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High-speed Train Propulsion & TCMS Design Production

TCMS Design

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1.Introduction

1.1. Description

JDEVS® TCMS is a computer system designed specifically for rail vehicle applications, which will handle the overall control and supervision of the train.

The train control system includes train control and subsystem control for the train communication network control method will be adopted. The train communication network will apply the MVB distributed bus control method, which complies with standard IEC-61375 named Train Communication Network.

1.2. Abbreviations

VCU	Vehicle Control Unit
DO	Digital Output
DI	Digital Input
IGBT	Insulated-Gate Bipolar Transistor
TCN	Train Communication Network
MVB	Multifunction Vehicle Bus
TDS	Train Diagnostic System
DCU/A	Drive Control Unit, Auxiliary converter
DCU/M	Drive Control Unit, Motor converter
DCU/P	Drive Control Unit, PWM converter
IDU	Intelligent Display Unit
HW	HardWare
SIL	Safety Integrity Level
CAN	Controller Area Network
EMD	Electrical Middle Distance
MTBF	Mean Time Between Failure
AFE Box	Active Front End Box
AB Box	Auxiliary & Battery Box

PH Box	Propulsion & High-voltage Box
PA Box	Propulsion & Auxiliary Box
Tc car	Trailer cab car
Mp car	Motor car with Pantograph
M car	Motor car
TCMS	Train Control and Monitoring System
LON	Local Operating Network
HMI	Human Machine Interface
LCD	Liquid-Crystal Display
PLC	Programmable Logic Controller

1.3. References

[1] Propulsion System Description JDEVS-HPDP-PS-SP-102

2.TCMS System Description

2.1. System

JDEVS® TCMS is a distributed system, which means signals to and from the computer system are connected to units distributed throughout the train. The distributed units can, for example, be mounted in boxes under the floor, under the driver's desk, or in a cabinet inside the vehicle. The different distributed units are connected, using serial data communication links. The greatest and most important advantage of this kind of system is that the amount of wiring between boxes is reduced drastically. It also means that it will be easy to extend the system in the future.

The system shall be composed of an MVB network (Multifunction Vehicle Bus) and Ethernet. MVB network is distributed within EMD (Electrical Middle Distance) medium, which fully complies with standard IEC61375. Its main function is to realize general control and monitoring for the whole train. MTBF (Mean Time Between Failure) designed for the system shall be more than 40000 hours.

All units, intelligent and non-intelligent, are connected to the train communication network and are controlled by the JDEVS® TCMS Vehicle Control Unit (VCU). The VCU contains the vehicle control application, which is an application developed for each type of vehicle.

The VCU communicates with the Propulsion Control Unit (PCU). The PCU is a functional unit, sometimes located in the same VCU as the vehicle control application, sometimes located in a separate VCU. The PCU contains the propulsion control application and is responsible for the propulsion and auxiliary system.

The PCU, in turn, communicates with the JDEVS® TCMS Drive Control Unit (DCU). The DCU is built on a single-board computer with a multiprocessor design to provide a suitable environment for the different parts of the software. By downloading a specific package of software each converter control is formed as listed below.

- JDEVS® DCU/M (Motor Converter Control)
- JDEVS® DCU/A (Auxiliary Converter Control)

- JDEVS® DCU/P (Active Front End Converter Control)

The onboard part of the train diagnostic system, JDEVS® TDS, is an integrated part of the JDEVS® TCMS system. The VCU in each car collects and stores the relevant information about events, faults, and vehicle status in the fault database. VCU communicates with an Intelligent Display Unit (IDU) via Ethernet. The fault information is presented in IDU, on the driver's desk.

All JDEVS® TCMS controller unit software is developed with a high level of standardization and well-defined structure ensuring high quality and enabling software re-use. EN 50128 is followed closely to meet the increasing market requirements for safe vehicle operation.

3.System Configuration

This technical description describes the technical solution from JDEVS® TCMS for the train control and communication system. JDEVS® TCMS is a system with high-standard designed for railway transportation.

This system configured for prototype Lab set that implement in JDEVS Lab.

3.1. Control System Configuration

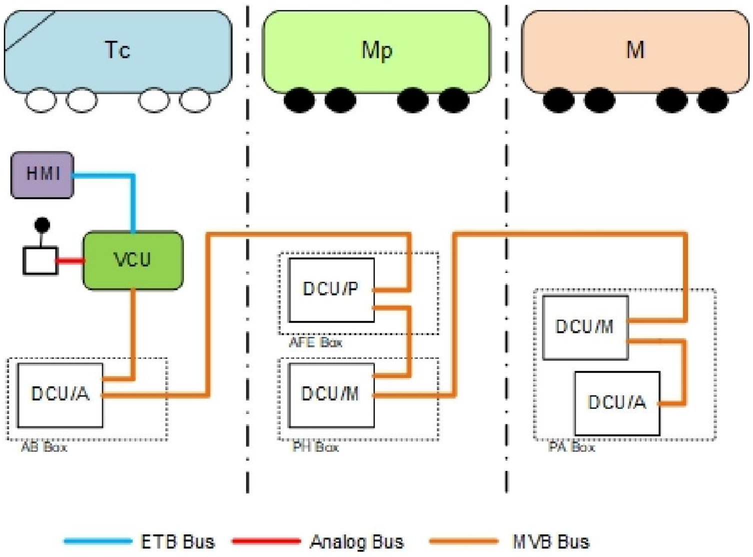

Figure 3.1: TCMS System overview

3.2. System Functions

3.2.1. VCU – Vehicle Control Unit

The main purpose for vehicle control part is to monitor and control those subsystems which will not lead to serious impact on train operation.

