

# **User Requirement Specification**

## **For**

# **ELECTRONIC INTERLOCKING INTERFACE TO LEVEL CROSSING PROTECTION CONTROLLER**

FOR THE USE IN  
PASSENGER RAIL AGENCY OF SOUTH AFRICA (PRASA)

ISSUED DATE	INTERLOCKING AND LEVEL CROSSING INTERFACE URS	G1 & G2 RE-SIGNALLING
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## 1. PURPOSE AND SCOPE

This document describes the user requirements for the interface between the electronic interlocking and the new Level Crossing Protection Controllers for the Gauteng Re-Signalling project.

## 2. STANDARDS, REFERENCE DOCUMENTS, TERMS AND ABBREVIATIONS

### 2.1 Standards

Table 1:

Reference	Title
SANS 3000-2-2-1:2012, edition 1	Part 2-2-1: Technical requirements for engineering and operational standards — Track, civil and electrical infrastructure — Level crossings
Cenelec Standard	<ul style="list-style-type: none"> <li>a) EN 50126 Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)</li> <li>b) EN 50128 Railway applications – Software for railway control and protection systems</li> <li>c) EN 50129 Railway applications – Safety related electronic systems for signalling</li> <li>d) EN 50159-1 Railway applications – Signalling and communications – Safety-related communication in closed transmission systems</li> <li>e) EN 50159-2 Railway applications – Signalling and communications – Safety-related communication in open transmission systems</li> </ul>
PRASA Documents	<ul style="list-style-type: none"> <li>a) User requirement specification for Level Crossing Protection System for Implementation as Part of the Gauteng Re-signalling project.</li> <li>b) Metrorail General Operating Instructions</li> <li>c) Trains Working Rules of PRASA</li> </ul>

## 2.2 Terms and Definitions

Terms/ Abbreviation	Definition
Level Crossing (LX)	Place approved by the network operator and the road authority (or the land owner in the case of a private road) where a road crosses the railway line(s) at grade
LX Island	The area of the LX where the road traffic crosses the rail, between the barriers.
LX Protection Signal	Railway signal controlled by the interlocking, which is used as a start element of a route passing the LX track.
LX states	One of the following: Open, Closed, Opening, Closing, Failed/Passivated.

## 2.3 Acronyms and Abbreviation

LX	Level Crossing
TCO	Train Control Officer

### 3. INTRODUCTION

A level crossing (LX) is a crossing of road and railway at the same level. In the description below the term level crossing is used for the technical equipment used for achieving the protection of trains and traffic road users.

This type of LX protection applies to all LXs irrespective of whether they are located on the open line, in the station, or on the open line area near the station.

A level crossing must be protected by two signals hence designated 'Protection Signals'.

In the Figure 1 – Level crossing Protection Signals below, the signal 14 is not a 'protecting signal' since the LX is not located in the running path of route from signal 14 to signal 10. Signals 10 and 4 are 'Protection Signals' because they allow a train to cross the LX.

