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INGESYS™ TCMS

PRODUCT OVERVIEW.

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1   Introduction

INGESYS™ TCMS is a scalable, flexible, high-performance Train Control and Monitoring System design for the railway sector.

A modular design with a comprehensive suite of processor modules, communication modules (TCN, CAN, PROFIBUS, ETHERNET) and I/O modules enable an optimized control solution for rail vehicles.

Maximum availability is obtained through redundant configurations (Power supply modules, Processor modules, I/O modules and Communications) with a hot standby behaviour for obtaining a bumpless changeover in case of failure.

An EN50155 standard compliant VCU system guarantees the achievement of low failure rates and high availability at the demanding operating conditions present at the train.

The *INGESYS™ TCMS* makes available to the user a wide range of programming languages (IEC61131, C++, *MATLAB®*/*SIMULINK®*) in order to increase the performance and profitability of the control engineer throughout the different phases of the train automation (programming, commissioning and maintenance).

An open and standard network architecture based on the state of the art technologies (CAN, ETHERNET, TCN) enables optimized stand alone or decentralized train automation solutions.

The *INGESYS™ TCMS* incorporates a wide range of functionalities (embedded Web server, logging functions, remote access, etc.) oriented to optimize the system monitoring and supervision activities.

INGETEAM´s experience in the automation field in different sectors (industry, energy, marine, and railway) ensures competitive and long term available solutions.

2   Hardware overview

2.1 System racks

Racks provide mechanical support and electrical interconnection.
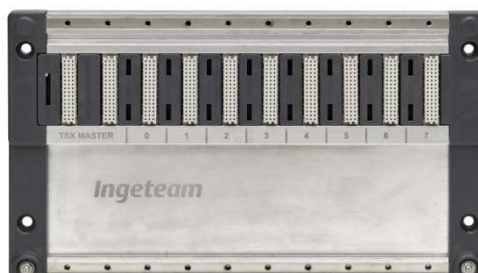
Two types of racks are available:

a) Racks including reserved slots for power supply modules.
    Designed for processor or bus terminal modules powered at 3,3V or 5,0V that require an external power supply module.

References	
IC3501	Power supply + Processor + 16 I/O one-slot modules
IC3503	Power supply + Processor + 4 I/O one-slot modules
IC3504	Power supply + Processor + 8 I/O one-slot modules
IC3505	Power supply + Processor + 2 I/O one-slot modules
IC3516	Redundant Power supply + Processor + 8 I/O one-slot modules

b) Racks not including reserved slots for power supply modules.
    Designed for processor or bus terminal modules powered at 24V that do not require an external power supply module.

References	
IC3511	Processor / header + 8 I/O one-slot modules
IC3512	Processor / header + 4 I/O one-slot modules
IC3513	Processor / header + 2 I/O one-slot modules
IC3515	Processor / header + 6 I/O one-slot modules

2.2 Power supply modules

IC3602 / IC3603 modules power the whole system via the backplane. Different input voltages are available.

The power supply modules are designed for redundant operation. Two power supplies can be connected in parallel. In case of one's failure, the second one immediately takes control without any voltage drop. The LEDs of the malfunctioning power supply module will switch off, so that the user can identify and replace it.

Redundancy operation is the well-known N+1 mode. When two power supply modules are connected in parallel the maximum output current is still 5A per output.

General Characteristics:

- ↗ 24Vdc, 125Vdc, 220Vac
- ↗ Max. current 5A
- ↗ Status indication LEDs
- ↗ Status monitoring from processor module
- ↗ High temperature operation
- ↗ N + 1 redundancy support
- ↗ EN50155 compliant

References	Specific Characteristics
IC3602	Power supply 24Vdc input
IC3603	Power supply 88-300Vdc / 85-250Vac input

	IC3602	IC3603
Electrical		
Input Voltage	14,4Vdc to 31,2Vdc	88Vdc to 300Vdc / 85Vac to 285Vac
Max. Input Current	3,2A	0,75A / 0,70A
Output Voltage	3,3V / 5,0V	
Max. Output current		
3,3 V	5A	
5,0 V	5A	
Max. Dissipated Power	12W	10W
Isolation		
Input-Output	2000Vac @ 60s	
Input-Earth	2000Vdc @ 60s	
Additional Features		
Reverse input voltage protection		
Input, 3,3V and 5,0V status indication LEDs		
Input and output voltage supervision		
Power fail indication to processor module		
N + 1 redundancy support		
Hot swap		
Mechanical		
Dimensions (WxHxD)	52,25mm x 175mm x 150,5mm	
Weight	540g	
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	

2.3 Processor modules

INGESYS™ TCMS processor modules ensure the right solution in terms of performance and robustness for each application.

A compact design incorporating high processing power and memory resources, communication interfaces (Ethernet, CAN ports) and storage interfaces to USB and flash devices on an EN50155 compliant platform.

Different programming languages IEC61131 languages (IL, ST, SFC, LD, FBD), advanced programming languages, like *MATLAB®/SIMULINK®* or C/C++, with a powerful range of application-specific software libraries provide the control engineer with the right tool for each requirement.

References	
IC3102	High performance processor module
IC3122	Medium performance processor module

2.3.1 IC3102 Processor module

The IC3102BE processor module enables maximum *INGESYS™ TCMS* functionality and performance, offering a state-of-the-art solution.

These processor modules optimally integrate the real-time control characteristics and robustness, with advanced control functional features (data management, embedded web servers, communications protocols, etc).

