Gigabit Ethernet Switch
for Industrial Fiber Ring Application

MICROSENS

General

Ethernet has been used in the controlling level of industrial applications for many years. Ethernet is continuing to beat the field bus technologies used to date in coupling equipment controls, sensors and actors. Process error-tolerant network components are absolutely essential because the network availability has a direct effect on production.

It is precisely to prevent this that MICROSENS has developed a mechanism for which a patent is pending that enables the Ethernet network to be reconfigured within milliseconds if an error occurs.

The switches can be configured and monitored either by SNMP or a PC-based management tool NMP (Network Management Platform). In addition to the NMP all statuses are displayed web based using an integrated HTTP server.

In addition to the two 1000Base-SX/LX fiber connections for chain linking several industrial switches, the MICROSENS industrial switches also offer seven 10/100Base-TX connections for linking such Ethernet terminals as machine controls, network uplinks, consoles and other network participants and one 10/100/1000Base-T port for a central uplink connection.

In an extended version this switch is available with a third optical fiber port (1000Base-X). This port can be used alternative to the 10/100/1000Base-T port.

For particularly demanding uses, the industrial switches are designed in a suitably robust construction with an integrated clamping device for direct assembly on 35 mm DIN rails. The devices meet the requirements for IP protection class 30 and are also designed for a larger temperature range.

The power supply of the devices is done by an external, central power supply unit. With the second power input the device can be supplied with redundant power. All electrical ports are either galvanic isolated or equipped with an effective over voltage protection.
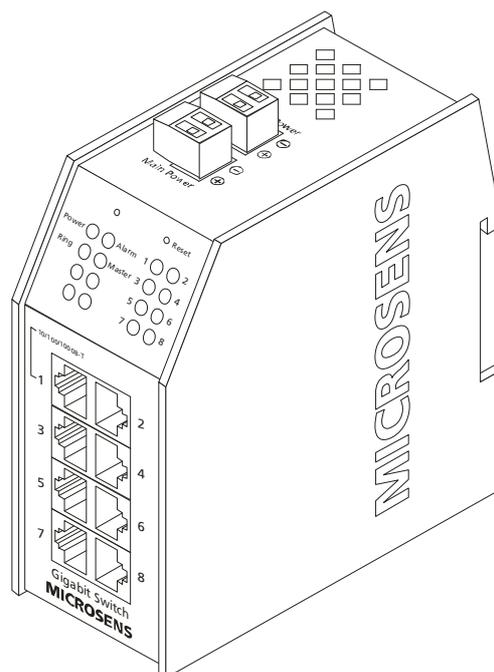

Fig. 1: Gigabit Ethernet switch for fault tolerant fiber rings

Technical specifications

Type	Manageable Gigabit Ethernet switch with 1x 10/100/1000Base-T, 7 x 10/100Base-TX and 2 x 1000Base-SX/LX uplink for industrial fiber ring
Fiber type	Multimode 62,5/125 or 50/125µm (1000Base-SX), Single mode 9/125µm, duplex (1000Base-LX)
Cable type	Shielded Twisted Pair cable, 100 Ohm, Category 5, Pinout RJ45-ports auto crossing
Data rate	10, 100 or 1000 Mbps

LED displays

Port 1-8	Link (on) and activity (flashing) of the TP ports
G1	Green: Copper port 1 with Gigabit Ethernet speed
	Orange: Third optical fiber port active, copper port 1 without function (optional)
Port 9-10	Link (on) and activity (flashing) of the fiber ports
P1	Green: Main Power Supply active
	Orange: Main Power Supply missing
P2	Green: Backup Power Supply active
	Orange: Backup Power Supply missing
Ring	Switch configured for ring mode
RM	Ring Master (only in ring mode)
Alarm	Fiber link interrupted or Power Supply problem