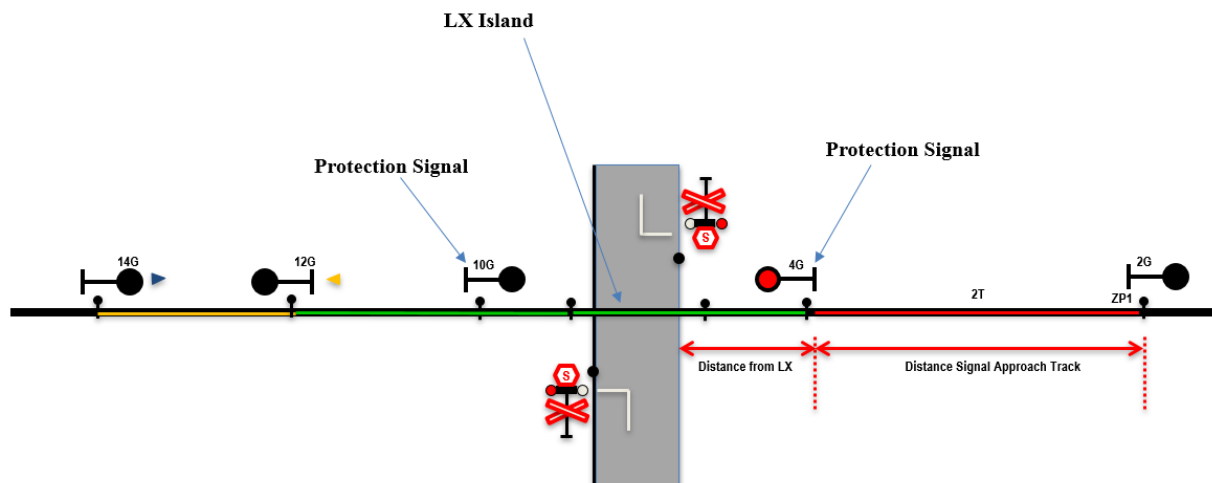


Figure 1: Level Crossing with Protection Signals

Level Crossings in overlap should be avoided. If a level crossing is located very close to the Destination signal of a route, the clearing of the origin signal of that route shall be delayed the same time as a zero-overlap route.

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## 4. OPERATIONAL REQUIREMENT OF LEVEL CROSSING

4.1 A Level Crossing shall be activated:

- (i) Manually by the TCO; or
- (ii) Automatically by the Interlocking.

4.2 The Level Crossing protection activation when LX in the Route, Normal operation with no faults on Level crossing or Interlocking:

4.2.1 The Interlocking shall request for protection:

4.2.1.1 When the route from the Protection Signal is called and its berth track is occupied, the Interlocking shall send a request to the LX Protection Controller to put protection in place per route over the LX;

- (i) When calling a Main signal.
- (ii) When calling a Shunt signal.
- (iii) When calling a U-signal.
- (iv) When calling a C-signal.

4.2.1.2 The level crossing protecting signal will display a main or shunt proceed aspect when the conditions below are fulfilled:

- (i) The level crossing has reported to the interlocking to be in the protected state.
- (ii) The Protection Signal configurable delay timer to ensure 30 second warning time, which starts when request for protection is send out, has elapsed.

4.3 The Level Crossing protection deactivation when LX in the Route:

4.3.1 The interlocking shall send a request to the LX Protection controller to deactivate the LX Protection for a specific Route.

4.3.2 The Interlocking shall send a deactivation request to the Level crossing controller to remove protection when all the routes that activated protection over LX island are traversed.

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- (i) When the train normalisation of all the track section/s through the LX island part of the route for which the protection was requested has/have taken place.
- (ii) When the Route (Green or Blue) for which the protection was requested is in the first defined state and cancelled.
- (iii) When the Route (Main, Shunt and Emergency) for which the protection was requested is in the final defined state and is cancelled and the track section between protection signals are not occupied.

4.4 The shall be Manual Request Command to the LX Protection Controller.

- 4.4.1 A manual activation command shall be provided to put Protection in place on the LX Protection Controller.
- 4.4.2 The manual protection deactivation Command shall be provided to remove Protection at a LX, if there is no activation request from the interlocking.
- 4.4.3 When the Level Crossing is manually activated, it can only be manually deactivated by a Manual deactivation command.
- 4.4.4 When the Level Crossing island is occupied, it can only be manually deactivated by an emergency Manual deactivation command.

The TCO, level crossing and interlocking interaction is demonstrated on operational sequence diagram in **Annex A**.

#### 4.5 LEVEL CROSSING FAILURE

- 4.5.1 The information whether the LX is protected or not is transmitted (received by the interlocking) via two antivalent channels. The LX is regarded as failed when any of the following occur:
  - 4.5.1.1 An antivalent failure is detected, i.e. the two channels are not antivalent;
  - 4.5.1.2 The LX is activated by the interlocking, confirm “protected” and then notifies “not protected”;
  - 4.5.1.3 The LX is not requested or activated by the interlocking for protection, but it sends “protected” confirmation.

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4.5.1.4 A “Failed” state is received from the LX protection controller.

4.5.1.5 To recover from any of these failures the LX must send “not protected” while the interlocking is not triggering the LX to be activated.

4.5.1.6 The Received LX Protection controller Fault state/modes shall be reported to maintenance terminal.

4.5.1.7 The Received LX Protection controller Fault state/modes shall be displayed on SATCOS.

4.5.1.8 If the interlocking has sent an activation or deactivation request to the LX, and the LX does not report closed or open within a pre-defined time, the interlocking system shall react by putting the LX on passivation state.

#### 4.5.2 Level Crossing Failure effect on Protection signals

4.5.2.1 If the protection signal cannot be cleared or called as a result of the interlocking failure, it should be possible to clear the emergency signal.

- (i) The Emergency signal will only clear if all other interlocking requirements for the emergency signal are met.
- (ii) The Emergency signal shall request or activate protection from the LX, but protection active will not be proven.

