Division / Business Unit:	Safety and Systems
Function:	Signalling
Document Type:	Standard

Design of Frauscher Axle Counters

ESS-05-05

Applicability

ARTC Network Wide

Publication Requirement

Internal / External

Primary Source

ESD-05-15

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.0	Jan 25	Standards	Stakeholders	Principal Signalling Engineer	Manager Engineering Services 17/01/2025

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	Jan 25		Document is renumbered from ESD-05-15. Included COM board redundancy as recommended by Frauscher.

Table of Contents

1 Introduction

1.1 Purpose

The purpose of this document is to provide a consistent approach and guidance for the design of Frauscher axle counter system for signalling application.

These requirements may be exceeded where there is a benefit to a particular project or installation.

1.2 Scope

This document covers design guidance for Frauscher FAdC axle counting systems deployed on the ARTC network for the purpose of rail vehicle detection.

This document is applicable to entire ARTC network.

1.3 Standard Owner

The Manager Engineering Services is the Document Owner. For any query, initial contact to be made at standards@artc.com.au.

1.4 Responsibilities

The Signal Design Engineers, Project Manager, Project Signal Engineers, Signal Maintenance Engineer and Business Unit Managers are accountable for implementation of this document. This is necessary to ensure consistency, maintainability, and reliability of the Signalling System.

This is applicable to all personnel who may have a requirement to be involved in the design and/or system development of Frauscher FAdC axle counting systems.

1.5 Reference Documents

Frauscher Documents

D20002	Installation / Operation - Frauscher Advanced Counter
D20003	Maintenance - Frauscher Advanced Counter FAdC R2
D20001	Design and Planning Manual – Frauscher Advanced Counter FAdC R2
D20006	Frauscher Diagnostic System FDS001 for FAdC
D21000	Brief description – Frauscher Advanced Counter FAdC-R2
D21001	System Documentation – Frauscher Advanced Counter FAdC R2
D21004	Brief description Advanced Service Display ASD101
D4181	Design and application of supervisor sections for axle counting system FAdC - R2
D4182	Reset options for the axle counting system FAdC - R2
D4183	Design and application of Counting Head Control for axle counting system FAdC - R2
D21003-3	Checklists for SABs FAdC R2

Australian Standards

AS 7651	Axle Counters

ARTC Standards

ESS-05-01	Resetting of Frauscher Axle Counter System
ESD-05-14	Frauscher Axle Counter Systems
ESA-11-01	Cables for Railway Signalling Applications - General Requirements
SDS 25	Signalling Circuit Design Standards
ESD-03-01	Level Crossing Design
ESS-09-02	Signalling Power Systems
ESD-25-01	CAD and Drafting Manual for Signalling Drawings
ESD-25-03	Signalling Documentation and Drawings

1.6 Definitions and Abbreviations

The following terms and acronyms are used within this document:

Term or acronym	Description
ASD	Advanced Service Display
FdS	Frauscher Diagnostic System
GAK	Trackside wheel sensor cable disconnection box
RSR-180	Frauscher axle counter wheel sensor
SV	Supervisory Section

2 General

This document outlines the requirements for design of Frauscher Axle Counters and methods of achieving these requirements in the design and system configuration.

Axle counter design and configuration shall comply with:
The ARTC Signalling Engineering Standards.
The Frauscher FAdC manuals.
Signalling Functional Specification, Signalling Design Brief, or other applicable documents.

3 Site Configuration

Axle counters operate as a system rather than individual discrete units such as more traditional track circuits. Axle counter track section share a common wheel sensor – so one individual wheel sensor counts axles out of one-track section and into the next at the same time. For this reason, it is important to consider track layouts.

3.1 Positioning of Wheel Sensors

The positioning of axle counter wheel sensors is flexible within the system layout. The signal design shall be developed such that wheel sensors are placed on the same rail for an installation where practical and prefer to be on the outside rail (left handrail). In a single track arrangement this may be adjacent to the buried cable route.

3.2 Design of Wheel Sensors

The design of an axle counter wheel sensor provides direction information into the axle counter system that is used as part of the system functionality to determine correct track section occupancy. In installations where an axle counter system is directly connected to a CBI, this directional information can be used within the system data to validate direction that corresponds to a particular route.

