WHITE PAPER

Establishing and maintaining a permanent PROFIBUS monitoring environment

Learn how to install and configure permanent monitoring solutions

What you will learn:

An in-depth guide to the PROCENTEC ComBricks • Example networks and how to incorporate permanent monitoring • The benefits of PROFIBUS permanent monitoring Additional tools and compatible network components

IDX Industrial Data Xchange
The Industrial Data Communications Experts

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1. Introduction

As I sit here in my home office in the middle of the global COVID-19 pandemic writing this white paper, I notice myself inadvertently glancing over at my phone, anticipating a phone call and wondering which one of our clients will be contacting us next with network issues.

“Our PROFIBUS network keeps tripping,” the voice on the other end of the line says, “we need you to come to site please and help us get back up and running.” After a round of questioning, it turns out they have been having intermittent issues for the last month or so, and now this has resulted in a total network failure, costing millions of Rands in lost production every hour.

“Where are you based?” I ask. “We are in Durban,” the client replies. “OK, no problem! Just give me an hour to book my flights, an hour to pack, an hour to drive to the airport, two hours on the flight, another two hours to hire a car and drive to your site, and another hour for me to complete your site induction. I should be there in eight hours!” I explain.

And this is the general procedure for network callouts that require national travel. Not only are you already losing money due to a PROFIBUS network failure, but you now need to sit through another eight to ten hours before the PROFIBUS engineer gains access to the site.

1.1 Purpose of this document

The purpose of this document is to educate you about permanent monitoring solutions, what you will need to install a permanent monitoring solution, how to configure it, features, functionality, benefits, and additional information available to the user.

We have experience around PROFIBUS permanent monitoring solutions from working with the PROCENTEC ComBricks and as such, the details described in this document will apply to this product. At this point, it is important to note that there is not just one generic solution that will work for everyone when it comes to permanent monitoring, and this is especially applicable when it comes to ComBricks, which, in essence, is modular in nature and allows for expansion as and when required.

Depending on your requirements, you may be satisfied with a solution that monitors and stores only high-level network events whereas someone else may want full access to all information for each of their networks. The route you decide to take ultimately depends on your approach and what you are trying to achieve.

1.2 About the author

As an internationally Certified PROFIBUS and PROFINET Engineer and Certified PROFIBUS Trainer employed at Industrial Data Xchange (an internationally Certified PROFIBUS/PROFINET Competence Centre), Sean Ogborne has accumulated many years of experience and has a passion to empower local expertise and help our industries to maximise network availability and uptime.

He is involved in fieldbus and industrial ethernet training, design, advanced troubleshooting, auditing, and commissioning support within the Sub-Saharan Africa region.

1.3 Industrial Data Xchange (IDX)

Industrial Data Xchange (Pty) Ltd, also known as IDX, is an industrial IT company based in Johannesburg, South Africa. IDX has extensive knowledge and experience in industrial communications. The IDX Academy also operates the PROFIBUS International Competence Centre (PICC) and is also a PROFIBUS International Training Centre (PITC) for Southern Africa.

On a day-to-day basis, IDX offers certified training and services related to industrial communications networks. We have attended hundreds of PROFIBUS (and other protocol) network audits and call outs, assisted in permanent monitoring solution adoption, developed protocol conversion solutions for information sharing and integration between new, disparate and legacy systems. IDX has developed sound fault-finding strategies and procedures along with the competence in understanding useful network statistics and how this information can be used to help you establish and maintain your systems and to leverage these systems for maximum productivity.

1.4 PROCENTEC

The ComBricks permanent monitoring solution discussed in this document has been designed and manufactured by PROCENTEC. PROCENTEC is an independent Dutch company and specialises in the development and manufacturing of automation products for PROFIBUS, PROFINET, Ethernet/IP, and a variety of other industrial Ethernet-based protocols. PROCENTEC operates the PROFIBUS International Competence Centre (PICC), the PROFIBUS International Training Centre (PITC) and the PROFIBUS International Test Lab (PITL) in the Netherlands.

2 The basis: ComBricks head stations and modules

ComBricks is a modular solution combining the power of the head station (the brains behind permanent monitoring) and the various modules that, in addition to performing the standard functions associated with such network components, also provide the ability for gathering information directly from the connected networks that can be used to analyse the health of these networks, and subsequently produce a preventative maintenance solution that promotes a proactive rather than reactive approach.

2.1 The ComBricks head station

Figure 1: ComBricks Head Station

The ComBricks head station is the single component that retrieves the information from the modules via the intelligent backplane and enables this information to be displayed in the integrated web page for further analysis and manipulation. It incorporates a microSD card that is used to store a variety of network information as well as configuration data for easy system back-up when required. There are three types of head stations available, namely the 1A, 1B, and 1C head station.

The 1A head station is the base model and provides the functionality for monitoring the status and for remote configuration of the connected modules only. The 1A head station is generally used in applications where smart modular repeater solutions are required with minimal monitoring capabilities. For this document we will not consider the 1A head station as a component that can be utilised in a permanent monitoring solution as we see it, instead, we will focus on the 1B and 1C head stations that both incorporate a ProfiTrace core.

The ProfiTrace core or ProfiTrace OE (Over Ethernet) is the mechanism used for the analysis of the network information and statistics. The difference between the 1B head station and the 1C head station is the number of networks that can be monitored. The 1B provides the ability to monitor one PROFIBUS network, whereas the 1C head station allows for monitoring of up to four PROFIBUS networks.

2.2 The ComBricks modules

The ComBricks modules are the network components directly connected to your network/s and are responsible for gathering the relevant information that can be used to trigger notifications and for further analysis. There is a wide variety of modules available, each with their own specific function, that can be added to the backplane to build a solution that meets your requirements based on the application.

All modules are completely compatible with each other and can be mixed and matched across the backplane to create a ComBricks solution that caters to your requirements. We will take a look at a few of the more commonly used modules and their functionality and capabilities below:

2.2.1 1 Channel RS 485 repeater

Figure 2: 1 Channel RS 485 Repeater

The single channel RS 485 repeater module is a transparent module that is connected into your PROFIBUS network. It features 1 DB9 connector and 1 removeable screw-terminal connector for connection into your PROFIBUS network. Physical DIP switches on the module allow you to set which network is being monitored, either network 1, 2, 3, or 4. A built-in termination switch allows you to disable or enable the termination as required. A single 1C head station and four single channel RS 485 repeater modules, inserted into the backplane, would allow you to monitor all four networks from a single web page.

With a single module, you can gather the necessary information that ProfiTrace OE requires in order to generate a complete live list of all devices on the entire network, create a channel list visualising the devices connected to that specific channel, detect relevant network statistics, and capture a message recording of the telegrams sent over the bus. When multiple modules are inserted into the backplane, ComBricks will act as a standard PROFIBUS single channel or multichannel repeater, allowing you to create a large star, tree, and bus structured networks with the capability of isolating certain sections of the plant.

2.2.2 SCOPE repeater

Figure 3: Scope Repeater

"The special one" - Not only does the SCOPE repeater module provide you with all the functionality associated with the single channel RS 485 repeater module, but it also boasts the ability to obtain certain electrical characteristics from the connected segment. What does this mean?

It means that in addition to providing a complete network live list, a channel list, gathering network statistics, and message recording functionality it is also able to capture the signals and driver voltages of devices connected on the segment.

Using ProfiTrace OE and the built-in oscilloscope, you will be able to analyse the signal waveforms of all devices on the segment. Being able to analyse the signal waveforms is fundamental in understanding the true health of your network. Analysis of the PROFIBUS signal waveforms allows you to identify several faults such as missing, unpowered or over terminations, the presence of electrostatic/electromagnetic interference, duplicate addresses, and impedance mismatches, such as incorrect cable-type used and the presence of stub/spur lines.

With the SCOPE repeater and the power of ProfiTrace OE, you will be able to display a bar graph showing the driver voltages of the devices on the connected segment so that you can ensure that these all fall within the recommended range of 2.5 V to 7.2 V. The information obtained by the SCOPE repeater module allows you to set up a more in-depth notification system that will help you in identifying and correcting faults before these faults result in complete network failure.

2.2.3 ComBricks PROFIBUS PA link/coupler module

Figure 4: PROFIBUS PA Link / Coupler Module

The PROFIBUS PA link/coupler module is the component used for monitoring of the PROFIBUS PA segments. It can be placed directly behind 3rd party non-Ex PA couplers and used for monitoring of the PA segment. When combined with the power of ProfiTrace OE, you can monitor the signal waveforms with the built-in oscilloscope and the PA signal strength using the bar graph view.

From the PA measurements page, you can analyse the levels of DC noise and jitter present on the network and of course, based on these measurements, you can configure triggers that will send notification alerts when one of these values goes outside of a specified range.

Not only is this component a monitoring device but it can replace any existing PA links/couplers or be incorporated into new installations as a PA link/coupler. It offers full functionality as a PROFIBUS PA link/coupler as well as a PROFIBUS PA monitoring tool.

2.2.4 Other modules available

There are several other modules available in the ComBricks range of products that can be used for a specific purpose. As this document focuses on the permanent monitoring of PROFIBUS networks, the other available modules are not necessarily relevant for our discussion, however, I would like to highlight a few of the modules that are available just as additional information.

- 2 channel repeater
  Similar to the single channel repeater, however, this module features two isolated channels and offers repeating capabilities across the module itself.

- Fibre optic modules
  There are a variety of fibre optic modules available that can provide the functionality associated with regular optical link modules (copper to fibre conversions). The various options allow you to choose between single-mode and multi-mode fibre modules, and with or without ring redundancy capabilities.

- DP slave module and digital input/output modules
  The DP slave module can be configured as an addressable slave on the PROFIBUS DP network. In combination with digital input/output modules, it provides you with the possibility to create your own PROFIBUS IO module slave device.

3 The web page and ProfiTrace OE

Using a web browser, the condition of your PROFIBUS network can be permanently monitored. The ComBricks web station is assigned an IP address and connected to your Local Area Network. From a personal computer, laptop, smartphone, or tablet that is connected to the network, simply type the IP address of the ComBricks unit into the address bar of a web browser to open up the ComBricks web page.

In this section, we will take a closer look at certain functionality and the different monitoring sections available from the web page.

3.1 Remote information and menu navigation

Figure 5: ComBricks Remote Information

At the top of each page there is a section that contains information about the ComBricks unit that you are connected to. The information displayed includes the IP and MAC addresses of the ComBricks head station, the system uptime (how long the unit has been powered on for), site information, temperature (the temperature inside the head station), the current system time, company information, country information and the measuring since time (how long this ComBricks has been permanently monitoring the network). A new measurement can be initiated by using the “clear all data” option in the device management screen.

The menu on the left-hand side of the web page allows you to navigate to, and monitor, certain aspects of your installation. In the following section, we will briefly discuss the information accessible through each of these menus.

3.2 Status

The status screen contains information about the ComBricks and all connected modules. It will provide an overview of the modules connected to each of the corresponding slot numbers and a status indicator to confirm that each of the connected modules is operational. The serial numbers and the current HW version for each module are also displayed.

Slot	Status	Module	Vendor	Serial #	Hw Rev
0	OK	Head Station Type 1B Online demo	PROCENTEC	006556	V1.9
1	OK	1 Channel RS485 Repeater Type 1	PROCENTEC	004690	V1.7
2	OK	1 Channel RS485 SCOPE Repeater Type 1 Redundant	PROCENTEC	006319	V1.4
3	OK	1 Channel RS485 SCOPE Repeater Type 1 Redundant	PROCENTEC	001938	V1.3
4	OK	Fiber Optic Ring module MM Type 1	PROCENTEC	000552	V1.1
5	OK	1 Channel PA-coupler 500mA Type 1	PROCENTEC	002049	V1.5
6	OK	4 Channel REL module Type 1	PROCENTEC	000645	V1.2

Figure 6: ComBricks Status Page

The description under the module column provides a link to further information pertaining to each of the modules. It is from here that you can monitor the status of the modules remotely without having to physically check on the units. The information available differs from module to module, but generally, information such as serial numbers, hardware and software versions, which network the selected module is connected to, the baud rate of the connected network, the status of the DIP switches and module LED indicators are shown.

Module info	
Slot:	2 - Redundant
Vendor:	PROCENTEC
Module type:	1 Channel RS485 SCOPE Repeater Type 1
Serial number:	006319
Software revision:	V1.16
Hardware revision:	V1.4
Module status:	OK
Number of channels:	1
Link to oscilloscope images page	Click here
Link to oscilloscope error images page	Click here

Channel 1	
Network:	1 (Plant 1)
Baudrate:	1.5 Mbps
Station count active on channel:	0
Redundancy:	On ●
Setting by:	Dipswitch
Terminator:	Off
Idle line voltage:	1.11 V
Hardware error LED:	● Off
Minimum signal error LED:	● On
Termination error LED:	● Off

Figure 7: ComBricks Status Module Information

3.3 System log

The system log is a date and time-stamped log of ComBricks events such as when the system started up, whether modules were removed or inserted, and information about when details are saved to the SD card. The log is kept intact after a power down and will continue logging when the system restarts. The log information can be downloaded in .txt file format and can be cleared as required.

