# USB-SPEmodul1 (T1L)

# System manual

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# Table of Contents

**1 Introduction ..... 6**
1.1 How to use this manual? ..... 6
1.2 Definitions ..... 7
1.2.1 Terms ..... 7
1.2.2 Safety instructions and warnings ..... 7

**2 Product Description ..... 8**
2.1 Intended use ..... 8
2.2 Product identification ..... 8
2.3 Product overview and interfaces ..... 10
2.4 Assembly/Disassembly and Installation ..... 11
2.4.1 Assembly instruction ..... 11
2.4.2 Installation ..... 11
2.5 Repair, Decommissioning and Disposal ..... 11
2.6 Technical data ..... 12

**3 Getting Started ..... 13**
3.1 System requirements ..... 13
3.2 Installation under Windows ..... 13
3.3 Installation under Linux ..... 15
3.3.1 Linux Kernel Version 6.1(LTS) ..... 16
3.3.1.1 Requirements ..... 16
3.3.1.2 Installation ..... 16
3.3.1.3 Update ..... 16
3.3.2 Linux Kernel Version 6.6 (LTS) ..... 16
3.3.3 Linux Kernel Version 6.9 and above ..... 16
3.4 Application hints ..... 17
3.4.1 Configure a static IP address ..... 17
3.4.1.1 Windows ..... 17
3.4.1.2 Linux ..... 17
3.4.2 Determine the MAC address ..... 17
3.5 Tools ..... 17

**Index ..... 18**

# List of Tables

Table 1: Overview of relevant manuals for the USB-SPEmodul1 (T1L) ..... 6
Table 2: Device Label description ..... 8
Table 3: Overview of device variants ..... 9
Table 4: Technical data ..... 12

# List of Figures

Figure 1: Device label ..... 8
Figure 2: Label on device back-side ..... 8
Figure 3: Side view of device (SPE interface connectors) ..... 10
Figure 4: Top view of device ..... 10
Figure 5: Device Manager after first connect ..... 13
Figure 6: Update Drivers – manually installation ..... 14
Figure 7: Update Drivers – browse location ..... 14
Figure 8: Update Drivers – successful ..... 15
Figure 9: Device Manager – check installation ..... 15

# 1 Introduction

Thank you for choosing the SYS TEC USB-SPEmodul1 (T1L). This manual guide you to unlocking the technical capabilities of our Single Pair Ethernet (SPE) adapter. This product provides an innovative interface, bridging USB 2.0 to Single Pair Ethernet networks.

Please take some time to read through this manual carefully. It contains important information about the commissioning and configurating of the USB-SPEmodul1 (T1L) to get the full potential of this adapter. It will assist you in getting familiar with the functional range and usage of this adapter, specifically designed to support the 10BASE-T1L SPE standard connect through an IEC 63171-2 compatible connector or a classic screw connector.

For more information, optional products, updates et cetera, we recommend you to visit our website: https://www.systec-electronic.com. The content of this website is updated periodically and provides you with downloads of the latest software releases and manual versions.

## 1.1 How to use this manual?

The document describes the product USB-SPEmodul1 (T1L) as well as the basic procedures for integration in your system. Table 1 lists up all relevant chapters and manuals for the USB-SPEmodul1 (T1L).

Table 1: Overview of relevant manuals for the USB-SPEmodul1 (T1L)

| **Information about…** | **In which chapter?** |
|---|---|
| About the device and product variants | See chapter 2.2 |
| About the indented use of the product | See chapter 2.1 |
| An overview about the interfaces (connectors) | See chapter 2.3 |
| All the things that need to be taken into account during assembly/disassembly and installation | See chapter 2.4 |
| Detailed technical data | See chapter 2.6 |
| Some things to consider when using it | See chapter 3 |
| How to uses the terms, safety instructions and warnings | See chapter 1.2 |

## 1.2 Definitions

### 1.2.1 Terms

This product may only be operated by personnel qualified for the specific task in accordance with the corresponding documentation for this specific task. This relates to its warning notices and safety instructions. Qualified personnel are those who, when working with these products, can identify risks and avoiding potential hazards

### 1.2.2 Safety instructions and warnings

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. These notices shown below are graded according to the degree of danger.