Vehicle control shall also provide assistance for failure diagnosis information storage and also make those events and failures display on IDU.

The JDEVS® TCMS VCU controls following:

- **Propulsion Control:**

The scope of the Propulsion Control is the control and protection of IGBT based motor and auxiliary converter. Brake blending is included. It covers all functionality needed to perform these tasks, implemented in hardware and software.

The Propulsion Control interfaces involves the following sub-systems:

- Train Operation
- High Voltage
- Motor inverter control and monitor
- Auxiliary inverter control and monitor
- Speed calibration
- Over-speed protection

The Propulsion Control interfaces the following propulsion sub-systems:

- Motor Converter Control, controls motor inverter control logic
- Auxiliary Converter Control, controls auxiliary inverter control logic
- Active Front End Converter Control, controls motor converter control logic

- **High Voltage:**

The scope of the High Voltage is to control and supervise:

- Line circuit breaker
- Starting enabling of DC system
- Pantograph control (Not in LAB configuration)
- Main circuit control and monitor
- Line current/voltage management

- **Train Operation and Control:**

The scope of the Train Operation Control is to control and supervise:

- Propulsion Control
- High Voltage Control
- Master controller reference
- Driver desk
- Driving direction

    - Traction/brake selection

- **Communication & Control:**

For the communication protocol and physical layer, IEC-61375 shall be fully complied. Controls and supervises the communication between units on the MVB. Handles the train inauguration and controls and supervises the communication.

- **TDS, Train Diagnostic System:**

TDS, Train Diagnostic System, gathers advanced maintenance event information with different levels of seriousness from all subsystems controlled by the VCU.

4.JDEVS® TCMS HW Products

In this section, the equipment used in the high-speed train prototype project is presented.

4.1. Vehicle Control Unit, VCU

VCU shall be the main processor unit for train and vehicle control. All units connected to MVB shall be under the control of VCU.

The RIOM is a powerful, multipurpose PLC featuring integrated communication gateways and remote input/output capabilities. It is typically used as a vehicle control unit able to manage electrical subsystems in TCMS architectures. Its powerful processing capabilities and robustness make it the perfect candidate for integration in a SIL 2 system architecture.

Figure 4.1: VCU

Main features:

- EN 50155/IEC 60571-compliant
- Power supply: 24Vdc, 36Vdc or 72-110Vdc
- DI: up to 64
- DO: up to 32

- AI: 4 I/U inputs ±10V (10kΩ) / ±20mA (125 Ω)
- AO: 4 I/U outputs 0-10Vdc (50mA max) / 0-20mA (10Vdc max)
- Communication: Ethernet, CAN 2.0, MVB, LON, RS485, RS-232

Table 1: RIOM Features

Mechanical	Dimension (without fixation)	Height x Width x Depth = 215 x 245 x 100 mm
	Fixation	By screw
	Weight	< 3.5 kg according to the configuration
Power supply	Voltage	24V (–40%,+25%), 36V or 72-110V (-30%,+25%)
	Consumption	45 W max according to the configuration
	Protection	Against polarity inversion and over voltage
CPU	Processor	ARM-based CPU (PXA270)
	Memory	Flash : 16Mo , RAM : 32Mo
Logical Inputs		
	Nominal voltage / Incoming Current	72-110V, 36V or 24V / 10 mA (continuous fritting)
	Protection	Polarity Inversion and Over voltage Non-dissipative inputs Patented solution
Logical Outputs		
	by board	8 Active / Common relays + 8 Active / Inactive / Common relays
	Voltages on the contact	16 to 160 Vdc
	Max. switching power / voltage / current	8A on 30 Vdc / 0,4A on 110 Vdc
	Insulation between outputs contacts	1000Vac (50 Hz, 1 mn)
Analog inputs		
	Scales	+/-10Vdc and/or +/-20mA
	Resolution / Accuracy	12-bit ADC / 2% full range worst case
Analog outputs		
	Scales	0-10V and/or 0-20mA
	Resolution / Accuracy	12-bit DAC / 2% full range worst case
Communications	Max configuration	Ethernet, CAN 2.0/2xRS485, MVB EMD or LON, 2x RS485, RS232 Maintenance link

4.2. Intelligent Display Unit, IDU

10-inch panel computer with Intel Atom® E3845 1.91 GHz processor, 4 GB RAM, 1 CFast socket with 16 GB card preinstalled, 1000-nit LCD with multi-touch, Linux preinstalled, 24 to 110 VDC, IP66, EN50155, -40 to 70°C operating temperature, conformal coating. Communicates to the VCU over the Ethernet.

Figure 4.2: IDU