System log

Descending | Pages: 1 2 3 4 5 6 7 8

#	Date & Time	Message
31	3-Jun-2020 13:36:40	Finished writing changed scope images for Slot 2 to the SD card
30	3-Jun-2020 13:18:22	Module added in slot 6: 4 Channel REL module Type 1 (sn:000645)
29	3-Jun-2020 13:18:20	Module added in slot 5: 1 Channel PA-coupler 500mA Type 1 (sn:002049)
28	3-Jun-2020 13:18:18	Module added in slot 4: Fiber Optic Ring module MM Type 1 (sn:000552)
27	3-Jun-2020 13:18:16	Module added in slot 3: 1 Channel RS485 SCOPE Repeater Type 1 (sn:001938)
26	3-Jun-2020 13:18:16	Module added in slot 2: 1 Channel RS485 SCOPE Repeater Type 1 (sn:006319)
25	3-Jun-2020 13:18:14	Module added in slot 1: 1 Channel RS485 Repeater Type 1 (sn:004690)
24	3-Jun-2020 13:18:12	System startup (00)

Figure 8: ComBricks System Log

3.4 Channel list

The channel list provides a visual representation of your ComBricks setup. It will display the head station and the corresponding modules and how these modules have been inserted into the backplane.

A live list representation will indicate which networks are being monitored by the module and the devices (device addresses) that are connected to each of the modules' channels.

Additionally, this channel list view will indicate whether these detected addresses are master or slave devices, whether or not they are in data exchange and if they have configuration or parameter faults.

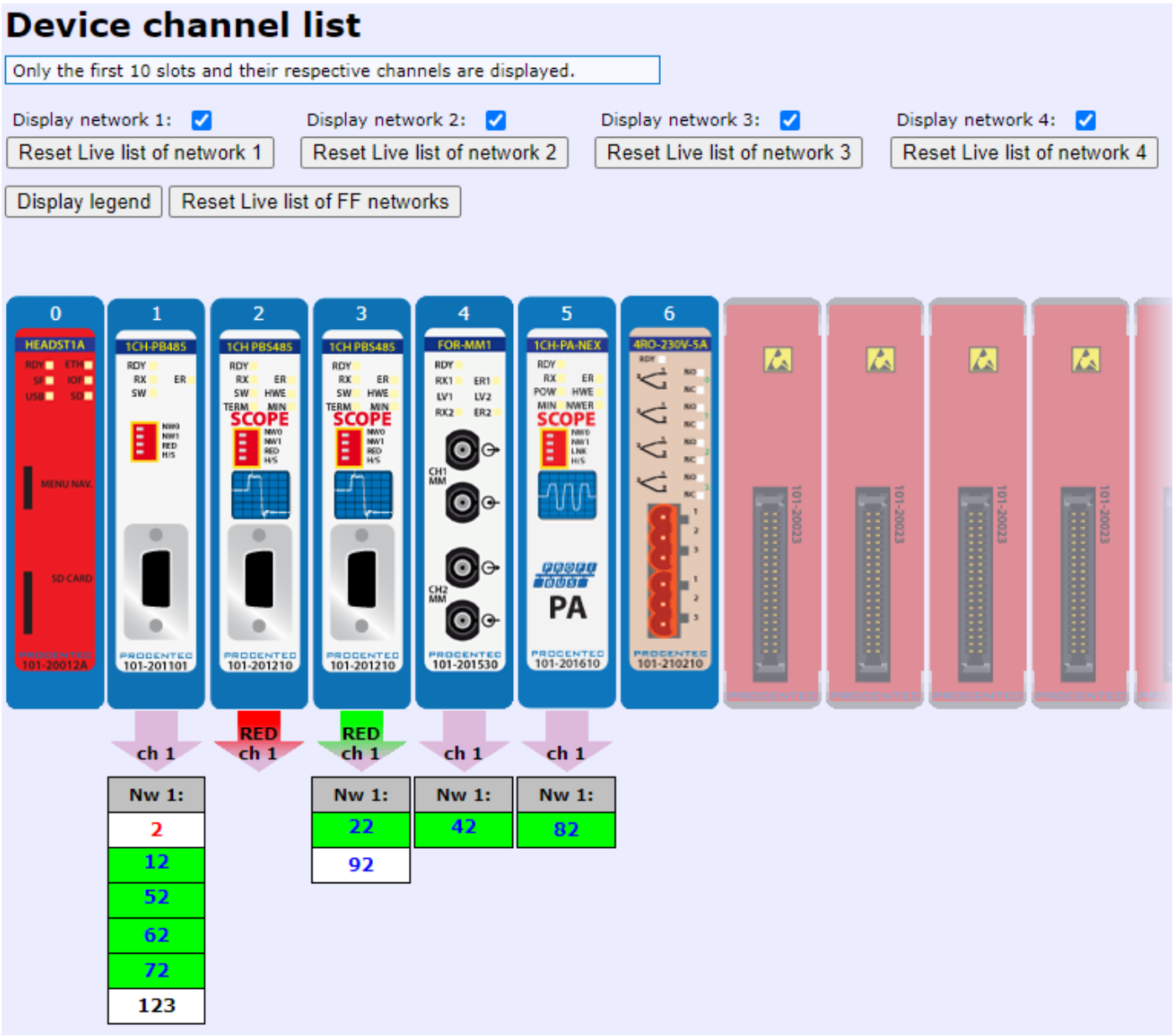

Figure 9: ComBricks Channel List

3.5 Live list

The live list view displays a list of devices present on the connected network as well as the baud rate of the connected network. You can choose to display the devices with their corresponding addresses on the network and optionally view the model name, a pre-configured tag name, and the device IDENT number amongst others.

The live list gives you a good idea of the status of the connected devices, from here you can easily identify any devices that are not in data exchange, any devices with configuration or parameter faults and any devices that are reporting diagnostics. The pop-up legend provides more information regarding the different colours and what this all means.

With a ComBricks 1B head station, you will be able to view the live list of one entire PROFIBUS network, a 1C head station allows you to monitor up to four separate PROFIBUS networks. There is an option to reset the live list which is an important feature and something that should be performed once a detected fault has been corrected.

Figure 10: ComBricks Live List

3.6 Statistics

PROFIBUS network statistics provide important information about the health of your network. The statistics view is often a good source of information to understand when and why network faults are occurring. Unlike on-site troubleshooting tools, that can only provide information for statistics captured during the time that your troubleshooting tool is connected to your network, the ComBricks is permanently monitoring and is therefore able to detect these statistics as and when they occur.

If you are struggling with intermittent faults, then the network statistics are likely to help you with identifying why these faults are occurring. At this point, it is important to note that there is no troubleshooting tool available that can accurately identify an exact cause or location of a PROFIBUS fault.

However, with the proper training and practical experience combined with the availability of troubleshooting tools, you will be able to interpret this information and this will guide you in making informed decisions to correct any suspected causes for network failures. With that said, let us have a look at a few of the network statistics that can be monitored, what they mean, and how they can be used to help you identify certain faults.

3.6.1 Syncs

A sync message can be thought of as an “are you there” message. Should a master send a message to a slave device and not receive a response, this will result in a sync message. A static number of sync messages shown in the statistics view, at a certain device address, indicates that the slave at that specific address was not in data exchange for a certain period. An increasing number of sync messages indicates that the device at that address is currently not in data exchange.

The reason that a device “falls off the bus” could be due to several reasons ranging from a device that has been physically removed, a device that has been powered down or even due to other issues on the network such as termination faults or EMI that intermittently render the slave unreachable.

3.6.2 Lost

The lost statistic is a counter that tracks the number of times a specific slave was not in data exchange i.e. the number of times it was disconnected from the network. This is an interesting statistic that can show which devices are more susceptible to communication faults.

As with sync messages, the reason for a lost device could be due to several reasons ranging from a device that has been physically removed, a device that has been powered down or even due to other issues on the network such as termination faults or EMI that intermittently render the slave unreachable.

3.6.3 Repeats

Repeats/retries indicate the number of times that the master needed to resend a message to a particular slave. The retry limit is set up in the PLC configuration and is often defaulted to a value between 3 and 5. What this means is that if a message to a slave becomes corrupted and/or does not reach its destination intact, then the master will resend that particular message.

The master will try to resend this message a certain number of times (as set up in the PLC configuration) before it registers a bus fault and the device falls off the network. The presence of repeats/retries are primarily indicative of intermittent communication faults as a result of reflections or EMI being present on the network.

3.6.4 Illegals

Illegal messages are corrupted messages. If you notice sporadic illegal messages scattered across your network, this is usually consistent with the presence of EMI. Illegal messages concentrated at a certain device address are often associated with duplicate PROFIBUS addressing on the network.

3.7 Network event log

The network event log supports the primary function that you would expect from a permanent monitoring solution. This date and time-stamped log stores a history of PROFIBUS events that have occurred on your network. With this information, you can identify exactly when certain faults are being experienced, especially useful for those intermittent faults that are often not captured.

Are faults occurring consistently at specific times of the day, perhaps when a neighbouring machine is started up? This could indicate noise being injected onto the network caused by the starting of a large motor and could convince you to consider your PROFIBUS cable routing.

Network event log

Plant 1 | Plant 2 | Plant 3 | Plant 4

Descending | Pages: 1 2 3 ... 85 86 87 88 89 90 91

#	Date & Time	Message
1815	30-Jun-2020 11:20:04	High/low signal on network 1 (Plant 1), too low on scope-module itself, 1.11V (slot 3 (Redundant)) - 60 minute interval
1814	30-Jun-2020 11:20:04	Redundancy fail on network 1 (Plant 1): Module 2 (Redundant), channel 1 failed - 60 minute interval
1813	30-Jun-2020 10:20:06	High/low signal on network 1 (Plant 1), too low on scope-module itself, 1.11V (slot 3 (Redundant)) - 60 minute interval
1812	30-Jun-2020 10:20:00	Redundancy fail on network 1 (Plant 1): Module 2 (Redundant), channel 1 failed - 60 minute interval
1811	30-Jun-2020 9:32:56	High/low signal on network 1 (Plant 1), too low on scope-module itself, 1.06V (slot 3 (Redundant)) - 60 minute interval
1810	30-Jun-2020 9:19:58	Redundancy fail on network 1 (Plant 1): Module 2 (Redundant), channel 1 failed - 60 minute interval
1809	30-Jun-2020 8:38:38	High/low signal on network 1 (Plant 1), too low on scope-module itself, 1.06V (slot 3 (Redundant)) - 60 minute interval
1808	30-Jun-2020 8:20:00	Redundancy fail on network 1 (Plant 1): Module 2 (Redundant), channel 1 failed - 60 minute interval
1807	30-Jun-2020 7:20:02	High/low signal on network 1 (Plant 1), too low on scope-module itself, 1.11V (slot 3 (Redundant)) - 60 minute interval

Figure 11: ComBricks Network Event Log

3.8 Oscilloscope images

Now we are getting into some of the exciting features! If you are using either the SCOPE repeater module or the PROFIBUS PA link/coupler module then you will be able to use the built-in oscilloscope to do some signal waveform analysis. An oscilloscope is a fundamental tool for PROFIBUS troubleshooting, without one, you will not be able to understand the true health of your PROFIBUS network. Analysis of the signal waveform allows you to easily detect faults that you would not necessarily be aware of.

Some of these faults could include: Missing or over terminations, which are usually apparent on PROFIBUS signals in the form of reflections; unpowered terminations that can be detected based on the idle voltage line; the presence of any noise/EMI that may be interfering with bus communications as well as the detection of any duplicate addressing.

Now, because certain network components such as repeaters or optical link modules offer optical isolation, waveform analysis is only possible for those segments that are directly connected to a SCOPE repeater or PROFIBUS PA link/coupler module. A full monitoring solution that provides for the ability to perform waveform analysis across your entire network would require one of these modules to be installed on each segment. We will discuss some of these installation applications a little later in the document, but just keep this in mind if you are wanting a full permanent monitoring solution.

Below is an example of the oscilloscope image of the device at address 92 on a PROFIBUS network.

