Technology for smarter trains
Meeting the challenges of modern train management systems
Modern trains are equipped with an increasing number of intelligent sub-systems to cope with the demands for improved performance, safety, energy efficiency and comfort. This evolution brings a number of challenges to train manufacturers, operators and system integrators. For instance, the lack of interoperability and integration between the different sub-systems may lead to a complicated system architecture and various technical challenges. We can say that the higher the number of separate sub-systems on-board, the higher the costs for train design, manufacturing, operation, maintenance and refurbishment.

EKE developed Trainnet® to be a versatile and comprehensive answer to all these challenges. Trainnet® is what I would like to call a “Super TCMS”, a Train Control and Management System that is fully capable of integrating all communication and safety enhancing systems such as PIS/PA, Event Recorders, HMI, GPS, 3G/WIFI and CCTV. The Trainnet® TCMS is fully capable of interacting with other on-board sub-system and provide you with additional features such as centralized control and diagnostics. The idea behind Trainnet® is to provide a single platform for the integration and automation of all train-borne intelligent systems. The Trainnet® concept enables us to offer an open, flexible, and cost-effective solution for any train. We provide you with turnkey integration services making your life easier.

Pekka Kuusela, Chief Executive Officer
Our products

The product section presents EKE’s technologies for train automation, system integration, onboard communication and increased safety. All the products are part of the Trainnet® family and use the same modular platform for maximum freedom and synergy.

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Technology for smarter trains

EKE provides leading technologies to train manufacturers, operators and integrators for improved train manufacturing and operations.

We provide tailored solutions for system integration, train automation, train communications and improved safety. We have solutions for high speed trains, commuter trains, metros, trams, passenger coaches and locomotives.

We are the experts for Train Control and Management Systems (TCMS), Train Communication Networks (TCN), Vehicle Control Units (VCU), Gateways, Ethernet Train Backbones (ETB) and Event Recorders.

Our expertise ranges from developing complete turnkey solutions to providing specific Hardware and Software products. We can also provide training, tools and guidance to support your own developments.

EKE is IRIS certified and our products comply with the International Railway Industry Standards such as EN 50155.

INTEGRATION
Integrate on-board systems via an efficient and versatile Train Communication Network (TCN). Hybrid networks are also supported.

AUTOMATION
Automate operations and diagnostics by developing a powerful Train Control and Management System (TCMS).

COMMUNICATION
Communicate with passengers and staff in the train and beyond via displays, audio announcements and wireless technologies.

SAFETY
Improve safety with our SIL technology, redundancies and safety enhancing systems such as Event Recorders and video surveillance.
Our promises

**PERFORMANCE**
- Most advanced technology…
  … that works together with older technology!
- Improved train operation reliability and safety
- Improved comfort and services to passengers

**FLEXIBILITY**
- Modular systems matching both your current and future needs
- Open platform and open standards for easy and unrestricted developments
- Integrate any system, even from third parties

**COST EFFICIENCY**
- Lower costs of design, installation and operation
- Faster diagnostics and maintenance to optimise train use
- Reduced cabling and weight with a more compact solution
EKE has 30 years of experience in Railways, working with high speed trains, commuter trains, metros, trams, passenger coaches and locomotives.

We have already installed more than 12,000 systems around the world and we continue to serve our customers with the highest quality and reliability.

Contact us for more information on our experiences and capabilities:

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www.eke-electronics.com

**Talgo AVRIL High Speed Train**

TCMS with Train Communication Networks. Includes WTB, MVB, CAN, Ethernet, I/O modules as well as SIL-2 functionalities.

**São Paulo Metro**

Metro trains provided with TCMS, Train Communication Networks, PIS, CCTV, Video and Event Recorders (RMM).

**London Underground**

TCMS, Driver display modules, Serial links to ATO, ATP, Train radio and brake controllers.

**Finnish Pendolino**

Gateways, Brake diagnostics data transmission system, Speedometers, Displays and Event Recorders.
Some of our reference projects

We have worked with our customers on both new trains and refurbishment projects from the frosts of Finland to the heat of Australia.
Waratah Australia

We at EKE strive to push the boundaries of existing technologies in order to serve our customers with unparalleled safety, performance and cost-effectiveness. We designed the first Train Communication Network (TCN) fully based on Ethernet and industry standard IP-protocols for the Sydney Double-Deck Suburban Waratah Trains. 78 trains of 8 cars (624 cars) were equipped with Trainnet® systems between 2007 and 2012.

All sub-systems were integrated into the Trainnet® TCMS for comprehensive train control and diagnostics. Deliveries included TCMS, Driver Display Units (DDU), Guard Display Units (GDU), TCN (including Ethernet Switching Units with Power-over-Ethernet), Event Recorders with Rugged Memory Modules, an automated Passenger Information System and Radio link interfaces.
Products
The Trainnet® TCMS improves train performance and safety while decreasing maintenance and operating costs.

The Trainnet® Train Control and Management System (TCMS) provides a single point of control over all train sub-systems. The TCMS enables control and monitoring over virtually any sub-system and function, for instance doors, brakes, PIS/PA and video surveillance, to name a few.

Using a unique control and management system allows for a simplified Train Communication Network (TCN). The train architecture becomes more efficient, thus saving on development and maintenance costs. In addition, the centralized TCMS is used to automate train operations and sub-system diagnostics, enabling increased reliability and quicker response times.

**EFFICIENT INTEGRATION**
The core of the Trainnet® TCMS is the Trainnet® Train Communication Network (TCN). The Trainnet® TCN is the infrastructure enabling the exchange of information throughout the train. It connects all the train sub-systems together via a common network (or several when requested), enabling centralized control.

In practice, the TCN consists of train computers, commonly referred to as Gateways, connected to each other as well as to train sub-systems. Trainnet® Gateways support multiple interface technologies including WTB, MVB, CAN, Serial Links and Ethernet. For more detailed information, please refer to the TCN and Gateway sections.

**TRAIN AUTOMATION**
The Trainnet® TCMS can be used to automate the train sub-systems. In most modern trains, on-board sub-systems generate a large quantity of data which is essential for safety (speed, braking, faults etc.) and operation purposes (system status, energy consumption, video recording etc.). The Trainnet® TCMS is able to gather this data, analyse it, and send logical commands and warnings. The information can be automatically exchanged between sub-systems and conveyed in real time to the train driver, the train captain, remotely located personnel and even passengers.

The Trainnet® TCMS is a versatile train computer which can be used in a number of applications such as:
- Diagnostics
- Automatic Train Inauguration
- PIS/PA system management
- Crew HMIs management
- Brakes and traction monitoring
- SIL and Safety Applications
- Fleet Management
- HVAC management
- Door management
- Lighting management
- CCTV system management
- Tank level monitoring
- Battery charge monitoring
- Train-to-wayside communication management

For more detailed descriptions of these applications, please refer to the Application Software section.

Trainnet® enables these applications to run on the same train computers that are used for Gateway functionalities, providing a more compact and cost-effective solution. Physically separated train computers can also be implemented, sometimes referred to as Vehicle Control Units (VCU).

Trainnet® systems provide all the necessary interfaces to connect with the sub-systems and the Train Communication Network.

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### Advantages

**Versatility**
Cover all your needs with a single system.

**Modularity**
Only pay for the features you need.

**Open software**
Keep control over your project at all times.

**Long term support**
Get support during the lifetime of your project.
Available technologies include a wide range of Bus Interface Modules (e.g. WTB, MVB, CAN, Serial Links and Ethernet) and Input/Output Interface Modules (Analogue Input, High Speed Analogue Input, Digital Input/Output, Digital Relay Output, Analogue Output, Pt-100 temperature Sensor Input). Remote Input/Output Modules (RIOM) are also available.

MORE CONTROL
The Trainnet® TCMS is a powerful and highly flexible system built on an open source software platform (Linux). You are free to develop your own applications as well as to integrate third party Hardware and Software onto the Trainnet® platform. With Trainnet®, you can develop your own applications using the ISaGRAF PLC Software. You can also develop applications as well make configuration modifications in C language, giving you full control. EKE has the expertise to develop all or a part of the Software for you, or alternatively provide training, tools and guidance to support your own developments. Finally, EKE can grant you the intellectual property rights (IPR) of the application Software in order to ensure you a safe, long-term investment.

On the Hardware side, the Trainnet® TCMS is modular. This means you can develop tailored systems matching your needs perfectly. By simply selecting the interfaces you need, you make sure the system answers all your demands while being cost-efficient. Systems can be easily upgraded with additional modules as needs arise.

QUALITY AND RELIABILITY
The outstanding quality and the unique design of Trainnet® products guarantee unparalleled reliability. Trainnet® products minimize the need for maintenance while maximizing train availability, providing a long-term cost benefit for operators. We provide support for more than 30 years in order to ensure that our customers are satisfied during the entire life-time of their project.

EKE is IRIS certified and Trainnet® complies with the railway industry standards, including the IEC 61375 series, IEC 61131 and EN 50155.
Trainnet® TCN is a highly reliable Train Communication Network used all around the world. It complies with the IEC 61375 standard for TCNs.

**WHAT IS A TCN?**
A Train Communication Network (TCN) is the infrastructure enabling the exchange of information throughout the train. It usually consists of a Vehicle Bus for intra-vehicle communications and a Train Bus for train-wide information exchange. Traditionally the highly standardized WTB (Wire Train Bus) technology is used as a train bus and MVB (Multifunction Vehicle Bus) as a vehicle bus. Other bus technologies such as CAN, Serial Links and PROFIBUS are also widely used as vehicle buses. MV or CAN can also be used to develop train-wide communication networks. The Ethernet bus technology (e.g. Ethernet Train Backbone, ETB) is a relative newcomer to be used as part of a TCN but has gained popularity in recent years, providing larger bandwidth and more flexible networks.

**EFFICIENT INTEGRATION**
There is often a lack of interoperability and harmonization between the different train sub-systems. Consequently, it is common to have several sub-systems within the train that use their own separate communication network and technologies. This leads to a complicated architecture and Software as well as excess wiring. The development of a single, fully integrated system greatly simplifies train management system architecture and allows significant savings.

Trainnet® Train Communication Network enables the concurrent use of multiple bus technologies including Ethernet, WTB, MVB, CAN and Serial Links, making it suitable for both new trains and refurbishment projects. By selecting only the bus technologies that you need, you can develop a fully customized system and keep costs down. This versatility allows the deployment of a single integrated communication network across the train, connecting all the train sub-systems together. Multiple independent networks can of course be deployed if that is what your project requires.

The Trainnet® TCN provides efficient and reliable communication and data-routing between systems and different networks throughout the train as well as to the wayside. The information conveyed by the Trainnet® TCN can be accessed from any point on the network and even remotely (e.g. from depot). Redundancy can be implemented for additional reliability, with the possibility to use a different technology for the redundant path if required. Finally, the Trainnet® open Software (Linux) enables you to develop your own applications freely and keep control over your project at all times. EKE also has the expertise to make all or a part of the Software for you, or alternatively provide training, tools and guidance to support your own developments. EKE can give you the intellectual property rights (IPR) of all applications Software to make sure you make a safe long-term investment.

**COMPARISON OF TRAIN BUS TECHNOLOGIES:**

<table>
<thead>
<tr>
<th></th>
<th>WTB (Wire Train Bus)</th>
<th>ETB (Ethernet Train Backbone)</th>
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</thead>
<tbody>
<tr>
<td><strong>Bandwidth</strong></td>
<td>1 Mbit/s</td>
<td>100 Mbit/s or 1Gbit/s*</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>32 nodes and a maximum</td>
<td>63 nodes and a maximum length</td>
</tr>
<tr>
<td><strong>network length</strong></td>
<td>overall length of 860 meters</td>
<td>of 100 m between nodes</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>IEC 61375-2-1</td>
<td>IEC 61375-2-5</td>
</tr>
</tbody>
</table>

*1Gbit/s is not standardized but technically available"
Example 1: Dynamic train configuration, no redundancy

Example 2: Dynamic train configuration, redundant train bus

Example 3: Fixed train configuration, fully redundant network

KEY APPLICATIONS

→ Redundancy
Building a redundant Train Communication Network (TCN) enables you to ensure continuous operations in case of a failure somewhere in the network. Where a single point of failure would disable the entire network (see Example 1), a redundant network provides alternative communication paths (see Example 3). Redundancy aims at eliminating single point of failures for flawless operations, even when malfunctions or breakdowns occur in the network. Implementing redundant networks helps preventing train immobilization and ensures availability of train functionalities at all time. Redundancy improves reliability and safety while saving costs in the long run.

→ Automatic Train Inauguration
Automatic Train Inauguration means that train consists can be connected, disconnected or switched without jeopardizing the train operations (Examples 1 and 2). Train configuration changes are automatically detected and the inauguration identify each car and its orientation thus enabling communications across the Train Communication Network. In the case of a fixed train set, the automatic inauguration may also be required in order to connect several trains together.

Trainnet® train bus technologies such as WTB and ETB (Ethernet Train Backbone) enable automatic inauguration. Even though MVB does not allow automatic inauguration EKE has developed a solution to dynamically configure trains using MVB bus as backbone. When a completely fixed train set is used, a cost-effective train communication network can be built without a dynamic train bus (Example 3).

→ Decentralized Event Management
Trainnet® TCN technology enables you to build a centralized system with full control over the system from anywhere in the network. It is also able to keep key information and instructions spread over the network. Where in some systems, the applications and event logs are kept in a central computer, Trainnet® TCN allows for each car to run its own applications as well as logging its faults and alarms. It means that if one computer fails, the functionality and logs of the other coach computers are preserved.

COMPATIBILITY
For a compact and efficient system, Trainnet® TCN Gateways can be used as part of a broader Trainnet® solution, for instance associated with an Event recorder, a Vehicle Control Unit (VCU) or as part of a complete TCMS. The Trainnet® TCN Gateways can also be used together with your own equipment or with sub-systems from other providers.

QUALITY AND RELIABILITY
The outstanding quality and the unique design of Trainnet® products guarantee unparalleled reliability. Trainnet® products minimize the need for maintenance while maximizing train availability, providing a long-term cost benefit to operators. We provide support for more than 30 years in order to ensure that our customers are satisfied during the entire life-time of their project.

EKE is IRIS certified and Trainnet® complies with the railway industry standards, including the IEC 61375 series, IEC 61131 and EN 50155.
TCN Gateways

The Trainnet® TCN Gateways are advanced train computers used in the creation of efficient Train Communication Networks (TCN).

**MODULAR CONCEPT**
The Trainnet® TCN Gateways are modular, enabling you to precisely select the train bus and vehicle bus technologies you require. Modules can be freely combined for a very flexible and versatile solution. The modular design enables you to select only the features you need for a cost-efficient solution. It also means that repairs and upgrades are quick and easy.

**A Trainnet® TCN Gateway usually consists of a Central Processing Unit (CPU), a power supply and at least one Bus Interface module. EKE has developed a comprehensive range of CPUs, power supplies and bus interface modules to accommodate most technical requirements and budgets. Please find below an example of a Gateway made of a selection of common modules.**

**BUS INTERFACES**
Trainnet® TCN Gateways can combine some or all of the following train and vehicle bus technologies, as your needs require:

- **Wire Train Bus (WTB)**
The WTB interface usually has two DE-9 connectors with redundant lines integrated in each connector. A version with 4 connectors and one with fritting are available as options.

- **ETB (Ethernet Train Backbone)**
The Ethernet Train Backbone is implemented with the Trainnet® ERU module. The ERU module is an Ethernet Switch and Router providing 10 Ethernet ports, 4 of which are dedicated to the ETB (with redundant lines).