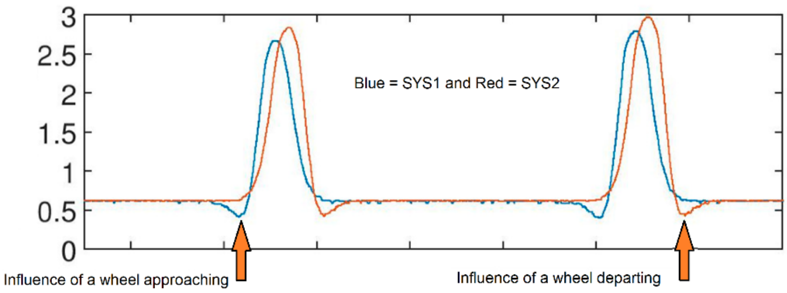


Figure 1 - Typical Waveform of 2 wheels passing over a Wheel Sensor

3.3 Identifying axle counter equipment

3.3.1 Identification of track sections

Axle counter track sections are to be numbered and/or named in compliance with ARTC's standards and practices for track circuits.

3.3.2 Identification of wheel sensors

Axle counter wheel sensors shall be numbered according to their corresponding cardfile AEB number.

The wheel sensor ID shall take the form of the letter Q followed by the AEB ID that the wheel sensor is connected to in the axle counter system. For example: - Q57.

Adequate planning shall be required where adjacent axle counting systems are implemented as train detection systems such that the Q number IDs shall not be similar to nearby wheel sensors connected to a different axle counter system or interlockings.

3.3.3 Presentation on drawings

When showing axle counter wheel sensors on a Signalling Arrangement Plan (SAP), the symbols to be used shall be as shown in Figure 2.

The Track Insulation Plan (TIP) shall include the additional detail of wheel sensor location KM and which rail the wheel sensor is to be mounted on as shown in Figure 3.