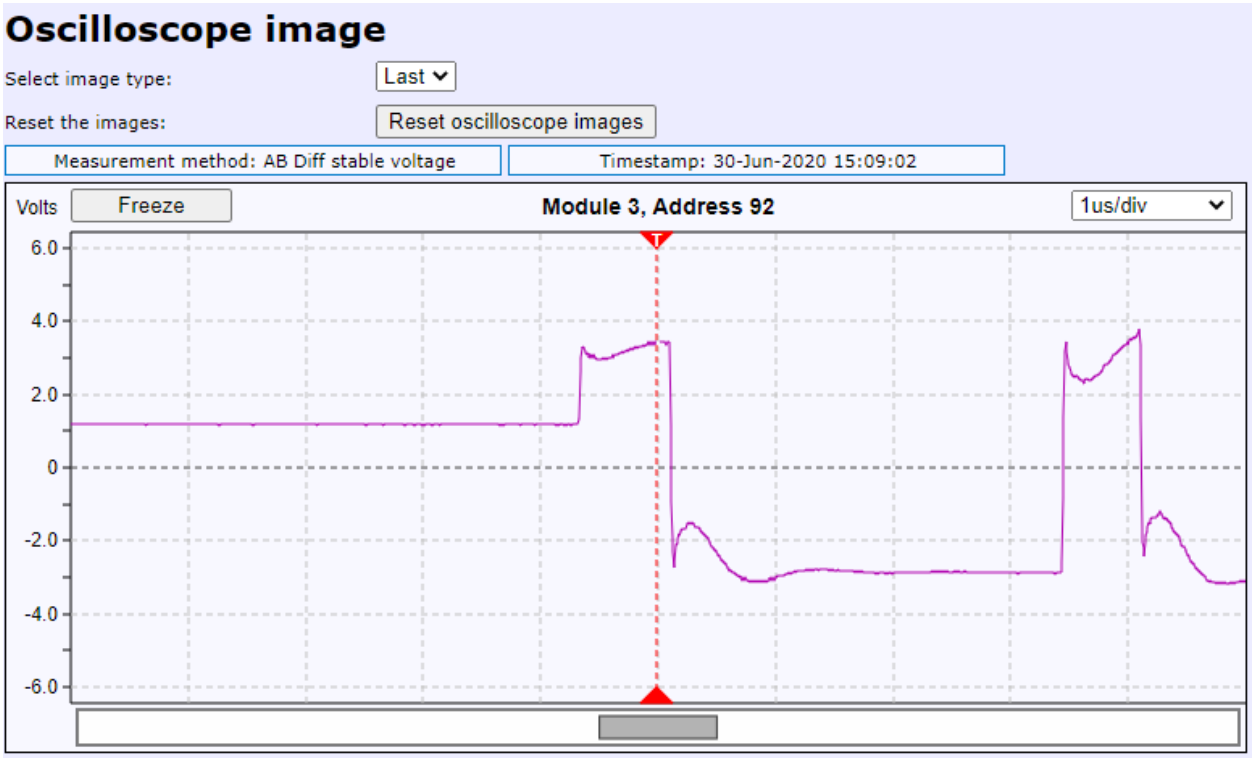

Figure 12: Oscilloscope Image

In addition to real-time analysis of the waveforms, the ComBricks solution will also save any detected oscilloscope errors to the SD card, these can be viewed from the ComBricks webpage for further analysis. The detected error waveform will also contain a date and time stamp of when the fault was detected.

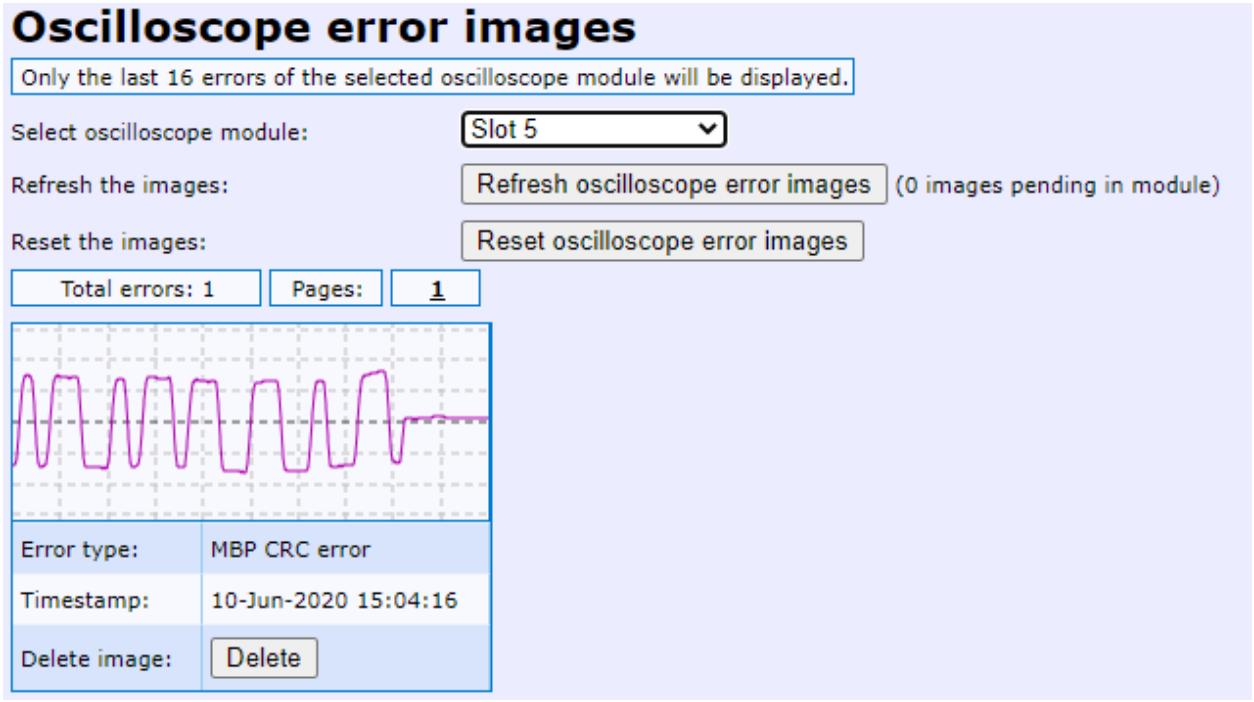

Figure 13: Oscilloscope Error Images

3.9 Bar graph images

The bar graph can be used to monitor the driver voltages of the devices on the connected segment. The driver voltages for healthy network communication should fall within the range of 2.5 V to 7.2 V. Voltages above 7.2 V usually indicate a missing termination, whereas voltages below 2.5 V could represent an over termination or impedance mismatches such as incorrect cable type being used.

The dotted lines on each of the bars additionally indicate the lowest driver voltage measured and the highest driver voltage measured. If you notice that the bar graph seems to be jumping a lot between a low and a high voltage, this is cause for concern and is usually a sign that a duplicate address exists on the network.

As with waveform analysis, to have a full monitoring solution, a SCOPE repeater module or a PROFIBUS PA link/coupler module is required to be installed on every segment, however, you may choose to install just one of these modules on a particularly troublesome segment, this is entirely up to you and your needs.

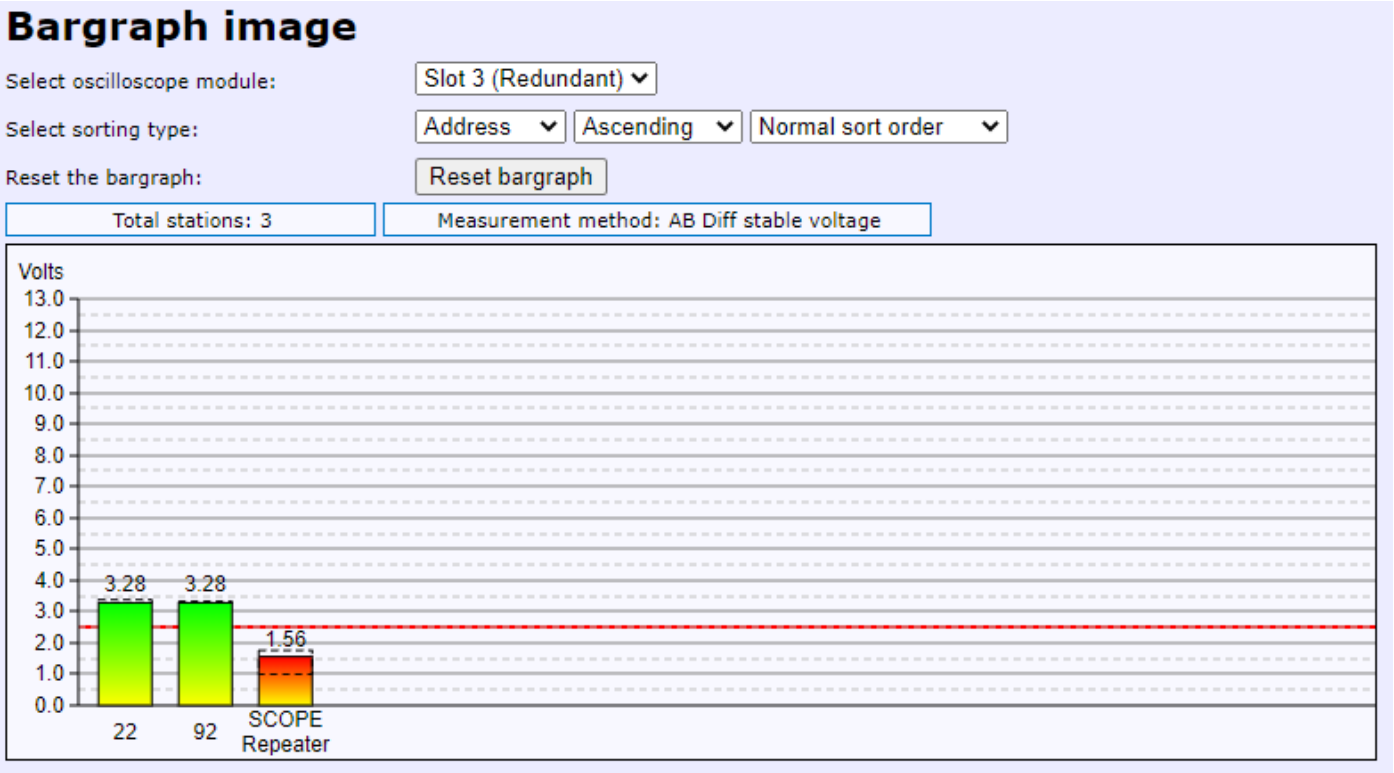

Figure 14: Bar Graph Image

3.10 PA measurements

With a PROFIBUS PA link/coupler module installed on your PA segments, ProfiTrace OE provides you with the capability to monitor specific PROFIBUS PA measurements. The information is displayed in the form of a signal waveform and includes measurements for the amount of DC noise detected, the signal amplitude, and the amount of jitter.

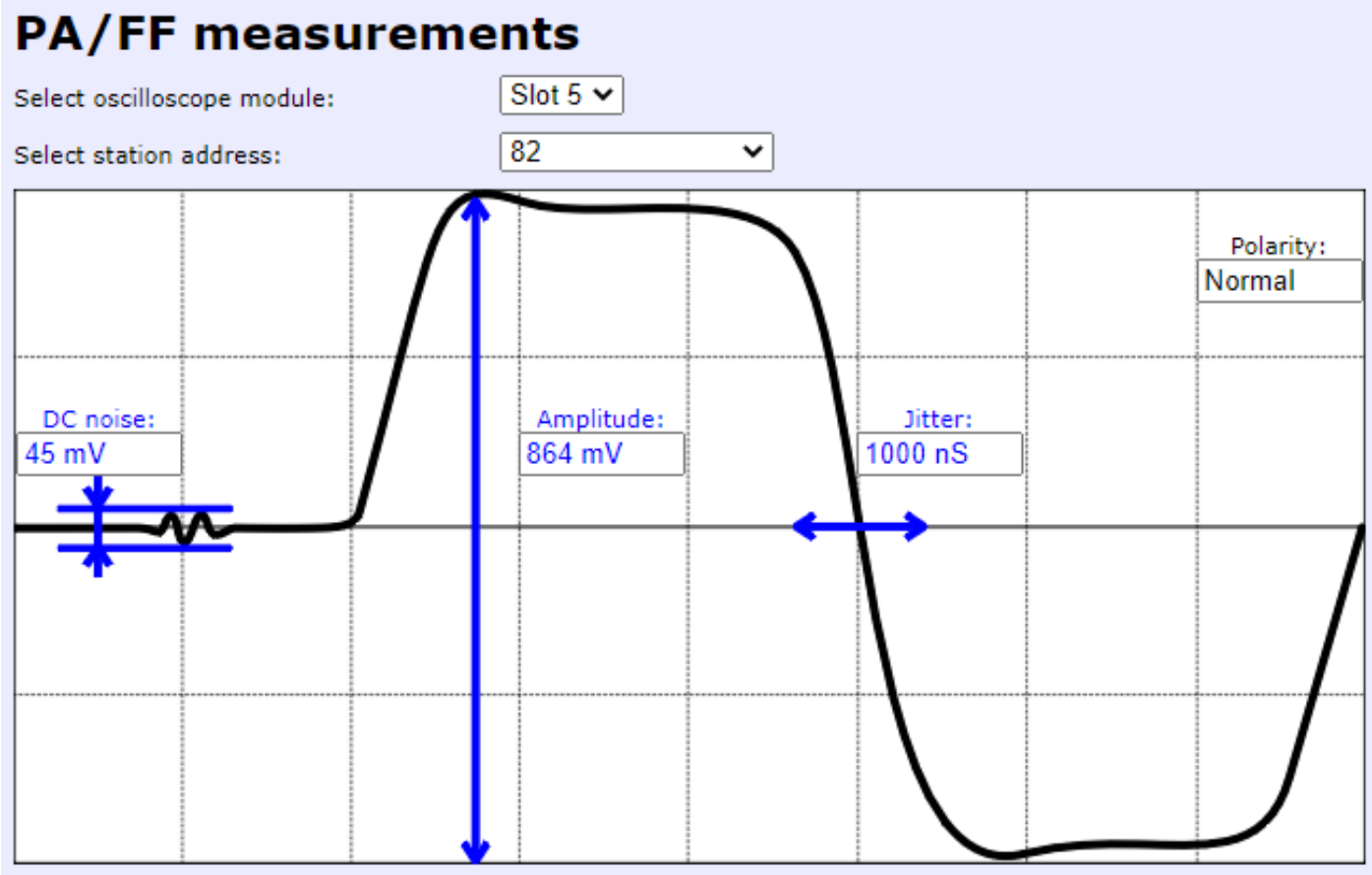

Figure 15: PROFIBUS PA Measurements

3.11 Configuration within the ComBricks web page

The setup for notifications as well as any other aspects related to the permanent monitoring of your PROFIBUS networks are all configured from the ComBricks web page, in this section we will take a look at a few of the configuration sections available.

