Weidmüller ⊃⊂

Industrial Ethernet Training 16

Introduction to IPv6

Abstract:
IPv6 is the newer version of IPv4, with it being a 128-bit long hexadecimal address, meaning it provides a much larger address space than its predecessor. With more and more devices connected to the internet, this is an essential upgrade to prevent the exhaustion of the maximum amount of IPv4 addresses. This application note explains the usage of IPv6 on Weidmueller device's and how to define IPv6 networks.

Weidmüller ⊃⊂

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			

Contact

Weidmüller Interface GmbH & Co. KG
Klingenbergstraße 26
32758 Detmold, Germany
www.weidmueller.com

For any further support please contact your local sales representative:
https://www.weidmueller.com/countries

Content

Weidmüller 🗲 3

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.

Disclaimer
This Application Note / Quick Start Guide / Example Program does not relieve you of the obligation to handle it safely during use, installation, operation and maintenance. Each user is responsible for the correct operation of his control system. By using this Application Note / Quick Start Guide / Example Program prepared by Weidmüller, you accept that Weidmüller cannot be held liable for any damage to property and / or personal injury that may occur because of the use.

Note
The given descriptions and examples do not represent any customer-specific solutions, they are simply intended to help for typical tasks. The user is responsible for the proper operation of the described products. Application notes / Quick Start Guides / Example Programs are not binding and do not claim to be complete in terms of configuration as well as any contingencies. By using this Application Note / Quick Start Guide / Example Program, you acknowledge that we cannot be held liable for any damages beyond the described liability regime. We reserve the right to make changes to this application note / quick start guide / example at any time without notice. In case of discrepancies between the proposals Application Notes / Quick Start Guides / Program Examples and other Weidmüller publications, like manuals, such contents have always more priority to the examples. We assume no liability for the information contained in this document. Our liability, for whatever legal reason, for damages caused using the examples, instructions, programs, project planning and performance data, etc. described in this Application Note / Quick Start Guide / Example is excluded.

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 hardware 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 is IPv6 important?

The IPv6 protocol is the successor of the IPv4 protocol. IPv6 was started in 1998 because of the limited amount of IPv4 addresses. Nowadays roughly 38% of internet traffic is using IPv6. It is very important to know that IPv4 and IPv6 are totally incompatible to each other. This means, that one cannot use IPv4 devices with IPv6 and vice versa without special translation hardware. It is possible though to run IPv4 and IPv6 at the same time. This is called dual stack support (IPv4 and IPv6). Most of the office and consumer IT operate in dual stack support.

4 What is a IPv6 address?

There are differences in IPv4 and IPv6 addresses. These differences are going to be shown in this chapter.

	IPv4	IPv6
Standard release	1981	1998
IP address format	192.168.1.10	2001:0db8:0000:08d3:0000:8a2e:0070:7344
Number of IP addresses	2^{32} = 4,294,967,296	$3.4 \cdot 10^{38}$ = 340,282,366,920,938,000,000,000,000,000,000,000,000

Table 1: Differences between IPv4 and IPv6

We can see our computer is operating in dual stack support since it has an IPv4 and IPv6 address. This allows hosts and users to simultaneously reach IPv4 and IPv6 content meaning it is more flexible in terms of compatibility.
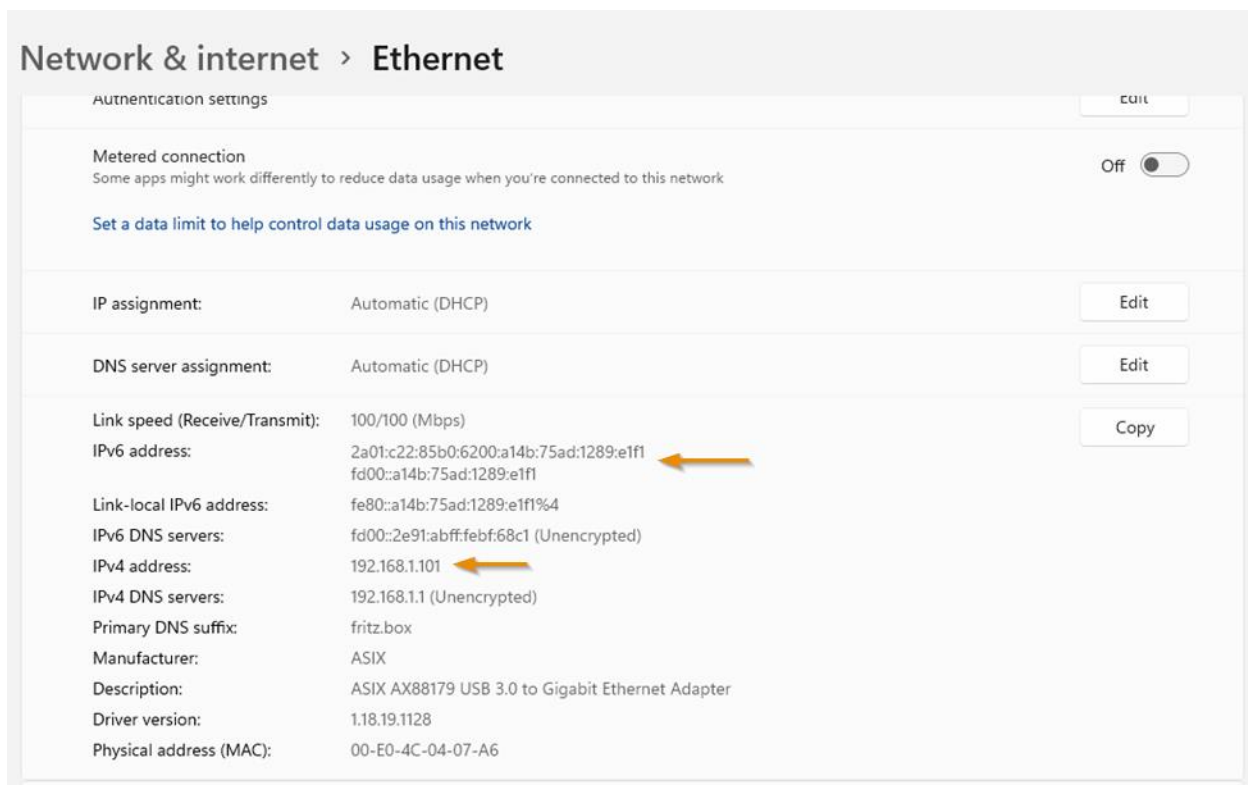

