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Parameterization of Train Protection and Warning System Based on ERTMS Level-1 Principles

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ABSTRACT: The train protection warning system is advancement in the precautionary applications for the authorized movements of trains. It is based on the first level principles of "European Railway Traffic management System" Standards. This system automatically activates the brakes on a train that has passed the SPAD or when it is over speeding than governed. The system comprises of mainly on-board equipment and track side equipment to control the train movement automatically by the program coding called the telegramswhich are transmitted from the EUROBALISE to the train. For Indian railways, the TPWS system is designed using the level-1 principles of ERTMS. The installation of components plays a vital role in the parameterizing of the components both on-board and track side. So the paramerters had to be chosen accurately with a perfect precision and are to be installed.

KEYWORDS: European railway traffic management system(ERTMS), Train protection &warning system (TPWS), telegram, parameterization.

I.INTRODUCTION

India is a country which holds one of the largest railway networks in the world. The railway signalling system is the base line control system which controls the movements of the trains. For Indian railways which is also called as the life line of the nation, the train traffic is very complex. So, the manual operation cannot be applicable in all the cases because it may result in the misalignment of track circuits resulting in derailing of trains. The train protection warning system reduces these types of issues predominantly. The TPWS project for Indian railways is implemented using ERTMS level-1 principles.It is fitted in the areas where Automatic Train Protection (ATP) systems are installed. Unlike ATP systems it does not aim to stop the train before the SPAD points in turn reduces the speed of the train and stops it intermediately. The TPWS system works on the ERTMS principles and different countries use different levels of the principles based on the railway technology and advancements in engineering.TPWS works on all fitted trains travelling at any speed and is designed to stop trains travelling up to 75mph within the safety overlap. Trains travelling more than 75mph still have their brakes applied and although they may not come to a complete stop within the safety overlap will have their speed dramatically cut so reducing the risk of a serious collision.

II.ERTMS LEVEL-1 PRINCIPLES

Level 1 is a cab signalling system that can be superimposed on the existing signalling system, leaving the fixed signal system in place. Eurobalise radio beacons pick up signal aspects from the trackside signals via signal adapters and telegram coders (Lineside Electronics Unit – LEU) and transmit them to the vehicle as a movement authority together with route data at fixed points. The on-board computer continuously monitors and calculates the maximum speed and the braking curve from these data. Because of the spot transmission of data, the train must travel over the Eurobalise beacon to obtain the next movement authority. In order for a stopped train to be able to move (when the train is not stopped exactly over a balise), there are optical signals which show permission to proceed. With the installation of additional Eurobalises ("infill balise") or a Euro Loop between the distant signal and main signal, the new proceed aspect is transmitted continuously.

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Features of Level-1:

- The movement authority is sent through the euro balise
- Provides a continuous speed supervision
- Train's location is ensured by the track circuits.
- Route management is realized by the existing interlocking systems.
- The integrity of the train is realized by the existing ground systems.
- Superposed with the line side signaling.
- Authorization to run is given by the beacons or the balise on the track side.
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III. ARCHITECTURE OF TPWS

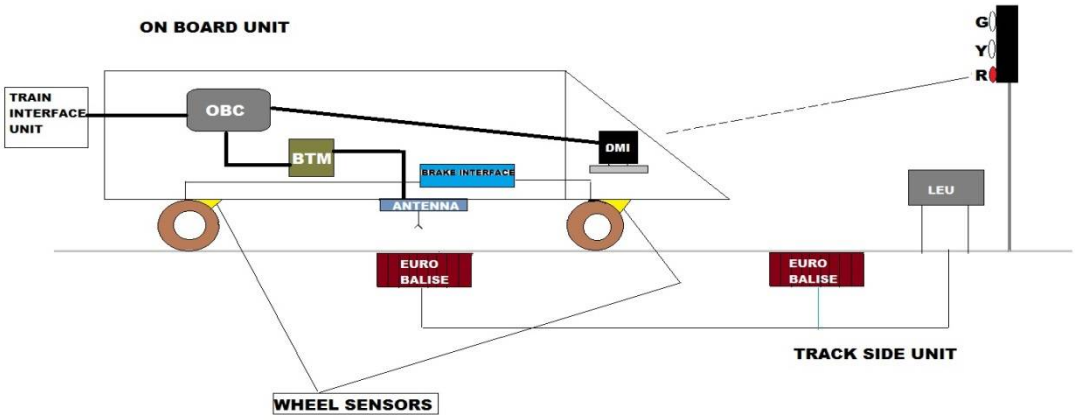

Fig1: block diagram assumption for tpws

The architectural block diagram of a train protection warning system is shown in the figure 1. It is clear from the figure 1 that it consists of two units:

