Protocol for Testing of Communications TCN MVB-EMD with auxiliaries

traintic

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1. ISSUE CONTROL

1.1. Issue Record

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1.2. Distribution list

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2. LIST OF ABBREVIATIONS AND DEFINITIONS

CAF	Construcciones y Auxiliar de Ferrocarriles, S.A.
COSMOS	Modular Train Control and Supervision System of CAF
EMD	Electrical Middle Distance
MVB	Multifunction Vehicle Bus
PD	Process Data
TCN	Train Communication Network
DSW	Device Status Word
HMI	Human Machine Interface

3. REFERENCES

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

[Ref. 2] Document 27000007: “Requirements related to TCN communication”

[Ref. 3] Document CAF *CS.GN.027*: “COSMOS. CFTP file transfer protocol”

4. INTRODUCTION

The purpose of this document is to define the basic test procedure for communication between the COSMOS system and the rest of the devices on the train that share the same communications bus (MVB-EMD), as is mentioned in section 10.1.1 of the document "TCN" [ref. 2].

Each externally supplied device shall be tested separately on a platform made up of various COSMOS devices. This procedure shall be used only to check the quality of the communication between COSMOS and the MVB device being tested and the downloading of files (for class 2 equipment) and the information published in the DSW.

These tests will only check Process Data (PD), Device Status (DS) and Message Data (MD) frames (MD only for class 2 nodes, following CFTP protocol defined in [Ref.3]).

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 TCN communications, and will have filled out the data sheet of this document, in a preliminary manner, in accordance with step 0 of the procedure.

All the points specified in the standard TCN, according to the class of the equipment under test (Class 1: PD +DS; Class 2: PD + DS + MD), shall be fulfilled in order to validate TCN communication.

5. TEST PLATFORM AND EXTERNAL DEVICES

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

- One control unit, let us call it CCU, where the pcMonitor software can be executed.
- A control unit in which the MVBCHECKER software and CDU is executed. We shall call this the CHECKER.
- A control unit where all the bus ports are published except for those published by the CCU, an IO control module and the equipment being tested. We shall call this TESTER.
- An input and output module of communications board to monitor the RLD.
- All the cables and terminators of the MVB line required to interconnect the platform and the equipment to be tested.
- Laboratory supply sources (110 VDC) for all devices with standard banana connectors.
- 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 shall be filled out and completed during the tests according to that agreed to between CAF, Traintic and the supplier of the equipment being tested, according to step 0 of this document.

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

- A unit of each device model to be tested, with the test logic implemented. All ports and variables that shall be used in the final logic of the CAF application must be included. It must ensure correct operation with the supervision requests regarding the DSW.
- 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 and communicate their equipment with the exterior.
- Should the equipment be supplied at a voltage different to that of the network (220 V VAC) or that which can be supplied by the test bench source (110VDC), the supplier must take the appropriate measures to supply their equipment.
- Items required to supply the equipment from banana type connectors.
- 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.

CAF shall provide the configuration of the MVB 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:

- CSTools CDB and CPF files with all the configuration relating to the equipment being tested. It must also be ensured that the Control Unit is Sink or Source of all the ports involved during the tests.

- XML file to be used with the MVBChecker, making the necessary adaptations to monitor the ports and variables required during the tests.
- MDB file to load in the input and output module.
- File with a list of the ports and variables applicable in the tests with their corresponding description (period, address, size, offset, type...).
- APP.elf file, compiled application with the option of activated monitoring (-DO_USE_MONITOR), all the ports and variables to be used during test execution. It must also:
    - Be ensured that the application has been compiled whereby the Control Unit is Sink or Source of all the ports involved during the tests.
    - Include the option of monitoring the DSW of the equipment being tested.
- ba_cfg.bin and ccu_cfg.bin files according to the CSTools configuration.
- TEST.elf file, compiled application with the activated monitoring option (-DO_USE_MONITOR) for publication of all the bus ports except for those of the CCU, IO control module and equipment being tested.

