eol • mol

Fiber Optical Switch

1 x N • 2 x M • N x (1 x M)

N x Shutter • Matrix N x M

Operation Manual

Version 10 – 02.2016

LEONI

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1. Safety Precautions

Handling Instructions for Fiber Optical Components

CAUTION! ***Any extreme stresses onto the optical cable could degrade the optical performance or damage the fiber.***

- Do not pull on the fibres!
- Never bend an optical cable more sharply than a 35mm radius!
- Bending over any sharp edges may damage or break the fiber!
- Avoid excessive heat near cables!
- All optical connectors should remain covered with dust cups in place when not in use.

Cleaning & Mating Instructions for Optical Connectors

- Clean both connectors prior to mating by using a high-grade isopropyl alcohol and a cotton swab.
- Allow connectors have to dry before mating.
- Insert the connector ferrule into the appropriate adapter smoothly.
- Do not over-tighten the connectors.
- Specifications for the eol series switches are based on an optimal connection. If the resulting values are unacceptable, please repeat the cleaning procedure and start again.

Special Instructions for Electrical Devices

- Do not remove power cable before switching off the power supply.

2. General Information

FEATURES

- excellent repeatability
- ultra low back reflection
- low insertion loss and PDL
- high optical isolation
- broad spectral range
- polarization maintaining option
- short switching time
- small dimensions

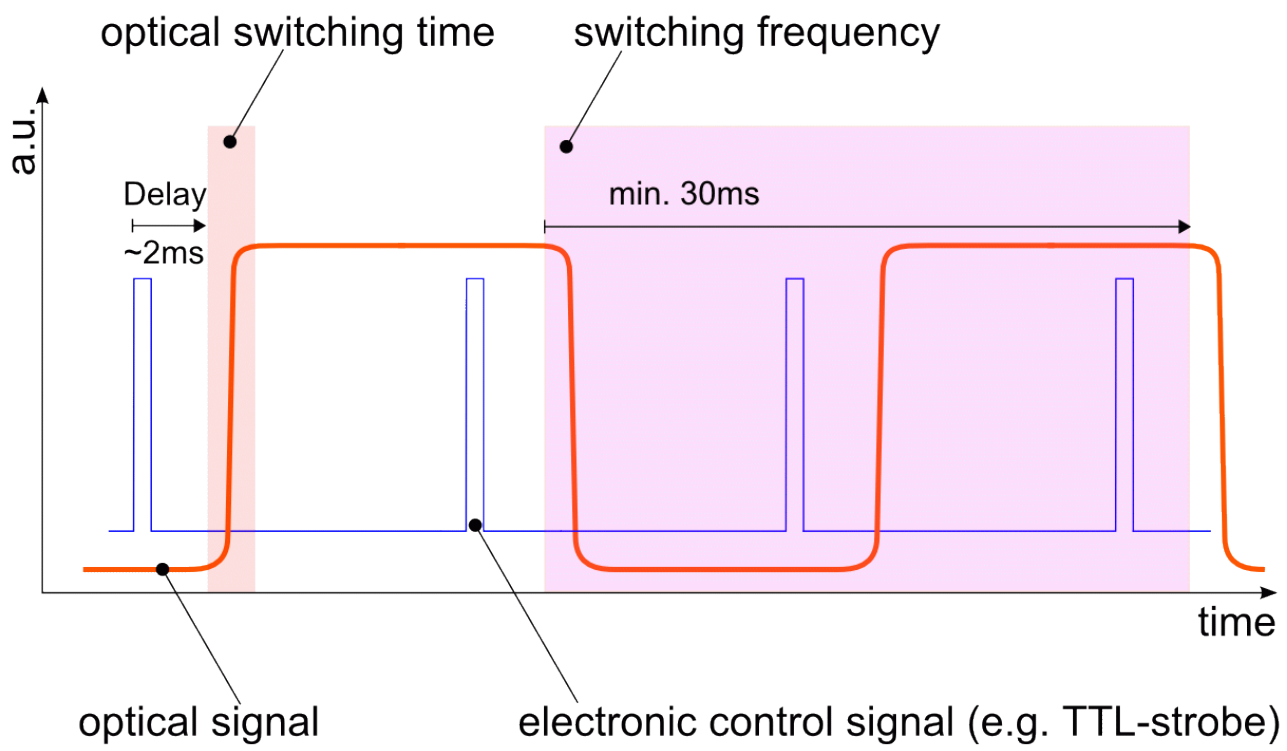
APPLICATIONS

- testing and measurement
- fiber optic sensing
- add/drop multiplex system
- network fault protection
- signal protection
- laser scanning microscopy
- fiber bragg sensors
- multi channel optical power monitoring

TECHNOLOGY

LEONI's fiber optical switches are mainly used for high demanding applications in telecommunications, optical measurement and test systems, industrial production and process control, as well as in biomedical section. Examples for such applications are Laser guiding systems for confocal fluorescence microscopy and laser scanning microscopy, fiber optic strain and temperature sensors for pipelines, bridges, tunnels etc., fiber optical measurement systems for environmental monitoring and also test equipment of optoelectronic devices in their production chain.

