- A user-friendly user interface similar to MS

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4. View

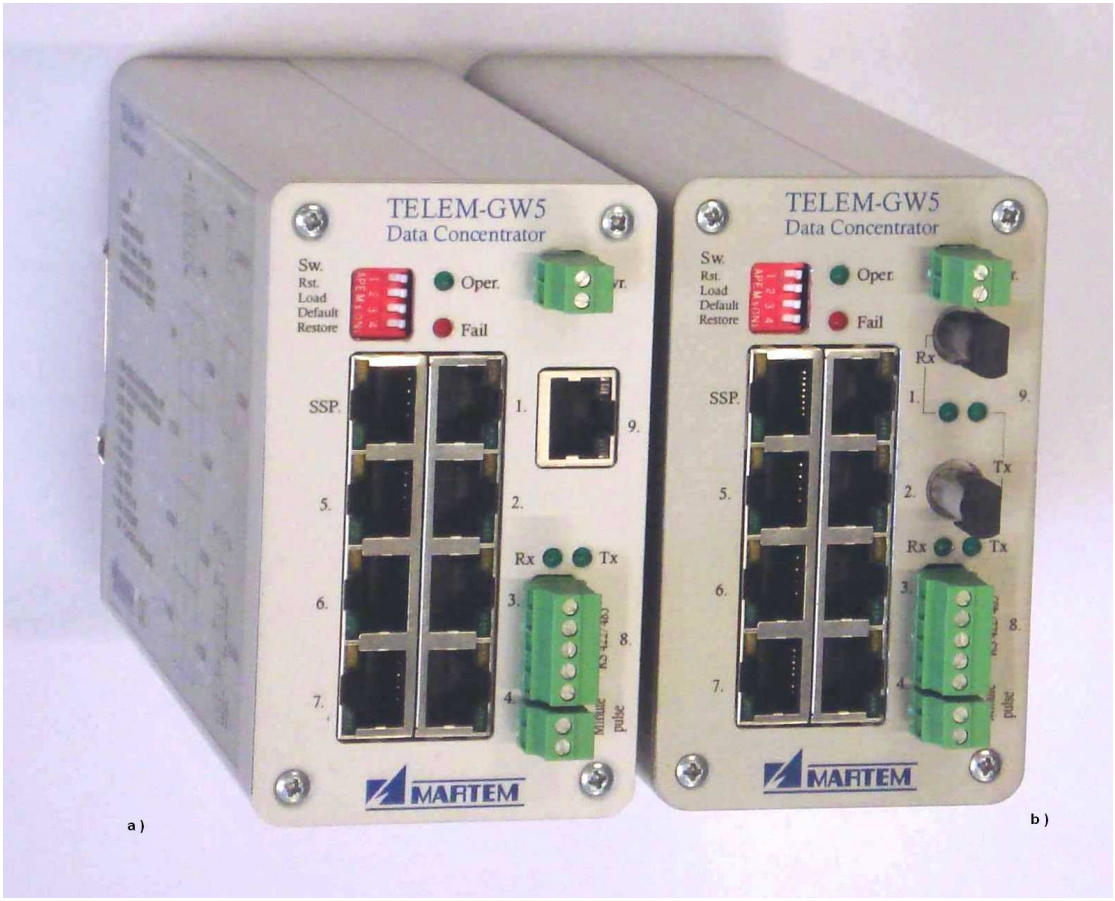


Figure 4 a) GW5 with Ethernet port, b) with optical port

5. Technical Data

Data communication protocols

- To higher or lower level systems IEC 60870-5-101 or IEC 60870-5-104
- To lower level devices in addition to IEC 60870-5-103, ModBus, Telem, EN 62056-21

Communication ports

- **1** - For connecting the GPS system for time synchronization if Switch 2 is in OFF position and for loading a program if Switch 2 is in ON position
- **2** - For connecting dial up modems (RS-232 interface signals DSR, CTS, RXD, TXD, DCD, RTS and DTR)
- **3…7** - RS-232 port (with RXD, TXD, RTS, CTS signals)
- **8 -** Isolated RS-422/485 port
- **9** - Fiber-optic or Ethernet port depending on the GW5 version
- **SSP** – Synchronous Serial Port for connecting TLM GW-IO and the LED alarm panel
- **Min. pulse** – minute pulse output (open collector transistor)

Data communication parameters

- 1 start bit
- Odd, even or no parity control
- Communication rates from 300 to 38400 bit/sec, asynchronous
- Configurable RTS/CTS handshaking for ports 2…7

Maximum number of configured devices and objects

- Max. number of objects 2000
- Max. number of devices 32

Mechanical parameters

- Degree of protection IP 32
- Dimensions (W x H x D) 64 x 107 x 164
- Weight 780 g
- Mountable DIN 35 rail

Power supply

- Supply voltage range from 12 to 32 V DC
- Power consumption < 5 VA

Disturbance tests

Immunity of isolated signal ports to

- Burst EN 61000-4-5
- Fast transients EN 61000-4-4
- HF field EN61000-4-6

Immunity of power supply to

- RF field EN61000-4-6
- Fast transients EN 61000-4-4

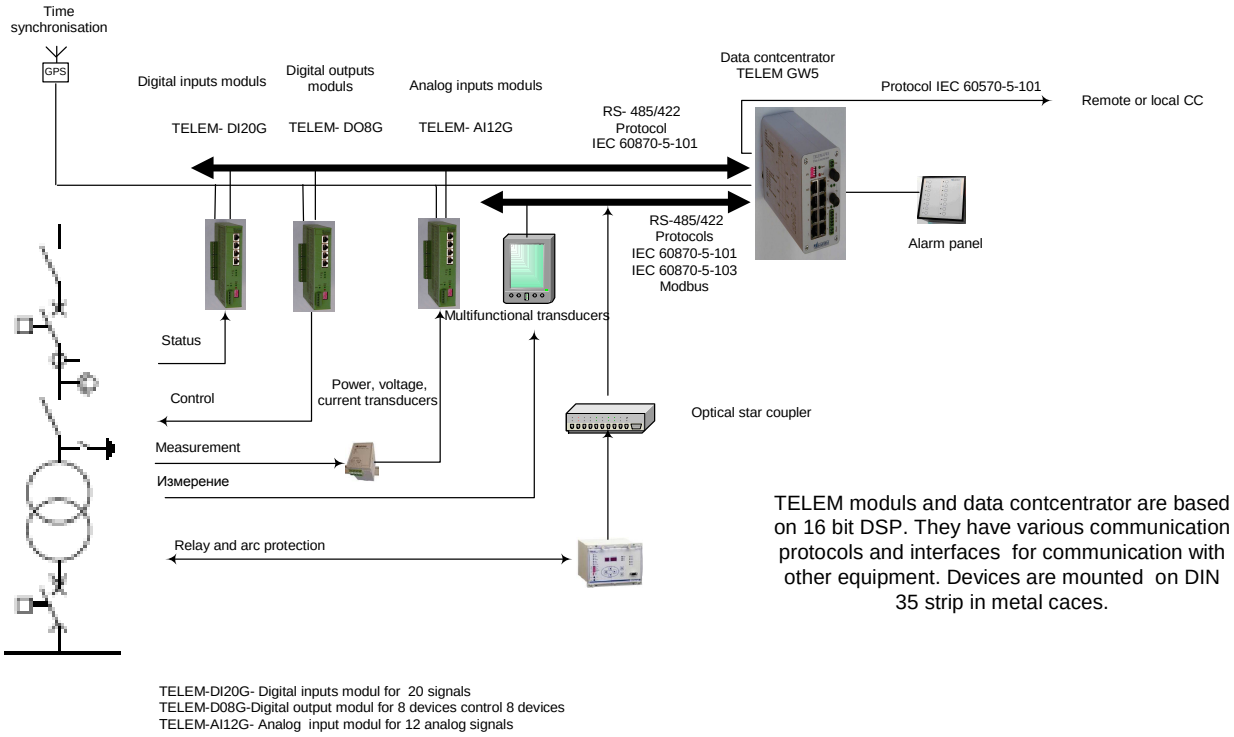
Immunity of case and signal ports to

- RF field EN61000-4-3
- Static discharge EN 61000-4-2

Emission

- Conducted to communication lines EN55022-5-2
- Conducted to power supply lines EN55022-5-1
- Emitted EN55022-10-3-5

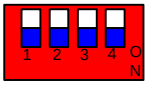
6. Typical Application for Electric Power Station



TELEM moduls and data contcentrator are based on 16 bit DSP. They have various communication protocols and interfaces for communication with other equipment. Devices are mounted on DIN 35 strip in metal caces.