6. TEST PROCEDURE

The general testing procedure is defined in this section.

6.1. Starting requirements

The equipment being tested must meet that laid down in standard TCN [Ref. 1], regarding MVB-EMD communication. The supplier must certify that the MVB-EMD communication of their devices has been approved in accordance with clauses "*3.2.5.9 EMD transmitter specification*" and "*3.2.5.10 EMD receiver specification*" of [Ref. 1], and that this fulfils that specified in the "Requirements related to the TCN" document [ref. 2].

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

0.1. An agreement must be reached between the supplier, CAF 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.

6.2. MVB Configuration

PHYSICAL ADDRESSES OF THE DEVICES (DEVICE ADDRESSES):

- COSMOS.CU1: ADD(0xXXX) MVB bus Administrator and Control Unit with the train logic implemented and with the possibility of monitoring and forcing the data of the MVB bus (using PcMonitor), in accordance with the bus configuration. The 0xXXX address shall be that specified in the final configuration of the train. We shall refer to this device as CCU.

- COSMOS.CU2: ADD(0xNNN) 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. The 0xNNN address shall be an address that is not used in the final configuration of the train. We shall refer to this device as CHECKER.

- COSMOS.CU2 ADD(0xMMM) Train Control Unit (Traintic), that shall be used for the simulation of the traffic of the whole train upon

	publication of all the bus ports except for those of the CCU, IO control module and equipment being tested. The 0xMMM address shall be an address that is not used in the final configuration of the train. We shall refer to this device as TESTER or AntiCCU.
• COSMOS.IO1 ADD(0xZZZ)	Input and output module used to monitor the RLD, and as 485 gateway where this type of bus is necessary. The 0xZZZ address shall be that specified in the final configuration of the train.
• EQU: ADD(0x)	Equipment analysed. Address in accordance with the bus configuration. We shall refer to this device as EQU.

PROCESS DATA PORT CONFIGURATION

The ports 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 ports or frames, whereby the correct operation shall be checked more than once.

The values to be tested shall be filled in on the data sheet, in the indicated points.

The offsets of each variable, and within each bitset, shall be defined in accordance with TCN standard [Ref. 1] (Example APPENDIX 2).

The DSW bits monitored shall be those referring to the status of the lines. LAT(8) and RLD(9) bits.

6.3. Communication quality

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

With the test configuration known, MVBCHECKER can detect frames that are not transmitted by the analysed equipment. A frame shall considered to not have been transmitted if it is more than 0% is not received in its period. The tests last 10 minutes.

STEP 1 (MVB): Check the communication on the platform with the external device.

The steps to be followed are:

1.1. Load the test configuration in COSMOS CU1 (CCU), connect it by means of MVB cables (with the corresponding terminators).

1.2. Load the test configuration in TESTER, connect it by means of MVB.

1.3. Prepare the communications analysis tool, i.e. load the testing configuration (mvb.xml file) and MVBCHECKER in COSMOS.CU2 (CHECKER), and connect it to the bus by means of MVB cables.

1.4. Set the equipment to be tested and connect it to the MVB bus.

1.5. Supply the whole platform

1.6. Measure the communication quality over a period of 10 minutes considering the PD frames generated by the COSMOS.CU1 (CCU) equipment and the analysed equipment. The number of incorrect frames must be counted in these circumstances:

- Using both lines (Check that the LAT bit changes every 16 seconds and that the RLD is equal to 0 during the whole test). According to the switchover point. 3.3.2.4. of Ref [1].
- Cutting line A (Check that the LAT bit is equal to 0 and that the RLD bit is equal to 1 during the whole test).
- Cutting line B (Check that the LAT bit is equal to 1 and that the RLD bit is equal to 1 during the whole test)

1.7. 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, in each of the three tests. Also the LAT and RLD bits must have the indicated values according to each case.

