AUSTRALIAN RAIL TRACK CORPORATION LTD

Engineering (Signals) Instruction **ESI-03-02**

Level Crossing Axle Counter Detection System Design

Where Frauscher ACS2000 Axle Counter System are proposed

Applicability

ARTC Network Wide	✓	**RIC (NSW CRN)**	✓

Amendment Record

Version	Date Reviewed	Clause	Description of Amendment
1.0	18 Dec 09		First issue of Instruction

Main Points

- **Configuration requirements**
- **Reset Miscount Situation, accommodate hi-rail vehicle operations**
- **Configuration checking & test procedures**

1 Introduction

ARTC is proposing the general and widespread use of the axle counter train detection system for level crossing activation. Axle counters have significant advantages over rail to wheel contact systems where light rail traffic or contaminated rail contact surfaces results in poor reliability for train detection. Another use may be to overlay a separate axle counter train detection system over an existing signalling system to reduce complexity, interface and ultimately cost.

Axle Counter systems are already in use for points track detection and single line block systems and this instruction provides guidance on the use of axle counter systems particularly for active rail level crossing protection installations.

Special requirements are necessary to reset axle counters when incorrect axle counts occur and lock out the system. Experience has shown that axle counters are highly reliable for train detection however hi-rail road/rail vehicles can experience miscounts due to the small wheel profile. Designers must take into account the operation of all rail traffic to ensure the reliability of the installed infrastructure.

This document only relates to the train detection portion of an active level crossing installation, other subsystems are covered by separate Engineering Instructions, type approvals, etc.

NOTE: THE USE OF AXLE COUNTERS ELIMINATES THE CONSEQUENTIAL BENEFIT OF "BROKEN RAIL DETECTION" AFFORDED BY CONVENTIONAL TRACK CIRCUITS.

Issued by	**Date**
John Furness, Manager Standards	07 January 2010

2 Design Guideline

The design of an Axle Counter system for an active level crossing installation is to be based on the following information in order of precedence:

- This Signal Engineering Instruction.
- ARTC Type Approval Report and conditions ESA 01-0610-020 WRSA, GCP4000
- Frausher ACS2000 Application Guidelines – document D1413-1e
- Frausher ACS2000 User Manual
- CAUTIONARY NOTE: THIS ENGINEERING INSTRUCTION IS ONLY TO BE USED IN TRAIN ORDER TERRITORY OR DARK TERRITORY (I.E. NON SIGNALLED). May be used in other areas by waiver endorsed by Signalling Standards Engineer.

3 System Configuration Requirements

The following configuration items are to be set in the ACS2000 data:

- Mode Jumpers
- Identification Code *Ref (D2167-2, page 16, section 4.2)*
- Configuration File *Ref (D2167-2, page 16, section 5)*
- The Character Site Name is to be in the format - “Town, Street name” (Cerberus).
- Crossing identification number (NNN) (Cerberus).
- The location is set in kilometres and metres as kkk.mmm (Cerberus).
- Note: time is taken from PC on each connection and is not stored on ACB

4 Site Configuration Scenarios

Directional axle counter heads are used to provide direction functionality. The circuitry in the axle counter head reports the direction of travel over that head detector to the processor in the Axle counter Board.