TELEM-DI20G- Digital inputs modul for 20 signals
TELEM-D08G-Digital output modul for 8 devices control 8 devices
TELEM-AI12G- Analog input modul for 12 analog signals

7. Switches



1 – RESET. Turn to ON and then to OFF again for Reset operation.
2 – OPER/LOAD. Operation in OFF and program loading via Port 1 in ON position.
3 – Fixed port 1 parameters. If in ON position, the port 1 address is 1, speed 9600 b/s, no handshake
4 – Restore the DEFAULT setup. Turn switch 4 to ON, do a Reset with switch 1, turn switch 4 to OFF while the red LED is blinking, wait until green LED starts to blink (do not do a Reset before that)

To enter into hardware test mode, switches 3 and 4 are simultaneously set to ON position and then followed by Reset. An ordinary PC terminal program is used for that. PC is connected to port 1.

8. Indication

For operation
Green LED – Blinking green indicates that the program is running
Red LED – Failure
For communication
Yellow LED – RX
Green LED – TX
Green LED at SSP port – blinking indicates the existence of GPS time synchronization

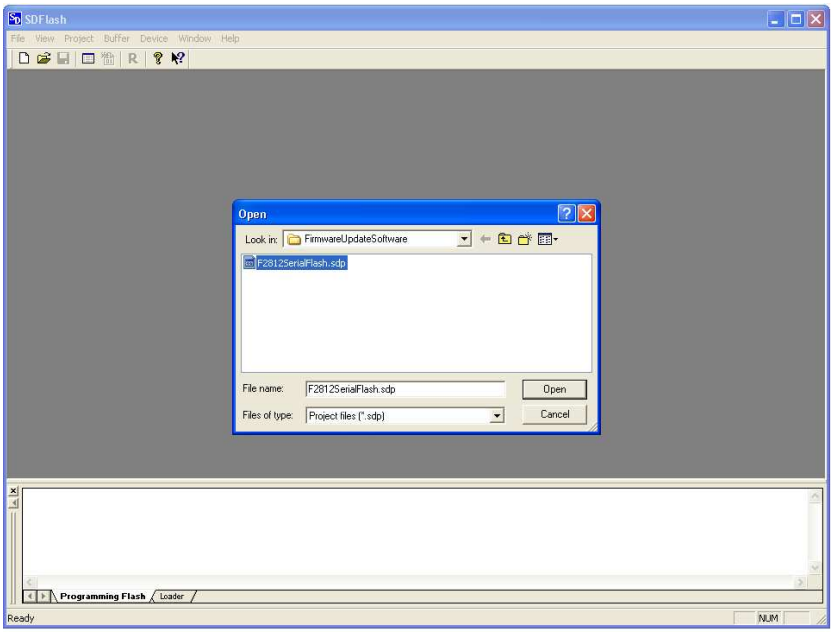
9. Firmware Update

Loading GW5 firmware from a PC computer is done through port 1. Switch 2 has to be set to ON position, followed by Reset. Firmware loader SDFlash.exe can be found on the GW5 configuration CD. Firmware code is stored in the gw5.out file.

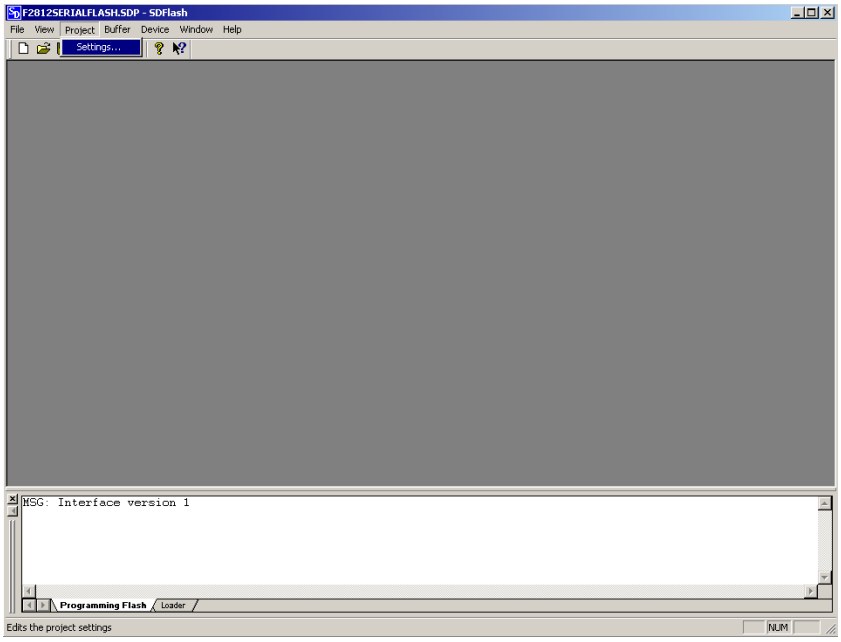
Firmware update from CD

1. Set the GW5 switch ”Firmware update mode“ to “On“ position
2. Reset with the “Reset” switch (do not leave it ”On“)
3. Open ”GW5 Firmware Update“

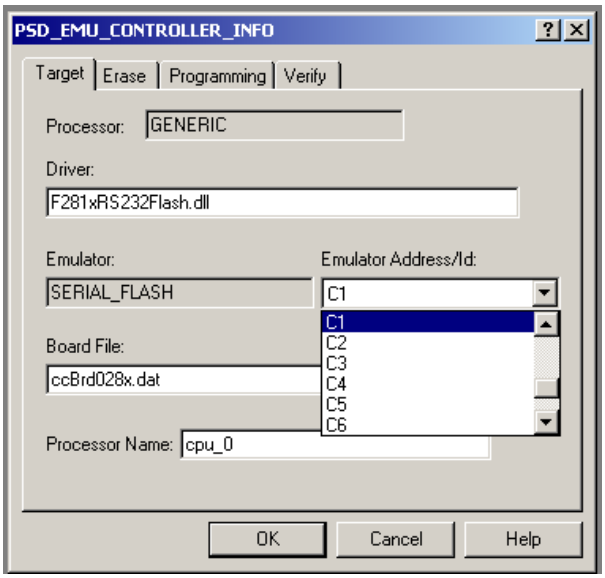
3. Open loader F2812SeriaFlash.sdp



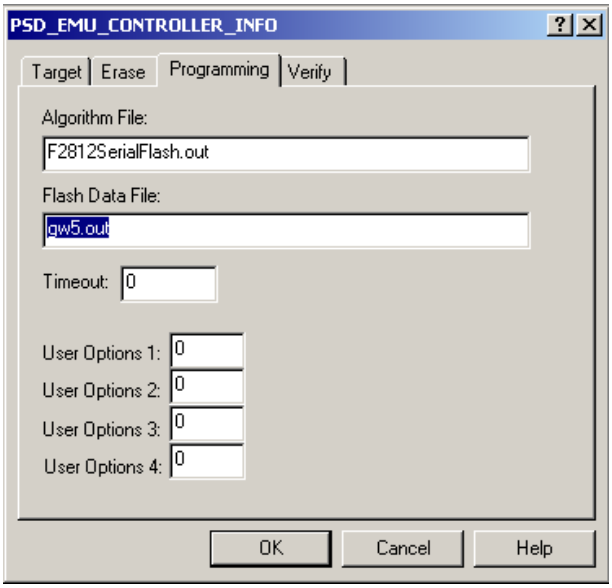
4. Open the Project tab => Settings



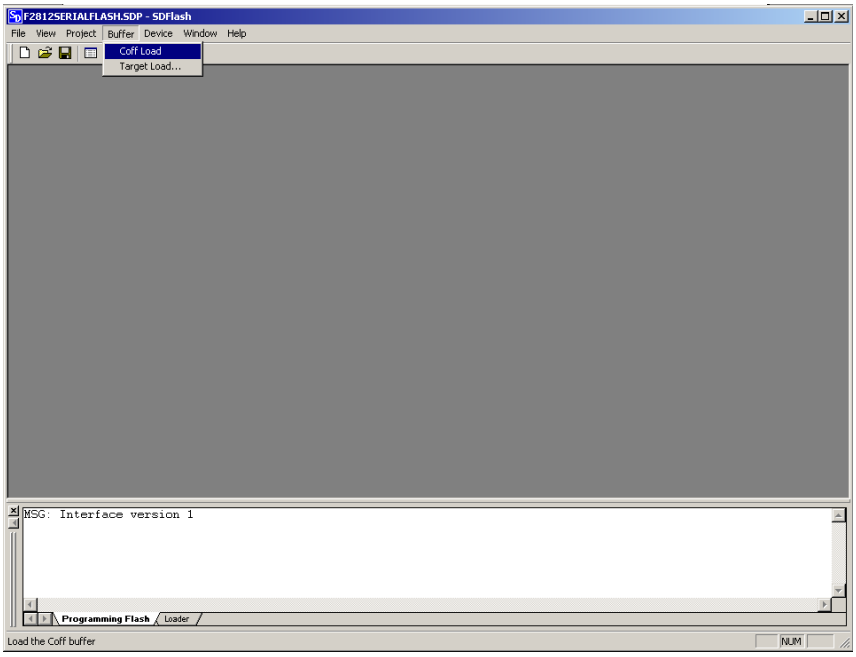
5. Choose Com
   Do not use bigger than C3 (Com 3).