General Characteristics:

- ↗ x86 500Mhz processor
- ↗ 2 Ethernet interfaces (10/100) M-12 connector
- ↗ 2 CAN interface
- ↗ RTSX interface (Remote IO)
- ↗ 1 USB host interface
- ↗ 4MB RAM for user application
- ↗ 10MB internal Flash for user application
- ↗ 62KB NVRAM
- ↗ CF slot for user data
- ↗ TEST/ON/OFF switch and status LEDs
- ↗ EN510155 compliant

References	Specific Characteristics
IC3102BE	2 Ethernet ports M12, 8 local slots(Local IO), RTSX 10Mbps, 2 CAN ports

	IC3102BE
Functional	
CPU	500Mhz Pentium Compatible
RAM Memory	4Mbytes for user application
NVRAM Memory	62Kbytes for user application
Internal Flash Memory	10MB for user application
CF Slot	Yes
Ethernet	2 x 10/100 BaseTX (M-12 connector)
USB	1 x USB 2.0 Host
CAN	2 x D-Sub9
TSX	8 channels
Electrical	
Power Supply	+5V / +3.3V from backplane
Current Consumption 3,3V	1A (max.) / 0.75A (typ.)
Current Consumption 5,0V	1.5A (max.) / 1.125A (typ.)
Max.Dissipated Power	11W
Additional Descriptions	
Watchdog	
Real-time clock with lithium battery	
3 position working mode switch (TST/ON/OFF)	
3 status indication LEDs	
Internal temperature supervision	
Self-diagnosis	
Hot swap	
Mechanical	
Dimensions (WxHxD)	78.5mm x 175mm x 150.5mm
Weight	1023g
Climatic	
Operating Temperature	Class TX:-40ºC to + 70ºC, passive cooling
Storage Temperature	-40ºC to + 85ºC
Relative Humidity	5% to 95% w/o condensing

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2.3.2 IC3122 Processor module

The IC3122 processor module is designed for medium-performance control applications with communication requirements in demanding environmental situations.

Software compatible with the IC3102 processor, shares the complete set of modules (I/Os, communications modules, etc.) offering the same control architecture.

General Characteristics:

- ↗ ARM 400Mhz processor
- ↗ 2 switched Ethernet interfaces (10/100), M-12 connector
- ↗ RTSX interface (Remote IO)
- ↗ 1 USB host interface
- ↗ 1,4MB RAM for user application
- ↗ 2MB for user application
- ↗ 32KB NVRAM
- ↗ TEST/ON/OFF switch and status LEDs
- ↗ EN510155 compliant

References	Specific Characteristics
IC3122CA	4 TSX channels (Local IO), 1 CAN port Versatile Link, 1 RTSX port (Remote IO), integrated 24Vdc power supply
IC3122DD	8 TSX channels (Local IO), 2 CAN ports, 2 serial RS232/485 ports, not integrated 24Vdc power supply
IC3122EA	4 TSX channels (Local IO), 2 CAN ports, integrated 24Vdc power supply
IC3122FA	8 TSX channels (Local IO), 2 CAN ports, not integrated 24Vdc power supply

	IC3122CA	IC3122EA	IC3122DD	IC3122FA
Functional				
CPU	400Mhz ARM			
Program memory	2MB for user application			
RAM Memory	1,4MB			
NVRAM Memory	32KB for user application			
Ethernet	2 x 10/100 BaseTX (internally switched M-12 connector)			
CAN	1 x Optical Versatile Link	2 x D-Sub9		
USB	1 x USB 2.0 Host			
TSX	4 channels		8 channels	
RTSX	1 x RTSX port	-		
Serial Communications	-		2 x RS232/485 ports	-
Electrical				
Input Voltage	11Vdc to 34Vdc		+3,3V / +5,0V (from backplane)	
Input Current	0,9A (depends on output power to backplane)		+3,3V: 0,7A (max.) / 0,575A (typ.) +5,0V: 0,1A (max.) / 0,050A (typ.)	
Output Voltage	3,3V / 5,0V (to backplane)		-	
Max. Total Output Power	4W (Shared between 3,3V and 5,0V)		-	
Max. Output current	Max.total output power must be taken into account		-	
Current Consumption 3,3V	1,1A		-	
Current Consumption 5,0V	0,7A		-	
Max. Dissipated Power	4W		2,5W	
Isolation	1000V		-	
Additional Descriptions				
Watchdog				
Real-time clock with Lithium battery				
3 position working mode switch (TST/ON/OFF)				
3 Status indication LEDs				
Internal temperature supervision				
Self-diagnosis				
Hot swap				
Mechanical				
Dimensions (WxHxD)	52,25mm x 175mm x 150,5mm			
Weight	540g			
Climatic				
Operating Temperature	Class TX:-40ºC to + 70ºC, passive cooling			
Storage Temperature	-40ºC to + 85ºC			
Relative Humidity	5% to 95% w/o condensing			

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2.4 Input / Output modules

INGESYS™ TCMS offers a complete set of digital and analog input / output modules to access process signals.

Railway sector requirements have been considered in their design enabling a scalable and optimised solution.

All I/O modules are EN50155 compliant.

References	
IC3311AAB	32 x 24Vdc digital inputs, connector for terminal blocks
IC3311CAB	32 x 24Vdc digital inputs, DIN 41612 F output connector
IC3314A	16 x 24Vdc digital inputs 8 x 24Vdc fast digital inputs for incremental encoders
IC3315A	16 x 110Vdc digital inputs 8 x 24Vdc fast digital inputs for incremental encoders
IC3315B	24 x 110Vdc digital inputs
IC3333AAB	32 x 24Vdc digital outputs HSD 250mA, connector for terminal blocks 17 groups (5 groups of 4 DOs and 12 DOs with independent supply for each group)
IC3333CAB	32 x 24Vdc digital outputs HSD 250mA, DIN 41612 F, 48 pin connector 14 groups (6 groups of 4 DOs and 8 DOs with independent supply for each group)
IC3336A	16 x 24Vdc 2A digital outputs (16 DOs with independent supply)
IC3337A	16 x 110Vdc 200 mA digital outputs (16 DOs with independent supply)
IC3338A	8 x relay outputs NO / NC, 24Vdc auxiliary power supply
IC3339A	8 x relay outputs NO / NC, 110Vdc auxiliary power supply
IC3356AB	16 analog inputs, ±10V ±20mA input ranges configured by SW, connector for terminal blocks
IC3356CB	16 analog inputs, ±10V ±20mA input ranges configured by SW, DIN 41612 F, 48 pin connector
IC3357AB	16 PT100 inputs, 2 wires, connector for terminal blocks
IC3357CB	16 PT100 inputs, 2 wires, DIN 41612 F, 48 pin connector
IC3374AB	8 x analog outputs, ±10V ±20mA input ranges configured by SW, connector for terminal blocks
IC3374CB	8 x analog outputs, ±10V ±20mA input ranges configured by SW, DIN 41612 F, 48 pin connector

2.4.1 Digital input modules

General Characteristics:

- ⇗ Status indication LEDs
- ⇗ Status monitoring from processor module
- ⇗ EN50155 compliant