PERFORMANCE / TIMING CHARACTERISTICS

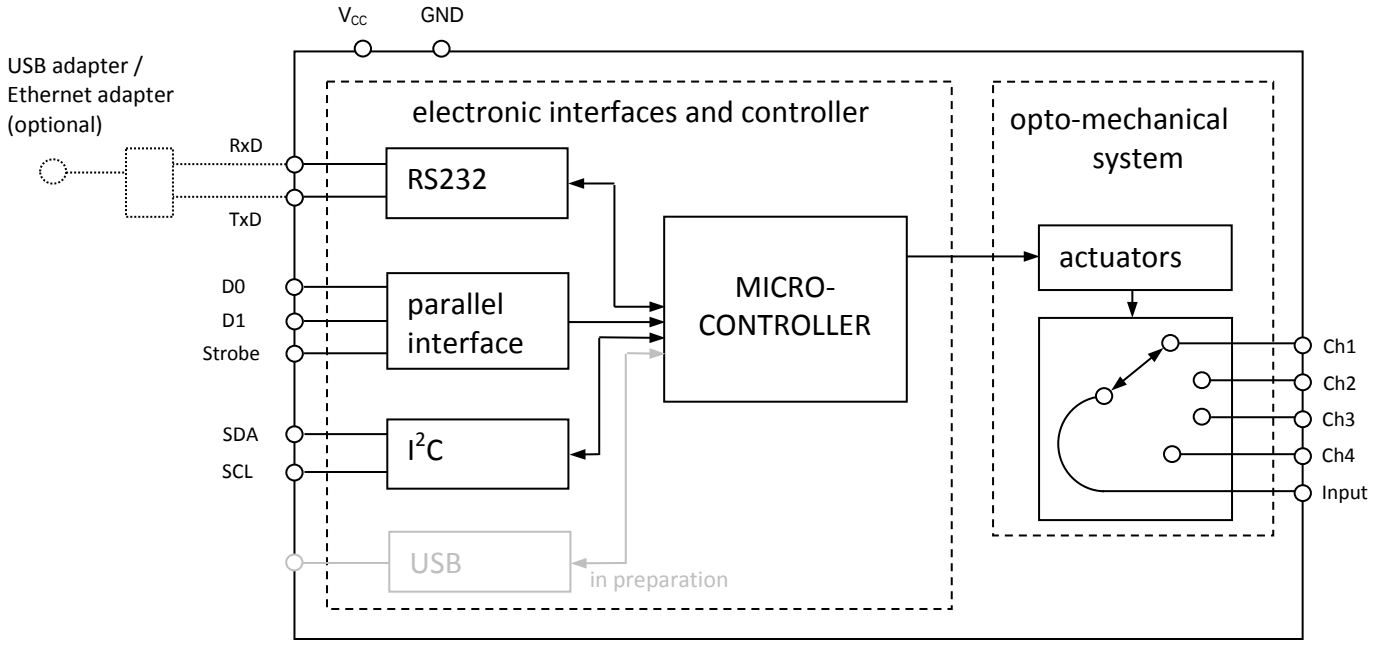


This diagram schematically shows the performance of a fiber optical switch. Furthermore it describes some usual words and phrases which are generally used in datasheets, quotations, catalogs and more.

- The first in this diagram is on the left: the ***delay*** means the time between electrical signal and the raise of the optical signal.
- The next important parameter is the ***switching time***. It is defined as the time in which the optical signal raises from 10% up to 90% of maximum level or falls from 90% to 10%.
- Another specified parameter is the ***switching frequency***. It's not related to the switching time above. We recommend not exceeding the mentioned 30 Hz in the diagram otherwise the switch could be damaged.

3. Communication Interfaces

3.1 FUNCTIONAL BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

Parameter		unit	test conditions / comments
operating voltage	5 ± 10%	V	
switching current	50	mA min.	switching frequency = 0Hz
	100	mA typ.	
	180	mA max.	switching frequency = 30Hz

3.2 PIN CONFIGURATION for Compact Housing

# PIN	PIN name	type*)	function test
1	V_{CC}	P	positive voltage 5V
2	GND	P	ground (reference point for interfaces)
3	TxD	O	transmitter data output of serial port
4	RxD	I	receiver data input of serial port
5	SDA	I/O	I^2C-compatible input/output pin
6	SCL	I/O	serial clock pin for I^2C interface
7	-	not used	**never** connect this pin to GND or V_{cc}
8	D0	I	address bit 0 for the TTL/parallel interface
9	D1	I	address bit 1 for the TTL/parallel interface
10[1)]	D2	I	address bit 2 for the TTL/parallel interface
11[1)]	D3	I	Address bit 3 for the TTL/parallel interface
12[2)]	strobe	I	clock pin for parallel interface

Notes:

*)
- P power supply
- I input
- O output
- I/O input and output simultaneously

1)
- in case of max. channel number < 5, parallel ports D2 and D3 does not exist

2)
- in case of max. channel number < 5, strobe is on pin 10

3.3 RS232

The RS232 interface allows controlling the switch from your PC or laptop directly. The interface is protected for short circuits by GND.
In case you ordered an USB interface the delivery contains an adaptor between RS232 and USB which must be connected to the RS232 interface of the switch. After connecting to the PC the operating system creates a new serial port as virtual COM port, which is usable like the standard RS232 interface.

SETTINGS

- 57600 Baud (standard*)
- 8 data bit
- no parity
- 1 stop bit
- no flow control

*) others on request

Pin Setting for Compact Housing (p. 19)

Pins on switch		Computer DB-9 pins
2 – GND		5 – GND
3 – TxD		2 – RxD
4 – RxD		3 – TxD

COMMANDS

All commands must be send as ASCII code. A command is not executed until terminated by a carriage return (CR; ASCII decimal code 13) **and** a new line (LF; ASCII decimal code 10).

command name	parameter	response	function
type?	none	*"eol 1xn"* [1]	response of the switch type
firmware?	none	*"v8.09"*	response of the firmware version number
ch?	none	*"2"*	indicates the current switch position
ch	*"1"..."n"* [1,2]	none	sets into the specified position *example: "ch3" -> enables channel 3*
i2c?		actual i²c address	response for the set i²c address
i2c	*"10"…"99"*		setting the i²c address

Note: [1] *n* depends on number of switching states (max. channel number)
[2] in case of an integrated blind channel, choose "0" to close all channels

In case of independent switches of the same type via one interface (e.g. n-times/n-fold shutter system) it is necessary to use the command 'grxxxx' and 'gr?' (see below)

For non-blocking matrices use the command 'setAB' and 'set?' (see below)

COMMAND FOR INDEPENDENT SWITCHES Nx(1xM) ('grxxxx' & 'gr?')

To work with various switches/shutters of type Nx(1xM) independently via one interface, it's necessary to use the command

gr***xxxx***

gr is the main command and ***xxxx*** is a hexadecimal number related to the desired switching states of all switches eol 1xM (e.g. gr***3AA3***). This number describes the states of switches.
By variation of the number of switches (N) and their channels (M) the command length varies between grxx, grxxxx and grxxxx xxxxℓ. (Note: when you need more than 4 hexadecimal digits you have add an ℓ (for long)).

For building up the command 'grxxxx' to switch the desired channel configuration, it is best to describe it by an example like the type 'eol 5x(1x6)'.

- That switch type consists of 5 independent switches 'eol 1x6'.
- For each switch there are 3 bits necessary to get all 6 channels
- Concatenated in the reversed order you got a 15-digit binary number: $\underbrace{xxx}_{M5}\ \underbrace{xxx}_{M4}\ \underbrace{xxx}_{M3}\ \underbrace{xxx}_{M2}\ \underbrace{xxx}_{M1}$
- According to the table for TTL (p. 12) choose the desired channel configuration
- Fill in and convert it to a hexadecimal number
- e.g. M1 Channel 2 (001)
  M2 Channel 1 (000)
  M3 Channel 6 (101) $\Rightarrow$ 011 1001 0100 0001 $\overset{Hex}{\longrightarrow}$ 3941 $\overset{group}{\longrightarrow}$ gr3941
  M4 Channel 5 (100)
  M5 Channel 4 (011)

The second command is to check the current switching state of the switches and is as follows

gr***?***

Ending up with CR and LF you got something like *gr3AA3*. Then you have to convert it back to a binary number and you know the switching state of the switches.

