Industrial Ethernet Training 04

Setting up an O-Ring network structure with Weidmueller switches

Abstract:
Setting up a communication redundancy such as an O-Ring structure in your network helps to protect critical links against network failures and keeps network downtimes at a minimum. Ring redundancy in your network allows you to set up redundant loops and routes resulting in a network with backup data transmission routes in the event of an abrupt failure such as a disconnected or damaged cable. This application note provides an example configuration of an O-Ring structure in your network.

Hardware reference

No.	Component name	Article No.	Hardware / Firmware version
1	IE-Training Kit-01	2881730000	1.1.2 (Build 125086)
2			
3			

IE-Training Kit Content

No.	Component name	Article No.	Hardware / Firmware version
1	IE-SR-4TX	2751270000	1.4.7
2	IE-SW-AL08M-8TX	2682280000	1.08
3	IE-SW-AL05M-5TX	2682250000	1.14
4	IE-CS-MBGW-2TX-1COM	2682600000	3.11

Software reference

No.	Software name	Article No.	Software version
1			
2			
3			

File reference

No.	Name	Description	Version
1			
2			

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https://www.weidmueller.com/countries

Content

1 Warning and Disclaimer

Warning
Controls may fail in unsafe operating conditions, causing uncontrolled operation of the controlled devices. Such hazardous events can result in death and / or serious injury and / or property damage. Therefore, there must be safety equipment provided / electrical safety design or other redundant safety features that are independent from the automation system.

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Security notes
In order to protect equipment, systems, machines and networks against cyber threats, it is necessary to implement (and maintain) a complete state-of-the-art industrial security concept. The customer is responsible for preventing unauthorized access to his equipment, systems, machines and networks. Systems, machines and components should only be connected to the corporate network or the Internet if necessary and appropriate safeguards (such as firewalls and network segmentation) have been taken.

2 Prerequisites for doing

You need to have the following hard- and software and documentation

- Industrial Ethernet Training Kit
- Application Note Industrial Ethernet Training 01 “Setting up default configuration of IE Training Kit” for applying default IP address configuration

3 Why and when O-Ring?

Per default, Weidmüller switches do not have a redundancy protocol activated, meaning that in the event of a component failure, the network would have a significant downtime which can be severe in the production line. Therefore, Weidmüller implemented several redundancy protocols (O-Ring, RSTP/MSTP, O-Chain and MRP).
All these redundancy protocols allow the user to build redundant topologies and therefore implement robust networks with more than one path between all elements to avoid that a failure in a link or in an element provokes a loss of communication.
It is important to know/understand the differences between these protocols to properly use them depending on the scenario and requirements that we may find.

- O-Ring is the protocol with fastest recovery time and will be described in this application note. It is always recommended to use because of its simplicity and good performance. But it only works in ring topologies and if all the switches are Weidmüller branded (Advanced / Substation Line).

- Rapid Spanning Tree and Multiple Spanning Tree (RSTP/MSTP) are standard protocols and therefore can be used to create redundant networks using switches of several brands. The other condition that may force us to use RSTP is when the topology is not a ring (e.g.: tree or mesh). If any of these two conditions apply, we will use RSTP/MSTP. It has to be considered that in RSTP/MSTP the recovery time is worse than in O-Ring. The only difference between RSTP and MSTP is that MSTP should be used when, besides the redundancy, also Virtual Local Area Networks (VLANs) are configured in the switches.

- O-Chain is also a proprietary protocol (described in Application Note 05 O-Chain) specifically designed to easily connect several Weidmüller switches to any existing network or topology in a redundant way.

- Media Redundancy Protocol (MRP) is a standard protocol, that can be used in ring topologies as well. It is not proprietary (as O-Ring) and therefore can be used to create rings with Weidmüller switches and different brands that also support MRP. The recovery time of MRP is not as good as in O-Ring, but better than in RSTP/MSTP. The maximum number of elements allowed in the ring is smaller than in O-Ring. It is important to note that only Weidmüller Full Gigabit Switches of Advanced / Substation Line support MRP protocol and that only the MRP-Client function is supported. Therefore, there should be at least one device of another brand in the ring, acting as MRP-Manager.