- **ECN (Ethernet Consist Network)**
An ECN can be used as vehicle bus but also as train bus in the...
case of a fixed consist. Trainnet® Ethernet Switches (ERU, 3U ESU, 1U ESU, UM-ESU) can be used to create ECNs. Power-over-Ethernet is available as an option with the 1U ESU modules to provide power to connected sub-systems via the Ethernet cables.

- **Multifunction Vehicle Bus (MVB)**
  The MVB physical medium can be ESD+, EMD or OGF. ESD+ and EMD have two DE-9 connectors with redundant lines integrated into each connector. The OGF comes with 4 ST-bayonet fiber connectors.

- **CAN Vehicle Bus (CVB)**
  The Trainnet® CAN module has two DE-9 connectors and is used to create up to two CAN buses. The 2 CAN ports can be independently configured as CAN 2.0 A/B or CANopen®.

- **Serial Links (S/L)**
  Serial Links interfaces can be used to create Vehicle Buses even though they are commonly used for direct connection to sub-systems. The physical layers RS-485 and RS-422 are supported. Modbus and customized protocols can be used.

Please contact us to discuss which architecture and modules best meet your requirements.

Trainnet® TCN Gateways are designed with ease of use in mind. Most Trainnet® modules have interface connectors at the front and communicate with each other via the backplane (includes VME bus). Mechanical coding of DE-9 connectors is available as an option.

**RACKS**
The Trainnet® TCN Gateways are usually provided as fully integrated systems, fitting in either 44TE or 84TE wide rack. The rack height is typically 3U or 6U. Other rack sizes like 20TE are also available: please ask us.

**MORE THAN A GATEWAY**
Other modules such as Event Recorders and Discrete Input and Output modules can also be integrated into the same rack to build a compact and cost-efficient train computer or TCMS.

**SUPPORT**
EKE provides at least 30 years of support for all Trainnet® products.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**
  - 3U 44TE Rack
    - 280 mm x 133 mm x 215 mm
    - (Installation width 240 mm)
  - 3U 84TE Rack
    - 483 mm x 133 mm x 215 mm
    - (Installation width 443 mm)
  - 6U 84TE Rack
    - 483 mm x 266 mm x 215 mm
    - (Installation width 443 mm)
  - Weight
    - Depends on rack and installed modules
  - Input Voltage
    - 24, 48, 52, 72 or 110 V DC
  - Temperature Range (operational)
    - -40 °C...+70 °C
  - MTBF (40 °C ambient temperature)
    - Depends on installed modules
  - Interface Options:
    - WTB, MVB, CAN, Ethernet, Serial Links

Read Module pages for more details.
The Trainnet® Vehicle Control Unit (VCU) is a powerful computer for train automation. The Trainnet® VCU can carry out advanced control and diagnostic functions.

The Trainnet® VCU can control any train sub-system such as brakes or doors. It can be used for both physical control (e.g. opening/closing/locking the doors, activate heating/cooling/ventilation etc.) and diagnostics (e.g. checking the proper closing of a door, monitoring brake temperature etc.) of train sub-systems. Please find below common applications:

- Diagnostics
- PIS/PA system management
- Crew HMIs management
- Brakes and traction monitoring
- SiL and Safety Applications
- Fleet Management
- HVAC management
- Door management
- Lighting management
- CCTV system management
- Tank level monitoring
- Battery charge monitoring
- Train-to-wayside communication management

For more details, please visit our Application Software pages.

Trainnet® enables these control and diagnostic applications to run on the same train computers that are used for Gateway functionalities, providing a more compact and cost-effective solution. Physically separated Gateways can also be implemented.

**KEY FEATURES**

The Trainnet® VCU can connect with sub-systems and the Train Communication Network. Available interfaces include a wide range of bus technologies (e.g. WTB, MVB, CAN, Serial Links and Ethernet) and Input/Output Interface Modules (Analogue Input, High Speed Analogue Input, Digital Input/Output, Digital Relay Output, Analogue Output, Pt-100 temperature Sensor Input). Remote Input/Output Modules (RIOM) are also available.

**MORE CONTROL**

The Trainnet® VCU is a powerful and highly flexible system built on an open source software platform (Linux). You are free to develop your own applications as well as to integrate third party Hardware and Software onto the Trainnet® platform.

With Trainnet®, you can develop your own applications using the ISaGRAF PLC Software. You can also develop applications and make configuration modifications in C language, giving you full control. EKE has the expertise to develop all or a part of the Software for you, or alternatively provide training, tools and guidance to support your own developments. Finally, EKE can grant you the intellectual property rights (IPR) of the application Software in order to ensure you a safe, long-term investment.

On the Hardware side, the Trainnet® VCU is modular. This means you can develop tailored systems matching your needs perfectly. By simply selecting the interfaces you need, you make sure the system answers all your demands while being cost-efficient. Systems can be easily upgraded with additional modules as needs arise.

**SUPPORT**

EKE provides support for at least 30 years for all Trainnet® products.

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**TECHNICAL SPECIFICATIONS**

**Dimensions (W x H x D)**
- 3U 44TE Rack: 280 mm x 133 mm x 215 mm (installation width 240 mm)
- 3U 84TE Rack: 483 mm x 133 mm x 215 mm (installation width 443 mm)
- 6U 84TE Rack: 483 mm x 266 mm x 215 mm (installation width 443 mm)

**Weight**
Depends on installed modules

**Input Voltage**
24, 36, 48, 52, 72 or 110 V DC

**Temperature Range (operational)**
-40 °C to +70 °C

**MTBF (40 °C ambient temperature)**
Depends on installed modules

**Interface Options:**
Remote Input/Output Module  
(ETHERNET RIOM, MVB RIOM)

**FUNCTIONS**
The Trainnet® RIOM enables data input and output within the vicinity of the I/O sources. It is used as an alternative to connecting I/O sources directly to the train computer (e.g. VCU) and it can lead to reduced cabling and thus cost savings.

**KEY FEATURES**
The RIOM supports both analogue and digital inputs/outputs. Most Trainnet® I/O module can be used, including AIM, AOM, DIO, DRO and PTI. You can find out more about these modules by reading the dedicated datasheets or by contacting a Sales representative at EKE.

The Trainnet® RIOM includes an interface module used for the communications with the train computer. It is also equipped with an independent power supply (Trainnet® PSR module).

**OPTIONS**

**Interfaces:**
- The Trainnet® Ethernet RIOM is equipped with one Ethernet interface for connectivity with the train computer (CPE module).
- The Trainnet® MVB RIOM uses MVB interfaces to connect with the train computer. By default, the MVB physical interface is Electrical Medium Distance (EMD) with two sub D-9 connectors. Electrical Short Distance with optical isolation (ESD+) and Optical Glass Fibre (OGF) mediums are available upon request.

**Number of modules:**
- In its most compact version, RIOM can use up to 8 EKE Trainnet® I/O modules and be fitted into a 44TE rack.
- An 84TE rack version is also available as an option to fit up to 18 I/O modules.

**TECHNICAL SPECIFICATIONS**

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<tr>
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<tr>
<td>280 mm x 133 mm x 215 mm</td>
<td>(installation width 240 mm)</td>
<td>483mm x 133mm x 215 mm</td>
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</table>

**Weight**
- 44TE option: 2.6 Kg (+ I/O module weights)
- 84TE option: 4 Kg (+ I/O module weights)

**Input Power**
- 24...36 V DC -30/+25%
- 48...110 V DC -30/+25%

**Temperature Range (operational)**
- -40 °C…+70 °C

**MTBF (40 ºC ambient temperature)**
Depends on installed I/O modules

**Interface options**
- **Ethernet RIOM:**
  - 1 x 10/100 Mbit/s M12
- **MVB RIOM:**
  - Electrical Medium Distance (EMD) with two sub D-9 connectors
  - (Isolated Electrical Short Distance (ESD) and Optical Glass Fibre (OGF) physical interface upon request)
**Ethernet Switches**

EKE is a pioneer in Ethernet based Train Communication Networks (TCN). Trainnet® Switches and Software were used on board the first train with 100% IP-based TCN.

**FUNCTIONS**

Depending on the Ethernet modules that you select, the following functions can be achieved:

- **Ethernet Train Backbone (ETB)**
  The Ethernet Train Backbone (ETB) is a modern train bus technology enabling a cost-effective setup with a large bandwidth (up to 100Mbit/s Vs 1 Mbit/s for WTB). It can replace or be used together with WTB and other train buses. Like the WTB, it allows for dynamic train configuration.

- **Ethernet Consist Network (ECN)**
  The Ethernet Consist Network (ECN) technology can be used to create vehicle buses and also as train-wide communication network in the case of fixed consist (no dynamic train configuration).

- **Ethernet Switch**
  Ethernet Switches are used to connect devices to the Train Communication Network enabling networked devices to communicate with each other. A managed switch manages layer 3 protocols, such as DHCP and IGMP. It also allows for finer configuration of the switch. When the switch is unmanaged, that functionality must be implemented by a connected device (managed switch or CPU).

- **Ethernet Router**
  The routing functionality allows the switch to be dynamically configured, thus redirecting messages to devices based on the latest information. A common application is dynamic train configuration: when changing the order of cars, the train communication network is automatically reconfigured. The position and orientation of each car is identified, enabling flawless communications throughout the train.

- **Power-over-Ethernet (PoE)**
  Power-over-Ethernet allows for the passing of electrical power in addition to data with Ethernet cabling.

**COMPARING TRAINNET® ETHERNET MODULES**

<table>
<thead>
<tr>
<th>ETC</th>
<th>ERU</th>
<th>3U ESU</th>
<th>1U ESU</th>
<th>UM-ESU</th>
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<tr>
<td><strong>FUNCTIONS</strong></td>
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<td>Train Computer Applications</td>
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<td>Ethernet Train Backbone (ETB)</td>
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<td>Ethernet Consist network (ECN)</td>
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<td>Managed Switch</td>
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<td>Router</td>
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<tr>
<td>Power-over-Ethernet</td>
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</table>
It means you can dramatically reduce setup costs and wiring as only one cable is required to each device. More and more devices support PoE including surveillance cameras, displays, GSM antennas, emergency phones etc.

Train Computer Applications
The Trainnet® Ethernet Train Computer (ETC) has the ability to execute complex train applications. It can be used as an Ethernet Switch to directly connect devices or to create a consistent network, but in addition, it can also manage a complete train computer. In practice, the ETC manages the other modules in the rack, such as bus modules (e.g. WTB for gateway applications) and Input/output modules (e.g. Digital Input Module for VCU applications). Using the Trainnet® ETC means you can create a very cost-effective Gateway, Vehicle Control Unit (VCU) or TCMS.

Modularity
The Trainnet® Systems are modular. You can build an Ethernet Switch with just the functionalities you need, for cost-efficiency. As a general rule, a standalone Trainnet® Ethernet Switch includes a Trainnet® Rack, a Trainnet® power supply and at least one Trainnet® Ethernet Module.

**POWER SUPPLY**
Most Trainnet® Systems can be powered using the Trainnet® PSV and Trainnet® PIU modules. When Power-over-Ethernet is needed, the Trainnet® PSE, Trainnet® ESS and optionally the Trainnet® PBU are used.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**
  - 3U 44TE Rack: 280 mm x 133 mm x 215 mm (installation width 240 mm)
  - 3U 84TE Rack: 483 mm x 133 mm x 215 mm (installation width 443 mm)
  - 6U 84TE Rack: 483 mm x 266 mm x 215 mm (installation width 443 mm)

- **Weight**
  Depends on rack and installed modules

- **Input Voltage**
  - PIU: 24, 36, 48, 52, 72 or 110 V DC
  - ESS (PoE): 36.52 or 110 V DC

- **Temperature Range (operational)**
  - -40 °C...+70 °C

- **MTBF (40 °C ambient temperature)**
  Depends on installed modules

- **Ethernet Interfaces**
  - 10/100 Mbit/s M12 except Trainnet® 1U ESU which comes also with 2 x 1 Gbit/s SFP ports (ESU1906A) or 15 x 1 Gbit/s SFP ports (ESU2250A).
  - Optionally, Trainnet® 3U ESU can have 2 x 1 Gbit/s M12 or SFP for ports 1 and 2.

Please read individual Ethernet Module datasheets for more detailed specifications.
Event Recorders

FUNCTIONS
A Trainnet® Event Recorder (ER) is an on-board data recorder for collecting and storing vital trainborne information. The Trainnet® Event Recorder can record all kinds of data including audio and video streams.

KEY FEATURES
Trainnet® Event Recorders are able to record virtually any available signals, analogue or digital. The Event Recorder can be programmed to record safety critical information like train speed, train position or brake temperature.

The Event Recorder can also record video streams from onboard digital video recorders (DVR) or directly from the cameras. For easy data retrieval, the stream format can be made compatible with your CCTV Software or any other video analysis Software that you are using.

Alternatively, we can develop customized video analysis tools to fit your needs.

Trainnet® Event Recorders have an Ethernet port, a USB port and an RS-485 port at the front for easy access. The Ethernet port

<table>
<thead>
<tr>
<th>COMPARING TRAINNET® EVENT RECORDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER FLAT 3U x 12TE</td>
</tr>
<tr>
<td>External Dimensions (W x H x D)</td>
</tr>
<tr>
<td>Rugged Memory Module (RMM)</td>
</tr>
<tr>
<td>Storage Memory</td>
</tr>
<tr>
<td>Connectivity</td>
</tr>
<tr>
<td>Included interfaces:</td>
</tr>
<tr>
<td>Optional interfaces:</td>
</tr>
<tr>
<td>. Bus interfaces</td>
</tr>
<tr>
<td>. I/O Interfaces</td>
</tr>
<tr>
<td>. Limitations</td>
</tr>
<tr>
<td>Power Supply Input Voltage</td>
</tr>
<tr>
<td>Power Supply Cabling</td>
</tr>
<tr>
<td>Option for side mounting</td>
</tr>
<tr>
<td>Included Software</td>
</tr>
<tr>
<td>Optional Software</td>
</tr>
</tbody>
</table>
and the USB port can be used to download the data stored in the recorder. Alternatively, the Ethernet port can be used to connect to a sub-system or an Ethernet Switch. The RS-485 port can also be connecting sub-systems.

All the Trainnet® Event Recorders are protected against shocks, vibration, humidity, temperature variations, excessive emissions and excessive voltages (follows the EN50155 standard). Front-panel imprints are available upon request.

MODULARITY
Additional interfaces can be easily added to the Event Recorder, as the system is modular. You can add bus interfaces such as MVB, CAN, S/L or Ethernet to connect with train sub-systems or Train Communication Network (TCN) in order to acquire data. You can also add Input/Output Interfaces to record various signals. Available I/O Interface Modules include Analogue Input, High Speed Analogue Input, Digital Input/Output, Digital Relay Output, Analogue Output and Pt-100 temperature Sensor Input.

For a compact and efficient system, Trainnet® Event Recorder can be used as part of a broader Trainnet® system, for instance integrated to a Gateway, a VCU or a TCMS.

DATA RETRIEVAL AND ANALYSIS
Data can be retrieved at any time via the Event Recorder Ethernet port using the Trainnet® TIP Software (Train Inspection Program). The TIP Software enables the download and the analysis of the train data. Alternatively, the data can be transferred to a USB stick, for convenient transport or storage. The data is easily imported from the USB stick to the TIP Software.

The Trainnet® Event Recorder proves useful beyond traditional use following an incident. The retrieved data can be visualized with the TIP Software in order to perform regular system performance analysis and train operational optimization.

RUGGED MEMORY MODULE
The Trainnet® Rugged Memory Module (RMM) is available as an option whenever a high level of data protection is needed. This crash-proof construction guarantees that the memory board is protected against fire, magnetic fields and any liquids, as well as against any mechanical stress during an impact or continued pressure. In practice, the memory board is embedded in a protected fire insulation block, surrounded by a special steel case that is hermetically sealed.

