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# Protocol for Testing of Communications RS-485 with auxiliaries



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## 1. DOCUMENT VERSION CONTROL

### 1.1. Document version record

Version	Reason for revision	Expiry
01	Document creation	08/01/2009
02	Document coding change	08/01/2009
03	<ul style="list-style-type: none"> <li>- RS485 Analyzer test removed.</li> <li>- Steps 2 and 3 results log modified</li> </ul>	09/11/2009

### 1.2. Distribution list

Name	Position	Company	Expiry
	OT-Systems	CAF	



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## 2. LIST OF ABBREVIATIONS AND DEFINITIONS

CAF	Construcciones y Auxiliar de Ferrocarriles, S.A.
COSMOS	CAF's Modular Train Control and Monitoring System
EMD	Electrical Middle Distance
MVB	Multifunction Vehicle Bus
PD	Process Data
TCN	Train Communication Network

## 3. REFERENCES

- [Ref. 1] IEC61375-1 Electric railway equipment – Train bus  
Part 1: Train Communication Network
- [Ref. 2] 27000003: Protocol for RS-485 communications with auxiliaries

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## 4. INTRODUCTION

The purpose of this document is to define the procedure of basic tests on communication between the COSMOS system and the devices used by the RS485 bus.

Each externally supplied device shall be tested separately on a platform made up of various COSMOS devices. This procedure shall be used to check the quality of the communications between COSMOS and the RS485 device under testing and the interpretation of the data and bit-offsets between both items.

Only the RS485 sections shall be considered for these tests.



The tests specified in this document shall be carried out at TRAJNTIC premises. Before these tests are performed the supplier shall have internally checked the correct operation of their equipment regarding RS485 communications, and will have filled out the data sheet of this document, in a preliminary manner, in accordance with step 0 of the procedure.

For correct communication between the various auxiliary systems and the train control and monitoring system a series of communication parameters and characteristics must be established such as transmission speed, parity bits, etc.

For greater detail of the communications and of the structure of the train consult the Traintic document [Ref. 2]

## 5. SCOPE

This document is applicable to all the RS485 buses that connect the train control and monitoring system with the different auxiliary equipment. Therefore, it is applicable to all the equipment connected to these buses, both to the modules or central units of the train control and monitoring system, which operate as bus master controllers, as well as all the equipment that is to be connected to these buses, and which act as slaves in the communication.

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## 6. TEST PLATFORM AND EXTERNAL DEVICES



TRAIINTIC shall prepare a testing platform consisting of at least the following items:

- A control unit that shall also include the PcMonitor function.
- A control unit in which the MVBCHECKER software is run.
- An input and output module to use as an RS485 gateway.
- All the cables and MVB line terminators required to interconnect the platform equipment, as well as the cables required to connect the equipment requiring RS485. The **RS485** cables shall end with **standard male banana** connectors.
- Supply with the voltage used in the project for all devices.
- The SW and HW tools required to generate the various test cases and to internally check the results in the COSMOS devices and at the MVB bus level.
- The testing data sheet filled out in a preliminary manner according to that agreed to between CAF, Traintic and the supplier of the equipment under testing, according to step 0 of this document.
- Auxiliary equipment which responds to the master frames to all the equipment making up the RS485 bus except for those of the equipment being tested.

The supplier of the equipment being tested must provide at least the following:



- A unit of each device model to be tested.
- The SW and HW tools required to generate the various test cases and to internally check the results in its devices.
- Supply connectors or other special connectors required to supply communicate its equipment with the exterior (the **supply** connectors must be **standard male banana connectors** and the **RS\$(% connectors must be standard male or female banana connectors)**).
- Should the equipment be supplied at a voltage different to that of the network (220 V AC) or that which can be supplied by the current project bench source, the supplier must take the appropriate measures to supply their equipment.
- The software tools (integrated in the equipment itself or supported with a connected PC) required to display the information received and **interpreted** by the equipment. This implies that the equipment being tested must have the data **interpretation logic** activated and not only a display system. For example: The date value must not be displayed in a Hexadecimal form.
- Schematic of the connection of the RS485 connector.

CAF shall provide the configuration of the MVB bus and the RS485 bus (ports, variables, directions, meaning of the various bits in a bitset, etc.) and the configuration files of the bus itself required in the tests. The files to be provided are as follows:

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- CStools CDB and CPF files with all the configuration relating to the equipment being tested.
- Configuration sheet with the frames of messages and variables of RS485.
- .mdb file for the configuration of input and output modules with RS485 and check variables implemented.
- Application of the CCU with monitoring function activated (for PCMonitor use).
- Administrator configuration file.
- mvb.xml file adapted if necessary to monitor the information regarding the tests.

**IMPORTANT NOTE:** During the tests the definitive logic of the MVB communications shall not be applicable. This means that not all the bus variables have to be published, only those involved in the communications tests. Nor shall there be control over the “lifebit” type variables, counters, etc. This means that they shall remain with set values or they shall be modified punctually whereby dependence on a constant change of these variables can lead to unsuccessful testing.

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## 7. TEST PROCEDURE

The general testing procedure is defined in this section.