Figure 1: Windows 11 dual stack operation

Besides, a more detailed view can be found on the specific network interface. Select the network interface in the "*Network Connections*" menu and click on "*Details…*".
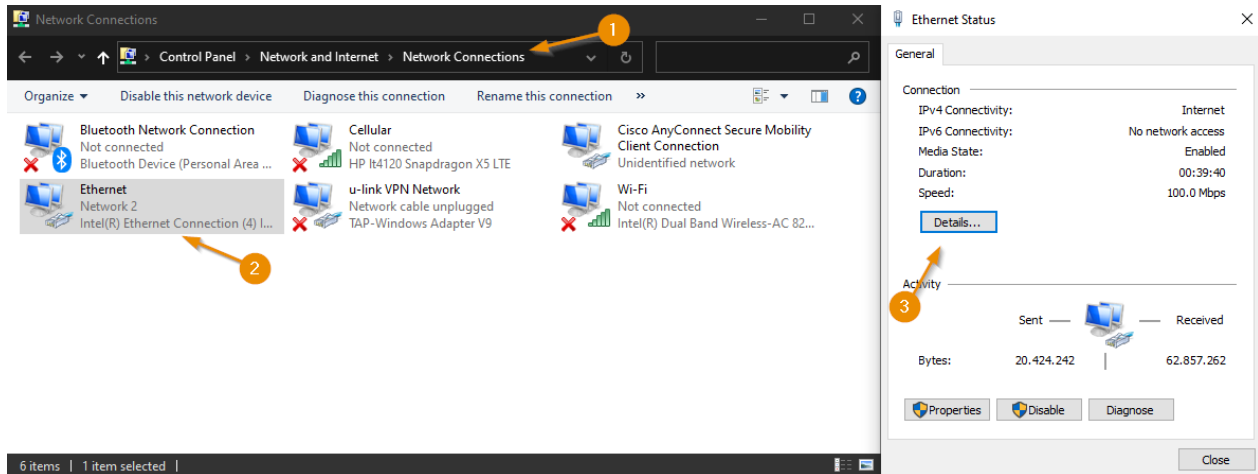

Figure 2: Checking network details

Afterwards, the following window opens showing a more advanced view of the network configuration on the specific interface.
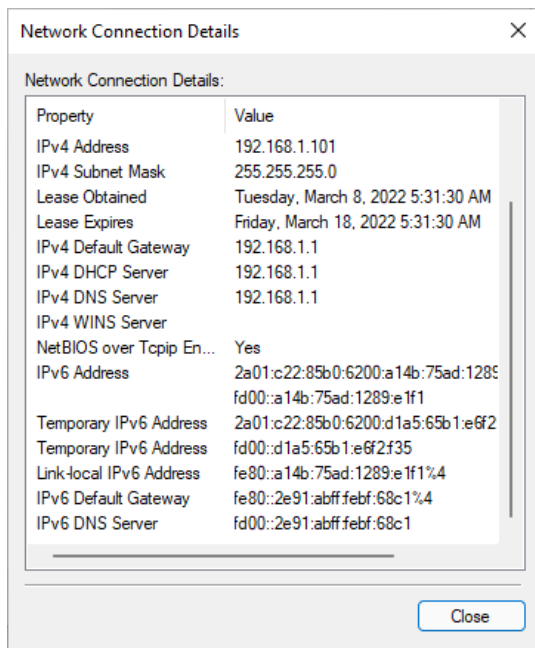

Figure 3: Network Connection details

There are different kinds of IPv6 Addresses with different usages that can be seen in the table beneath.

