CONTROLLER

SFLCON

MEASUREMENT AND CONTROL SYSTEM FOR TUNNELS LIGHTING

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INTRODUCTION

The SFLCON controller is the perfect complement for SFLINT luminance photometers developed by SIFISA for the measurement of luminance and tunnel lighting control.

Based on a Siemens PLC, is responsible for taking data from 1 or 2 SFLINT-485 luminance photometers and, based on the value obtained, on or off up to 6 circuits each luminance meter, depending on 6 luminance ranges.

The controller asks the average luminance of the luminance photometers, which avoids possible changes in clouds, reflections, etc. Therefore, the actual placing in operation occurs after five minutes, time the equipments take to calculate the first average luminance. However, values are taken every minute, which makes the system very robust to communication failures.

After 10 attempts to communicate with no response from either equipment, it is marked as failed and all circuits are switched on. This situation returns to normal as soon as the luminance photometer gets a response.

EQUIPMENT INSTALLATION

The controller can be installed on standard rail or panel, both horizontal and vertical.

As a general rule for the laying out devices of your system, always separate the devices that generate high voltage and high electrical noise from the low-voltage, logic-type devices, such as SFLCON.

When configuring the layout of the controller inside your panel, consider the heat-generating devices and locate the electronic-type devices in the cooler areas of your cabinet. Operating any electronic device in a high-temperature environment will reduce the time to failure.

Avoid placing low voltage signal wires and communications cables in the same tray with AC power wiring and high-energy, rapidly-switched DC wiring.

S7-1200 PLCs are designed for natural convection cooling. For proper cooling, you must provide a clearance of at least 25 mm above and below the devices.

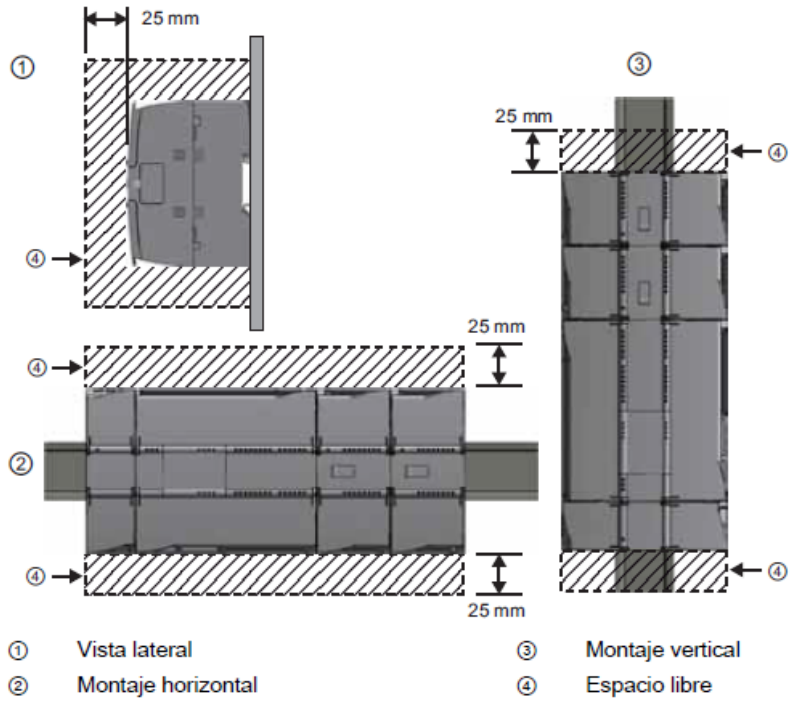


Figure 1: Orientation and spacing

For more information, read the manual for Siemens S7-1200 PLCs.

Before connecting or disconnecting any electrical device must be verified that the power is removed, as well as from any device connected to it.