### 7.1. Starting requirements

The equipment being tested must certify that the RS-485 communications, of its devices, have been tested. The specifications of standard TCN [Ref. 1] shall be followed for the offsets of each variable, and within each bitset (Example APPENDIX 1).

STEP 0: Fill in the testing protocol in a preliminary manner.

- 0.1. An agreement must be reached between the supplier, CAF and TRRAINTIC regarding the set of variables and values to be tested during the tests, in accordance with the train bus configuration.
- 0.2. Fill in the testing protocol in a preliminary manner, with the set of agreed variables and values.



Note: During the tests different values or sets of variables to be tested can be decided, depending on the needs arising.

### 7.2. MVB Configuration

#### PHYSICAL ADDRESSES OF THE DEVICES (DEVICE ADDRESSES):

- COSMOS.CU04: ADD(0x) Control and Administrator Unit of MVB bus (Traintic). It's address shall be determined in the configuration of the bus. It shall also include the monitor function (using PcMonitor) to monitor and force the data, in accordance with the bus configuration.
- COSMOS.CU2: 0xFFE Train Control Unit (Traintic), to analyse the quality of the communications (using MVBCHECKER). This analyses the frames that reach it but does not generate any.



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### 7.3. RS485 Configuration



#### DEVICE ADDRESSES:

- COSMOS.IO1: ADD(0x)      Input and output module used as 485 gateway. This administrates the RS485 communications. It's MVB and RS485 address shall be determined in the configuration of the bus.
- EQU: ADD(0x)      Equipment analysed. RS485 address in accordance with the bus configuration.
- COSMOS.IO1\_AUX: ADD(0x)      Auxiliary unit responsible for responding to the master frames to other equipment making up the RS485 bus.

#### PERIODIC FRAMES CONFIGURATION

The frames used in the tests shall form part of the configuration of the buses, whereby the test does not required any additional configurations to those already established for the equipment in question.

The values of the variables shall form at least two sets of values for all the frames, whereby the correct operation shall be checked more than once.

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## 7.4. Communication quality

A COSMOS unit installed with the MVBCHECKER shall be used as a tool to measure the communication quality.

Knowing the test configuration, MVBCHECKER can monitor the check variables related to the RS485 frames, and a zero value of the check shall mean a loss of the slave frame of RS485. The tests last 10 minutes.

To perform the next step the device to be tested (which will have been configured beforehand with the test configuration) is connected to the RS485 bus, together with an auxiliary unit which responds for the equipment not existing at the time of the test (providing there is more than one slave unit on the bus). The communication quality is measured.



The purpose is, on the one hand, to check the CRCs of the equipment being tested, and, on the other hand, to check the CRCs and the replies of the other frames making up the bus traffic and to check that the equipment being tested does not interfere with the rest of the bus frames.

**STEP 1:** Check the communication on the platform with the external device.

Therefore, the steps to be followed are as follows:

- 1.1. Set the equipment to be tested and connect it to the RS485 bus according to Appendix 2.
- 1.2. Set the slave unit that responds to the frames of non existing equipment in the test and connect it to the bus.
- 1.3. Supply the whole platform.
- 1.4. Measure the communication quality over a period of 10 minutes considering the check variables of the RS485 slave frames generated by the analysed equipment via the COSMOS.IO1 module.
- 1.5. Fill in the results data sheet, with the results obtained.

The result of this test shall be satisfactory only if ZERO incorrect frames are detected during the testing period.

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## 7.5. Content of the transmitted data

Once the communication quality has been checked the content of the data transmitted in both directions shall be displayed.

Each device must be prepared for:



1. Displaying on a display or PC the data received from the COSMOS module via RS485 ("Sink Ports").
2. Modifying the content of the data to be transmitted via RS485 ("Source Ports").

**STEP 2:** Modification of the content of the variables in the device being tested, according to the agreed sets of data, and verification of the new values in the destination devices.

- 2.1. Load the equipment being tested (EQU) with all data for ports or frames originated in this equipment with a zero value (or other value by defect if this is not possible).
- 2.2 Using a PcMonitor to check that all the variables appear on the bus with the expected value.
- 2.3 Change the values of the equipment being tested to the following group of agreed values.
- 2.4 Using a PcMonitor to check that all the variables appear on the bus with the expected value.
- 2.5 Repeat step 2.3 with the following set of values.
- 2.6 Using a PcMonitor to check that all the variables appear on the bus with the expected value.
- 2.7. Once the sets of values are completed, fill in the data sheet with the obtained results.

**STEP 3:** Modify the content of the variables in the COSMOS module and check that the equipment being tested receives the expected values. This step shall only be necessary when data is transmitted in RS485 within the master frames of the COSMOS-IO.01 module. The data interpretation logic must be enabled according to the variable type.

- 3.1. Disenable the COSMOS.CU04 equipment logic and modify the source variables of the COSMOS.CU04 equipment with ZERO value by means of PcMonitor. These variables shall be published by the COSMOS-IO.01 in RS485 within the master frames.
- 3.2 Check that the equipment being tested received all the ports with the correct content.
- 3.3 Modify the values of the variables sent by COSMOS to the following set of expected values by means of PcMonitor.