Here it is 0011 1010 1010 0011 $\Rightarrow \underbrace{011}_{M5}\ \underbrace{101}_{M4}\ \underbrace{010}_{M3}\ \underbrace{100}_{M2}\ \underbrace{011}_{M1}$

$\Rightarrow \underbrace{ch4}_{M5}\ \underbrace{ch6}_{M4}\ \underbrace{ch3}_{M3}\ \underbrace{ch5}_{M2}\ \underbrace{ch4}_{M1}$

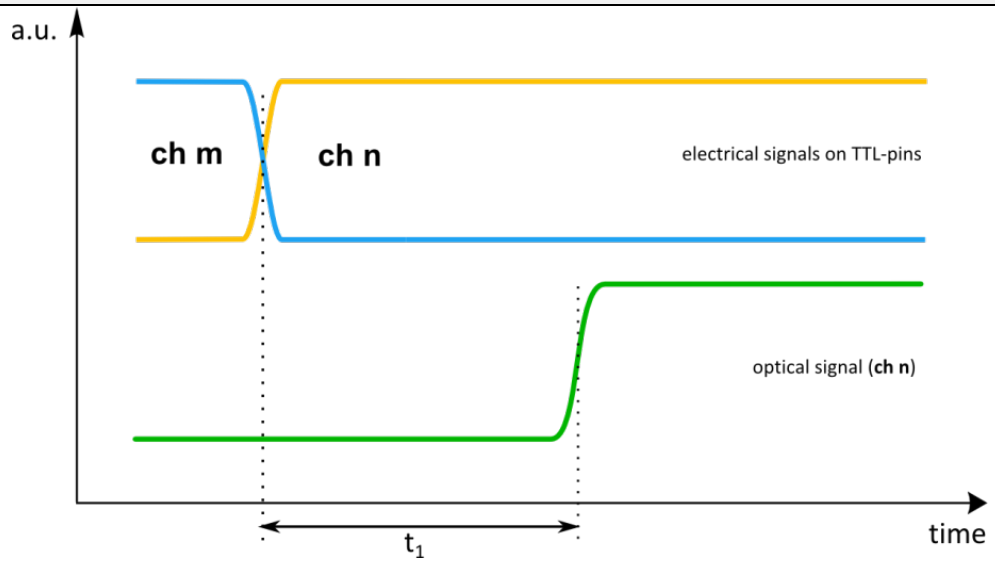
COMMANDS FOR NON-BLOCKING MATRICES M x M AND N x M

command name	Parameter	Response	function
type?	None	*"eol matrix nxm"*	response of the switch type
firmware?	None	*"A Mega V…"*	response of the firmware version number
set?	None	*"connection1x"* *"connection2y"* *…*	indicates the current switch positions
set	*"27", "53"*	none	sets into the specified position *example: "set35" -> enables connection: input 3 to output 5*
set00	None		closes all connections to state "blind"

3.4 TTL INTERFACE

- Switch can only receive data, not transmit
- Switch can be programmed either with or without a chip selection signal (strobe)
- Interface operates with standard TTL levels
- All TTL pins are at high level, when they are not connected

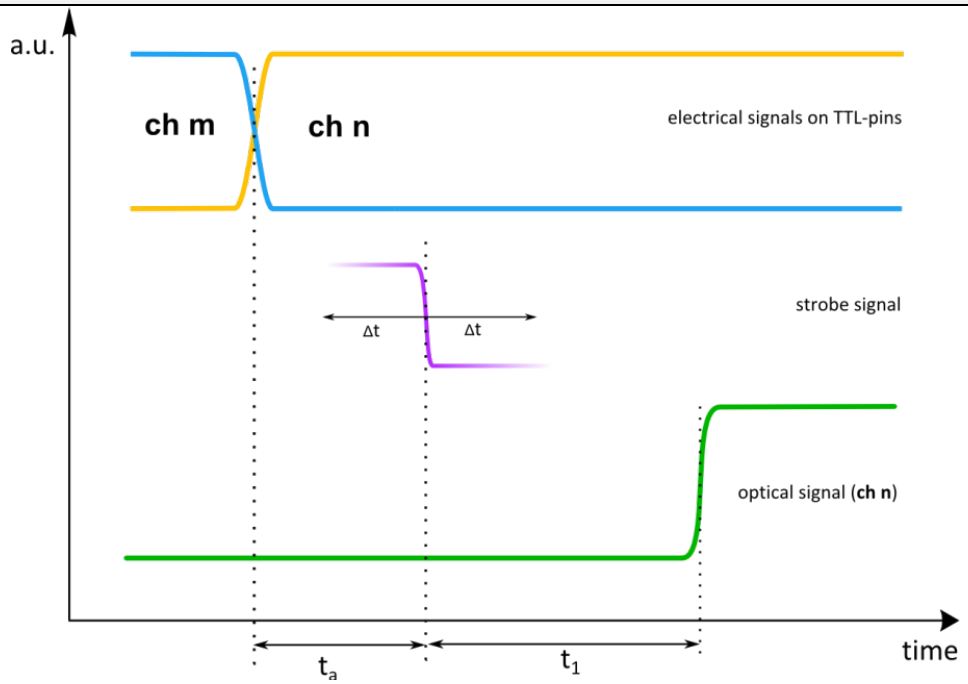
STANDARD TTL



After detecting a new switching state (binary code) at the data input port, the switches moves to the corresponding channel after time delay t_1. In order to avoid problems this code must be kept constant for a period of 40 µs.

t_1 = 3ms (eol series) and 6ms (mol series)

TTL WITH CHIP SELECTION SIGNAL (STROBE)



With the strobe feature the desired channel becomes active only by a fallen slope on the strobe pin, independent of timing of setting the TTL code. Before and after this fallen slope the signal on the strobe pin has to be constant for a time period of Δt. Switching occurs after a duration t_1.

Δt	> 45 µs
t_a	arbitrary time
t_1	3ms (eol series) and 6ms (mol series)

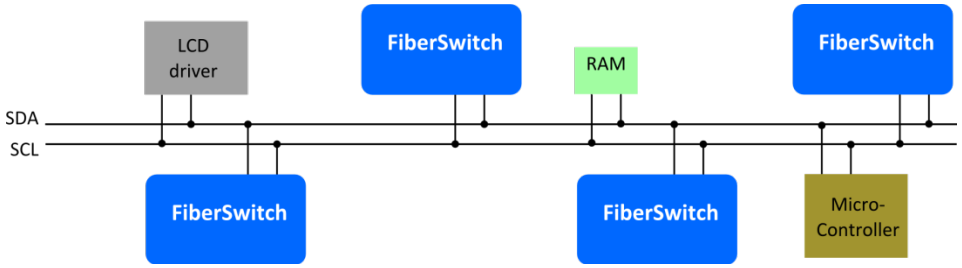
Please note:

After each switching process the switch will not accept signals for the next 5ms. Other values are possible on customer's request.
See the following table for the necessary binary code corresponding to the required switch channels.