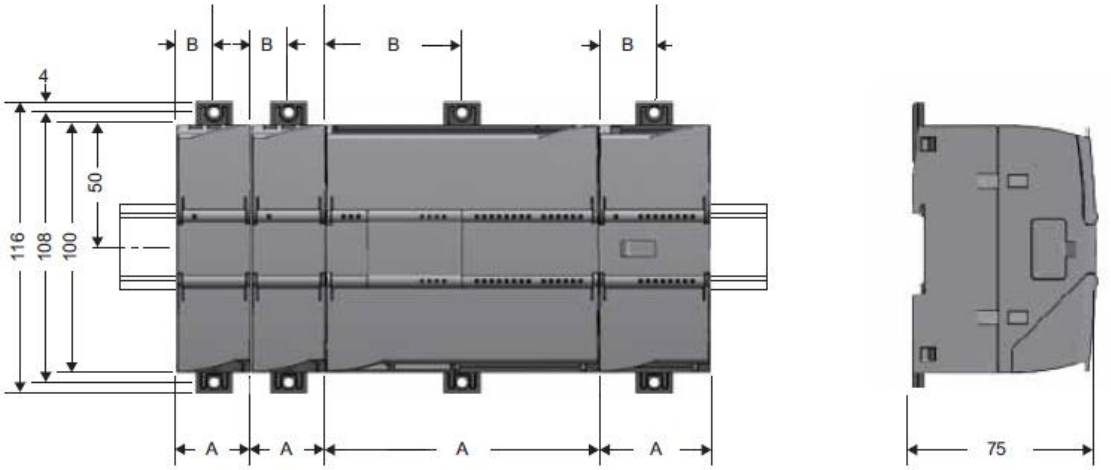


Figure 2: Dimensions

Device		Width A	Width B
CPU	CPU 1211C and CPU 1212C	90 mm	45 mm
	CPU 1214C	110 mm	55 mm
Outputs		45 mm	22.5 mm
Communications	RS232 and RS485	30 mm	15 mm

The best way to ground your application is to ensure that all the common and ground connections are grounded to a single point. This single point should be connected directly to the earth ground for your system.

For improved electrical noise protection, it is recommended that all DC common returns be connected to the same single-point earth ground.

All ground wires should be as short as possible and should use a large wire size (2 mm^2 / 14 AWG)

When designing the wiring of your system, provide a single disconnect switch that simultaneously removes power from the controller power supply, from all input circuits, and from all output circuits. Provide overcurrent protection, such as a fuse or circuit breaker.

Always route wires in pairs, with the neutral or common wire paired with the hot or signal-carrying wire. Use shielded wires for optimum protection against electrical noise.

OUTPUT CONNECTION

The controller has 18 outputs (24 VDC) with the following description:

CPU	
DQa.0	Circuit first interval of luminance photometer 1.
DQa.1	Circuit second interval of luminance photometer 1.
DQa.2	Circuit third interval of luminance photometer 1.
DQa.3	Circuit fourth interval of luminance photometer 1.
DQa.4	Circuit fifth interval of luminance photometer 1.
DQa.5	Circuit sixth interval of luminance photometer 1.
DQa.6	Fault flag of luminance photometer 1.
DQa.7	Reserved for future use.
DQb.0	
DQb.1	
Outputs module	
DQa.0	Circuit first interval of luminance photometer 2.
DQa.1	Circuit second interval of luminance photometer 2.
DQa.2	Circuit third interval of luminance photometer 2.
DQa.3	Circuit forth interval of luminance photometer 2.
DQa.4	Circuit fifth interval of luminance photometer 2.
DQa.5	Circuit sixth interval of luminance photometer 2.
DQa.6	Fault flag of luminance photometer 2.
DQa.7	Reserved for future use.

The behaviour of all outputs can be programmed independently, each admitting four types of operation:

- Type 1: 

  This is the most common mode and is the only existing in the previous version of the system. The output is activated when the luminance is greater than or equal to the entered setpoint value and remains on until you drop it.

- Type 2: 

  The output is activated when the measure is maintained between the two levels given, and deactivated outside that range. This mode of operation is useful, for example, to control equipment which allows two levels.

- Type 3: 

  In this mode, the output behaviour differs if the luminances are raising or lowering. In the first case, the output is activated when luminance reaches the power on level. In the second case, decrease in luminance, is disabled when it reaches the value off.
  In the area between the two levels, state is maintained regardless of the occurrence of increases or decreases in luminance.
  This behaviour occurs regardless of which of the two values is greater.

- Type 4: 

  This is the most complete mode and, therefore, the most complex. Like the above, it is different if the luminances are raising or lowering.
  If they grow, the output is set between the levels of growing. In the second case, decrease in luminance, it remains active between the values entered for the descent.
  As in the previous case, in the transition zones, the output state is maintained.

If a equipment does not answer for 10 consecutive connections (10 minutes) activates the corresponding error signal and switches on the desired circuits of the sensor.

The controller has 16 unused inputs.

COMMUNICATIONS

The SFLCON controller has two communication ports:

- RS-485 (CM 1241 RS485) is intended to communicate with the SFLINT luminance photometers. It is a female DB9 connector whose pinout is defined later.
- RS232 (CM 1241 RS232) used to program the configuration parameters from a PC and receive the report of the luminances measured at each moment. In this case the connector is a male DB9.