- On-board unit
- Track side unit

TRACKSIDE COMPONENTS:

The track side components used in the tpws are:

- Eurobalises
- Line side electronic unit(LEU)

Eurobalise: The Eurobalises enable a single-directional data transmission to be provided from the track tothe train. The Eurobalises are grouped together in twos, threes or fours. The groups areformed by one fixed balise with one to four switchable balises. All the groups of balises(switchable and fixed) are concatenated.

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Fig2: Eurobalise installed on track and close view

Line side electronic unit (LEU):

The line side electronic unit is one of the main systems in the TPWS project. The LEU is responsible for analysing, trans receiving, and generation of telegrams from and to the balise.The LEU Cabinet houses the LEU card file, a fan tray, a Power line filter on the 110V ac input, a 110V ac / 24V dc Power supply for reading the ECR contacts and necessary terminals for interconnecting the wires to the LEU card file. The LEU cabinet used in IRPMU project houses the necessary ECRs also in it. A typical LEU Cabinet installed at site is shown in figure 3.

The Line side Electronic Unit (LEU) module is the main component of track side equipment in TPWS project. The purpose of the LEU encoder is to information regarding the state of signalling and train running authorization to the ETCS On-board equipment by means of ETCS messages defined in the European specifications. To achieve this, the LEU encoders are physically connected to the interlocking systems or the trackside signalling devices so as to transmit signalling information while at the same time being connected to the Eurobalises which they manage. There are two processors which are galvanically separated and processes are carried out independently. The two processors communicate their results to each other at predetermined intervals. Each processor assesses its results based on those received from other. Positive outcome is validated. Watch Dog “fail safe circuit for safety disabling in case of failure.

Fig3: LEU cabinet in the field

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Integrated power supply for LEU:

The source of power available at the trackside location was 110Vac while the LEU-ID module works with 48Vdc input. Naturally a power converter from 110Vac to 48Vdc supply was required to operate the trackside equipment. Although the power converter apparently looks quite simple, it had to go through a number of engineering changes to take care of the disturbances in the 110Vac input supply. The most significant feature incorporated was a capacitor bank to hold the DC output even when there is a momentary interruption in the input AC supply for about a few seconds.

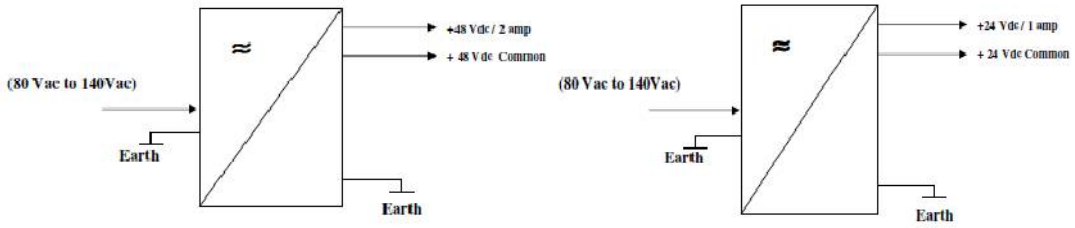

Fig4: 48V and 24V power supply circuit

On-board components:

The TPWS on-board components are equipped in the locomotive and they provide a complete supervision of the train's condition such as speed, distance etc to the balise through the antenna system.The on-board components of the TPWS system include the OBC- onboard computer, BTM- balise transmission module, Antenna, Wheel sensors, DMI- driver machine interface.

The train data from the on-board system are fed to the fixed EUROBALISE through the antenna and the balise transmits the telegrams to the LEU module which in turn analyses the information and sends it back to the switchable balise which is the first level operation of ERTMS principles.

IV.EUROBALISE PROGRAMMING

Each Eurobalise shall be correctly programmed prior to line commissioning. In order to implement the telegram writing procedure in the Eurobalise, you shall get access to the Eurobalise shell connector area, by removing the special covering lid. It is recommended that the writing operation should be carried out prior to installing the Eurobalise on the sleeper (e.g. at a laboratory or in the warehouse). The Eurobalise can, if necessary (e.g. due to a line configurationvariation or maintenance operations, etc.), be programmed on the line withoutbeing removed from its support: in fact, you will just need to remove the covering lid and, in case of a Eurobalise connected to the LEU, disconnect the cable connecting the junction box with the Eurobalise.The telegram writing phase shall be implemented both for the Eurobalises that will be used with "fixed information" and the Eurobalises connected with the LEU.

