KONTRAC
TRAIN CONTROL AND
MANAGEMENT SYSTEM

www.koncar.com
For almost three decades we have been helping our clients in solving challenges related to control, electronics, communication and ICT issues in railway sector. We have specialized ourselves in R&D and delivery of solutions, which are highly customized to individual customers’ needs. We always strive towards finding the optimal solution for both sides.

Three key elements are crucial for our approach.
Firstly, we treat our customers as equal partners in defining system requirements and as a part of our team in finding the optimal solutions for required applications.
Secondly, our experienced, highly competent and creative associates, responsible for research, always try to meet customer’s requirements and harmonize them with the developing costs, LCC, RAMS and CENELEC requirements. Our SIL4 certified control solutions are the crown of this philosophy.
Thirdly, our philosophy is to develop solutions which are simple, modular and highly customizable for a wide range of applications. On the other hand, our obsolescence management allows backward compatibility of key hardware and software components and more than 20 years lifetime of our control solutions. This is the best proof that customers and low LCC of our solutions are our top priorities.
Thanks to that, we are able to deliver modern and remarkable technical solutions and constantly improve them. Our approach is unique on the market and makes us a highly reliable partner!
KEY BENEFITS

Long-life // backward compatibility // obsolescence management

All our products are characterized as long-life and highly reliable. Furthermore, our smart obsolescence management makes our modular HW&SW platform backward compatible during at least 20 years. In practice, this means that every newly developed HW module can be easily integrated into every generation of our platforms, from the oldest to the newest one. In terms of costs, it means that in order to add or change the system functionalities you do not need to change the whole system, but only single modules.

The same philosophy is applied in our software platform. This allows us easier migration of software from old to a new generation of processors. All electronics suffer from rapid obsolescence process. Our unique graphical programming tool GRAP-IDE allows us to migrate software from old to a new generation of processors in the shortest possible time. Our philosophy is to have the same software developing environment at user level, no matter of hardware type or hardware generation. This way we have migrated the application program, which was written back in 1991, to the new ARM CPU almost automatically, with a minimum of manual work.

Another example can be shown from our excitation system for power plants, which is based on the same HW&SW platform. After 20 years of use, the customer needed new communication protocols, internet connection, failure loggers, etc. We did not need to change the entire system. We changed only the main control unit and added new functionalities to the application program. Modular HW&SW platform allows us to do that.

KIET’s (KONČAR - Electrical Engineering Institute) HW&SW platform saves not only your money but also time needed to integrate changes into your system. This improves availability of your vehicle and reduces further costs.
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KEY BENEFITS

Scalability // modularity

KONTRAC TCMS can be easily integrated into various rail vehicles, thanks to its modular platform. It is developed not only for new, modern vehicles but also for modernization/refurbishment of vehicles, such as locomotives. The system can be upgraded or changed anytime, if there is need for it. The system can be also used for control, monitoring, and management of power converters.

Customization // Reliability // Availability // Maintainability.

KONTRAC TCMS architecture allows customers to choose the configuration for their vehicle. Depending on requirements, vehicles can be equipped with one or two KONTRAC VCU (Vehicle Control Unit). Reliability, Availability, and Maintainability of our VCU is very high, which ensures low costs during the vehicle lifecycle. Some of our customers wanted to raise the bar and make their LCC even lower. We accepted the challenge and delivered redundant configuration of our VCU. This resulted in only 2 vehicle defects (vehicle needed to be towed into the service station) in a fleet of 142 tramways, during 12 years, 63 000 000 km and 7 500 00 working hours. Furthermore, these defects occurred at the early stage of system delivery.

Our system is designed to allow the vehicle to be driven by a driver even with the failure in a power converter’s control system, or with a single pair of motors.

One proprietary platform for multiple solutions

One platform for multiple usages allows us to:
›› Develop a more reliable system
›› Match a wider range of functionalities where necessary
›› Develop new functionalities faster
›› Correct errors faster (error found in the application in one system is automatically corrected in all other systems as well)
›› Re-use components

These advantages are positively reflecting on you as a customer. What you get is:
›› Higher reliability of your vehicle
›› Better customer support
›› Faster failures and errors correcting
›› better value for money
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KEY BENEFITS

Robustness // harsh environment

Many manufacturers are trying to show robustness and reliability of their equipment. We are not trying to convince you the same by just giving you specifications and numbers.

What we can do is give you the real-life example. Our equipment, which is being used in a hydro power plant in Costa Rica was completely flooded in 2009, and covered with the mud.

This is the same HW&SW platform used for KONTRAC TCMS. Afterward, all modules were simply washed, dried, individually examined and plugged back in the rack. Our system showed no errors after it was put back in action. We make robust equipment for the harshest environments.

Testing

During the process of development all our solutions are thoroughly tested in laboratories. We have 10 laboratories, 7 of them accredited according to the EN ISO/IEC17025. Type testing can also be done in independent laboratories, upon customers’ request.
Compliance with the highest safety requirements

The same proprietary HW&SW platform is used in our railway crossing solution with the highest functional safety level, SIL4.

Unique graphical programming tool

Our experience in embedded control solutions goes back almost 30 years. Simultaneously with development of our first embedded control system, we launched the first generation of Grap-IDE.

The mission of Grap-IDE was to provide application engineers intuitive and easy to use graphical programming tool. It follows our modular platform philosophy and allows us to create control structures faster than ever before. It is a key player in our obsolescence management.

Grap-IDE is a complete programming solution with no additional tools required. It is used in control solutions for hydro/thermal power plants, railway vehicles, railway crossings, transformer substations and renewable energy.
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SERVICES

Research & Development

Thanks to our expert knowledge we offer applied research services for highly demanding products in the field of electric traction (power converters and inverters, control solutions, communication networks, and equipment). We can help you in different stages of projects: from defining requirements to testing and commissioning.