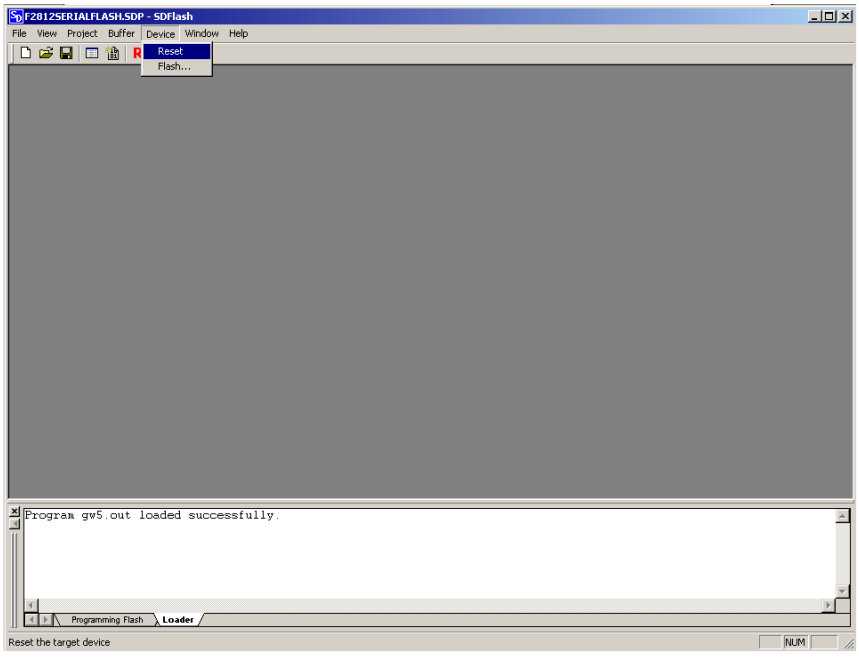
6. Show the way to the target.
   If the gw5.out file is in the same catalogue as SDFlash.exe (the program that you use for firmware update) then gw5.out is sufficient. However, if you want to download firmware from some other place then you have to show the exact way, for example, C:\GW5\ Firmware\…\gw5.out



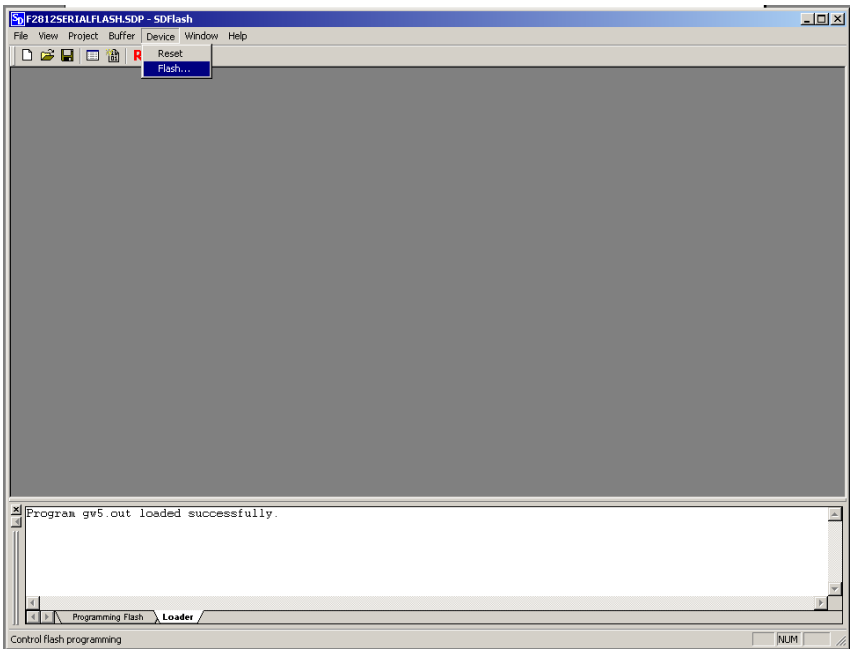
7. Coff load
   Open the Buffer tab => Coff Load



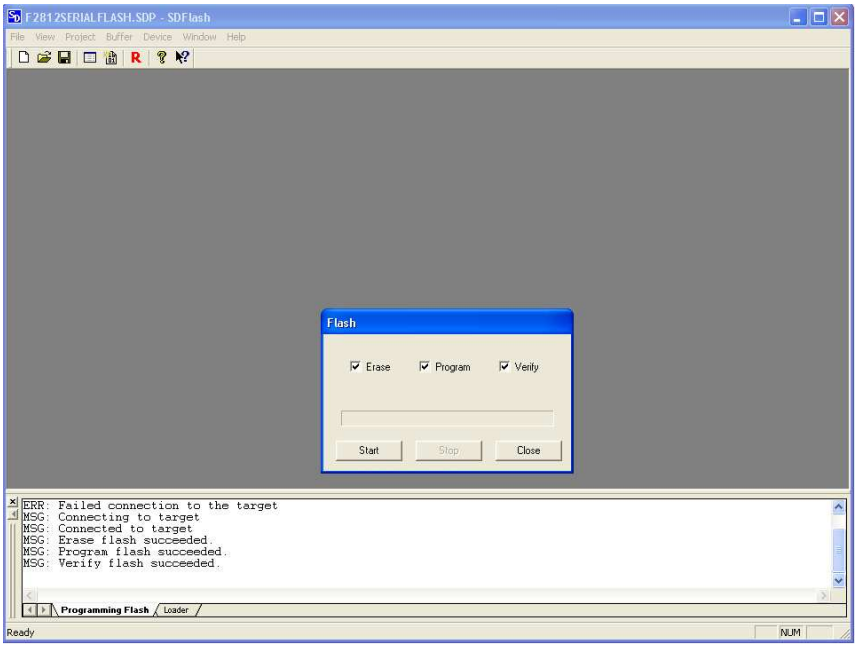
8. Reset
   Open the Device tab => Reset



9. Start programming
   Open the Device tab => Flash



Start the Program



If the connection with the target has failed then reset GW5 (switch 1) and repeat the last step (position 9).
If Erase-, Program- and Verify have succeeded, close the window and move the GW5 set switch „Firmware update mode“ to “Off” position.

10. GW5 Configuration Tool

10.1 Getting Started

When starting the GW5 configuration program, user interface window with the main menu is opened:

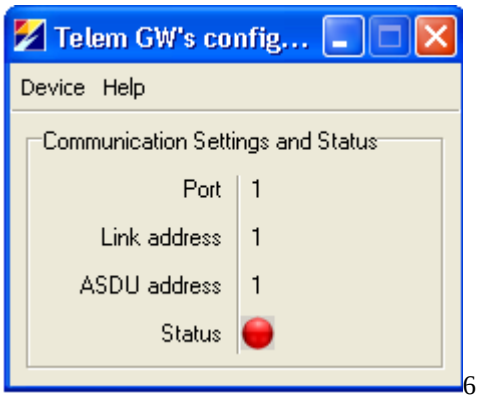


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Figure 10. 1.1 User interface window

Warning **Check communication** – If there is no connection with the GW5 device then a warning message is displayed together with an alarm beep (Figure 1).
"Stop sound" button – Stops the alarm sound.