3.11.1 Message recording

It is possible to record messages sent over the bus that can be used for advanced troubleshooting of your PROFIBUS network. You can trigger these message recordings based on when an event occurs. The possible triggers are lost devices, sync messages, repeats or retries, illegal messages, and diagnostic messages.

When one (or more) of these events occur, ComBricks can capture a certain number of messages preceding the event and a certain number of messages after the event. The number of messages captured in the message recording file can be configured by the user. There is an option to re-trigger, which enables you to record multiple message recording files based on the same event. If this checkbox is disabled ComBricks will record only one message recording based on the first instance of the trigger.

Message recording files are saved to the SD card and are date and time-stamped. The message recording files can be opened, and further analysed, in either the standard ProfiTrace or ProfiTrace for ComBricks

software that needs to be installed locally on your personal computer or laptop. This software is free to download from the PROCENTEC website.

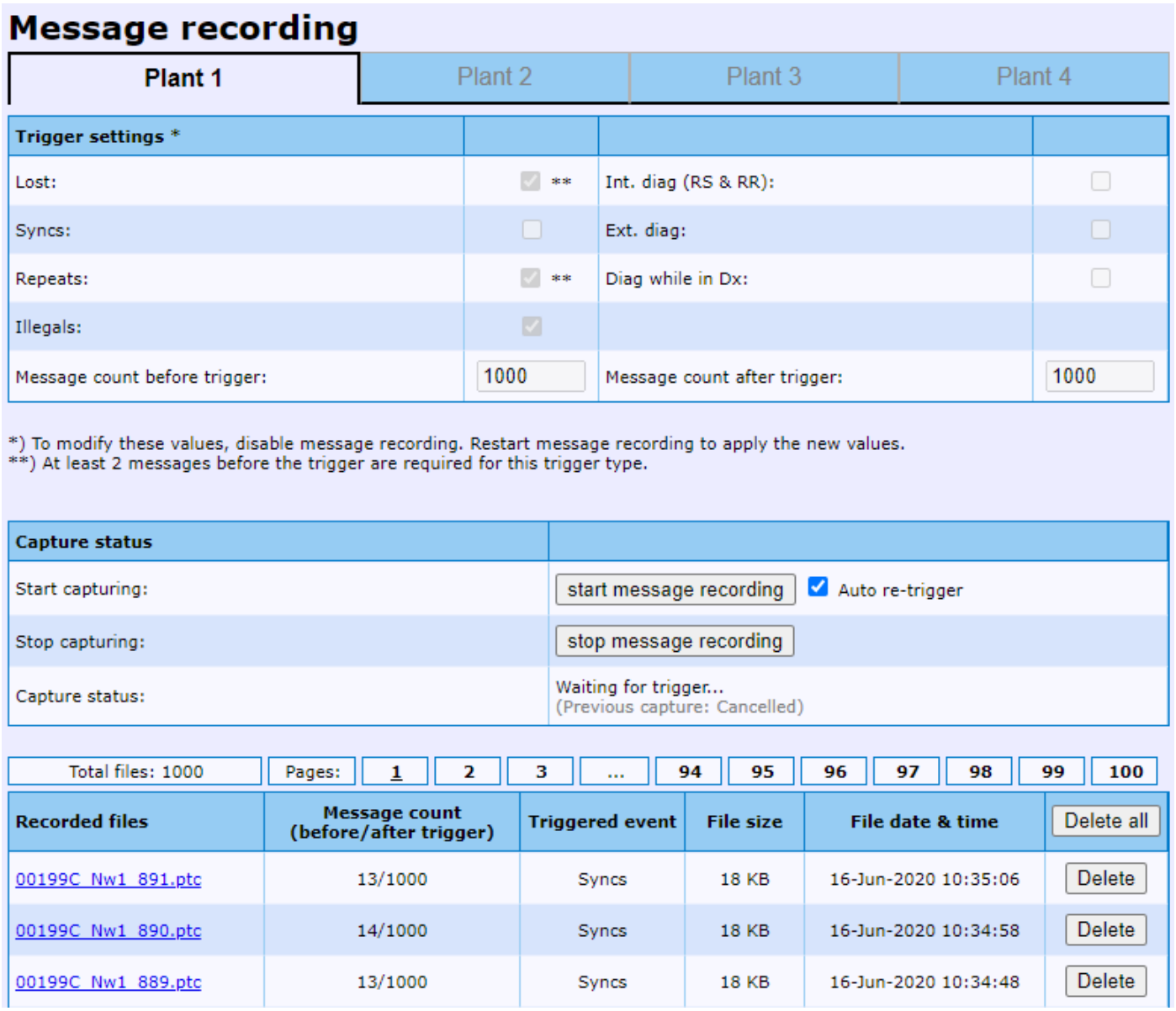

Figure 16: ComBricks Message Recording Page

3.11.2 Email and log event configuration

The ComBricks permanent monitoring solution can detect events that occur on the network that may potentially lead to a network failure. These detected events can be configured as the basis for the network event log (discussed earlier) or as a trigger to send email notifications to the relevant personnel.

This is the foundation for preventative maintenance. Users can be made aware of certain incidents that occur and can rectify the fault before it results in network downtime and subsequently loss of production. The solution can be configured to monitor both ComBricks system faults, such as loss of power to the ComBricks head station or ComBricks system errors, as well as PROFIBUS network events.

The PROFIBUS network event triggers are based on PROFIBUS statistics (lost, syncs, illegals, etc.), baud rate changes, high or low signal voltages, low idle voltage, redundancy failures, PROFIBUS PA events, and fibre optic events.

Figure 17: E-mail and Log Event Configuration Screen

3.11.3 Output event configuration

By using the built-in relay output on the ComBricks head station or using the separate relay module it is possible to configure the system to directly respond to bus faults. Power switches, hold switches, indicators, back-up systems, etc. can all be connected to the relay output. When a PROFIBUS fault is detected, the system can be configured to switch the relay, which allows systems to directly and independently act when bus communication becomes unreliable.

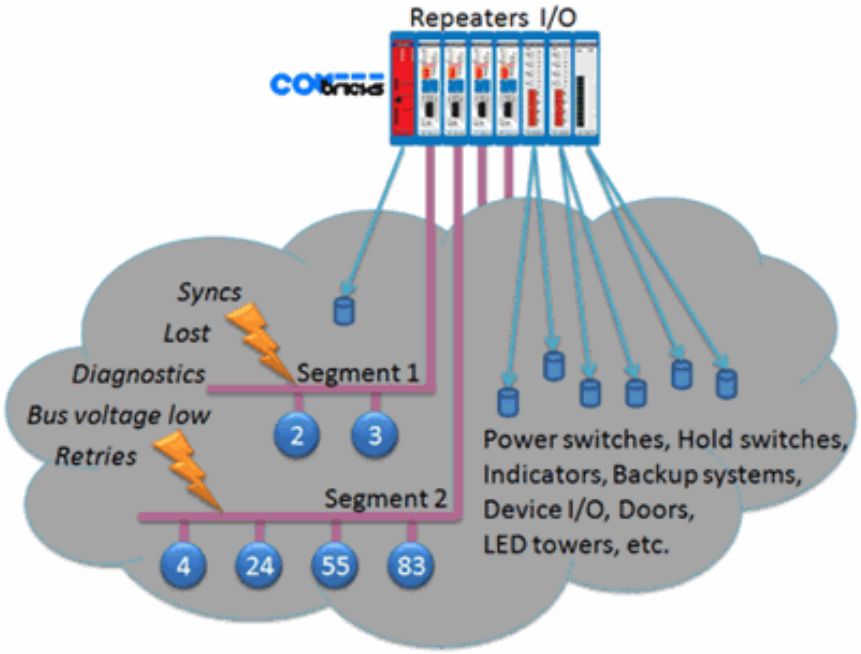

Figure 18: Applications for Output Events

3.11.4 Oscilloscope configuration

The oscilloscope configuration page allows you to configure the settings that ComBricks uses to detect faults based on the signal waveforms and the device driver voltages (bar graph). The idle voltage minimum and maximum level, as well as the driver voltage minimum level, can be set.

When a measurement is outside of the configured range it can be used to trigger an event that will either be stored in the network event log or used to send a notification alert in the form of an email.

3.11.5 General, network and IP configuration

The general configuration page allows you to configure date and time settings as well as site-specific information. The network configuration page is used to rename each of your networks (up to four) that are being monitored by ComBricks as well as to choose between hardware or software settings of the modules.

Hardware settings are configured using the physical DIP switches on the modules, software settings allow you to make these changes directly from the ComBricks web page. The IP configuration page allows you to set the IP address of the ComBricks head station.

3.11.6 Diagnostic slave configuration

This section of the web page allows you to configure existing ProfiHubs, that are installed on the network, to directly report diagnostic information detected on each of their connected segments to ComBricks. In addition to narrowing down detected illegal messages to a specific segment, which is a great help in determining possible EMI injection, a ProfiHub configured as part of the ComBricks solution will also provide greater insight into the topology of the network. A ProfiHub channel list is available from the ComBricks web page and details the addresses of the devices connected to each of its channels.

4 ComBricks permanent monitoring solution examples

With ComBricks being a modular solution it opens up for the possibility of a permanent monitoring solution that can be built to suit almost any application, on the other hand, however, it can be a daunting task to try and decide on an initial setup that checks the boxes for your requirements.

In this section, I will try and outline a few ComBricks solutions that can be used as a basis for your PROFIBUS permanent monitoring needs. For the sake of simplicity, I am going to split this into three sections, namely: High-level, high-level with problematic segment focus and a full permanent monitoring solution.

4.1 High-level permanent monitoring solution

The high-level permanent monitoring solution focusses on obtaining network statistics across the entire network/s and allows for network event logging and notifications to be sent to relevant personnel if a fault occurs or is likely to occur.

A ComBricks high-level permanent monitoring solution can obtain the relevant network statistics irrespective of whether or not repeaters or other media converters such as OLM's are installed on the network. As the high-level solution focuses primarily on the network statistics and not on the electrical characteristics of the signals, only one ComBricks module is required to monitor an entire network.

4.1.1 Example 1: High-level permanent monitoring of one PROFIBUS network

Let us take figure 19 below, as an example of our existing PROFIBUS network. Here we have our PLC with one CP card (for Network 1). There are two OLM's, one repeater and one DP/PA coupler installed on the network, hence we have three PROFIBUS DP segments and one PROFIBUS PA segment.

Note the locations of the terminations. For a high-level permanent monitoring solution of this network, we would need just one ComBricks head station and one single channel repeater module. The head station needs only to be of type 1B as only one network is being monitored, as opposed to a 1C head station that allows for monitoring of up to four networks.

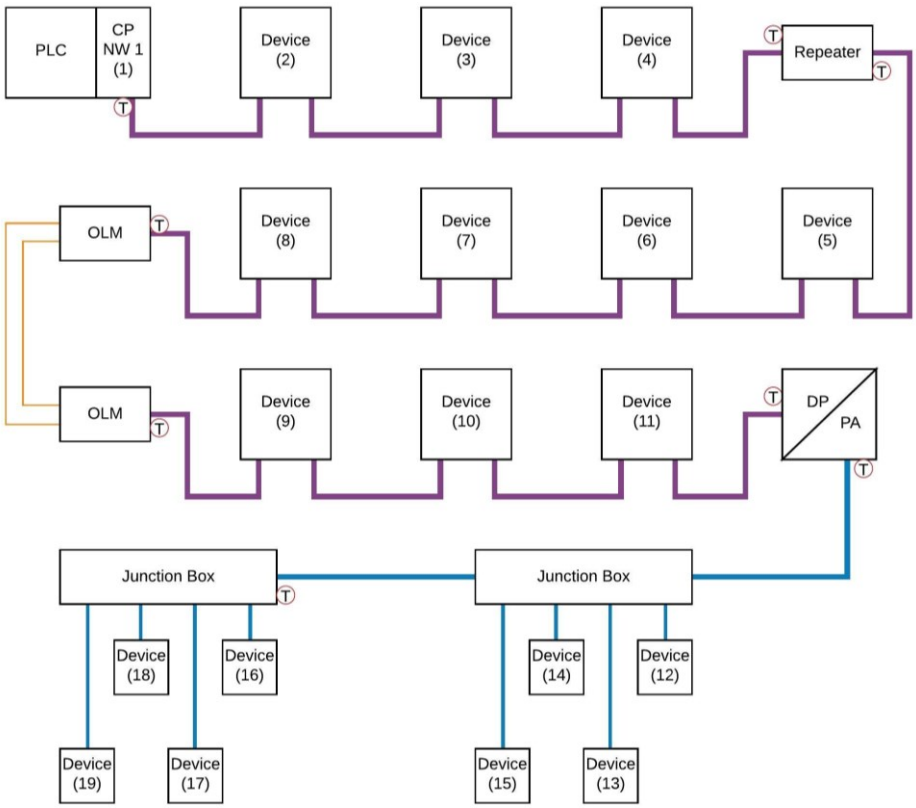

Figure 19: Existing PROFIBUS Network Layout - Single Network Example

The ComBricks unit can be installed at any point on the network. It is often convenient to install the ComBricks on the PLC segment as shown in figure 20 below. To do this, a new piece of PROFIBUS cable needs to be installed that daisy-chains from the PLC into the ComBricks. The termination that was enabled on the PLC is now disabled and instead, we enable the termination on the ComBricks.