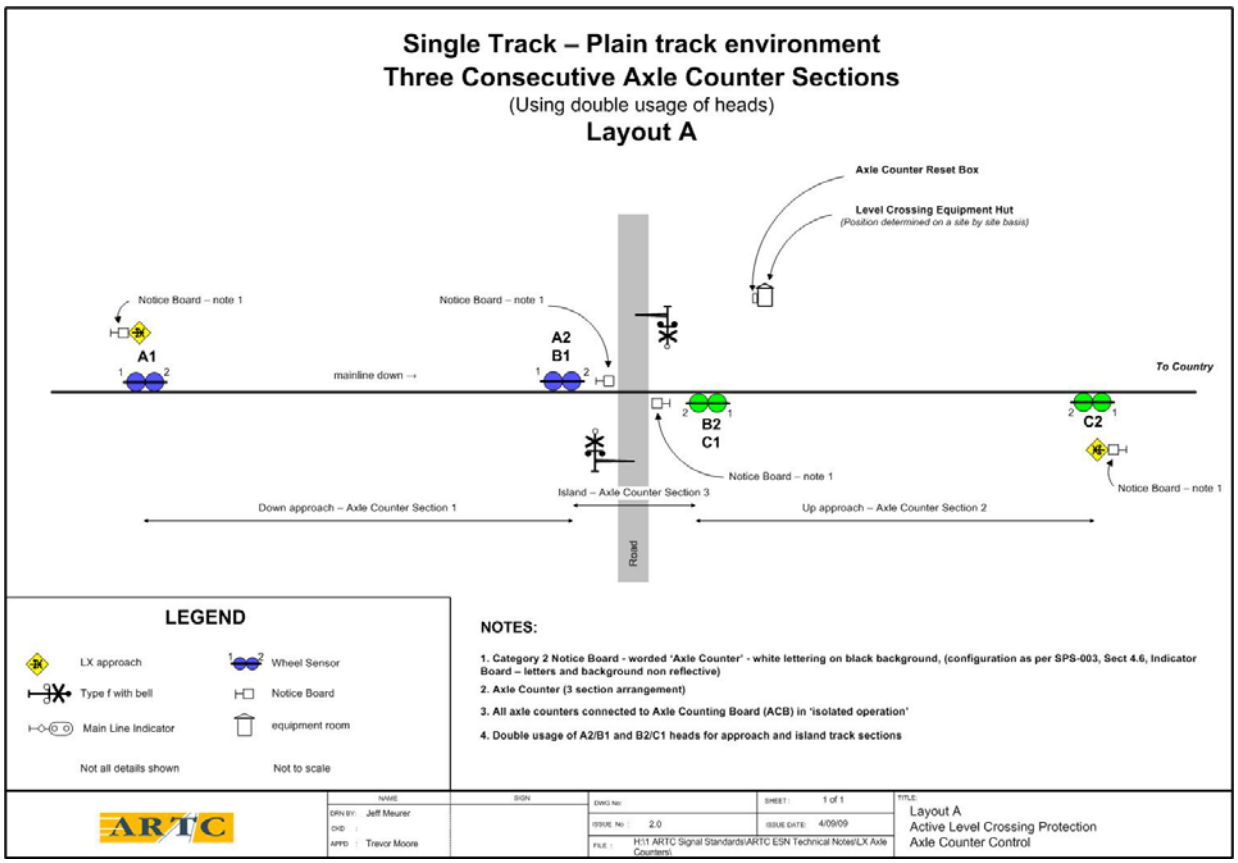
Several typical design scenarios will be encountered and these are described below; other non-typical situations will occur and will require special consideration as they occur.

Hi-Rail Put-on and Take-off

Level crossings may be used as locations for the Put-on and Take-off of Hi-Rail vehicles. Whenever, this is done on an Axle Counter section, then the axle counter is required to be Reset. It is preferred that the axle counter section is not used as the standard location for Put-on and Take-off. There should be consultation with the respective Team Manager to address this situation and where practicable identify or construct an alternative location for Put-on and Take-off. In all cases staff who may use the level crossing or axle counter sections for Put-on and Take-off should be instructed in the processes for the Reset of the axle counter section.

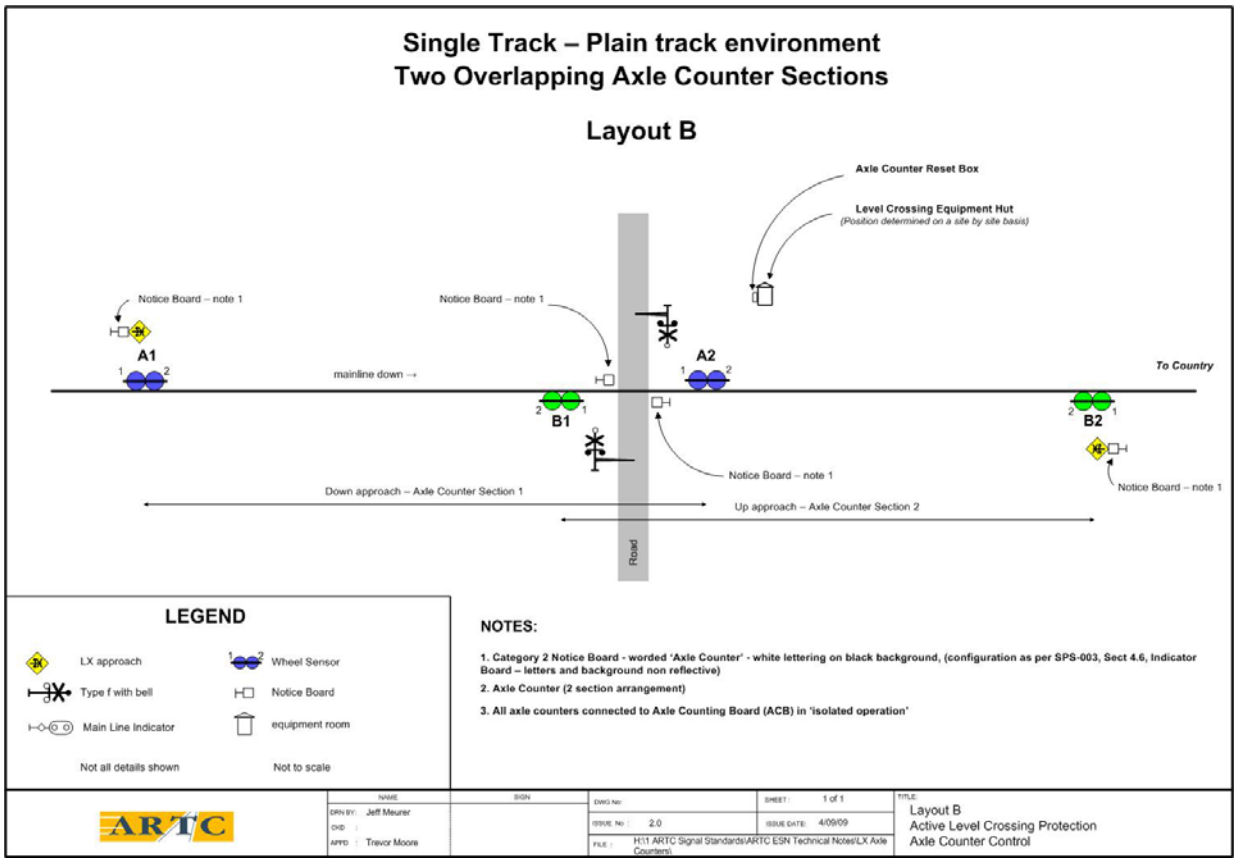
Single track – plain track environment – three axle counter sections