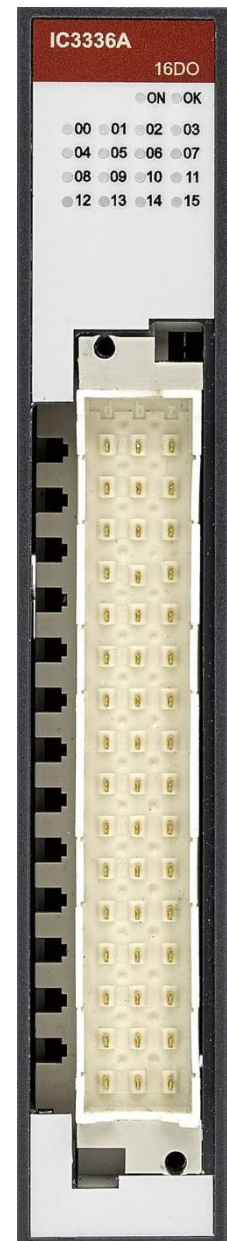| References	Specific Characteristics
IC3311AAB	32 x 24Vdc digital inputs, connector for terminal blocks
IC3311CAB	32 x 24Vdc digital inputs, DIN 41612 F output connector
IC3314A	16 x 24Vdc digital inputs 8 x 24Vdc fast digital inputs for incremental encoders
IC3315A	16 x 110Vdc digital inputs 8 x 24Vdc fast digital inputs for incremental encoders
IC3315B	24 x 110Vdc digital inputs

	IC3311AAB	IC3311CAB	IC3314A	IC3315A	IC3315B
Functional					
Number of inputs	32		24		
Connection mode	Common return for all the inputs				
Number of Low / High speed input	32 (24V) / 0		16 (24V) / 8(24V)	16 (110V) / 8 (24V)	24(110V) / 0
High Speed Counters	0		up to 4 counters for 4 incremental encoders		0
Digital filter	RC		One configurable digital filter for each input		
Self-diagnosis	TSX bus and channel inputs		TSX internal bus		
Hot swap	Yes				
Electrical					
Input technology	Opto-isolator				
Isolation output to system	Test 2500Vdc				
Isolation between inputs	No				
Nominal input voltage	24Vdc			110Vdc	
Max. current per input	3mA		10mA	2mA (110V)/ 10mA (24V)	2mA
Current Consumption 3,3V	150mA (max.) / 110mA (typ.)		150mA (max.) / 131mA (typ.)		
Mechanical					
Dimensions (WxHxD)	26mm x 175mm x 130mm				
Weight	275g				
Slot width	1 slot. IC3 / TSX				
Output connector	Connector for terminal blocks	DIN 41612 F, 48 pin			
Climatic					
Operating Temperature	Class TX:-40ºC to + 70ºC				
Storage Temperature	-40ºC to + 85ºC				
Relative Humidity	5% to 95% w/o condensing				
Accessories (Not included)					
Field connection options	Spring terminal socket. 1,5mm² (2 IC3571 per module)	DIN 41612 F, 48 pin Socket			
	50 pin flat cable adapter (1 IC3573 per module)				

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2.4.2 Digital output modules

General Characteristics:

↗ Status indication LEDs

↗ Status monitoring from processor module

↗ Short-circuit protection

↗ Overheating protection

↗ EN50155 compliant

References	Specific Characteristics

IC3333AAB	32 x 24Vdc digital outputs HSD 250mA
	  17 groups (5 groups of 4 DOs and 12 DOs
	  with independent supply for each group)
	connector for terminal blocks

IC3333CAB	32 x 24Vdc digital outputs HSD 250mA
	  14 groups (6 groups of 4 DOs and 8 DOs
	  with independent supply for each group)
	DIN 41612 F, 48 pin connector

IC3336A	16 x 24Vdc 2A digital outputs (16 DOs with independent supply) DIN 41612 F, 48 pin connector
IC3337A	16 x 110Vdc 200 mA digital outputs (16 DOs with independent supply) DIN 41612 F, 48 pin connector
IC3338A	8 x relay outputs NO / NC, 24Vdc auxiliary power supply DIN 41612 F, 32 pin connector
IC3339A	8 x relay outputs NO / NC, 110Vdc auxiliary power supply DIN 41612 F, 32 pin connector

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	IC3333AAB	IC3333CAB
Functional		
Number of outputs	32	
Connection mode	17 groups(5 groups of 4 DOs and 12 DOs) with independent supply	14 groups(6 groups of 4 DOs and 8 DOs) with independent supply
Self-diagnosis	TSX internal bus and outputs	
Hot swap	Yes	
Electrical		
Output technology	Solid state relay (SSR) opto-isolated	
Isolation output to system	2500Vdc	
Isolation between outputs	No	
Aux. Power supply voltage	24Vdc (rated) 19 Vdc (min.), 30Vdc (max.)	
Max. current per output	250mA	
Max. total current per module	5A, limited by internal fuse	
Current Consumption 3,3V	Outputs ON: 400mA (max.) / 350mA (typ.) Outputs OFF: 60mA (typ.)	
Mechanical		
Dimensions (WxHxD)	26mm x 175mm x 130mm	
Weight	220g	
Slot width	1 slot. IC3 / TSX	
Output connector	Connector for terminal blocks	DIN 41612 F, 48 pin
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	
Accessories (Not included)		
Field connection options	13 pin spring terminal socket (4 IC3593 per module)	DIN 41612 F, 48 pin Socket

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	IC3336A	IC3337A	IC3338A	IC3339A
Functional				
Number of outputs	16		8	
Connection mode	16 DOs with independent supply		3 points switching contact (NO/NC)	
Self-diagnosis	TSX internal bus			
Hot swap	Yes			
Electrical				
Output technology	Solid state relay (SSR) opto-isolated		Electromechanical relay	
Isolation output to system	2500Vdc			
Isolation between outputs	No		Functional	
Aux. Power supply voltage	24Vdc	110Vdc	24Vdc	110Vdc
Max. current per output	2A	250mA	5A @ 20ºC, 2A @ 70ºC	
Max. total current per module	20A	4A	-	
Max. contact voltage	-	-	160Vdc	
Current Consumption 3,3V	200mA (max.) / 150mA (typ.)		200mA (max.) / 170mA (typ.)	
Mechanical				
Dimensions (WxHxD)	26mm x 175mm x 130mm			
Weight	240g		345g	
Slot width	1 slot. IC3 / TSX			
Output connector	DIN 41612 F, 48 pin		DIN 41612 F, 32 pin	
Climatic				
Operating Temperature	Class TX:-40ºC to + 70ºC			
Storage Temperature	-40ºC to + 85ºC			
Relative Humidity	5% to 95% w/o condensing			
Accessories (Not included)				
Field connection options	DIN 41612 F, 48 pin Socket		DIN 41612 F, 32 pin Socket	