Depending on customers’ requirements the Institute can offer a variety of solutions for electric or diesel multiple units, electric or diesel locomotives or tramways:
- delivery of complete standardized vehicle control and monitoring solution (TCMS) with onboard communication infrastructure and service of integration with equipment of other manufacturers
- solutions tailored for a particular type of vehicle
- refurbishing and modernization of vehicles control and monitoring systems
- support in all phases of the product’s life cycle - development, commissioning and operation
- expert consultancy regarding communication infrastructure of vehicle

REFERENCES
KONTRAC TCMS is KIET’s proprietary HW&SW platform for train control and management systems. It is designed as a modular and scalable solution which can be highly customized to individual customers’ requirements. In-vehicle communication network, based on CAN bus, RS485, Ethernet or MVB, allows seamless on-board communication between all intelligent units. Depending on vehicle type and requirements, a Wired Train Bus (WTB) is used for communication between the vehicles in multiple compositions.

Thanks to the communication network, KONTRAC TCMS is a distributed system with the following sub-systems:

» KONTRAC Vehicle Control Unit - VCU
» KONTRAC Distributed I/O
» KONTRAC Driver-Machine Interface - DMI
» KONTRAC Energy Metering System - EMS
» KONTRAC Intelligent Controller - ICNT
COMPONENTS

Modular platform allows integration in the variety of rail vehicles, tramways, electric and diesel-electric trains and locomotives. KONTRAC TCMS platform is one of few on the market which fully supports old vehicles modernization, such as old diode or thyristor locomotives.

We are successfully co-operating with system integrators to make the old locomotives ready for the next 20-30 years of operation. After the modernization, they are equipped with advanced, digital control and DMI unit.
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VEHICLE CONTROL UNIT

Vehicle Control Unit - VCU is the vehicle main control system. It is based on our proprietary and modular HW&SW platform. It is responsible for:

›› Control
›› Measuring
›› Sequencing
›› Protection
›› Supervision
›› Communication tasks in the whole vehicle

It can be found in tramways, trains and locomotives. Since there are specific requirements for each rail vehicle, VCU can be delivered in different configurations to match every vehicle. Every VCU rack consists of:

›› Electronic modules
›› Power supplies
›› Motherboard (buses)

KONTRAC VCU consists of wide-range of hardware modules:

›› Supply subsystem, which consists of power supplies and their control circuits
›› Motherboard
›› Central processing module
›› CAN communication module
›› Voltage and current measurement module
›› Digital speed measurement module
›› Synchronization module
›› Impulse generator module
›› Analog inputs and outputs module
›› Digital inputs and outputs modules
›› Pulse amplifier module

KONTRAC VCU modules common characteristics:

›› Operating temperature range: -40 to +85 °C (IEC 60571:2006, Class Tx)
›› Shock and vibrations: IEC 61373:2010, Category 1, Class B
›› Meets requirements of the following standards: EN50155:2007, EN50121-3-2:2006, EN61000-6-2:2007, EN61000-6-4:2005
›› Programming tool: Grap-IDE

VCU can be used as a single control unit or two completely redundant control units. The same hardware can also be used in propulsion converter’s control units. Redundant configuration can be found e.g., in KONČAR’s TMK2200 series tramways. VCU communicates with all distributed intelligent units, driver-machine interface (LCD panels in driver’s cabin) via CAN, Ethernet, RS485 or MVB busses. WTB bus is used for communication between vehicles in composition.
KONTRAC Distributed I/O is a compact, reliable, modular and robust platform designed for industrial control applications. It is used for collecting, processing, and dissemination of digital and analog signals.

Features of KONTRAC Distributed I/O platform:

- Proprietary HW&SW modular design
- Configurable LCD display and keypad
- Optical LED indicators on front panel of housings
- Ethernet communication interface
- Mounting with screws or on a DIN rail
- Integrated CF card for data logging
- Remote diagnostic functions
- Programming tool: Grap-IDE
- Operating temperature range: -40 to +85 °C (IEC 60571:2006, Class Tx)
- Shock and vibrations: IEC 61373:2010, Category 1, Class B
- Meets requirements of the following standards: EN50155:2007, EN50121-3-2:2006, EN61000-6-2:2007, EN61000-6-4:2005

KONTRAC Distributed I/O consists of multiple hardware modules:

- Motherboard
- Main control unit
- Digital inputs and outputs modules
- Analog inputs and outputs modules
- Temperature measuring modules
- Combined modules
- CAN communication modules
KONTRAC Driver-machine interface (DMI) can be found in all vehicles equipped with KONTRAC TCMS. It is designed for processor-intensive graphic and video application. It has 10.4 inch, high resolution display.

Depending on configuration and requirements, a vehicle can have one or more DMIs installed. They can work in redundant configuration, e.g., in trains, where typically 3 DMIs are installed. In rail vehicles such as tramways, there is typically 1 DMI installed, with no redundancy. Modular design allows a customer to make his own configuration.
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ENERGY METERING SYSTEMS

KONTRAC Energy Metering System (EMS) is an universal energy metering system for all railway vehicles. It can be easily adapted to different series of trains and locomotives. All components of the system are developed and certified according to EN 50463 international standard.

KONTRAC EMS is based on KONTRAC Distributed I/O system’s main control unit cVISK04 EMS, developed especially for this task. It works together with vehicle Ethernet infrastructure, GPS system, KONČAR’s Instrument transformers (voltage and current) and Certified Energy calculation unit, which is compatible with EN50463 and TSI LOC&PASS international standards.