6.4. Control of the answer of the testing device

After the test of the communication quality, we are going to test that the testing device answers only the frames that belongs to it. In other words, we are going to check that the device doesn´t publish frames of other devices connected to MVB bus.

We are going to use as a tool a Control Unit wich publish every frame of the bus except the frames that are published by the Control Unit of the train, IO module of control, HMI if exists and the device that we are testing. This device is called TESTER (we can use the same CCU that we use to do the CHECKER function, because after the communication quality test we don´t need this device any more)

STEP 2 (MVB): The RLD led state in the IO module of Control.

With the CCU, IO module, the testing device and the TESTER connected and working in the bench, we verify that the RLD led stays off (to 0) during the tests of “Content of the transmitted data.”

6.5. 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 MVB ("Sink Ports").
2. Modifying the content of the data to be transmitted via MVB or RS485 (“Source Ports”).

STEP 3 (MVB): 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 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 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 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 4 (MVB): Modify the content of the variables in the COSMOS module and check that the equipment being tested receives the expected values.

3.1. Turn off the COSMOS.CU1 (CCU) equipment and modify the source variables of the COSMOS.CU1 (CCU) equipment with ZERO value by means of pcMonitor.

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. With the same interpretation for bitset type variables, check that the same interpretation is made for both sent and received variables.

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.

STEP 5 (MVB)[1]: Downloading of file of a testing device by the CFTP protocol [Ref. 3].

5.1. Execute the application TIMON connected to HMI by ethernet.

5.2. The supplier must define the names of the files that we can download and the path.

5.3. Configure TIMON with the data of device: testing device MVB address, name of files and path of the files if necessary.

5.4. Connect TIMON for the download and visualization with the tool.

5.5. Fill the template with the results.

[1] This tests is for devices that implements de CFTP protocol for the transfer files with message data and for devices that the customers want to do this test.

6.6. Control of the State information

After checking the transmitted data and the correct interpretation in both directions, we are going to test that the device use properly the bits of Device Status Word.

The bits to analize are LAT (bit 8) and RLD (bit 9).

STEP 6 (MVB): LAT and RLD bits state of Device Status of the testing device.

6.1. Using both lines check in COSMOS.CU04 (CCU) that the bit RLD stay in 0.

6.2. Cutting the line A check in COSMOS.CU04 (CCU) that the bit LAT is 0 and bit RLD is 1.

6.3. Cutting the line B chek in COSMOS.CU04 (CCU) that the bit LAT is 1 and bit RLD is 1.

Note: *TCN [Ref. 1] standard, in point* ***3.3.2.4-(d)*** *specifies that* ***LAT*** *must change after answering the Device Status Request, this is mandatory for class 1 devices and a configurable option for the other classes.*

6.7. Communication Quality check in the HMI

If the device under the test is going to be installed in different coaches with different physical addresses (and with different logical addresses in its ports), it is necessary to test the communication of each one in the HMI.

That's why, the device under test should have the option to change the physical address of device, and the logical address of the ports of MVB bus.

STEP 7 (MVB): Communication Quality check in the HMI.

7.1 Check with the HMI in the "Devices" screen that every time that the address of the device is changed, this device appears as "OK".

6.8. 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 8: 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.

APPENDIX 1: RESULTS DATA SHEET

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

STEP 1 (MVB) (**)						
Name of port and logic address.	Number of frames lost in 10 minutes					
	Line A*		Line B*		Lines A+B	
	LAT	**RLD**	**LAT**	**RLD**	**LAT**	**RLD**
	OK		Not OK			
Result-Step 1 (MVB)	❑		❑			
COMMENTS-STEP1 (MVB)						

STEP 2		
RLD bit state during the test of data content after adding the TESTER device to the MVB.	led RLD	
	OK	No OK
	❑	❑
COMMENTS-STEP 2 (MVB)		