**DANGER**

**Danger signs warn for potential life-threatening situations. There may be occur damage not only to the device and its surroundings, but also to the operating personnel. Do under no circumstance ignore these warnings!**

**WARNING**

**Warnings show, when certain situation could damage the device or its surroundings. Make sure to always follow the instruction, to not harm any parts of the hardware.**

**NOTICE**

**Notices describe, which things could inflict potentially harmful things to the device. There is no imminent danger to personnel or the surrounding hardware, but the functionality of the device could be permanently impaired.**

# 2 Product Description

## 2.1 Intended use

The device is intended to use as an USB-adapter to a Single Pair Ethernet network in an industrial environment. The device thus makes the new Single Pair Ethernet standard available for devices with a USB interface. In this way, sensors can be connected over very long distances (1000m) or an existing twisted pair cable can be used to transmit Ethernet messages.

The device is not intended to use in an explosive atmosphere, or in a safety relevant environment. The device does not support Power-over-data-line (PoDL).

## 2.2 Product identification

The device is offered in different product variants. On the back side of the device enclosure there is a label, identifying which device it is. An example is shown in Figure 1.


Figure 2: Label on device back-side

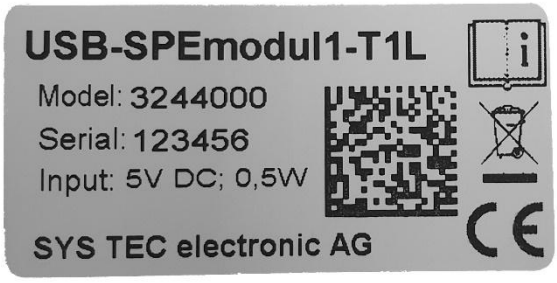



Figure 1: Device label

A detailed explanation for the label information can be found in Table 2.

Table 2: Device Label description

| Label | Description |
|---|---|
| **Name** | Name of the specific device, e.g. USB-SPEmodul1 (T1L) |
| **Model** | Item number for ordering and support requests |
| **Serial** | Serial number – this is individual for each device |
| **Input1** | Description, which voltage/power the device will need to function properly |
| **Data Matrix** | It contains the information from above and additionally the MAC addresses for each Ethernet interface. The string has the following structure:<br><br>*Name_Model_Serial_MAC*<br><br>The code reads as:<br><br>*USB-SPEmodul1-T1L_3244000_1234567_f8dc7a3bb9e2* |
| **Pictogram** | 1. There is a Manual and it must be read before using the device.<br>2. The device must not be disposed of with normal household waste.<br>3. The device is compliant with relevant EU legislations. |

Table 3 lists the available hardware variants this manual is related to.

Table 3: Overview of device variants

| Model | Name | Channel | Main feature |
|---|---|---|---|
| 3244000 | USB-SPEmodul1 (T1L) | 1x SPE | - SPE 10BASE-T1L<br>- without PoDL support<br>- Housing: table case |
| 3344000 | USB-SPEmodul1 (T1L) | 1x SPE | - SPE 10BASE-T1L<br>- without PoDL support<br>- open frame variant |

## 2.3 Product overview and interfaces


Figure 4: Top view of device

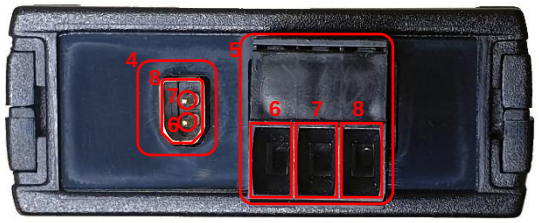



Figure 3: Side view of device (SPE interface connectors)

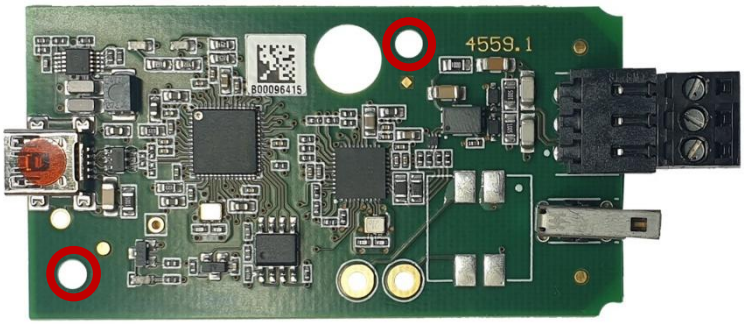
| LED description | | | | |
|---|---|---|---|---|
| No. | Name | Color | State | Description |
| 1 | power-LED | green | on | power on |
| 2 | lnk/act-LED | yellow | on | active link on SPE |
| | | | blinking | activity on SPE |
| 3 | state-LED | green | - | no function (reserved for future purposes) |