Windows 10/11 names	IP address	Usage
IPv6 Address	2a01:c22:85b0:6200:a14b:75ad:1289:e1f1	Global Unicast Usage of MAC address Valid inside the Internet
IPv6 Address	fd00::a14b:75ad:1289:e1f1	Unique local address Usage of MAC address Valid inside a private network
Temporary IPv6 Address	2a01:c22:85b0:6200:d1a5:65b1:e6f2:f35	Global Unicast Randomly generated for privacy Valid inside the Internet
Temporary IPv6 Address	fd00::d1a5:65b1:e6f2:f35	Unique local address Randomly generated for privacy Valid inside a private network
Local IPv6 Address	fe80::a14b:75ad:1289:e1f1%4	Link-local address Automatic IP address setting. Usage of MAC address ZoneID "%4" = Valid for Device 4 (Windows internal counter) Valid only a one network segment without routers

Table 2: Usages of different IPv6 addresses

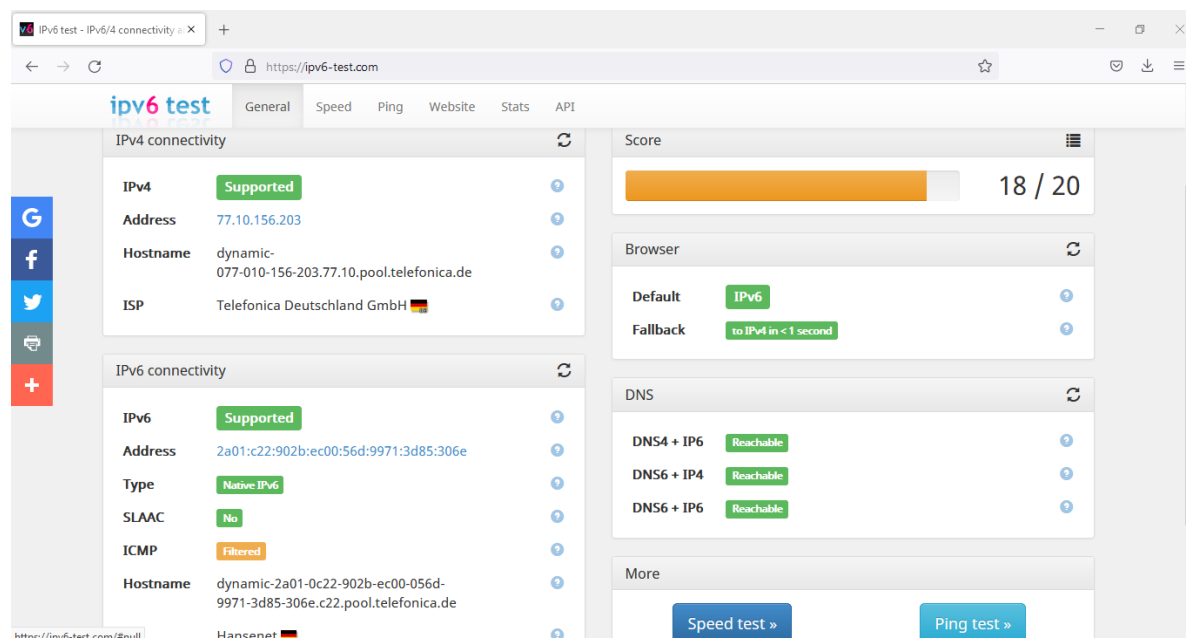To check if your internet connection already supports IPv6 you can use several websites, such as the following https://ipv6-test.com.

Figure 4: IPv6 compatibility test

5 Windows Basic Setup

In this chapter we are going to connect to the IE-SW-AL08M-8TX switch via IPv6. To do this we first need to find out which IPv6 address the switch uses. To do this please connect your PC to the LAN port of the switch with an Ethernet cable.