GSM / GPRS / EDGE / UMTS network

DHS - Data Handling System
GPS - Global Positioning System
DCS - Data Collection Service
CMF - Current Measurement Function
GSM - Global System for Mobile Communications
HMI - Human-Machine Interface
ECF - Energy Calculation Function
KONTRAC Intelligent Controller (ICNT) accepts all driver inputs, processes them and sends them to other control units by means of the so-called “X-by-wire” principle. Simply, this is the system which driver uses to move the vehicle, speed-up or slow down the vehicle and stop the vehicle.

**KONTRAC gateway**

**Features of KONTRAC gateway:**

- Data gateway which connects local vehicle control network to WTB multiple unit control network
- Supported vehicle local networks are CAN, MVB and Ethernet local networks
- To provide support for complete control of multiple EMUs from single cabin (traction / braking, door control, diagnostics, air conditioning, passenger information, etc.)
- On passenger trains with locos to provide support for control of diagnostics, air conditioning and passenger information in WTB equipped coaches

KONTRAC gateway device is responsible for WTB communication bus between multiple EMUs or locomotives

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**Features of KONTRAC ICNT:**

- Developed upon the proprietary long-life HW&SW platform
- Completely redundant 2-channels configuration
- Supports safety-critical real-time functions
- Supports communication with other intelligent units in vehicle
- 2 CAN/CANopen interfaces
- 2 RS485 interfaces
- 2 general-purpose microprocessors
- 2 microcontrollers
- Remote diagnostic functions
- Programming tool: Grap-IDE

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**INTELLIGENT CONTROLLER - ICNT**
KONTRAC TCMS communication is based on different communication busses and protocols. Vehicle control unit communicates via CAN, Ethernet, RS485 or MVB busses with all sub-systems inside the vehicle, such as control units for doors, brakes, black boxes, battery charger, heating and air conditioning, toilette, etc.

**VEHICLE COMMUNICATION STRUCTURE**

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Besides in-vehicle communication, KONTRAC TCMS supports communication between vehicles in composition using Wired Train Bus (WTB). Up to 3 vehicles can be connected in composition. The entire composition is controlled from one control room.

To make these actions possible, every vehicle in composition needs to have a gateway unit, which transfers information between vehicle buses and train bus.

Gateway, together with its communication interfaces, is used to control vehicles composition. It is assembled in a separate rack.
KONTRAC SafeHMI system platform consists of Safe Human-Machine Interface (HMI) and Distributed Safe I/O. The platform (modules) is certified by TÜV SÜD for the highest Safety Integrity Level, SIL4 according to CENELEC standards EN 50126-1/EN 50128/EN 50129.

Hazard rate of the interface to interlocking system

<table>
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<th>Symbol</th>
<th>Measure</th>
<th>Description</th>
<th>Value for N_{BD}</th>
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<td>( \lambda_{CH} )</td>
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<td>( \mu )</td>
<td>h(^{-1})</td>
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<td>( \lambda_{SYS} )</td>
<td>h(^{-1})</td>
<td>Hazard Rate</td>
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</table>

KONTRAC SafeHMI system platform is a modular HW&SW platform developed especially for functional safety applications.

The system consists of SafeHMI and multiple hardware modules of Safe I/O:

- Motherboard
- CAN communication module
- Power supply
- Digital inputs modules (8 and 16 channels)
- Digital output module (2 channels)
During developing of SafeHMI platform, we enforced innovative approach in accomplishing the highest level of safety. It combines one- and two-channel architecture together with the interaction between HMI layout and operator to detect errors. The operator can use integrated keyboard, but to confirm safety-critical commands, additional safety buttons need to be used.

Safe I/O components come in two identical, independent channels. It is possible to connect up to four Safe I/O systems with SafeHMI display.

During type testing, SafeHMI platform successfully passed all safety tests and met SIL 4 safety requirements. TÜV SÜD certified SafeHMI platform to SIL 4 compliance according to standards EN50126, EN50128 and EN 50129.
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Grap - IDE

Powerful graphical programming, service and diagnostic tool

KONTRAC TCMS software is based on proprietary graphical programming tool, Grap-IDE. It is designed especially:

›› For developing control algorithms
›› As service and diagnostic tool
›› For Human-machine interfaces.

Grap-IDE is integrated development environment which consists of carefully in-house developed and implemented:

›› Real-time operating system
›› Low-level optimized libraries of graphical Elements
›› Service and diagnostic tool
›› Embedded Human-machine interfaces design
It is an intuitive graphical software development tool. It enables fast creation of high quality embedded software, without extensive programming knowledge. It is optimized for developing different embedded systems such as control systems for power converters, active filters, power supplies and safety critical systems. Grap IDE is also used for development of rich and intuitive DMI applications for visualization and diagnostics of all vehicle related informations. This allows system integrators to develop application that are faster than ever, without thinking of code optimization. 

**Grap-IDE plays an important role in our obsolescence management.**
COMPONENTS OVERVIEW
Racks have to be used with VCU modules. According to customer’s requirements we will propose some of standard or custom made solutions. It is possible to use one or more racks of different sizes; typically it is one rack 48 - 84 TE for trains, tramways and simple locomotive configurations or two racks 84 TE for locomotives in which VCU performs also TCU (Traction Control Unit) functions.

Technical specifications:

- Operating temperature -40°C to +85°C
- Dimensions: optional
- Compliant with EN 50155, EN 50121-3-2, and IEC/EN 61000-4-2, -3, -4, -5, -6
**VCU modules**

**Power supplies**

Different VCU configurations require different power supplies. Typically we use standard DC/DC modules.