| Connector description | | |
|---|---|---|
| No. | Connection | Description |
| 4 | X100* | IEC 63171-2 compatible connector |
| 5 | X101* | 3-pin plug connector |
| 6 | SPE-P | positive SPE connection |
| 7 | SPE-N | negative SPE connection |
| 8 | Shield | cable shield connection |
| *The connectors are internally connected. Only use one at a time. | | |

## 2.4 Assembly/Disassembly and Installation

### 2.4.1 Assembly instruction

Securing the device with screws is exclusive to the openFrame variant. Utilize the M3 screw holes (refer to the image below) for this purpose. It is recommended to use washers beneath the board. When selecting screw heads, washers, and nut sizes, ensure they are small enough to avoid interference with assembled electronic components. Be certain that the maximum torque does not exceed 1 Nm.




### 2.4.2 Installation

The shielding connection on the USB-SPEmodul1 (T1L) serves the specific purpose of improving electromagnetic compatibility (EMC) mitigation. For optimal performance and protection, it is crucial to externally connect the shield of the SPE cable to a grounding source.

In IEC 63171-2 compatible connectors, conductor cross-sections matching the specific connector (not included) can be attached. These typically range from 0.14mm² to 0.34mm² (26 to 22AWG). For the 3-pin screw connector, conductor cross-sections between 0.2mm² and 1.5mm² (28 to 14AWG) can be connect.

## 2.5 Repair, Decommissioning and Disposal

Once the useful life has expired, the device must be taken out of operation and disposed of properly. The device must not be disposed of with household waste. The device must be disposed of in accordance with the current legal regulations of the respective countries.

A failed device cannot be repaired or can only be repaired by the manufacturer.

## 2.6 Technical data

The following sections summarize the technical data that the user must take into account when using the respective device.

Table 4: Technical data

| Parameter | Condition | Value |
|---|---|---|
| Power Supply | USB bus powered | 5V±5% |
| | Current consumption | 0,075A±5% |
| Temperature range | Storage temperature | -25°C … 85°C |
| | Operational temperature | -40°C … 85°C |
| Dimension | LxWxH in mm | 78x45x18 |
| Protection class | With housing | IP30 |
| Weigth | Without connectors and cables | 33,4g |
| USB signal interface | Standard | USB 2.0<br>Supports HS (480 Mbps) and FS (12Mbps) |
| | Connector type | USB-C |
| SPE signal interface | Standard | 10BASE-T1L |
| | Galvanic isolation | Yes |
| | Bit rate | 10Mbit/s |
| | PoDL | Not supported |
| SPE connector type A | Standard | IEC 63171-2 |
| | Mating cycles | 750 |
| SPE connector type B | Standard | 3 pole, 3,5mm grid |
| | Mating cycles | 25 |
| | Wire clamping range | 0,2mm² … 1,5mm² |
| | AWG conductor | AWG28 … 14 |

# 3 Getting Started

## 3.1 System requirements

Required Operating Systems:

- Microsoft Windows 10 / Windows 11
- Linux:
  - Kernel 6.1.x (LTS): using dkms and **systec_spe** driver package
  - Kernel 6.6.x (LTS): Support is **directly** available in the Linux Kernel
  - Kernel >=6.9.x: Support is **directly** available in the Linux Kernel.

**WARNING**

**There is a bug in unmentioned Kernel versions that may result in a Kernel crash. Kernel versions 6.6 and 6.9 include all necessary patches.**
**Kernel version 6.1 does not contain these patches. So please use the Kernel module provided at our homepage for Kernel version 6.1 and follow the installation instructions. Kernel versions not mentioned are not tested. Please, use the USB-SPEmodul1 (T1L) with caution on unmentioned Kernel versions.**

**NOTICE**

**To ask for the Kernel version in Linux open a terminal and type the following command:**

```
uname -r
```

## 3.2 Installation under Windows

Note that the Windows Kernel Driver is only available for Windows 10 x86 and x64 and for Windows 11. There is no support for older operating systems.