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3.4 Check that the equipment being tested receives the same variables values as those sent and that these are interpreted the same at the destination and source. With the BITSET type variables pay special attention to the interpretation of the bits sent and received.

3.5 Repeat step 3.3 with the following set of variables.

3.6 Check that the equipment being tested receives the ports or frames, reads the same values of the variables and interprets the same as the COSMOS equipment.

3.7. Once the sets of values are completed, fill in the data sheet with the obtained results.

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## 7.6. Results report.

Upon completion of the tests TRAINTIC shall generate a results report that must contain at least the following information:

1. Detailed testing procedure
2. The filled out data sheets with the results obtained and the observations considered appropriate.
3. The signatures of the officers in charge of the tests.



STEP 4: Prepare the results report and sign it.

4.1 Make a copy of this document.

4.2. Fill in the data sheets generated by the supplier with the test results.

4.3. Make three copies of the signed report, one for TRAINTIC, another for CAF and the other for the supplier of the equipment being tested.

Note: Should any of the indicated representatives not attend the tests, a copy shall be sent by fax to be signed and this must be returned to be forwarded to the other participants.

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## APPENDIX 1: RESULTS DATA SHEET

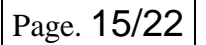
### STEP 0

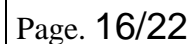
Fill in ports, variables and values previously agreed.

### STEP 1 RS-485 communication quality check

Variable Check Name of each RS485 frame	Passing zero of the check variables in 10 minutes	
Result-Step 1	OK	Not OK
	<input type="checkbox"/>	<input type="checkbox"/>

### COMMENTS-STEP1

[illegible]



Result-Step 2 (MVB)	OK	Not OK
	<input type="checkbox"/>	<input type="checkbox"/>



## An abstract graphic design featuring several organic, flowing shapes in shades of light blue and lavender. The shapes are positioned in the lower right quadrant of the frame, with one large, rounded form at the bottom right and several smaller, more elongated shapes above and to the left of it. The overall aesthetic is clean and modern, with a focus on soft, pastel colors.



[illegible]

### STEP 3 (Forcing of variables of the unit being tested)

VARIABLE NAME	INTERPRETATION OF THE VALUE RECEIVED AT DESTINATION	
	OK	NOK
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
Result-Step 3	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>
Comments step 3		

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## STEP 4<sup>1</sup>

### Description of the equipment being tested

Auxiliary equipment the test is performed on	
HW version of the equipment	
SW version of the equipment	

### Test Execution

Number of tests performed	
Number of tests performed successfully	
<b>Need to perform new tests</b>	YES <input type="checkbox"/> NO <input type="checkbox"/>



### Remarks

--

### OFFICERS IN CHARGE (PRESENT AT THE TESTS)

TRAIANTIC APPROVAL	EQUIPMENT COMPANY APPROVAL	CUSTOMER APPROVAL
Name:	Name:	Name:
Signed	Signed	Signed
Date:	Date:	Date:

<sup>1</sup> Complementation of step 5 replaces the use of the GDP-06 model of the quality management system where the same information is requested from the suppliers, whereby the complementation of both models is not necessary.

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## APPENDIX 1: EXAMPLE PORTS, VARIABLES AND OFFSETS

The ports or frames must be interpreted as a succession of bits, i.e. in a port of n bits, the first shall be bit 0 and this shall be located to the left. The last shall be bit n-1 and shall be located to the right.

B0	B1	B2	B3				...				Bn-2	Bn-1
----	----	----	----	--	--	--	-----	--	--	--	------	------

**Offset:** Number of bits the value on the left must be moved so that the bit referred to is the highest bit.

In short, the offset of a variable shall be its position within the port, counting the number of bits from the left. It must be taken into account that the first bit is bit 0 (offset = 0).

### Examples:

V1(BOOLEAN1), offset = 8

B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	...
								V1					
								0					
								Value = 1					
								1					

V2(UNSIGNED8), offset = 8

B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	...
								V2									
								7	6	5	4	3	2	1	0		
								Value = 134									
								1	0	0	0	0	1	1	0		

V3(BITSET16), offset = 0

B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	...
V3																	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Value = {bit0=1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, bit15=0}																	
1	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0		

V4(ANTIVALENT2), offset = 8

B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	...
								V4					
								0	1				
								Value = 1					
								1	0				

## APPENDIX 2: RS485 CONNECTION

Two braided and screened copper wires shall be used as the physical transmission medium.  
The connector pinning for RS 485 is as follows:

	PIN	CONECTOR RS-485 o RS422 : D-SUB9 MACHO
	1	A: RS485 +; Para RS422 (Recepción +)
	2	B: RS485 -; Para RS422 (Recepción -)
	3	GND
	4	Y: RS485 +; Para RS422 Transmisión +
	5	Z: RS485 -; Para RS422 Transmisión -
	6	TERM.A: En el terminador conectar con A (Pin 4)
	7	TERM.B: En el terminador conectar con B (Pin 5)
	8	GND
	9	Sin conectar

Should the equipment be a line terminator, bridges shall be made between pins 4 and 6, 5 and 7.