Layout A Preferred Configuration



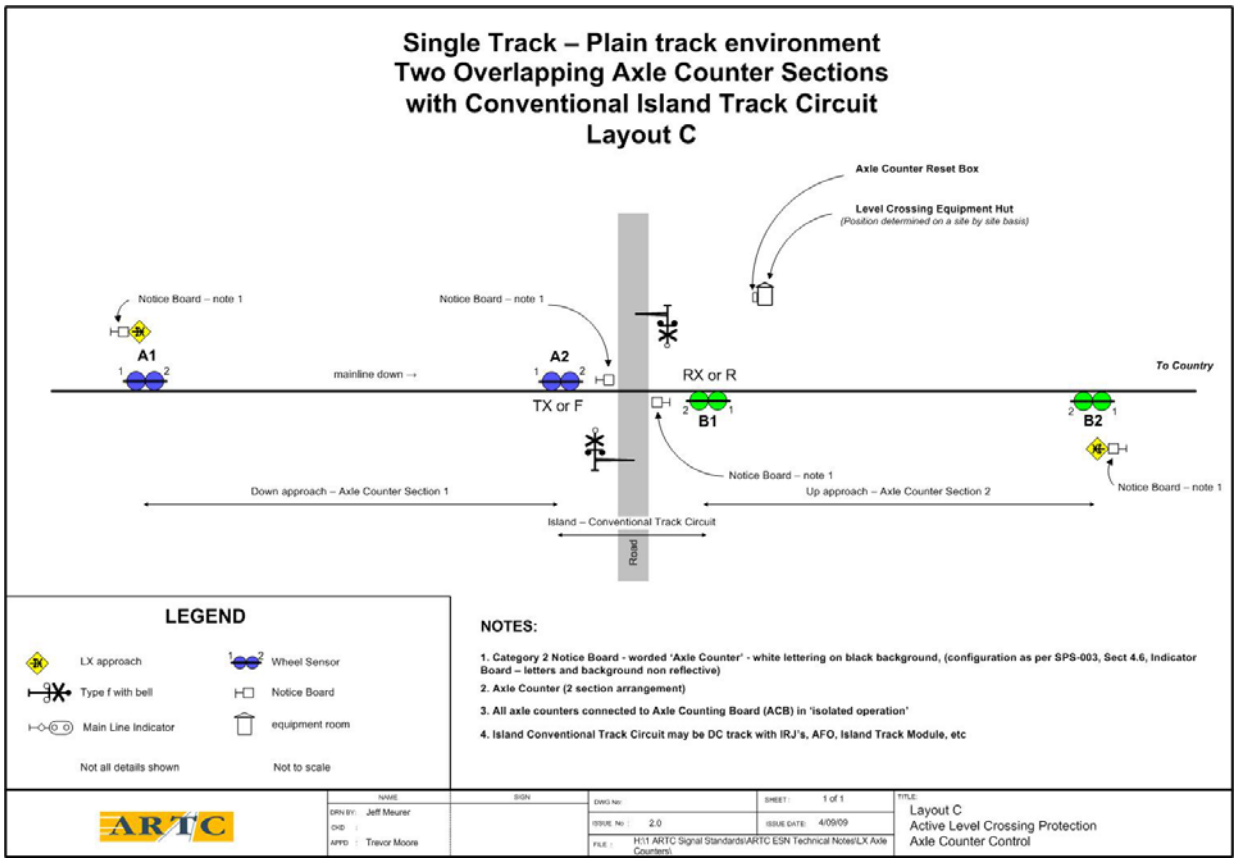
This arrangement is suitable for upgrading of a typical single line level crossing with 3 track circuits (i.e. Up approach, island and down approach tracks) as the three axle counters can readily substitute the existing track circuits. This is the preferred design configuration.