1. Plug the Ethernet cable into your PC
2. Check if the Ethernet interface has a IPv6 link local address, which can be found in the Windows' "*Networks Settings*"
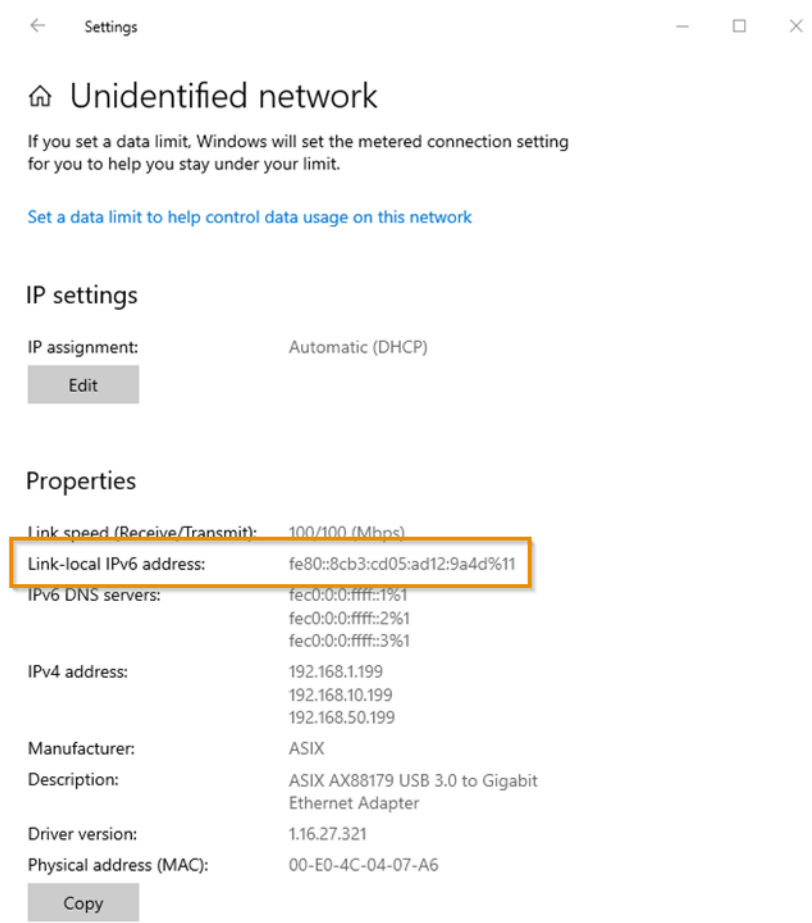

Figure 5: Link local IPv6 address

> **Hint: If you can't find a IPv6 address, IPv6 is most likely deactivated by your company IT or your computer does not support IPv6, which can be tested with the website we mentioned beforehand.**

3. To find out the IPv6 address you must use IPv4 to connect to the device. For the "IE-SW-AL08M-8TX" switch open a web browser and type in the URL http://192.168.1.20. Navigate to "*IPv6 Setting*" and read the IPv6 link-local address "*fe80::215:7eff:fe1d:28*". Usually, this address is generated from the device MAC address, so this means for every device this IP-address is different and unique.
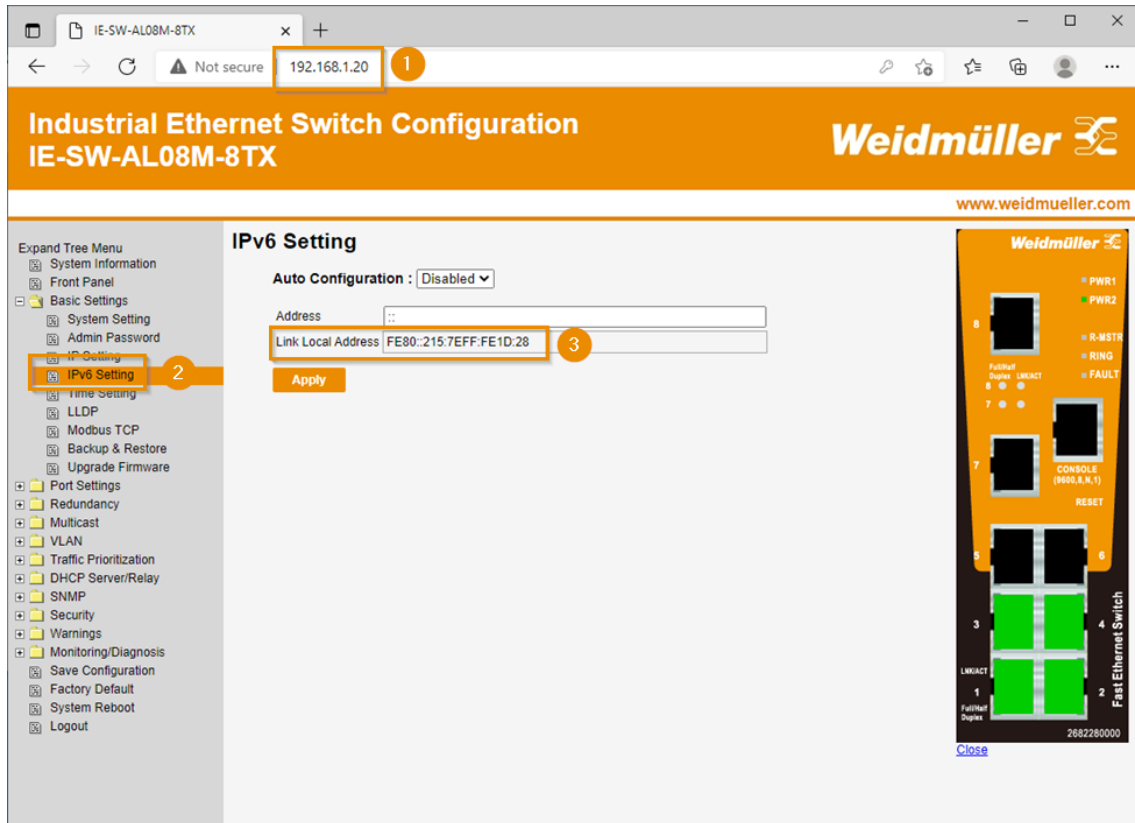

