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Functional model for the remote control of traction units

Modèle fonctionnel de la commande à distance des unités motrices
Funktionsmodell für die Fernsteuerung von Triebfahrzeugen



UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

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Summary

The purpose of this document is to produce a general model that describes in a functional manner the remote control of traction units.

The document makes direct reference to *UIC Leaflet 556* which deals with data transmission on the train bus and specifies the functions that take place between the vehicles concerned (locomotives, multiple units, railcars, trainsets and driving trailers) including the rules under which the necessary telegrams are formed, transmitted and processed.

Four different control types are defined covering the basic functions that are always to be guaranteed for remote control and the more complex ones that allow more flexibility in the remote control of the traction units but may not be always available on existing rolling stock.

1 - Scope

This Leaflet is applicable to all traction units and driving trailers that are equipped with a train bus in accordance with *UIC Leaflet 556* (see Bibliography - page 37).

This Leaflet can also be applied to other kinds of rolling stock, e.g. EMUs, DMUs (see List of abbreviations - page 36) and high speed trains, in order to develop the remote control application based on an existing standard and to achieve interoperability.

This Leaflet is applicable to both diesel and electric traction vehicles.

2 - General

2.1 - Introduction

This leaflet specifies the implementation of the remote control of traction units using the telegrams specified in *UIC Leaflet 556* for this purpose; additional telegrams, if needed, have to be agreed inside the "Steering Group UIC – Train bus".

In spite of the large variety of the existing railway vehicles and their different functional characteristics, a single reference model which includes the different operating procedures that can be present on a given vehicle has been developed.

This leaflet does not standardise the functions which take place within the individual vehicles or the design and arrangement of the control equipment, but only the application interface among vehicles. However, a standardized behaviour of certain remote control functions may affect the specification of the corresponding local functions of each vehicle and, consequently, have an impact on the implementation of the application software.

The introduction of standardized traction unit remote control functions raises the problem of how these can be exhaustively tested with a reference base, the structure and performance of which reproduces the contents of *UIC Leaflets 556, 557 and 647* (see [Bibliography - page 37](#)). The procedure to assess the conformity to these leaflets is specified in point 6 - page 33.

This leaflet forms part of a set which consists, among others, of the following (see [Bibliography - page 37](#)):

- | | |
|----------------------------|---|
| - <i>UIC Leaflet 541-5</i> | Brakes; |
| - <i>UIC Leaflet 550</i> | Power supply installations; |
| - <i>UIC Leaflet 550-1</i> | Electrical switch cabinets on passenger stock; |
| - <i>UIC Leaflet 553</i> | Heating, ventilation and air-conditioning in coaches; |
| - <i>UIC Leaflet 555</i> | Electric lighting in passenger rolling stock; |
| - <i>UIC Leaflet 556</i> | Information transmission in the train (train bus); |
| - <i>UIC Leaflet 557</i> | Diagnostics on passenger rolling stock; |
| - <i>UIC Leaflet 558</i> | Remote control and data cable; |
| - <i>UIC Leaflet 652</i> | Diagnostics on tractive units and driving trailers. |

This implies that some remote control functions, for example doors or brake operation, are described in the documents listed above and are not specified in this leaflet.

2.2 - Basic concepts

Basic concepts applied throughout this leaflet are:

- this leaflet needs to deal with a minimum set of signals. It only contains the essential ones in order to achieve the correct duty of the remote control system functions;
- this leaflet does not standardise the functions related to particular features specific to the different railway operators or manufacturers. These are to be dealt within national technical standards and the related signals have to be placed in the national reserve; in such a way information completeness is guaranteed and confusion at the international higher level is avoided;
- the signals described in this leaflet are chosen on a large common base in order to provide all the information and to prevent any misunderstanding. All the basic signals on which remote control is based can be generated directly by devices placed on the driver's desk;
- if not otherwise specified in the leaflet, both the leading and the slave vehicles perform the same logic operation after a command. The implementation of the command can obviously be different on each vehicle;
- not all commands issued by the leading vehicle are explicitly acknowledged by the slave vehicles, but the leading vehicle can check the status of the trailing vehicles by means of their R2 telegrams;
- each vehicle shall protect itself in every condition. This means that the remote control commands that are recognised as unsafe shall not be executed. If the communication is interrupted at any time each vehicle in the composition shall put itself in a safe state.

2.3 - Operating conditions

The conditions to allow the Remote Control application to work properly are:

- the control system of the involved vehicles is active;
- the train bus is in normal operation according to *UIC Leaflet 556*.

For the majority of the functions described here a leading vehicle shall be present in the composition. The activation of the driver's desk identifies the leading vehicle.

For the purpose of traction remote control the leading vehicle is also referred to as the "Master". All other involved vehicles are referred to as "Slaves".