2.4.3   Analog input modules

General Characteristics:

- ↗ SW configured
- ↗ High resolution
- ↗ Self-diagnosis
- ↗ EN50155 compliant

References	Specific Characteristics
IC3356AB	16 analog inputs, ±10V ±20mA input ranges configured by SW, connector for terminal blocks
IC3356CB	16 analog inputs, ±10V ±20mA input ranges configured by SW, DIN 41612 F, 48 pin connector
IC3357AB	16 PT100 inputs, 2 wires, connector for terminal blocks
IC3357CB	16 PT100 inputs, 2 wires, DIN 41612 F, 48 pin connector

	IC3356AB	IC3356CB	IC3357AB	IC3357CB
Functional				
Input signal	Voltage / Current		PT100 sensor	
Number of inputs	16		16	
Connection mode	Common GND reference		2 wires	
Measurement ranges	-20mA to +20mA, 0 to 20mA, +4mA to 20mA, -10V to +10V, -5V to +5V, -1V to +1V, 0 + 5V, 0 + 10V		-50ºC to 200ºC	
Refresh time	5,2ms (max.)		48ms (max.)	
A/D converter	16 bits			
Self-diagnosis	TSX and ADC			
Hot swap	Yes			
Electrical				
Break down current in current mode	+/- 40mA		-	
Break down voltage	+/- 18V		-	
Open circuit voltage	-		3,4V (max.)	
PT100 current	-		1,6mA (max.)	
Isolation input to system	1500Vac, 60s			
Isolation between inputs	No			
Input impedance, voltage mode	>33KΩ		-	
Input impedance, current mode	440Ω (min.), 460Ω (max.)		-	
Current Consumption 3,3V	550mA (max.) / 430mA (typ.)		600mA (max.) / 400mA (typ.)	
Mechanical				
Dimensions (WxHxD)	26mm x 175mm x 130,41mm			
Weight	210g			
Slot width	1 slot. IC3 / TSX			
Output connector	Connector for terminal blocks	DIN 41612 F, 48 pin	Connector for terminal blocks	DIN 41612 F, 48 pin
Climatic				
Operating Temperature	Class TX:-40ºC to + 70ºC			
Storage Temperature	-40ºC to + 85ºC			
Relative Humidity	5% to 95% w/o condensing			
Accessories (Not included)				
Field connection options	Spring terminal socket. 1,5mm^2 (2 IC3571 per module) / 50 pin flat cable adapter (1 IC3573 per module)	DIN 41612 F, 48 pin Socket	Spring terminal socket. 1,5mm^2 (2 IC3571 per module) / 50 pin flat cable adapter (1 IC3573 per module)	DIN 41612 F, 48 pin Socket

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2.4.4 Analog output modules

General Characteristics:

↗ Voltage or current outputs, software configurable

↗ Output status diagnosis

↗ Short-circuit protection

↗ Overheating protection

↗ EN50155 compliant

References	Specific Characteristics
IC3374AB	8 analog outputs ,±10V ±20mA input ranges configured by SW, connector for terminal blocks
IC3374CB	8 analog outputs ,±10V ±20mA input ranges configured by SW, DIN 41612 F, 48 pin connector

	IC3374AB	IC3374CB
Functional		
Number of outputs	8	
Connection mode	Common GND reference	
Output signal	Voltage / Current	
Output ranges	-10V to +10V,0 to +10V, 0 to +5V, -20mA to +20mA, 0 to 20mA, +4mA to 20mA	
Refresh time	2,5ms (max.)	
A/D converter bits	16	
Self-diagnosis	TSX and ADC	
Hot swap	Yes	
Electrical		
Aux. supply voltage	24V +/- 10%	
Aux. supply current	370mA (max.) , with all outputs at 20mA	
Isolation output to system	1500Vac, 60s	
Isolation between outputs	No	
Resistive load in voltage mode	1KΩ (min.)	
Resistive load in current mode	500Ω (max.)	
Current Consumption 3,3V	160mA (max.) / 115mA (typ.)	
Mechanical		
Dimensions (WxHxD)	26mm x 175mm x 130,41mm	
Weight	230g	
Slot width	1 slot. IC3 / TSX	
Output connector	Connector for terminal blocks	DIN 41612 F, 48 pin
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	
Accessories (Not included)		
Field connection options	Spring terminal socket. 1,5mm^2 (2 IC3574 per module) Socket to flat cable adapter (1 IC3578 per module)	DIN 41612 F, 48 pin Socket

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2.5 Communication modules

2.5.1 Trainbus communication (TCN) modules

INGESYS™ TCMS provides communication modules according to the *Train Communication Network* (*TCN*) defined in the IEC61375-1 standard. A Multi- function Vehicle Bus (MVB), module (IC3291), for networks within a single vehicle and a Wire Train Bus (WTB), module (IC3292), for communication across the entire train.