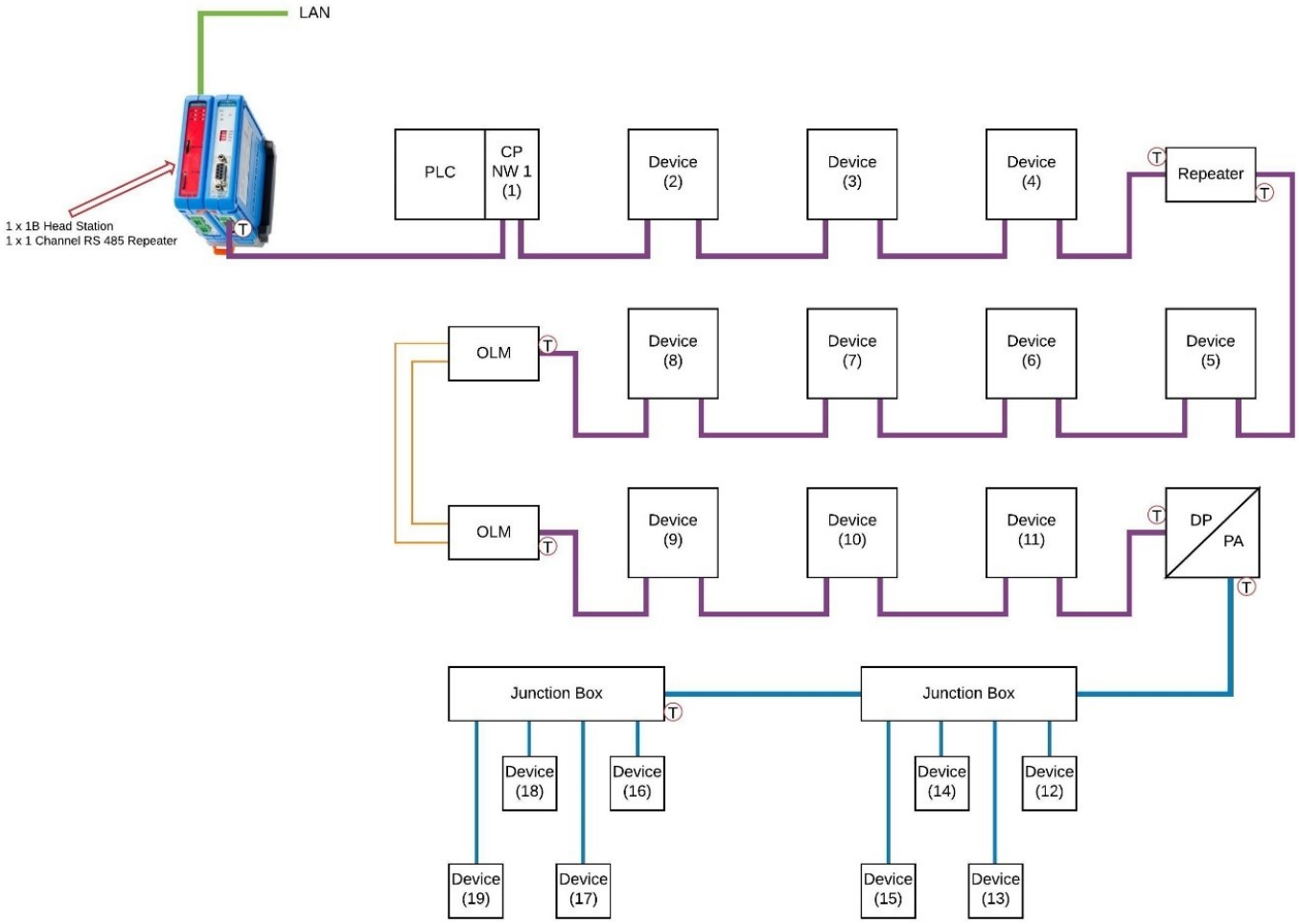

Figure 20: High-Level Permanent Monitoring - ComBricks Installed at PLC

There is no limitation with regards to ComBricks placement. If space constraints exist in the PLC panel, there is nothing stopping you from installing the ComBricks unit next to the 1st repeater (as shown in figure 21) which will again just require that a new piece of PROFIBUS cable is daisy-chained from the second channel of the repeater into the ComBricks and that the location of the termination is moved so that it is now enabled on the ComBricks instead of on the repeater.

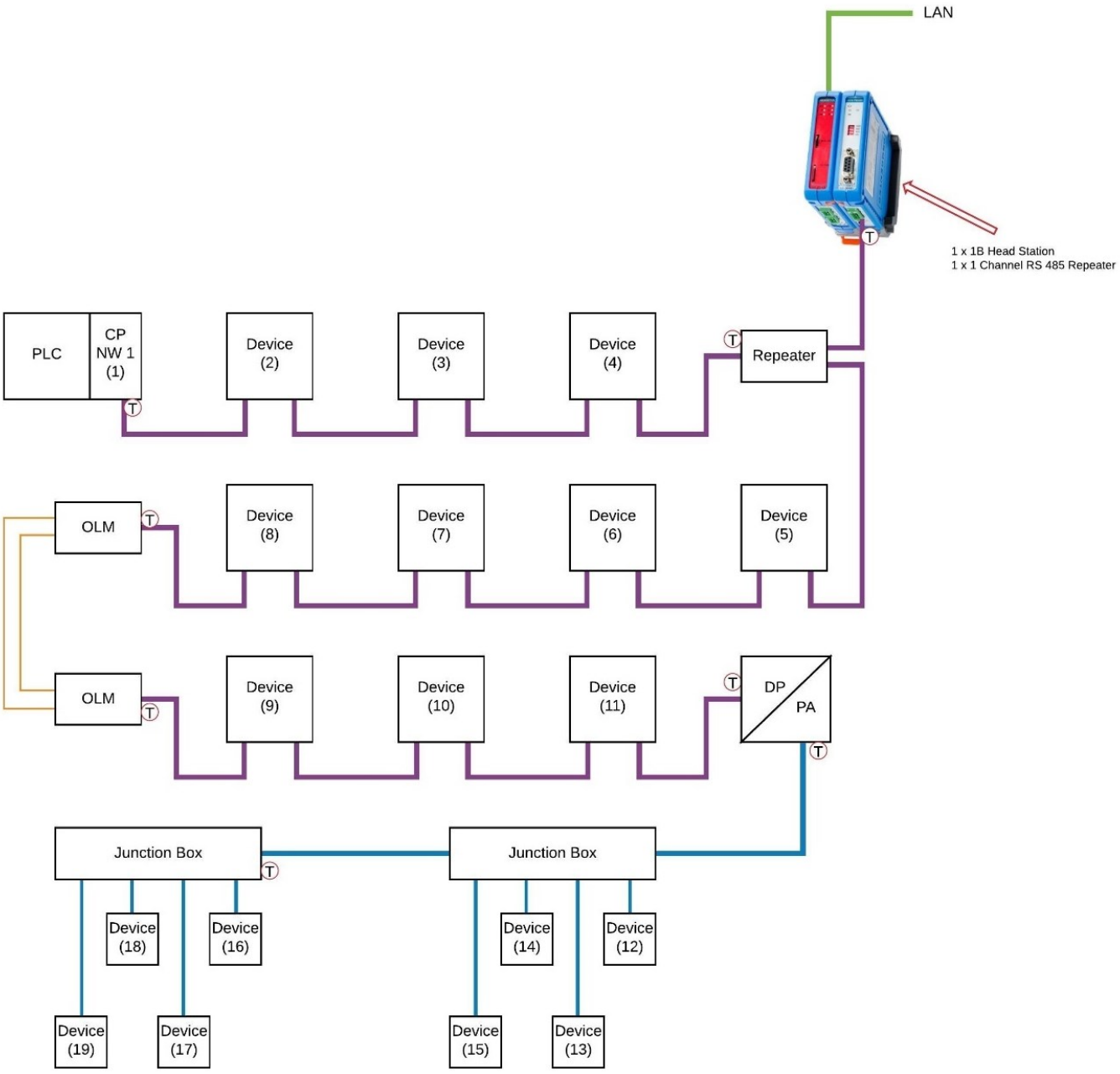

Figure 21: High-Level Permanent Monitoring - ComBricks Installed at Repeater

4.1.2 Example 2: High-level permanent monitoring of four PROFIBUS networks

It is possible to monitor up to four PROFIBUS networks using the 1C head station, which makes for a cost-effective solution that is easily managed. You will often find that the PLC consists of many CP modules, each one acting as a master to their respective networks. Have a look at figure 22 below for an example of an existing installation, here we have one PLC with four CP cards, hence four PROFIBUS networks.

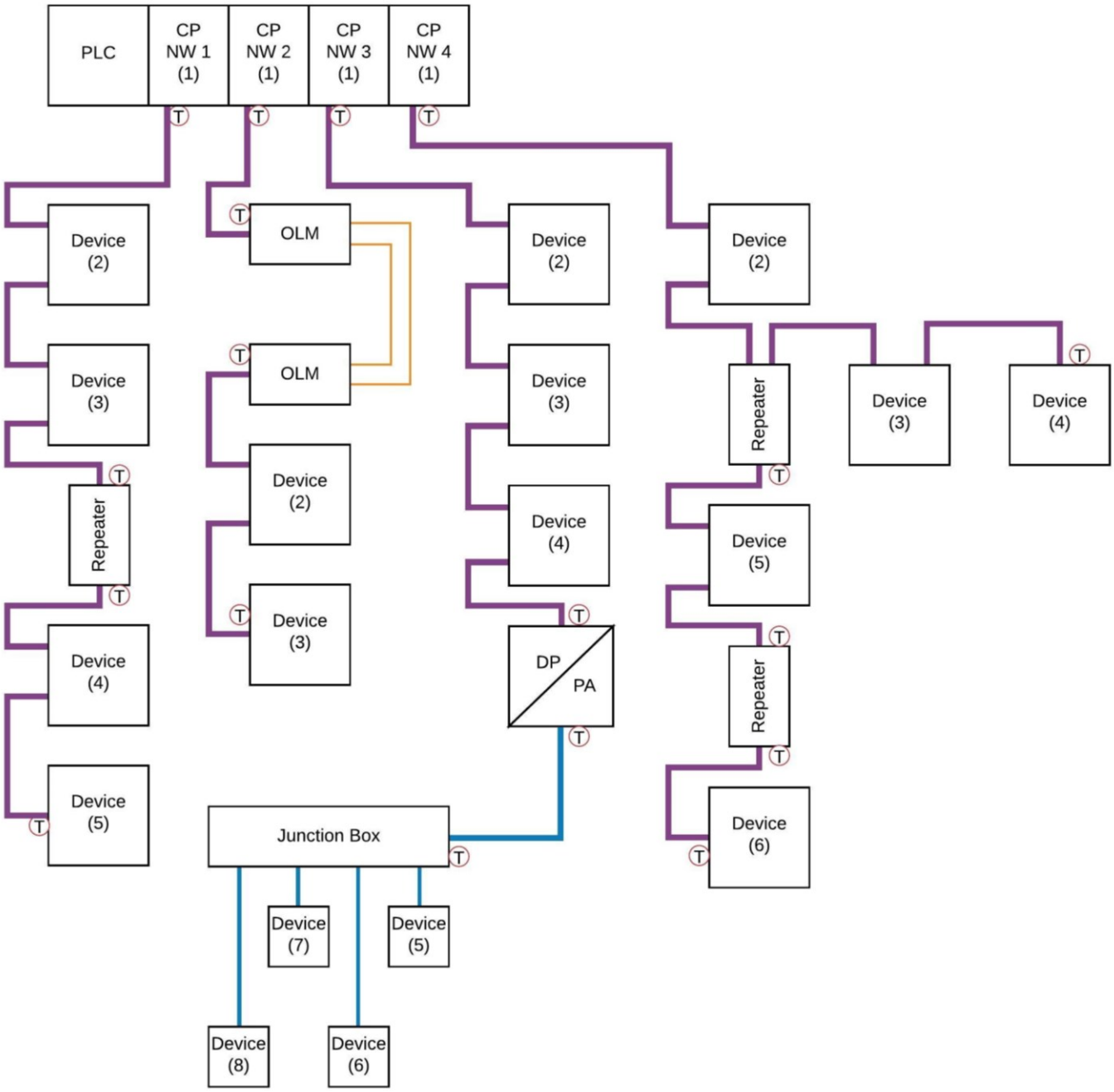

Figure 22: Existing PROFIBUS Network Layout - Four Networks Example

For a high-level permanent monitoring solution based on this example, we would need a ComBricks 1C head station and four single channel repeater modules. For ease of installation, and to minimise additional cable runs it is best to install the ComBricks solution near the PLC. We would simply need to daisy-chain out of each CP card into the respective single channel repeater modules.

The termination would be disabled on the PLC and would be enabled on the ComBricks modules instead. The DIP switches on each of the ComBricks modules are used to distinguish between each of the networks.

