MODURBAN

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MODONBOARD SUBPROJECT

– DELIVERABLE REPORT –

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Deliverable Title:	Integration and validation plan and reports
Responsible partner:	ALSTOM
Contributors:	WP2 Partners

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Documents history

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V1-draft	2-12-08	Creation	ALSTOM
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The scope of the document applies to:

<table>
<tr><th rowspan="3">Metro systems only</th><th colspan="3">Metro and Light Rail</th><th rowspan="3">Light Rail only</th></tr>
<tr><th rowspan="2">With no differenciation</th><th colspan="2">With specific adaptation(s)/recommendation(s) (1)</th></tr>
<tr><th>For metro</th><th>For Light Rail</th></tr>
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(1) – Put a [D] if these adaptations/recommendations are present in the document and a [L] if they will have to be detailed later.

SECTION I – DELIVERABLE SUMMARY

D12 Intelligent driving prototyping	
Deliverable ID , associated WP & Subproject	D12: Integration and validation plan and reports MODONBOARD / WP2
Type of Deliverable	Specification
Input / Starting stage	
Output / Final stage	

Lead partner(s)	
Achievement to date (%)	
Expected date of achievement	
Type of exploitation	
Exploitation potential	
Protection	*Not Relevant*
Protection date	*Not Relevant*

IP's	***Partners, (type, identification, date)***
Pre-existing Know-How	
Exploitation Rights	

Associated Risk analysis	***Type, solution envisaged, action, actors***	***Actual Reduction***
Before start		
During task implementation		

D12: Intelligent driving prototyping

Deliverable Abstract

Objective of WP2 is to think about an intelligent driving to tackle with the problem of time varying train parameters, ageing of train and discrepancies on train parameters of a whole fleet. Intelligent driving will modify the train control in case the command is no more able to reach asked ATC performances.

Objective of D12 is to specify test of the electrical interface.

Associated Milestone (if relevant):

TABLE OF CONTENT

TABLE OF FIGURES

SECTION 2 – DELIVERABLE DETAILED DESCRIPTION

1. INTRODUCTION

Objectives of this document are to define the functional test of the intelligent driving Rapid Prototyping System .

1.1. Document Organisation:

This document is made of 5 clauses:

1 – Introduction: This clause addresses the objectives of the document.

2 – Electrical interface to be tested: This clause describes the electrical interface of the RPS.

3 – Tests: This clause describes the tests and their results

4 – Synthesis: This clause comprises the summary of the tests and the on site needs

1.2. Objectives:

This document forms is part of the Work Package 2 “Onboard Intelligent Driving” which objectives are, according to the [DOW] to define and develop an intelligent automatic driving for the ATO in order to tackle with the problem of time varying train parameters, ageing of trains and discrepancies between trains in a fleet.

1.3. Glossary

ATO	**Automatic Train Operation**
DC	**Direct Current**
FPGA	**Field Programmable Gate Array**
PC	**Personal Computer**
PWM	**Pulse Width Modulation**
RPS	**Rapid Prototyping System**
TTL	**Transistor-Transistor Logic**

2. Electrical interface to be tested

2.1. General information

Protections of the electrical interface are done by opto-coupler for the low power lines (odometer, analog output) and transil diodes (for the high power lines: braking/motoring commands) to avoid electrical loop.
We had breakers (25 A) to protect the relays from the 110 V from the train.

The test of the whole electrical interface takes place in 12th, September 2008.

2.2. Electrical interface description

2.2.1. Power Supply

For the electrical interface, two power supplies are used:

- a 24 V, 50 W linear DC power
- the 5 V from PC 104;

The 24 V is used to power the antennae and the relays.

2.2.2. Inputs

Two Inputs lines are defined for the odometer and Antenna signals.

2.2.2.1. Antenna signals

A 27 MHz, 32 bits frame has to be detected. The detection is done by a FPGA which rebuild a 6 µs gate. This gate is too fast for the real time software. We had derivated an external clock from the counter card to slow down the gate to a 3 ms signal, slow enough for the 1 kHz sample time of the software.