**DC/DC Converters HP Series, for power supply ±24V and +5V**

**Technical specifications:**

- Output voltage: 24V/5.1 V
- Output power: 96/92 W specified at $T_{\text{amb}} = 71 \degree C$
- Input voltage: $V_{\text{min}} = 12.5V$, $V_{\text{cont}} = 16.8-137.5$, $V_{\text{max}} = 154 V$
- Input over- and programmable undervoltage lockout including inhibit function
- Full input-to-output isolation, negligible inrush current, soft start, overtemperature protection, 10 ms interruption time, and input over- and undervoltage lockout
- Rectangular current limiting characteristic
- Case 4 TE, fully enclosed, PCB boards protected by lacquer, status through LEDs at the front
- Compliant with EN 50155, EN 50121-3-2, and IEC/EN 61000-4-2, -3, -4, -5, -6, -8
- Safety-approved to IEC/EN 60950-1 and UL/CSA 60950-1 2nd Ed

**DC/DC Converters HP Series, for power supply +33V**

**Technical specifications:**

- Output: 33 V, 9.6 A
- Output power: 96/92 W specified at $T_{\text{amb}} = 71 \degree C$
- Input voltage: $V_{\text{min}} = 12.5V$, $V_{\text{cont}} = 16.8-137.5$, $V_{\text{max}} = 154 V$
- Input over- and programmable undervoltage lockout
- Inrush current limitation, inrush current limitation
- 10 ms hold-up time
- Rectangular current limiting characteristic
- Parallel operation with active current shading
- Case 12 TE, fully enclosed, PCB boards protected by lacquer, status through LEDs
- Compliant with EN 50155, EN 50121-3-2, and IEC/EN 61000-4-2, -3, -4, -5, -6
**VCU modules**

**Power supply controller DMK457**

*Technical specifications:*
- Status LED indicators on front panel
- Operating temperature -40°C to +85°C
- Dimensions (H x W x D): 233 x 160 mm (9,2 x 6,3 inch), double Euro-card format
- Input voltage: $V_{\text{min}}$ 12,5 V, $V_{\text{cont}}$ 16,8-137,5 V, $V_{\text{max}}$ 154 V

Module DMK457 serves as energy storage and input filter for power supplies. Additionally DMK457 tracks power supplies’ input voltage and power supplies’ output voltages. In the event of power supply undervoltage, it generates logic signals /ACFAIL, /PSFL15V, /SYSRESET, /PSFAIL.

**Main processor unit DMK105O**

*Technical specifications:*
- Freescale ColdFire family Microprocessor
- Memory: 2 MB SRAM, 2 MB magnetic RAM, 8 MB FLASH, 32 KB EEPROM, compact flash card interface
- 1 x RS-232 for commissioning and debugging, galvanically isolated
- 2 x RS-485, 1 x optical interface and 1 x ETHERNET 100/10 Mbps interfaces for interconnecting with other control systems, galvanically isolated (including interfaces to GPS and PPS signal).
- Backplane interface for peripheral IO modules based on VMEbus standard (IEEE 1014) and I/O channel bus
- LED programmable indicators on front panel
- HEX programmable indicator on front panel
- Programming tool: Grap-IDE
- Consumption: 5 V DC ± 5 %, 600 mA Typ., 900 mA max.
- Operating temperature -40°C to +85°C
- Dimensions (H x W x D): 233 x 160 mm (9,2 x 6,3 inch), double Euro-card format

DMK105O central processing unit is a single board computer designed as a system controller in systems based on VMEbus. Module can be used for measurement, supervision, diagnostic and control of the real-time processes. Besides, it incorporates communication controller functions, thus enabling the same CPU Board to support a wide range of applications.

Compared to older versions of CPU module, DMK105O provides enhanced internal possibilities such as: more available on-board memories, more RS-485 channels, Ethernet, possibility for connection to GPS device, independent “watchdog”, battery backup components, dynamic reconfigurable Disturbance recorder, Event logger, communication with intelligent Digital inputs, ambient temperature sensor…
VCU modules

Communication module VMECAN

Technical specifications:

- Supports two independent CAN/CANopen communication channels through two 8-bit CAN controllers
- CAN controllers fully hardware and software independent for each other
- Intended for use in embedded systems based on DMK10X main processor board
- 16-bit parallel asynchronous communication with DMK10X module through VME
- Programmable board base address (using CPLD)
- Optical LED indicators on the front panel
- Independent local reset circuits
- Consumption: 5 V DC ± 5 %, 700 mA
- Operating temperature -40°C to +85°C
- Dimensions (H × W × D): 233 × 160 mm (9.2 × 6.3 inch), double Euro-card format

VMECAN communication interface module is used to create up to two fully independent CAN Buses which are galvanically separated. It uses backplane VMEbus interface (IEEE 1014) for communication with DMK105O central processing unit. Multiple VMECAN modules can be controlled by a single DMK105O central processing unit. Module supports CAN 2.0 A/B, CANopen and J1939 communication protocols. Every CAN interface has independent microcontroller which provides enhanced communication bus diagnostics and event logging capabilities. The module has two CAN network connectors on the front-panel, one 9-pin sub-miniature D-type connector for each independent interface and have CiA DS-102 standard pin assignment.