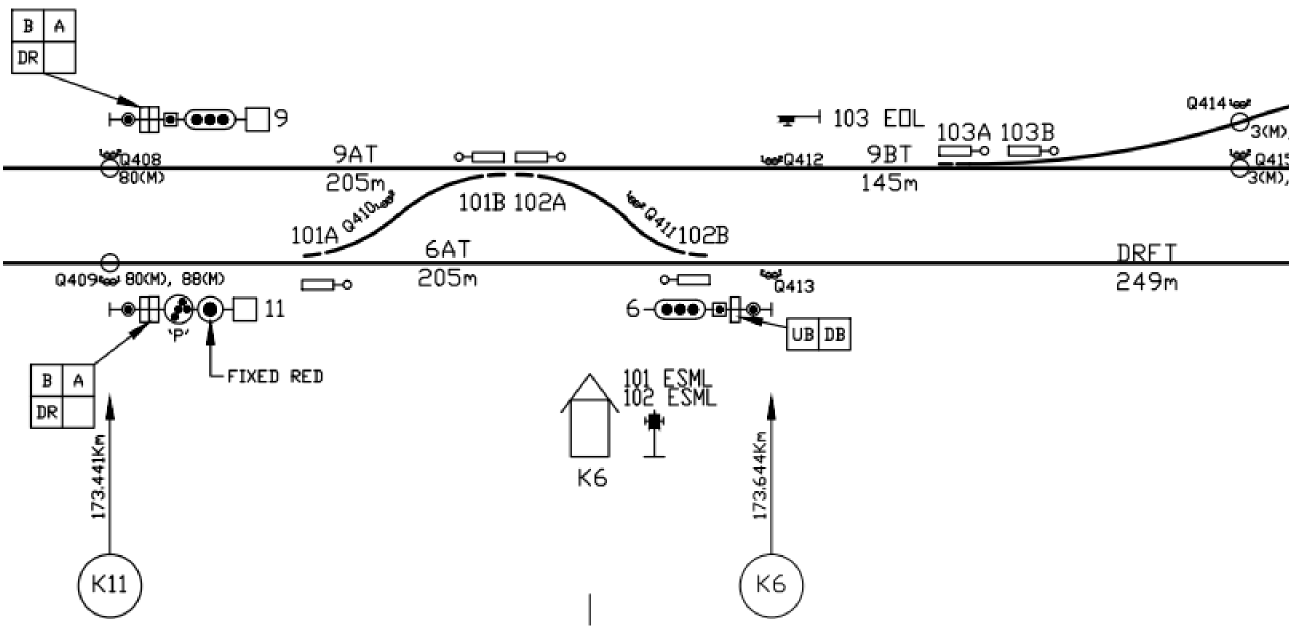


Figure 2 - Presentation on SAPs

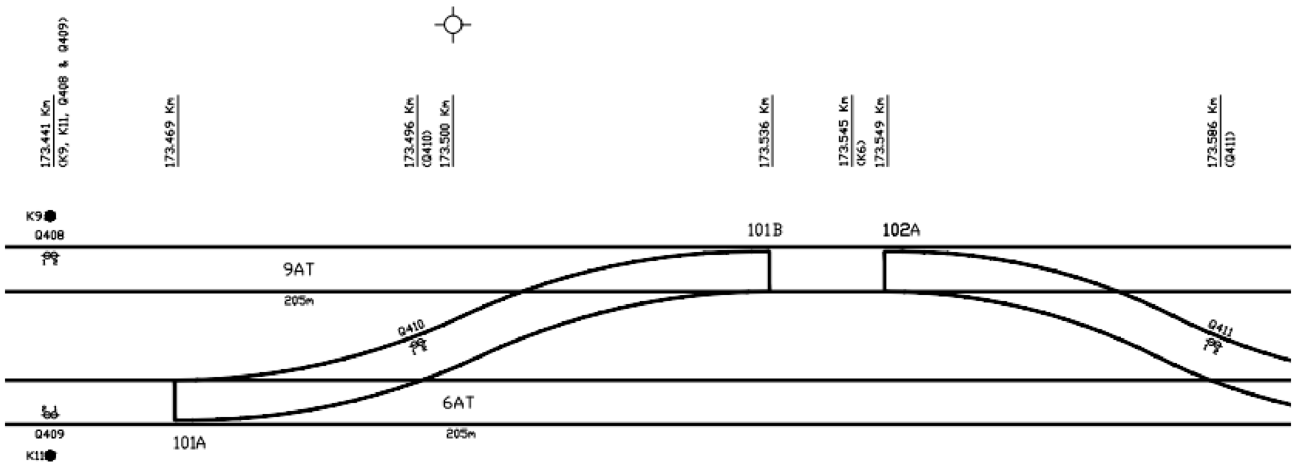


Figure 3 - Presentation on TIPs

3.4 Managing Hi-Rail Operations

In some sections of the network there may be a requirement for hi-rail or similar vehicles to 'on rail' or 'off rail' within axle counter train detection systems areas. In these situations, it is preferable to not include maintenance or other little used or short sidings within the train detection system. This will eliminate the requirement for axle counter resets as part of normal maintenance activities.

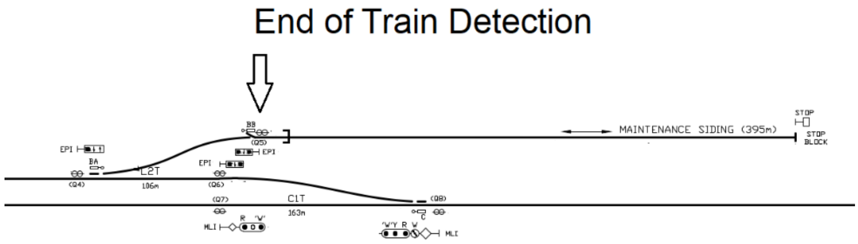


Figure 4 – Proposed Typical Arrangement for Hi-Rail Usage

3.5 Partial Traversing

Where shunting or regular reversing of rail traffic may occur in an area that uses axle counters as the train detection system, it is important to design the location of wheel sensors such that they are not within areas where rail traffic may reverse or stop. As a rail wheel approaches a wheel sensor, the wheel sensor becomes influenced by the wheel and when a wheel passes over a wheel sensor without stopping a valid count occurs. Should a wheel approach a wheel sensor and stop within this area of influence a miscount can occur – regardless of the direction that the wheel moves. This is called a Partial Traverse. The axle counter system can tolerate up to a certain amount of influence of an approaching wheel and will record a partial traverse without a disturbance, but once the threshold has been attained a miscount occurs.

3.6 Use of Axle counters at Turnouts and Crossovers

Where axle counters are applied over turnouts or diamond or switch diamond crossings, the location of wheel sensors shall consider the clearance points between turnout lines. In the example below the Down crossover track section is bounded by wheel sensors Q3, QX and Q5 and the Up crossover track section is bounded by Q2, QX and Q4 – with a common wheel sensor QX between the Up and Down line.