3 - Types of remote control

In order to guarantee a minimum level of compatibility for the interoperability and to allow the most advanced implementation of remote control systems, four different types of control (control types 1, 2, 3, 4) are introduced here; these are applicable both to electric and to diesel traction.

The concept of remote control is based on the functional representation of each vehicle. This means that any traction unit is seen from the train bus as a set of functions and a set of state variables. The different types of control include different functions to allow the remote control of interoperable traction units.

The first type of control (Control Type 1 or CT1) is the basic one and shall be always guaranteed when interoperability of the remote control of traction units is required.

Besides the functions covered by CT1 (see [List of abbreviations - page 36](#)), some other options, which can simplify the operation of the trains and which are thought to be useful in improved remote control systems have been considered. These options are included in control types 2, 3 and 4.

The Master learns during the train bus inauguration how many traction units with electrical or diesel traction equipment are in the train and which types of control they support. This allows the Master to properly request the Slave to initiate a particular type of control necessary to perform a specific remote control command, independently from the types of control supported by the other vehicles. In any case, the types of control that can be activated within the train composition at a certain moment are only those supported by the leading vehicle.

The available control types 2, 3 and 4 may be dynamically combined with control type 1 according to the request of the Master; for example it is possible to have control 1+2+3+4, control 1+3, control 1+2+3 and so on.

In the next points the different control types are described in greater detail.

o 3.1 - Control type 1 (CT1) - Mandatory control system

This defines the minimum requirements that each vehicle involved in the remote control application must fulfil.

Control type 1 distinguishes between electric and diesel traction for certain functions and allocates these to the control types 1e (CT1e) and 1d (CT1d) (see [List of abbreviations - page 36](#)).

There is no difference in the functional model between CT1e and CT1d for the majority of the functions. However, due to the obvious technical differences, some of them are specific to electric or diesel traction units.

The activation of traction takes place separately in CT1e and CT1d. If the Master supports both control types it is possible to use the complete functionality of all the electric and diesel traction units that are in the train.

CT 1 commands are sent broadcast mode, i.e. they reach all the Slaves at the same time.

3.2 - Control type 2 (CT2) - Control type with selective traction unit operation

Control type 2 (see [List of abbreviations - page 36](#)) is introduced to selectively command different traction units in the train in order to better manage complex train configurations and particular operating conditions.

Once CT2 is activated between the Master and the Slaves that support it, CT2 commands have higher priority over the corresponding CT1 commands. However, when a safety related behaviour is involved, CT1 commands have higher priority over the corresponding CT2 commands and the control type of the Slave is reset to CT1. In all other cases an explicit CT2 order is requested to reset the control type to CT1.

3.3 - Control type 3 (CT3) - Control type with distributed speed control

Control type 3 (see [List of abbreviations - page 36](#)) is introduced to allow the Master to transfer the speed control function to another vehicle.

In any case the speed of the train shall be controlled by just one vehicle.

A distinction between electric and diesel traction is not necessary.

3.4 - Control type 4 (CT4) - Control type with interactive procedures

This type of control allows monitoring of status and operative conditions of the Slaves, report of faults and alarms and management of the necessary corrective actions.

Two basic functionalities are provided by CT4 (see [List of abbreviations - page 36](#)):

- authorisation request issued by a Slave and subsequent permission from the Master in order to achieve a proper management of faults and diagnostic events;
- test request issued by the Master and related report of the test results from the Slave.

Due to the interactive procedures needed for this type of control, it can only be implemented on vehicles equipped with a suitable display and input device.

Diagnostic communication is achieved by exchanging directly the text of the messages and of the menu of the proposed choices to cope with the event. The operator selects the proper options and the corresponding code is sent to the vehicle that issued the authorisation request.

4 - Functional model

4.1 - Remote control process

The technology of the various traction units (locomotives, EMUs, etc.) within the various railway operators can be very different, considering, for example, the setting up of the traction power (contact breakers, switch gear, converters) and its control (relay logic, analogue and digital electronic equipment, microprocessors).

Because of the existing technical differences, there are also large differences in the input and output of the control equipment. Therefore it is not possible, in most cases, to use the signals transmitted over the train bus to directly control the equipment or to obtain these signals directly from the control equipment.

For this reason, signals that contain all the necessary information are defined for the train bus. These signals must be "translated" in each vehicle in order to work with the actual control equipment. This process is represented in Fig. 1.