The wire used for communications with the luminance photometers should be a standard twisted pair (for example Belden 9841). Its main features must be:

Type of wire:	Shielded twisted pair.
Loop resistance:	< 115 Ω/km
Capacitance:	30 pF/m
Nominal impedance:	Approx. 135 Ω to 160 Ω (f: 3 MHz to 20 MHz)
Attenuation:	0.9 dB/100 m (f: 200 kHz)
Section:	0.3 mm^2 to 0.5 mm^2
Diameter:	8 mm ± 0.5 mm

The RS485 standard uses differential transmitters and receivers, i.e. they do not need to have a reference to ground. The ground wire connection is made only when the ground difference between devices is very large or to improve insulation against noise. However, certain precautions must be taken before making this connection, as the union of earth cable between devices of the line can generate significant current flow, due to different ground potentials that may exist between these devices.

To solve this problem, you can connect the ground wire to a single device or connect it to everyone, but with a series resistor of 100 Ω or more.

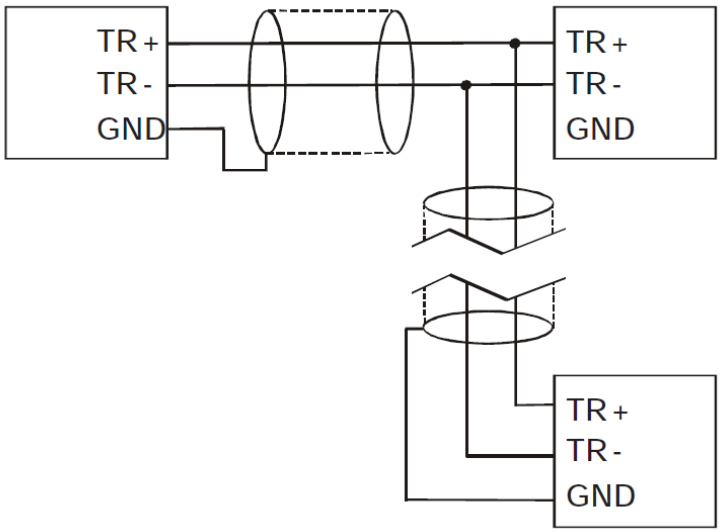


Figure 3: Ground connection to one device

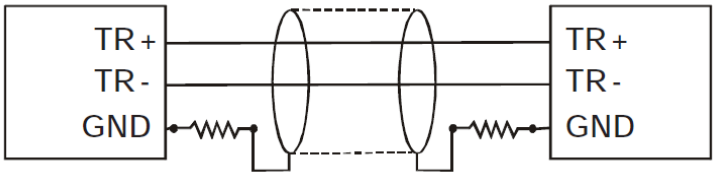


Figure 4: Ground connection through resistor

In addition, the RS485 standard also states that termination resistors should be placed at both ends of the transmission-reception line, and the same impedance of the line (120Ω). This is done to avoid unwanted reflections or echoes that may disrupt or distort the information.

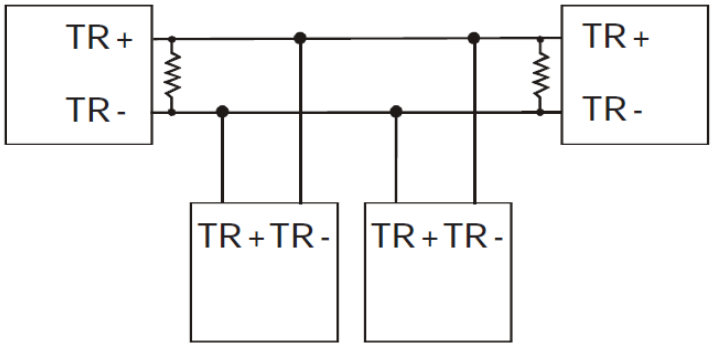
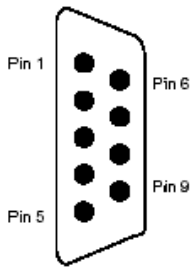


Figure 5: End resistors connection

The RS485 connector has the following pinout:



Pin 1	Chassis
Pin 2	Common
Pin 3	RS-485 Signal B (+)
Pin 4	RTS (TTL)
Pin 5	Common
Pin 6	+5 V (Serial resistor of 100 Ω)
Pin 7	+24 V
Pin 8	RS-485 Signal A (-)
Pin 9	Reserved
Housing	Chassis

For a 485 communications network, the maximum length of the communications cable is 1000 m without using a repeater.

CONFIGURATION

The main configurable parameters of SFLCON controller are: the ID of attached luminance photometers, the luminance levels to switch on/off the outputs, the time and date, and whether or not to report the measurements of the luminance.

To set up these parameters is necessary to connect a computer to the RS232 port of the PLC. This connection can be made with any MODEM-Null type serial cable, such as the one supplied with the equipment.