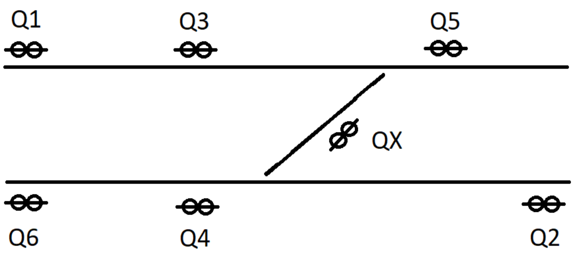


Figure 5 – Proposed Typical Arrangement for a standard Crossover

4 Resetting Axle Counters

Axle counter manufacturers design their systems to be able to be reset in a number of ways – including some internal functionality that manages resets automatically when certain conditions are met within a system.

Refer to ESS-05-01 – Resetting of Frauscher Axle Counters and Frauscher manuals for details.

5 Configuration of Axle Counter System

5.1 Indoor Equipment

Axle counter indoor equipment wherever possible should be installed within a single cardfile housing and may be spread across a number of backplanes as per the system design requirement. The overvoltage protection (BSI) shall be located at the point of entry of the cables and connected to the signalling earth in accordance with the Frauscher manual D21001 – System documentation.

Where relays are used, electrical noise generated by de-energisation of the relays may interfere with the axle counter cardfile. In the design signal designer may consider relays controlled by an output circuit from axle counter cardfile to be snubbed with a 1N4007 diode fitted in the reverse direction across the coil. This method may be considered for 12VDC, 24VDC, and 50VDC relays and it may not be suitable for other polarised circuits. Where designer decide to fit the diode across the relay coil, consideration should be given to the requirement in the design for AC immunity of the relays.

5.2 Wiring and Cables

Wiring connections between the 'RSR180' connection and the BSI inside the location box shall be 'star quad' shielded cable. Wiring connections between the plug couplers of the cardfile backplane and the wiring changeover termination strip should be 0.25mm2 as per the Frauscher requirement.

Cables between the BSI and the trackside box (GAK) shall be 'star quad' shielded cable. Loop resistance of the cable between RSR180 and AEB shall not exceed 250 ohms.

External cables between the location and the GAK are generally laid up as star quad as per OEM technical requirements. Cables between the RSR180 and the GAK shall be moulded and attached with the RSR180 wheel sensor. These cables are available in different lengths.

Refer ARTC standard ESA-11-01 – Cables for Railway Signalling Applications – General Requirements for internal wiring and cables.

5.3 Power Supply Boards

FAdC R2 arrangements can be configured for single or redundant Power Supply boards (PSC). Preference should be given to two power supply cards to allow redundancy in the system. Where redundant power supplies are used the PSCs may be located on the separate backplanes with the power connections jumpered between two power supply cards. A backup battery is required for the axle counter systems. For more information, please refer ESD-05-14.

5.4 I/O Transmission

Where there is a requirement to transmit I/O information to and/or from remote axle counter cardfiles, the following should be considered as per Frauscher requirement:

Where Dual or Quad modes are used in the design, the relay output should have I/O-EXB switching contacts in both positive and negative legs of the coil circuit.

Intermixing of Single, Dual and Quad modes is not permitted on the same I/O-EXB as per the Frauscher requirements. Refer Frauscher manual D21001-6.

Where the number of locations is small, to simplify wiring arrangements separate I/O-EXBs should be used. For example, where a level crossing has a central location and 2 remote locations that have separate axle counter cardfiles where I/O data is transmitted to the central location, then there shall be a I/O-EXB for each location.

Where the number of locations are large, I/O information may be 'daisy chained' from output to input of the same I/O-EXB to send the I/O data onwards to the next location along the communications network.

5.5 Connection to Interlockings

The vital interface between the axle counter system and the interlocking system should comply with requirements detailed in this section. Any equipment failure shall provide failsafe track occupancy information to the interlocking system.

5.5.1 Relay Interface

For relay or CBI systems where there is no Frauscher approved COM-xxx module, the interfacing should be by relays. In this arrangement the relays provide galvanic isolation between the systems.

Any other interface should be agreed and approved by local signal maintenance engineer.

5.5.2 Direct Parallel Interface

Direct track occupied / track clear may be wired directly between an axle counter parallel output device and a type approved object controller where these devices are used for interfacing to the interlocking.

Device combinations for this purpose shall be approved for use with both the signal interlocking system and the axle counter system in accordance with manufacturer documentation and type.