The following parameters are shown for information:

- **Port** – PC port which is used to communicate with GW5
- **Link address** – Link address of GW5
- **ASDU address** – ASDUI address of GW5
- **Status –** Status of the connection. RED – no connection, GREEN – connection OK

Main menu

Device – For selecting the device type
Communication - For changing communication parameters. It opens the following window:

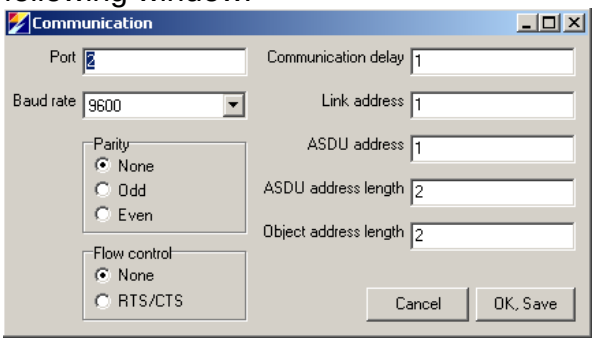


Figure 10.1.2. Communication parameters window

Fields in the communication parameters window

- **Port** – PC communication port which is used to communicate with GW5
- **Baud rate** – Data communication rate
- **Parity** – Use of parity control bit
- **Flow control** – Determines whether the RTS/CTS handshaking is used
- **Communication delay** – Delay between reception of data and the next query in milliseconds
- **Link address** – Link address of GW5
- **ASDU address** – ASDUI address of GW5
- **ASDU address length** – The length of the ASDU address in bytes: typically 2, possible values are 1 or 2.
- **Object address length** – Length in bytes. Typically 2, possible values are 1, 2 or 3.

10.2 GW5 Configuration Window

To open the GW5 configuration window, select **Device > GW5/RTA Setup** from the user interface main menu.

Shortcut icons below the menu bar:

 - Open a new configuration

 - Open a configuration file

 - Save the configuration to a file

 - Read the configuration from GW5

 - Write the configuration to GW5

 - Reset GW5. Possible Reset codes: 1 – Simple Reset; 2 – Reset that also clears memory buffers; 3 – Reset that also restores the default setup.

Saving, editing and opening configuration data

Configuration data is saved to the hard disk in the form of comma separated files*.CSV files when the **Save** or **Save As** command is chosen from the File menu. Correspondingly, the **Open** command from the File menu opens this type of file. **Open** and **Save** can also be accessed via shortcut icons.
*.CSV files can be conveniently edited with Excel software or even with the Note Pad program. When editing the configuration with Excel, the file has to be saved as a comma separated CSV file.

Table of configuration window menu items

Main menu	Submenu (shortcut key)						
File	New (Ctr+N)	Open (Ctr+O)	Save (Ctr+S)	Save As	Exit		
Common	Read Config (Ctr+R)	Write Config Ctr+W)	Send Reset	TCP/IP Settings	General Settings	Modem Settings	
Tools	Options						
View	Basic	Advanced					
Help	Help F1	About					

10.3 Tab Cards in the Configuration Window

Configuration and setting parameters can be utilized by using topic tab cards: **Ports, Devices, Objects, Formulas, Status.**
A click on a tab card button switches between tab cards.

Using the grid area
Parameters can be selected or changed in the grid area cells. Values of some cells can be changed directly and those of others via a list box or a popup window.

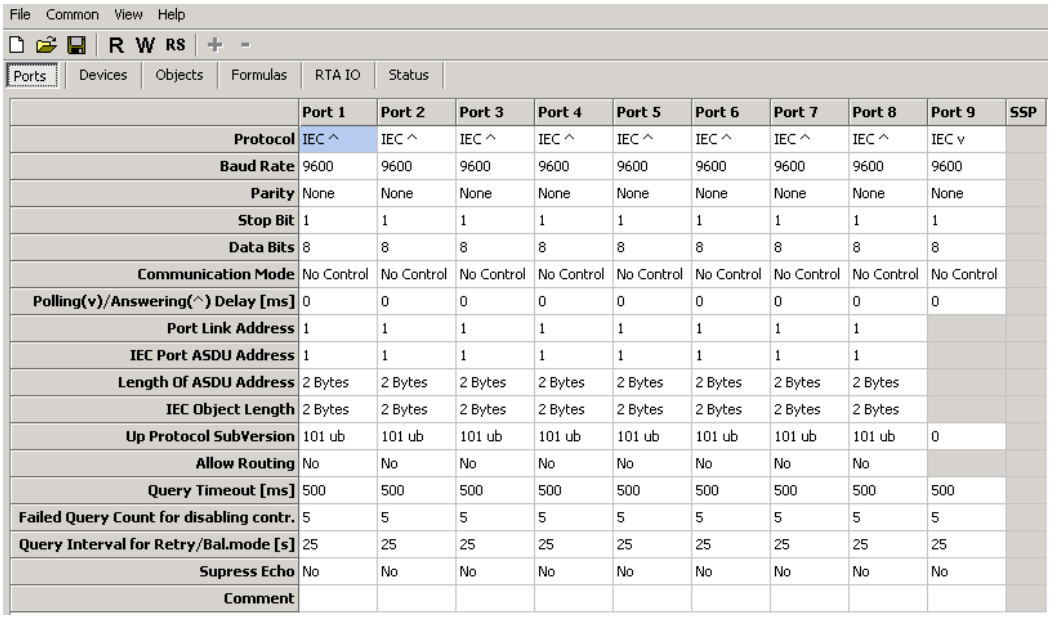
Values of the same column can be copied to clipboard. Use a left mouse click together with the Shift key to copy and a left mouse click together with the Ctrl key for paste operation.

Status message in the bottom left corner of the window shows the result of the last data modification action (OK, Error, etc).

10.3.1 Ports Tab Card

Ports/configuration tab card (Figure 10.3.1) is active when the GW5 configuration window is opened.

From the **View** menu a **Basic** or an **Advanced** view of the **Port configuration tab card** can be selected. The Advanced view shows the additional query and echo suppression parameters.



	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	SSP
Protocol	IEC ^	IEC ^	IEC ^	IEC ^	IEC ^	IEC ^	IEC ^	IEC ^	IEC v	
Baud Rate	9600	9600	9600	9600	9600	9600	9600	9600	9600	
Parity	None	None	None	None	None	None	None	None	None	
Stop Bit	1	1	1	1	1	1	1	1	1	
Data Bits	8	8	8	8	8	8	8	8	8	
Communication Mode	No Control	No Control	No Control	No Control	No Control	No Control	No Control	No Control	No Control	
Polling(v)/Answering(^) Delay [ms]	0	0	0	0	0	0	0	0	0	
Port Link Address	1	1	1	1	1	1	1	1		
IEC Port ASDU Address	1	1	1	1	1	1	1	1		
Length Of ASDU Address	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes		
IEC Object Length	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes	2 Bytes		
Up Protocol SubVersion	101 ub	101 ub	101 ub	101 ub	101 ub	101 ub	101 ub	101 ub	0	
Allow Routing	No	No	No	No	No	No	No	No		
Query Timeout [ms]	500	500	500	500	500	500	500	500	500	
Failed Query Count for disabling contr.	5	5	5	5	5	5	5	5	5	
Query Interval for Retry/Bal.mode [s]	25	25	25	25	25	25	25	25	25	
Supress Echo	No	No	No	No	No	No	No	No	No	
Comment										

Figure 10.3 .1 Configuration window with an advanced Port configuration tab card

Configuration parameters of a port:

- **Protocol** – Communication protocol used by all the devices of this port. Each protocol name is accompanied with a symbol l"^" or ”v ” which indicates whether the port is used for an uplink or a downlink channel. For example, “Modbus v” means that this port is used for downlink with Modbus protocol.
- **Baud rate** – Data communication rate
- **Parity** – Use of parity bit for all the devices on this channel
- **Communication Mode** – Makes it possible to choose between the following handshaking options:
  - No control
  - RTS/CTS Control
  - RTS Callout Request – a Request by the RTS signal to the offline modem for calling out
- **Polling Delay** – Delay between reception and the next query
- **Port Link Address** – Link address of the device on uplink channels
- **IEC ASDU Address** – ASDU address on uplink channels
- **Length of the ASDU Address** – Length of the ASDU address in bytes on uplink channels. Typically 2, possible values are 1 or 2
- **IEC Object Length** – Length of the IEC object address in bytes on uplink channels. Typically 2, possible values are 1, 2

More on the advance view:

- **Allow Routing** – Allows routing of IEC 60870-5-101 protocol messages between the upper and lower level channels
- **Up Protocol Subversion** – Number of protocol subversion on uplink channels

- **Query Timeout in milliseconds -** Query timeout for devices on downlink channels
- **Query Timeout count** – Count of timeouts after which the error flag is raised and the query of this device temporarily suspended
- **Query Disabling Timeout in Sec-s** – Time period after which the suspended device is queried again
- **Suppress Echo** – If the sent messages are echoed back by the connected devices then they need to be suppressed

If some parameters in the grid area have a grey background then these are not used for the chosen protocol type but you are still allowed to modify them.