Single track – plain track environment – two axle counter overlapping sections



This arrangement may be used for a installation where hi-rail vehicles do not take on and take off. This is the simplest arrangement and with fewer components is less likely to result in technical miscount errors. This layout may be used only where layout A is not suitable.

Single track – plain track environment – two axle counter sections with Island Track Circuit

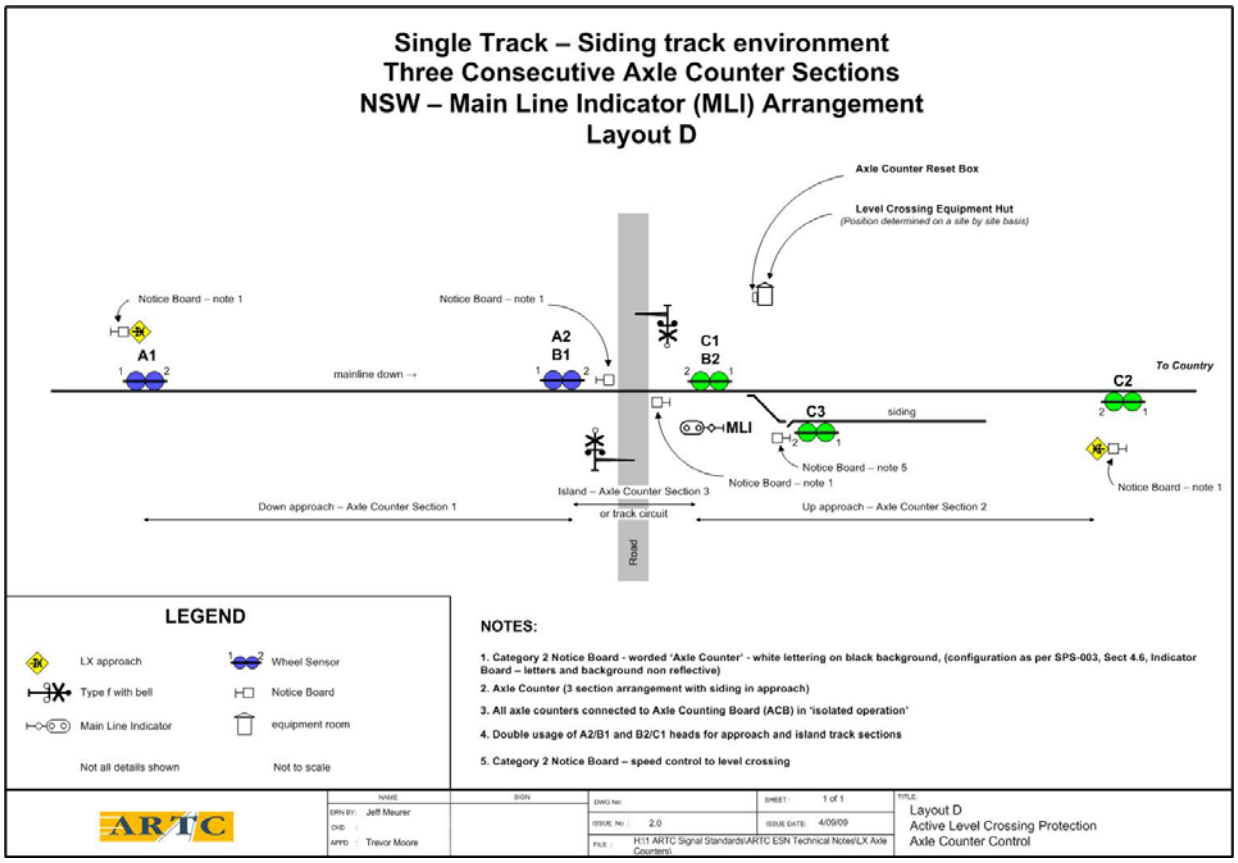


This arrangement is an improved arrangement over option A with regard to hi-rail operations i.e. hi-rail vehicles may enter or depart the crossing via the conventional island track circuit section. Independent axle counter track sections are used for the approaches. Island track protection is provided by a time delay (typically 8 seconds) on the axle counter section providing protection for the train passing over the crossing

Note (1): reliable detection of the rail vehicle wheels is maintained through the scrubbing of the rail head by road motor vehicles.