General Characteristics:

- ↗ Two redundant channels
- ↗ MVB. Multifunction Vehicle Bus:

    - o Optical fibre connection
    - o Bus administrator capacity

- ↗ WTB. Wire Train Bus:

    - o Supporting the UIC protocol ("International Union of Railways) according UIC-556 Leaflet

- ↗ EN50155 compliant

References	Specific Characteristics
IC3291	MVB communication module
IC3292A	WTB communication module

	IC3291	IC3292A
Functional		
Communication Protocol	TCN – MVB – OGF (optical fibre)	TCN – WTB
Line number	2	2
Connection type	2 x ST	2 x D-Sub9
Physical medium	HCS Multimode 200µm (optical fibre pair)	Shielded twisted pair
Transmission speed	1,5Mbit/s	1Mbit/s
Diagnosis LEDs	Yes	
Self-diagnosis	Yes	
Hot swap	Yes	
Electrical		
Current Consumption 3,3V	500mA (max.) / 360mA (typ.)	210mA (max.) / 170mA (typ.)
Current Consumption 5,0V	195mA (max.) / 150mA (typ.)	195mA (max.) w/o fritting / 160mA (typ.) 740mA (max.) with fritting / 630mA (typ.)
Dissipated Power	2,7W	1,7W (max.) w/o fritting 4,4W (max.) with fritting
Mechanical		
Dimensions (WxHxD)	26mm x 175mm x 130,41mm	52mm x 175mm x 130,41mm
Weight	225g	385g
Slot width	1 slot. IC3 / TSX	2 slots. IC3 / TSX
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	

2.5.2 Serial communication module

INGESYS™ TCMS offers different possibilities to interface external devices via serial links. RS232 or RS485 (half or full duplex) with the most standard serial protocols are available.

General Characteristics:

- ↗ Three software-configurable serial ports RS-232/RS-485(half/full duplex)
- ↗ TX/RX LEDs per channel
- ↗ Intelligent modules
- ↗ FIFO buffer UART
- ↗ EN50155 compliant

References	Specific Characteristics
IC3251AB	3 serial RS232/RS485 ports, D-Sub9 connector

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	IC3251AB
Functional	
Communication	Serial RS232/RS485 (Half and Full duplex)
Number of ports	3
Connection type	D-Sub9 (female)
Physical medium	Copper
Maximum transmission speed	RS-232 Up to 64Kbit/s RS485: Up to 500Kbit/s
Tx and Rx LEDs	Yes
Diagnosis LEDs	Yes
Self-diagnosis	Yes
Hot swap	Yes
Electrical	
Current Consumption 3,3V	420mA (max.) / 400mA (typ.)
Dissipated power	1,4W (max.)
Galvanic isolation	500Vdc between field signals and internal logic
Isolation technology	Opto-isolator
Mechanical	
Dimensions (WxHxD)	26mm x 175mm x 130,41mm
Weight	220g
Slot width	1 slot. IC3 / TSX
Climatic	
Operating Temperature	Class TX:-40ºC to + 70ºC
Storage Temperature	-40ºC to + 85ºC
Relative Humidity	5% to 95% w/o condensing

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2.5.3 CAN communication module

IC3261 module incorporates the CANopen master or Slave functional feature in *INGESYS™ TCMS*, following the profiles given in the CiA 301 specification released by CAN in Automation.

The use of CANopen eases technical details, simplifying the control engineer's task of developing the application and improving reliability.

General Characteristics:

- ↗ 1Mbit/s Maximum transmission speed
- ↗ D-Sub9 connectors
- ↗ EN50155 compliant

References	Specific Characteristics
IC3261AB	CANopen Master / Slave module, 2 ports

	IC3261AB
Functional	
Communication Protocol	CAN (CANopen)
Number of ports	2
Connection type	D-Sub9 male
Max. Transmission speed	Up to 1Mbit/s (Cable length dependent)
Diagnostic LEDs	Yes
Self diagnosis	Yes
Hot Swap	Yes
Electrical	
Data link and physical layer	CAN
Current Consumption 3,3V	250mA (max.) / 230mA (typ.)
Current Consumption 5,0V	50mA (max.) / 30mA (typ.)
Mechanical	
Dimensions (WxHxD)	26mm x 175mm x 130,41mm
Weight	205g
Slot width	1 slot. IC3 /TSX
Climatic	
Operating Temperature	Class TX:-40ºC to + 70ºC
Storage Temperature	-40ºC to + 85ºC
Relative Humidity	5% to 95% w/o condensing

2.6 Input / Output expansion bus

2.6.1 RTSX expansion bus

RTSX is a proprietary bus and together with CAN is one of the possible communication buses for the *INGESYS™ TCMS*'s distributed topology.

A 10Mbits transmission rate and exhaustive diagnosis features ensure the system's integrity, reliability and determinism.

The bus expansion follows a nested star topology with up to two sublevels and up to 256 remote I/O units can be connected by an optical fibre link (plastic or HCS).

Two different components integrate the bus: the router modules that enable bus expansion, and header modules that integrate I/O expansion racks in the RTSX bus. The processors modules incorporate RTSX master ports to directly access a remote expansion I/O unit incorporating an RTSX header module.

References	
IC3201AB	Header module 16 slots without built-in power supply
IC3202AB	Header module 8 slots with built-in power supply
IC3221	Router RTSX 1M-4S
IC3222B	Router RTSX 2M-4S

2.6.1.1 Header modules

Header modules are components of *INGESYS™ TCMS* distributed architecture, carrying out the expansion of the central unit with remote I/O units when a larger number of inputs/outputs than those permitted by a local set is required, or when a distributed input/output configuration is required.

Communication between central rack and remote racks is based on the RTSX master-slave proprietary bus, an optical fibre bus (POF for distances up to 50m or HCS fibres for distances up to 200m) that guarantees robust and real-time communication between the central processors and modules located in remote racks*.*

There are various header modules available, depending on the maximum slot number and the incorporation of power supply.

References	Specific Characteristics
IC3201AB	Header module 16 slots without built-in power supply
IC3202AB	Header module 8 slots built-in without power supply

|	IC3201AB	IC3202AB
Functional		
Communications	RTSX	
Number of ports	1	
Max. Transmission speed	10Mbit/s	
Max. Installation distance per section	50m for POFs, 200m for HCS	
Diagnosis LEDs	Yes	
Hot swap	Yes	
Electrical		
Connection type	Versatile Link (V-LINK)	
Max. Number of TSX slaves	16	8
Built in rack power supply	No	Yes
Input Voltage	+3,3V / +5,0V (from backplane)	11Vdc to 34Vdc
Input Current	+3,3V: 0,9A (max.) / 0,675A (typ.) +5,0V: 0,1A (max.) / 0,050A (typ.)	24Vdc: 0,9A (max.)
Output Voltage	-	3,3V / 5,0V (to backplane)
Max. Output current		
3,3V	-	2,5A
5,0V	-	1,75A
Max. Dissipated Power	3W	6W
Isolation	-	1000V
Mechanical		
Dimensions (WxHxD)	52mm x 175mm x 130,41mm	
Weight	450g	
Slot width	2 slot. IC3 / TSX	
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	

2.6.1.2   RTSX Star coupler

IC3221 RTSX 1M-4S Star coupler permits the connection of 1 RTSX master module and the expansion of the RTSX Bus up to 4 slave channels. Additionaly the IC3222B RTSX 2M-4S Star coupler permits the connection of 2 RTSX master modules for redundant topologies.