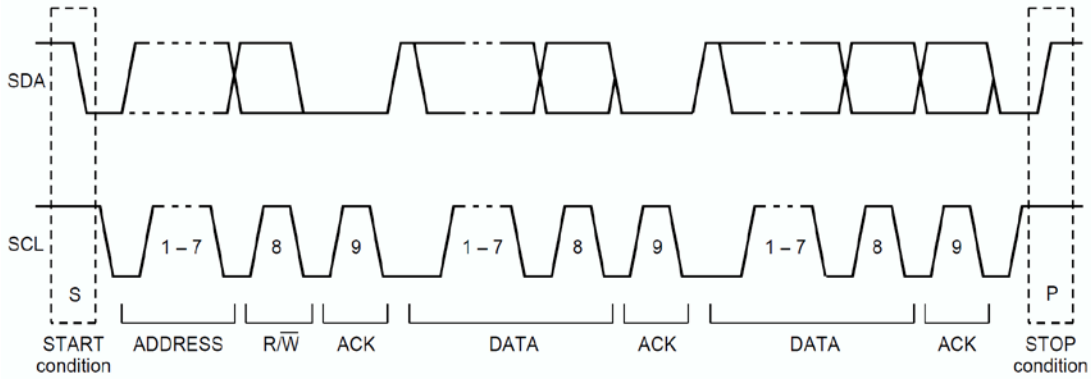
D3	D2	D1	D0	Channel
0	0	0	0	**1**
0	0	0	1	**2**
0	0	1	0	**3**
0	0	1	1	**4**
0	1	0	0	**5**
0	1	0	1	**6**
0	1	1	0	**7**
0	1	1	1	**8**
1	0	0	0	**9**
1	0	0	1	**10**
1	0	1	0	**11**
1	0	1	1	**12**
1	1	0	0	**13**
1	1	0	1	**14**
1	1	1	0	**15**
1	1	1	1	**16**

3.5 I²C INTERFACE

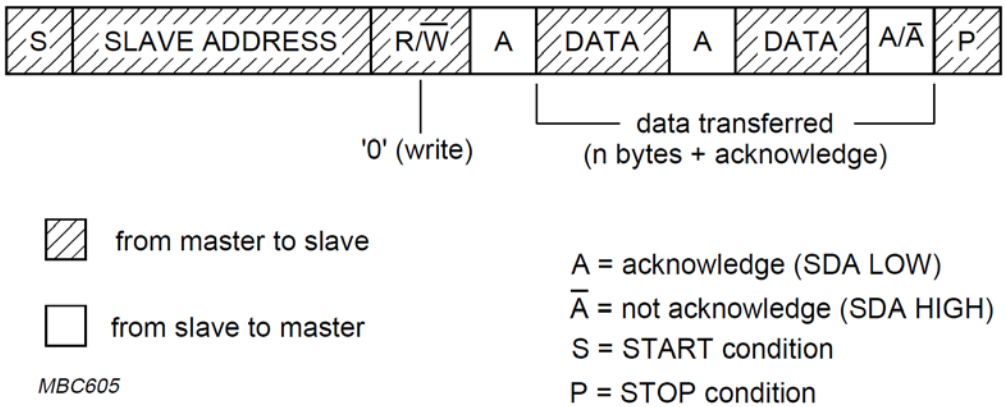
The I²C- Interface works with two lines, serial data (SDA) and serial clock (SCL), as a communication bus (see figure below). Each device is recognized by a unique address (whether it is a microcontroller, LCD driver or memory) and can operate as either a transmitter or receiver, depending on the function of the device. An LCD driver may be only a receiver, whereas a memory can both receive and transmit data. In addition to transmitters and receivers, devices can also be considered as masters or slaves when performing data transfers. A master is the device which initiates a data transfer on the bus and generates the clock signals to permit that transfer. At that time, any other device addressed is considered a slave.



The switches work with I²C-interface in standard mode developed by Philips Semiconductors (now NXP Semiconductors). Both SDA and SCL are bidirectional lines, connected to a positive supply voltage via a current-source or pull-up resistor. When the bus is free, both lines are HIGH. Due to various technologies connected to the bus (CMOS, NMOS, bipolar) the levels of a logical “0” (LOW) and “1” (HIGH) are not fixed and are set to 30% (LOW) and 70% (HIGH) of V_{CC}. The following figure shows a typical timing for the I²C-Bus:



All transactions begin with a START (S) and are terminated by a STOP (P). START and STOP conditions are always generated by the master. Every byte put on the SDA line must be eight bits long and must be followed by an Acknowledge bit.
After the START condition (S), a slave address is sent. This address is seven bits long (0…127) followed by an eighth bit which is a data direction bit (R/W) — a ‘zero’ indicates a transmission (WRITE), a ‘one’ indicates a request for data (READ). (See figures below)



USING A FIBER SWITCH AS SLAVE

Example for switching different channels:

- The I²C address of a switch is 68 (factory setting).
- As a 7 bit number it is 1000100
- For the switching process the first byte looks like

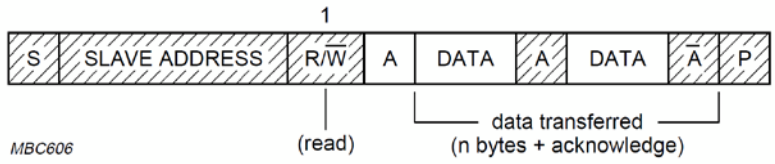
1 0 0 0 1 0 0 0

Address(68) W(Write)

- In the second byte (first data byte) the master sends the desired channel

Channel 1:	0000 0001
Channel 2:	0000 0010
Channel 3:	0000 0011
Channel 16:	0001 0000

Example for requesting the actual channel:



- According to the scheme the first byte looks like

1 0 0 0 1 0 0 1

Address(68) R(Read)

- In the second byte (first data byte) the slave sends the binary channel number to the master

Channel 1:	0000 0001
Channel 2:	0000 0010
Channel 3:	0000 0011
Channel 16:	0001 0000

- In comparison the direction of data is the opposite, so shading in the figure is the opposite.

Deviations from standard mode:

- Switch does not respond to the general call address 0000 000
- Switch does not support a 10bit addressing
- In correspondence to the specifications only bitrates up to 100kBit are accepted
- Due to some reservations, I²C-addresses between 10 … 99 are accepted

USING A FIBER SWITCH AS MASTER

If you want to use a FiberSwitch as a master device, you have to use the RS232 interface between a PC and the switch as master. The firmware has to be 4.xx; 5.xx.
The settings are:

- Baud rate: 57600
- Data: 8 Bit
- Stop: 1 Bit
- Parity: none
- Flow control: none

The already existing commands for this interface works properly for the switch connected via RS232.

- ch?
- ch
- firmware?
- type?
- i2c? this allows to query the actual I²C address
- i2c this allows to set the I²C address to any fixed value between 10 and 99 (for example i2c15 sets the address 15)

After a new address has been set, it remains unchanged even after switch off the power supply, as this address is stored in the flash memory of the controller.