Once connected the computer to the controller, you can communicate with it using the software supplied with the controller.

SOFTWARE SETUP

For the correct operation of the system is necessary that the computer has:

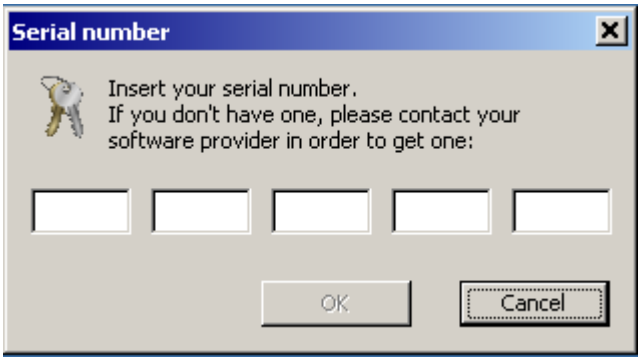
- Windows XP or higher.
- RS232 port. If you do not have it, you can install an USB-series converter.
- 1024 x 768 resolution. With lower resolutions will not be visible the whole screen.
- A SFLCON controller.
- A serial number to allow communication with your controller. This number appears on the installation CD.

Once you have verified compliance with these requirements, the CD should be inserted into the computer, and the installation will start automatically. Otherwise, you should run the program SFLCON.EXE that appears on the disc (black and red icon).

During the setup process you should confirm where you want the software to be installed, as well as the name that will appear in the Start Menu.

SOFTWARE OPERATION

Whet ha application starts for the first time, you will be asked for a serial number.

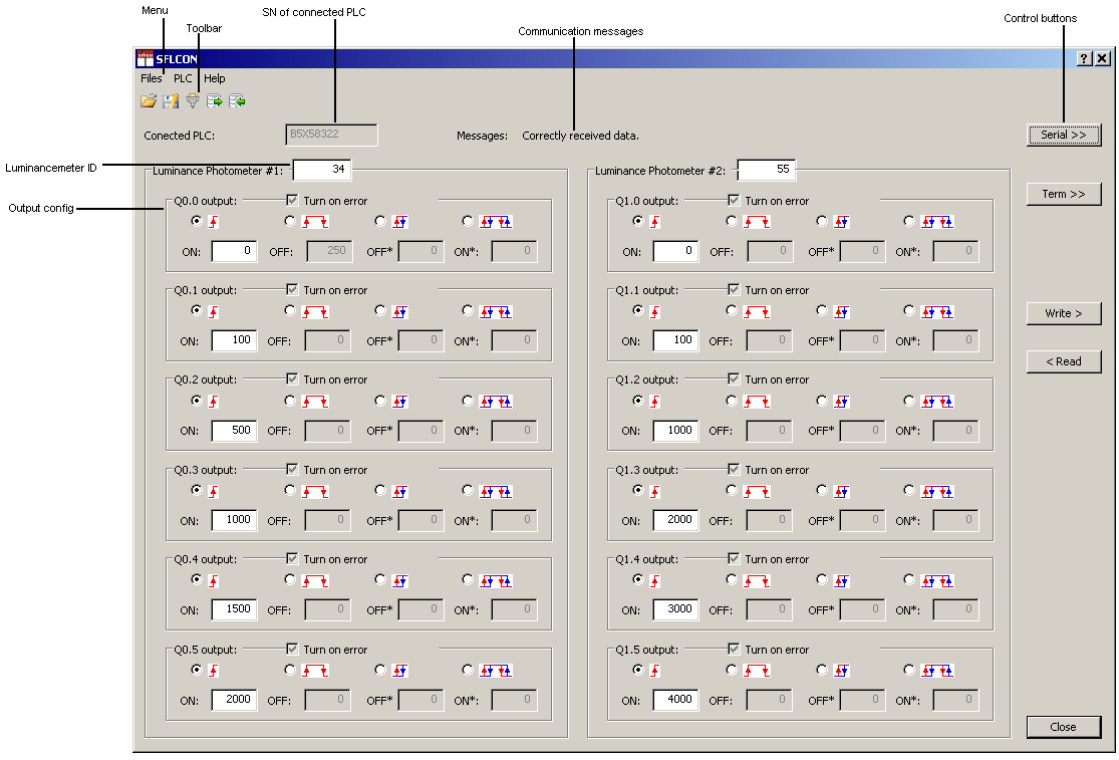


It appears on the installation CD or can be supplied by your provider. Note that if not inserted or is not correct, you can not save the configuration to the PLC.

Similarly, if the serial number you have does not match your SFLCON controller, nor shall record the information and may use the application only for reading the configuration.