Focusing now on O-Ring redundancy, we can see that every switch has an ingoing and outgoing port for all the data traffic, working in a unidirectional manner. This means, that data is only transmitted in one direction through the ring, with one backup line which is blocked until a malfunction occurs. Our backup route gets activated within a few milliseconds after failure and allows network traffic to flow normally. The following picture shows a possible O-Ring protocol constellation working and then showing the functionality of the backup line in the event of a broken line.

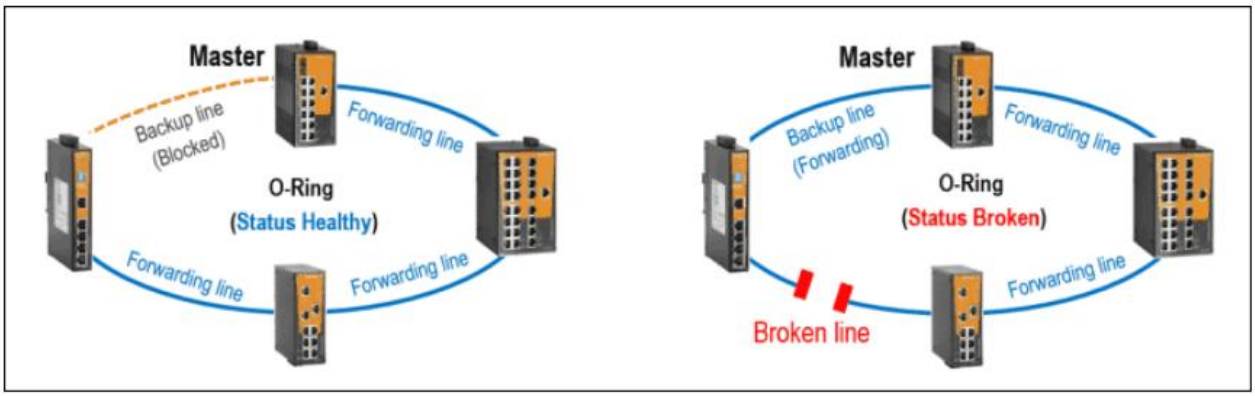

Figure 1: Example constellation of O-Ring topology

4 Configuration of O-Ring

Since our Training Kit provides three switches, we will use only these as an example for a configuration of O-Ring redundancy. First of all, please disconnect all cables and **only** connect your computer via Ethernet cable to your 8-port managed switch or connect to any of your router's LAN ports and then connect the router to the switch. Furthermore, connect the two 5-port switches on the Training Kit in a chain topology to the 8-port switch, one by one. By that, we do not have any interference or traffic collisions when having two simultaneous connections.

1. After connecting all cables properly, go to the 8-port switch's web interface. Make sure your setup, including computer and possibly router, are in the same network and then connect to the web interface with the IP *192.168.1.20* by typing it into the browser's URL field and logging in with the default credentials.

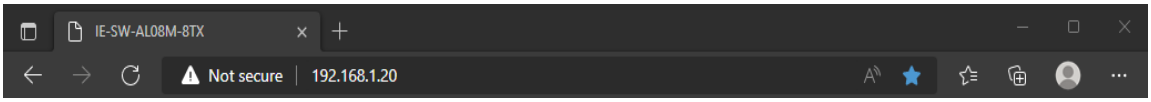

Figure 2: Connecting to switch web interface

2. For the configuration settings, we navigate the menu tree to "*Redundancy*" and then select the option "*O-Ring*". First, enable the ring redundancy protocol by selecting "*Enabled*" in the drop-down menu "*Ring Redundancy*" and set the switch as "*Ring Master*" by clicking the checkbox. Then, we select the port in which the left 5-port switch is connected to as the 1st ring port in the drop-down menu (in our case: Port 02).
   Besides, select the 2nd ring port in which we will connect the third switch to have a ring between the devices (note: do not connect the switches physically yet, as you will not be able to connect to the third switch on the right due to two simultaneous connections). You should see the status displaying "*Broken*".