Note (2): with agreement of the local Team Manager it is preferable to identify or construct an alternative hi-rail take off clear of the crossing and use Layout A.

Single track – siding track environment – three axle counter sections with siding in approach



The approach requirements for all train paths to the level crossing shall be considered. Each approach path shall be recorded in the Level Crossing (Axle Counter) Control Table. Additional axle counters and or timing sections may be required to accommodate station stops or other regular train stopping locations.

5 Axle Counter Reset Facilities

5.1 Background

Axle counters are very accurate and very reliable. However, their failure modes are different from track circuits and they do not automatically reset when the track section is clear. They may require a reset from time to time when there is a miscount, typically for a high rail vehicle. The need for a reset for an equipment failure is very rare, but may be required for a power supply failure. Axle counters by virtue of their advantages will often be used on lightly used lines and often at remote locations far from Maintenance and Operations staff. Miscounts will cause the track section to show occupied after the passage of a train or rail vehicle. This causes continuous operation of the level crossing warning protection. A convenient procedure for resetting is important to reduce the disruption to motorists and disruption to maintainers during an out of course failure response at remote locations.

Two types of error are encountered on the Frauscher ACS2000 system:

1) Serious Error – system fault (very rare)
2) Simple Error – miscount or power restart

5.2 Reset procedure

All track sections for the level crossing will be reset using a combination of the serious and simple resets using a single switch operation. The reset switch is to be mounted in a special housing secured with an Operator key padlock. A 3 position switch, sprung to the centre, is to be used:

- Centre is the normal position, then to Reset -
- Turning to the left and holding for minimum 1 second and then;
- Turning to right and holding for minimum 1 second.
- Return to Centre termed Normal, to complete the operation;

Each axle counter track section is to be separately indicated using LED's mounted in the housing, they indicate Red for Occupied/Failed. A Green LED shall indicate track section Clear.

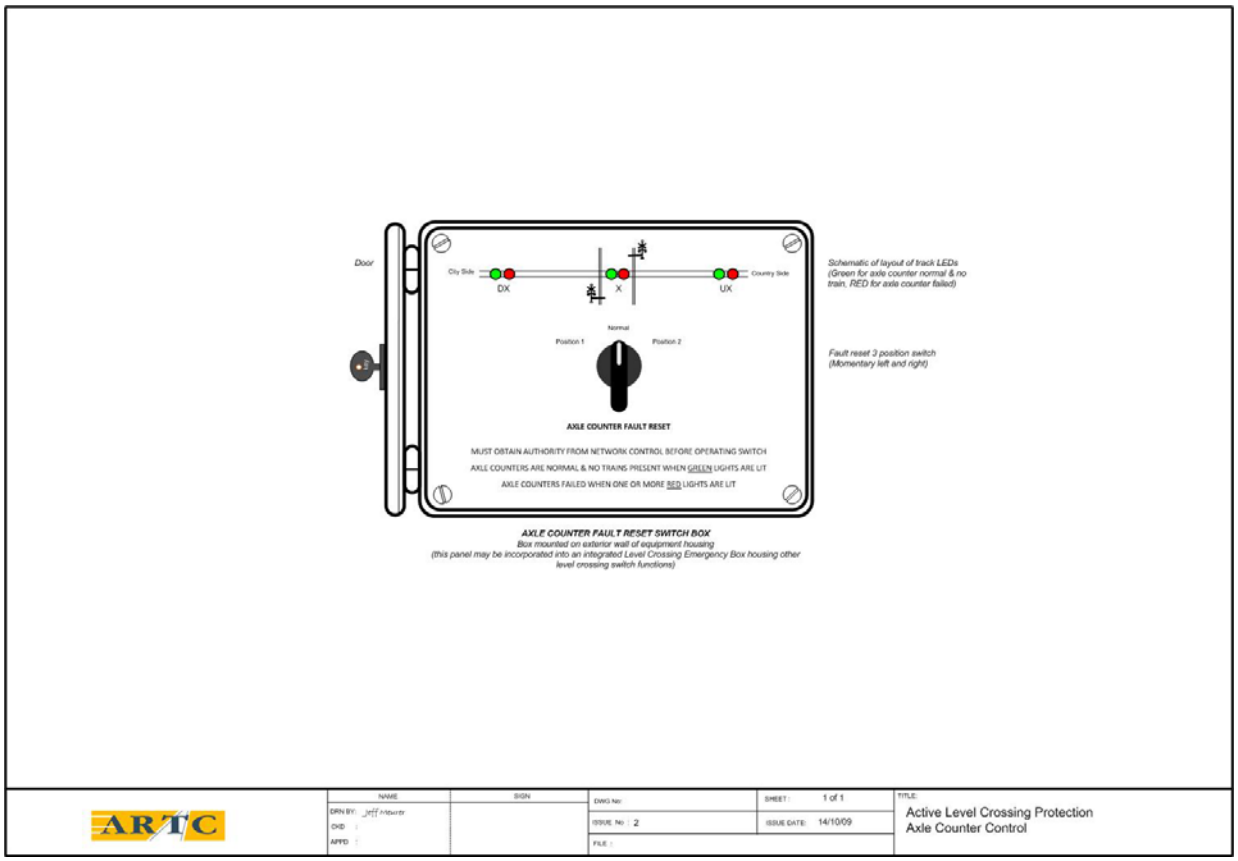
There is a 120sec timer to ensure that upon resetting the axle counters, the level crossing protection will continue to operate for a period of 120 seconds. There shall be a flashing red LED underneath the reset switch which shall indicate that the timer is timing.