The design of the Trainnet® Rugged Memory Module fulfils the British (GM/RT2472-1.2002) and European (EEIG 97E461-3.1998) crash-worthiness as well as the IEEE (1482.-1.1999) standards. This makes the Trainnet® Event Recorder suitable for trains worldwide.

JURIDICAL RECORDING UNIT
The Trainnet® Juridical Recording Unit (JRU) is a train event recorder complying with the ERTMS/ETCS standard. The Trainnet® JRU has all the features of other Trainnet® Event Recorder and is equipped with the Trainnet® Rugged Memory Module for data protection.

The Trainnet® JRU can record data from the ETCS (i.e. European Vital Computer, EVC) and/or from nation-specific control systems (i.e. Specific Transmission Module, STM). The ETCS architecture illustration highlights the two standard setup options.

GPS/GNSS
As an option, a GNSS (Global Navigation Satellite System) receiver can be integrated into the Event Recorder. Versions with GPS+GLONASS and GPS+BeiDou are available. This option requires 4TE of additional space in the rack (one free bus interface slot).

RACKS AND SIZES
The modularity of the Trainnet® Event Recorders means you can choose a rack size based on your needs: the more additional interfaces or features you need, the larger is the rack that you need to select. The table on the previous page presents some of the possible alternatives.
Human Machine Interface (HMI)

FUNCTIONS
The Trainnet® Human Machine Interfaces (HMI) are interactive displays. They can be used to display information to train drivers or crew members with interactive displays. They can also be used as CCTV monitor as well as for any Trainnet® applications.

KEY FEATURES
The Trainnet® HMIs are flexible devices providing ease of use and robustness for all Trainnet® applications.

The touch control buttons positioned around the display area provide great durability with no mechanical part to wear out. The layout of the keys is designed according to the international UIC 557 standard. You can easily configure the keys to match any of your requirements.

The flat displays, including the touch control buttons, are protected behind an anti-reflective vandal proof safety glass (IK 07, IP 65 tightness) for durability.

As the displays are very compact, they can be fitted virtually anywhere in the train and are easy to mount (rear fixing for protection). Two sizes are available for flexibility: 6.5” and 12.1” with respectively 640 x 480 and 1024 x 768 pixel resolutions.

As part of a Trainnet® System, the HMI is usually configured and controlled by the Train Computer's CPU (Trainnet® CPG, Central Processing unit with Graphics controller). There is a DVI-I interface and a touch screen interface integrated into the same cable.

The Trainnet® HMI also sends self-diagnostics data to the Train Computer, such as module temperature and the count of lamp’s operating hours. The display does not include any moving parts and the lamp is the only replaceable component. The absence of components that are subject to any wear out guarantees a long unit lifetime.

OPTION
The Trainnet® HMI 12.1” is available as a full touch screen as an option (12.1” FT). The 12.1” FT display does not have touch control buttons around the display area.

TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Dimension (W x H x D)</th>
<th>6.5”: 220 x 170 x 125 mm</th>
<th>12.1”: 340 x 270 x 106 mm</th>
<th>12.1” FT: 320 x 260 x 75 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>6.5”: 3.7 kg</td>
<td>12.1” and 12.1” FT: 6 kg</td>
<td></td>
</tr>
<tr>
<td>Input Power</td>
<td>6.5”: 24 V DC or 110 V DC</td>
<td>12.1”: 24 V DC, 72 V DC or 110 V DC</td>
<td>12.1” FT: 110 V</td>
</tr>
<tr>
<td>Power Consumption, Typical</td>
<td>6.5”: Standby 3.5 W (no image), Full brightness 11 W</td>
<td>12.1”: Standby 4 W (no image), Full brightness 15 W</td>
<td>12.1” FT: Standby 5 W (no image), Full brightness 15 W</td>
</tr>
<tr>
<td>Temperature Range (operational)</td>
<td>-25 ºC...+70 ºC</td>
<td>-25 ºC...+70 ºC</td>
<td>-25 ºC...+70 ºC</td>
</tr>
<tr>
<td>MTBF (40 ºC ambient temperature)</td>
<td>50 000 h</td>
<td>50 000 h</td>
<td>50 000 h</td>
</tr>
<tr>
<td>Display Resolution</td>
<td>6.5”: 640 x 480 (VGA)</td>
<td>12.1” and 12.1” FT: 1024 x 768 (XGA)</td>
<td></td>
</tr>
<tr>
<td>Active Display Area</td>
<td>6.5”: 133 x 99 mm</td>
<td>12.1”: 246 x 184 mm</td>
<td>12.1” FT: 245 x 184 mm</td>
</tr>
<tr>
<td>Colour Depth</td>
<td>262 I44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viewing Angle (Cr≥10)</td>
<td>6.5”: 50-50(H) 60-30(V)</td>
<td>12.1”: 65-65(H) 75-45(V)</td>
<td></td>
</tr>
<tr>
<td>Luminance</td>
<td>6.5”: 440 cd/m² typ.</td>
<td>12.1” and 12.1” FT: 320 cd/m² typ.</td>
<td></td>
</tr>
</tbody>
</table>
ISaGRAF
PLC Software

FUNCTIONS
The ISaGRAF Software is designed for efficient programming of PLC applications of Trainnet® Systems. It is also used for commissioning and debugging. It complies with the IEC 61131 standard.

KEY FEATURES
ISaGRAF is a control software environment that enables you to create distributed control systems. It offers a combination of a highly portable and robust control engine (Virtual Machine) as well as an intuitive application development environment (Workbench).

The ISaGRAF Application development Workbench supports all of the standard IEC 61131 control program languages as well as the Flow Chart.

These Languages are:
- Sequential Function Chart (SFC)
- Function Block Diagram (FBD)
- Ladder Diagram (LD)
- Structured text (ST)
- Instruction List (IL)
- Flow Chart (FC)

You may use any or all of the control languages in your application as it best suits your needs.

The ISaGRAF series of toolkits give you the ability to write your own I/O drivers and supports "C" user programs. Functions and function blocks written in C can be called directly from any of the six supported languages. These routines become an extension of the ISaGRAF languages.

We have already developed number of functions and function blocks that are designed for rail applications. For instance for communication over various train networks such as WTB with UIC 556, MVB and for most typically used Ethernet protocols.

All the Trainnet® CPUs (CPG, CPS, and ETC) except CPE include ISaGRAF Linux run time to execute the ISaGRAF applications. The Trainnet® target supports multitasking systems.

TECHNICAL REQUIREMENTS

Latest Supported Software Version
ISaGRAF 5.22
Operating System
Windows 7 32-bit or Windows XP
RAM Memory
2 GB
Hard Drive
20 GB
Ports
Ethernet
USB
Application Software

Trainnet® systems can be programmed to run various applications for automation, integration, communication and safety. This sections cover some of the most important applications. Programming can be done either with the ISaGRAF PLC Software or in C-language. You can freely develop your own applications or let EKE do it for you.

AUTOMATION AND DIAGNOSTICS

Trainnet® TCMS and VCU can run applications used for the control and monitoring of train sub-systems. For diagnostics, applications can be designed to issue warnings when preset limits are crossed or in case of technical error. The applications can even be programmed to give instructions or take corrective actions automatically. Such applications reduce response times and increase train availability. Controlled sub-systems and functions may include:

- HVAC (heating, cooling, airflow monitoring, fresh air intake management, condensation and evaporation monitoring etc.)
- Doors (opening, closing, locking, jammed door detection etc.)
- Lights (on/off, dimming, day/night setup implementation etc.)
- CCTV (camera status, automatic display relevant screen to the driver in case of incident etc.)
- Water tanks (levels of fresh water and used water etc.)
- Batteries (charge/discharge monitoring etc.)
- Brakes and traction (status, brake temperature, traction effort etc.)
- PIS/PA (see PIS manager)

Trainnet® Train Computer

Application Software

TRAINNET® TRAIN APPLICATIONS, FOR THE MONITORING, CONTROL AND/OR AUTOMATION OF:

1. HVAC
2. Bearing temperature (SIL-2)
3. Speed measurement (SIL-2)
4. Lateral vibration (SIL-2)
5. Brakes
6. Traction
7. PIS/PA
8. Diagnostics
9. Lights
10. Water tanks
11. CCTV
12. Batteries
13. Doors
14. Emergency communications
15. Data protection (event recorder)
16. Train-to-wayside communications
**TRAINNET® PIS MANAGER**
The Trainnet® PIS Manager is an application that enables you to implement and run a Passenger Information System (PIS) directly from your Trainnet® system, with no need to buy a separate PIS/PA system. The information to be conveyed is completely based on your project requirement and can be transmitted via the screens and loud speakers of your choice.

**Example: VALE train PIS/PA, Brazil**

**AUTOMATIC INAUGURATION**
With an automatic train inauguration, consists can be connected, disconnected or switched without jeopardizing the train operations. The train configuration changes are automatically detected and the Train Communication Network (TCN) continue to work flawlessly. WTB and Ethernet Train Backbone technology supports such dynamic configuration. EKE has also developed an application Software enabling automatic train inauguration when using MVB as a train backbone for communication.

**GRAPHICAL USER INTERFACES**
Develop the Graphical User Interface (GUI) and the logic that goes with it for you HMI displays. Applications can range from driver displays to train captain display, on traditional displays or on mobile devices. The most common applications are diagnostic and control functions.

**SIL APPLICATIONS**
The Safety Integrity Level, or SIL, indicates the risks of failure of a system. SIL is basically an indicator of performance: the higher the SIL level, the lowest the risk of system failure. It helps you save on maintenance and reduces train immobilization. EKE can develop for you, or help you develop, SIL-2 functionalities (EN50126/EN50128/EN50129) in order to enhance reliability and safety. EKE has expertise with SIL-2 applications including speed measurement, bearing temperature monitoring and lateral vibration, to name a few.

**MOBILE APPLICATIONS**
The Trainnet® Mobile Applications are services accessible from mobile devices present in the train. In practice they are extensions to your Trainnet® TCMS or VCU: information is exchanged between the train computer and the mobile devices via a wireless network (WLAN).

**Mobile PIS**
With the Trainnet® Mobile Passenger Information System (PIS), passengers can access travel information from their smartphones and tablets. Passengers can check the train departure time, the train location, train connections, train speed or outside temperature. Safety and traffic announcements can also be displayed in real-time. Additional services such as news, weather forecast, the restaurant menu, games as well as advertisements can be provided to passengers via this mobile platform.

**Mobile HMI**
The Trainnet® Mobile HMI (Human-Machine Interface) enables train managers and train crews in general to access and take control of the train TCMS from their tablets and smartphones via a protected WLAN. The train manager can for example switch lights or modify air conditioning from anywhere in the train. The Trainnet® Mobile HMI can include the PIS Manager described above, giving them control over the PIS system from their mobile device. Train system status, faults and alarms can also be monitored by the train crew from the mobile HMI, if desired. Such a mobile HMI can partly or completely replace traditional HMIs usually installed in every coach, thus allowing significant cost savings.

https://cityrail.train2964:8080
The Trainnet® Train Inspection Program (TIP) is a Software tool used for the transfer and analysis of the data recorded in the Trainnet® Event Recorders. The tool allows for the visualization, analysis and printing of the records, as well as real-time train monitoring.

**Key Features**

- The Software is compatible with Windows 8, Windows 7, Windows XP and Windows Vista operating systems. The Data can be downloaded with the TIP Software by connecting a PC or a USB memory stick to the Trainnet® Event Recorder.

- The TIP has been designed with the ease of use and customization in mind. The Software is able to display the data in several ways such as graphically and numerically or with signal states and comprehensive reports. The Trainnet® TIP can also be configured to show exactly the information needed for a specific task. The user can instantly locate incidents or a particular piece of information by using the built-in search and statistical functions.

- The data can also be exported to a third party application as the data can be converted to an open format (CSV file).

- The TIP Tool also provides an on-line monitoring feature that allows you to monitor any selection of signals in the car in real-time, without interfering with the Trainnet® Event Recorder’s normal operations. Under all conditions, the TIP Software tool ensures that your data is kept confidently with the highest levels of integrity.

- The Event Recorder data can be archived on a computer, where each registered individual data file can be retrieved for later analysis with the Software. The TIP also allows the saving of a selected portion of recorded data to a new file, without modifying the original data in any way.

- TIP has a feature that enables you to display several data files simultaneously. This feature enables you to easily compare different types of data from the same track sections. The feature can also be used for driver comparison and to reveal slow changes in signals (trends).

- The data can also be exported to a third party application as the data can be converted to an open format (CSV file).

- The TIP Tool also provides an on-line monitoring feature that allows you to monitor any selection of signals in the car in real-time, without interfering with the Trainnet® Event Recorder’s normal operations. Under all conditions, the TIP Software tool ensures that your data is kept confidently with the highest levels of integrity.

**Technical Requirements**

- **Operating System**
  - Windows 8, 7, XP or Vista
- **RAM Memory**
  - 2 to 4 GB
- **Hard Drive**
  - 120 GB or more (if large ER files)
- **Processor**
  - Dual core processor
- **Ports**
  - Ethernet
- **Display**
  - If laptop is used, external HD display would be preferred to ease the analysis of Event Recorder data.
Portable System Tester (PST)

FUNCTIONS
The Trainnet® Portable System Tester (PST) is a Software tool used to perform diagnostics and configurations of Gateways and train computers. A computer equipped with the PST, can be connected to any gateway or train computer using either serial or Ethernet connection, providing a single point of access to all coaches within the train set.

KEY FEATURES
The Trainnet® Portable System Tester (PST) is compatible with Windows 8, Windows 7, Windows XP and Windows Vista Operating Systems.

The Trainnet® PST is a tool for downloading event history data (e.g. faults and alarms) and provides built-in features for examining the data. Additionally, it is a tool for settings the system time and other operational parameters.

The tool features are largely based upon customer requirements and are project-dependent. However, some of the possible functionalities include:

- Set up operational parameters to the Train Computer, such as time, coach number and type or wheel diameter.
- View I/O channels statuses as well as TCMS link status and signals.
- Download system faults and event logs.
- Keep track of the diagnostic data (faults) already retrieved, and when performing successive retrievals, it downloads only the new, un-retrieved, portion of the data.
- Access to system data, including the train bus process and message data, binary tree (Modbus data), etc.
- Allows modifying off-line parameter files to edit start-up or functional parameters.
- Allows incorporation of any HTML files into the tool, which typically is used to integrate User and Maintenance documentation.
- Customize functions in order to create special reports for selected events, such as Test and Trend Reports, Maintenance Alerts, etc.
- Integrate the Electronic Serial Number (ESN) Programming Tool.

The PST tool is protected against unauthorised use with usernames and passwords. Users can be arranged in groups that have different permissions to access the data. Selected functionalities can be granted to staff members according to their role (e.g. administration rights or different level of maintainer roles with read/write rights or read only possibility).

TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Windows 8, 7, XP or Vista</td>
</tr>
<tr>
<td>RAM Memory</td>
<td>2 to 4 GB</td>
</tr>
<tr>
<td>Hard Drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Processor</td>
<td>Dual core processor</td>
</tr>
<tr>
<td>Ports</td>
<td>Ethernet</td>
</tr>
</tbody>
</table>

PORTABLE SYSTEM TESTER (PST)
Our Services

EKE provides services to support you from the early stages of your project to its very end.

CONSULTING
We can help you to define specifications and to design your system in the most efficient way. We can also advice you on sourcing and recommend suitable technologies and products for the best results. We can help with all technical aspect of your project.