Figure 6: locating the switches link local Address

4. With the link-local address, we can access the switch the same way we did with IPv4. Therefore, put the IPv6 address from the "*Link Local Address*" field into the browser's URL field but we have to put it in square brackets, like the following example: *"[fe80::215:7eff:fe1d:28]"*.
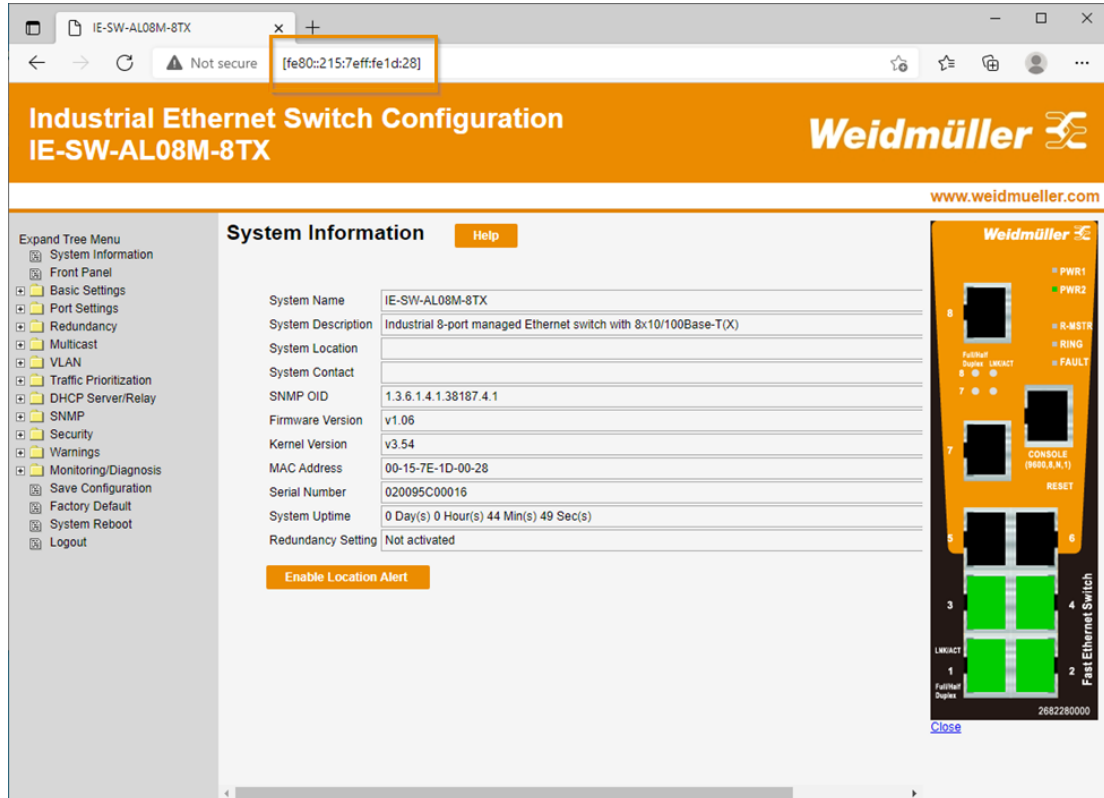