See figures 23 and 24 below:

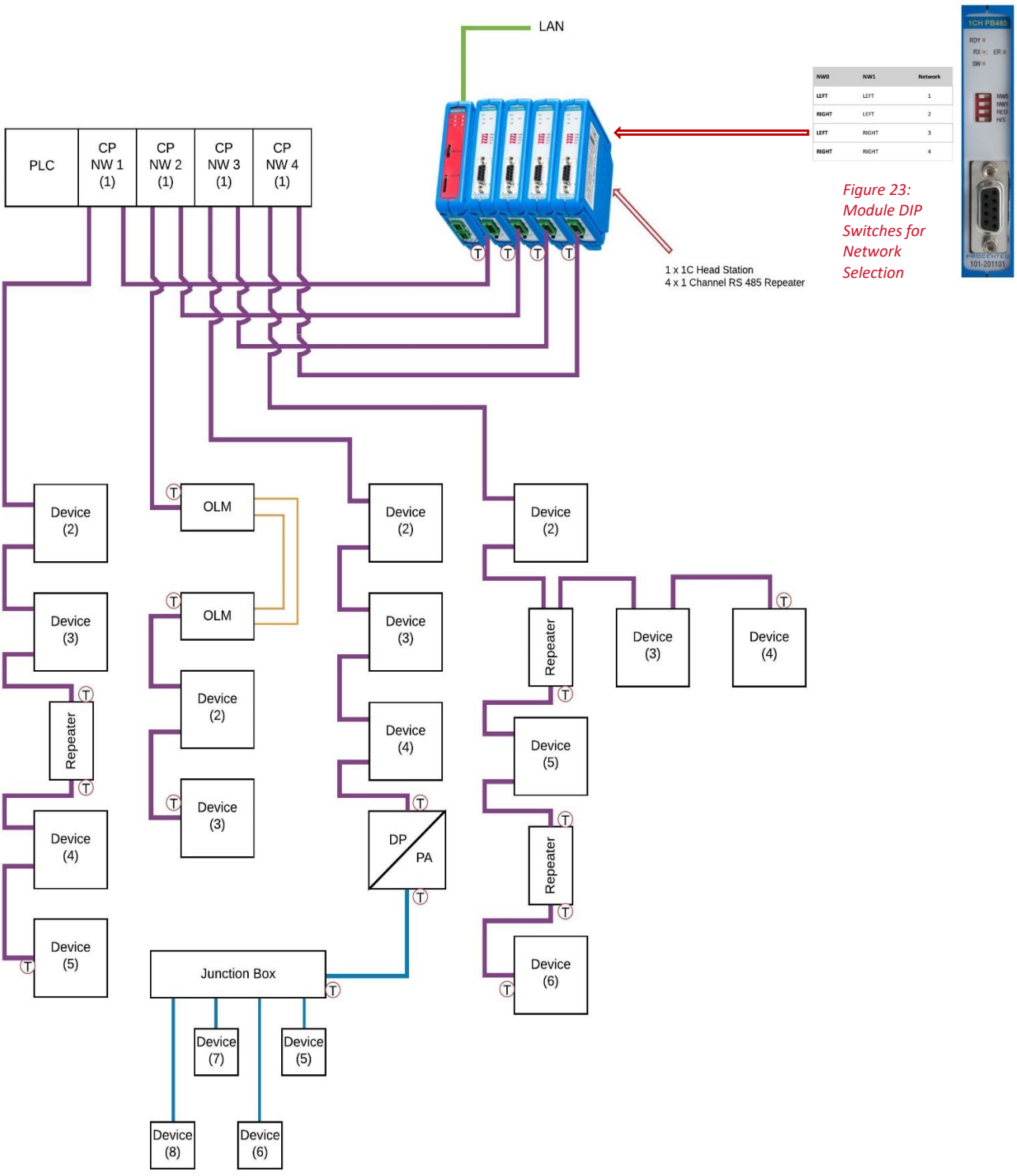

Figure 23: Module DIP Switches for Network Selection

Figure 24: High-Level Permanent Monitoring of Four Networks - ComBricks Installed at PLC

4.2 High-level permanent monitoring with problematic segment focus

If you are looking for a permanent monitoring solution that provides you with message-level diagnostics for the entire network and you are aware of a specific segment that seems to be problematic, then it is time to introduce the SCOPE repeater module.

4.2.1 Example 3: Specific segment focus on one PROFIBUS network

To explain this, we will refer to the example of our existing PROFIBUS network, see figure 25 below:

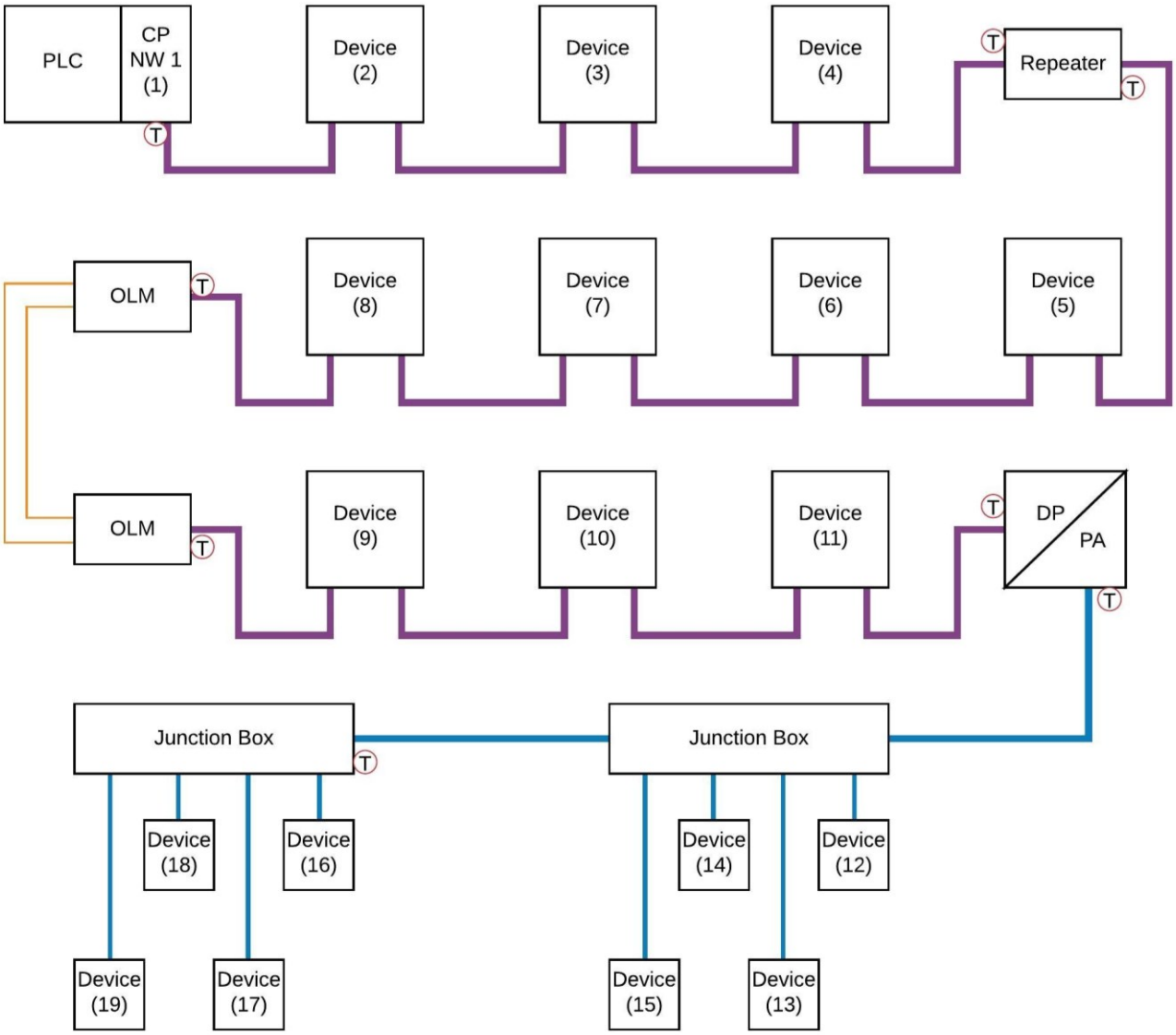

Figure 25: Existing PROFIBUS Network Layout - Single Network Example

In this case, let us assume that you are often experiencing problems that are affecting the segment after the OLM and before the DP/PA coupler which in turn affects the devices at addresses 9, 10, and 11. To obtain more information about this particular segment we would need to have a SCOPE repeater installed on this segment that gives us the ability to analyse the electrical characteristics of this particular segment.

Installing a ComBricks 1B head station and SCOPE repeater module at the 2nd OLM, i.e. Daisy-chaining out of the OLM into the ComBricks and moving the location of the end terminator, would provide the solution.

Having the SCOPE repeater module installed on this segment would now enable us to analyse the signal waveforms and bar graph driver voltages of all devices installed on this segment, this effectively means that we are now able to troubleshoot this particular segment in more detail.

Having insight into the electrical characteristics of a particular segment makes it easier to troubleshoot certain faults that you would not necessarily detect with message-level diagnostics. Faults that can be detected by analysing the electrical characteristics could include termination issues, impedance mismatches, noise/interference being injected onto the bus (EMI), cable breaks, and cable shorts.

It is important to point out that by installing the ComBricks at this point on the network you are not compromising your high-level monitoring. You will still be able to analyse and monitor the live list and statistics of all devices on the network, you are simply changing the installation location to gain additional information from a specific segment. Figure 26 below, shows how the ComBricks will be installed for this particular solution.

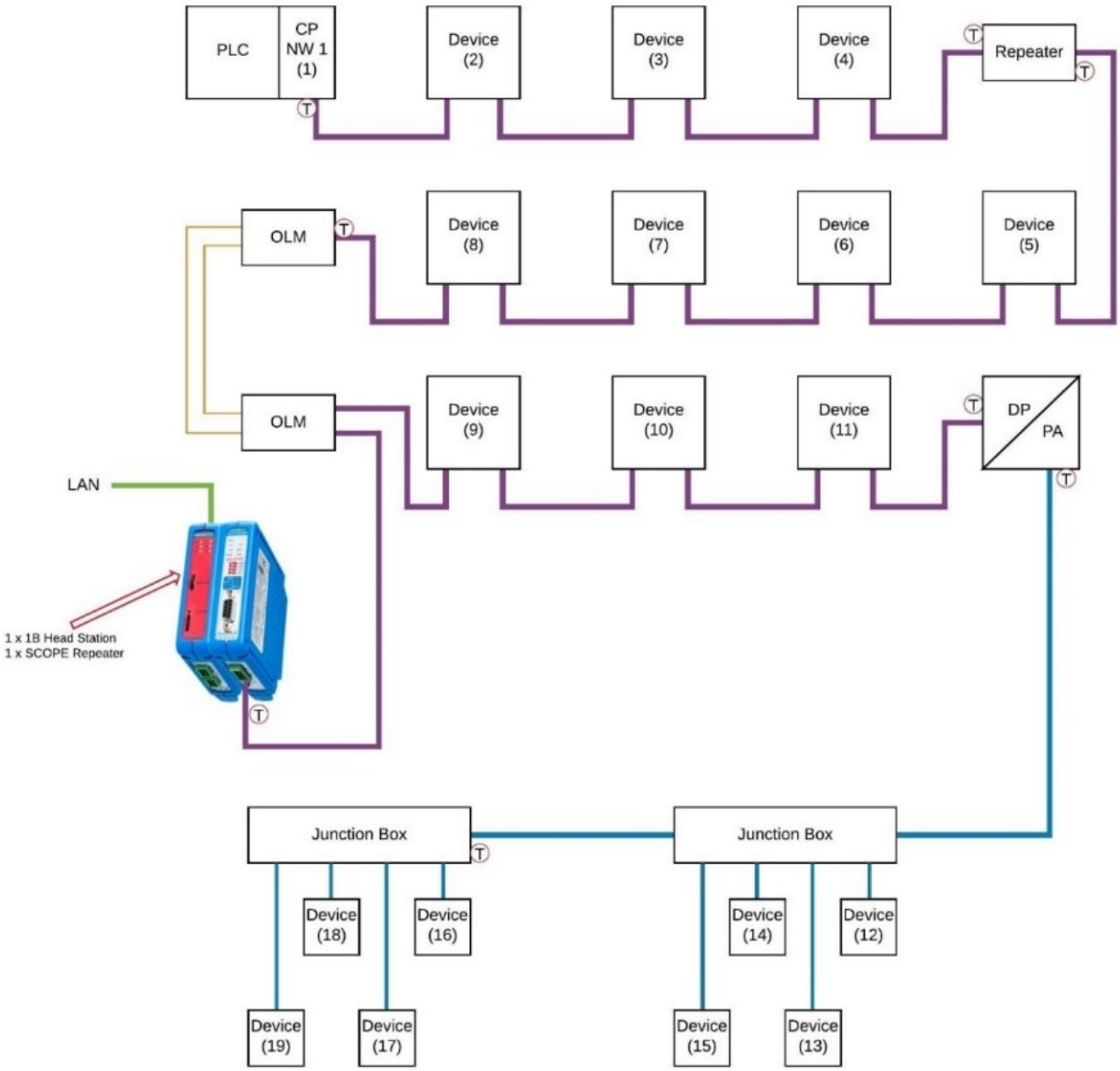

Figure 26: Specific Segment Focus Permanent Monitoring - ComBricks Installed on Problematic Segment

It is also possible to apply this principle to the PA segment whilst retaining the ability for message-level diagnostics (high-level monitoring) of your entire PROFIBUS network.

To accomplish this, we would need to use a 1B head station, a single channel repeater module (to monitor the PROFIBUS DP side) and a PROFIBUS PA link/coupler module that allows you to monitor the electrical characteristics (jitter, DC noise, amplitude, and signal waveforms) of your PA segment. This ComBricks solution could be installed on your network as illustrated in figure 27 below.