Important: All commands must end with CR (#13) and LF (#10). The same does apply to the response.

For a communication with slaves via the I²C-bus it is necessary to indicate the desired switch. So we need a new syntax.

i***[No.]***i***[ADR]***t and i***[No.]***i***[ADR]***r

All has to be send as ASCII symbol (like ‚ch5' for channel 5), except the placeholders ([No.] and [ADR]) in the brackets. They have to be transmitted as a decimal number and not as ASCII symbol.

t or r means „transmit" or "receive"

[ADR] I²C address of the desired switch.

[No.] command number:
- 1…127 - desired channel at transmitting ‚i…i…t'
- 1 - 1Byte for channel request ‚i…i…r'
- 204 - question: type?

As response from the master the syntax looks like:

i***[No.]***c and i***[No.]***i***[err]***c

ended with CR und LF.

i*[No.]*c Response after command for transmitting ('i…i…t')
After correct transmission *[No.]* gives back the command number
In case of a failure it is the failure code

i*[No.]*i*[err]*c Response after channel request ('i[1]i[68]r')
[err] shows the failure code
[*No.*] shows the current channel

List of failure codes

General

192	-	no error
191	-	no data requested
190	-	to many data requested
189	-	bad I²C address
188	-	unknown question

Receiver Modus ('i…i…r')

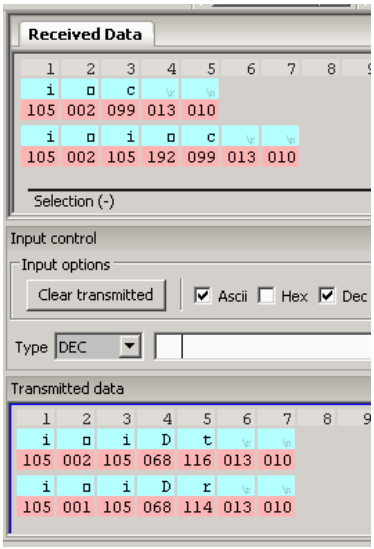
147	-	MT_DATA_NACK instead of MT_DATA_ACK received
146	-	neither MT_DATA_ACK nor MT_DATA_NACK received
145	-	time out on transmit data

144 - MT_SLA_NACK instead of MT_SLA_ACK received
143 - neither MT_SLA_ACK nor MT_SLA_NACK received
142 - time out on transmit address
141 - no START condition
140 - time out in START condition

Transmitter Modus ('i...i…t')

137 - MT_DATA_NACK instead of MT_DATA_ACK received
136 - neither MT_DATA_ACK nor MT_DATA_NACK received
135 - neither MT_DATA_ACK nor MT_DATA_NACK received, last Byte
134 - time out on transmit data
133 - MT_SLA_NACK instead of MT_SLA_ACK received
132 - neither MT_SLA_ACK nor MT_SLA_NACK received
131 - time out on transmit address
130 - no START condition
129 - time out in START condition
128 - other error

Example



This picture shows the ASCII symbols in blue and the corresponding decimal number in red.
In the upper field is shown the received data and in the lower field the transmitted one.

The first command sets channel 2. The response of the master is the number of channel 2 (transmission correct). For the I²C address '68' (dec.) it's also possible to write a 'D', according to the ASCII table.

The second command is the channel request (1 Byte). The response is filled with the current channel and the failure code '192' (no failure).

For an own written program it's also possible to use the corresponding decimal numbers for building up the whole command. You can decide to use the red line or blue line or mix it like described above.

3.6 ETHERNET

To realize communication via a Local Area Network we use the Xport by Lantronix inside the switch (please see chapter 4 on page 23). It is an adapter from Ethernet to serial interface. For more information please visit www.lantronix.com

SETTING THE IP ADDRESS

For proper operation in a network, the IP address of the device has to be consistent with the network address.

Example:

IP of the PC	192 . 168 . 000 . 001
Subnetmask	255 . 255 . 255 . 000
IP of the shutter	192 . 168 . 000 . 022

For setting the IP address of the switch you can use two methods.

(a) using **LANTRONIX Device Installer**

A simple configuration of the IP address and of the XPort (Ethernet- to-RS232 converter inside the switch system) can be done through the Lantronix Device Installer. For this please install the Lantronix Software from your CD.

Otherwise you can download the latest version from the internet.
(http://www.lantronix.com/support/downloads.html)

Start the *DeviceInstaller* program

Click on the ***Assign IP*** Icon

Enter the hardware address (MAC-address) of the XPort IE: 00-20-4A-xx-xx-xx (see Test Protocol of the specific switch) in the hardware field and click ***Next***

Select ***Assign a specific IP address*** and click ***Next***

Enter the IP address, Subnet mask and default gateway (the gateway parameter is optional) you want to assign the XPort, then click ***Next***

Click ***Assign***

IMPORTANT:

Please change only the IP address in the XPort settings. Do not change port number and serial interface, otherwise the device will not respond to your inputs.
In case of any changes of the XPort configuration please reset all changes to default and set the BAUD rate to 57600.

(b) using **ARP and TELNET**

Open a windows command prompt (Start, Run, enter command or CMD depending on your operating system)

From the windows command prompt enter the IP address and MAC address (see Test Protocol) as shown below:

```
C:\arp –s 192.168.xxx.xxx 00-20-4a-nn-nn-nn
```

(Replace ***x*** *with your new IP and* ***n*** *with the MAC-address of the device)*

Hit return

At the next command prompt telnet to the same IP address using port 1
C:\telnet 192.168.xxx.xxx 1

Hit return. (message 'failed to connect' should appear within 2 to 3 seconds)

At the next command prompt telnet to the same IP address using port 9999
C:\telnet 192.168.xxx.xxx 9999

Hit return. You will be prompted to "Press Enter to go into Setup Mode"

Hit return again as soon as you see the prompt to access the configuration choices. The prompt will time out after ~5 seconds.

The configuration settings display, followed by the Change Setup Menu

...
Change Setup:
0 Server
1 Channel 1
3 E-mail
5 Expert
6 Security
7 Default
8 Exit without save
9 Save and exit Your choice ? _

Select 0 for server configuration.