Railway overhead line measurements DMK326

Technical specifications:

- 4 16-bit ADC channels
- Inputs: 1 × ± 10.909 Vp, 3 × ± 3.33 mA
- TMS320LF2407A DSP based
- 8-bit asynchronous communication with the DMK10x and DMK151 through I/O channel
- Programmable board base address
- Optical LED indicators on the front panel
- Serial RS-232 for development and service
- Consumption: 5 V DC ± 5 %, 500 mA, 700 mA max.
- Operating temperature -40 °C to + 85 °C
- Dimensions (H × W × D): 233 × 160 mm (9,2 × 6,3 inch), double Euro-card format
- Programming tool: Grap-IDE

DMK326 module is used for measurement of overhead line voltage, main transformer primary currents and heating line current. Additionally, DMK326 implements analog and digital protections (overvoltage, undervoltage, differential, overcurrent). It is based on signal processor, which processes measurements in real-time, calculating all needed values (effective values, frequencies, active and reactive power, …). DMK326 is used together with transformers unit (current transformers 5 A / 2 mA and voltage transformers 100 V / 5 V) and extender. It supports redundant configurations.
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VCU modules

Speed measurements DMK157

Technical specifications:

- 8 galvanically isolated inputs for the incremental encoder pulses (four pairs of A - basic and B - 90° el. phase-shifted pulse trains)
- 4 galvanically isolated inputs for zero (reference) pulses
- 4 galvanically isolated inputs for the control of power supplies for the incremental encoders (15 V DC)
- 8-bit parallel asynchronous communication through local I/O channel bus
- Software configurable board position
- Optical indicators (LED) for the status of the incremental encoders power supplies and for zero (reference) pulses from incremental encoders featuring that option
- 15-pin SUB-D test connector
- Consumption: 5 V DC ± 5 %, 280 mA max.
- Operating temperature -40 °C to +85 °C
- Galvanic isolation voltage: 1000 V
- Dimensions (H × W × D) : 233 × 160 mm (9,2 × 6,3 inch), double Euro-card format

DMK157 module is FPGA based module designed for incremental encoders based speed measurement. The module is attached to the I/O channel bus, which enables its communication with the central processing unit (CPU module). The module measures the speed of four shafts. Employed incremental encoders should provide two regular pulse train outputs and, optionally, the zero (reference) pulse output (ensuring a single pulse per revolution). DMK157 counts the pulses from incremental encoders and sends their count to the central processing unit, which calculates the speed of each particular shaft.

A/D and D/A conversion DMK342

Technical specifications:

- 8 galvanically isolated voltage (0-10 V) or current (0-20 mA) inputs, 12-bit
- 2 galvanically isolated voltage (0-10 V) or current (0-20 mA) outputs, 12-bit
- 8-bit asynchronous communication with the DMK10x through I/O channel
- Software configurable board position
- Optical indicators (LED) on front plate of module
- RS-232 for development and service (not accessible to users)
- Independent local reset circuit
- Consumption: 5 V DC ± 5 %, 214 mA max., 15V DC ± 5 %, 174 mA max.
- Operating temperature -40 0C to +85 0C
- Dimensions (H × W × D) : 233 × 160 mm (9,2 × 6,3 inch), double Euro-card format

DMK342 is a intelligent A/D and D/A module providing 8 galvanic isolated inputs which can be voltage (0-10 V) or current inputs (0-20 mA), as well as 2 galvanic isolated outputs which can be voltage or current outputs (0-10 V / 0-20 mA). The type of signal (current or voltage) is hardware defined and can not be changed after commissioning. It can be used for acquisition of reference signals and signals related to pressures.
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VCU modules

Data acquisition and firing unit DMK151

**Technical specifications:**

- DSP based module for control of thyristor power converters
- 12 analogue inputs for current and voltage transducers
- 3 digital inputs for discrimination of commutation
- 2 synchronization digital inputs
- 3 digital inputs from external analogue comparators
- 8 digital inputs providing status of pulse amplifiers
- 16 firing signals
- 8 digital outputs for software control of pulse amplifiers
- 2 digital output signals for protection functions
- Power supply consumption: +5 V DC ± 5 %, 400 mA max; ±15 V, 40 mA max, ±24 V, 200 mA max
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D): 233 × 160 mm (9.2 × 6.3 inch), double Euro-card format

DMK151 module provides control of semi- or fully-controlled line-commutated converters of one motor group (armature and excitation current converters for various types of DC traction motors - with series connected or independent excitation). Module features analogue comparators for implementation of HW protection functions (overcurrent, overvoltage). Firing unit is synchronized with the overhead-line voltage.

Synchronization and discrimination of commutation unit DMK148

**Technical specifications:**

- 1 input for synchronization voltage
- 3 inputs for discrimination of commutation voltage (one per motor group)
- 3 inputs for AC current measurements employing measurement current transformers
- Outputs: 4 analogue measurement signals; 3 digital outputs for discrimination of commutation; 2 synchronization digital outputs; 3 digital outputs from analogue comparators (for implementation of protection functions)
- 2 optical indicators (LED)
- Power supply consumption: +5 V DC ± 5 %, 50 mA max; ±15 V, 80 mA max
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D): 233 × 160 mm (9.2 × 6.3 inch), double Euro-card format

DMK148 synchronization and discrimination of commutation unit ensures analogue interface for current and voltage measurements (AC overhead line voltage, high- and low- side overhead line current as well as heating line current) implemented by external measurement transformers. After signal conditioning, analogue outputs are forwarded to other modules with A/D functionality. Module provides all necessary analogue and digital signals for correct synchronization and operation of firing units for half- or fully-controlled line commutated thyristor converters.
Digital outputs DMK133

Technical specifications:
- 24 opto-isolated digital outputs
- 16 channels with Solid State Relays (continuous load current 1.8 A, load voltage 100 V, I/O isolation voltage 2500 V AC, maximum operating speed 0.5 cps.)
- 8 channels with Mechanical Relays. (Contact char. CO type, 8 A, 240 V, rated frequency of operation 6 min-1)
- Transient peak limiter
- 8-bit asynchronous communication with the DMK10x through I/O channel
- Internal power supply monitoring
- Internal reset circuit sets all channels in inactive state during power-up sequence
- Reset signal from CPU board sets all channels in inactive state
- Optical indicators (LED) for the status of each output channel + FAIL LED
- Programming tool: Grap-IDE
- Consumption: 5 V DC ± 5 %, 214 mA max., 15 V DC ± 5%, 174 mA max.
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D) : 233 × 160 mm (9,2 × 6,3 inch), double Euro-card format

DMK133 module is an universal peripheral unit connected to local I/O Channel. DMK133 supports 24 opto-isolated digital output channels. The board is an interface between the microprocessor system and the process equipment used for control, indication and alarm functions. 16 channels have solid-state relays in normally opened state (NO), and 8 mechanical relays in NO state.