If you want to enter or modify the serial number at any time during program execution, you can do it form the Help menu -> Serial Number.

After closing this window, the application main screen will be displayed.



The main screen allows access to all program functions. From it, it's possible to connect with the controller, read and write the configuration, save it to and retrieve from disk and access to a terminal to communicate with the controller manually.

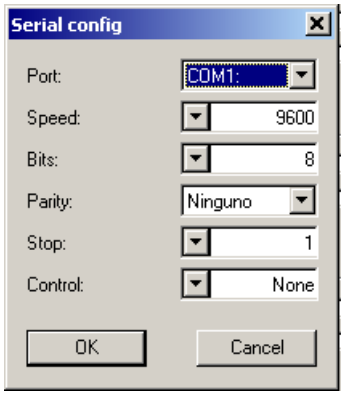
At the top of screen, you can find information fields, such as identification of

connected PLC or a line of posts which Hill show whether there has been communication error or successfully received data.

Immediately below, the screen is divided into two zones, which correspond to the configuration of the two SFLINT-485 luminance photometers can be connected.

Once you access the application, **cannot communicate with the controller until you have configured the communications**. To do this, it can be accessed from the menu PLC -> Communications, from the third icon of toolbar,  or from the communications button located on the right side of the screen.

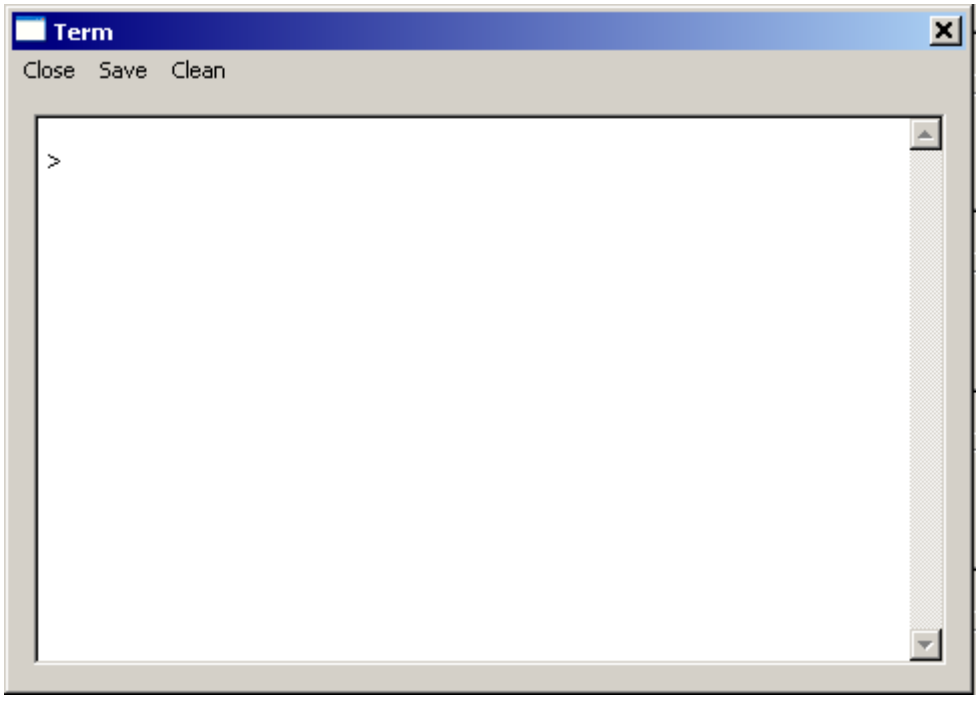
This will open a dialog box that will detect all COM ports present and available in the system. This is the only configuration needs to be done, since the other parameters are configured by default each time you enter into the dialog.
Once you choose the port, just click OK, leaving the other fields unchanged, i.e.: Speed 9600, Bits 8, Parity none and Control none.



Returning to the main screen, will have enabled Terminal, Read and Write options (write option only if you have entered a valid serial number).

Once you have configured the communications, the first step should always be the recovery of the PLC configuration. That will allow us to verify that connection is correct and the attached controller is the licensed one and, therefore, be possible to modify it.

To read this configuration is enough access from menu option PLC -> Read, from toolbar  or press the button "< Read" on the right side of the screen. If communication is successful, all fields will show the information stored in the controller, including the serial number, that appears at the top f the window (box "Connected PLC"). The message line will show data has been received correctly.



The program has a Terminal window that can comunícate with the controller as you did in previous versions. To access it, you can do it from menú PLC -> Terminal, from the last icon of toolbar or from the button on the right of the screen.

To verify communication with the controller, just press Enter, to which the controller responds with '>'.