Mounting	35 mm hat rail, according DIN EN 50 022
Power supply	18 - 36 V DC (optional 48 V DC) / max. 500 mA by external power supply connections with screw terminals, redundant ports
Power consumption	typ. 8 Watt
Dimensions	50 x 108 x 116 mm (w x d x h)
Operating temperature	-20°C to 60°C
Storage temperature	-20°C to 80°C
Rel. humidity	5% to 90% non condensing
Management	- Status information via web based management (http-Server) or support of SNMP - Configuration via PC based management tool (NMP)

Optical parameter

Multimode	*min. distance:*	550 m (full duplex, 50/125µm)
	Output power:	-10 dBm
	Sensitivity:	-20 dBm
	Wavelength:	850 nm
Single mode	*min. distance:*	10 km (full duplex)
	Output power:	- 8 dBm
	Sensitivity:	- 22 dBm
	Wavelength:	1300 nm

Mounting

The switch is housed in a solid metal box with an integrated fixture for the installation on standard 35 mm DIN EN 50 022 rails.

The fixation of the MICROSENS switch on the rail is done with a locking pin that can be opened from the bottom side. If multiple devices are mounted in line, a minimum space of 20 mm should be kept between the devices, to ensure a sufficient heat dissipation.

Switch Features

The integrated switch has a store-and-forward architecture and can transmit all packets non-blocking between the five ports at full wire speed. For data buffering the switch incorporates 1MBit of memory.

Up to 4096 different MAC addresses can be stored simultaneously in the internal switch address tables. An automatic aging mechanism updates the tables max. 5 min. after the last reception of data.

Twisted Pair Connections

The integrated auto-crossing function of all Twisted-Pair ports makes the use of crossed patch cables unnecessary. The switch automatically detects the pinout of the connected cable and adapts the port accordingly. For all connections standard 1:1 Twisted Pair cables can be used.

The Autonegotiation mechanism detects automatically the speed and transmission mode (full or half duplex) between connected ports. A manual configuration is not required.

Power supply

The power supply is done by an external power supply with an output voltage of 24 V DC. This power supply is not included at delivery, but can be ordered separately (MS700405). The connection is done by the pluggable screw terminals on the top of the device. The connection of a redundant power supply can be done by the second screw terminal.

Management

The integrated http server offers to show status information by using a standard internet browser. A special configuration is not necessary. Additional to the web based management the switch offers a MIB to be used in all standardized Network Management Systems (NMS) supporting SNMP protocol.

With the PC based management tool NMP it is possible to configure all ports of the switch manually.

With this tool it is also possible to do the initial TCP/IP setting (IP address, Gateway etc.). This configuration can be changed afterwards using the TCP/IP protocol.

The management information are available inside of the network (inband management). A special connection is not necessary. Due to this all four twisted pair ports are available to connect other devices.