Control of power thyristors DMK500

Technical specifications:
- 4 channels for synchronous firing control of power thyristors in semi- or fully-controlled line commutated locomotive’s rectifiers
- Each channel features independent galvanically isolated stage
- LED indication of blockade for each half of the pulse amplifier module (BL1 i BL2)
- Consumption: +33 V DC ± 5 %, 600 mA max.
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D) : 233 × 160 mm (9,2 × 6,3 inch), double Euro-card format

DMK500 module features 4 channels for synchronous firing control of power thyristors employed in semi- and fully-controlled line commutated locomotive’s rectifiers, driving attached pulse transformers. Each output channel has independent driving stage, galvanically isolated from the rest part of the VCU.

Driver stages are driven by firing unit module (DMK151). Each pair of output channels, driving assigned half of the power amplifier module, is controlled by corresponding pair of blockade and enable signals. Front panel LED indicators provide clear status of operating mode of DMK500 module.
VCU modules

Digital inputs DMK127

Technical specifications:

» 32 standard galvanic isolated digital inputs; 4 groups of 8 channels with one common signal ground. Possibility of connecting 4 common signal grounds together (typical state)

» 4 fast galvanic isolated digital inputs; input signal frequency range: 0.1 Hz to 3.2 KHz (with 0.1 Hz resolution)

» 8-bit asynchronous communication with the DMK10x through I/O channel

» Overvoltage protection for each channel

» Reverse voltage protection on each channel

» Independent local reset circuit

» Support for simultaneous board reset through I/O channel

» Digital filtering of input signals via microcontroller

» Programming tool: Grap-IDE

» Consumption: 5 V DC ± 5 %, 93 mA max

» Operating temperature: -40 °C to +85 °C

» Dimensions (H × W × D): 233 × 160 mm (9.2 × 6.3 inch), double Euro-card format

DMK127 digital input module is a universal input module. It is used for filtering, conditioning and acquisition of digital inputs. It supports 32 standard +24 V galvanic isolated inputs, and 4 +24 V fast galvanic isolated inputs for speed measurement.
The **cVISK controllers** include an industrial 80MHz processor with real-time operating system and offer removable CompactFlash card for storing large amount of data. Several models are available, depending on the built-in optional module, allowing cVISK device to be used as stand-alone control unit for small systems. For controlling larger systems it is used with VMB motherboards.

cVISK has an alphanumeric LCD display, 8 keys keyboard and 10 LEDs, which allow interaction between the user and the system. It communicates via CAN and parallel bus or via Ethernet port.

Controller is available in different configurations:

- **cVISK00** - cVISK controller without built-in module
- **cVISK01** - cVISK controller with built-in VAI0801 module (8 analog inputs)
- **cVISK02** - cVISK controller with built-in VDI3201 module (32 digital inputs)
- **cVISK03** - cVISK controller with built-in VRTD0801 module (8 RTD inputs)
- **cVISK05** - cVISK controller with built-in VATD01 module (10 digital inputs, 5 analog inputs, 8 RTD inputs)

**Technical specifications:**

- CPU: Freescale ColdFire family Microprocessor
- CPU memory: 1 MB SRAM, 512 KB MRAM, 8 MB flash, 32KB EEPROM, up to 32 GB CF card (optional)
- Communication: 2 Ethernet ports (10/100 Mbps), internal CAN and local parallel bus communication with other Distributed I/O modules
- 2 electromechanical DPDT relays
- Indicators: Alphanumeric LCD display, size 16x4 characters, 10 LED indicators
- Keyboard: 8 keys keyboard
- Programming tool: Grap-IDE
- Consumption: 24 V (16.8-33.6 V DC range), 5 W + total consumption of additional modules
- Operating temperature: -40 °C to +85 °C
- Dimensions (H x W x D): 150 x 200 x 100 mm (5.9 x 7.87 x 9.94 inch)
- Weight: 900 g
DISTRIBUTED I/O MODULES

VMB motherboard

Technical specifications:
- Number of slots: 2, 4, 8 slots
- Operating temperature: -40 °C to +85 °C
- Dimensions (H x W x D): 150 × 95 × 18.5 mm (2-slot, 5.9 × 3.74 × 0.73 inch), 150 × 147 × 18.5 mm (4-slot, 5.9 × 5.79 × 0.73 inch), 150 × 247 × 18.5 mm (8-slot, 5.9 × 9.72 × 0.73 inch)
- Weight: 200 g (2-slot), 300 g (4-slot), 500 g (8-slot) + weight of mounted cVISK controller

VMB motherboards enable connection of additional modules to the cVISK controller. Distributed I/O platform has motherboards with 2, 4, or 8 slots. Motherboard is connected with cVISK controller via expansion connector. Modules are mounted and fixed by screws. Protective covers are provided for unused slots.