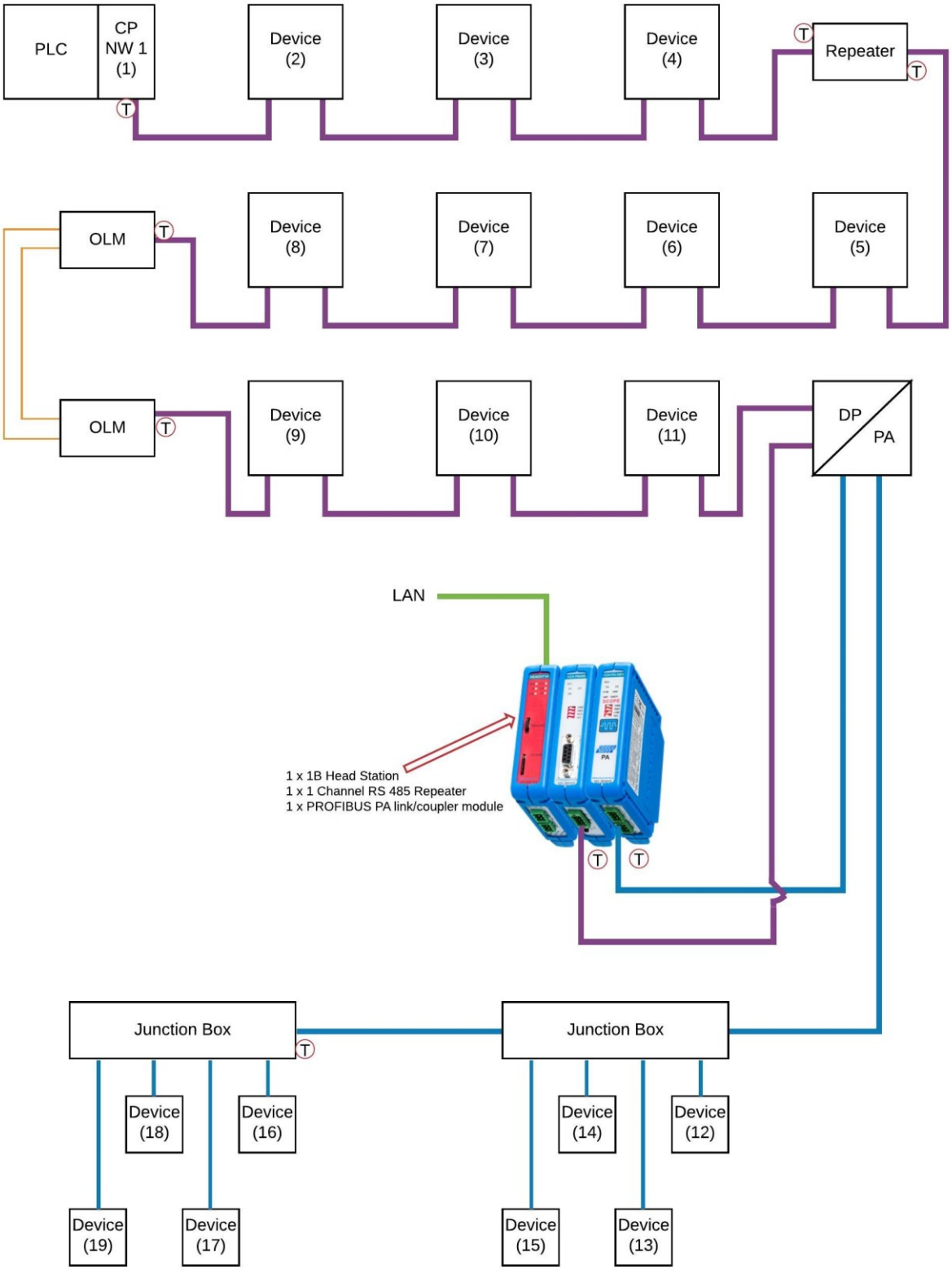

Figure 27: PA Segment Focus Permanent Monitoring - ComBricks Installed on PA Segment

4.3 Full permanent monitoring solution

A full permanent monitoring solution provides for the ability to monitor the electrical characteristics of each segment over and above the message-level diagnostics.

To accomplish this, additional ComBricks units with SCOPE repeater modules and PROFIBUS PA link/coupler modules will need to be installed across the network. To explain this, we will once again, take a look at our existing PROFIBUS network, see figure 28 below.

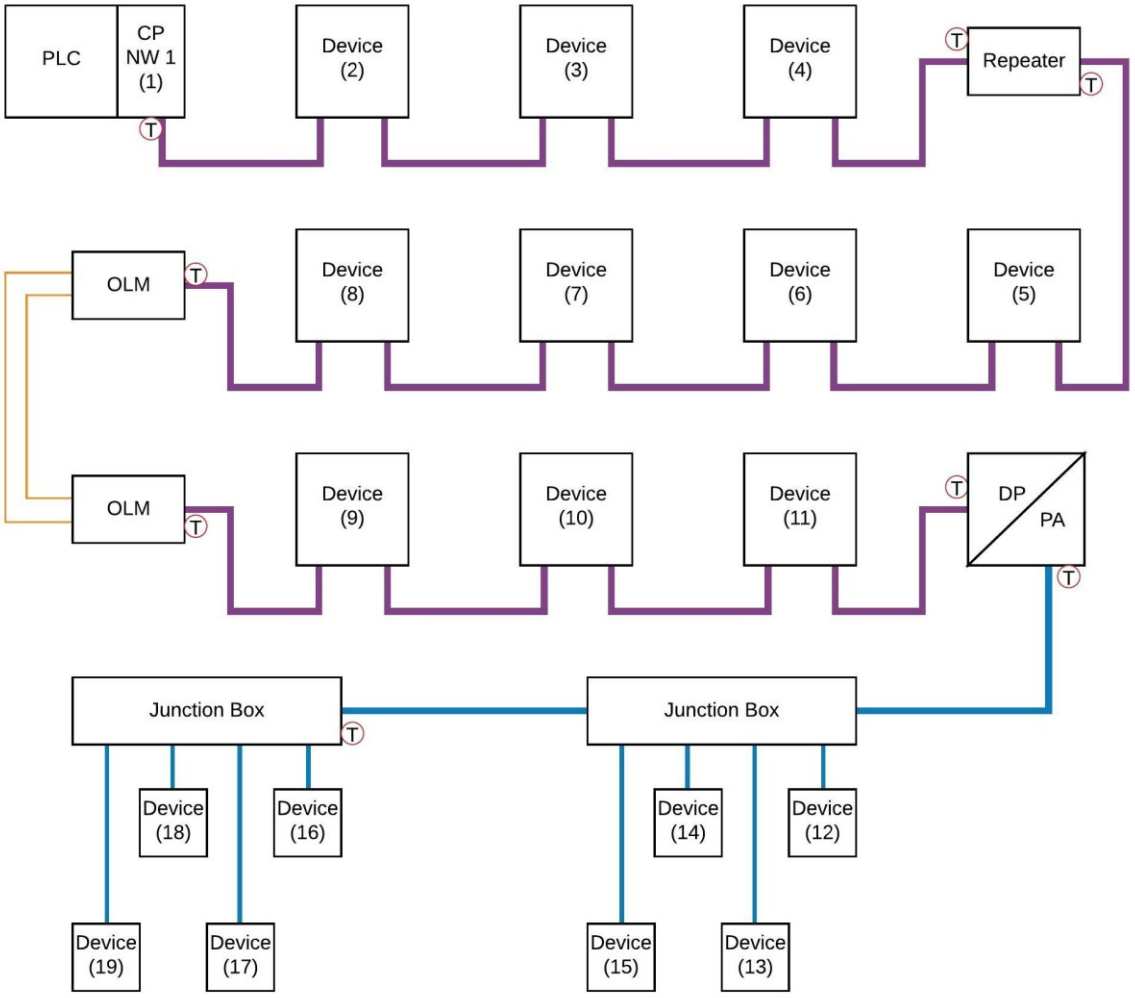

Figure 28: Existing PROFIBUS Network Layout - Single Network Example

4.3.1 Example 4: Full monitoring of one PROFIBUS network (Existing installation)

To be able to analyse signal waveforms and bar graph driver voltages of all devices across the network, ComBricks units with SCOPE repeater modules will need to be installed on each PROFIBUS DP segment.

An additional ComBricks unit with a PROFIBUS PA link/coupler module is required to monitor the electrical characteristics of the PROFIBUS PA segment. See figure 29 below.

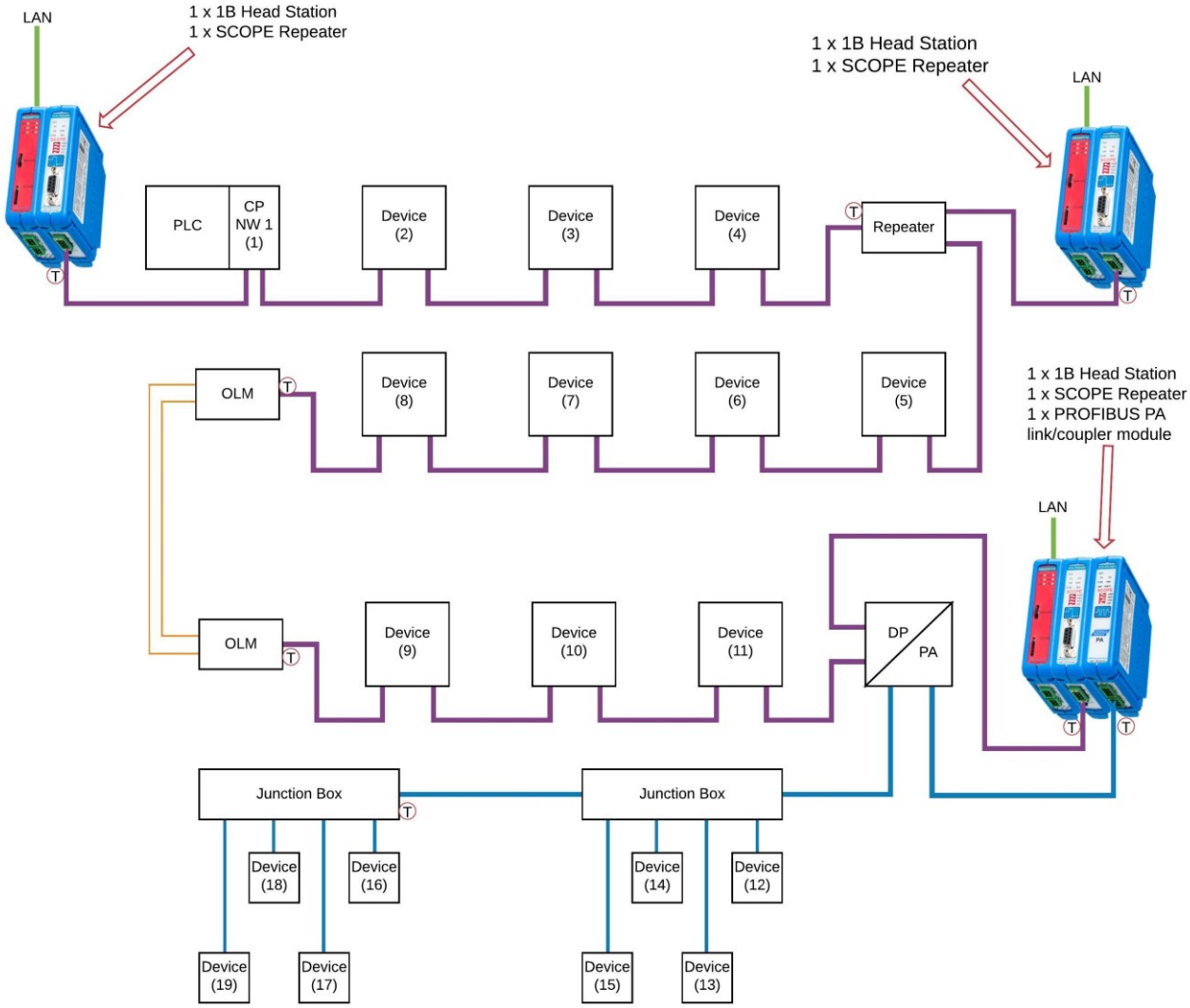

Figure 29: Full Permanent Monitoring - ComBricks Installed on Each Segment

4.3.2 Example 5: Full monitoring of one PROFIBUS network (Design proposal)

By implementing ComBricks at the design phase, it is possible to obtain full monitoring capabilities whilst at the same time, reducing the number of network components required throughout the installation.

As many of the ComBricks modules, in addition to providing monitoring functionality, also act in the same way as regular network components (repeaters, OLM's, PROFIBUS PA link or couplers) it is possible to design a network that meets all the requirements of a full permanent monitoring solution and provides for all your segmentation and isolation requirements associated with PROFIBUS installation limitations.

It is important to note that this is not solely aimed at new installations, existing network components can be replaced with ComBricks units that perform the same functionality and provide the ability for monitoring. See figure 30 below.