With the deactivation of the autonegotiation function of the twisted pair ports the configuration of the speed to 10 or 100 Mbit/s and full or half duplex mode is done manually.
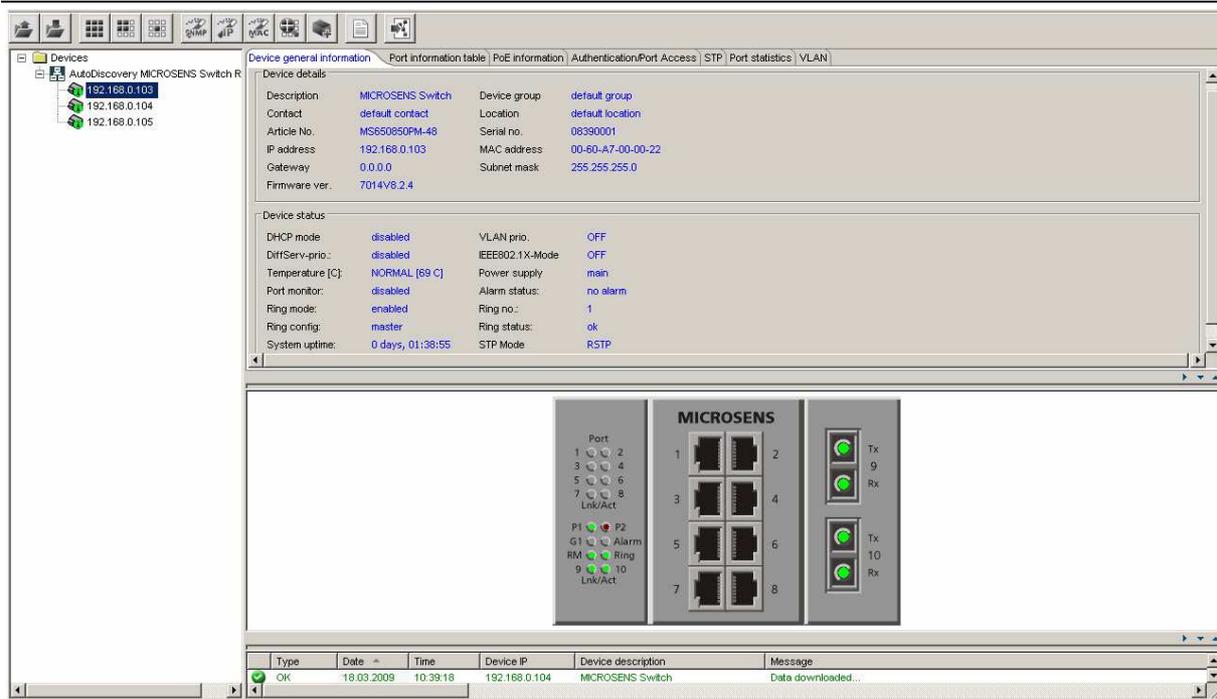
Fig. 2: Network Management Platform (NMP).

Ring Function

The two fiber ports of the device can be used to build up a ring structure. Ring structures are commonly used in industrial and telecommunication environments as they give redundant protection against failures at minimum cabling expense.

In normal operation the ring connection is logically interrupted by monitoring device (switch configured for Ring Master mode). In case of failure (broken connection or switch damage) the logically interrupted connection is activated by Ring Master.

A big advantage of this solution is, that no additional central device is necessary for the redundancy feature. Even if the ring master itself fails, the interruption of the ring stays at this location.
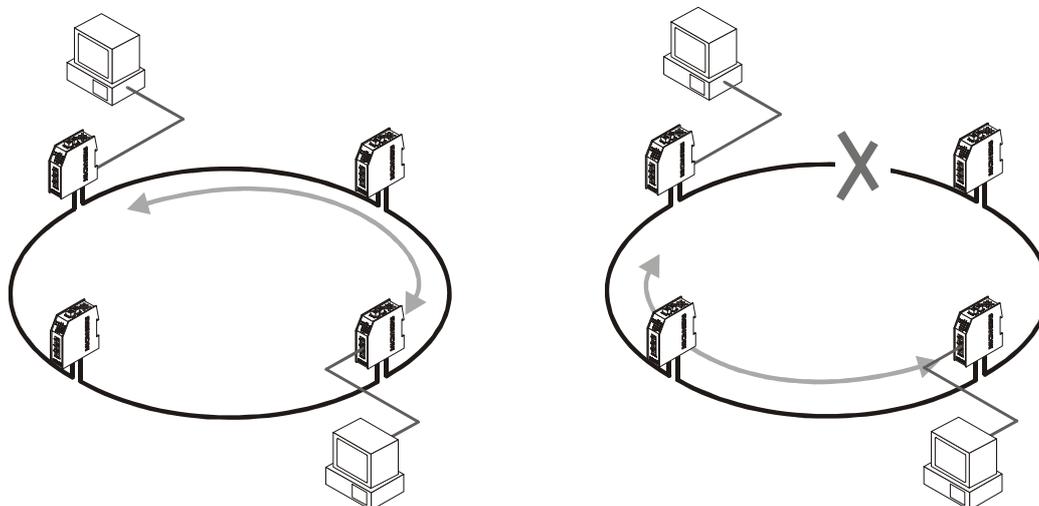
Normal operation status   Data transmission in failure status

Ring Mechanism

The MICROSENS patented protection mechanism supports the fast reconfiguration of the data transmission in case of failure of one fiber segment. This function is a fixed feature of the industrial switch. During this operation one switch is having the manager function, all other switches are normal ring switches.