Figure 7: Connecting to the switch via IPv6 Link Local Address

6 Set IPv6 address manually

In this example, we are manually assigning an IPv6 address to the device and to the computer with unique local addresses (ULA). The address is defined by fc00: /7 (addresses from fc00… to fdff…). The "/7" means the prefix length and defines the maximum possible network length. By adjusting the prefix length, we can decide how many IP address are available in the network. For example, the prefix length of 124 would allow the network to have 16 different IP addresses in total (see marked area below). You can also learn about the prefix length and subnet masks using an online subnet mask calculator.

```
2001:0db8:0126:0000:0000:0000:0000:0000            Amount of IP addresses
      |||| |||| |||| |||| |||| |||| ||||
      |||| |||| |||| |||| |||| |||| |||128 ------------------------------------ 1
      |||| |||| |||| |||| |||| |||| ||124 ------------------------------------ 16
      |||| |||| |||| |||| |||| |||| ||120 ----------------------------------- 256
      |||| |||| |||| |||| |||| |||| 116 ------------------------------------ 4 096
      |||| |||| |||| |||| |||| |||112 ------------------------------------ 65 536
      |||| |||| |||| |||| |||| ||108 ------------------------------------ 1 048 576
      |||| |||| |||| |||| |||| |104 ------------------------------------ 16 777 216
      |||| |||| |||| |||| |||| 100 ------------------------------------ 268 435 456
      |||| |||| |||| |||| |||96 ------------------------------------ 4 294 967 296
      |||| |||| |||| |||| ||92 ------------------------------------ 68 719 476 736
      |||| |||| |||| |||| |88 ------------------------------------ 1 099 511 627 776
      |||| |||| |||| |||| 84 ------------------------------------ 17 592 186 044 416
      |||| |||| |||| |||80 ------------------------------------ 281 474 976 710 656
      |||| |||| |||| ||76 ------------------------------------ 4 503 599 627 370 500
      |||| |||| |||| |72 ------------------------------------ 72 057 594 037 927 900
      |||| |||| |||| 68 ------------------------------------ 1 152 921 504 606 850 000
      |||| |||| |||64 ------------------------------------ 18 446 744 073 709 600 000
      |||| |||| ||60 ------------------------------------ 295 147 905 179 353 000 000
      |||| |||| |56 ------------------------------------ 4 722 366 482 869 650 000 000
      |||| |||| 52 ------------------------------------ 75 557 863 725 914 300 000 000
      |||| |||48 ------------------------------------ 1 208 925 819 614 630 000 000 000
      |||| ||44 ------------------------------------ 19 342 813 113 834 100 000 000 000
      |||| |40 ------------------------------------ 309 485 009 821 345 000 000 000 000
      |||| 36 ------------------------------------ 4 951 760 157 141 520 000 000 000 000
      |||32 ------------------------------------ 79 228 162 514 264 300 000 000 000 000
      ||28 ------------------------------------ 1 267 650 600 228 230 000 000 000 000 000
      |24 ------------------------------------ 20 282 409 603 651 700 000 000 000 000 000
      20 ------------------------------------ 324 518 553 658 427 000 000 000 000 000 000
```

Figure 8: IPv6 subnet table

In this example, we want to define a network "*fd00: :*" with the prefix length "*/124*". This means, that we have in total 16 IP addresses from "fd00:0000:0000:0000:0000:0000:0000:0000" to "fd00:0000:0000:0000:0000:0000:0000:000f". To avoid the repetition of the zeros in the address, it can be shortened with "*: :*" in between like the following IPv6 address assignment: "*fd00::1*" (this is the first available IP address in the defined network)

Introduction to IPv6

To set up the IPv6 address manually for the computer, navigate to the Network adapter options and edit the IP settings on the corresponding network interface as follows. This can be done on either Windows 10 or Windows 11; both are depicted below.

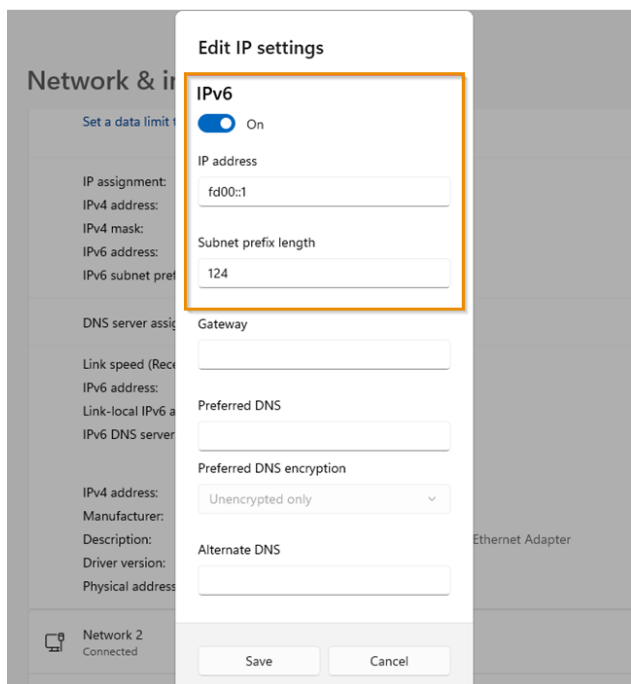1. Set the IP-address to "*fd00::1*" with the prefix length 124 on the computer.
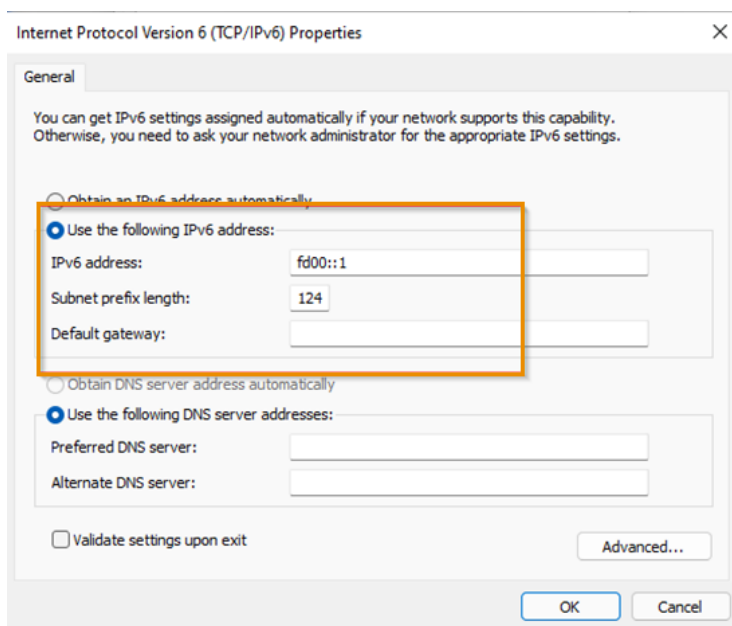