TRAINING
We provide all the necessary training to help you master our technologies, including both Hardware and Software. We can also share with you our experience and know-how to make sure you use our products and tools as efficiently as possible.

SUPPORT
We support you during the entire lifetime of your project. We can help you to develop your own system or alternatively develop it for you. We can also assist you at the installation, testing and commissioning stages, to the extend your require.

MAINTENANCE AND REPAIRS
We guarantee at least 30-years of support for all our products. It shows the faith we have in their quality. We provide fast product repairs, spare parts, Hardware and Software upgrades, support contracts and on-site technical assistance.
Modules
**Ethernet Train Computer (ETC)**

**MODULE FUNCTIONS**

The Trainnet® Ethernet Train Computer (ETC) is a CPU used to manage train computers and sub-systems connected to them. It integrates an Ethernet Switch to build Ethernet Consist Networks, Ethernet train buses (if fixed train set) or for direct connection to sub-systems. It is ideal to develop cost-effective and efficient Train Communication Networks (TCN) and TCMS.

The Trainnet® ETC can be used to develop, store and run applications for the control and diagnostics of on-board systems. It can also implement gateway functionalities by providing the necessary interfaces and routing capabilities between Train Buses, Vehicle Buses and sub-systems. It implements the ECN link layer function of the IEC 61375-3-4 Train Communications Network Standard.

The Trainnet® ETC can run the PLC (ISaGRAF®). That means that the ETC can be used to control any train sub-system, from the Passenger Information System (PIS) to air-conditioning. Bus interface modules (e.g. WTB, MVB, CAN) and I/O modules can be easily integrated to and managed by the ETC to extend the capabilities of the train computer.

**KEY FEATURES**

For train management system application, the ETC has a configurable executor, the ISaGRAF® kernel. Users can also write their own C-tasks as they desire, either as an ISaGRAF® extension or on top of the module’s Linux kernel.

The Trainnet® ETC non-blocking (QoS Layer 2) switching architecture provides large bandwidth: it has 10 Ethernet ports which are 10/100BASE-TX Mbit/s Full Duplex Ethernet with auto MDI/MDIX M12 connectors. If required two of the Ethernet ports can be replaced by 1 Gbit/s optical fiber SFP ports or M12 X-coded 1 Gbit/s ports for increased bandwidth.

An Electronic Serial Number (ESN) port is available for device identification and configuration.

The 10 ports of the ETC can be partitioned to create distinct ECN subnets using a virtual router. The device supports dynamic routing protocols. The possibility of using link aggregation provides an opportunity to increase data transfer capabilities as well to create redundancies.

Port mirroring can be used to copy packet data seen on a switch port to another port for diagnostic and monitoring purposes. The ETC supports Virtual Router Redundancy Protocol (VRRP) providing enhanced reliability: if a module stops working, its IP address is automatically transferred to a redundant device, ensuring continuous operations.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**: 16 TE x 3 U x 160 mm
- **Weight**: 520 g
- **Input Power**: 5 V DC ± 5 % (1.5 A typ. 3 A max.)
- **Temperature Range (operational)**: -40 °C…+70 °C
- **MTBF (40 ºC ambient temperature)**: 690 000 h
- **Ethernet Interfaces**: 10 x 10/100 Mbit/s M12 (1 Gbit/s M12 or SFP as an option for ports 1 and 2)
- **Serial Interfaces**: 1 RS 485 on back for I/Obus connectivity
  1 RS 232 on front (for maintenance, configuration or ESN dongle)
- **Switching Buffer Memory**: 2 Mbits
- **Management CPU**: PowerPC 667 MHz
- **Flash Memory**: 4 GB
- **RAM**: 256 MB
- **VME Bus (EIC821) interface**: A24/D16 Master

**EN 50155**

IEC 61375-3-4

IEC 61131
Central Processing Unit with Graphical Display Controller (cpg)

**MODULE FUNCTIONS**

Trainnet® CPG can be used as a processor to manage train computers and sub-systems connected to them. It has two main functions. Firstly, it is the core of the Train Communication Network. It provides the necessary interfaces and routing capabilities between the Train Bus, the Vehicle Bus and the sub-systems. Secondly, it can act as the brain of the Train Control and Management System (TCMS) or VCU, providing the means to develop, store and run applications for the control and diagnostics of on-board systems.

The Trainnet® CPG module is a graphical display controller module that supports both analogue and digital displays. It can be used to manage the display of video surveillance recordings. The Trainnet® CPG module is also capable of storing digital media content such as audio announcements in a compressed format for on-board use.

**KEY FEATURES**

The Digital Signal Processor of the Trainnet® CPG is dedicated for video and audio processing. The Digital Visual Interface (DVI-I) combines both analogue and digital signals and can be directly connected to DVI displays with resolutions up to 1024 x 768 pixels. Touch screens can be connected either through an isolated RS 485 interface or a DVI-cable when using Trainnet® Human Machine Interface (HMI). The audio interface line output can be used to drive audio announcement systems. The interface is isolated on the digital side in order to provide the best audio quality.

Three programmable isolated asynchronous or bit-synchronous SCC channels are available (RS 485) for the connection to compatible devices in the train.

Two 10/100 Mbit/s Full Duplex Ethernet interfaces can be used to connect to any Ethernet Communication Network, typically connecting the CPG with switches or other electronic racks. The Ethernet interfaces can also be directly connected to any Ethernet enabled devices (e.g. network cameras). A bridge between two channels is also supported. The number of Ethernet interfaces can be increased with one of the Trainnet® Ethernet Switches.

The ISaGRAF® kernel embedded in the CPU acts as the CPU’s operating Software. Train management applications can be developed with the ISaGRAF® Software in order to create the desired control and diagnostic functions of the train. The open platform runs on the Linux Operating Software and supports further Software development in C language, either as an ISaGRAF® extension or on top of the module’s Linux kernel. The PowerPC processor provides enough processing power for demanding applications with 400 MHz core speed and 64 megabytes of 64-bit wide 100 MHz SDRAM.

A PST interface (usually serial link or Ethernet) enables the use of the Trainnet® Portable System tester (PST) as well as other tools for event log operations, maintenance, debugging, downloading and application development purposes.

The Trainnet® CPG real-time clock is powered by a back-up capacitor and will run for a minimum of 30 days from the time power is no longer applied.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**: 8 TE x 3 U x 160 mm
- **Weight**: 300 g
- **Input Power**: 5 V DC ± 5 % (1.5 A max., 1 A typ.)
- **Temperature Range (operational)**: -40 °C...+70 °C
- **MTBF (40 ºC ambient temperature)**: 770 000 h (CPG1824A)
- **Video Interface**: DVI-I; Single TMDS digital output and analogue RGB Resolution up to 1024 x 768
- **Audio Interface**: Isolated stereo audio line output 0 – 700 mVRMS to 10 kΩ load
- **Touch Screen Interface**: Integrated RS 485 on DVI interface
- **Serial Interfaces**: 2 isolated RS 485 on front (if not using the Touch Screen Interface) 1 RS 232 on front (for maintenance, configuration or ESN dongle) 1 RS 485 on back for i/Obus connectivity
- **Ethernet Interfaces**: 2 x 10/100 Mbit, M12 connectors
- **Boot Flash Memory**: 8 MB
- **File System Flash Memory**: 512 MB (On request up to 2 GB)
- **Processor RAM**: 64 MB
- **Graphics Controller RAM**: 32 MB
- **Digital Signal Processor RAM**: 16 MB
- **VME Bus (IEC 821) Interface**: A24/D16 Master or Slave
Central Processing Unit with Serial Links (cps, cpf)

**MODULE FUNCTIONS**
The Trainnet® CPS can be used as a processor to manage train computers and sub-systems connected to them. It has two main functions. Firstly, it is the core of the Train Communication Network. It provides the necessary interfaces and routing capabilities between the Train Bus, the Vehicle Bus and the sub-systems. Secondly, it can act as the brain of the Train Control and Management System (TCMS) or VCU, providing the means to develop, store and run applications for the control and diagnostics of on-board systems.

**KEY FEATURES**
The Trainnet® CPS Module is a processing unit providing serial communication interfaces. Three (four as an option) programmable isolated asynchronous or bit-synchronous SCC channels are available (RS 485) for connection to compatible devices in the train.

A 10/100 Mbit/s Full Duplex Ethernet interfaces can be used to connect to any Ethernet Communication Network, typically connecting the CPS with switches or other electronic racks. The Ethernet interface can alternatively be directly connected to any Ethernet enabled devices (e.g. network cameras). The number of Ethernet interfaces can be increased with one of the Trainnet® Ethernet Switches.

A USB Host Interface is provided to connect memory sticks or other devices for maintenance purposes. B-type connector is used to protect unattended usage (special tools required).

The ISaGRAF® kernel embedded in the CPU acts as the CPU’s operating Software. Train management applications can be developed with the ISaGRAF® Software in order to create the desired control and diagnostic functions of the train. The open platform runs on the Linux Operating Software and supports further Software development in C language, either as an ISaGRAF® extension or on top of the module’s Linux kernel.

Options

**Event logging memory:** the Trainnet® CPS is simply a Trainnet® CPS with an extended event logging flash memory (4 Gb vs 512 MB). Trainnet® CPF can act as a low cost event recorder when limited memory and protection are required. The Trainnet® CPF has all the features of the Trainnet® CPS.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D):** 4 TE x 3 U x 160 mm
- **Weight:** 255 g
- **Input Power:** 5 V DC ± 5% (1.5 A max., 1 A typ.)
- **Temperature Range (operational):** -40 °C...+70 °C
- **MTBF (40 ºC ambient temperature):** 950 000 h
- **Ethernet Interface:** 1 x 10/100 Mbit M12 connector
- **USB Interface:** One 2.0 High Speed host, Type B connector
- **Serial Interfaces:** 3 isolated RS 485 on front 1 RS 485 on back for U/Obus connectivity
- **Boot Flash Memory:** 8 MB
- **File System Flash Memory:** 512 MB
- **Event Logging Flash Memory:** 512 MB (5PS256A) 4 GB (CPF3027A)
- **Processor RAM:** 64 MB
- **VME Bus (IEC 821) Interface:** A24/D16 Master or Slave
CPU with Serial Links and GPS (CPS-GPS, CPF-GPS)

**MODULE FUNCTIONS**
The Trainnet® CPS-GPS can be used as a processor to manage train computers and sub-systems connected to them. It has three main functions. Firstly, it is the core of the Train Communication Network. It provides the necessary interfaces and routing capabilities between the Train Bus, the Vehicle Bus and the sub-systems. Secondly, it can act as the brain of the Train Control and Management System (TCMS) or VCU, providing the means to develop, store and run applications for the control and diagnostics of on-board systems. Thirdly, it integrates a GNSS receiver to provide location and time information for synchronisation with the processed data.

**KEY FEATURES**
The Trainnet® CPS-GPS Module is a processing unit providing serial communication interfaces. Three (four as an option) programmable isolated asynchronous or bit-synchronous SCC channels are available (RS 485) for connection to compatible devices in the train.

A 10/100 Mbit/s Full Duplex Ethernet interfaces can be used to connect to any Ethernet Communication Network, typically connecting the CPS-GPS with switches or other electronic racks. The Ethernet interface can alternatively be directly connected to any Ethernet enabled devices (e.g. network cameras). The number of Ethernet interfaces can be increased with one of the Trainnet® Ethernet Switches.

A USB Host Interface is provided to connect memory sticks or other devices for maintenance purposes. B-type connector is used to protect unattended usage (special tools required).

The ISaGRAF® kernel embedded in the CPU acts as the CPU’s operating Software. Train management applications can be developed with the ISaGRAF® Software in order to create the desired control and diagnostic functions of the train. The open platform runs on the Linux Operating Software and supports further Software development in C language, either as an ISaGRAF® extension or on top of the module’s Linux kernel. The PowerPC processor provides enough processing power for demanding applications with 400 MHz core speed and 64 megabytes of 64-bit wide 100 MHz SDRAM.

A PST interface (usually serial link or Ethernet) enables the use of the Trainnet® Portable System tester (PST) as well as other tools for event log operations, maintenance, debugging, downloading and application development purposes.

The Trainnet® CPS-GPS real-time clock is powered by a back-up capacitor and will run for a minimum of 30 days from the time power is no longer applied.

The GNSS function is available for simultaneous GPS and GLONASS or, optionally, GPS and BeiDou. CPS-GPS supports active and passive antennas.

**OPTIONS**
- **Event logging memory:** The Trainnet® CPF-GPS is simply a Trainnet® CPS-GPS with an extended event logging flash memory (4 Gb vs 512 MB). Trainnet® CPF-GPS can act as a low cost event recorder when limited memory and protection are required. The Trainnet® CPF-GPS has all the features of the Trainnet® CPS-GPS.

**TECHNICAL SPECIFICATIONS**
- **Dimensions (W x H x D):** 8 TE x 3 U x 160 mm
- **Weight:** 265 g
- **Input Power:** 5 V DC ± 5 % (1.5 A max., 1 A typ.)
- **Temperature Range (operational):** -40 ºC...+70 ºC
- **MTBF (40 ºC ambient temperature):** TBD
- **Ethernet Interface:** 1 x Ethernet
- **USB Interface:** One 2.0 High Speed host, Type B connector
- **Serial Interfaces:** 3 isolated RS 485 on front, 1 RS 485 on back for VBus connectivity
- **GNSS Antenna Interface:** SMA
- **Supported GNSS:** GPS+GLONASS, GPS+BeiDou
- **Boot Flash Memory:** 8 MB
- **File System Flash Memory:** 512 MB
- **Event Logging Flash Memory:** 512 MB or 4 GB
- **Processor RAM:** 64 MB
- **VME Bus (IEC 821) Interface:** A24/D16 Master or Slave
Central Processing Unit with Ethernet Bus (cPE)

**MODULE FUNCTIONS**
The Trainnet® CPE is a straightforward processing unit designed exclusively for Ethernet bus connectivity. It is used exclusively as a part of the Trainnet® Remote Input/Output Module (RIOM) to redirect I/O signals between the train computer (e.g. VCU) and the RIOM.

**KEY FEATURES**
The Trainnet® CPE comes with a 10/100 Mbit/s Full Duplex Ethernet interface that is used to connect to the Trainnet® train computer.

The Trainnet® CPE simply reads and writes I/O signals. It is able to redirect input signals from the RIOM to the train computer. The CPE can also get information from the train computer and pass it on to the RIOM I/O modules that generate output signals.

Please note that the CPE does not have a real-time clock or flash memory: it cannot be used to run train applications. It works only when it is connected to a Trainnet® train computer, typically a Gateway, VCU or TCMS.

**TECHNICAL SPECIFICATIONS**
- **Dimensions (W x H x D)**: 4 TE x 3 U x 160 mm
- **Weight**: 140 g
- **Input Power**: 5 V DC ± 5 % (1 A max., 0.5 A typ.)
- **Temperature Range (operational)**: -40 °C...+70 °C
- **MTBF (40 °C ambient temperature)**: 1,630,000 h
- **Ethernet Interface**: 1 x 10/100 Mbit M12 connector
- **Serial Interfaces**: 1 x RS 485 on back for I/Obus connectivity
- **Boot Flash Memory**: 8 MB
- **File System Flash Memory**: 512 MB
- **Processor RAM**: 64 MB
- **VME Bus (IEC 821) Interface**: A24/D16 Master or Slave

**EN 50155**
**IEC 61131**
Module Functions
Trainnet® Wire Train Bus (WTB) modules are used to create train-wide communication networks. The WTB module implements the WTB link layer functions of the IEC 61375-2-1 standard. The TCN’s real-time protocols, the UIC leaflet 556 specifications and the routing between the WTB and other buses are implemented by the gateway CPU Module.