4.5.2.2 If any protection signal is displaying a proceed aspect (main or shunt) and the LX which is being protected reports a failed state or “not protected”, then the protection signals must close immediately.

- (i) The TCO should be able to degrade the route over the LX to clear the emergency signal.

4.5.2.3 If a LX reports “protected” without being activated by the interlocking (LX is regarded as “failed” interlocking-wise) no protecting signal shall show a proceed aspect.

#### 4.5.3 Interlocking Failure affecting Level crossing

4.5.3.1 When any of the LX tracks get occupied without a request to activate Level crossing, the Level crossing should be activated (start closing process).

### 4.6 MAXIMUM CLOSING TIME WARNING

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- 4.6.1 If a LX is closed for longer than a pre-defined time (Configurable) (i.e. 'Maximum closed time'), the interlocking system shall react by issuing a warning to the operator to check the conditions for the affected LX.

## 5. INTERFACE BETWEEN AREA ELEMENT CONTROLLER COMPUTER AND LEVEL CROSSING PROTECTION CONTROLLER

- 5.1 The Interlocking “activation command” is issued to the level crossing by energising two safety relays outputs.
- 5.2 Any level crossing must be proven operational for a pre-defined time before it can be considered.
- 5.3 The protected, i.e. information activated (status “closed, lights on”) is transmitted to the interlocking and must be read by fail safe input.

## 6. LEVEL CROSSING COMMANDS

- 6.1 The following commands are available at the TCO operations workplace SATCOS:
- 6.1.1 Manual activation of LX; With this command, the TCO activates the LX permanently. The LX will be activated until the permanent activation is cancelled by the operator.
- 6.1.2 Manual deactivation of LX: With this command, the TCO cancels the activation of the LX. (level 1 command)
- 6.1.3 Emergency Manual deactivation of LX: With this command, the TCO cancels the activation of the LX when the is one or more tracks occupied over the level crossing island. (level 2 command)

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## 7. LEVEL CROSSING SATCOS INDICATION CATALOGUE

On SATCOS, the following symbol in Figure 1 shall represent Level Crossing Protection Controller Object.

The full indication symbols for different status of the Level Crossing Element are shown on **Annex B Table 2**.