Figure 9: Windows 11 IPv6 Settings

Figure 10: Windows 10 IPv6 Settings

2. Next, set the IPv6-address "*fd002: :2*" in the IPv6 Settings of the switch. To do this, we first have to navigate to the menu "*Basic Settings*" and open "*IPv6 Setting*". Then, disable "*Auto Configuration*" and enter "*FD00::2*" in the "*Address*" field. This is the next possible IP address in our defined network. For comparison, an IPv4 address of "*192.168.1.1*" and "*192.168.1.2*" work the same way. Lastly, press "*Apply*".
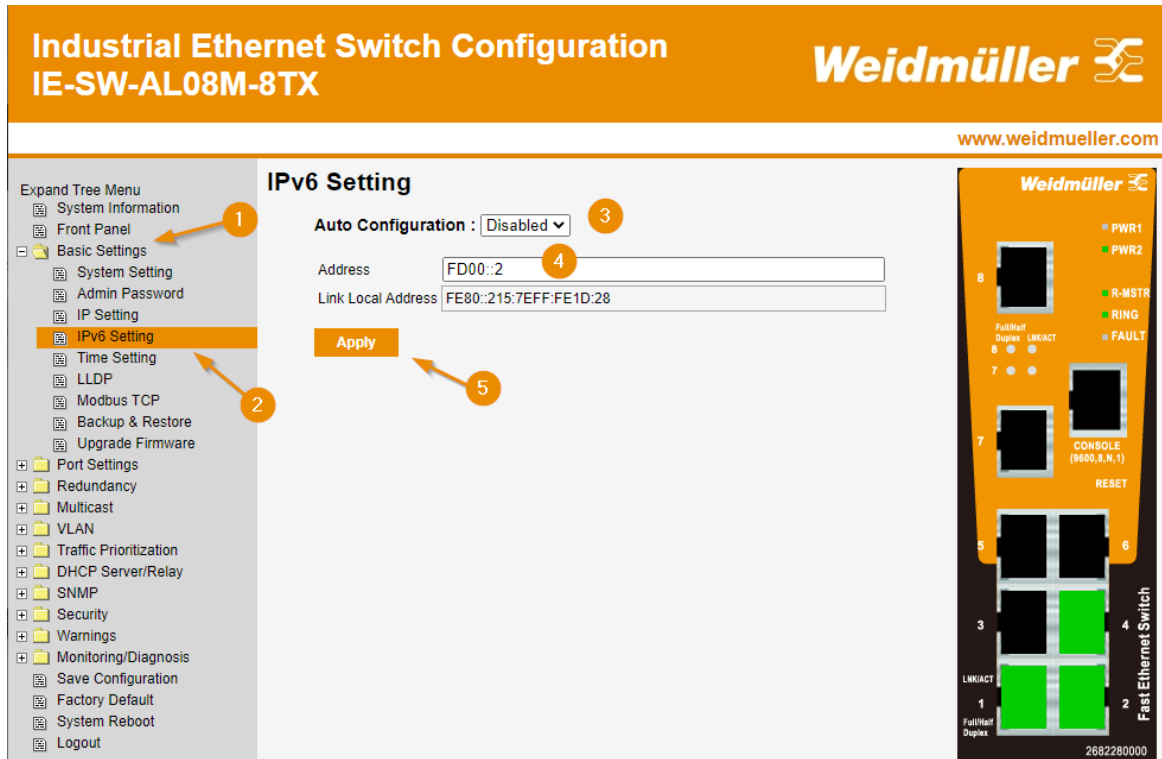
Figure 11: IPv6 Settings inside of the switch