For an installation under Windows OS, please carry out the following steps:

1. Open the Windows Device Manager.
2. Connect the USB-SPEmodul1 (T1L) via USB cable to the PC.
3. Under “Other devices” you will find a new entry with the name “USB-SPEmodul1” as shown in Figure 5.
   Right-click on this device to open the context menu. Then click on “Update driver”.
4. A new window opens (see Figure 6). Select “Browse my computer for drivers”.
5. Browse to the location of the driver located on your hard disk as shown in Figure 7. Use “Driver_x64_<version>” for Windows 10 x64 and for Windows 11 and use “Driver_x86_<version>“ for Windows 10 x86. Then click to the Next button.
6. If the installation was successful, Windows displays the window as shown in Figure 8. Confirm this window with the Close button.
7. The USB-SPEmodul is now listed under “Network adapters” in the device manager as shown in Figure 9.

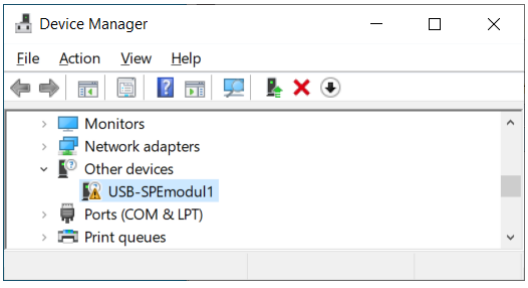



Figure 5: Device Manager after first connect

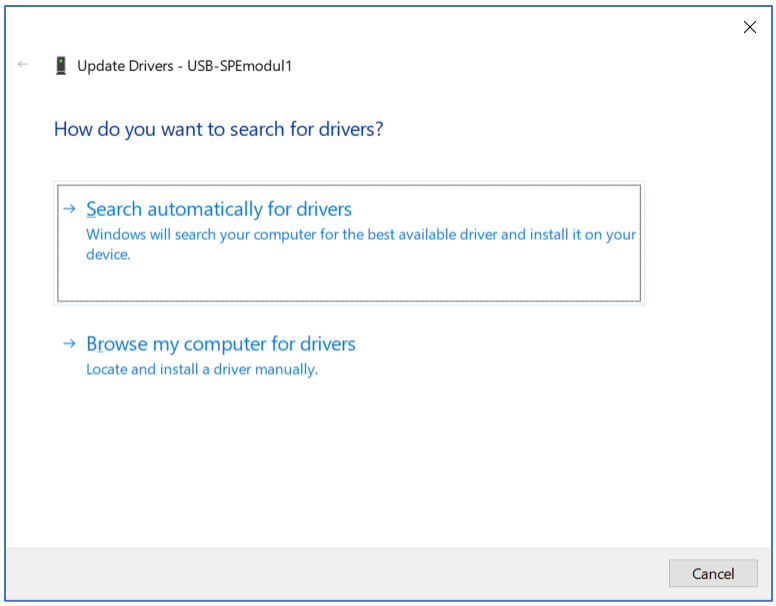



Figure 6: Update Drivers – manually installation

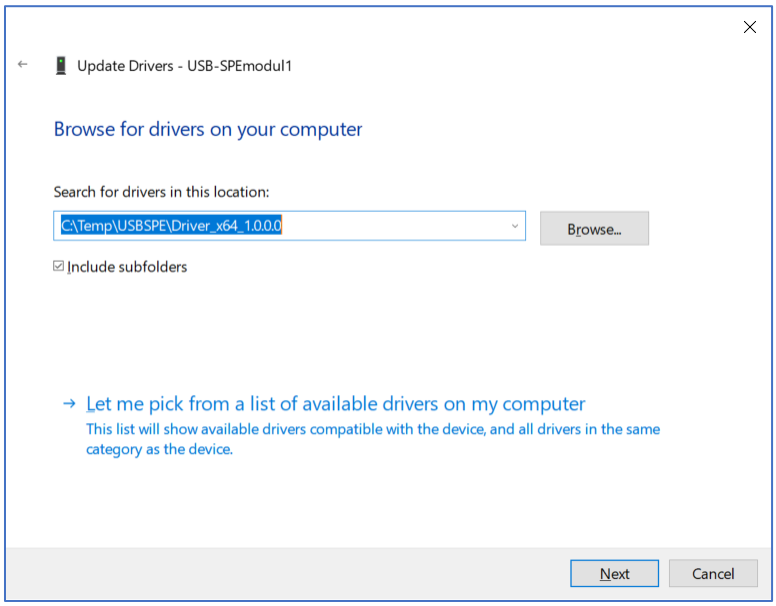