10.3.2 Devices Tab Card

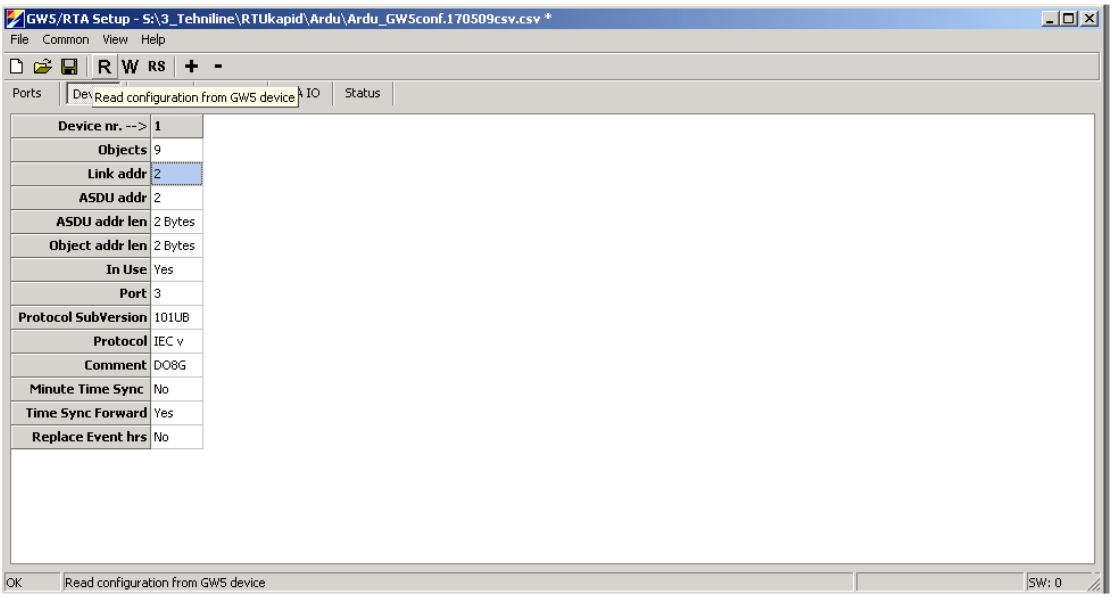


Figure 10.3.2. Devices tab card

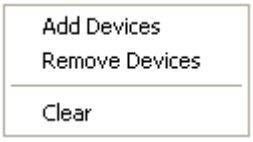
Up to 32 downlink devices can be connected to GW5 and configured on this tab card.

Parameters:

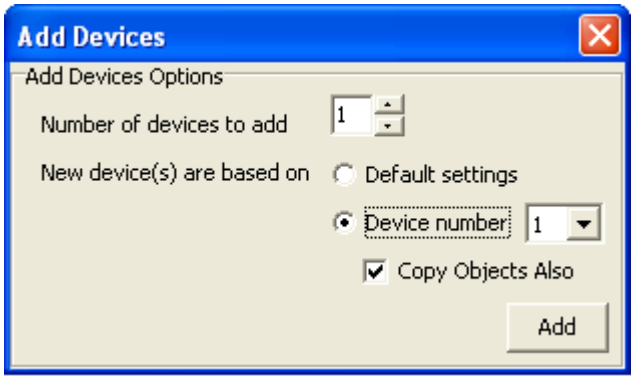
- **Device nr** – Sequence number of the device
- **Objects** – Number of objects in the device
- **Link address** – Link address of the connected device
- **ASDU address** – ASDU address of the connected device
- **ASDU address length** – Length in bytes, possible values are 1 or 2
- **Object address length** – Length in bytes, possible values are 1, 2 or 3
- **In use** – Indicates whether the device is in use or not. If the device is not in use, the whole row has a grey background
- **Port** – Port no. of GW5 to which the device is connected
- **Protocol Subversion** – Number of protocol subversion
- **Protocol** – For information only. It is filled automatically according to the number of the used port.

Adding devices

By clicking on the + shortcut icon, a new device with default settings is added. It is also possible to add new devices with a right mouse click which makes the extended control menu to appear.



Add Devices dialog box appears.



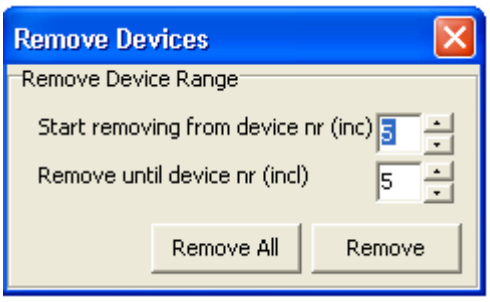
Set the Add Devices options:

- Number of devices to add
- Default settings or the device number from where the settings are derived
- Copy Object Also

Click the Add button.

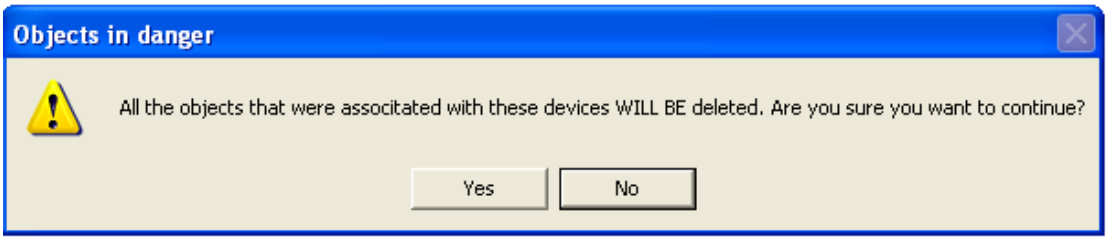
Removing Devices

To remove a device, select **Remove Devices** from the extended control menu or click on the shortcut icon.



Select the range of the removed devices and click the **Remove** or **Remove All** button. The selected device is also removed after the warning dialog when - is clicked.

Clearing Devices
To clear the Device Tab Card, select Clear from the extended control menu.
A warning window always appears before removing operations are concluded:



Select **Yes** to accept or **No** to cancel the removal operation of the devices.

10.3.3 Objects Tab Card

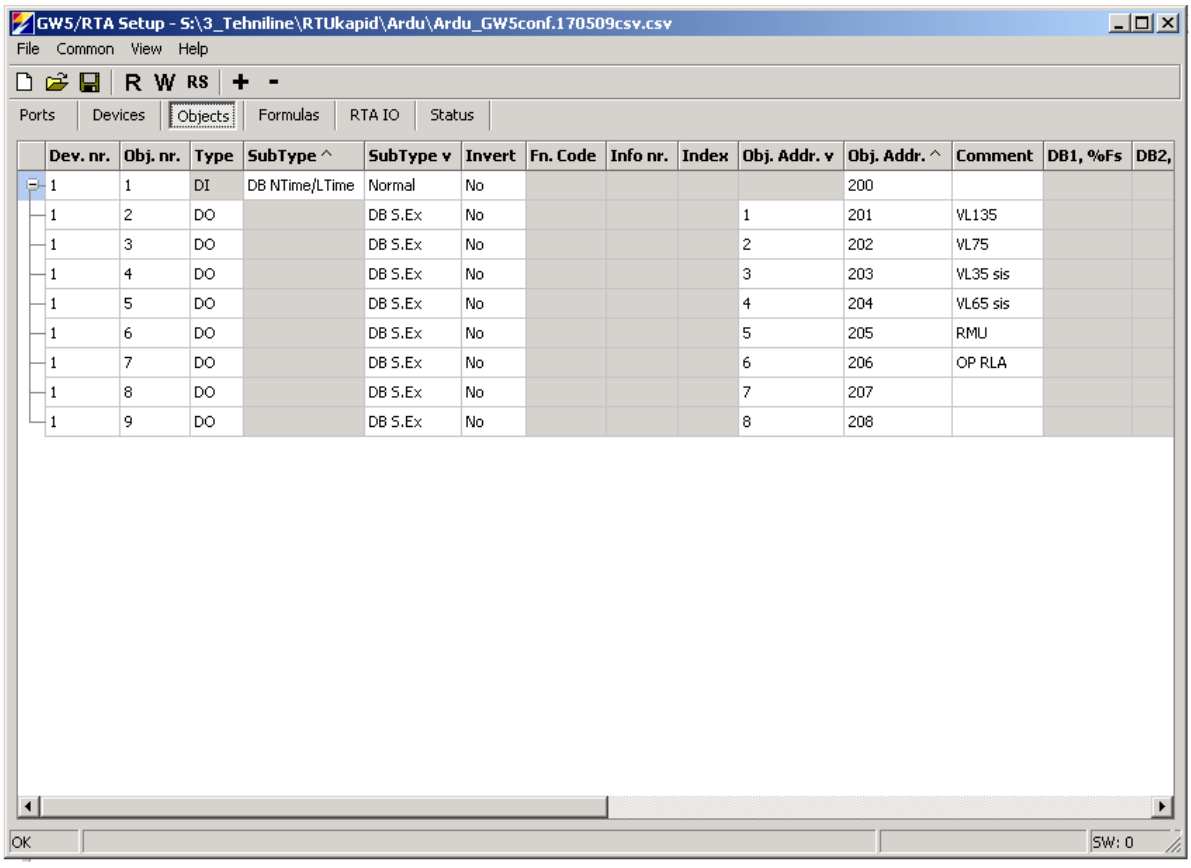
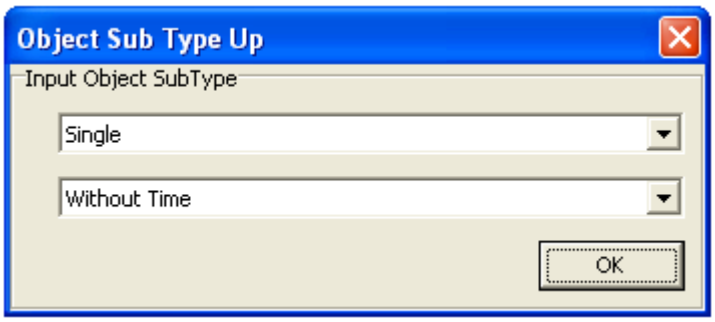