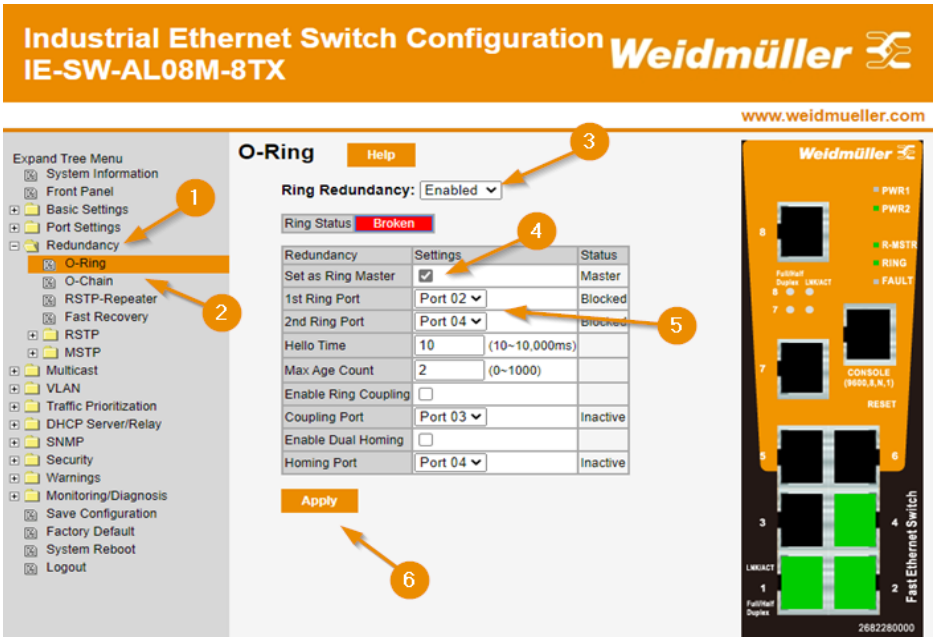

Figure 3: O-Ring settings 8-port switch

4.1 Configuration of 5-port switches

1. The next devices in the topology are the 5-port switches next to our 8-port managed switch. We repeat the procedure explained beforehand by typing in *192.168.1.30* or *192.168.1.40* in the URL field.

2. Next, we once again navigate the menu tree, as we did in the 8-port switch, to "*Redundancy*" and then "*O-Ring*". Subsequently, we repeat once again the steps from before but considering that the 5-port switches will not have the role of Ring Master as we have already given this role to the 8-port switch and only one master is required. So, activate the ring redundancy and then choose the two ports where the according switch is connected to the 8-port and to the 5-port switch (in our case: Ports 01 and 02) and hit *Apply*. Note that the status remains "*Broken*".