From this mode, you can read and write luminance photometers ID, date and time, report status, and basic output levels, which does not affect the operating modes and the rest of levels that define them. However, except for activating the report and view it on screen, it discourages interaction with the controller in this way.

For information purposes, the operating instructions of the commands in text mode are included below:

There are a total of 8 commands to communicate with the controller: 4 for writing and 4 for reading. Any combination other than those explained below fails:

- Syntax error: 1: Wrong command.

- Identification of the luminance photometers: WE and RE.

To setup the identification numbers of the luminance photometers connected to the controller you must send the following message:

WE ID1 ID2 (Enter)

Where ID1 and ID2 are the identifiers of the first and second luminance photometer, respectively. For example, if you want to connect a device with ID: 123 and another with ID: 257, the message will be:

WE 123 257 (Enter)

If everything is correct, the SFLCON will return a confirmation:

ID 123 257

This is the same answer you get if you ask for the identification of the luminance photometers:

RE (Enter)

They can also get two error messages:

- Syntax error: 2: There is an error in the ID of the first luminance photometer (contains non-numeric characters, there is no character, etc…)
- Syntax error: 3: There is an error in the identifier of the second luminance photometer, due to reasons similar to those above. In this case, the identifier of the first luminance photometer will have been stored (can be checked with RE).

In the case you want to connect only a luminance photometer, there are two options:

- It is possible to put two identifiers and leave the outputs of the second one unconnected.
- The second option is to put the same identifier twice, so you have 6+6 outputs, if you established two sets of intervals, or 12, if the intervals of device 2 follow the device 1 ones.

- Levels of switch on and off: WL and RL.

  There are six levels for each device, so if luminance exceeds the first limit, the first output is activated, if more than limit 2, also the second will be switched on, and so on. It is assumed that the limits should be sorted from lowest to highest, although this aspect was not verified.

  To set limits is necessary to send a command with the six levels of a luminance photometer:

  WL 1 0 1000 2000 3000 4000 5000

This command sets the limits of the first luminance photometer (whatever that is its ID) to 0, 1000, 2000, 3000, 4000 and 5000.

In case of no error, the system returns the same result as with the command RL:

EQ: 1 Level: 1 0
EQ: 1 Level: 2 1000
EQ: 1 Level: 3 2000
.....
EQ: 2 Level: 1...
.....
EQ: 2 Level: 6

They can also get two error messages:

- Syntax error: 4: The first data is neither 1 nor 2. This value indicates to what photometer are the levels.
- Syntax error: 5: Any of the six levels is missing or wrong.

- Date and time: WD and RD.

The controller has a real time clock that can be modified and read. Its value does not affect the operation of the equipment, but it is interesting to have a time reference in the values of the report.

To set the value you can use the WD command followed by the year (2 digits), month, day, hour, minutes and seconds. For example:

WD 05 12 31 11 58 0

Returns an answer as:

31/12/05 11:58:00

You can always get the date and time with RD, which returned in the format seen before. THE SYSTEM DOES NOT CHECK THE VALIDITY OF THE DATA.

The possible error message is:

- Syntax error: 6: Any of the six values needed is missing or wrong (contains non-numeric characters).

- Report: WR and RR.

The controller can send a report of the measures taken on Port 1, including date and time. This report can be activated with:

WR 1

To which responds:

Report: ON

Similarly:

WR 0

Will return:

Report: OFF

And report will be deactivated.

The state of activation or deactivation of the report can be viewed with the command RR.

The last possible error message is:

- Syntax error: 7: The data is neither 0, disable, nor 1, enable.

Once the report is activated, a message containing the date, time and luminance of both photometers will be received once per minute:

31/12/05 12:00 357 1890

If any of the devices fails communicating, its value will be replaced by dashes.

SUMMARY OF ERRORS

There are seven possible errors in computer – controller communications:

Syntax error: 1	Unrecognized command. It is none of the eight combinations described.
Syntax error: 2	WE command. Wrong ID for the first luminance photometer. May be missing or contain characters other than numbers.
Syntax error: 3	WE command. Wrong ID for the second luminance photometer. May be missing or contain characters other than numbers.
Syntax error: 4	WL command. Error in the number of luminance photometer. Valid values are only 1 and 2.
Syntax error: 5	WL command. Error on one level. May be missing or contain characters other than numbers. There should be 6.
Syntax error: 6	WD command. Error in one of the date and time data. May be missing or contain characters other than numbers. Must be 6 in total.
Syntax error: 7	WR command. Error in the data. Valid values are only 0

	and 1.

As already indicated above, each of the outputs can be configured in four different operating modes:

- Type 1: 

  It is the most common mode and is the only existing in the previous versions of the system.
  The output is activated when the luminance is greater than or equal to the setpoint value entered and remains on until it goes below that value.