The communication channels are via optical fibre with V_LINK type connectors. It supports up to 10Mbit/s.

Each channel incorporates a status indication LED.

References	Specific Characteristics
IC3221	Router RTSX 1M-4S
IC3222B	Router RTSX 2M-4S
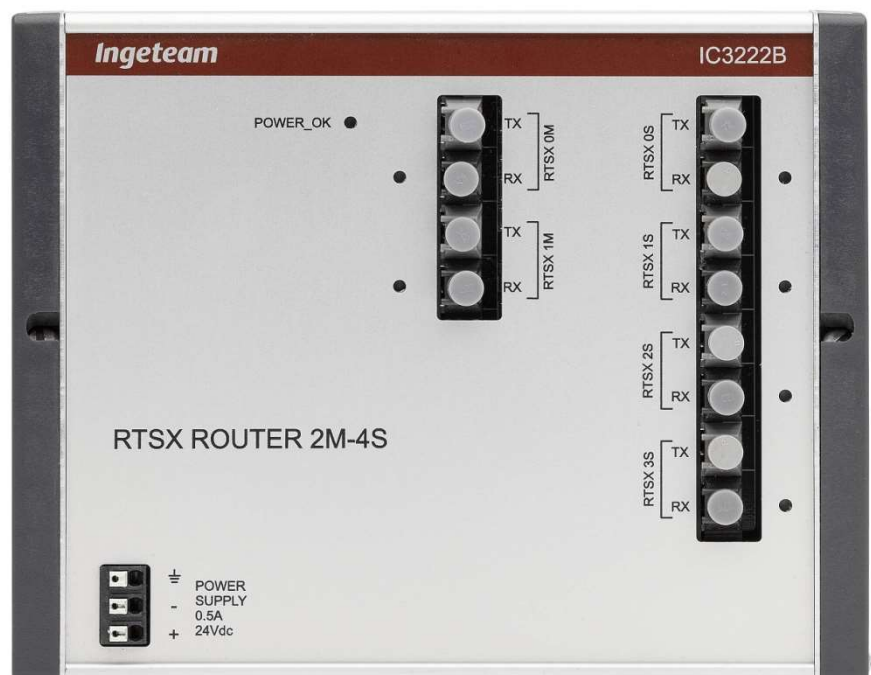
	IC3221	IC3222B
Functional		
Configuration	1 *INGESYS™ TCMS* controller accessing 4 remote I/Os racks	Up to 2 *INGESYS™ TCMS* controllers accessing 4 remote I/Os racks
Max. Transmission speed	10Mbit/s	
Max. Installation distance per section	50m for POFs, 200m for HCS	
Diagnosis LEDs per channel	Yes	
Hot swap	Yes	
Electrical		
Average power consumption	3,5Watts	
Power supply voltage (rated)	18-30Vdc	
Mechanical		
Dimensions (WxHxD)	125mm x 161mm x 40mm	
Weight	189g	
Mounting	DIN rail	
Climatic		
Operating Temperature	Class TX:-40ºC to + 70ºC	
Storage Temperature	-40ºC to + 85ºC	
Relative Humidity	5% to 95% w/o condensing	

2.6.2 CAN expansion bus

2.6.2.1 Header modules

IC3205 CAN header modules enable the access of the main controller processor to remote I/O racks via CAN bus.

Remote I/O racks are used in application with a larger number of inputs/outputs than those permitted by a local rack or when decentralised input/output modules throughout an installation are required.

IC3205 header modules behave as a gateway between the main controller processor, master of the CANopen bus and slaves situated in the remote I/O racks. Hence, the header modules act as a CANopen slave in the system and in turn as a TSX local bus master in the expansion rack.

References	Specific Characteristics
IC3205A	CAN header module up to 8 TSX slaves modules without power supply

	IC3205A
Functional	
Communication Protocol	CAN (CANopen)
Number of ports	1 with two plug connectors
Connection type	D-Sub9 (male/female)
Available Transmission speed	125kbit/s , 250kbit/s , 500kbit/s , 1Mbit/s
Node Id	1 to 16
Diagnosis LEDs	Yes
Hot Swap	Yes
Electrical	
Max. Number of TSX slaves	8
Built in rack power supply	No
Current Consumption 3,3V	630mA (max.) / 880mA (typ.)
Current Consumption 5,0V	50mA (max.) / 150mA (typ.)
Mechanical	
Dimensions (WxHxD)	52mm x 175mm x 130,41mm
Weight	450g
Slot width	2 slot. IC3 / TSX
Climatic	
Operating Temperature	Class TX:-40ºC to + 70ºC
Storage Temperature	-40ºC to + 85ºC
Relative Humidity	5% to 95% w/o condensing

3   Redundant architectures

INGESYS™ TCMS offers an adequate response to high availability demands integrating different redundant functionalities and topologies. The control engineer has the possibility to adjust the system to the different availability demands.

Highest availability is achieved with Hot-standby redundant processors, redundant power supplies, I/Os and communication buses. Integrated monitoring mechanisms enable the detection of a redundant element failure triggering a bumpless changeover, with no impact on the progress of the vehicle.

For less demanding availability applications, Warm-standby redundancy could be used. Integrated monitoring mechanisms enable the detection of a redundant element failure, triggering a controlled changeover with a temporary shutdown of the system.