Each switch is monitoring the status of the connected fiber segment. In case of failure the connected switch forwards this information to the ring manager. The ring manager terminates the interruption of the ring immediately. The data is transmitted in all directions then. This fast signaling a fast failure detection within a few milliseconds (depending on the ring size).

Ring Configuration

The configuration of the operating mode for the ring application is done with the Network Management Platform (NMP).

At the menu point Hardware Setting it is possible to select the two modes master or slave. The switch which is configured in master mode is doing the ring manager functions to avoid the multiplication of the data.

If one connection or one device fails this information is forwarded to the ring manager (master) by a special protocol. The ring manager keeps the operation of the complete segment up.

Advantage of this solution is that the ring manager itself has not to be redundant, because if the manager fails the data can not be multiplied. The segments stays under operation.

To avoid that the signaling in case of failure has no affect on other rings, it is possible to define different rings with numbers from 0 to 255 by the network management.

All switches with ring functionality are having the management features included and are offering the detection and signaling of any failure.

With this concept a limitation in regards to the maximum ring length is not given.

Best practice is to install the devices in their original position and to open the cabling in one position. For further configuration a PC with the latest version of the MICROSENS NMP running is required. The ring is configured in 4 basic steps:

- Assigning an initial IP-address to each ring switch
- Configuring all switches as rings slaves
- Configuring one switch as ring master
- Physically close the ring

Step 1: Assigning an initial IP-address to each ring switch

To assign IP address you should to use MAC-based Auto-Discovery function from NMP. This function allow you to search MICROSENS switches without IP address assigned or with IP address which doesn't belong to your network (it searches also switches already configured). MAC Discovery Function searches devices only in your broadcast domain. (broadcast domain - The portion of a network that is reachable by a network broadcast)

You can apply new IP address by right mouse click on the device name in the tree view, and choose "IP Settings" from popup menu.
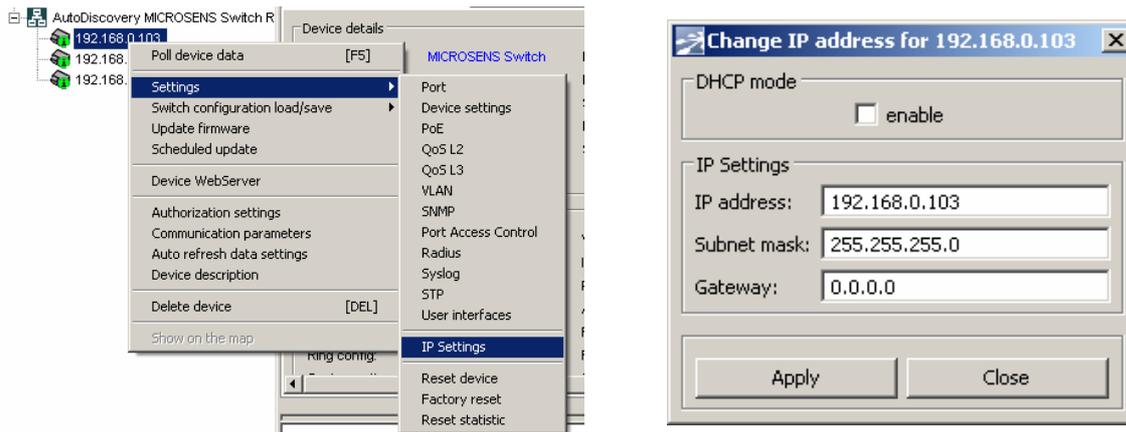
Pressing the 'Apply' button applies the entered values to the current device in configuration mode.