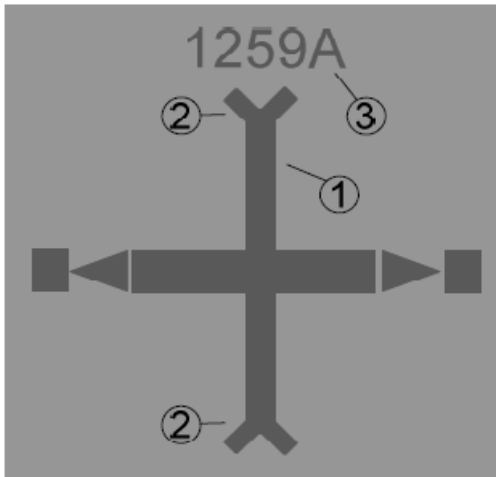


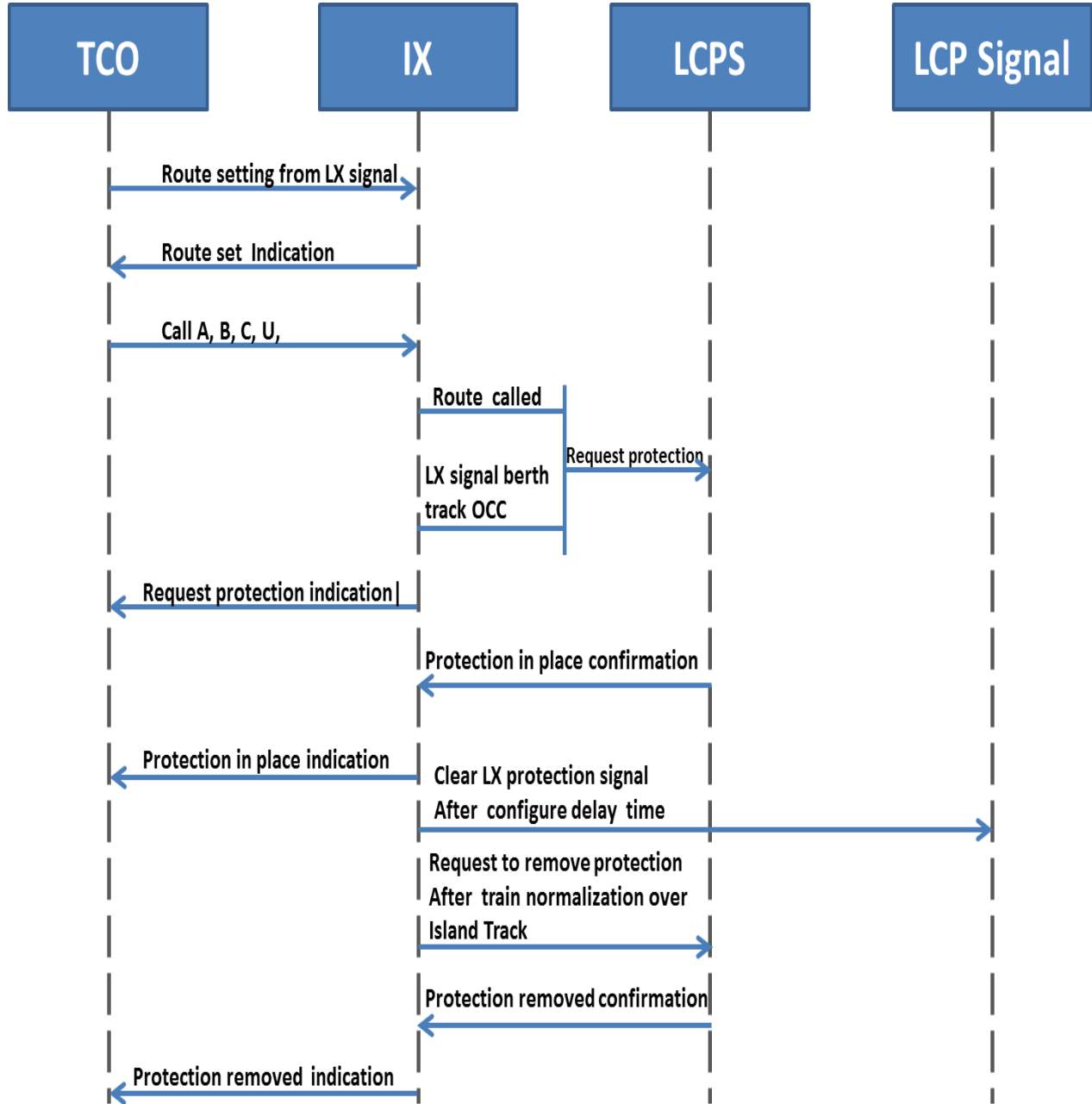
Figure 1 – Level Crossing object SATCOS symbol

The colour priority in case of concurrent indications for the crossing track element (1) is: Red Flashing > Red > Yellow Flashing > Yellow > Black<sup>2</sup>. For the Level Crossing label (2) the same colour priorities apply.

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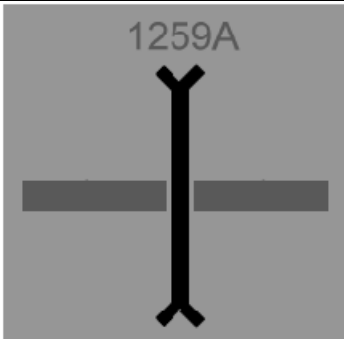
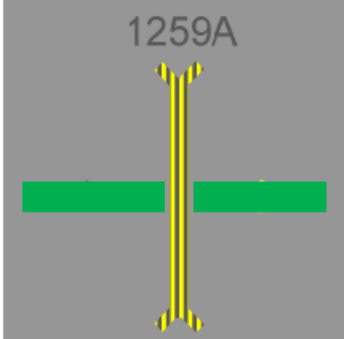
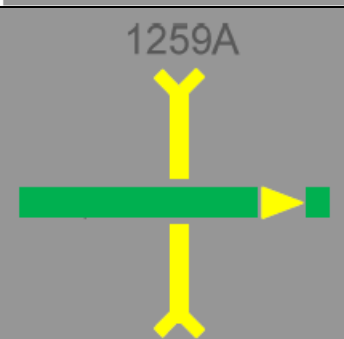
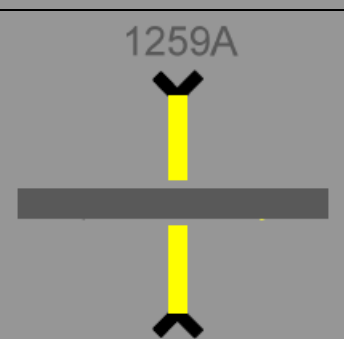
## 8. ANNEXURE– CATALOGUE OF INDICATION