Analog inputs VAI0801

Technical specifications:
- 8 current or voltage inputs, 0(4) - 20 mA; 0-5 V, 0-10 V, 0-15 V
- software-configurable input type and range
- 12-bit resolution
- Galvanic isolation level > 1000 V DC (1s)
- 2 LED indicators
- Programming tool: Grap-IDE
- Consumption: 5 V DC, 0.9 W
- Operating temperature: -40 0C to +85 0C
- Dimensions (H x W x D): 145 × 26 × 145 mm (5.71 × 1.02 × 5.71 inch)
- Weight: 300 g, 80 g (VAI0801-B)

VAI0801 module supports 8 current or voltage inputs. Type and range of inputs are individually software configurable. Channels are galvanically isolated from the rest of the system. Each channel has separate voltage and current terminals. Module is available as a standalone module for VMB motherboard, or as built-in module in cVISK01 controller. The module communicates with cVISK controller via local CAN bus.
Analog outputs VAO0801

**Technical specifications:**
- 8 current outputs 0(4) - 20 mA
- 16-bit resolution
- Short circuit and open loop detection
- Galvanic isolation $\geq 1000$ V RMS (1 s)
- Power supply 5 V DC via Distributed I/O system bus and external 24 V DC (9-30 V DC) for analog output stages
- Programming tool: Grap-IDE
- Consumption: 5 V (internal from Distributed I/O system), 0.5 W, 24 V DC (external), 4.32 W max.
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D): 145 × 26 × 145 mm (5.71 × 1.02 × 5.71 inch)
- Weight: 300 g (aluminum case), 610 g (steel case, optional), 80 g (VAO0801-B)

**VAO0801 module** supports 8 current output signals. All channel outputs are galvanically isolated from the main Distributed I/O system. Loop power supply voltage 9-30 V DC is supported. Output refresh rate on all eight outputs is 200 samples/s. Module supports output failure detection. The module communicates with cVISK controller via local CAN bus.

Digital inputs VDI1602

**Technical specifications:**
- 16 digital inputs
- 4 groups of 4 channels
- Input current 14 mA (24 V DC), input range 0-30 V DC, logical levels: ON (>17 V DC), OFF (<6 V DC)
- Programming tool: Grap-IDE
- Operating temperature -40 °C to +85 °C
- Dimensions (H × W × D): 145 × 26 × 145 mm (5.71 × 1.02 × 5.71 inch)
- Weight: cca. 300 g

**VDI1602 module** is used for filtering, conditioning and acquisition of digital inputs. Digital inputs are divided in 4 groups of 4 channels. Each group has a separate ground. The channels support 24 V DC nominal input voltage. Inputs are protected from transient overvoltage’s and reverse polarity. The channels support 24 V DC nominal input voltage and have low input impedance for reliable operation.
DISTRIBUTED I/O MODULES

Digital outputs VDO1602

**Technical specifications:**
- 16 solid state digital outputs, sourcing type
- Operating voltage 16.8 V DC - 32 V DC
- Maximum output current per channel: 1 A
- Overload detection and short circuit protection
- Isolation voltage 2500 V RMS
- Programming tool: Grap-IDE
- Consumption: 5 V, 0.3 W
- Operating temperature -40 °C to +85 °C
- Dimensions (H x W x D): 145 x 26 x 145 mm (5.71 x 1.02 x 5.71 inch)
- Weight: cca. 300 g

**VDO1602 module** contains 16 semiconductor type digital outputs. All channels are galvanically isolated from the main Distributed I/O system. There is no channel-to-channel isolation - output ground is common for all outputs. Maximum output current for each channel is 1 A. Each channel has overload detection and short circuit protection. Fault feedback information is available in the application program.

Combined inputs module VATD01

**Technical specifications:**
- 5 analog inputs, 12-bit A/D resolution,
- 4 RTD inputs 16-bit A/D resolution
- 10 digital inputs, 2.9 mA (30 V DC)
- 2 LED indicators
- Programming tool: Grap-IDE
- Consumption: 5 V, 0.8 W
- Operating temperature -40 °C to +85 °C
- Dimensions (H x W x D): 145 x 26 x 145 mm (5.71 x 1.02 x 5.71 inch)
- Weight: cca. 300 g, 80 g (VATD01-B)

**VATD01 module** is a combined module which supports 10 digital inputs, 5 current analog inputs and 4 inputs for temperature measurement. It combines functionalities of modules VAI0801, VRTD0801 and VDI3202. The module is available as a standalone module for VMB motherboard, or as built-in module in cVISK05 controller. The module communicates with cVISK controller via local CAN bus.
DISTRIBUTED I/O MODULES

Temperature measurement module VRTD0801

Technical specifications:
- 8 RTD analog inputs
- Analog/digital conversion: 16-bit
- 2 LED indicators
- Programming tool: Grap-IDE
- Consumption: 5 V, 0.63 W
- Operating temperature: -40 °C to +85 °C
- Dimensions (H × W × D): 145 × 26 × 145 mm (5.71 × 1.02 × 5.71 inch)
- Weight: cca. 300 g, 80 g (VRTD0801-B)

VRTD0801 module is used to measure 2-, 3-, 4-wire RTD and resistance. Four-wire RTDs are suitable for applications with long signal wires and low noise levels, but also 2- and 3-wire measurements can be performed. Channels are connected on the same ground and are galvanically isolated from the rest of the system. Local processor performs linearization and scaling for sensors with different temperature coefficients. Module is available as a standalone module for VMB motherboard, or as built-in module in cVISK03 controller (VRTD0801-B).