- Type 2: 

  The output is activated when the measure is maintained between the values given (ON and OFF), falling off outside this range.
  This mode of operation is useful, for example, to control equipments which allow two levels.

- Type 3: 

  In this mode, the output behaviour differs if the luminances are growing or declining. In the first case, the output is activated the setpoint marked as ON is reached. In the second case, decrease in luminance, is disabled reaching setpoint OFF*.
  In the area between both values, state is maintained regardless of the occurrence of increases or decreases of luminance.
  This functionality occurs regardless of which of the two values is greater.

  For example, if defined values are ON = 150 cd/m² and OFF = 100 cd/m², output will be activated when luminance exceeds 150 and will not turn off until it go down 100.*

  In the event that setpoints are changed, i.e.: ON = 100 cd/m² and OFF = 150 cd/m², the operation is slightly more complex. The output will be activated when luminance goes greater than 100, if it is growing, and output will remain in that state until luminance goes below 100 or over OFF* setpoint (150). From that moment, it will remain active until luminance goes below 150 and will not switch on again beyond 150 or, once it get down to 100, goes over again.*

- Type 4: 

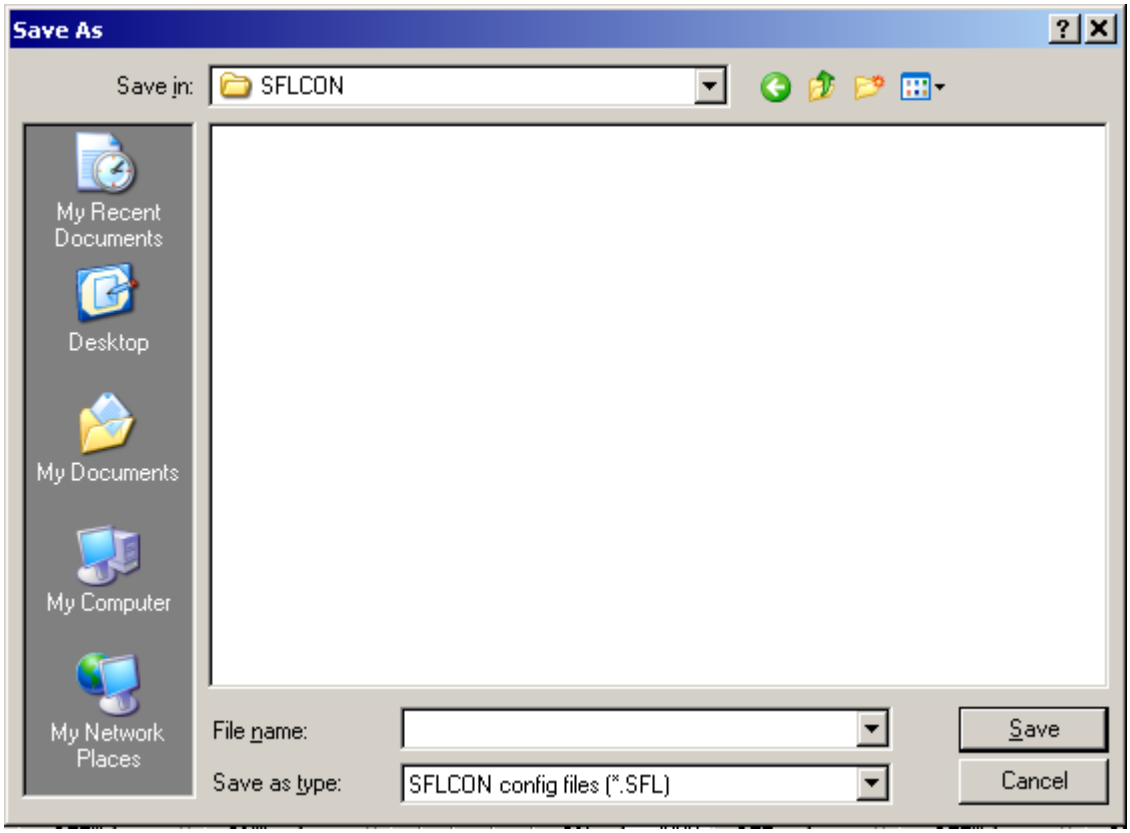
  This operation mode is the most compete and, therefore, the most complex. Like the above, it is different if the luminances are growing or declining.
  If they grow, the output is set between the ON and OFF setpoints. In the second case, decrease of luminances, it remains active between the values entered for ON* and OFF*.
  As in the previous case, in the transition zones, i.e., between ON and OFF* on the one hand, and OFF and ON* on the other, the output state is maintained.