Key Features
The WTB MAU supports physical cable redundancy as specified in the IEC 61375-2-1 standard. It uses TCN standard’s Sub D-9 type connectors located on the front panel of the module. Communication to the gateway is done through a shared memory over the IEC 821 VME back plane bus. The WTB link layer functions are implemented by the WTB module’s local processor.

The Trainnet® WTB module has a static shared RAM memory accessible from both the local CPU and the VME Bus interface. The TCN standard’s source and sink port handling for WTB process data is supported.

A separate memory area is reserved for message data and maintenance messages as well as for Remote Procedure Call type access to the Link Layer primitives. The WTB module is able to provide applications with timing synchronization when a Macro Period finishes.

The WTB module is realised through the highly efficient combination of a dedicated microprocessor and FPGA logic. In addition to strict compliance with the IEC 61375-1 standard, the WTB module has the capability of carrying out enhanced diagnostics functions, like monitoring the bit error ratios between individual train coaches in order to identify communication issues.

In order to handle incompatible cabling or extremely harsh operating conditions, the WTB module is able to act as a bus repeater by completely regenerating the data streams towards both extremities. Intelligent repeater management is included in the WTB module’s system Software. It supports the selection of an optimal number of concurrently enabled repeaters on the train bus, thus allowing the network timing to retain undegraded specifications.

Options
Fritting Voltage: The WTB bus interface sustains fritting voltage. Fritting voltage source is available as an option (Trainnet® WTF, ref. WTB1912A).

Redundant Connectors: In the basic module, the bus redundancy is integrated into a single bus connector. Separated connectors for the redundant bus are available as an option (ref. WTB1912A).

Technical Specifications
- Dimensions (W x H x D):
  - 4 TE x 3 U x 160 mm (WTB1822A, left picture)
  - 8 TE x 3 U x 160 mm (WTB1765A, middle picture)
  - 8 TE x 3 U x 160 mm (WTB1912A, right picture)
- Weight:
  - 170 g (WTB1822A)
  - 320 g (WTB1765A)
  - 295 g (WTB1912A)
- Input Power:
  - 5 V DC ± 5 % (1 A max., 0.5 A typ.)
- Temperature Range (operational):
  - -40 °C...+70 °C
- MTBF (40 ºC ambient temperature):
  - 1,140,000 h (WTB1822A)
  - 490,000 h (WTB1765A)
  - 411,000 h (WTB1912A)
- Train Bus:
  - IEC 61375-1: WTB
- Data Rate:
  - 1 Mbit/s (Half speed 500 kbit/s on request)
- MAU
  - Transformer isolation
  - Combined or individual bus connectors
- VME Bus (IEC 821) Interface
  - A24 Slave with D08(EO)/D16
  - 256 kB DP RAM for process and message data
Multifunction Vehicle Bus Interface Module (MVB)

MODULE FUNCTIONS
Trainnet® Multifunction Vehicle Bus (MVB) modules are used to create vehicle buses or more comprehensive train communication networks. The Multifunction Vehicle Bus Module implements the MVB link layer functions of the IEC 61375-3-1 Train Communications Network standard. The TCN’s real-time protocols and the routing between the MVB and other buses are implemented by the gateway CPU Module.

KEY FEATURES
The Trainnet® Multifunction Vehicle Bus module supports physical cable redundancy and full bus master functionality as specified in the IEC 61375-3-1 standard. Bus administrator redundancy is supported on the Software level.

TCN standard’s D-9 type connectors (or ST-bayonet fibre connectors) are located on the front panel of the module. Communication to the gateway is conducted through shared memory over the IEC 821 VME back plane bus. The MVB link layer functions are implemented by the MVB module’s local processor. Multiple Trainnet® MVB modules can be controlled by a single Trainnet® CPU to implement physically separated MVB networks.

The Trainnet® MVB module has static shared RAM memory accessible from both the local CPU and the VME Bus interface. A separate memory area is reserved for message data and maintenance messages as well as for Remote Procedure Call type access to the Link Layer primitives.

The MVB module is realised through a highly efficient combination of local microprocessor, FPGA logic and a dedicated MVB controller (ASIC). In addition to strict compliance with the IEC 61375-3-1 standard, the MVB module has the capability of carrying out some diagnostic functions.

OPTIONS
Physical interface. The following MVB module physical interfaces are available: Electrical Short Distance with isolation (ESD+), Electrical Medium Distance (EMD) and Optical Glass Fibre (OGF) medium. ESD+ and EMD come with two sub-D-9 connectors while OGF has four ST-bayonet fibre connectors.

TECHNICAL SPECIFICATIONS
Dimensions (W x H x D)
4 TE x 3 U x 160 mm

Weight
ESD: 160 g / EMD: 220 g / OGF: 180 g

Input Power
5 V DC ± 5 % (1 A max., 0.5 A typ.)

Temperature Range (operational)
-40 °C…+70 °C

MTBF (40 ºC ambient temperature)
1 320 000 h (MVB2791A)
1 950 000 h (MVB1820A)
720 000 h (MVB2616A)

Physical Medium
Isolated Electrical Short Distance (ESD, MVB2791A)
Electrical Medium Distance (EMD, MVB1820A)
Optical Glass Fibre (OGF, MVB2616A)

Data Rate
1.5 Mbit/s; Manchester encoding

VME Bus (IEC 821 Interface)
A24 Slave with D08(EO)/D16
246 kB SRAM and 512 kB traffic memory for process and message data
The CAN Vehicle Bus Interface Module (CVB) is used to create up to two CAN Buses in the train. The 2 CAN ports can be independently configured as CAN 2.0 A/B or CANopen®. The Trainnet® CVB module implements the CAN link layer functions. The routing between the CAN bus and other buses are implemented by the gateway CPU Module.

The CVB module is realised through a highly efficient combination of local microprocessor, FPGA logic and two dedicated CAN controllers. The Trainnet® CAN Vehicle Bus Interface Module has the capability of carrying out some specific diagnostics functions. Interfaces are Dual CAN 2.0 B and ISO 11898 compatible with a CiA DS-102 standard pin assignment, implemented with SJA1000 standalone CAN controllers.

The Trainnet® CVB module has static shared RAM memory accessible from both the local CPU and the VME Bus interface.

**Key Features**
- The module has two CAN network connectors on the front-panel, one 9-pin sub-miniature D-type connector for each independent interface. Communication to the gateway is done through shared memory over the IEC 821 VME back plane bus. The CAN network access is implemented with two CAN controller chips, and the CAN link layer functions with the CAN module’s local CPU. Multiple Trainnet® CVB modules can be controlled by a single Trainnet® CPU to implement physically separated CAN networks.

**Options**
- **Bus Interfaces:** The Trainnet® CVB module is available as an option with integrated bus termination resistors.

**Technical Specifications**
- **Dimensions (W x H x D):** 4 TE x 3 U x 160 mm
- **Weight:** 165 g
- **Input Power:** 5 V DC ± 5 % (500 mA nominal)
- **Temperature Range (operational):** -40 °C…+70 °C
- **MTBF:** (40 ºC ambient temperature) 600 000 h (CVB1521A CAN terminated) 600 000 h (CVB2456A CAN not terminated)
- **CAN Network Interface:** Two CAN interfaces
- **Data Rate:** Up to 1 Mbit/s
- **Protocol:** CAN 2.0 compatible
- **Electrical:** 24 V compliant, optically isolated
- **Connector:** 9-pin sub-miniature D-type connector
- **Bus Termination:** On board 120 Ohm termination on request
- **VME Bus (IEC 821) Interface:** A24Slave with D08(E0)/016
Serial Links Interface Unit (SIU)

**MODULE FUNCTIONS**
The Trainnet® Serial Links Interface Unit (SIU) is used to implement up to eight serial links. The physical layer level and parts of data link layer are implemented within SIU and higher protocol layers are implemented on the system CPU.

For gateway applications, the routing between the Serial Link buses and other buses are implemented by the train computer CPU module.

**KEY FEATURES**
The module has one DIN41612-F48 connector on the front panel where Serial Links can be connected. Serial links are split in two identical groups which are isolated from the FPGA and from each other. In each group there are four Serial Links that can be configured in different ways according to the table below.

Communication between the module and the train computer/system is done through shared memory over the IEC 821 VME back plane bus.

The Trainnet® SIU module provides 2 kByte long RX and TX double buffers for each serial link. The system CPU can access these buffers through the VME shared memory. A dedicated FPGA controls precise timing for all eight channels in parallel and provides convenient double buffering for the system CPU. This guarantee high performance in demanding safety critical applications.

**OPTIONS**
The Trainnet® SIU comes in 2 different versions offering different Serial Interface combinations. Please consult the table below for specifications. Other configurations are available upon request.

**TECHNICAL SPECIFICATIONS**
Dimensions (W x H x D)
4 TE x 3 U x 160 mm

Weight
140 g

Input Power
5 V DC ± 5 % (250 mA typ., 400 mA max.)

Temperature Range (operational)
-40 °C…+70 °C

MTBF (40 °C ambient temperature)
2 600 000 h

Connector
DIN41612-F48 (at front)

Serial Link Interfaces
2 isolated groups

See table for all options

FPGA Shared Memory
TX buffers: 8 x 2 x 2 kB
RX buffers: 8 x 2 x 2 kB

VME Bus (IEC 821) Interface
A24 Slave with D08(E0)/D16

**STANDARD SIU MODULES:**

<table>
<thead>
<tr>
<th>MODULE REFERENCE</th>
<th>RS-485 HALF OR FULL DUPLEX*</th>
<th>RS-232**</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIU3448A</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>SIU3449A</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

* The RS-485 Full Duplex can be used for RS-422 applications
** Optional handshake signals
**Ethernet Router Unit (ERU)**

**MODULE FUNCTIONS**

The Trainnet® Ethernet Router Unit (ERU) is a combination of high performance Ethernet router and switch. It is used as an Ethernet Train Backbone node (ETBN) to create integrated Ethernet Train Backbone (ETB) and Ethernet Consist Networks (ECN). It provides connectivity for devices with an Ethernet connection and can complement or replace the Wire Train Bus (WTB).

The Trainnet® ERU module implements the ETB link layer function of the IEC 61375-2-5 as well as the ECN link layer function of the IEC 61375-3-4 Train Communication Network Standards. The Ethernet technology’s large bandwidth (typically 100 Mb/s) is particularly suitable for data intensive systems like video surveillance or Passenger Information Systems.

**KEY FEATURES**

The Trainnet® ERU module routes traffic between the ETB and the ECN. 4 ports are dedicated to the ETB (2 separate lines in each direction of the vehicle) and 6 to the ECN. The bypassing functionality allows the information from the ETB to go through even if the car is unpowered. The Trainnet® ERUs non-blocking (QoS Layer 2) switching architecture provides large bandwidth: its 10 ports are 10/100BASE-TX Mbit/s Full Duplex Ethernet with auto MDI/MDIX M12 connectors. If required, two Ethernet ports can be replaced by 1 Gbit/s optical fiber SFP ports or M12 X-coded 1 Gbit/s ports for increased bandwidth. The Ethernet ports are located on the front panel of the module and communication to the gateway is done via one of the Ethernet ports. An Electronic Serial Number (ESN) port is available for device identification and configuration.

The ERU’s ECN ports can be partitioned to create distinct ECN subnets using a virtual router. The device also supports dynamic routing protocols. The possibility of using link aggregation provides an opportunity to increase data transfer capabilities as well to create redundancies.

The ERU module automatically handles the train inauguration as consists are connected to and disconnected from the train set. There is support for dynamically connecting up to 63 train backbone nodes. The module also has a DDNS server (i.e. dynamic DNS server), so that end devices in vehicles can connect to each other through their domain names, not only the IP addresses. The ERU provides the train topology information to applications in a train directory.

Port mirroring can be used to copy packet data seen on a switch port to another port for diagnostic and monitoring purposes. ERU supports Virtual Router Redundancy Protocol (VRRP) providing enhanced reliability: if a module stops working, its IP address is automatically transferred to a redundant device, ensuring continuous operations.

The ERU’s ECN switch provides connectivity to the consist network switches in a ring configuration (allows redundancy), or by connecting ports directly to end devices. The switch provides services such as Dynamic Host Configuration Protocol (DHCP) in order to assign IP addresses to end devices automatically. The management processor also provides VLAN configurations and Layer 3 switching. It enables diagnostic functions such as the identification of faulty cables.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**: 16 TE x 3 U x 160 mm
- **Weight**: 500 g
- **Input Power**: 5 V DC ± 5 % (1.5 A typ. 3 A max.)
- **Temperature Range (operational)**: -40 °C...+70 °C
- **MTBF (40 °C ambient temperature)**: 450 000 h
- **Ethernet Interfaces**: 4 x 10/100 Mbit/s M12 for ETB, 6 x 10/100 Mbit/s M12 for ECN (1 Gbit/s M12 or SFP as an option for ports T1 and T2)
- **Serial Interface**: 1 RS 232 on front (for maintenance, configuration or ESN dongle)
- **Swiching Buffer Memory**: 2 Mbit
- **Management CPU**: PowerPC 667 MHz
- **Flash Memory**: 512 MB
- **RAM**: 256 MB

EN 50155
IEC 61375-2-5
IEC 61375-3-4
The Trainnet® Ethernet Switching Unit (1U ESU) is an Ethernet switch used to build Ethernet Consist Networks (ECN). It can also be used to create an Ethernet train bus in the case of a fixed trainset with no need for automatic inauguration.

The Trainnet® 1U ESU module implements the ECN link layer function of the IEC 61375-3-4 Train Communications Network Standard. The Ethernet technology’s large bandwidth (typically 100 Mb/s) is particularly suitable for data intensive systems like video surveillance or Passenger Information Systems.

**Key Features**

The Trainnet® 1U ESU has 15 Ethernet ports which can have different properties. Three port technologies are available:

- 12 x 10/100 Mbit/s with PoE, M12
- 1 x 10/100 Mbit/s, M12
- 2 x 1 Gbit/s available in SFP module slot

The Ethernet ports are located on module’s front panel and communication to the gateway is done via one of the Ethernet ports. Ports can be partitioned to create distinct ECN subnets using a virtual router. The device also supports dynamic routing protocols and link aggregation (to increase data transfer capabilities but especially to create redundancy). Port mirroring can be used to copy packet data seen on a switch port to another port for diagnostics and monitoring purposes. 1U ESU supports Virtual Router Redundancy Protocol (VRRP) providing enhanced reliability: if a module stops working, its IP address is automatically transferred to a redundant device, ensuring continuous operations.

The 1U ESU provides connectivity to the consist network switches in a ring configuration (allows redundancy), or by connecting ports directly to end devices. The switch provides services such as Dynamic Host Configuration Protocol (DHCP) in order to assign IP addresses to end devices automatically. The management processor provides also VLAN configurations Layer 3 switching. It enables diagnostic functions such as the identification of faulty cables and PoE monitoring. It features a non-blocking (QoS Layer 2) switching architecture.