Step 2: Configuring all switches as ring slaves

In order to see all initialized switches in the MICROSENS Network Management Platform, the Auto Discovery process must be started by pressing the corresponding toolbar-button. Now all switches should appear in the device list window. For configuration of the switches, right click on one switch in the device list and choose 'Device settings' from the context menu.
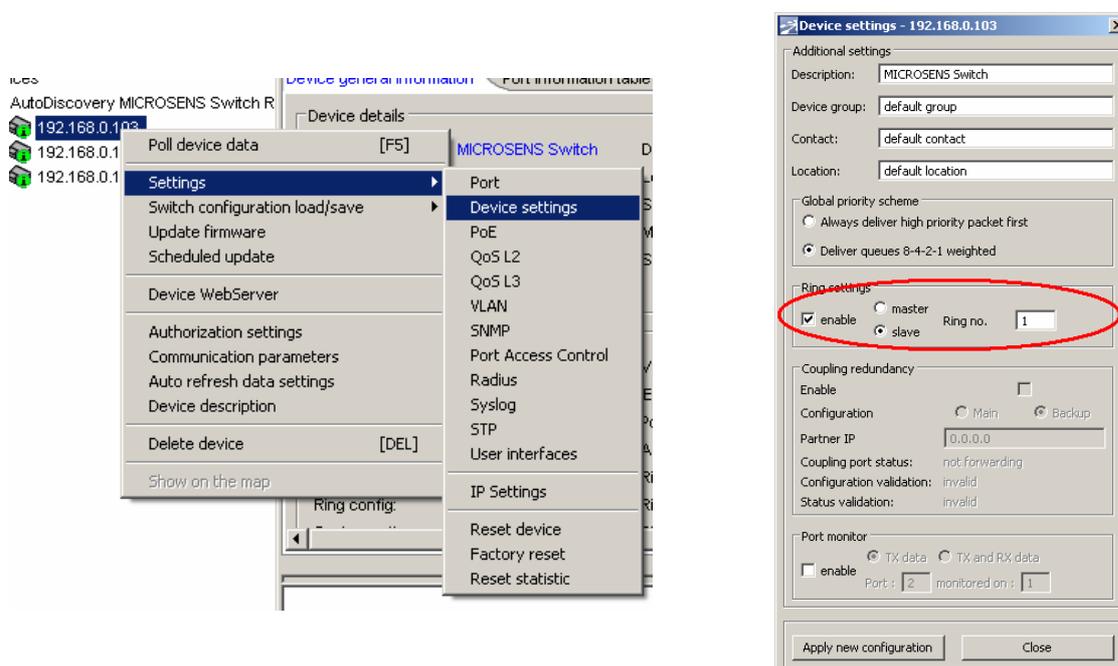
The "Device settings" window has a section for the ring-configuration.
Three values can be set:

- Ring mode enable/disable

  This checkbox activates the ring mode – select 'Enable'

- Ring Master/Ring Slave

  This radio buttons configure the ring mode – select 'Slave'

- Ring Number

  To prevent interference in multi ring environments, each ring must have a unique
   ID-number. Enter '1' or any other number between 0 and 255.

Once these settings are made, they must be applied to all devices in the ring. Choose 'Apply new configuration'. Now all ring switches are set to ring mode with slave functionality.