Manually enter the IP Address. This permanently assigns the IP address,

Manually enter the gateway address (optional)

Manually enter the host bits for the subnet mask (refer to XPort User Manual, section 4, Table 4.1 – Standard IP network Netmasks) (optional)

Do not change the parameters of the serial connection (**1 Channel 1**)

When you are finished, select 9 to save and exit. The unit reboots

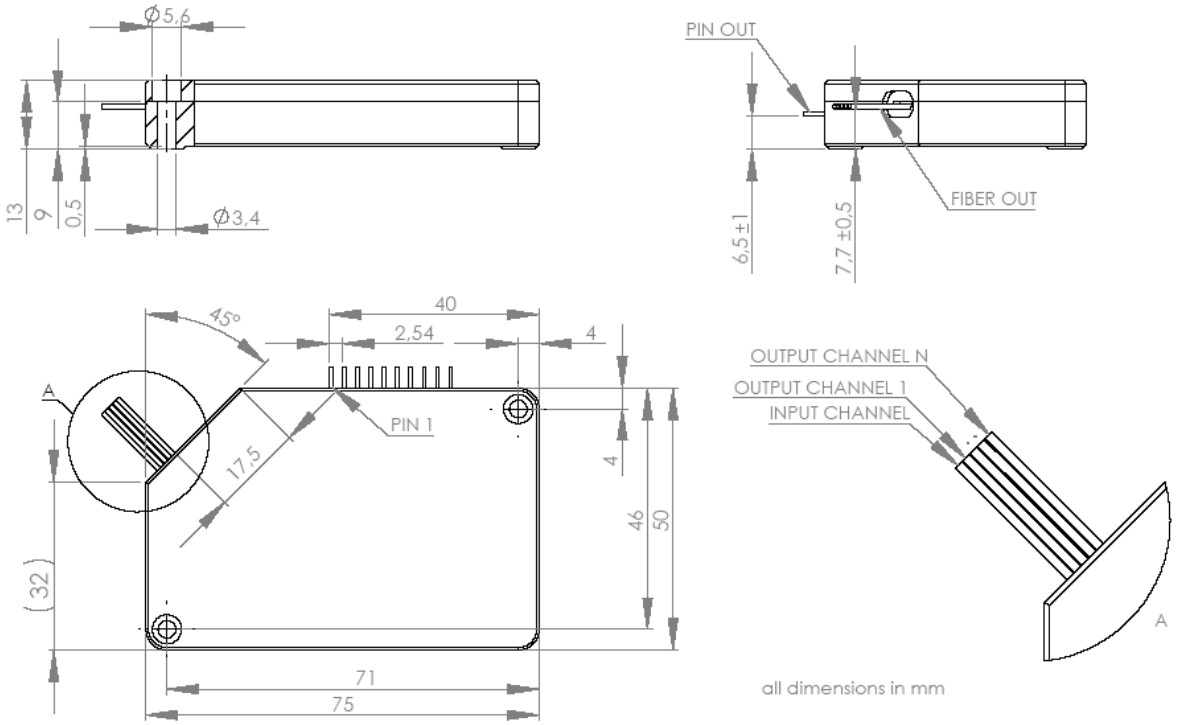
COMMUNICATION PROPERTIES

Due to an Ethernet-to-Serial-adapter the necessary commands remain the same from the RS232 interface (page 9).