If there is a communication error with a luminance photometer and stop responding, each output can be activated, deactivated or left with the current value.

-  Turn on error.
-  Off on error.
-  On or off depending on the last luminance received, regardless of the error condition.

After changing all the necessary parameters on the screen, the information must be transmitted to the controller so that it is permanently stored on it and modify its operation mode. So you must use PLC menu, option Write, or click the fifth icon from toolbar  , or press "Write >" button on the right side of the screen. If communication is successful, data has been received correctly will be shown in the message line, once written they are read again.

You can store controller settings on your computer. To do this, from menu File -> Save or from the second icon of the toolbar  , you access the "Save File" system window. The appearance of this window depends on the OS you are using.

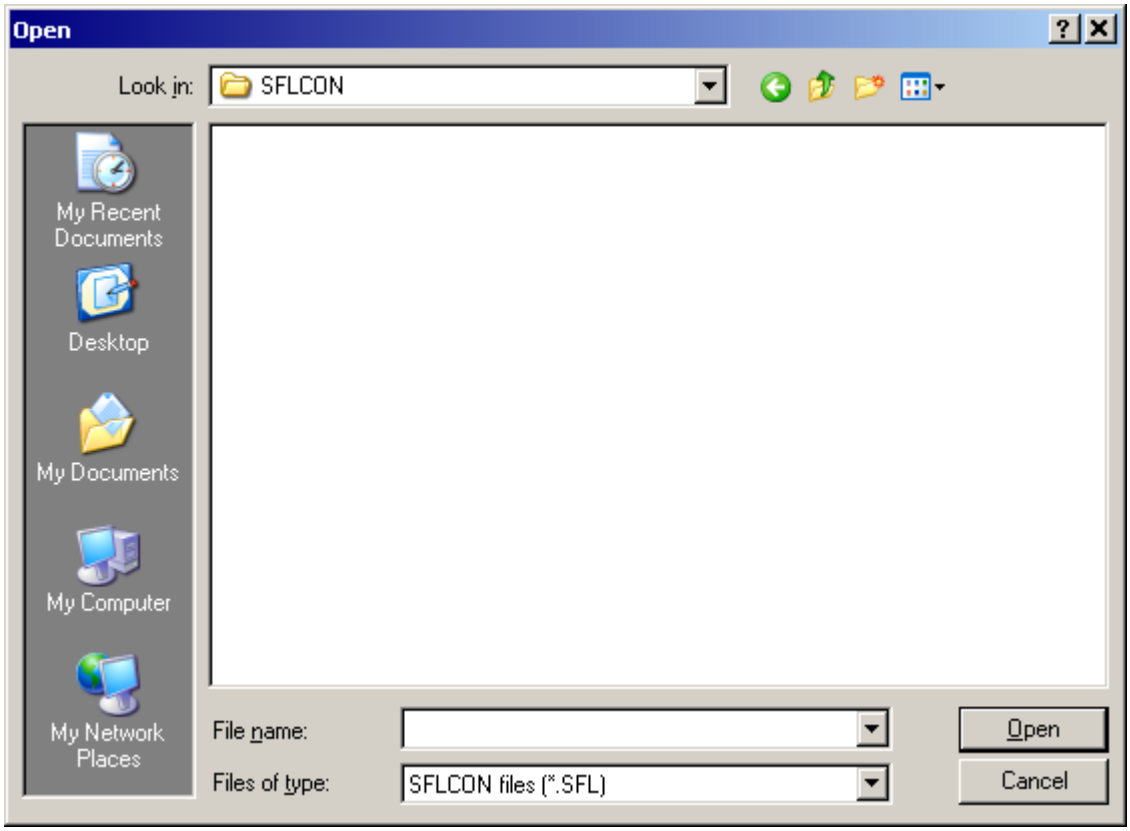


The extension of data files for the controllers is SFL. This will be added automatically when you save the file.

With this option, you save to disk the IDs of both luminance photometers, the behaviour of all outputs, including the levels of each one, and their operation mode in case of error.

Since no PLC identification is stored, this configuration can be restored in the event that the controller must be replaced.

Similarly to the way you save a configuration, you can also read a setup file from disk. To do this, from menu File -> Open or from the first icon of toolbar  , you access to "Save File" system dialog. Again, the appearance of this window depends of the OS you're using.



The extension of data files for the controller is SFL. However, it is possible to open any file, for no checks are made, but the result can be unpredictable.

This option reads from the disk the IDs of both luminancimeters, the operation mode of all outputs, their levels and the behaviour in case of error.

The data read from disk will be overwritten by the ones received from PLC, so its imperative to have made at least one reading from PLC before retrieving your save settings.