Testing Specification
CAN-COSMOS Communication with auxiliaries

traintic

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TABLE OF CONTENTS

1. DOCUMENT VERSION CONTROL

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2. LIST OF ABBREVIATIONS AND DEFINITIONS

COSMOS	Traintic's Modular Train Control and Monitoring System
MVB	Multifunction Vehicle Bus
TCN	Train Communication Network
CAN	Controller Area Network

3. REFERENCES

[Ref. 1] IEC61375-1 Electric railway equipment – Train bus
Part 1: Train Communication Network

[Ref. 2] 27000002 (CS.V3.3001): CAN-COSMOS Communications Specification

4. INTRODUCTION

The purpose of this document is to define the procedure of basic tests on communication between the COSMOS_MIM system and the devices used by the CAN bus as a gateway to said system.

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

These tests will only consider the frames transmitted via the CAN bus, according to the communications specification established in [Ref. 2].

The tests specified in this document shall be carried out at TRAINTIC premises. Before these tests are performed the supplier shall have internally checked the correct operation of their equipment regarding CAN-COSMOS 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, etc.

For greater detail of the CAN bus and communications specification consult the document [Ref. 2].

5. SCOPE

This document is applicable to all the CAN 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.

6. TEST PLATFORM AND EXTERNAL DEVICES

TRAINTIC 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 a CAN 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 CAN. The CAN 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 the end customer, 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 CAN 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 **CAN 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 CAN connector/connectors.

The end customer shall provide the configuration of the MVB bus and the CAN bus (equipment identifiers, frame identifiers, ports, variables, 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:

- CSTools CPF and CDB files with all the MVB and CAN settings relating to the equipment being tested (the configuration sheet can also be requested with the CAN variables and messages frames).
- 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 the set values 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.

7. TEST PROCEDURE

The general testing procedure is defined in this section.

7.1. Starting requirements

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

These tests will only consider the sections transmitted via the CAN bus, according to the communications specification established in [Ref. 2].

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

0.1. An agreement must be reached between the supplier, the end customer and TRAINTIC 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 bus 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.

7.3. CAN-COSMOS bus configuration

DEVICE ADDRESSES:

- COSMOS.IO1: ADD(0x) — Input and output module used as CAN to MVB gateway. This administrates the CAN-COSMOS communications. Its CAN address (node identifier) and MVB address will be determined in the bus configuration.
- EQU: ADD(0x) — Equipment analysed. CAN address (node identifier) 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 CAN bus. This device will have various associated CAN addresses.

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.

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, the MVBCHECKER can monitor the check variables related to the CAN frames, and a zero value of the check shall mean a loss of the slave frame of CAN. 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 CAN 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, one the one hand to check that the unit being tested responds appropriately to the master frames in the set time for this, and also, to check the responses of the other frame which make up the bus traffic and ensure that the unit being tested does not interfere with the other frames of the bus. As a result, a check is made to ensure there is no saturation in the configured CAN bus. A check is also made to ensure the correct interpretation of the CAN connector pins, validating the connection of the unit being tested.

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 CAN 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 CAN 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.

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 CAN ("Sink Ports").
2. Modifying the content of the data to be transmitted via CAN (“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).

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 CAN 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 CAN 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.

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.

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 the end customer 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.

APPENDIX 1: RESULTS DATA SHEET

STEP 0
Fill in ports, variables and values previously agreed.

STEP 1 CAN communication quality check		
Variable Check Name of each CAN frame	Passing zero of the check variables in 10 minutes	
Result-Step 1	OK	Not OK
	❑	❑
COMMENTS-STEP1		

STEP 2 (Monitoring variables of the unit being tested)		
VARIABLE NAME	INTERPRETATION OF THE VALUE RECEIVED AT DESTINATION	
	OK	NOK
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
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	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
Result-Step 2 (MVB)	OK	Not OK
	❑	❑
COMMENTS-STEP 2		

STEP 3 (Forcing of variables of the unit being tested)		
VARIABLE NAME	INTERPRETATION OF THE VALUE RECEIVED AT DESTINATION	
	OK	NOK
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
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	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑

STEP 3 (Forcing of variables of the unit being tested)		
VARIABLE NAME	INTERPRETATION OF THE VALUE RECEIVED AT DESTINATION	
	OK	NOK
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
	❑	❑
Result-Step 3	OK	Not OK
	❑	❑
Comments step 3		

STEP 4[1]				
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				
Need to perform new tests	YES		NO	
Comments				

OFFICERS IN CHARGE (PRESENT AT THE TESTS)		
TRAINTIC APPROVAL Name: Signed Date:	EQUIPMENT COMPANY APPROVAL Name: Signed Date:	CUSTOMER APPROVAL Name: Signed Date:

[1] 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.