5.5.3 Direct Serial Interface

For Computer Based Interlocking (CBI) where there is a Frauscher approved COM-xxx module, the interfacing may be by direct connection. In this arrangement there is no requirement for any interfacing relays as all I/O is passed across a network connection cable using a 'Safe Ethernet' protocol.

COM board redundancy shall be provided in such a way that failure of a card does not result in loss of communications to the axle counter system or affect the operations of the Axle Counter System.

This data may be in the form of track section occupancy status, or, may be wheel sensor count data such that the CBI carries out the track section occupancy status. The CBI may be in a remote location.

Communication between the CBI and the axle counter system shall comply with EN 50159. The required Category of the transmission system will depend on meeting the preconditions listed below:

1. precondition 1 – the number of pieces of connectable equipment to the transmission system is known and fixed
2. precondition 2 – the characteristics of the transmission system are known and fixed
3. precondition 3 – the risk of unauthorised access to the transmission system is negligible

Closed transmission system (Category 1)

- the transmission system satisfies all preconditions

Open transmission system (Category 2)

- the transmission system satisfies precondition 3 but not precondition 1 or precondition 2

Open transmission system (Category 3)

- the transmission system does not satisfy precondition 3

Protocols for this purpose shall be approved for use with both the signal interlocking system and the axle counter system in accordance with manufacturer documentation and type approval conditions.

5.6 FdS System Logger

FdS shall be installed to diagnose the axle counter system. The connection from the COM-xxx or COM-AdC module to a FdS logging system is preferred via Ethernet link. The IP address for this unit shall form part of the configuration files. Where both E1 and E2 have been configured as Ethernet communication bearers, the FdS may be connected into the Ethernet system by way of a router, port multiplier or other similar device. Maintenance staff should be able to remotely access FdS, where in a location with 4G/5G or other remote access.

5.7 Communication Link

Communication links for remote axle counter cardfiles to effectively communicate, can be:

- Fibre Optic Cable – via an approved modem or controlled network switch.
- Radio Link – Additional encryption may be required to improve the security of the data being transmitted. System shall be able to be configured to manage the levels of data as per the requirement.
- Copper cable – Where Axle Counter cardfiles are located in close proximity and CAT5 cabling arrangement do not exceed the distance specified by industry standard.

Patch leads for connecting E1 and/or E2 ports on the COM-xxx or COM-AdC module to another communication device should be moulded CAT5 telecommunications cable using 24 AWG wire and preferably in green colour.

Patch leads for connecting CAN bus's between backplanes are to be moulded CAT5 or CAT6 telecommunications cables and shall not have metal shrouds. The preferential colour is green.

Communications links shall have galvanic isolation between the axle counter cardfile equipment and any external circuits. Opto-isolators, or transformers are normally used to provide galvanic isolation.

Where there is no requirement for connections to be made in Ethernet ports E1 and/or E2 of the COM-xxx or COM-AdC module, blanking plugs shall be inserted into all unused Ethernet ports to protect against an inadvertent insertion of an ASD cable. Where redundancy is required both E1 and E2 ports on the COM-xxx or COM-AdC module are to be configured as active.

5.8 Axle Counter Equipment Housing

Axle Counter equipment housing and cable routes shall comply with ARTC Standards and Specifications. The equipment location layout shall provide:

- Layout of equipment
- Equipment for surge protection.
- Layout of equipment and wiring to reduce electrical noise and temperature effects.

Cable routes positioning should consider the proximity to high voltage earth for Earth Potential Rise issues and surge protection issues.

Duplicate communication cables or diverse cables shall be physically separated or have physical protection so that likelihood of both cables getting damaged in the one incident is minimised.

6 Configuration File

The files required to configure a FAdC cardfile should be generated by Frauscher utilising the information contained in the Frauscher configuration questionnaire for the scheme and signal design.

Once the files have been generated and a valid CRC number and verifier information added to the files, they can be loaded onto the CF flash memory card in a folder entitled “CONFIG”. After inserting the memory card into the COM-xxx or COM-AdC module, the cardfile is powered up and the files will be executed within the system to configure all modules in use. FAdC R2 - System Documentation – Frauscher Advanced Counter FAdC R2 - D21001-2 should be referred for creation of the configuration files. Configuration files are generally based on or derived from the Signal Functional Specifications, Signalling Design Briefs and/or Frauscher requirements Designers are to ensure that the configuration files are produced utilising the current approved Frauscher developed templates and CRC generation software.

For FAdC R2 system there is a single file to configure the COM-xxx or COM-AdC module.