3. Afterwards, the device asks to reconnect to http://[FD00::2]. Hit the "*OK*" button to connect.
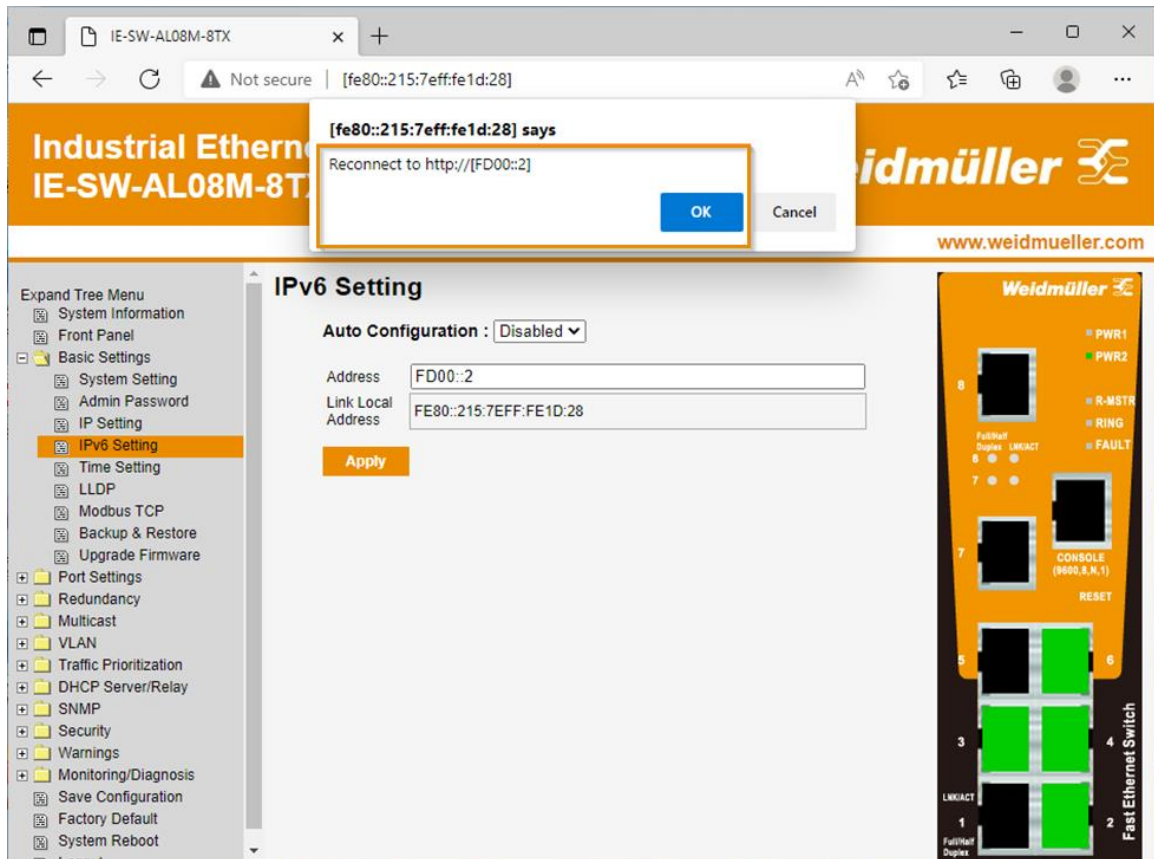
Figure 12: Reconnecting to the switch via IPv6

4. Now, we are connected with the switch via the IPv6 address *"http://[FD00::2]"*.
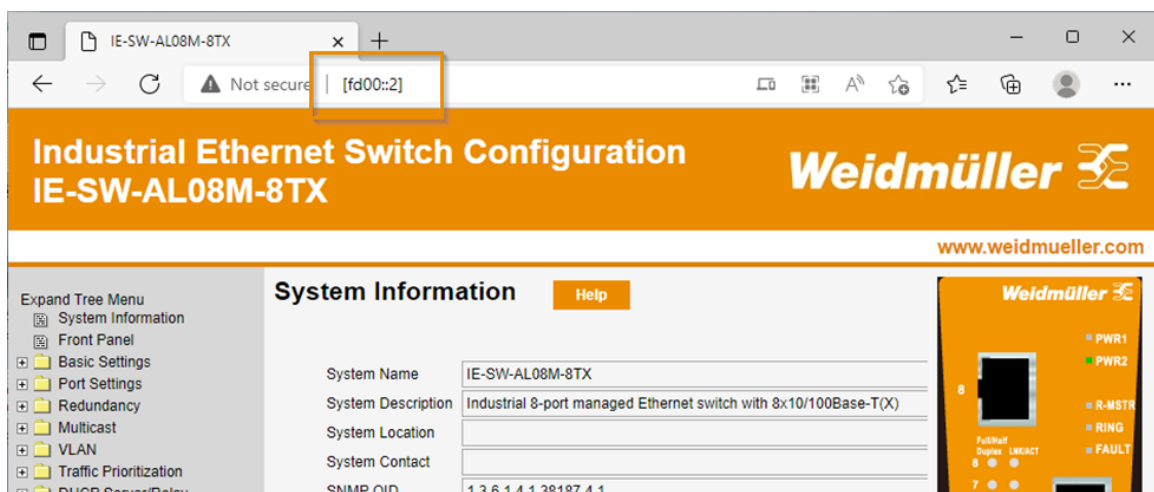
Figure 13: Connection to the switch via IPv6

7 Results

In this Application Note we have learned what an IPv6 address is, how it works and what differentiates it from IPv4 addresses with the possible advantages it has. Also, we have learned how to change from an IPv4 address to a IPv6 address, how to define an IPv6 network the same way we did with IPv4 beforehand and we further can connect to the web interface via the IPv6 address making the IP address future proof to IPv4.

8 List of figures

9 List of tables