The *INGESYS™ TCMS* redundancy can involve the following elements:

- Processor redundancy
- Different redundant I/O topologies are available:
    - Shared I/O redundant topology.
    - Duplicated I/O redundant topology.
- Ethernet and field bus communication redundancy
- Power supply redundancy: Up to two powers supply modules can operate in parallel in an N+1 configuration.
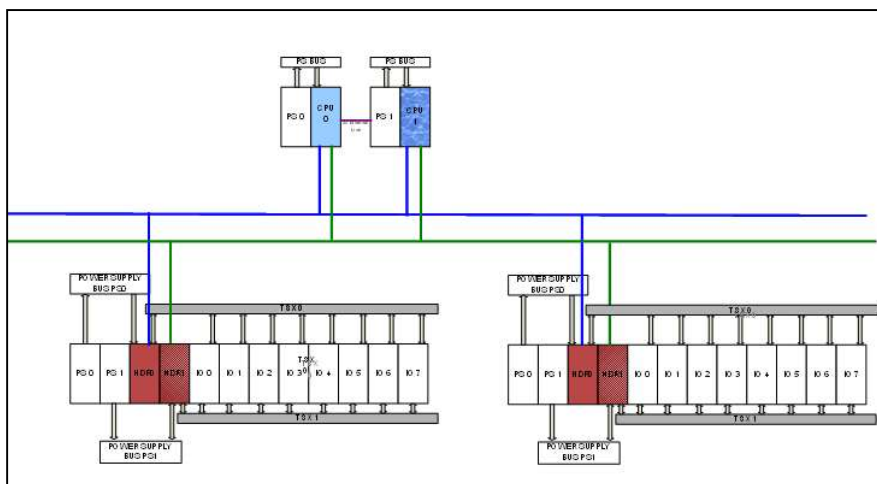

Fig. 3.1   *INGESYS™ TCMS* general redundancy diagram.

4   Model based design : *MATLAB*®/*SIMULINK*®

INGESYS™ TCMS enables the control engineer to develop control strategies using *MATLAB*®/*SIMULINK*® facilitating at the same time the certification of the generated code and allowing a full model based design development.

The whole code generation cycle is considered:

Control strategy development:

* Controller Design Process is based on *SIMULINK*® Blocks

* Easy and fast integration of powerful *SIMULINK*® Block Libraries

* Control Model can be verified offline on the Computer

Code generation:

* Automatic code generation for the *INGESYS™ TCMS* Controller

* Direct download to the *INGESYS™ TCMS* Controller

Online Tuning and Testing:

Code running on the controller can be online tuned and tested using the *External Mode* operation:

* Process variables can be directly available on the Scopes of the Simulink® model

* Variable and Parameter changes can be forced on the *INGESYS™ TCMS* using *SIMULINK*® model or *MATLAB*® Environment

Model Parameter Management:

Once the model has been compiled or downloaded, it is possible to modify the model behaviour modifying its parameters:

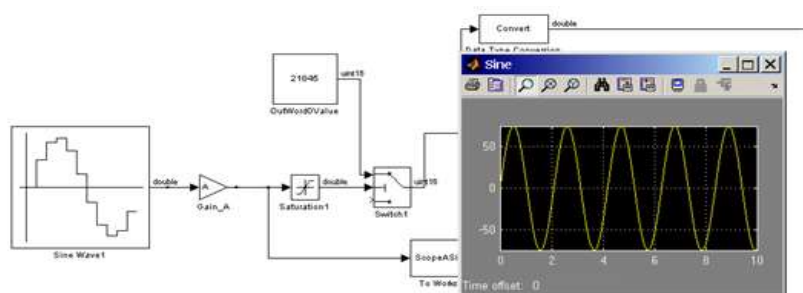* Modifying the model related parameter file (.mat file)

* By user program

Fig. 4.1   *INGESYS™ TCMS* Simulink® model example.

5   Monitoring features

INGESYS™ TCMS integrates a set of features oriented to the system monitoring and diagnosis tasks:

Integrated Web Server:

- Panel Designers Tool

- Active Alarms, Historical Alarms, Variables and Parameters management
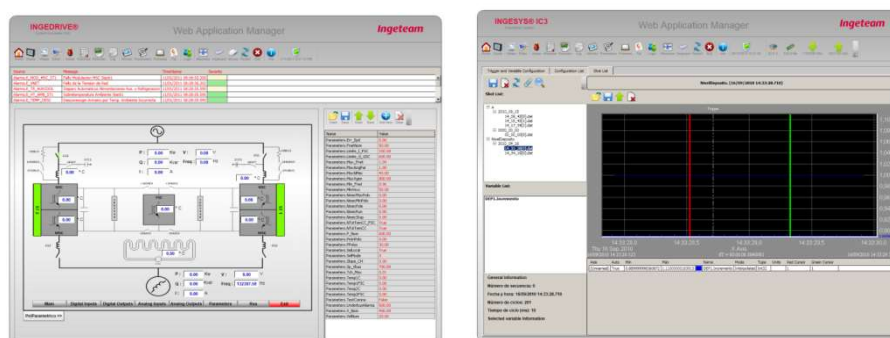
- FTP Client

- Integrated Recorder Module

Fig. 5.1   *INGESYS™ TCMS* web server panel viewer and recorder example.

Monitoring:

- Logging functionalities

- Analyzes machinery behavior

- Watches characteristic values keep below their threshold

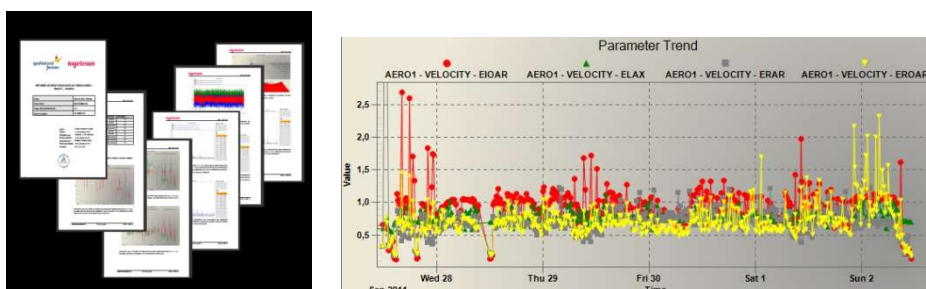- Supports Maintenance optimum plans

- Prevents unexpected breakage

Fig. 5.2   *INGESYS™ TCMS* logging and monitoring functionalities.

6   Standards and certifications

INGESYS™ TCMS is EN50155 compliant, ensuring reliable operation in the toughest environment conditions.

The fulfilment of exhaustive tests guarantees its electromagnetic, climatic and mechanical resistance to extreme environment conditions.

Electromagnetic compatibility (EMC) is guaranteed by a robust design based on INGETEAM´s experience in the design of embedded control systems for the industrial and railway automation.