While producing configuration files, designer identifies the system configuration requirements such as the axle counter modules, cardfiles and backplanes to be used, system interconnects (CAN bus and power), vital and non-vital I/O requirements, and other requirements. The configuration files are created utilising a standard text editor to create the data file. It is recommended that NOTEPAD++ be used for this purpose. This file is given a filename extension of “ADC”.

For processing of the completed configuration files, the Frauscher Checksum Calculator software is to be used. This software calculates a CRC number and adds this to the end of each file processed and resaves the file with the same file name and extension. The Designer shall then add the “verifier” information to each file Before saving the file. In case there is a formatting error or a reserved word, the Checksum Calculator, will return an error with a line number and not add a CRC to the end of the file. System cycle and response times may be adversely affected by configured CAN bus timing and Network delays. Checksum calculator will not detect the logical errors and hence final configuration shall be tested to confirm that system operates as required.

6.1 Configuration File Header

In addition to the standard templates supplied by Frauscher to persons who have undertaken the appropriate FAdC design training, the following additional information is to be inserted at the beginning of the file. This additional information allows tracking of changes to maintain where alterations to the system configuration are required.

```
//
// AUSTRALAIN RAIL TRACK CORPORATION (ARTC)
// LOCATION NAME - ANY TOWN
// LOCATION TYPE - LEVEL CROSSING
//
// FAdC AXLE COUNTING SYSTEM CONFIGURATION FILES
// CRC CHECKSUM VERSION: 2.01
//   ===================================================================
// WARNING
// ALTERATION OF THIS FILE MAY COMPROMISE THE SAFE
// PERFORMANCE OF THIS PROGRAM AND THE AXLE COUNTER SYSTEM
//   ===================================================================
// DESIGNED BY         Joe Designer
// COMPANY             XYZ SIGNAL DESIGN COMPANY PTY LTD
// DATE                10 December 2021
// JOB NUMBER          EJ051234
// JOB TITLE           UPGRADE Track Circuits TO AXLE COUNTER
// FILE NAME           C0001_00.ADC
//   ===================================================================
// CURRENT REVISION NO. 005
//   ===================================================================
// DATE                10 December 2021
// DESIGNED BY         ABC Designer
// REVIEWED BY         DAVID REVIEWER
// VERIFIED BY         PHIL VERIFIER
// APPROVED BY         MARTHA APPROVER
//   ===================================================================
// PROGRAM REVISIONS
// REV COMMENT                       NAME              DATE        TIME
//   -------------------------------------------------------------------
// 001 INITIAL DESIGN                J.DESIGNER        05/06/2021  1130
// 002 ADD SIDING SENSORS            J.DESIGNER        08/06/2021  1310
// 003 REMOVED DUPLICATION           A.HELPER          11/08/2021  1530
// 004 MAJOR UPDATE                  J.BLOGGS          20/10/2021  1030
// 005 ADD LX BARRIERS               J.DESIGNER        22/10/2021  1430
//   ===================================================================
// NOTES :
//
//
//
// ===================================================================
//
```

7 Design

The typical arrangements for interface wiring between axle counter cardfiles and other equipment provide guideline to signal designer for ensuring consistency between applications.

7.1 Axle Counter Overview The easiest design is to place the track evaluation IO-EXBs adjacent to AEBs 4 and 5 at the end backplane positions. When AEB 4 evaluates DXT and XT a fault at AEB4 or a fault of the individual wheel sensors (Q1, Q2 or Q3) will lead to occupied sections.

It is better to link IO-EXBs to AEBs where their own wheel sensor/s is/are part of the output section.

7.2 – Cardfile Design - This design layout shows the preferred rack arrangement with the correct labelling of the cardfile – front and rear. The rack layout shall show the correct labelling conventions – front and rear.

7.3 – Ethernet Connections, including FdS where used - Where both COM-xxx or COM-AdC Ethernet ports are used, the FdS will be connected to the system via a network switch or similar router device. The configuration files will show the complete IP arrangement of where the diagnostic information will be routed to.

7.4 –Trackside Equipment Connection arrangements - This design shows the typical direct wired arrangement of wheel sensors

7.5 – Relay outputs (Quad and Single), Reset inputs, Power and CAN Bus jumpering.

The easiest design is to place the Fm relay in the final part of the circuit connecting R2 directly to the N24 bus. In this situation the Fm relay is still susceptible to interference through the N24 bus. It is better to place the Fm relay as shown so that both sides of the coil are switched through the Quad switching arrangement within the IO-EXB.