STEP 3 (MVB) (*)		
VARIABLE NAME	VALUE AND INTERPRETATION AT SOURCE	VALUE RECEIVED AND INTERPRETATION AT DESTINATION
INITIAL VALUES		
GROUP 1 VALUES		
GROUP 2 VALUES		
	OK	Not OK
Result-Step 3 (MVB)	❑	❑
COMMENTS-STEP3 (MVB)		

STEP 4 (MVB) (*)		
VARIABLE NAME	VALUE AND INTERPRETATION AT SOURCE	VALUE RECEIVED AND INTERPRETATION AT DESTINATION
INITIAL VALUES		
GROUP 1 VALUES		
GROUP 2 VALUES		
	OK	Not OK
Result-Step 4 (MVB)	❑	❑
COMMENTS-STEP4 (MVB)		

(*) Monitor the RLD constantly throughout the Test.

STEP 5 (*)		
NAME OF THE FILE	**PATH**	**INTERPRETATION OF DOWNLOADED FILE**
Result – Step 5 (MVB)	OK	No OK
	❑	❑
COMMENTS STEP 5		

(*) Optional test, this test is going to do if the customer wants to devices that have implemented the CFTP protocol as a requirement in the Project.

STEP 6						
STATE OF THE LINES (CUTS)						
	Line A		Line B		Lines A+B	
	LAT	**RLD**	**LAT**	**RLD**	**LAT**	**RLD**
Result-Step 6 (MVB)	OK		No OK			
	❑		❑			
COMMENTS-STEP 6 (MVB)						

STEP 7	
Name of configuration and physical address	**State of device in "Devices" screen**
	OK / No OK
Result-Step 7 (MVB)	❑ / ❑
COMMENTS-STEP 7 (MVB)	

STEP 8				
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	
Observations				

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

APPENDIX 2: EXAMPLE PORTS, VARIABLES AND OFFSETS

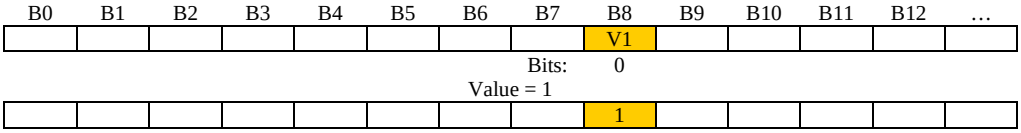
The ports must be interpreted as a succession of bits, i.e. in a port of n bits, the first shall be bit 0 and this shall be located to the left. The last shall be bit n-1 and shall be located to the right.

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

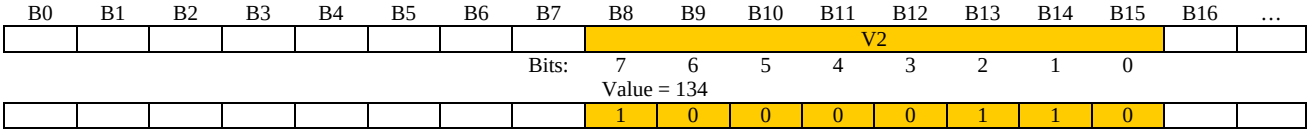
In short, the offset of a variable shall be its position within the port, counting the number of bits from the left. It must be taken into account that the first bit is bit 0 (offset = 0).

Examples:

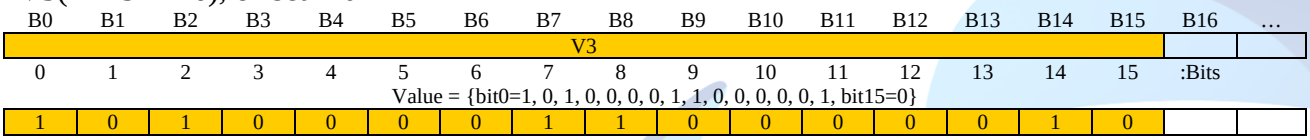
V1(BOOLEAN1), offset = 8



V2(UNSIGNED8), offset = 8



V3(BITSET16), offset = 0



V4(ANTIVALENT2), offset = 8