**Technical Specifications**

- **Dimensions (W x H x D)**: 84 TE x 1 U x 160 mm
- **Weight**: 550 g
- **Input Power**: 5 V DC ± 5 % (4 A max., 1.5 to 2.5 A typ.)
- **Temperature Range (operational)**: -40 ºC…+70 ºC
- **MTBF (40 ºC ambient temperature)**: 550 000 h (ESU1906A)
  640 000 h (ESU2250A)
- **Ethernet Interfaces**
  - **ESU1906A**
    - 12 x 10/100 Mbit/s with PoE, M12
    - 1 x 10/100 Mbit/s, M12
  - **ESU2250A**
    - 15 x 1 Gbit/s available in SFP module slot
- **Switching Buffer Memory**: 2 Mbits
- **Management CPU**: Blackfin DSP, 500 MHz, 100 Mbit/s Ethernet
- **Flash Memory**: 8 MB
- **RAM**: 16 MB

**Options**

- **Port combinations** (2 options available to meet different technical requirements):
  - 12 x 10/100 with PoE + 1 x 10/100 + 2 x SFP (ESU1906A)
  - 15 x SFP (ESU2250A)
Compact Ethernet Switching Unit (3U ESU)

**MODULE FUNCTIONS**

The Trainnet® Compact Ethernet Switching Unit (3U ESU) is a versatile Ethernet switch module suitable for building cost effective Ethernet Consist Networks (ECN). It can also be used to create an Ethernet train bus in the case of a fixed train set when there is no need for automatic inauguration.

The Trainnet® 3U ESU module implements the ECN link layer function of the IEC 61375-3-4 Train Communications Network Standards. The Ethernet technology’s large bandwidth (typically 100 Mb/s) is particularly suitable for data intensive systems like video surveillance or Passenger Information Systems.

**KEY FEATURES**

The Trainnet® 3U ESU non-blocking (QoS Layer 2) switching architecture provides large bandwidth: it has 10 Ethernet ports which are 10/100BASE-TX Mbit/s Full Duplex Ethernet with auto MDI/MDIX M12 connectors. If required, two of the Ethernet ports can be replaced by 1 Gbit/s optical fiber SFP ports or M12 X-coded 1 Gbit/s ports for increased bandwidth. The Ethernet ports are located on the front panel of the module and communication to the gateway is done via one of the Ethernet ports. An Electronic Serial Number (ESN) port is available for device identification and configuration.

The car can be equipped with two redundant Trainnet® 3U ESU modules in order to increase system reliability. If the principal module fails, the secondary module takes over the functionality.

The Trainnet® 3U ESU provides connectivity to the consist network switches in a ring configuration (allows redundancy), or by connecting ports directly to end devices. The switch provides services such as Dynamic Host Configuration Protocol (DHCP) in order to assign IP addresses automatically to end devices. The management processor also provides VLAN configurations and Layer 3 switching. It enables diagnostic functions such as the identification of faulty cables.

The 10 ports of the 3U ESU can be partitioned to create distinct ECN subnets using a virtual router. The device also supports dynamic routing protocols. The possibility of using link aggregation provides an opportunity to increase data transfer capabilities as well to create redundancies.

Port mirroring can be used to copy packet data seen on a switch port to another port for diagnostic and monitoring purposes.

The device also supports Virtual Router Redundancy Protocol (VRRP) providing enhanced reliability: if a module stops working, its IP address is automatically transferred to a redundant device, ensuring continuous operations.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**: 16 TE x 3 U x 160 mm
- **Weight**: 520 g
- **Input Power**: 5 V DC ± 5% (1.5 A typ. 3 A max.)
- **Temperature Range (operational)**: -40 °C…+70 °C
- **MTBF (40 °C ambient temperature)**: 690 000 h
- **Ethernet Interfaces**: 10 x 10/100 Mbit/s M12 (1 Gbit/s M12 or SFP as an option for ports 1 and 2)
- **Serial Interface**: 1 RS 232 on front (for maintenance, configuration or ESN dongle)
- **Switching Buffer Memory**: 2 Mbits
- **Management CPU**: PowerPC 667 MHz
- **Flash Memory**: 512 MB
- **RAM**: 256 MB
Unmanaged Ethernet Switching Unit (UM-ESU)

**MODULE FUNCTIONS**
The Trainnet® Unmanaged Ethernet Switching Unit (UM-ESU) is a straightforward Ethernet switch module. It can be used to connect Ethernet devices. When associated with a managed switch (e.g. Trainnet® ETC, 1U ESU, 3U ESU or ERU), it can also be used to create cost effective Ethernet Consist Networks (ECN).

**KEY FEATURES**
The Trainnet® UM-ESU non-blocking switching architecture provides large bandwidth: it has 8 Ethernet ports which are 10/100BASE-TX Mbit/s Full Duplex Ethernet with auto MDI/MDIX M12 connectors. The Ethernet ports are located on the front panel of the module and communication to the gateway is done via one of the Ethernet ports.

**TECHNICAL SPECIFICATIONS**
- Dimensions (W x H x D): 12 TE x 3 U x 160 mm
- Weight: 250 g
- Input Power: 5 V DC ± 5 % (0.4 A typ. 0.7 A max.)
- Temperature Range (operational): -40 °C...+70 °C
- MTBF (40 °C ambient temperature): 4,000,000 h
- Ethernet Interfaces: 8 x 10/100 Mbit/s M12
- Switching Buffer Memory: 2 Mbits

EN 50155
PROFIBUS Vehicle Bus Interface Module (PVB)

MODULE FUNCTIONS
The Trainnet® PROFIBUS Vehicle Bus Interface module (PVB) is used to create up to two PROFIBUS Buses in the train. The routing between the PROFIBUS bus and other buses are implemented by the train computer’s CPU Module.

The Trainnet® PVB implements the FFFIS interface between the ERTMS/ETCS and the JRU (Juridical Recording Unit). In practice, the PVB module can interface between the JRU and the EVC (European Vital Computer) and/or STM (Specific Transmission Module).

KEY FEATURES
The PVB module has two PROFIBUS network connectors on the front-panel, one 9-pin sub-miniature D-type connector for each independent interface. The 2 ports can be used to implement redundancy.

Communication to the gateway is done through shared memory over the IEC 821 VME back plane bus. Multiple Trainnet® PVB modules can be controlled by a single Trainnet® CPU to implement several PROFIBUS networks.

The Trainnet® PVB module has a static shared RAM memory accessible from both the local CPU and the VME Bus interface.

The PVB module is realised through a highly efficient combination of local microprocessor, FPGA logic and two embedded PROFIBUS controllers.

The Trainnet® PVB module has a Software-selectable termination.

OPTIONS
Upon request, the Trainnet® PVB can also be developed for generic PROFIBUS DP applications (IEC61158).

Illustration: ETCS architecture

TECHNICAL SPECIFICATIONS

Dimensions (W x H x D)
4 TE x 3 U x 160 mm

Weight
165 g

Input Power
5 V DC ± 5 % (500 mA nominal)

Temperature Range (operational)
-40 °C...+70 °C

MTBF (40 °C ambient temperature)
520 000 h

PROFIBUS Network Interface
Two PROFIBUS interfaces

Cable Recommendation:
Profibus cable type A:
Shielded Twisted Pair
Impedance 135-165 Ω (f = 3 to 20 MHz)
Capacitance < 30 pF/m
Resistance < 110 Ω/km
Conductor area ≥ 0.34 mm² (22 AWG)

Data Rate
Up to 1.5 Mbit/s

Protocol
FFFIS

Connector
9-pin sub-miniature D-type connector
AWG 20 STP cable recommended

Bus Termination
On board 150 Ohm termination, Software activated

VME Bus (IEC 821) Interface
A24 Slave with D08(E0)/D16
Analogue Input Module (AIM)

MODULE FUNCTIONS
The Trainnet® Analogue Input Module (AIM) provides a standard interface for analogue input signals. Signals can be current (-20…+20mA) and voltage (-10…+10V). Separate channels are provided for frequency signal measurements with the capability to measure pulse-width ratio (PWM). The Trainnet® AIM converts the analogue signals and makes them available to the train computer’s CPU Module.

The Trainnet® Analogue Input Module can be used as a part of a Trainnet® TCMS, VCU or Event Recorder. Alternatively, the Trainnet® AIM can be fitted into the Trainnet® Remote I/O Module (RIOM).

KEY FEATURES
The Trainnet® AIM has 10 current channels and 10 voltage channels divided in three isolated groups. 4 frequency channels are also available.

The 10 current measurement channels can measure currents between -20 and +20 mA. The module has the capability to supply voltage to external sensors or to supply loop voltage to the current loops. The module’s 10 voltage measurement channels can measure voltages between -10 and +10 V. The resolution of the input A/D conversion is sign+12 bits, and the cut-off frequency of the hardware low pass filter is 10 Hz. Both current and voltage channels are capable of giving over range indications which can be used for diagnostic purposes.

The 4 frequency input channels can measure frequencies up to 16 kHz, period, pulse width, pulse count and rotary decoding with direction indication (compatible with most industry standard tachometers).

The module has its own 32-bit embedded processor that uses factory calibration values to convert the measurement value to mV or μA with great accuracy. The embedded processor also implements diagnostics functions and reports to the system CPU module if it suspects that the input values cannot be trusted.

SIL-2 CERTIFIED
The module development is based on the railway standards EN 50126, EN 50128 and EN 50129 in accordance with safety integrity level SIL 2. A non-SIL certified version of the module is also available.

TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Dimension (W x H x D)</th>
<th>4 TE x 3 U x 160 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>160 g</td>
</tr>
<tr>
<td>Input Power</td>
<td>5 V DC ± 5 % (650 mA typ, 3 A max)</td>
</tr>
<tr>
<td>Temperature Range (operational)</td>
<td>-40 °C...+70 °C</td>
</tr>
<tr>
<td>MTBF (40 ºC ambient temperature)</td>
<td>500 000 h (AIM2505A)</td>
</tr>
<tr>
<td>I/O Connector</td>
<td>DIN41612-F48 (at front)</td>
</tr>
<tr>
<td>Host Interface</td>
<td>RS 485 serial</td>
</tr>
<tr>
<td>Input Channels, Analogue</td>
<td>10 voltage channels, -10…+10 V (Vin)</td>
</tr>
<tr>
<td></td>
<td>10 current channels, -20…+20 mA (Iin)</td>
</tr>
<tr>
<td>Input Channels, Frequency</td>
<td>4 input channels</td>
</tr>
<tr>
<td>Frequency Input Voltage Range</td>
<td>0…36 V DC</td>
</tr>
<tr>
<td>Frequency Input Threshold level</td>
<td>Each channel has its own software configurable threshold level, fixed hysteresis</td>
</tr>
<tr>
<td>Frequency Input Range</td>
<td>DC to 16 Hz, 0.25 Hz resolution</td>
</tr>
<tr>
<td>Frequency Input Pulse Width Measurement</td>
<td>0.1% resolution</td>
</tr>
<tr>
<td>Tachometer Supply Outputs (Vout)</td>
<td>15 VDC, max. 100 mA</td>
</tr>
</tbody>
</table>
High Speed Analogue Input Module (HSA)

MODULE FUNCTIONS
The Trainnet® High Speed Analogue Input Module (HSA) provides a standard interface for analogue input signals. Signals can be current (-20...+20mA) and voltage (-10...+10V). Separate channels are provided for frequency signal measurements with the capability to measure pulse-width ratio (PWM). The Trainnet® HSA converts the analogue signals and makes them available to the train computer’s CPU Module.

The Trainnet® High Speed Analogue Input Module can be used as a part of a Trainnet® TCMS, VCU or Event Recorder.

KEY FEATURES
The Trainnet® HSA has 4 current channels and 4 voltage channels divided in four isolated groups. 4 frequency channels are also available.

The 4 frequency input channels can measure frequencies up to 16 kHz, period, pulse width, pulse count and rotary decoding with direction indication (compatible with most industry standard tachometers).

The module has its own 32-bit Floating point Digital Signal Processor for a high signal processing capability and uses factory calibration values to convert the measurement value to mV or μA with great accuracy. The embedded DSP processor can be used to perform signal processing tasks like filtering. It also implements diagnostics functions and reports to the system CPU module if it suspects that the input values cannot be trusted.

SIL-2 CERTIFIED
The module development is based on the railway standards EN 50126, EN 50128 and EN 50129 that are in accordance with safety integrity level SIL 2. A non-SIL certified version of the module is also available.

TECHNICAL SPECIFICATIONS
- Dimensions (W x H x D): 4 TE x 3 U x 160 mm
- Weight: 170 g
- Input Power: 5 V DC ± 5 % (1 A typ. 3 A max.)
- Temperature Range (operational): -40 °C...+70 °C
- MTBF (40 °C ambient temperature): 390 000 h (HSA2620A)
- I/O Connector: DIN41612-F48 (at front)
- Host Interface: VME Bus A24/D08/D16 Slave
- Input Channels, Analogue: 4 voltage channels, -10...+10 V (Vin)
- 4 current channels, -20...+20 mA (Iin)
- Input Channels, Frequency: 4 input channels
- Frequency Input Voltage Range: 0...36 V DC
- Frequency Input Threshold level: Each channel has its own software configurable threshold level, fixed hysteresis
- Frequency Input Range: DC to 16 kHz, 0.25 Hz resolution
- Frequency Input Pulse Width Measurement: 0.1% resolution
- Tachometer Supply Outputs: 15 VDC, max. 70 mA each
**Analogue Output Module (AOM)**

**MODULE FUNCTIONS**
The Trainnet® Analogue Output Module (AOM) provides standard interface for analogue output signals. The Trainnet® AOM receives instructions from the train computer’s CPU Module and sends analogue signals to sub-systems accordingly.

The Trainnet® AOM can be used as a part of a Trainnet® TCMS, VCU or Event Recorder. Alternatively, the Trainnet® AOM can be fitted into the Trainnet® Remote I/O Module (RIOM).

**KEY FEATURES**
The module has 4 individually isolated analogue output groups. All groups are identical and have 4 analogue output channels. Each group has two PWM outputs.

By default, 2 channels are configured as current loop transmitters with integrated loop supply (current mode) and 2 channels as bipolar voltage output and two digital pulse width modulation outputs (voltage mode). The channel configurations can easily be changed from current mode to voltage mode and vice-versa, depending on your needs. The Trainnet® AOM is able to provide current loop supply voltage internally: there is no need for an external power supply. Configurable ranges are from 4 to 20 mA for current and from -10 to +10 V for voltage.

Each output channel has parameters for calibration (factory set), and diagnostics to detect short or open in current loop and short in voltage output. Outputs are factory calibrated. The module has its own 32-bit embedded processor to manage serial communication with the train computer’s CPU module. The embedded processor also implements diagnostic functions and reports to the train computer’s CPU module if it suspects that the output values cannot be trusted.

The module has an RS 485 serial bus interface for connecting to the train computer.

**SIL-2 CERTIFIED**
The module development is based on the railway standards EN 50126, EN 50128 and EN 50129 that are in accordance with safety integrity level SIL 2. A non-SIL certified version of the module is also available.

**TECHNICAL SPECIFICATIONS**
- **Dimensions (W x H x D)**: 4 TE x 3 U x 160 mm
- **Weight**: 165 g
- **Input Power**: 5 V DC ± 5 % (1 A typ., 3A max.)
- **Temperature Range (operational)**: -40 ºC...+70 ºC
- **MTBF (40 ºC ambient temperature)**: 770 000 h (AOM2610A)
- **I/O Connector**: DIN41612-F48 (at front)
- **Host Interface**: RS 485
- **Current Output Mode**: 4…20 mA
  - 1 µA resolution
- **Voltage Output Mode**: -10…+10 V
  - 1 mV resolution
- **PWM Outputs**: Selectable base frequency 10 Hz to 10 kHz
  - Pulse width adjustable with 0.1% resolution
  - Output level 15 V
Digital Input/Output Module (DIO)

**MODULE FUNCTIONS**
The Trainnet® Digital Input/Output Module (DIO) provides a standard interface for digital input and output signals. The Trainnet® DIO receives the digital signals via its input channels and makes them available to the train computer’s CPU Module. The Trainnet® DIO receives instructions from the train computer’s CPU Module and sends digital signals to the sub-systems accordingly via its output channels. Separate channels are provided for frequency measurements.