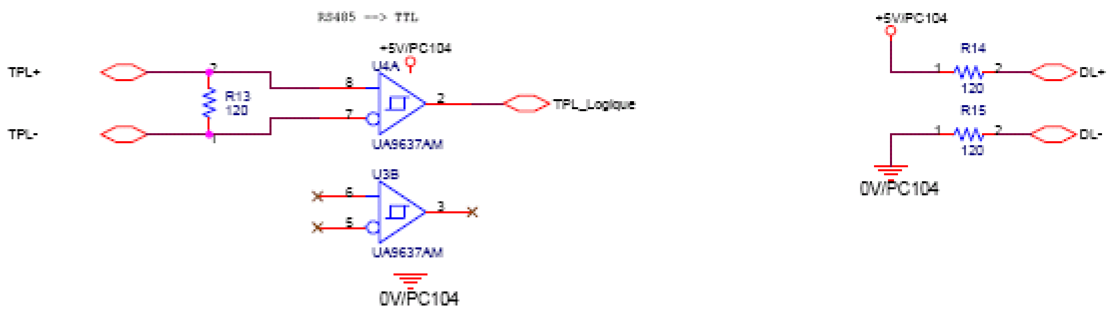

Figure 1. Diagram of the electronic of reception of the trig Balise and the Down Link

To validate the Eurobalise Trig the Down link pin of the Antennae plug is set to 5 V all the time long. The 5V is derivated from the PC 104 board.

The scheme of the wiring is the following:

2.2.2.2. Odometer signals

The odometer signals are transformed in a TTL format to be sent to the Counter/timer card.

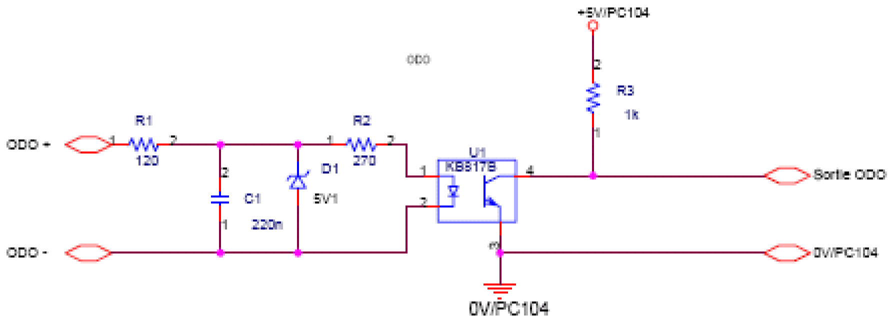

Figure 2. Scheme of the electrical interface for odometer reception

2.2.3. Outputs

The outputs could be divided between the logical relays lines and the analog output for electrical braking.

2.2.3.1. Relays output

The relays are commanded by the relays card. They are powered by the linear 24 V linear power and connected to the 110 V tracks from the train.