Remote IO rack controller VRIO01

Technical specifications:
- Remote control of Distributed I/O rack with up to 8 peripheral modules
- Remote control buses: 2 x CAN, Modbus, 2 x Ethernet
- Consumption: 24 V (16.8-33.6 V DC range), 2 W + total consumption of additional modules
- Based on NXP ARM processor
- Indicators: 2 LED indicators
- Programming tool: Grap-IDE
- Operating temperature: -40 °C to +85 °C
- Dimensions (H × W × D): 145 × 52 × 145 mm (5.71 × 2.05 × 5.71 inch)
- Weight: cca. 420 g

VRIO01 remote IO rack module is main module of Distributed I/O control system. Vehicle Control Unit (VCU) can control up to 16 remote IO racks over CAN bus, Modbus or Ethernet. Remote IO racks contains up to 8 Distributed I/O peripheral modules. VRIO01 provide data gateway between Distributed I/O modules and vehicle VCU. This module is powered by external power supply, and it provides galvanically separated power supply to other Distributed I/O modules on the motherboard.
KONTRAC - TRAIN CONTROL AND MANAGEMENT SYSTEM

DRIVER-MACHINE INTERFACE

Technical specifications:

- UIC612 layout
- TFT color display 10.4" SVGA 800 x 600, automatic dimming
- Standard interfaces: RS232, RS485, Ethernet 2x, CANopen, MVB optional
- Power Supply Input: 24 V DC (-25 % +30 %)
- Operating system: Linux/Windows
- Programming tool: GrapDisplay
- Cooling Fanless
- Operating temperature: -40 °C to +85 °C
- Degree of protection: Front IP65, housing IP42
- Dimensions (H × W × D): 310 × 214 × 120 mm (12.2×8.43×4.72 inch)
- Standards: EN50155: 2008; Shock / Vibration EN 61373, Category 1, Class B (incorporated into vehicle body): 1999; EMC EN50121-3-2: 2006; Fire and Smoke NF F16-101/102, EN ISO 11925-2, EN 45545, internal cabling is free of halogencontent

SafeHMI SYSTEM MODULES

All SafeHMI components are CENELEC SIL4 certified according to EN 50126, EN 50128 and EN 50129 by TÜV SÜD. Main application of these components is to realize safety systems where human lives are exposed to dangerous situations. These applications are e.g., railway level crossing control and other railway safety applications.

Safe HMI display

Technical specifications:

- TFT color display 10.4" SVGA 800 x 600
- Unique redundant safety structure
- Interface: 2 x CAN, 2 x RS-485
- Programming tool: Grap IDE
- Power Supply Input: 24 V DC (-30%, +20 %)
- Operating temperature: 0 °C to +55 °C
- Consumption: 10 W
- Dimensions (H × W × D): 310 × 214 × 120 mm (12.2×8.43×4.72 inch)

SafeHMI display unit is the central part of the SafeHMI system. Visual information may be displayed on the integrated LCD TFT display or on the external monitor. For visualization of data are developed Safety display algorithms which are displayed using Safety Sweep method to prove content of display. User inputs can be provided by integrated keyboard and optional external pushbuttons (external pushbuttons are required for assigning commands). Interface to the remotely controlled equipment is provided through the serial RS485 link, CAN bus and through the optional digital inputs and digital outputs on the SafeHMI I/O modules.
Safe communication and power supply modules SVCAN and PSO1

Technical specifications:
- CAN repeater and galvanic separation of the CAN bus
- 5 LED indicators
- Programming tool: Grap-IDE
- Operating temperature: -25 °C to +70 °C
- Dimensions (H × W × D): 145 × 52 × 145 mm (5.71 × 2.05 × 5.71 inch)
- Weight: cca. 420 g

sVCAN&PSO1 module performs functionalities of CAN repeater and galvanic separation of the CAN bus, i.e. electrical and logical separation of local CAN bus on the motherboard from external CAN bus. This module is powered by external power supply, and it provides 5 V DC galvanically separated power supply to other SafeHMI I/O modules on the motherboard.

Safe digital inputs and outputs module SVDI0803

Technical specifications:
- 8 digital inputs
- 2 groups of 4 channels
- Input current 16 mA (60 V DC), input range 0-72 V DC
- 4 LED indicators
- Programming tool: Grap-IDE
- Operating temperature: -25 °C to +70 °C
- Dimensions (H × W × D): 145 × 26 × 145 mm (5.71 × 1.02 × 5.71 inch)
- Weight: cca. 300 g

sVDI0803 digital input module is used for filtering, conditioning and acquisition of digital inputs. Module monitors eight digital inputs divided into 2 groups of 4 channels. Each group has a separate ground. Channels support 60 VDC nominal input voltage. Inputs are protected from transient overvoltages and reverse polarity. Module communicates via local CAN bus.
Safe digital inputs and outputs module SVDI1602

**Technical specifications:**
- 16 digital inputs
- 4 groups of 4 channels
- Input current 14 mA (24 V DC), input range 0-30 V DC, logical levels: ON (>17 V DC), OFF (<6 V DC)
- 4 LED indicators
- Programming tool: Grap-IDE
- Operating temperature: -25 °C to +70 °C
- Dimensions (H x W x D): 145 x 26 x 145 mm (5.71 x 1.02 x 5.71 inch)
- Weight: cca. 300 g

**sVDI1602** digital input module is used for filtering, conditioning and acquisition of digital inputs. Digital inputs are divided into 4 groups of 4 channels. Each group has a separate ground. Channels support 24 V DC nominal input voltage. Inputs are protected from transient overvoltage's and reverse polarity. Module communicates with sVCAN&PS01 controller via local CAN bus.

Safe digital inputs and outputs module SVDO0201

**Technical specifications:**
- 2 safety relays
- 6 LED indicators
- Programming tool: Grap-IDE
- Operating temperature: -25 °C to +70 °C
- Dimensions (H x W x D): 145 x 26 x 145 mm (5.71 x 1.02 x 5.71 inch)
- Weight: cca. 300 g

**SVDO0201** is a digital output module, which contains two safety relays equipped with forcibly guided contact structure that enables detection of contact welding and construction of safety circuits. Each channel has three terminals: normally closed (NC), normally open (NO) and relay common terminals (IC). Module communicates with sVCAN&PS01 controller via local CAN bus.