Figure 7: Update Drivers – browse location

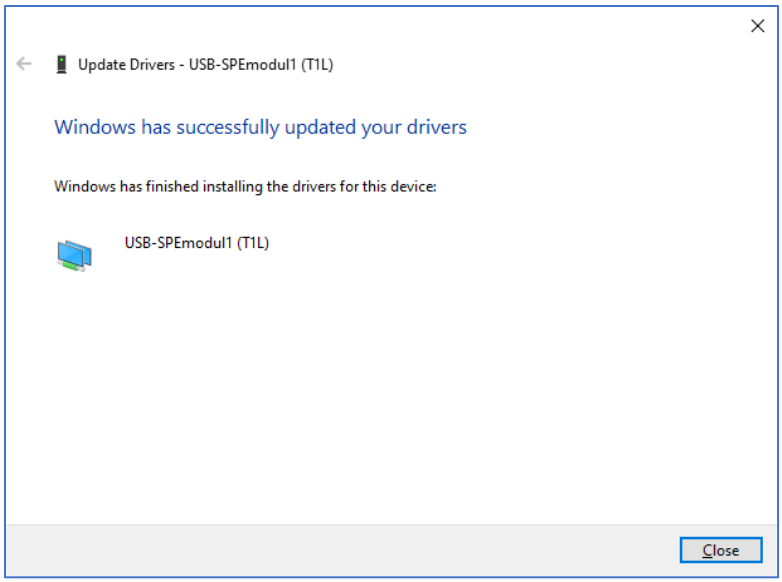



Figure 8: Update Drivers – successful

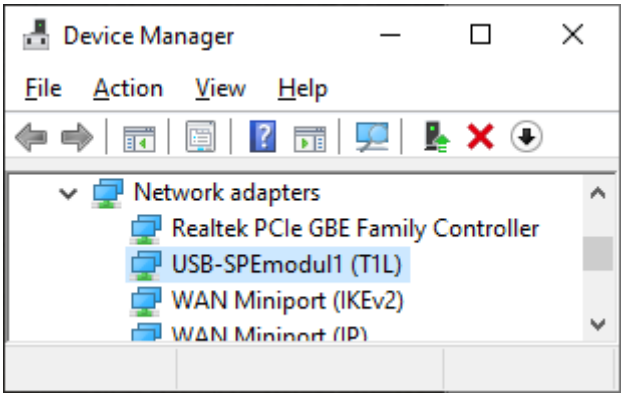



Figure 9: Device Manager – check installation

### 3.3 Installation under Linux

The following Kernel components need to be enabled:

```
CONFIG_NET=[m,y]
CONFIG_NETDEVICES=[m,y]
CONFIG_PHYLIP=[m,y]
CONFIG_USB=[m,y]
CONFIG_USB_NET_DRIVERS=[m,y]
CONFIG_USB_NET_SMSC95XX=[m,y]
CONFIG_USB_PHY=[m,y]
CONFIG_USB_USBNET=[m,y]
```

To read out the kernel configuration available at your system you can use `[z]grep`, e.g.:

```
zgrep NETDEVICES /proc/config.gz (Arch Linux)
grep NETDEVICES /boot/config-6.x.y-… (Debian)
```

### 3.3.1 Linux Kernel Version 6.1(LTS)

#### 3.3.1.1 Requirements

- dkms
- Linux header files
- make
- gcc

For a Debian based distribution, you can use the following command to install the dependencies:

```
sudo apt install dkms build-essential linux-headers-generic
```

#### 3.3.1.2 Installation

Please download the kernel module source code from our support website. Unzip the archive into a temporary folder.