One switch with three sets of contacts is used to reset the three axle counter sections.

5.3 On Site

The primary method of resetting will be by manual operation of switches on the exterior wall of the level crossing control equipment enclosure.

The box housing the switches will be secured with an Operators Key with the OP2 key warding that is captive after unlocking.



5.4 Remote

It is ARTC's intention to provide remote reset facilities on all axle counter level crossings at a later date. This remote facility will take the form of a data link to either the appropriate train controllers work station control system or to a maintenance terminal at an Engineering office location.

Dual time separated non vital inputs are to be used to provide security of information with a reset command.

ARTC requires that the reset controls provided on site are connected to an appropriately placed terminal strip on the equipment rack to allow for future connection of remote equipment at a later time.

5.5 Design to eliminate hi-rail resets

Axle Counter miscounts can be caused by the following hi-rail manoeuvres:

1) hi-rail putting on or taking off at the rail crossing, causing a miscount as a result of axles not counting in or out of the section;

   - Layout C is the most reliable hi-rail option for these activities, as the island track is a conventional track circuit and no miscounts should occur.

The initial implementation will require that the level crossing is NOT to used for Hi-rail take-off appropriate signs must be erected.

2) hi-rail passing entirely through both the crossing approaches

   - A detection 'technical' miscount in this scenario has the potential not to be identified by the hi-rail operator and could cause significant delay to road users. The hi-rail operator has departed the site and is unlikely to see the crossing continuously operating.

5.6 Sweep Train (Clearing Train)

In the case of level crossing axle counter track sections it is not necessary to require a sweep (clearing) train to pass through the section before resets can be performed *(D10002-05-2.1, page 17, section 1.7.4)*

6 Signal Design Considerations

6.1 Signal or Main Line Indicator (MLI)

At critical road locations it may be appropriate to install one or more signals or indicators on either side of the level crossing. The signals / indicators can be used to suppress the level crossing warning if an approach section fails due to miscount or other equipment fault.

6.2 Track Vacancy & Occupancy Output

Both A1 and A2 relay outputs are to be wired and the two ACB states (0&1) are to be utilised for track occupied track clear control. The A1 (Fm) output open and the A2 (P) output closed is track section occupied. The A1 (Fm) output closed and the A2 (P) output open is track section clear. The A1 (Fm) output open and the A2 (P) output open is axle counter fault and the track section should be set as occupied. The A1 (Fm) output closed and the A2 (P) output closed is axle counter fault and the track section should be set as occupied.

(D10002-05-2.1, page 18, section 1.8)

6.3 Axle Counter Reset Procedures

Administrative operating procedures are being developed that will allow authorised staff to operate the reset facilities.

6.4 Control Tables

All the requirements for the Level Crossing axle counter system are to be detailed in the Control Tables. Each level crossing shall have its own Control Table on a separate sheet or sheets. The Control Table shall detail all the design parameters to be set in the Axle Counter configuration. It shall have a separate section for each approach path and for common configuration data. The approach distances shall be defined in terms of distances, warning time and respective train speed. Special requirements for logic for the Axle Counter system shall be detailed in the Control Table.

6.5 Circuit Diagrams

Mode Jumper positions are to be detailed on the circuit diagrams.

DN Jumper positions are to be detailed on the circuit diagrams.

DIR jumper positions are to be detailed on the circuit diagrams.

6.6 Track clear / occupied output device

Output relay for vital circuits shall be WRSA QS2 or QN1 type housed in the same Level Crossing equipment enclosure as the ACS2000 system.