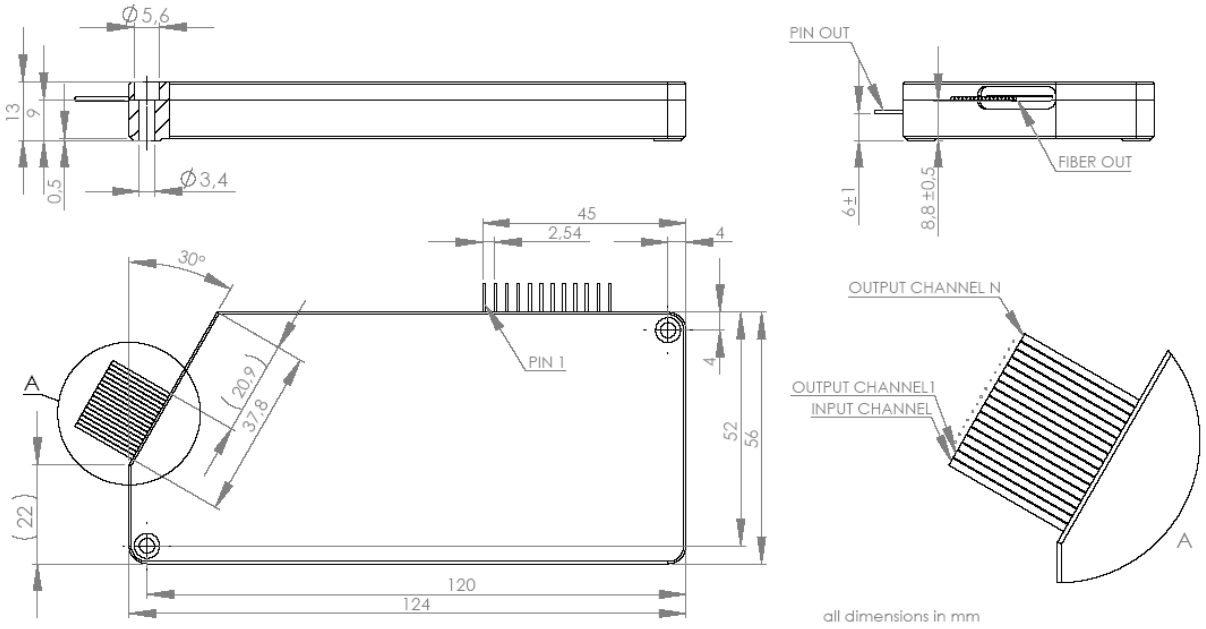
4. Housing

4.1 COMPACT HOUSING

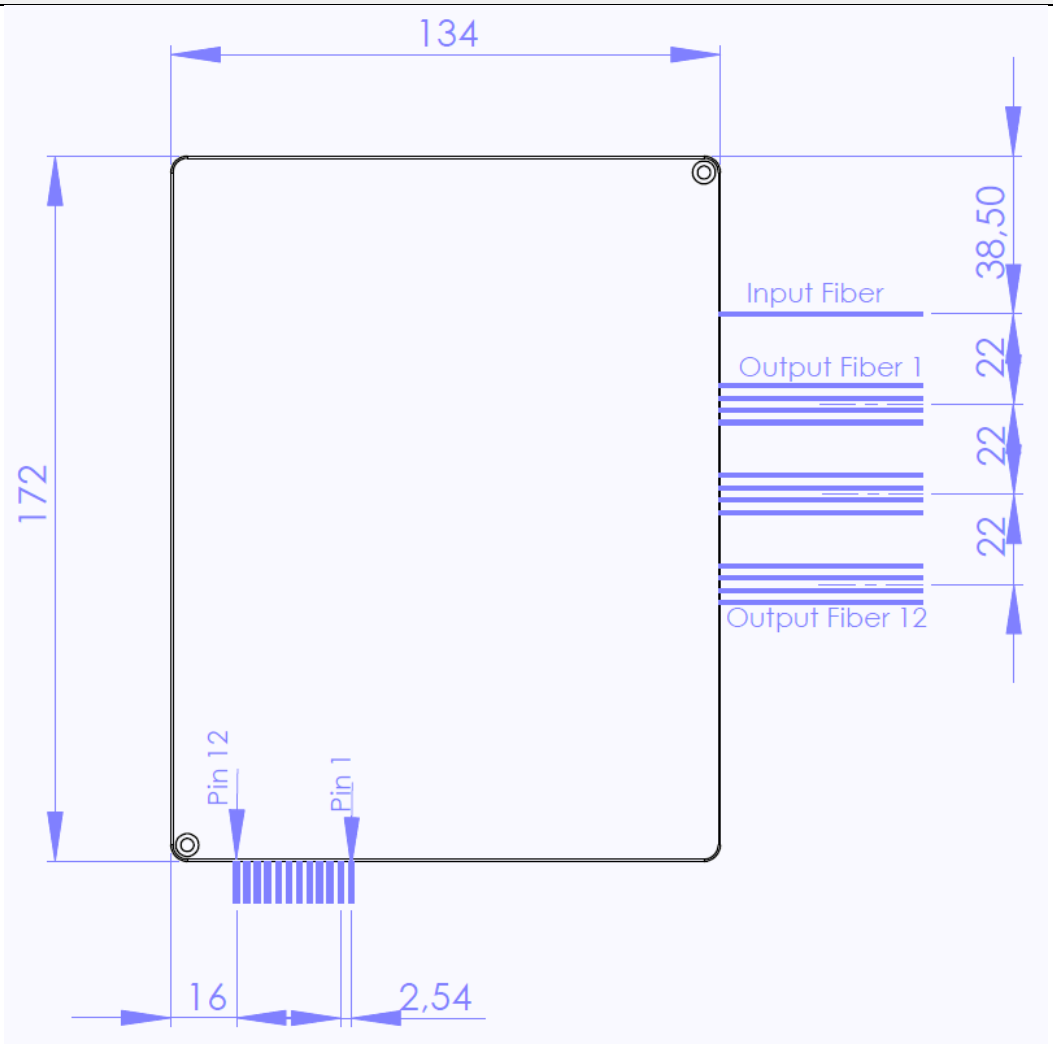
SMALL



LARGE

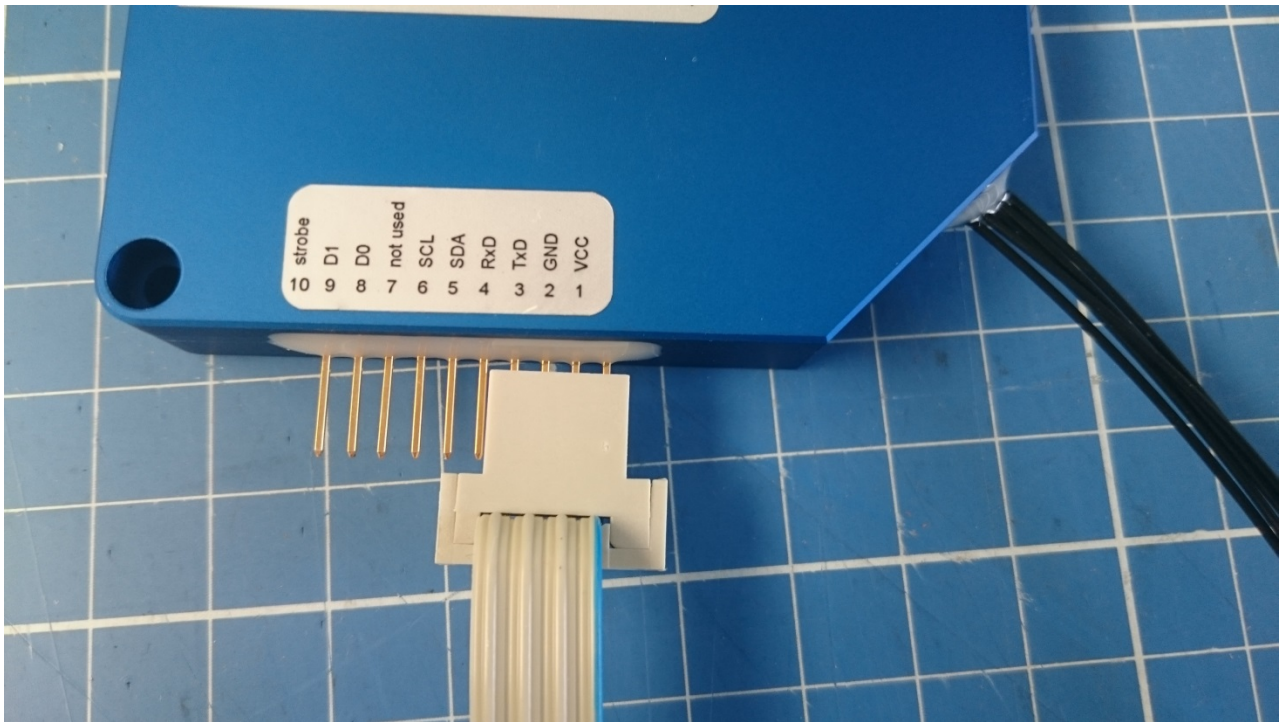


MULTIPLE MODULE HOUSING



AKG HOUSING

PIN CONNECTOR FOR ALL COMPACT HOUSINGS



All compact housings do have the same pin assignment as shown in table on page 8 and the picture above. As accessory the delivery contains a ribbon cable as shown with a blue marked wire. This coloured stripe indicates the pin no. “1”.

4.2 TABLE TOP HOUSING

5V with RS232 (D-Sub) and I²C

5V with RS232 (D-Sub) and TTL (SMA (remote))

5V with TTL (D-Sub)

100-240VAC (KG plug) with Ethernet (LAN, RJ-45)

In these housings we generally ship switches with a 5V plug for power supply in the rear panel. Additionally we equip the device with a D-Sub plug for communication via RS232 as standard. All other interfaces like TTL, Ethernet or I²C or different power supplies up to 240V are also possible by request.

All table top housing dimensions are shown in the table below.