Open a terminal with root privileges. Change into the source directory unpacked before.
Use the following command within this directory:

```
dkms install ./
```

**NOTICE**

**Sometimes, e.g. in Debian, the PATH variable does not contain the source directory for dkms and depmod executable. Thus, the command above fails with "command not found" error. Please use the following command in this case during installation:**

```
export PATH=$PATH:/sbin ; dkms install ./
```

**This will add the /sbin directory temporary into the PATH variable to find all programs for the installation process.**

#### 3.3.1.3 Update

Open a terminal with root privileges and type the following command:

```
dkms autoinstall
```

### 3.3.2 Linux Kernel Version 6.6 (LTS)

There are no needs if the following Kernel configurations is additionally available:

```
CONFIG_ADIN1100_PHY=[m,y]
```

Otherwise please download the kernel module **systec_spe** and follow the instructions from 3.3.1 Linux Kernel Version 6.1(LTS).

### 3.3.3 Linux Kernel Version 6.9 and above

There are no needs if the following Kernel configurations is additionally available:

```
CONFIG_ADIN1100_PHY=[m,y]
```

Otherwise please download the kernel module **systec_spe** and follow the instructions from 3.3.1 Linux Kernel Version 6.1(LTS).

## 3.4 Application hints

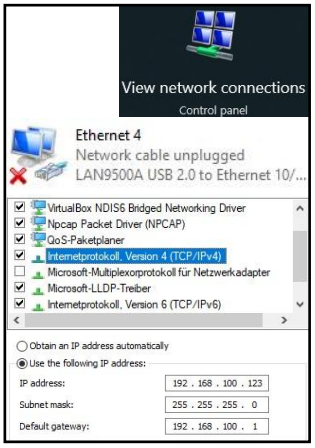
### 3.4.1 Configure a static IP address

#### 3.4.1.1 Windows

After successfully installing the drivers and connecting the USB-SPEmodul1 (T1L) to your system, the device is recognized as an Ethernet interface. To ensure seamless communication with an SPE-enabled counterpart, it is essential for both devices to be in the same subnet. If a static IP address is required, the following configuration steps must be performed.

Follow the steps below to make the necessary settings:

1. Click on the Windows Start menu and type "Network connections" into the search field.
2. Select the "Network connections" option from the displayed results.
3. Locate the Ethernet interface connected to the USB-SPEmodul1 (T1L) and right-click on it.
4. Choose "Properties" from the context menu.
5. Navigate to the "Network" tab and select Internet Protocol Version 4 (TCP/IPv4).
6. Click on "Properties."
7. Select the option "Use the following IP address" and enter the desired IP address to ensure the device is in the same subnet as the SPE-enabled counterpart.
8. Click "OK" to apply the settings.




After completing these steps, the USB-SPEmodul1 (T1L) should be ready to successfully connect with the SPE-enabled counterpart. Check that the IP addresses are configured correctly to ensure communication.

#### 3.4.1.2 Linux

For Linux, the configuration depends on the network manager used:

- ip:
  `ip address add <static-ip/mask> dev <USB-SPEmodul1 (T1L) device>`
- nmcli:
  `nmcli device modify < USB-SPEmodul1 (T1L) device> ipv4.address \`
  `"<static-ip/mask>" ipv4.method manual`

### 3.4.2 Determine the MAC address

In some applications, configuring routers requires knowing the MAC address. The device's programmed MAC address is part of the QR code. The content and structure of the QR code is described in Section 2.2.

## 3.5 Tools

As the USB-SPEmodul1 (T1L) serves solely as an adapter, additional software is required to send, receive, and analyze valid data. This software must be provided by the corresponding counterpart. Ensure that the software meets the requirements of the USB-SPEmodul1 (T1L) and is compatible with your system.

# Index


***A***

Application hints .....17
Assembly instruction.....11

***C***

Configure a static IP address .....17

***D***

Determine the MAC address .....17

***G***

Getting Started .....13

***I***

Installation.....11
Installation under Linux.....15
Installation under Windows.....13
Intended use .....8

***L***

Linux Kernel Version 6.1(LTS)..... 16
Linux Kernel Version 6.6 (LTS)..... 16
Linux Kernel Version 6.9 and above..... 16

***M***

Manuals
Overview ..... 6

***P***

Product identification..... 8
Product overview and interfaces..... 10

***S***

Safety instructions and warnings ..... 7

***T***

Technical data..... 12
Tools ..... 17

| | |
|---|---|
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