Step 3: Configuring one switch as ring master
Reopen the "Device settings" window by right click in the device list on the switch that shall be the ring master device and select the 'Master' button in the ring mode window. Now one switch in the ring is configured as master, all others are configured as slaves.
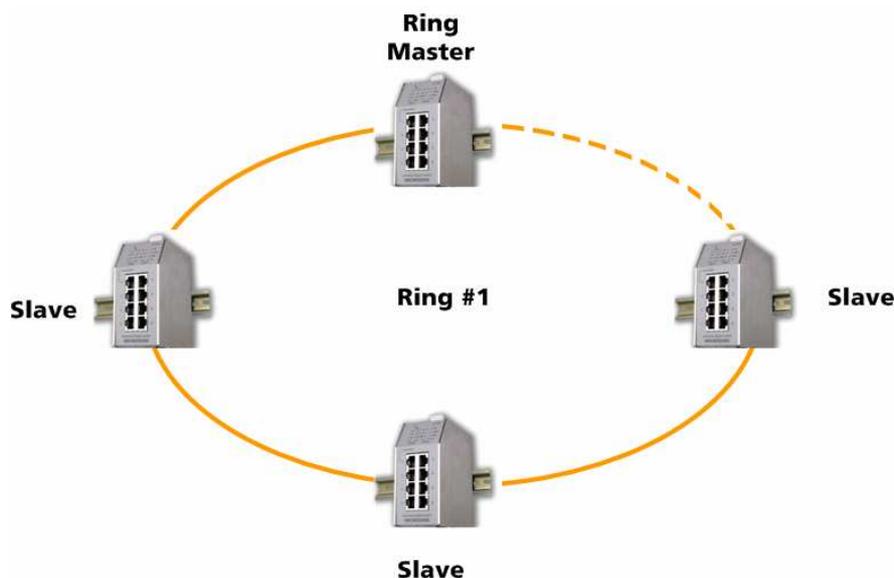
Step 4: Physically close the ring
If all devices are configured correctly, the ring can be closed physically by connecting the segment left open during the configuration cycle.

The ring configuration is now completed. As the ring behaviour works fully automatic, no more interference with the switches during operation is required. Upon a ring failure, the master will reconfigure the ring. When the ring is closed again, the master will automatically fall back into normal operation mode.
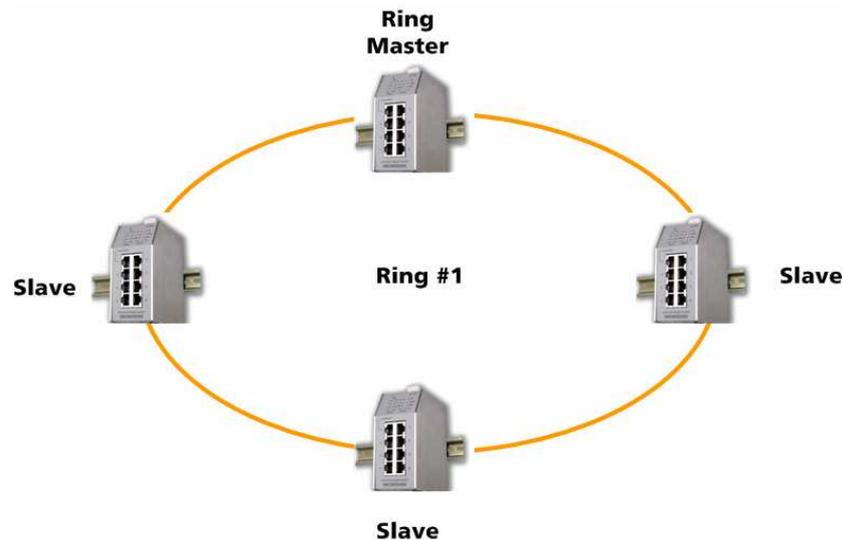
Spanning Tree Protocol

The Spanning Tree Protocol is a network protocol that ensures a loop free topology. Spanning tree allows a network design to include redundant links to provide automatic backup paths if an active link fails, without the danger of bridge loops, or the need for manual enabling/disabling of these backup links. The Rapid Spanning Tree Protocol (RSTP) is an evolution of the Spanning Tree Protocol and provides for faster spanning tree convergence after a topology change.