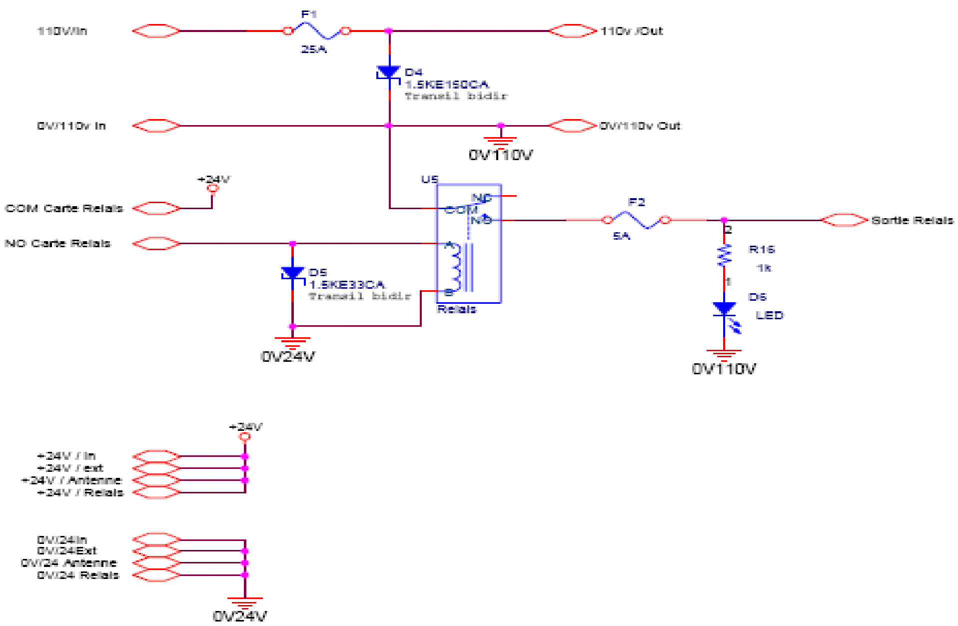

Figure 3. Electronic Scheme of the Relays output electrical interface

The Relays are normally Off and equipped with led lighten when they are closed and feed with 110 V DC power. They also can be manipulated manually. They are protected with transil and breaker.

2.2.3.2. Analog output

The analog output is driven by the counter/timer card which sends a PWM signal. This signal is transformed in 0 to -10 V DC signal by the electronic describe in scheme under.

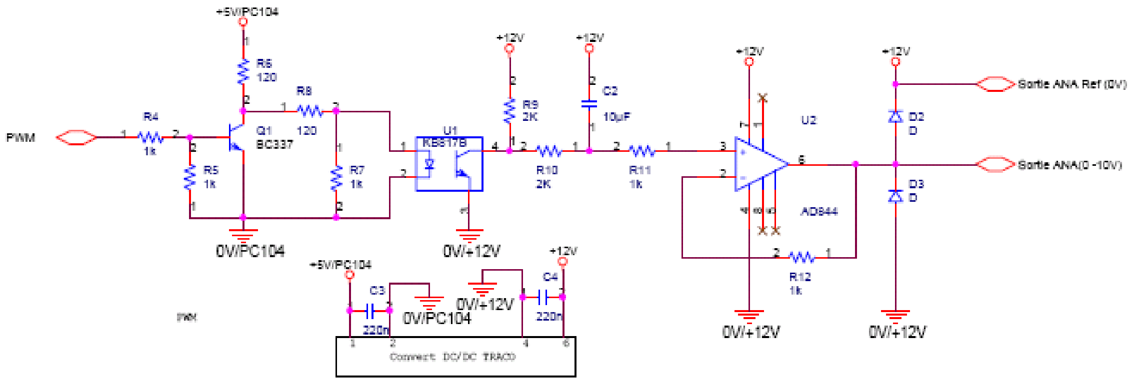

Figure 4. Electrical scheme of the Analog output interface

2.3. Installation

The different cards are stacked in a shelter shown in the picture below:

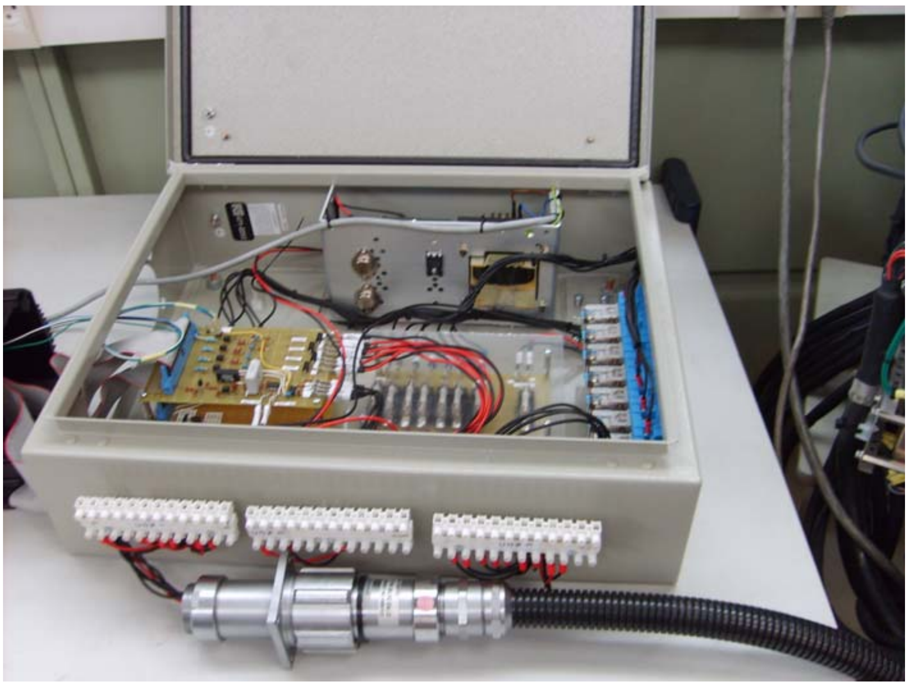

Figure 5. Photo of the electrical interface

3. Tests

We made functional tests to verify the electrical interface compliance with the on site needs and the communication with the RPS.