Steps:

- Balise configuration files(.tgo) transfer from the CD to the Palmtop
- Balise programming
- Verification of the TLG emitted by the balise

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Fig5: Components of Balise Programming Verification Tool

V. INSTALLATION AND PARAMETERIZATION OF COMPONENTS

In any system, the installation plays a major role in establishing a clean and safe distribution and parameterizing of the entire system. In the TPWS system, the installation of the on-board and trackside equipment must be done in an accurate manner based on perfect dimension plan for every component used in the system.

Speed sensors:

The sensor is an optical system that operates in the infrared range. A rotating slotted disc placed between an IR transmitter and IR receiver interrupts the continuous light beam from the IR transmitter. The IR receiver detect the pulsating light beam and produces a frequency that is proportional to the rational speed. This frequency is then amplified and then transmitted to the evaluating systems for processing. The speed sensor is to be mounted on the axle box cover similar to the existing arrangement.. The drive dog of speed sensor is engaged with the drive pin mounted on the wheel axle. Necessary mounting cover provision is required to be provided by Railway for each EMU (2 nos.).

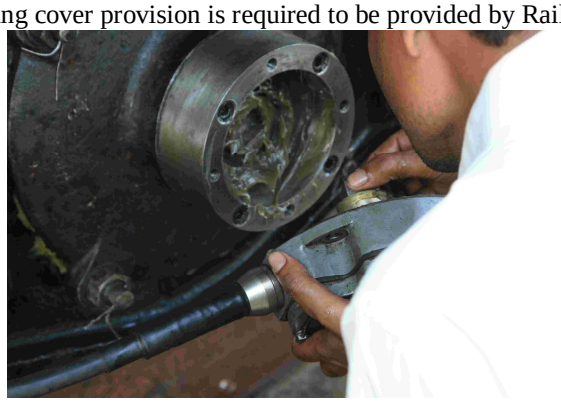

Fig6: Installation of wheel sensors

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EUROBALISE installation:

The balise is installed to transmit vital data between the track and train. The STANDARD EUROBALISE (FM9129300100), along with the (BOAF) electronic card it contains, and the other electrical (TX-RX antennae) and mechanical (casing and Interface 'C' connector), are a fundamental element in transmitting data from the track to the train.

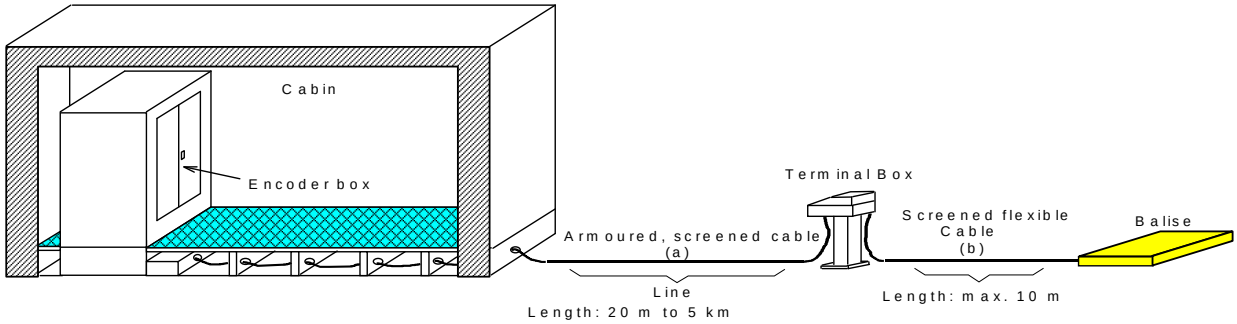

Fig7: Eurobalise installation sketch

VI.CONCLUSION

It is a great opportunity for us to serve Indian Railways which is the life line of the nation. The train protection and warning system has a great benefit to Indian railways in avoiding accidents which may occur predominantly. Parameterisation of the entire system is very much necessary for establishing continuous safety in the train. This system can control certain parameters such as fuel, distance and automatically apply the brakes in the train when it has passed the danger signal without the knowledge of the Loco pilot. This project is getting implemented in India and it is under test at various regions of Railways where there is a complicated mode of signalling to be implemented manually.

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