Figure 10.3.3 Objects tab card
The first object of every device is used as the communication status signal of the device. If its value is “1” then communication with this device is broken. The object (first object) of communication status signal is not counted in the **Objects** row of the **Device Tab Card.**

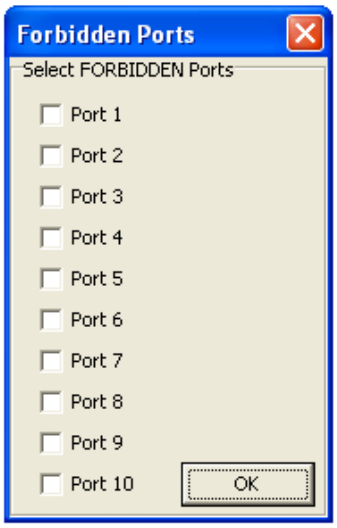
Columns:
Type – Object's type: digital input (DI), digital output (DO), analog input (AI), counter (CN)
Sub Type^ – Object's subtype for uplink. The following dialog box opens on clicking:



Subtypes of object and time marking mode can be selected.

Object type	Format	Time marking
DI – Digital input	Single Double	Without time With Short Time With Long Time With Short Time if got with time tag With Long Time if got with time tag
DO – Digital output	Single Double Direct Execute Select Execute	
AI – Analog input	Normalized Floating point Step position	Without time With Short Time With Long Time With Short Time if got with time tag With Long Time if got with time tag
CN – Counter		

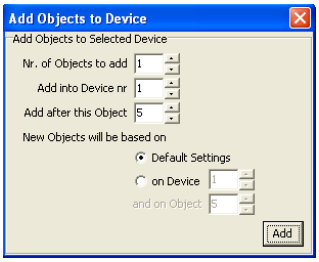
- **Invert** – Object's value will be inverted
- **Fn.code** – Function code on the IEC 60870-5-103 protocol
- **Info no**. – Information number on the IEC 60870-5-103 protocol
- **Index** – Object index on the IEC 60870-5-103 protocol. It indicates the order number of the object in message types 3 and 9 of analog measurements.
- **Object.Addr v** – Object's downlink address
- **Object.Addr ^** – Object's uplink address
- **DB** – Deadband (% of full scale). If the value has changed less than the deadband then it is not spontaneously transferred.
- **DB2** – This is used instead of DB if the **Crit.Min** and **Crit.Max** fields are used and the value falls within these limits. **In case of offline** (GSM) channel, if the change in value is bigger than deadband 2 (% of full scale) then a call to SCADA system is initiated. **Raw Min, Raw Max** – Minimum and maximum raw values of analog measurement (before scaling).
- **Scale Min, Scale Max** – Minimum and maximum scale values of analog measurement.
- **Crit.Min, Crit.Max** - minimum and maximum values in % from the full scale of analog measurements on which GW5 initializes communication (Fig. 10.5.1). If Crit. Max and Crit. Min do not have values, DB1 and DB2 are in use. If Crit. Max and Crit. Min have the value 'zero', only DeadB1 is in use. If the analog measurement value is between Crit. Min and Crit. Max, DB2 is in use. If the analog measurement value is out of limits, DB1 is in use.
- **Forb. Ports** – Uplink port to which the object's value transfer is blocked. To select uplink ports, which should not be used for transferring these object values, double-click on the cell of the **Forb. Ports** column and select the corresponding ports from the window that has appeared.



Adding Objects

By clicking on the + button, a new device with default settings is added. Objects can also be added with a right click on the device tab card. After that the following extended control menu appears:

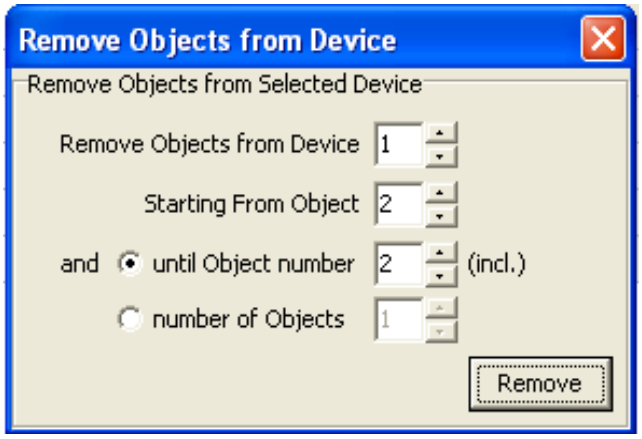
When selecting Add Objects, the following dialog box appears:



Removing Objects

To remove a device, click the - button or select Remove Devices from the extended control menu.

When selecting Remove Objects from the extended control menu, the following dialog box appears:



Hints

- Repeated object addresses are shown on yellow background.
- When leaving the Object Tab Card, all the objects are hidden. To see the objects on returning to Object Tab Card, use **Expand All** from the extended control menu that appears after a right click.

10.3.4 Formulas Tab Card

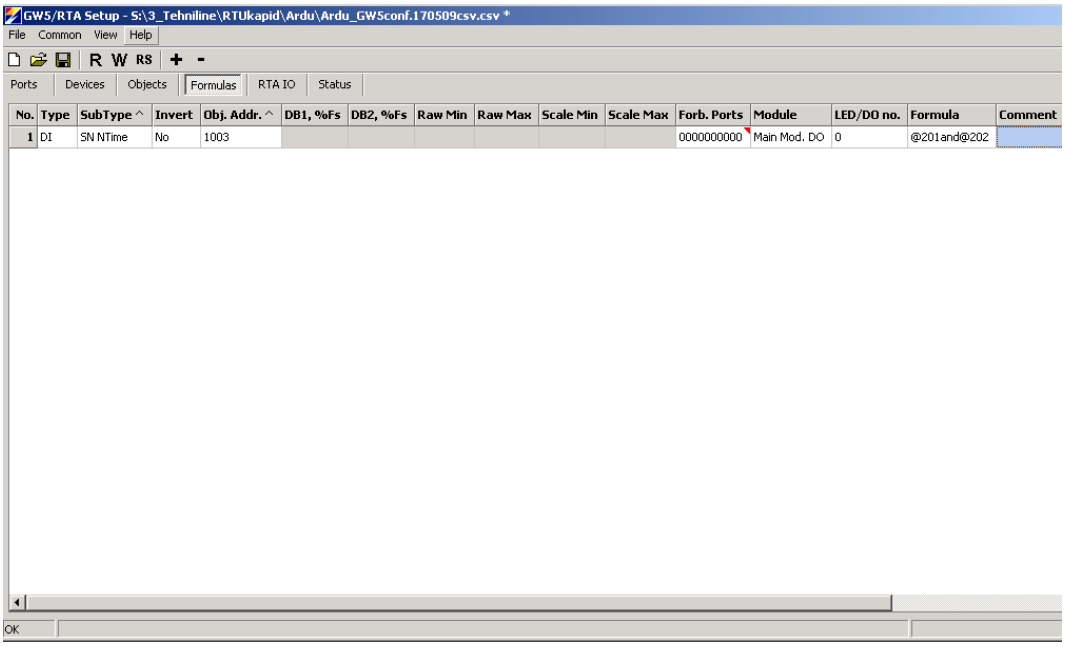


Figure 10.3.4 Formulas tab card

Columns:

- **Type, Sub Type, Sub Type , Invert, Object Adr ^, DeadB, Crit.Value, Raw Min, Raw Max, Scale Min, Scale Max, Forb.Ports, obj. -** as in **Objects Tab Card**
- **DO** – Number of the digital output (1…16) in the TLM GW-IO device controlled by the result of this formula
- **Alarm** – The alarm (LED) number (1…16) on the LED Alarm panel which corresponds with the result of this formula
- **Formula** – formula string

Editing formulas
Formulas can be created between the values of analog and/or digital objects.