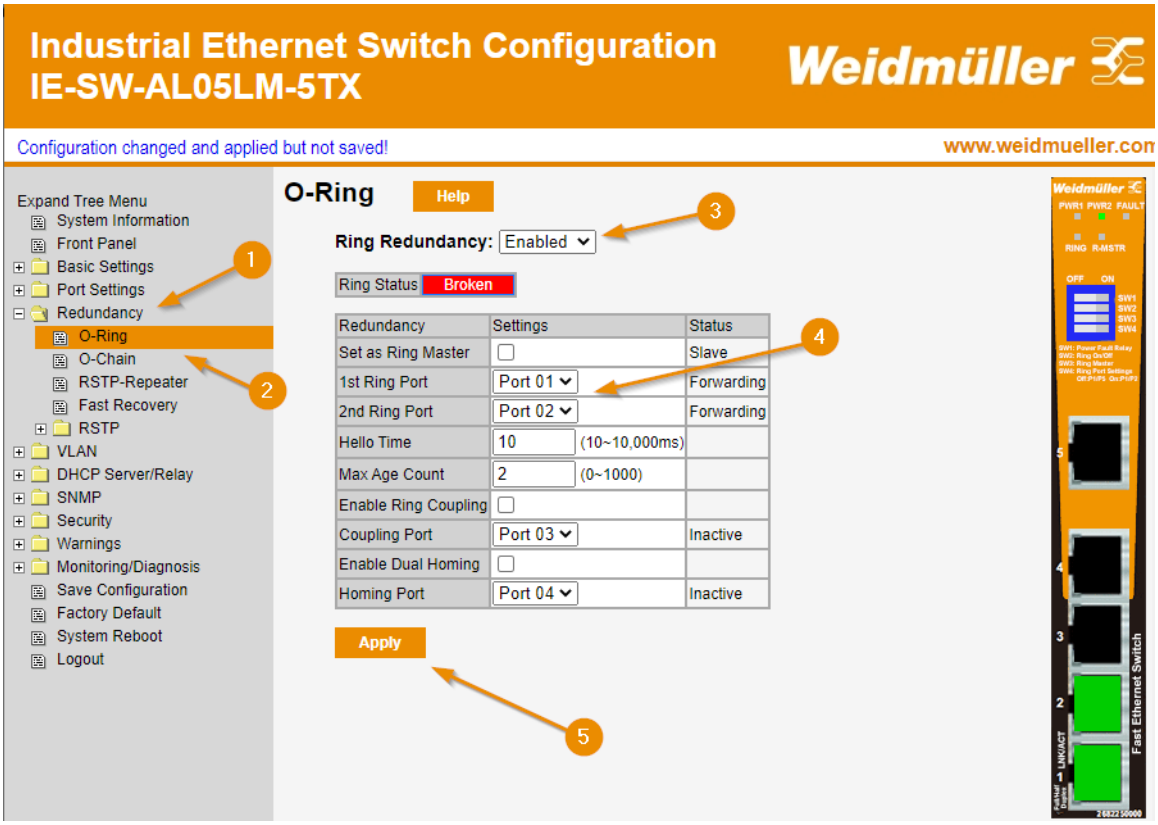

Figure 4: O-Ring configuration 5-port switches

*Repeat this procedure step by step for **both 5-port** switches on the Training Kit.*

4.2 Connecting switches physically

As mentioned before, we do not connect the last cable yet as to avoid traffic collisions. Having the O-Ring configured properly, the switches are now able to detect the two identical routes and manage our connection from the 8-port switch to the right switch on the board as the backup route as depicted in the pictures at the beginning.
Therefore, connect the cable to finish the O-Ring redundancy protocol for the network.
Finally, check the Ring status of the switches to ensure that the O-Ring configuration is working properly. If everything is working accordingly, save the configuration in the switches to ensure a working operation even after a possible reboot of the device.