7.6, 7.7 and 7.8 – Axle Counter Reset Switch arrangement

For FAdC R2, where multiple Supervisory Sections (SVs) may be configured, the pre-reset / reset wiring shall be provided to the portion of the AEB where the master SV resides. Consideration may be given to adding other SV sections to be reset – this will be dependent upon the system layout and configuration and needs to be mandated by the Signalling Functional Specification.

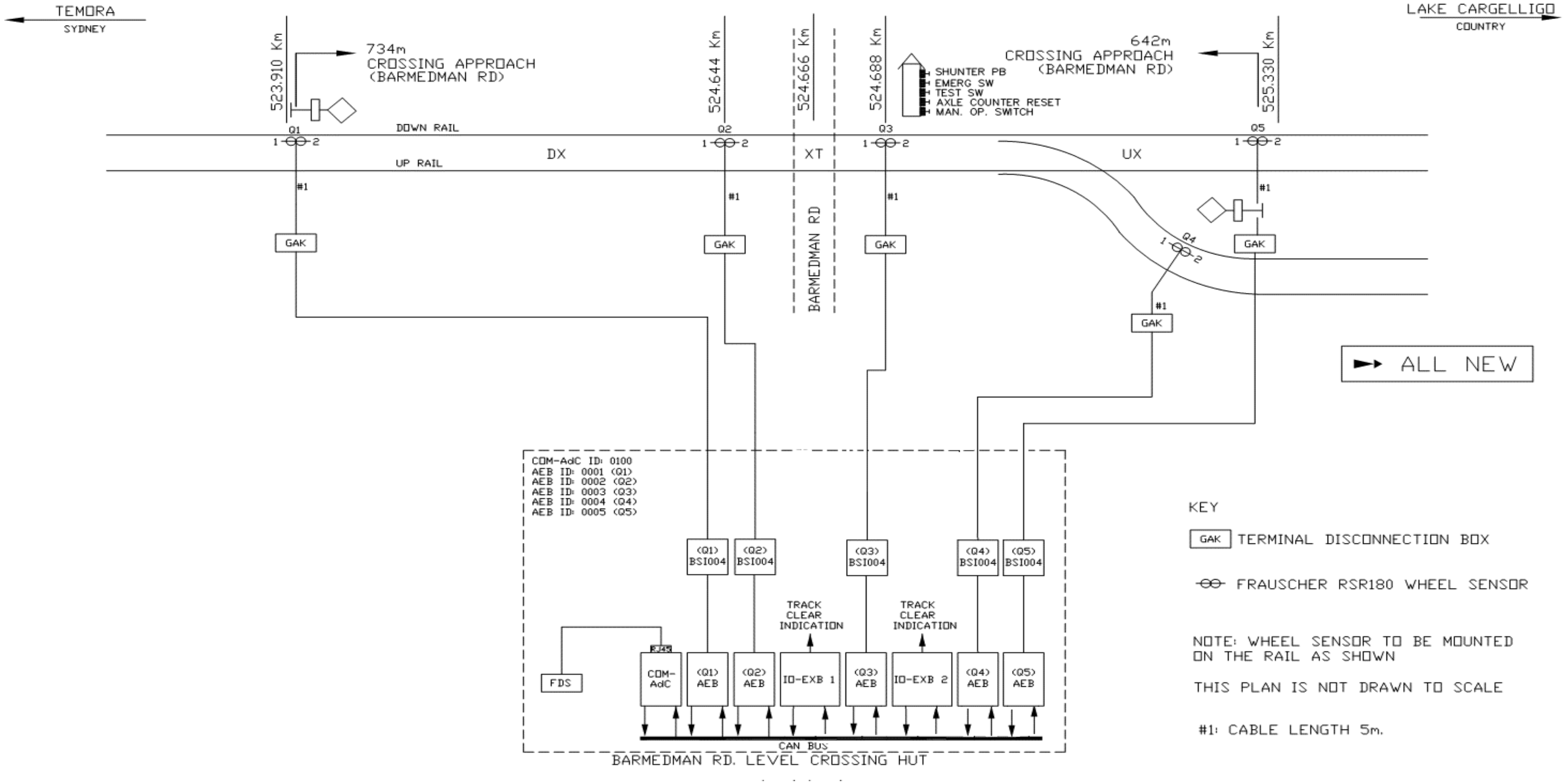
There shall be no requirement for an independent set of pre-reset / reset contacts used to reset each AEB's track section. This will mean for a 3 track level crossing with a single SV configured, only a single switch will be required. The current practice of using an independent set of contacts to reset each track section will be discontinued. Where multiple SVs may be used, a single switch may still be used, paralleling AEB pre-reset / reset inputs as required. The individual track section indications will still be required to be shown in the reset box.