### 8.1.1 Annex A: Sequence diagram

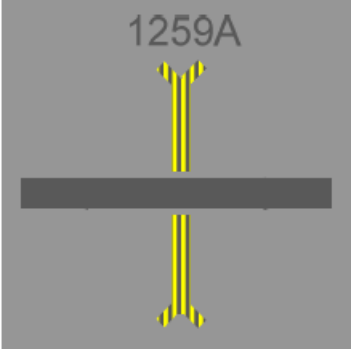
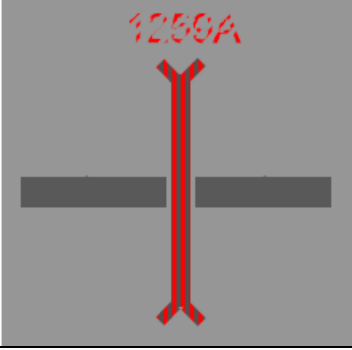
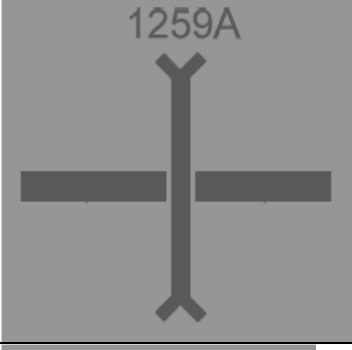
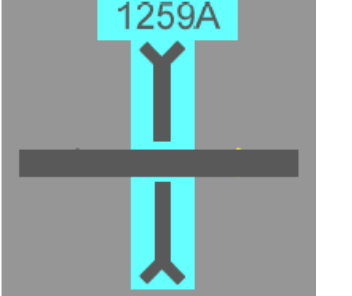


### 8.1.2 ANNEX B: The Table 2 below represent the Level Crossing Status on HMI (SATCOS)

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No.	Symbol	Description
1		Normal state, Level Crossing not activated and not protected- Open for motorist
2		Level Crossing requested but protection acknowledgment not receive yet
3		Level Crossing activated and protected, close for motorist
4		Level Crossing manually activation by the TCO



5			Level Crossing manually requested to open by the TCO, but acknowledgment not received yet.
6			Level Crossing Passivation.  Vital input communication to level Crossing lost or discrepancy between vital input channels
7			Level Crossing without status information (Interface error between HMI and Logic Module).
8			LX element selected

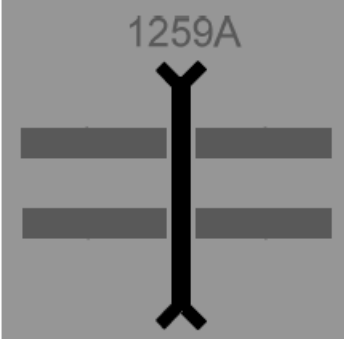
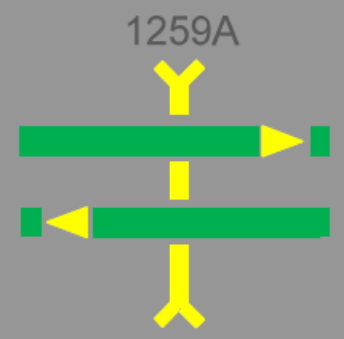
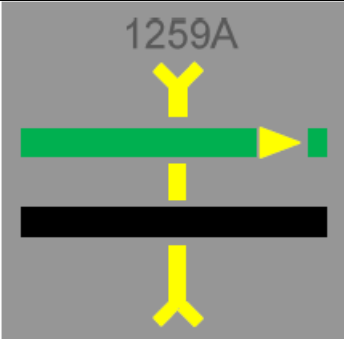
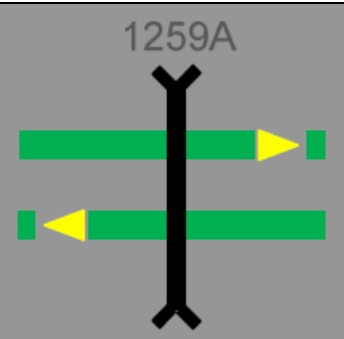
9			Level Crossing over two lines not activated and not protected – Open for the motorist
10			Level Crossing over two lines activated and protected, the two lines have routes.
11			Level Crossing over two lines activated and protected, only one route is set
12			Level Crossing Over two lines not activated (Open), level crossing not requested to close yet.

Table 2: LEVEL CROSSING SYMBOL CATALOGUE