Referencing to object values
To use the measurement object in the formula, insert an @ sign together with the **object address up.**
Example: @101 points to the value of the object with an address to uplink 101.

Constants
Constants can be used in formulas.
Example: 1.1+2.2+3 consists of 3 floating point constants

Brackets
Brackets can be used in formulas to change the priority of the operation.
Example: sqrt(@101/2+@102); (@201+@202+@203)/3

Operators

Oper.	Obj. type	Description	Sample	*Priority
+	DI/AI	Addition	@101+3,2	3
-	DI/AI	Subtraction	@101-0,49	3
*	DI/AI	Multiplication	@101*2	2
/	DI/AI	Division	@101/2	2
^	DI/AI	Exponentiation	@101^2	1
<	DI	Greater than	@101<0,499	4
>	DI	Less than	@101>0,5	4
sqr	DI/AI	Square	sqr(@101*10)	0
sqrt	DI/AI	Square route	sqr(@101*10)	0
and	DI	Logical conjunction	@201and@202	5
or	DI	Logical disjunction	@201or@202	6
xor	DI	Exclusive disjunction	@201xor@202	6
not	DI	Logical negation	not@201	0
dbl	DI	Converts 2 single digital inputs into a double signal	@201dbl@202	7
sin	DI/AI		sin@301	0
cos	DI/AI		cos@301	0
tan	DI/AI		tan@301	0
arcsin	DI/AI		arcsin@301	0
arccos	DI/AI		arccos@301	0
arctan	DI/AI		arctan@301	0

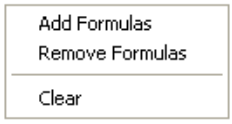
* priority determines the order of operations in the formula (the highest priority is 0)

Notes

- All analog values should be scaled before making calculations; therefore, it is very important to fill the **Raw Min, Raw Max, Scale Min, Scale Max** fields with Normalized values that are used in calculations.
- After editing the formula, the program automatically validates this formula and shows the result in the status area. If the formula is incorrect, the background of the edited formula is changed to pink and an error message is displayed in the status area.
- By clicking on the  button, a new formula row with default settings is added.

  By clicking on the button, the selected formula row is removed.

- Formula rows can also be added, removed or cleared by using the extended control menu like in the Object Tab Card. It appears with a right mouse click on the Formula Tab Card.



  To add a Formula, select **Add Formulas**, to remove a Formula, select **Remove Formula** and to clear all formulas, select **Clear.**
- The formulas of DI type of objects can contain AI values and floating point constants. If the result of the formula is greater than 0, the value of the DI object is “1”; if the result of the formula is less than or equal to 0, the value of the DI object is “0”.

< or > statement: if the statement is true, the value of the DI object is 1; if the statement is false, the value of the DI object is 0.

10.3.5 Status Tab Card

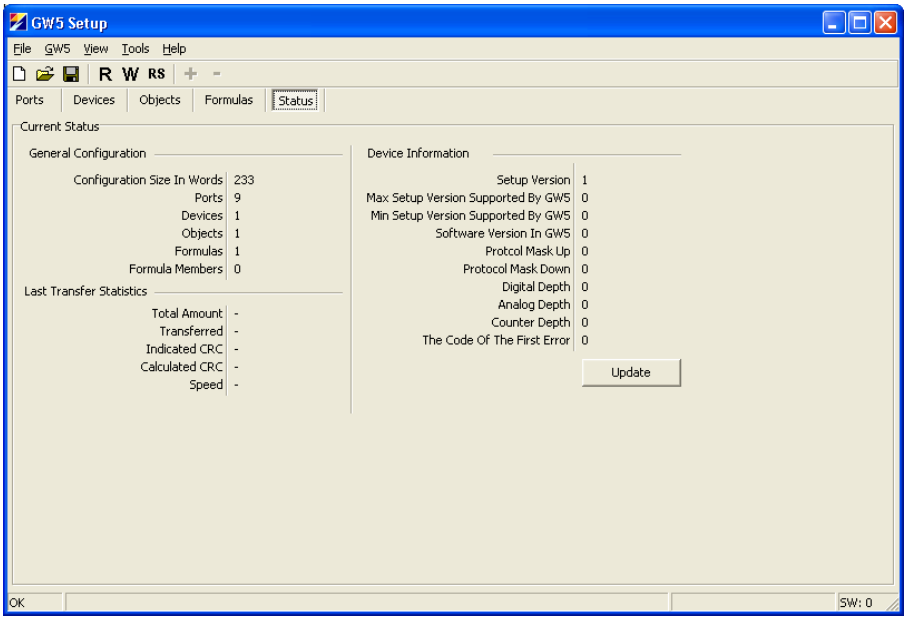


Figure 10.3.5 Status tab card

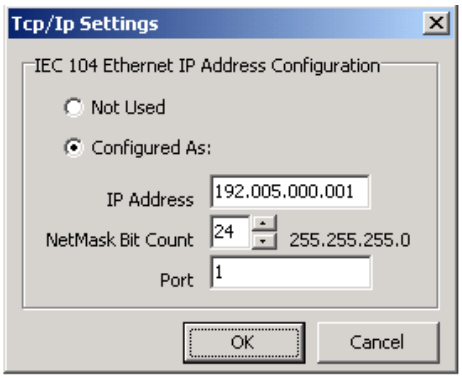
Status tab card presents the status of GW5 general configuration parameters and transfer statistics.

Update button is used to get information from the connected GW5 and it is displayed under Device Information.

11. Common Main Menu

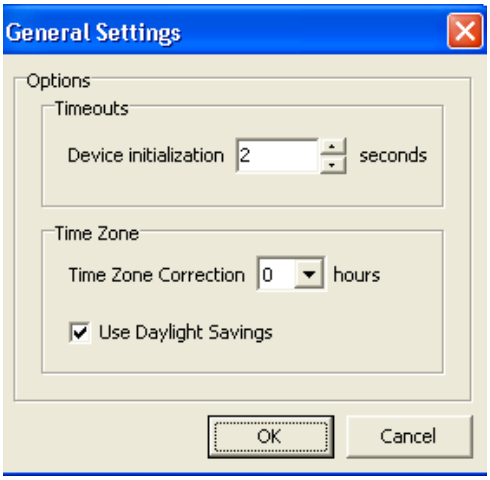
11.1 TCP/IP Settings

Only used for GW5 with Ethernet port to determine IP parameters.



11.2 General Settings

To determine device initialization timeouts and time zone correction.

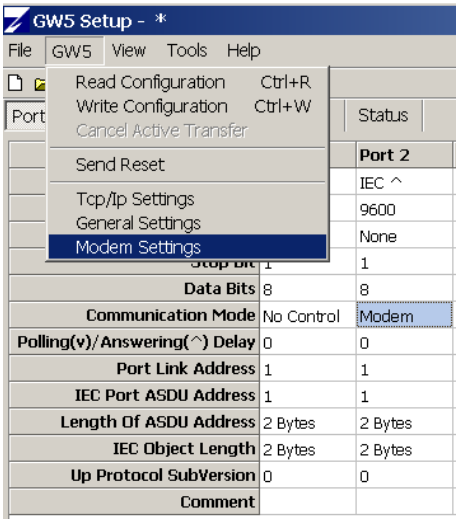


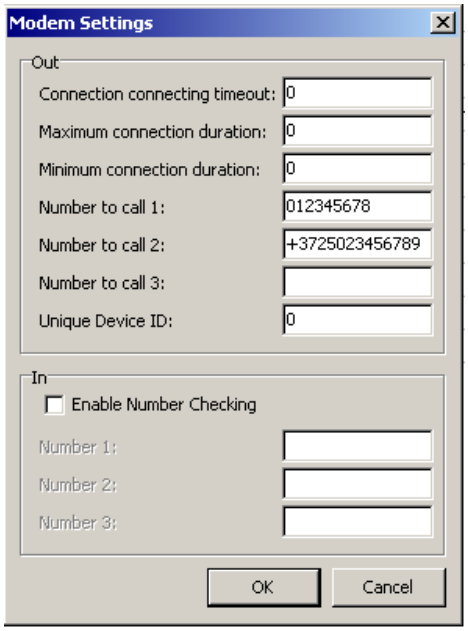
11.3 Telephone Modem Settings

Modem Settings are used to determine calling parameters in the dial-up mode operation.