APPENDIX 1: EXAMPLE PORTS, VARIABLES AND OFFSETS

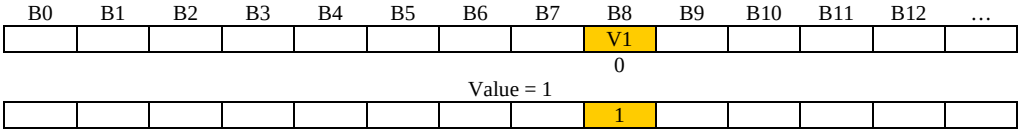
The ports or frames must be interpreted as a succession of bits, i.e. in a port of n bits, the first shall be bit 0 and this shall be located to the left. The last shall be bit n-1 and shall be located to the right.

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

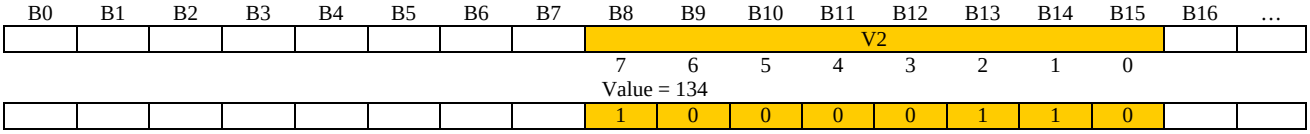
In short, the offset of a variable shall be its position within the port, counting the number of bits from the left. It must be taken into account that the first bit is bit 0 (offset = 0).

Examples:

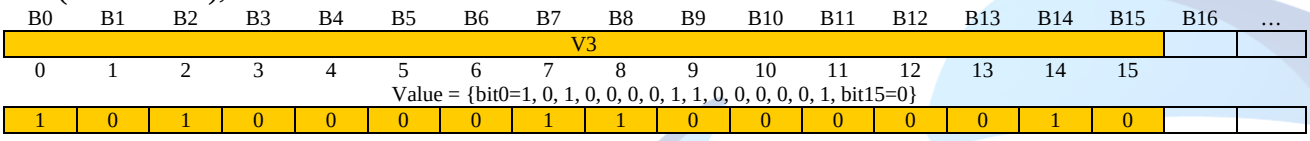
V1(BOOLEAN1), offset = 8



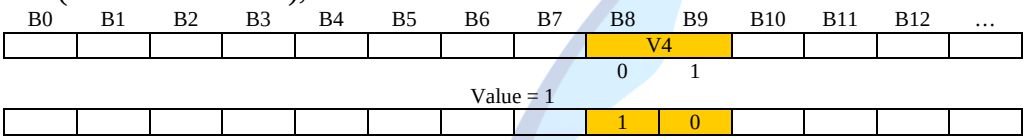
V2(UNSIGNED8), offset = 8



V3(BITSET16), offset = 0



V4(ANTIVALENT2), offset = 8



APPENDIX 2: CAN BUS PYSICAL LAYER

Two braided copper wires + 1 wire for CAN_GND shall be used as the physical transmission medium. The 3 wires will be screened, with the cable screen only connected to one of the units connected to the bus. The cable's AC impedance must be 120Ω.

The overhead SubD-9 connector pinout for CAN depends on whether the auxiliary unit has one or two CAN connectors.

Unit with a single CAN connector:

Pin	Signal	Description
1	TERM_LOW	On the terminator, connect with CAN_L (pin 4)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_GND	CAN ground
4	CAN_L	CAN_L bus line (dominant low)
5	CAN_SHLD	Optional CAN shield
6	CAN_GND	CAN ground
7	CAN_H	CAN_H bus line (dominant high)
8	TERM_HIGH	On the terminator, connect with CAN_H (pin 9)
9	CAN_H	CAN_H bus line (dominant high)

Figure 1: SubD-9 connector pinout on unit with 1 CAN connector

Should the equipment be a line terminator, bridges shall be made between pins 1 and 4, 8 and 9.

Unit with two CAN connectors:

Pin	Signal	Description
1	TERM_LOW	On the terminator, connect with CAN_L (pin 2)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_GND	CAN ground
4	-	Not connected
5	CAN_SHLD	Optional CAN shield
6	-	Not connected
7	CAN_H	CAN_H bus line (dominant high)
8	TERM_HIGH	On the terminator, connect with CAN_H (pin 7)
9	-	Not connected

Figure 2: Pinout connector SubD-9 on unit with 2 CAN connectors

Should the equipment be a line terminator, bridges shall be made between pins 1 and 2, 7 and 8 on one of the two connectors.