MICROSENS Gigabit Ethernet Switch support both of these protocols (STP and RSTP), and their configuration is done with the Network Management Platform (NMP). You can configure Spanning Tree Protocols by right mouse click on the device name in the tree view, and choose "STP" from popup menu.

STP and RSTP - main parameters

- **Spanning tree function**: you can choose protocol (STP, RSTP) or disable function

- **Bridge priority**: A value used to identify the root bridge. The bridge with the lowest value has the highest priority and is selected as the root. The value must be a multiple of 4096 according to the protocol standard rule.

- **Bridge hello time**: The time that controls switch sends out the BPDU packet to check RSTP current status. Enter a value between 1 through 10.

- **Bridge max. Age**: The number of seconds a bridge waits without receiving Spanning-tree Protocol configuration messages before attempting a reconfiguration. Enter a value between 6 through 40.

- **Bridge forward delay**: The number of seconds a port waits before changing from its Rapid Spanning-Tree Protocol learning and listening to STP states to the forwarding state. Enter a value between 4 through 30

You can configure path cost and priority of every port.

- **Priority**: you Decide which port should be blocked by priority in LAN. Enter a number 0 through 240. The value of priority must be the multiple of 16

- **Admin path cost:** The cost of the path to the other bridge from this transmitting bridge at the specified port. Enter a number 1 through 200000000

- **Admin point to point**: Some of the rapid state transactions that are possible within RSTP are dependent upon whether the port concerned can only be connected to exactly one other bridge (i.e. it is served by a point-to-point LAN segment), or can be connected to two or more bridges (i.e. it is served by a shared medium LAN segment). This function allows the P2P status of the link to be manipulated administratively. True is P2P enabling. False is P2P disabling.

- **Admin edge port:** The port directly connected to end stations cannot create bridging loop in the network.

Port Access Control

Port-based network access control makes use of the physical access characteristics of IEEE 802 LAN infrastructures in order to provide a means of authenticating and authorizing devices attached to a LAN port that has point-to-point connection characteristics, and of preventing access to that port in cases which the authentication and authorization fails. A port in this context is a single point of attachment to the LAN infrastructure.

MICROSENS Gigabit Ethernet Switch supports Port Access Control, and the configuration is done with the Network Management Platform (NMP). The configuration is possible by right mouse clicking on the device name in the tree view, and choosing "Port Access Control" from popup menu.
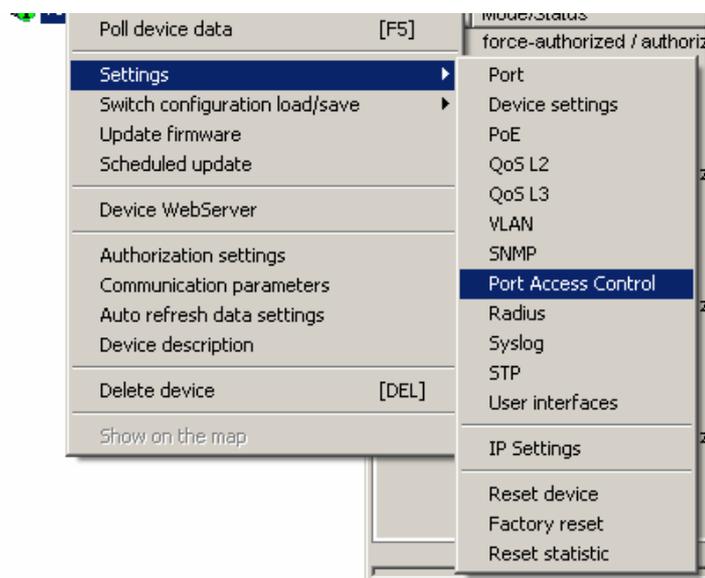
Port Access Control – Basic settings

- **Port access control enabled**: you can enable or disable this function.
- **Mode for unauthorized ports**: Settings mode for unauthorized ports. One of three action can be set: blocking, using default VLAN or sending only notification.