Alternatively direct track occupied / track clear can be wired directly into a Microlok II or crossing controller if these devices are used for crossing control.

6.7 Block Signalling Track Sections

Vital track clear information for a signal interlocking shall be derived independently from ACS2000 equipment. Vital outputs from any part of the ACS2000 equipment may only be used to directly control separate Level Crossing protection equipment (including adjacent ACS2000 systems) and/or provide monitoring of the ACS2000 system.

This Engineering Instruction permits the use of axle counters only in level crossing detection scenarios. Other ARTC design standards may permit the use of axle counters for purpose other than level crossings.

6.8 Occupied Status Time

After the last wheel leaves the track section, switching from occupied to clear occurs immediately.

6.9 Double Usage

Cables used to handover between evaluation boards should be as short as possible and maximum length of 30m *(D10002-04-1.2 page 6, section 1.3.1),* typically a 500mm "moulded network cable" straight NOT crossed (otherwise damage WILL result).

6.10 Spark suppression on load

Adequate measures are to be taken to ensure spark suppression at the load controlled by the opto-couplers of the evaluation board *(D10002-04-1.2, page 6, section 1.3.3)*

6.11 Transmission mode

Transmission mode is not approved under this Engineering Instruction, Isolation Mode is the only method approved for use due to the difficulty in testing for maintenance purposes, and complexity in testing and setting to work procedures.

6.12 Auto Cancelling after Shunting Operations

During shunting operations it is the preferred practice is to provide automatic cancellation of the crossing operation by the island track circuit energising after the shunting train clears the crossing track.

This feature should be retained wherever possible in new designs using axle counter train detection systems. If it is proposed not to utilise this arrangement then shunters push buttons must be used.

6.13 Signalling Plan

The location of strike in points and all axle counter equipment shall be detailed on the Signalling Plan. Strike in points and level crossing signs shall also be detailed on the Drivers Diagram.

The axle counter head position on either the up or down rail is to be specified on the signalling plan. Note the counting heads are normally placed on the left hand rail in the normal direction of travel.

6.14 Island Track Circuits

Any island track circuits are to be set to be longer than the longest wheelbase of rail vehicles. For ARTC this is nominated as island track circuits are not to be less than 26 metres.

7 Hardware Issues

7.1 Cables

So as to ensure almost interference free signal transmission, 7/0.50mm star-quad signalling cables are required for single and double usage heads (D10002-04-1.2, page 41) is approved for connecting between the axle counter head track side disconnection box (GAK) to the overvoltage connection board (BSI) in the equipment enclosure.

Maximum loop resistance of cable from wheel sensor to evaluation module is

At Uo=15VDC ……..25 ohm

At Uo=30VDC ……..250 ohm

The supply current at the wheel sensor is not to drop below 59 mA.

Check this section against *D10002-03-1.2, Page 10, Section 6.1*

Maximum loop resistance for wheel sensor RSR180 is 200 ohm

This implies a theoretical cable length of >10km

(D10002-04-1.2, page 43, section 3.2)

7.2 Rail Types

Many rail profiles are used on the ARTC network, particularly on light rail branch lines; the following restrictions apply to the mounting of the wheel sensor to a rail profile:

Min height of rail = 120mm, min width of head of rail = 50mm, max. width of head of rail = 78mm, min width of web of rail = 9mm, max width of web of rail = 18mm

In addition to the above restriction of the wheel sensor profile to rail there are limits relating to the ability to mount the rail claw mounting relative to the size of the rail.

Reference OEM's design application manual.

7.3 Over voltage Protection Boards

The over-voltage protection board (BSI) must be fitted as detailed in the Frauscher application guidelines.

7.4 Wheel Sensor Type

RSR180 type wheel sensor is the only approved version at this time. When setting up the axle counter head, in relation to the rail height, the ARTC approved "go/no-go" gauge is to be used.

7.5 Type Approval

The current type approved Axle Counter System and Sub System components are listed on ARTC's Internet site.

7.6 Supply Source

Two options are available:

1) Separate Supply - Generally it is necessary to connect the axle counter system to a discrete 24VDC battery supply to meet the operating input voltage range of 19 to 72 volt DC. The supply must be filtered. The capacity of the battery should operate the ACS2000 system for 36 hours continuously.

2) Alternatively a converter can be installed connected to the level crossing battery - A type approved 12VDC to 24VDC converter may be used to supply the ACS2000 system

Note: Either arrangement must provide a highly filtered DC supply. The ACS2000 is highly sensitive to spikes and over-voltage. Failure to address this issue will result in destruction of the ACS components.