3.1. Inputs

3.1.1. Odometry test

The verification of the odometer is made for a range of frequency from 0 Hz up to 500 Hz to simulate a stopping point and a maximum speed around 35 km/h. Those test aim at verifying the counting capability on the system and their compliance with our needs.

We checked if
- the calculated speed is correct,
- the maximum duration of a run doesn't reset the counter,
- the maximum speed during a run is reachable with our system

3.1.1.1. Equipment

- Signal generator: TTL ± 5V up to 500 Hz to simulate a speed around 35 km/h (we consider that the odometer is a 130 pulses per turn and the perimeter of the wheel is 257 cm)
- Oscilloscope to verify the wave form and frequency
- RPS (the PC hosting the Matlab/Simulink xPC target environment and the target PC)

3.1.1.2. Test procedure

<u>Installation</u>

1 - Plug the RPS and the signal generator on the electrical interface and an oscilloscope
2 - Set the signal: square, ± 5V and a frequency comprise between 1 Hz to 500 Hz by step of 100 Hz
3 - Verification of the signal on the oscilloscope
4 - Set the duration on the Simulink board (10 s or 200 s the estimated duration of a run)
5 - Set the digital counter on the SImulink board at 0

<u>Test</u>

1 - Verification on the Simulink board that the 10 s counting is compliant with the settled frequency
2 - Same test with the calculation of the speed.

3.1.1.3. Results

The pulses' counting during 10 s is OK with an error of 3% at 500 Hz.
The speed is OK.
The counter doesn't reset after 200 s at 500 Hz.

3.1.2. Eurobalise trig test

3.1.2.1. Equipment

- Voltmeter
- beacon
- Eurobalise
- Oscilloscope to verify the frame
- 10 m cable used on board to join the beacon to the electrical interface

3.1.2.2. Test procedure

Installation

1 - Plug the antennae cable between the electrical interface and after a test sequence to the antennae and the RPS to the electrical interface
2 - Set a digital board on Simulink

Test

1 - Test the voltage on each pin of the plug of the antennae with a voltmeter before plugging to the antenna
2 - Pass the Eurobalise above the beacon

3.1.2.3. Results

Plug antennae: OK.

Trig Balise counting is OK. 5 passages, 5 trig detected by the software.

3.2. Outputs

3.2.1. Relays tests

3.2.1.1. Equipment:

- 110V DC power supply (max 1,5 A)
- Voltmeter

3.2.1.2. Test procedure

Installation

1 - Plug the 110V power supply on the electrical interface and the RPS

Test

1 – Manual testing: closed manually each relays in order to verify if the leds are lighten in closed position
2 – Send a command from the PC host to the relays and verify that the leds are lighten
3 – test the open lines with the voltmeter

3.2.1.3. Results

Manual test: OK 110V in each line when relays are closed.
Software command: OK 110V in each line when relays are commanded.

3.2.2. Analog output test

3.2.2.1. Equipment:

- Voltmeter
- 150 ohms resistor

3.2.2.2. Test procedure

1 – Plug the host PC to the PC target plugged to the electrical interface
2 – Plug a 150 ohms resistor
3 – Send a command with the host PC in the range [2,5 -7,5] V by step of 1 V

3.2.2.3. Results

Analog output: OK with an accuracy of ± 0,2 V for each step.

N.B.: The 150 ohms impedance could not be the good reference on train. The concept we used is validated but as we don't know the real value it could imply new settings on board.

4. Synthesis

The concepts used for the RPS and the electrical interface are functional.

Some parameters of the software will be retuned on site because of the uncertainty about the wheel diameter, the resistance at input and outputs.