Housing Dimensions for table top housings

AluCompact 1		187 x 125 x 30 - 80
AluCompact 2		227 x 166 x 30 - 80
AluCompact 3		187 x 225 x 30 - 80
AluCompact 4		227 x 266 x 30 - 80

PIN ASSIGNMENT FOR ALL TABLE TOP HOUSINGS

Pin Setting for D-Sub -Connector

RS232		TTL
5 – GND		5 – GND
2 – TxD		1 – D0
3 – RxD		2 – D1
		3 – D2
		4 – D3
		9 – strobe

4.3 19'' RACK

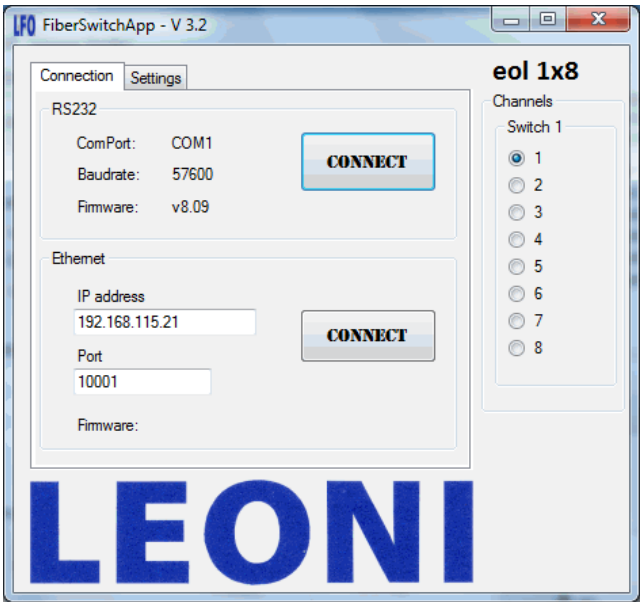
For 19 inch racks the available interfaces and power supplies are the same like for the table top housings.

5. Software

5.1 FIBER SWITCH APP

TAB: CONNECTION

To start the standard control software double-click ‘FiberSwitchApp Vxx.exe’, provided on a CD.

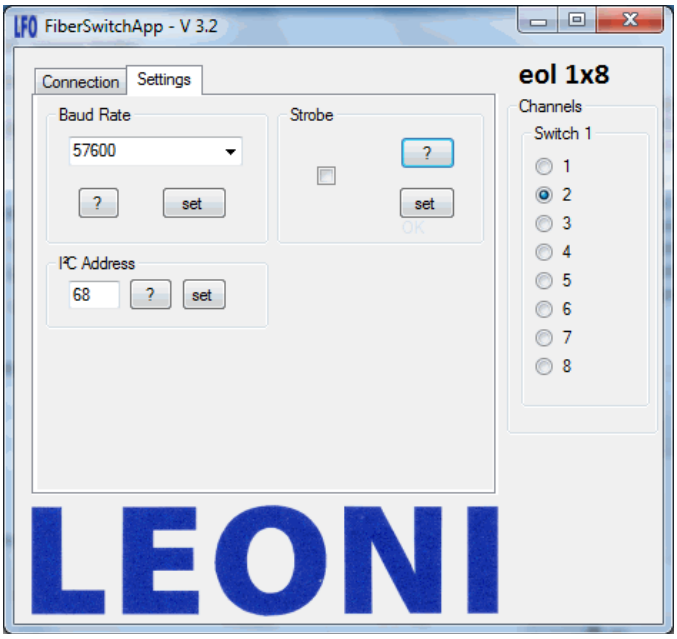


In dependency of your desired interface choose the “CONNECT” button either in the box for RS232 or Ethernet. Via RS232 the software searches automatically all available COM ports in your system to find the switch and shows the port, BAUD rate and firmware of the switch in their fields.
Via Ethernet you first have to set the IP address which has to be consistent to your network (see page 17). After that you have to fill in this address and click also on the “CONNECT” button.

After connecting the switch, you will see the type of the switch and all available channels on the right side. Now you can control the switch by clicking a desired channel.

TAB: SETTINGS

On the second Tab “Settings” you can configure the shown parameters.

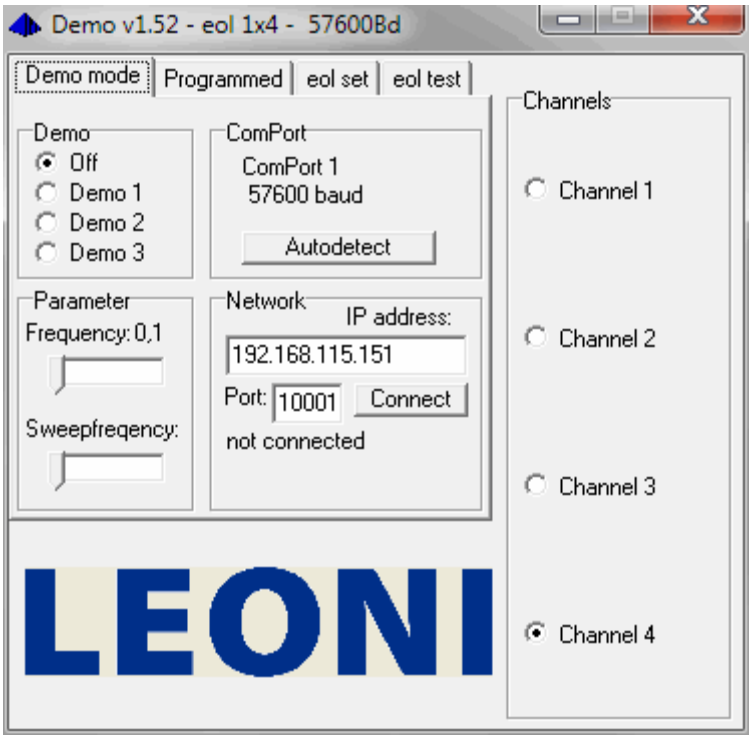


By clicking the question mark you ask for the certain parameter and get a response either in the text boxes or in the checkbox.
For changing these parameters you first have to choose the BAUD rate from the drop down or write the desired I²c address or activate the checkbox for the strobe feature and press afterwards the “SET” button to transmit the parameter to the switch.

5.2 DEMO SOFTWARE

TAB: DEMO MODE

To start the “DEMO-software” double-click ‘DemoVxx.exe’, provided on a CD.
During the starting routine the software will search for the switch, connected to a COM port. If it finds a switch, it will show the main window below.
In case of a different interface (e.g. Ethernet) no switch will found, what appears in a dialog box.



Now the switch is ready for being controlled by this demo software.

- From the Demo window (see above) the type of switch (e.g. eol 1x4) and the Baud rate (e.g. 57600) can be seen in the main title bar.
- On the right, there are 4 radio buttons for the 4 channels of the switch 1x4, where you can choose a desired channel by mouse click. In case of an “eol 1x16” there are 16 radio buttons for 16 channels.
- On the left, there is a box “Demo”, where you can choose a switch routine for demonstration.

    - ***Off:*** When button “Off” is selected you can switch to the desired channel by mouse click on the 4 buttons on the right
    - ***Demo 1:*** switches in consecutive order through the channels step by step (1; 2; 3; 4; 1; 2; ….) with the desired frequency (see box “Parameter”)
    - ***Demo 2:*** switches in random order between channels with the desired frequency
    - ***Demo 3:*** switches in straight order but changes the switch frequency periodically with the sweep frequency

Finally, the boxes “ComPort” and “Network” are used when connecting the switch via RS232 or Ethernet.

Via the Ethernet interface you have to fill in the correct IP address and the Port number 10001 and click ‘Connect’ to build up the communication with the switch.