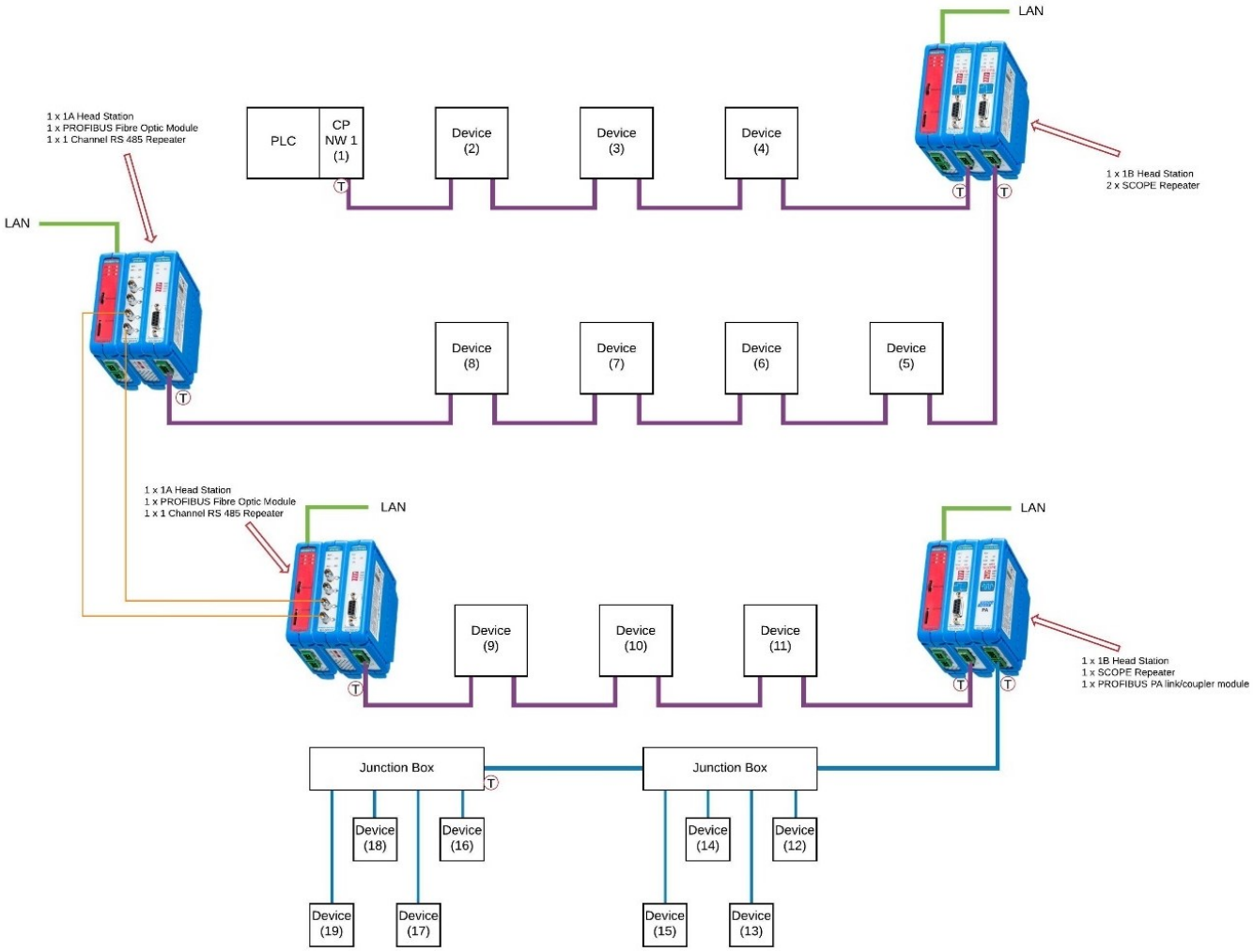

Figure 30: Full Permanent Monitoring - ComBricks New Network Design Proposal

5 Other useful tools and network components

There is additional software as well as compatible network components available that work hand-in-hand with your ComBricks permanent monitoring solution to both simplify and provide supplementary information with regards to the monitoring of your site. We will discuss the Network Condition Indicator (NCI) tool and ProfiHub integration in the following section.

5.1 Network Condition Indicator (NCI) tool

The NCI tool is free to download and offers users the ability to monitor multiple sets of ComBricks units across their site from one central location. ComBricks units are added into the tool using their respective IP addresses and the interface provides a traffic light overview of all ComBricks head stations.

The traffic light will turn either red or yellow when errors are detected on any of the ComBricks units, it is then possible to identify the individual ComBricks unit reporting the error and thus the network that is affected. It also offers easy access to the web page for any of the loaded ComBricks units which is especially useful when large quantities of ComBricks are installed across the site, no need to remember the IP address of each ComBricks unit, simply access the web page for a specific head station directly from the NCI tool.

Earlier in this document, I mentioned the importance of resetting all measurements once an error had been detected and corrected, this is usually actioned from the web page of the relevant ComBricks. With the NCI tool, this feature is included and allows you to reset all measurements of all loaded ComBricks units.

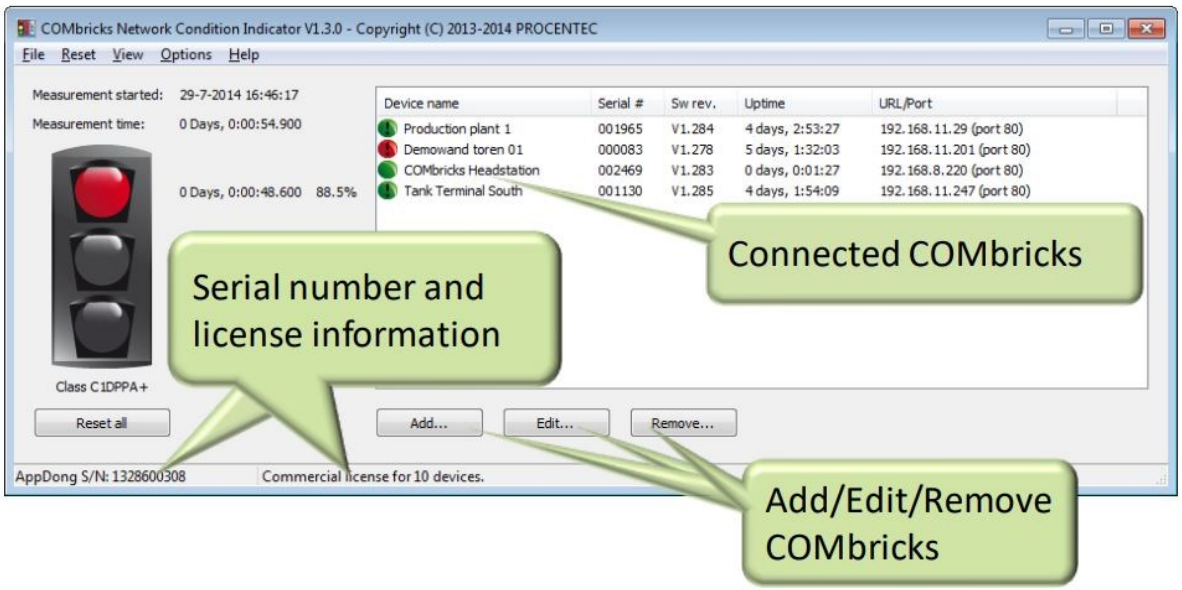

Figure 31: Network Condition Indicator (NCI) Tool

5.2 ProfiHub

The ProfiHubs (multi-channel repeaters) now feature diagnostic slave functionality, which means that they can report diagnostic information to the PLC or SCADA when configured. This new functionality is also fully compatible with ComBricks and when activated, offers complimentary information on each channel of the ProfiHub.

Configuration of the ProfiHub diagnostic slave is done from the web page of the ComBricks unit. Network parameters need to be entered into the configuration page and the internal PROFIBUS master of the ComBricks head station needs to be activated, after which, diagnostic information can be read directly. Once successfully configured, a new menu item “Diagnostic slave info” will be available on the ComBricks web page.

From this page you can analyse the number of illegal messages detected on each channel of the ProfiHub, allowing you to pinpoint communication issues to a specific segment. The page also boasts a visual representation of the ProfiHub and displays (in a live list-style representation) the devices that are connected to each channel, giving you a better understanding of the network topology.

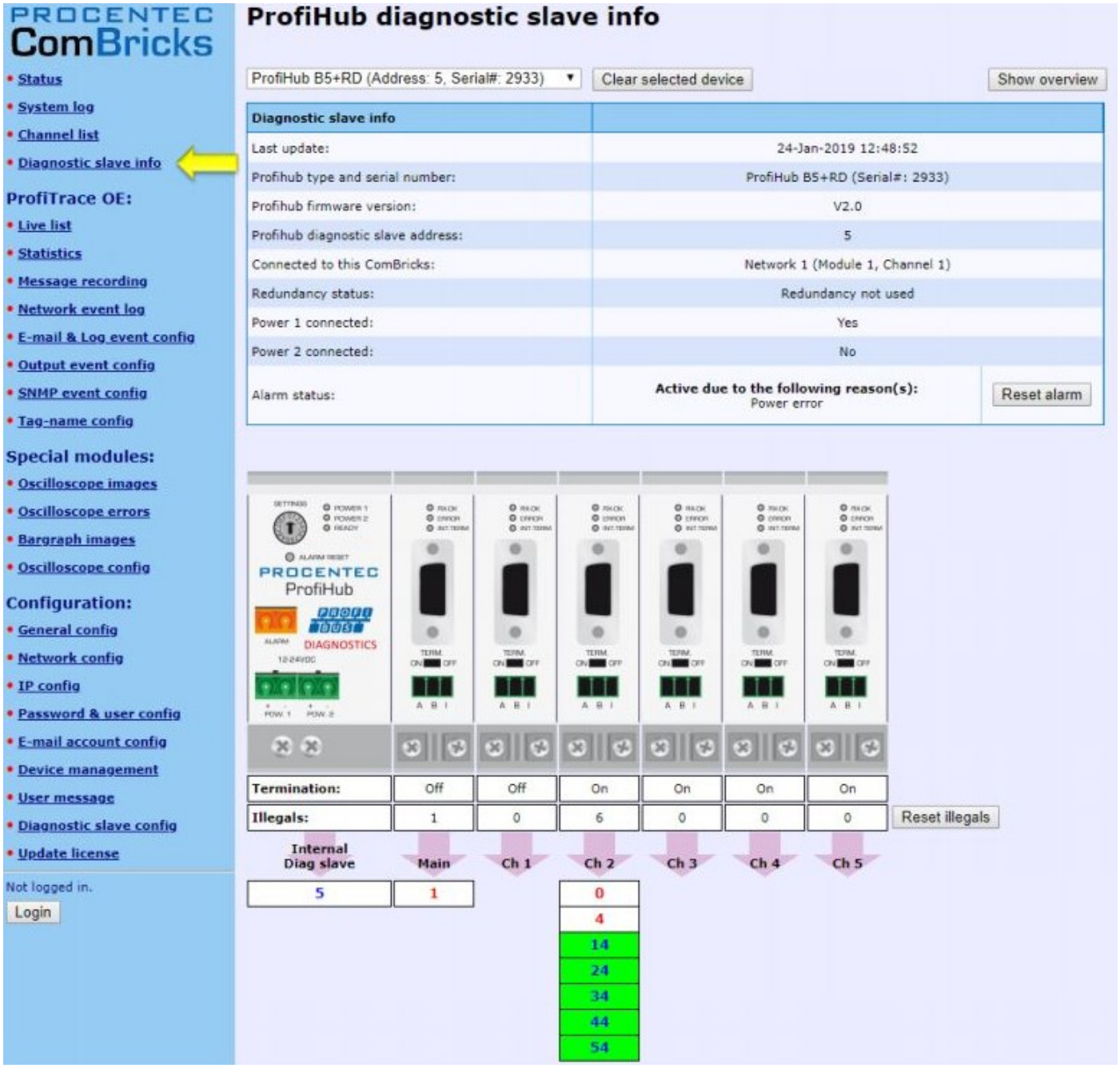

Figure 32: ProfiHub Diagnostic Slave Integration with ComBricks

6 The benefits of a permanent monitoring solution

Mitigating production losses due to industrial network failures is the single most important benefit that can be realised by incorporating a permanent monitoring solution at your plant or site. Having insight into your networks at all times allows the relevant personnel to stay on top of the network health.

Provided you have an internet connection and secure VPN access, a remote solution, such as ComBricks, allows you to monitor your networks from almost anywhere in the world. This principle can also be applied to reduce the number of costly call-outs associated with network faults. By granting qualified personnel temporary access to the ComBricks web page, PROFIBUS engineers will be able to troubleshoot your networks without needing to be on site.

The notification functionality introduces the concept of preventative maintenance, you want to be notified when something out of the ordinary occurs so that you can address it before it results in losses. There is no downside to permanent monitoring, so my recommendation is to invest in the required ComBricks infrastructure now so that you can start realising the benefits immediately!

7 Conclusion

Maintaining and monitoring PROFIBUS networks prevents unnecessary downtime that results in production losses and costly call outs. Having insight into each of your networks by means of a permanent monitoring solution provides you with the information needed to quickly identify and correct problems before they cause total network failures.

Remote access capabilities provide experienced professionals with the information needed to help diagnose network issues without having to be on site and the alerting functionality allows you as the user to take action based on notifications received directly from the system. It is important that personnel responsible for the PROFIBUS networks are equipped with the necessary knowledge required to identify faults and how to go about correcting such faults.

With that said, certified PROFIBUS training together with on-site diagnostics tools and permanent monitoring solutions will help you work towards failure-free networks that maximise production and profits.

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