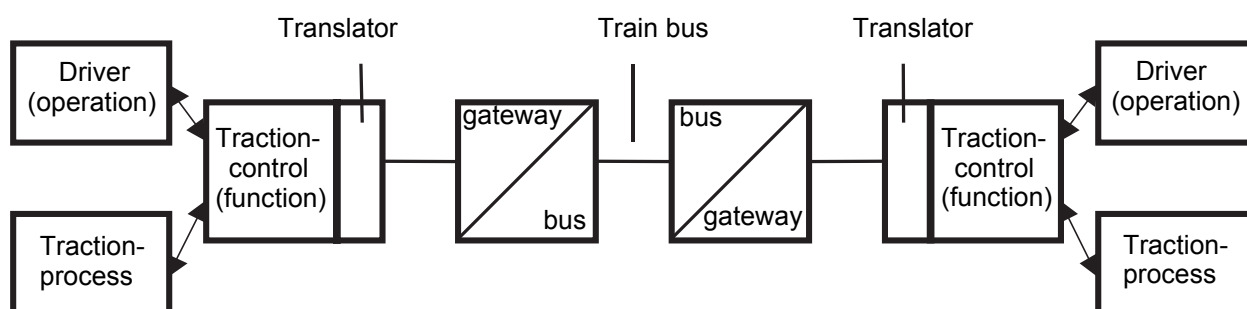


Fig. 1 - Logic diagram of the remote control process

4.2 - Macrofunction definition

Traction units are very complex systems and different solutions for their design have been developed by different manufacturers and operators. All of them, however, converge to the same operational results and so it is possible to deal only with primary signals according to the nature of this leaflet.

In order to properly define them, they have been arranged in functional modules, called macrofunctions, as listed below:

- train composition,
- primary energy,
- parking brake,
- air and pneumatics,
- auxiliary energy,
- traction and dynamic brake,
- equipment protection,
- data validation.

This organisation is shown in Fig. 2.

Each macrofunction contains a set of functions: the functions are described by the corresponding remote control signal, mapped in telegrams described in *UIC Leaflet 556, Appendix A*, as listed in the following paragraphs.

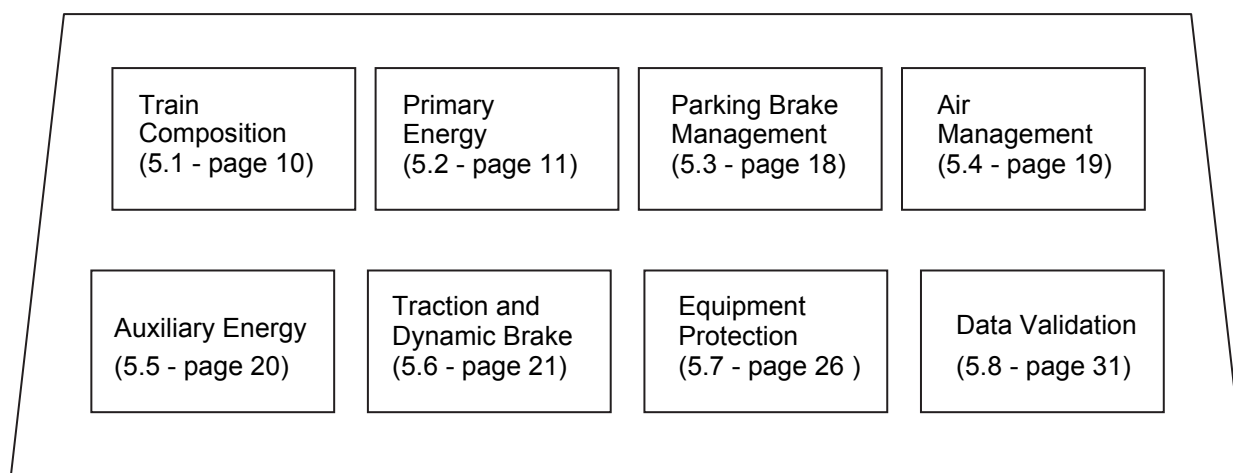


Fig. 2 - The macrofunctions structure

4.3 - Macrofunction structure

This leaflet fully specifies the structure and the meaning of each signal listed below. Each function shall be used as specified in the present document. The technical implementation of the function is not defined in this document and is left to railway operators and manufacturers.

Each macrofunction is described in detail by the following elements:

- the concept, which defines its function from the logic point of view;
- the interface, which correlates it with the other involved macrofunctions;
- the list of the signals.

Each signal is characterised by the following elements:

- the purpose, which identifies the carried information and its meaning, i.e. the logical behaviour of the related function on the train bus;
- the data specification, i.e. the details of the signal implementation on the train bus, including the telegram type (R=Regular or E=Event telegrams according to definitions given in *UIC Leaflet 556*) and the data format and encoding;
- the communication specification in terms of information flow and signal behaviour in time (permanent or impulsive);
- the number of the telegram, as stated in *UIC Leaflet 556, Appendix A*, in which the signal is mapped.