The Trainnet® Digital Input/Output Module can be used as a part of a Trainnet® TCMS, VCU or Event Recorder. Alternatively, the Trainnet® DIO can be fitted in the Trainnet® Remote I/O Module (RIOM).

**KEY FEATURES**
The Trainnet® DIO has 24 input channels and 8 channels which can be used either as input channels or output channels. 2 frequency input channels are also available. Up to four outputs can be connected in parallel to increase output current.

One special feature of the DIO module is to support the UIC-556 sleep mode. The DIO can remain active with WTB modules, and provide local inauguration and battery voltage monitoring.

The module also provides emergency output short circuit protection: if the output current exceeds its maximum value, the short circuit protection shuts down the output. The status of the short circuit protection is available to the train computer’s CPU module.

Two separate group voltages with common ground allow split behind two circuit breakers, or having a mixed voltage system. Input and Input/Output channels are split evenly between group voltage 1 and 2. Please note that the groups are not isolated from each other.

**SIL-2 CERTIFIED**
The module development is based on the railway standards EN 50126, EN 50128 and EN 50129 that are in accordance with safety integrity level SIL 2. A non-SIL certified version of the module is also available.

**TECHNICAL SPECIFICATIONS**

- **Dimensions (W x H x D)**: 4 TE x 3 U x 160 mm
- **Weight**: 1.79 g
- **Input Power**: 5 V DC ± 5 % (500 mA max., 200 mA typ.)
- **Temperature Range (operational)**: -40 °C...+70 °C
- **MTBF (40 ºC ambient temperature)**: 1 500 000 h (DIO2378A) 1 170 000 (DIO2908A) (SIL-2)
- **I/O Connector**: DIN41612-F48 (at front)
- **Host Interface**: RS 485
- **Number of Input-only Channels**: 24
- **Number of Input/Output Channels**: 8
- **Number of Frequency Input Channels**: 2
- **Battery Voltage Monitor**: Yes, one or two (UIC-556)
- **Temperature Measurement**: Yes, local CPU
- **Input type**: Current sink
- **Output Type**: High side (FET) from battery voltage
- **Voltage Drop**: Max. 2 V
- **Input/Output Voltage Range**: 16.8...137.5 V DC (1 sec 14...154 V DC)
- **Threshold levels**: Software selectable (both, positive and negative) (either V or % Vin)
- **Software Selectable Wetting Current**: 0 ... 25 mA
- **Output Current**: 1.0 A Continuous
Digital Relay Output Module (DRO)

**MODULE FUNCTIONS**
The Trainnet® Digital Relay Output Module (DRO) provides standard relay contacts. The Trainnet® DRO receives instructions from the train computer’s CPU Module and controls output relays accordingly.

The Trainnet® DRO can be used as a part of a Trainnet® TCMS, VCU or Event Recorder. Alternatively, the Trainnet® DRO can be fitted in the Trainnet® Remote I/O Module (RIOM).

**OPTIONS**
The Trainnet® DRO has 8 relay output channels located on the module’s front side. A SIL-2 certified version of the module is also available, but please note that it only has 4 relay output channels. Relays are of type SPDT (Single Pole Double Throw). Relay contacts are available from the DIN41612F connector at the front of the module.

The module is able to take up pre-set output states in case of emergency. If the communication between the train computer’s CPU module and the DRO fails, the relays go to emergency states that you can define in the application Software. When the Trainnet® DRO is unpow- ered, all relays are in Normally Closed state. Emergency states should be defined to match the wiring to Normally Open (NO)/ Normally Closed (NC) contacts.

**SIL-2 CERTIFIED**
The SIL-2 DRO module development is based on the railway standards EN 50126, EN 50128 and EN 50129 that are in accordance with safety integrity level SIL 2.

**TECHNICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (W x H x D)</td>
<td>4 TE x 3 U x 160 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>190 g</td>
</tr>
<tr>
<td>Input Power</td>
<td>5 V DC ± 5 % (500 mA max., 200 mA typ.)</td>
</tr>
<tr>
<td>Temperature Range (operational)</td>
<td>-40°C...+70°C</td>
</tr>
<tr>
<td>MTBF (40 ºC ambient temperature)</td>
<td>830 000 h (DRO2342A)</td>
</tr>
<tr>
<td>Relay electrical life</td>
<td>500 000 cycles</td>
</tr>
<tr>
<td>I/O Connector</td>
<td>DIN41612-F48 (at front)</td>
</tr>
<tr>
<td>Host Interface</td>
<td>RS 485</td>
</tr>
<tr>
<td>Number of Channels</td>
<td>8 [4 only if SIL-2]</td>
</tr>
<tr>
<td>Relay Type</td>
<td>Change over (SPDT) AgNi 0.15 Contacts</td>
</tr>
</tbody>
</table>
| Maximum Switching Current vs Voltage| 24 V DC  3.5 A  
|                                   | 48 V DC  1.4 A                              |
|                                   | 110 V DC  0.5 A                             |
| Temperature Measurement           | Yes, local CPU                              |
Pt100 Temperature Sensor Input Module (PTI)

MODULE FUNCTIONS
The Trainnet® PTI module is a PT-100 temperature sensor input module. It acquires the signals from the PT-100 temperature sensors (resistance measurement) and converts them into temperature values expressed in degrees Celsius. The PTI module makes the measured temperature values available to the train computer’s CPU.

The Trainnet® PTI can be used as a part of a Trainnet® TCMS, VCU or Event Recorder. Alternatively, the Trainnet® PTI can be fitted in the Trainnet® Remote I/O Module (RIOM).

KEY FEATURES
The Trainnet® PTI has six PT-100 measurement channels which can measure temperature within the -110 to +325 °C range with over range indication. Each channel is isolated from each other, thus a fault in one channel will not affect the others. PT-100 temperature sensors can be connected using 2-wire, 3-wire or 4-wire schemes providing flexibility.

The measurement resolution is 0.01 °C, with accuracy better than ±1 °C within the measurement range.

The module has its own 32-bit embedded processor that uses factory calibration values to convert measurement values to degrees Celsius with the best possible accuracy. The embedded processor also implements diagnostic functions and reports to the train computer's CPU module if it suspects that the input values cannot be trusted. The Trainnet® PTI detects the temperature sensor as well as cable faults and input channel faults.

TECHNICAL SPECIFICATIONS

- Dimensions (W x H x D) 4 TE x 3 U x 160 mm
- Weight 160 g
- Input Power 5 V DC ± 5 % (310 mA typ., 400 mA max.)
- Temperature Range (operational) -40 °C...+70 °C
- MTBF (40 °C ambient temperature) 1,580,000 h (PTI2037A)
- I/O Connector DIN41612-F48 (at front)
- Host Interface RS 485
- Input Channels 6 Pt100 sensor
- Connection Type 2-wire, 3-wire or 4-wire
- Measurement Range -110 °C to +325 °C
- Resolution 0.01 °C
- Accuracy Better than ± 1 °C (3- or 4-wire)
**Power Supply Unit for VME (PSV)**

**MODULE FUNCTIONS**
The Trainnet® Power Supply Unit for VME (PSV) is a highly reliable switching mode power supply module. It works only together with the Trainnet® PIU module which takes power from the train batteries and transfers it to the Trainnet® PSV module. The Trainnet® PSV module is specially designed for VMEbus systems.

**KEY FEATURES**
The Trainnet® PSV has built-in circuitry to detect and control the input current in the event of a power-up. Controlling the in-rush current prevents component damages.

The Trainnet® PSV grace supply function enables the module to continue working for a short period of time when the power is cut off. The PSV module withstands 10 ms input power breaks without disrupting any of the normal operations. If the break lasts longer, the power supply is capable of supplying a +5 V DC output during a minimum of 100 ms after the input power is lost (80 ms for PSV1133B).

The ACFAIL and SYSRESET signals are activated to ensure proper shutdown of the systems. This feature allows the system to record sub-system and module states during the shutdown, thus enabling event diagnostics.

When the input supply voltage is below the set minimum value, Trainnet® PSV minimizes current consumption in order to prevent the deep discharge of train batteries.

For various versions and specifications, please revert to the table above.

---

**TECHNICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Reference</th>
<th>PSV1133B</th>
<th>PSV9033A</th>
<th>PSV2513A</th>
<th>PSV3034A</th>
<th>PSV1513A</th>
<th>PSV018A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (W x H x D)</td>
<td></td>
<td></td>
<td>8 TE x 3 U x 160 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>500 g</td>
<td>470 g</td>
<td>500 g</td>
<td>470 g</td>
<td>500 g</td>
<td>500 g</td>
</tr>
<tr>
<td>Temperature Range (operational)</td>
<td>40 °C...+70 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTBF (40 °C ambient temperature)</td>
<td>690 000 h</td>
<td>700 000 h</td>
<td>690 000 h</td>
<td>700 000 h</td>
<td>690 000 h</td>
<td>690 000 h</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>24 V DC</td>
<td>24...36 V DC</td>
<td>36...52 V DC</td>
<td>48...110 V DC</td>
<td>72 V DC</td>
<td>110 V DC</td>
</tr>
<tr>
<td>Input Voltage Range (V DC)</td>
<td>16.8...30.0</td>
<td>16.8...46.8</td>
<td>25.2...65.0</td>
<td>33.6...143</td>
<td>50.4...90.0</td>
<td>77...138</td>
</tr>
<tr>
<td>Input Current (&lt;0.1 s/1 s)</td>
<td>4 A max.</td>
<td>7.25 A max.</td>
<td>4 A max.</td>
<td>3 A max.</td>
<td>3 A max.</td>
<td>2 A max.</td>
</tr>
<tr>
<td>Input Power</td>
<td>80 W max.</td>
<td>122 W max.</td>
<td>75 W max.</td>
<td>100 W max.</td>
<td>100 W max.</td>
<td>100 W max.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>&gt; 78%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td>60 W</td>
<td>80 W</td>
<td>54 W</td>
<td>80 W</td>
<td>80 W</td>
<td>80 W</td>
</tr>
<tr>
<td>Output Voltage 5 V DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Output Current</td>
<td>8.5 A</td>
<td>13 A</td>
<td>8.5 A *</td>
<td>13 A</td>
<td>12 A</td>
<td>13 A</td>
</tr>
<tr>
<td>Minimum Output Current</td>
<td>0.5 A</td>
<td>0.1 A</td>
<td>0.5 A</td>
<td>0.1 A</td>
<td>0.5 A</td>
<td>0.5 A</td>
</tr>
<tr>
<td>Ripple/noise (±20 MHz)</td>
<td>50 mVpp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage Hold-on (at nom. load)</td>
<td>80 ms</td>
<td>100 ms</td>
<td>100 ms</td>
<td>100 ms</td>
<td>100 ms</td>
<td>100 ms</td>
</tr>
<tr>
<td>Output Voltage 12 V DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Output Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripple/noise (±20 MHz)</td>
<td>50 mVpp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>12.15 V DC ± 2 %</td>
<td></td>
<td>11.80 V DC min.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Total output loading must not exceed Output power.*

---

**System Reset**

+5 V DC

**Power Safe Capacitor Switching Circuit Isolation Transformer**

Input Voltage 12 V DC

+5 V DC

EMI and EMC Protection

Input Voltage 5 V DC

**In-rush Current Limiter**

Shut-down Logic

Output Circuit

Supply Input
Power Input Unit (PIU, VIU)

Module Functions
The Trainnet® Power Input Unit (PIU) is used to pass train battery voltage to the Trainnet® PSV module, thus powering the entire Trainnet® systems.

Key Features
The Trainnet® PIU input voltages can be 24 V DC (PIU2056A), 36 to 52 V DC (PIU2510A), 72 V DC (PIU2280A) or 110 V DC (PIU2219A). A Trainnet® PSV with a similar input voltage must be selected.

Options
Isolated DC Converter Output:
An isolated DC/DC converter may be installed as an option to provide power to any external equipment. If required, the output voltage may be switched off during the system reset in order to force hard-resets of external equipment. Currently available PIU modules with DC Converter Output are listed in the table below. We can also provide you with another versions upon request.

Vehicle Identification Unit (VIU):
The Trainnet® VIU (Vehicle Identification Unit) has the functionalities of the Trainnet® PIU, and in addition, provides an interface for Electronic Serial Number (ESN). An Electronic Serial Number (ESN) dongle can be connected to VIU for device identification and configuration.

Technical Specifications
Dimensions (W x H x D)
4 TE x 3 U x 160 mm
Weight
100 - 150 g
Input Voltage
24, 36-52, 72 or 110 V DC available
Other on request
Temperature Range (operational)
-40 ºC…+70 ºC
MTBF (40 ºC ambient temperature)
44 570 000 h
Output Voltage (optional)
12 V DC (from PSV)
Technical Data DC Converter option
Weight
350 g
Input Voltage
24 or 110 V DC available
Others on request
MTBF (40 ºC ambient temperature)
500 000 h
Output Voltage and Power
See table

Vehicle Identification Unit (VIU)
Weight
155 g
Input Voltage
110 V DC
MTBF (40 ºC ambient temperature)
5 360 000 h

Available PIU Modules with DC Converter Output:

<table>
<thead>
<tr>
<th>Module Reference</th>
<th>Input Voltage</th>
<th>Output Voltage</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIU2034A</td>
<td>24 V DC</td>
<td>16 V DC</td>
<td>17 W</td>
</tr>
<tr>
<td>PIU2023A</td>
<td>110 V DC</td>
<td>16 V DC</td>
<td>17 W</td>
</tr>
<tr>
<td>PIU3392A</td>
<td>110 V DC</td>
<td>24 V DC</td>
<td>46 W</td>
</tr>
<tr>
<td>PIU3394A</td>
<td>110 V DC</td>
<td>24 V DC</td>
<td>25 W</td>
</tr>
</tbody>
</table>
## Technical specifications

<table>
<thead>
<tr>
<th>Reference</th>
<th>PSR3031A</th>
<th>PSR3032A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (W x H x D)</td>
<td>8 TE x 3 U x 160 mm</td>
<td>8 TE x 3 U x 160 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>410 g</td>
<td>410 g</td>
</tr>
<tr>
<td>Temperature Range (operational)</td>
<td>-40 °C...+70 °C</td>
<td>-40 °C...+70 °C</td>
</tr>
<tr>
<td>MTBF (40 °C ambient temperature)</td>
<td>800 000 h</td>
<td>800 000 h</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>24 to 36 V DC</td>
<td>42 to 110 V DC</td>
</tr>
<tr>
<td>Input Voltage Range (V DC)</td>
<td>16.8 ... 47.8</td>
<td>33.6 ... 143</td>
</tr>
<tr>
<td>Input Current (1s) (V DC)</td>
<td>14.4 ... 50.4</td>
<td>28.8 ... 154</td>
</tr>
<tr>
<td>Input Current (&lt;0.1 s/1 s)</td>
<td>7.5 A max.</td>
<td>4 A max.</td>
</tr>
<tr>
<td>Supported Supply Interruption Efficiency</td>
<td>10 ms</td>
<td>10 ms</td>
</tr>
<tr>
<td>Output Power</td>
<td>80 W</td>
<td>80 W</td>
</tr>
<tr>
<td>Output Voltage 5 V DC</td>
<td>&gt; 80% (typically 85%)</td>
<td>&gt; 80% (typically 85%)</td>
</tr>
<tr>
<td>Maximum Output Current</td>
<td>16 A max.</td>
<td>16 A max.</td>
</tr>
<tr>
<td>Minimum Output Current</td>
<td>0.1 A min.</td>
<td>0.1 A min.</td>
</tr>
<tr>
<td>Ripple/noise p-p</td>
<td>50 mVpp (&lt;20 MHz)</td>
<td>50 mVpp (&lt;20 MHz)</td>
</tr>
<tr>
<td>Output Voltage At nominal line, nominal load</td>
<td>5.15 V DC ± 2 %</td>
<td>5.15 V DC ± 2 %</td>
</tr>
<tr>
<td>At line range, load range</td>
<td>5.05 V DC min.</td>
<td>5.05 V DC min.</td>
</tr>
</tbody>
</table>

## Key features

The Trainnet® PSR can be operated with either 24 to 36 V DC (PSR3031A) or 48 to 110 V DC (PSR3032A) coach supply voltage and provide 5 V DC output power. The input supply is provided directly from the train battery to the PSR module through a 2W2C D-Sub connector. The Trainnet® PSR has built-in circuitry to detect and control the input current in the event of a power-up. Controlling the in-rush current prevents component damages.