1. On the switch's web interface, navigate to Save Configuration and press "*Save*".

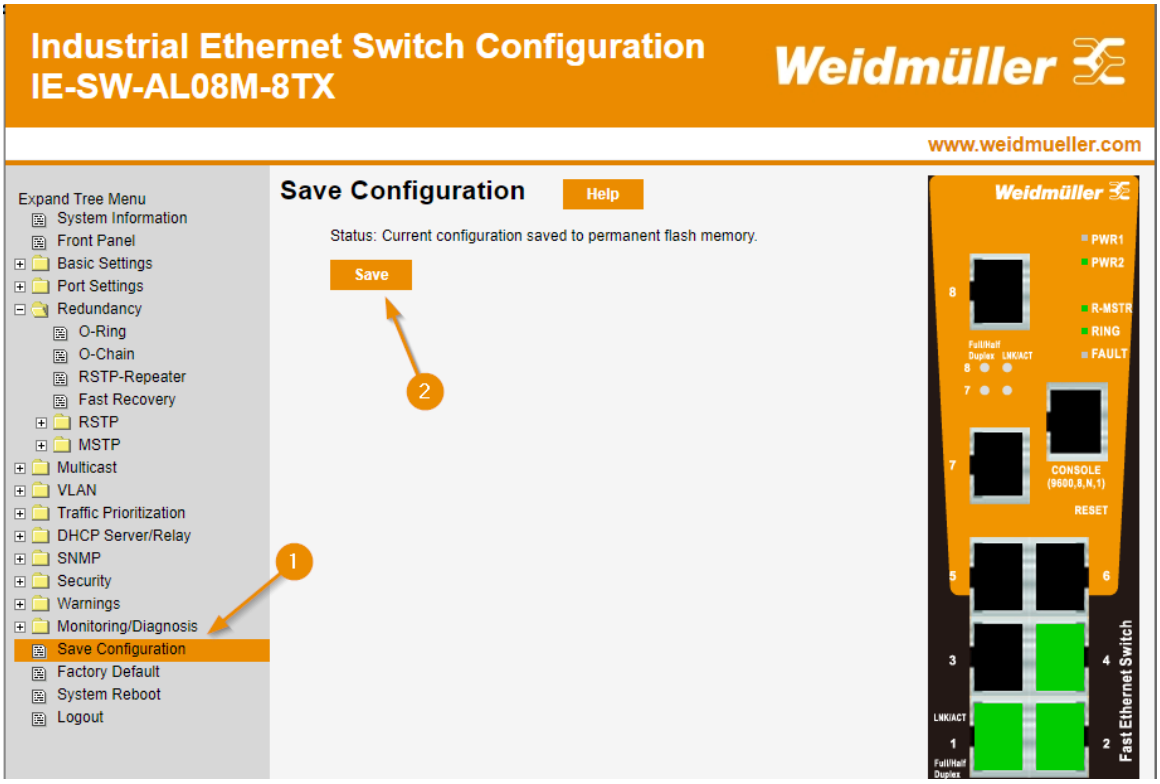

Figure 5: Saving configuration

2. The ring status can be checked either in the System Information panel or O-Ring redundancy settings.

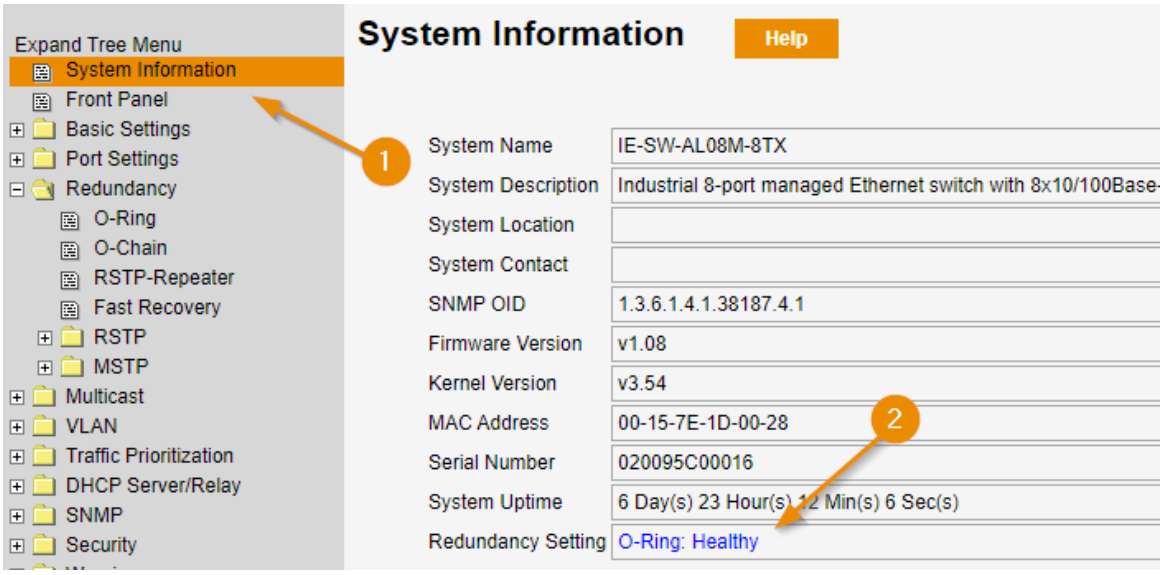

Figure 6: O-Ring Status System Information panel

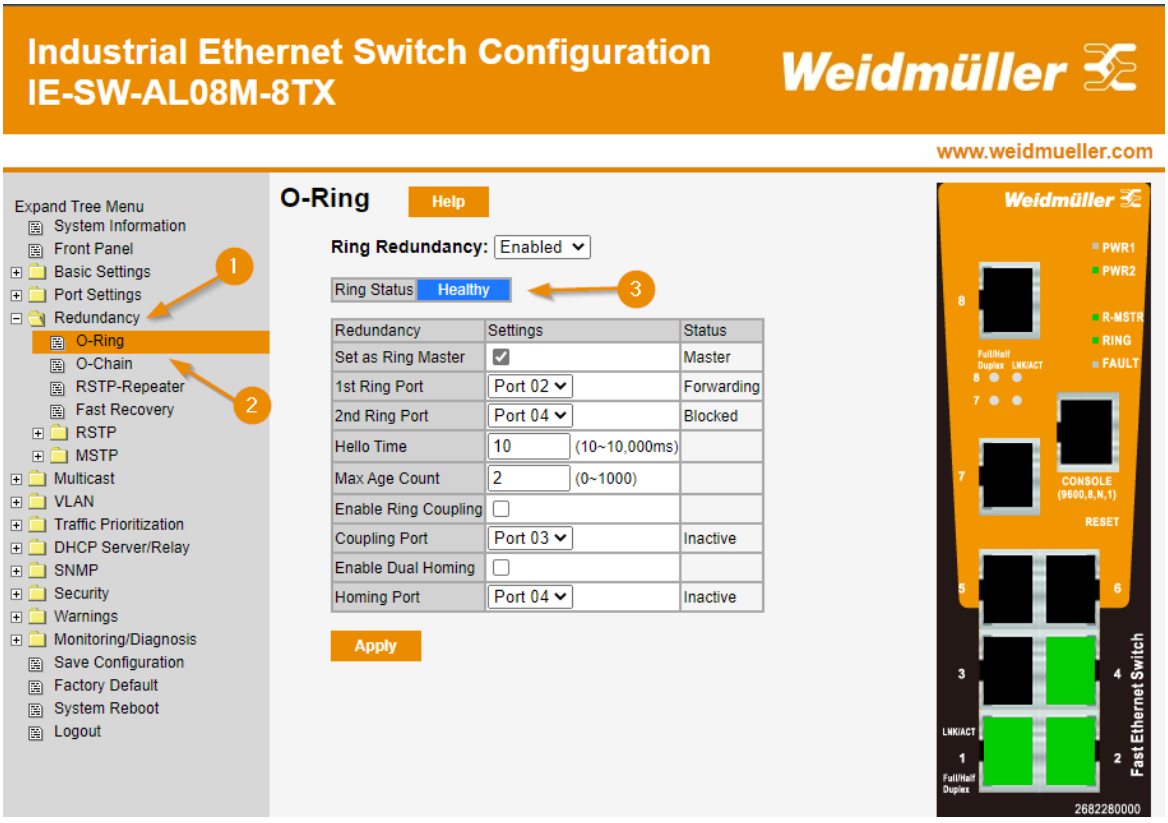

Figure 7: O-Ring status in settings

5 Results

We have now successfully setup the O-Ring redundancy feature of our switches to ensure a steady and stable data transmission with backup routes in case of a failure. Furthermore, we know how to configure the Ring Master and check upon the redundancy protocol status of the switches. Moreover, the importance for a redundant network is apparent to ensure a secure operation.