Port Access Control – Port settings

Ports can be in one of five authorization modes.

- **IEEE 802.1x Authentication**: This mode is the normal 802.1X mode. A port sends EAP packets to the supplicant and will not become authorized unless it receives a positive response from the authentication server.
- **Force-authorized:** This mode, is the default mode. In this mode, a port is always authorized and does not require any messages from either the supplicant or the authentication server. Force-authorized mode is used when you do not want to run 802.1X on a particular port. This is typically the case when connecting

to another switch, a router ,or a server, and also when connecting to clients that do not support 802.1X.

- **Force-unauthorized:** This mode prevents a port from becoming authorized even if the user has the appropriate credentials. This mode essentially disables the port from use by any user or device.

- **RADIUS MAC Authentication:** RADIUS protocol is used to MAC Authentication.

- **MAC Locking:** This mode gives possibility to authentication from up to 4 users per port on the basis of the MAC – addresses.

Safety Notes

WARNING: Infrared radiation as used for data transmission within the fiber optic, although invisible to the human eye, can nevertheless cause damage.

To avoid damage to the eyes:

- never look straight into the output of fiber optic components – danger of blinding!
- cover all unused optical connections with caps.
- commission the transmission link only after completing all connections.

The active laser components used with this product comply with the provisions of **Laser Class 1**.

DANGER: Conductive components of power and telecommunications networks can carry dangerously high voltage.

To avoid electric shock:

- Do not carry out installation or maintenance work during lightning storms.
- All electric installations must be carried out in accordance with local regulations.

Order Information

Art.-No.	Description	Connectors
MS650850M	Gigabit Ethernet Switch with ring function 1x 10/100/1000Base-T, 7x 10/100Base-TX, 2x 1000Base-SX, ST multimode 850 nm	4x ST 8x RJ-45 2x Power, 1x Alarm
MS650851M	Gigabit Ethernet Switch with ring function 1x 10/100/1000Base-T, 7x 10/100Base-TX, 2x 1000Base-SX, SC multimode 850 nm	4x SC 8x RJ-45 2x Power, 1x Alarm
MS650852M	Gigabit Ethernet Switch with ring function 1x 10/100/1000Base-T, 7x 10/100Base-TX, 2x 1000Base-LX, SC single mode 1310nm, 10 km	4x SC 8x RJ-45 2x Power, 1x Alarm
MS650861M	Gigabit Ethernet Switch with ring function 1x 10/100/1000Base-T, 7x 10/100Base-TX, 3x 1000Base-SX, SC multimode 850 nm	6x SC 8x RJ-45 2x Power, 1x Alarm
MS650862M	Gigabit Ethernet Switch with ring function 1x 10/100/1000Base-T, 7x 10/100Base-TX, 3x 1000Base-LX, SC single mode 1310nm, 10 km	6x SC 8x RJ-45 2x Power, 1x Alarm

Accessories

Art.-Nr.	Description	Connectors
MS700420	Hat-rail power supply 24 Watt 24 V / 1,0 A, wide range input 85-264 VAC	In: 3-pin Out: 2-pin
MS700421	Hat-rail power supply 60 Watt 24 V / 2,5 A, wide range input 85-264 VAC	In: 3-pin Out: 5-pin
MS700422	Hat-rail power supply 120 Watt 24 V / 5 A, wide range input 85-264 VAC	In: 3-pin Out: 5-pin
MS700430	Hat-rail power supply 60 Watt 48 V / 1,25 A, wide range input 85-264 VAC	In: 3-pin Out: 5-pin
MS700434	DC/DC hat-rail power supply 24 Watt 24 V / 1,0 A, wide range input 18-75 V DC	In: 3-pin Out: 2-pin

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