When input supply voltage is below the minimum value, Trainnet® PSR minimizes current consumption in order to prevent the deep discharge of train batteries.
**Power Supply Over Ethernet Module (PSE)**

**MODULE FUNCTIONS**
The Trainnet® Power Supply Over Ethernet (PSE) module provides 48 V DC output power to the Trainnet® Ethernet Switching Unit (1U ESU). The Trainnet® PSE enables the Power-over-Ethernet (PoE) functionality of the Trainnet® 1U ESU.

**KEY FEATURES**
The Trainnet® PSE is used to power up the PoE output on the Trainnet® 1U ESU. In practice, one PSE provides power to 4 Ethernet ports on the 1U ESU. When using two Trainnet® 1U ESU simultaneously, the Trainnet® PSE can provide power to both of them, and provide a total of 8 ports.

The output voltage of the Trainnet® PSE is 48 V DC. The input voltage can be 36-52 V DC (PSE2524A) or 110 V DC (PSE2217B). The Trainnet® PSE can provide a maximum power output of 62 W to be split between the powered ports: for example, 15.4 W for 4 ports or 7 W for 8 ports.

The Trainnet® PSE has built-in circuitry to detect and control the input current in the event of a power-up. Controlling the in-rush current prevents component damages.

When input supply voltage is below the set minimum value, Trainnet® PSE minimizes current consumption in order to prevent the deep discharge of train batteries.

The Trainnet® PSE grace supply function enables the module to continue working for a short period of time when the power is cut off. The PSE module withstands 10 ms input power breaks without disrupting any of the normal operations.

The PSE module works only together with the Trainnet® Ethernet Switch Supply (ESS) module which takes power from the train batteries and transfers it to the Trainnet® PSE.

**OPTION**
**Bypass Unit Module**
When the external devices requiring PoE consume little power (Class 1, 0.44 - 3.54 W), the Trainnet® PSE Bypass Unit Module (PBU) can be used. The Trainnet® PBU takes power from the PSE module and distributes it to another set of 4 ports (8 if using two 1U ESU modules). Two PBU modules can be used with one PSE module, sharing the PSE’s 62 W between 12 ports of the 1U ESU (up to 24 ports if using a second 1U ESU module).

**TECHNICAL SPECIFICATIONS**

**Trainnet® ESS Module**

**Dimensions (W x H x D)**
24 TE x 1 U x 160 mm

**Weight**:
280 g

**Temperature Range (operational)**
-40 °C...+70 °C

**MTBF (40 °C ambient temperature)**
800 000 h

**Input Voltage**
36-52 V DC (PSE2524A) or 110 V DC (PSE2217B)

**Input Voltage Range**
25.2 ... 65.0 V DC (PSE2524A) or 77.0 ... 137.5 V DC (PSE2217B)

**Input Power**
80 W max.

**Output Voltage**
48 V DC ± 2 % (at nominal line, nominal load)
46 V DC min. (at line range, load range)

**Output Voltage Hold-on**
10 ms (at nominal load)

**Trainnet® PBU Module**

**Dimensions (W x H x D)**
12 TE x 1 U x 160 mm

**Weight**:
60 g

**Temperature Range (operational)**
-40 °C...+70 °C

**MTBF (40 °C ambient temperature)**
5 000 000 h

**Input Voltage**
36-52 V DC (ESS2525A) or 110 V DC (ESS2184A)
The Trainnet® Rugged Memory Module (RMM) is a highly protected memory module to be used as part of a Trainnet® Event Recorder. As the essential part of the Train Event Recorder, it collects and stores vital train-borne information. Depending on your needs, it can record all kinds of data including audio and video recordings.

**Key Features**

The Trainnet® Rugged Memory Module is used together with a Trainnet® 3U 84TE Rack and a power supply (usually Trainnet® PSV and Trainnet® PIU modules) to build a fully functional and standalone Event Recorder. The Trainnet® RMM can also be integrated to a larger Trainnet® System, for instance in a 6U 84TE Rack, as an addition to a Gateway, VCU or TCMS.

The Trainnet® Rugged Memory Module (RMM) is meant to be used whenever a high level of data protection is needed. Its crash-proof construction guarantees that the memory board is protected against fire, magnetic fields and any liquids, as well as any mechanical stress during an impact or a continuing pressure. In practice, the memory board is embedded in a protected fire insulation block, surrounded by a special steel case that is hermetically sealed.

The design of the Trainnet® Rugged Memory Module fulfills the British (GM/RT2472-1.2002) and European (EEIG 97E461-3.1998) crashworthiness as well as the IEEE (1482.-1.1999) standards.

The Trainnet® RMM can store both analogue and digital signal data. The desired train information can be stored for a predetermined period of time. Data can be retrieved at any time using the Trainnet® TIP Software (Train Inspection Program) which enables system performance analysis and optimization. Data can be copied from the RMM to a USB stick for convenient transport and storage.

The Ethernet and USB ports located on the front of the module can be used to retrieve data from the memory module. The Trainnet® RMM can acquire data from the Ethernet port but also via the VME back plane (thus from added interface modules) and the RS 485 port located on the front panel. The module gets power from the VME back plane.

The RMM can record video streams from onboard digital video recorders (DVR) or directly from cameras. For easy data retrieval, the stream format can be made compatible with your CCTV Software or any other video analysis Software that you use. Alternatively, we can develop customized video analysis tools to fit your needs.

**Options**

**Memory:**
Memory can be 2 GB or 16 GB.

**Front-panel Inprints:**
Front-panel imprints are available on request in English or any other language of your choice.

**GPS/GNSS:**
A GNSS (Global Navigation Satellite System) receiver can be integrated to the RMM to provide location and time information. One version with GPS+GLONASS and one version with GPS+BeiDou are available. Please note this option will increase the module's width by 4 TE.

**Technical Specifications**

- Dimensions (W x H x D): 32 TE x 3 U x 160 mm
- Weight: 7 Kg
- Input Power: 5 V DC ± 5 % (1 A max., 0.5 A typ.)
- Temperature Range (operational): -40 °C...+70 °C
- MTBF (40 ºC ambient temperature): 890,000 h (2 GB) and 870,000 h (16 GB)
- Interfaces:
  - 3 or 4 isolated RS-485
  - 1 x 10/100 Mbit/s Ethernet, M12 connector
  - 1 x USB 2.0 Host for retrieval
- Memory: 2 GB or 16 GB

**Protection Levels (Rugged Memory Module)**

- **Shock:** Up to 100 g / 10 ms and 55 g / 100 ms
- **Crush:** Up to 110 kN for 5 minutes in all axes
- **Penetration:** Up to 23 kg drop from a height of 1.5 m focussed on an area of 30 mm2
- **Temperature:** Up to 700 °C for 5 minutes and 650 °C for 30 minutes followed by 300 °C for 1 hour followed by 100 °C for 5 hours
- **Chemical Immersion:**
  - Winter Diesel (**), Summer Diesel (**), Regular Water (**), Salt Water (**), Lubricating Oil (**), Transformer Oil (**), Hydraulic Oil (**), Anti-Fire Fighting Foam (**), Refrigerant R134A (**), Alcohol (**), Anti Freeze (**), Battery Acid (**)
  - minimum for 48 hours
  - minimum for 60 minutes
- **Magnetic Field:**
  - Current flow of 64 kA at rising rate of 107 A/s
- **Hydrostatic pressure:**
  - Immersion in salt water at a depth of 15 meter for 48 hours

**Technical Specifications**

- Dimensions (W x H x D): 32 TE x 3 U x 160 mm
- Weight: 7 Kg
- Input Power: 5 V DC ± 5 % (1 A max., 0.5 A typ.)
- Temperature Range (operational): -40 °C...+70 °C
- MTBF (40 ºC ambient temperature): 890,000 h (2 GB) and 870,000 h (16 GB)
- Interfaces:
  - 3 or 4 isolated RS-485
  - 1 x 10/100 Mbit/s Ethernet, M12 connector
  - 1 x USB 2.0 Host for retrieval
- Memory: 2 GB or 16 GB

**Protection Levels (Rugged Memory Module)**

- **Shock:** Up to 100 g / 10 ms and 55 g / 100 ms
- **Crush:** Up to 110 kN for 5 minutes in all axes
- **Penetration:** Up to 23 kg drop from a height of 1.5 m focussed on an area of 30 mm2
- **Temperature:** Up to 700 °C for 5 minutes and 650 °C for 30 minutes followed by 300 °C for 1 hour followed by 100 °C for 5 hours
- **Chemical Immersion:**
  - Winter Diesel (**), Summer Diesel (**), Regular Water (**), Salt Water (**), Lubricating Oil (**), Transformer Oil (**), Hydraulic Oil (**), Anti-Fire Fighting Foam (**), Refrigerant R134A (**), Alcohol (**), Anti Freeze (**), Battery Acid (**)
  - minimum for 48 hours
  - minimum for 60 minutes
- **Magnetic Field:**
  - Current flow of 64 kA at rising rate of 107 A/s
- **Hydrostatic pressure:**
  - Immersion in salt water at a depth of 15 meter for 48 hours
**Standard Racks**

**FUNCTIONS**
Trainnet® Racks are required with every Trainnet® System. Trainnet® modules only work when integrated into a Trainnet® Rack. The Racks enable communication between modules via an integrated IEC 821 VME back plane bus. All modules also take power from the power supply via the back plane.

**KEY FEATURES**
Trainnet® Racks come in different sizes to fit all needs. While 44TE and 84TE wide racks are commonly used, a 20TE wide rack is also available for smaller systems. When working with a high number of modules or when requiring the 1U ESU module (Power-over-Ethernet), the 6U 84TE can be used. Other racks sizes are also available upon request.

The 3U 44TE and 3U 84TE Racks have different back plane options. Please read the table below for an overview of the possible rack-backplane combinations. The number of free slots for both VME modules (CPUs, bus interface modules and HSA module) and I/O modules (all I/O but HSA) are mentioned. The space required for the power supply is already taken into account.

**OPTIONS**

**Side mounting for 20TE Racks:**
The 3U 20TE Racks can be side mounted as an option, instead of the usual front mounting. Dimensions are then W127 x H133 x D306 mm.

**TECHNICAL SPECIFICATIONS**

**External Dimensions (W x H x D):**
- **3U 20TE Rack**
  - 158 x 133 mm x 215 mm
  - (Installation width 117 mm)
- **3U 44TE Rack**
  - 280 mm x 133 mm x 215 mm
  - (Installation width 240 mm)
- **3U 84TE Rack**
  - 483 mm x 133 mm x 215 mm
  - (Installation width 443 mm)
- **6U 84TE Rack**
  - 483 mm x 266 mm x 215 mm
  - (Installation width 443 mm)

**Weight:**
- **3U 20TE Rack:** 1.3 Kg
- **3U 44TE Rack:** 2.3 Kg
- **3U 84TE Rack:** 4 Kg
- **6U 84TE Rack:** 7.3 Kg

**Ingress Protection (IP) rating:**
- 20

**AVAILABLE VME AND I/O SLOTS IN TRAINNET® RACKS**

<table>
<thead>
<tr>
<th>RACKS</th>
<th>VME ONLY SLOTS</th>
<th>VME OR I/O SLOTS</th>
<th>I/O ONLY SLOTS</th>
<th>MTBF</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3U 20 TE</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 480 000 h</td>
<td></td>
</tr>
<tr>
<td>3U 44TE</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>1 830 000 h</td>
<td></td>
</tr>
<tr>
<td>3U 44TE RIOM</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>2 330 000 h</td>
<td></td>
</tr>
<tr>
<td>3U 84TE</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>980 000 h</td>
<td></td>
</tr>
<tr>
<td>3U 84TE - Dual</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>970 000 h</td>
<td>The right back plane has an extra VME slot that usually remain unused</td>
</tr>
<tr>
<td>Right</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3U 84TE RIOM</td>
<td>4*</td>
<td>7</td>
<td>0</td>
<td>1 440 000 h</td>
<td>28TE* reserved for RMM or third party equipment</td>
</tr>
<tr>
<td>6U 84TE</td>
<td>Select a 3U 84TE rack version</td>
<td>18</td>
<td>1 130 000 h</td>
<td>The other 3U fits 2 x 1U ESU</td>
<td></td>
</tr>
</tbody>
</table>

*If using RMM, please note it uses 1 VME slot (leaving 3 out of 4 free)
Flat Racks

FUNCTIONS
Trainnet® Racks are required with every Trainnet® System as Trainnet® modules only work when integrated into a Trainnet® Rack. The Racks enable communication between modules via an integrated IEC 821 VME back plane bus. All modules also take power from the power supply via the back plane.

The Trainnet® Flat Racks are designed to be used in trains where space is limited, for instance trams and light rail vehicles. They are also providing an alternative to Standard racks dimensions and mounting mechanisms. In addition, using the Trainnet® Flat Racks can be cost-efficient when systems are simple and require only few modules.

KEY FEATURES
Trainnet® Flat Racks come in 3U, 6U and 9U format, either as a 12TE or 16TE wide rack. Thanks to their small sizes, Flat Racks can be used in the vicinity of train systems, thus allowing savings by reducing cabling. The Flat Racks have a power supply connector integrated at the back.

The number of free slots for both VME modules (CPUs, bus interface modules and HSA module) and I/O modules (all I/O but HSA) are mentioned in the table below. The space required for the power supply is already taken into account. Please contact us for further needs.

AVAILABLE VME AND I/O SLOTS IN TRAINNET® RACKS

<table>
<thead>
<tr>
<th>RACKS</th>
<th>VME ONLY SLOTS</th>
<th>VME OR I/O SLOTS</th>
<th>I/O ONLY SLOTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3U 12 TE</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3U 16 TE</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>6U 12 TE</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6U 16 TE</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>9U 12 TE</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>9U 16 TE</td>
<td>0</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

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TECHNICAL SPECIFICATIONS

- External Dimensions (W x H x D):
  - 3U 12TE Flat Rack: 87 x 229 mm x 215 mm
  - 3U 16 TE Flat Rack: 107 mm x 229 mm x 215 mm
  - 6U 12TE Flat Rack: 87 x 363 mm x 215 mm
  - 6U 16 TE Flat Rack: 107 mm x 363 mm x 215 mm
  - 9U 12TE Flat Rack: 87 x 496 mm x 215 mm
  - 9U 16 TE Flat Rack: 107 mm x 496 mm x 215 mm

- Weight:
  - 3U 12TE Rack: 1.21 Kg
  - 3U 16TE Rack: 1.32 Kg
  - 6U 12TE Rack: 2.15 Kg
  - 6U 16TE Rack: 2.33 Kg
  - 9U 12TE Rack: 3.09 Kg
  - 9U 16TE Rack: 3.33 Kg

- Ingress Protection (IP) rating: 20
Specifications and appearances are subject to change without prior notice.

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