The modem can be used only through communication port 2. Only this port has all the necessary handshaking signals for the modem.

1. Open **Ports** tab card on the GW5 configuration window.
2. Set the **Communication Mode** to port 2 **Modem Callout**.





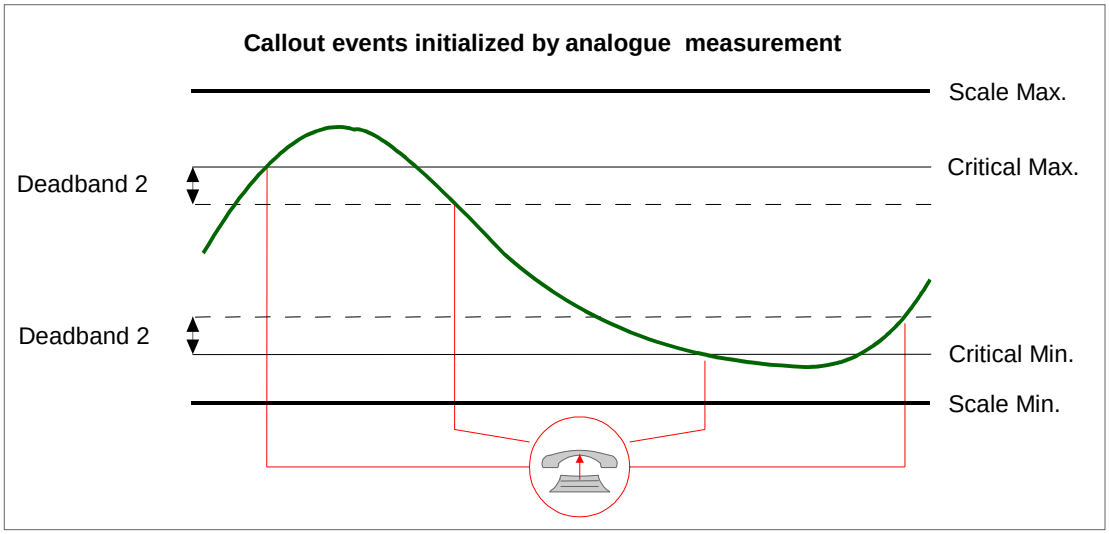
3. From the **Common** menu open **Modem Settings**.

Callout parameters:

- **Connection connecting timeout** - if the connection was not established during this time (seconds), GW5 will try to call out again.
- **Maximum connection duration** - if the connection is still open after this time, it will be closed by GW5. If the value of this parameter is 0 then GW5 will never close the connection.
- **Minimum connection duration** - if the connection was broken during this time, GW5 will try to call out again.
- **Number to call** – if the first number is busy then the gateway will call the next number. If all the numbers are busy then the gateway will call around the numbers until some number answers.
- **Unique Device ID** - additional information about GW5 callouts (ID number, may be used if the modem cannot send its phone number).

Number Checking may be enabled for **incoming** calls. In this case, the connection may be established only from these 5 phone numbers maximum. (The phone numbers must be typed up exactly as the modem receives them).

GW5 initializes a communication line when one of the digital inputs changes or when analog measurement value changes over the determined minimum and maximum ranges and the callout event is not forbidden for this input. If the communication is initialized by GW5, it terminates the connection after all data is sent.



11.3.1 Callout events

12. Communication Cables

Port RJ-45 pin layout.

PIN	Port 1 RS232/Load/GPS	Port 3…7 RS232	Port 2 RS232	SSP port For TLM IO	Port 8 Isolated RS 422/485
1	+ RS 422 RD + *		DSR	CSIO	RX -
2		CTS	Cts	GND	Rx +
3	GND	GND	GND	+ SSPCLK	Tx +
4	RxD	RXD	RXD	- SSP CLK	TX -
5	TxD	TXD	TXD	+ SSP DATA in	S GND
6	GND	GND	DCD	- SSP DATA in	
7		RTS	RTS	+ SSP DATA out	
8	- RS 422 RD - *	RD - *	DTR	- SSP DATA out	

* GPS Time

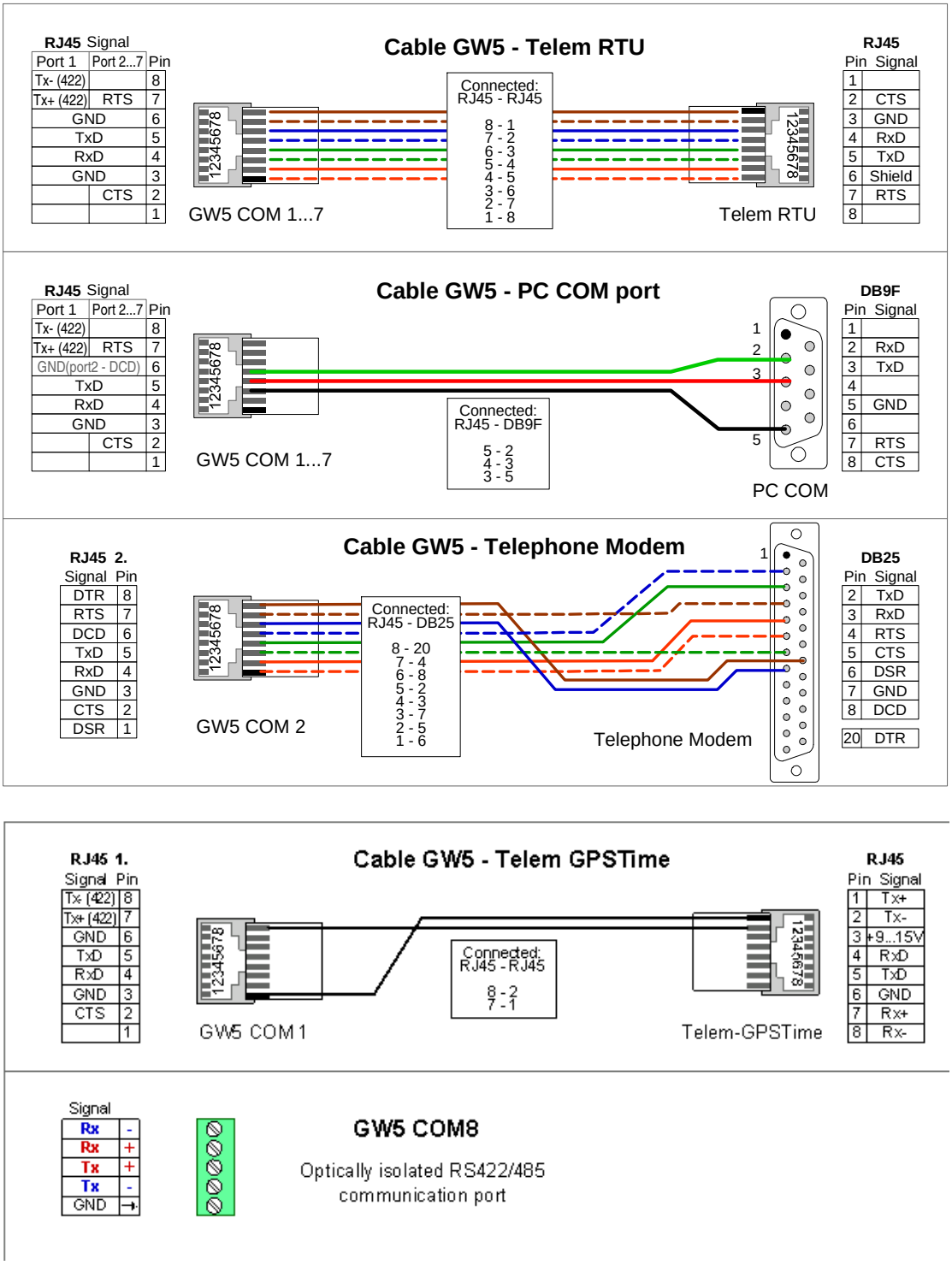


Figure 11.1 GW5 communication cables

13. Notes

- If not stated otherwise on the individual pages of this document, AS Martem reserves the right to make modifications.
- Although the contents of this publication have been checked for conformity with the hardware and software described, we cannot guarantee complete conformity since errors cannot be excluded.
- The information provided in this manual is checked at regular intervals and any corrections that might become necessary are included in the next releases.
- Any suggestions for improvement are welcome.
- The contents of this manual are subject to change without prior notice.

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