7.7 Cable connectors

Cable connectors attached to the rear of the card file are to be clearly labelled as the coding on each ABP backplane is identical. Clear wiring segregation labelling is to be used to assist in clear identification *(D10002-04-1.2, page 41, section 3.1).*

7.8 Reuse of existing cables

It is generally not permissible to use existing cables other than approved new cables specifically installed for the connection between the axle counter head and the BSI (Cable Termination Frame) unless specifically approved. *(D10002-04-1.2, page 43, section 3.2)*

7.9 Cable Shielding

Cable shielding if provided shall be connected to earth. *(D10002-04-1.2, page 45, Section 5.2)*

7.10 Electromagnetic Interference

Wiring of the entire axle counter system must be designed to prevent electromagnetic spikes that could damage or interfere with the axle counter equipment. Care is to be taken in the arrangement of apparatus and wiring to ensure no interference voltages are induced by other systems including High Voltage Impulse AC track circuits (Jeumont Schneider) track equipment, electromagnetic relay coils, etc.

7.11 Partial Traversing

Software specific reset procedure can be implemented for partial traverse for example shunting trains *(D10002-05-2.1, page 17, section 1.7.5)*

7.12 ACB Types - Reset

ACB type 014 which has the required Reset configuration and the unidirectional operation is to be used for this application.

7.13 Wiring Safety Considerations

Cable connection interfaces must be designed to prevent inadvertent short circuit connection between circuit wires, or circuit and shield, on the following critical circuits:

1) A1(Fm) and A2 (P/Fm)
2) Reset
3) Counting Head Inputs

Ref (D10002-06-1.2, page 4, section 2.2)

7.14 Connector Coding

All Boards are coded to the backplane. Connectors are specific to the ACB boards. *Ref (D10002-07-1.2, page 3, section 4)*

7.15 ACB Maximum Service Inactivity

The ACB must operate at least once in every 85 days, this requires a switch from clear to occupied track status then occupied to clear, or vv. *Ref (D10002-08-1.2, page 4, section 6)*

On tracks where suspension of services occurs, eg seasonal wheat lines, a special operational procedure is required to ensure the axle counter is activated by use of a test damper prior to the resumption of train services.

NOTE: ONE TEST PLATE IS TO BE PROVIDED AT EACH INSTALLATION FOR MAINTENANCE PURPOSES.

7.16 Surge Suppression

Surge protection shall be provided in accordance with ARTC specification SCP 04 'Lightning and Surge Protection Requirements' for Electronic equipment subject to Category C exposure.

7.17 Level Crossing Monitor Interface

A level crossing monitor interface is to be provided in accordance with the standard requirements.

7.18 Main Line Indicators (MLI)

Where an MLI is used, layout D is to be used.

7.19 ACB Version

For new works only the latest approved version of module, together with the associated maintenance software, may be used.

All modules at a site (included in the same circuit book) shall use the same versions of modules on the same ARTC acceptance certificate.

7.20 Standards & Procedures update

Operations, maintenance and Safeworking procedures, including amendments to routine maintenance and testing standards e.g. ESM-07-01, ESM-07-02 and ESM-03-01 (proposed), shall be published by ARTC before the equipment is commissioned.

7.21 Standard Typical Circuits

For use in accordance with ARTC specification SDS 25 and standard typical circuits developed and/or approved specifically for ACS2000 equipment.

8 References

Data used to compile this Engineering Instruction:

Frauscher - Axle Counter Application Guide D1413-1e (2/1/02)

Frauscher - System Description D10002-02-1.2 (2/7/04)

Frauscher - Axle Counter Mounting & Commissioning D1414-2 (31/1/02)

Frauscher - Axle Counter Mounting Instructions for Overvoltage Protection Boards D1653-2e (30/7/04)

Frauscher - Axle Counter ACS2000 Diagnostics D2167-2 (17/11/06)

Frauscher - Axle Counter Structure of Documents D10002-01-2.1 (19/1/05) Parts 1,2,3,4,5,6,7,8,9,10,11,12

WRSA – Burgins Rd Level Crossing – Request for Approval

VLine – Burgin's Rd Level Crossing – 23/3/07 - Provisional Type Approval

Railway Group Standard – Introduction of Axle Counters – Managing the Risk – June98

Railway Group Standard – Introduction and use of Axle Counters – Managing the Risk – Feb03

Railway Group Standard -Resetting and Restoration to Service of Signalling Systems – June98

ARTC – Engineering (Signal) Instruction- Resetting Axle Counters – ESI 06-02 – 8/11/06

ARTC – New Equipment & Systems Type Approval – Axle Counter System – 08-08-10-009 – Apr05

ARTC – Engineering Standard Signalling – Level Crossings ESD 03 01 Sep 09

ARTC – Technical review workshop May09