Exhaustive climatic tests according to international standards guarantee a reliable operation from – 40ºC to 70ºC (EN50155 TX range). Long term operation is guaranteed by exposing units to more severe than nominal thermal conditions that simulate a longer testing period (HALT - Highly Accelerated Life Test). A robust mechanical design guarantees a reliable operation under demanding vibration conditions.

EN 50155 STANDARD CERTIFIED

	Test	Type	Routine	Clause
1	Visual inspection	✓	*	12.2.1
2	Performance test	✓	*	12.2.2
3	Cooling test	✓	-	12.2.3
4	Dry heat test	✓	-	12.2.4
5	Damp heat test, cyclic	✓	-	12.2.5
6	Supply overvoltages	✓	-	12.2.6
7	Surges, electrostatic discharge and transient burst susceptibility tests	✓	-	12.2.7
8	Radio interference test	✓	-	12.2.8
9	Insulation test	✓	*	12.2.9
10	Salt mist test	✓	-	12.2.10
11	Vibration, shock and bump test	✓	-	12.2.11
12	Watertightness test	✓	-	12.2.12
13	Equipment stress screening	✓	-	12.2.13
14	Low temperature storage test	✓	-	12.2.14
NOTE 1	The execution of tests marked "*" is mandatory.			
NOTE 2	The execution of tests marked "-" is subject to contract agreement between the user and the manufacturer.			
NOTE 3	For the purpose of these tests ambient temperature shall be defined as 25 °C ± 10 °C.			

Fig. 6.1   *INGESYS™ TCMS* certified EN 50155 STANDARD tests.

6.1 Electromagnetic compatibility

INGESYS™ TCMS complies with European directive 2004/108/CE on electromagnetic compatibility (EMC) as well as EN50155 Railway Standard.

The following table shows the approved standards tests and the levels applied:

Test	Standard Applied	Test Level
Power Supply Immunity Tests	EN 50155:2007	Class S2
Electric shock Immunity tests	EN 61000-4-2 EN 50121-3-2:2007	Shock on contact: ±6kV Shock in the air: ±8kV
Radio-frequency, radiated, electromagnetic field immunity tests	EN 61000-4-3 EN 50121-3-2:2007	20V/m / 80Mhz – 1Ghz 10V/m / 1,4GHz – 2,1GHz 5V/m / 2,1GHz – 2,5GHz
Rapid transient bursts immunity tests	EN 61000-4-4 EN 50121-3-2:2007	±2kV (signal) ±2kV (DC power supply)
Shock wave immunity tests	EN 61000-4-5 EN 50121-3-2:2007	±2kV line to earth ±1kV line to line
Immunity against conducted disturbances induced by radio-frequency fields	EN 61000-4-6 EN 50121-3-2:2007	10Vrms
Radiated emission measurement	CISPR 16-2-3 EN 50121-3-2:2007	50dB (µV/m) between 30MHz and 230MHz, 57dB (µV/m) between 230MHz and 1000MHz
Conducted emission measurement	CISPR 16-2-3 EN 50121-3-2:2007	99dB (µV/m) between 0,15MHz and 0,5MHz, 93dB (µV/m) between 0,5MHz and 30MHz
Insulation Test	EN 50155:2007	Insulation resistance: 500Vdc Dielectric Strength: 500Vac / 710Vdc

Tbl. 6.1   Summary of EMC tests.

6.2 Climatic conditions

The *INGESYS™ TCMS* environmental limits are described in the following table:

Climatic Conditions	
Temperature Range	-40ºC to +70ºC (EN50155:2007 TX)
Relative Humidity Range	30% to 90%

Tbl. 6.2   Climatic Environment Conditions.

6.3 Vibrations

INGESYS™ TCMS has exceeded the following vibration and shock tests according to EN50155 to guarantee its reliable operation:

Vibrations Test		
Constant frequency	Frequency Severity Duration	15Hz 28,9m/s^2 4,5hours on each axis (x,y,z)
Frequency scan	Range Severity Duration	From 3Hz to 100Hz See Frequency Scan Test 4,5hours on each axis (x,y,z)

Tbl. 6.3   Vibrations Test.

Shocks Test	
Shock type	1/2 sinusoidal wave cycle
Acceleration peak/pulse duration	15g / 11ms
Number of pulses	3 successive pulses in each direction (+ & -) and per axis (x,y,z) = 3x2x3 = 18 pulses

Tbl. 6.4   Shocks Test.

Frequency Scan Test									
Frequency (Hz)	5	11	18	20	30	32	50	60	100
Ax, Ay, Az (m/s^2)	2	11	11	20	20	14	14	10	10

Tbl. 6.5   Frequency Scan Test.

INGESYS™ TCMS has also been designed to conform to the following vibration tests as stated in EN50155 (IEC 61373:2010):

Vibrations Test		
Random vibration tests	Frequency Duration Severity ASD Level ((m/s^2)^2/Hz) RMS Value (m/s^2)	5 to 150Hz 10min on each axis (x,y,z) Vertical 0,0301 Transversal 0,0144 Longitudinal 0,0144 Vertical 1,01 Transversal 0,700 Longitudinal 0,700
Simulated long-life testing	Frequency Duration Severity ASD Level ((m/s^2)^2/Hz) RMS Value (m/s$^{2)}$)	5 to 150Hz 5h on each axis (x,y,z) Vertical 0,964 Transversal 0,461 Longitudinal 0,461 Vertical 5,72 Transversal 3,96 Longitudinal 3,96
Shock tests	Waveform Number of pulses Severity Peak Accel (m/s^2) Duration (ms)	Half-sine pulses 3 positive and 3 negative successive pulses in each axis 50 30

Tbl. 6.6   Vibrations Test as stated in EN50155 (IEC 61373:2010).

6.4 Storage and transport conditions

The "Storage and Transport Conditions" table below, details the conditions for storing and transporting *INGESYS™ TCMS* modules in their original packaging:

Storage and Transport Conditions	
Vibrations	See Mechanical Environment Conditions
Shocks	See Mechanical Environment Conditions
Temperature Range	-40ºC to +90ºC
Relative Humidity Range	10% to 95%

Tbl. 6.7   Storage and Transport Conditions.

One of the primary goals of Ingeteam Power Technology is the continuous improvement of its equipment; consequently, the information contained in this catalogue may be modified without previous notice.

For further information, please refer to the manual or contact us.

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