7.9 to 7.11 – DIP switch settings

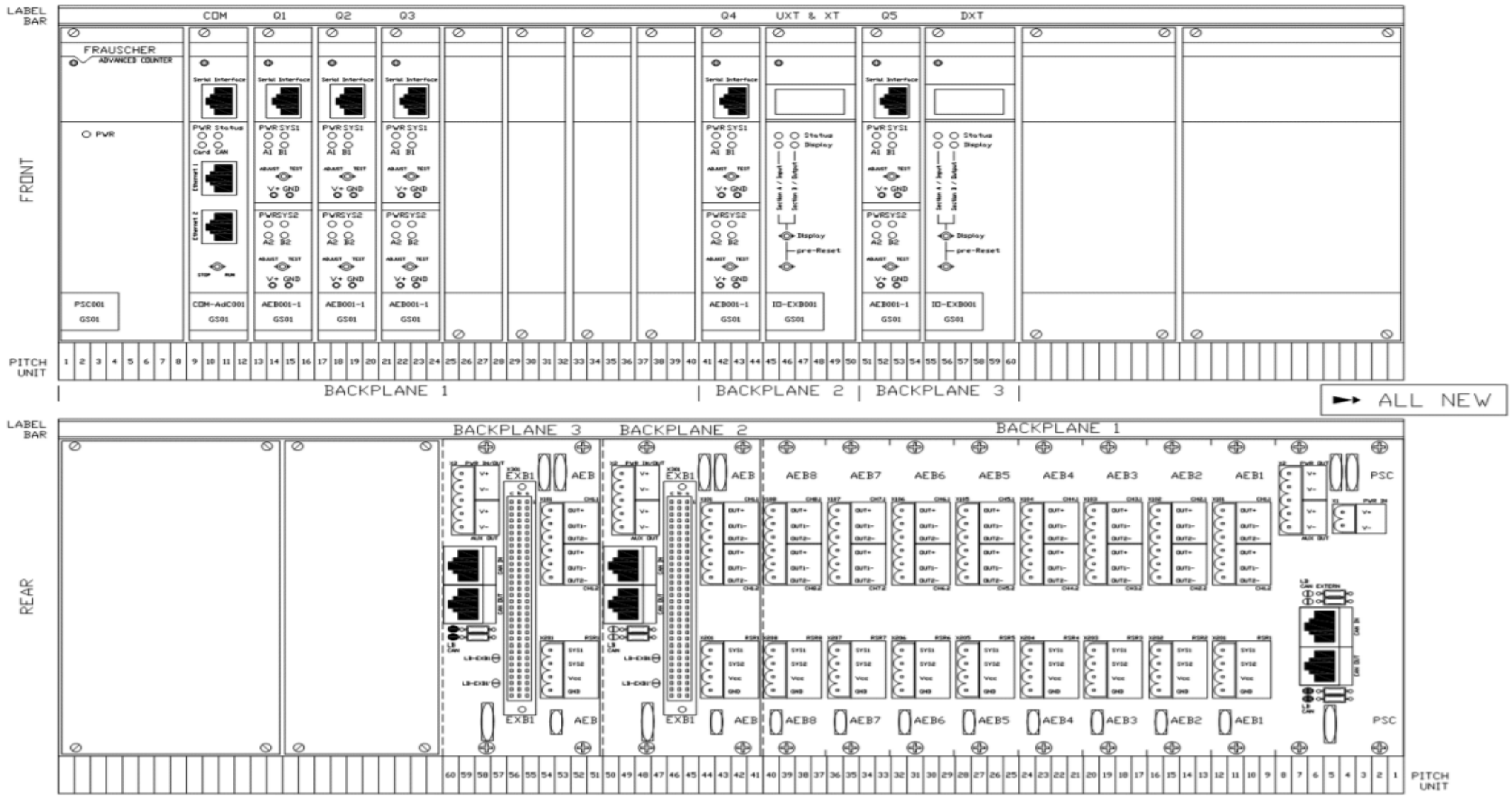
It provides DIP switch settings which will be based on actual design requirements.

7.12 represents the preferred method of power supply arrangement.

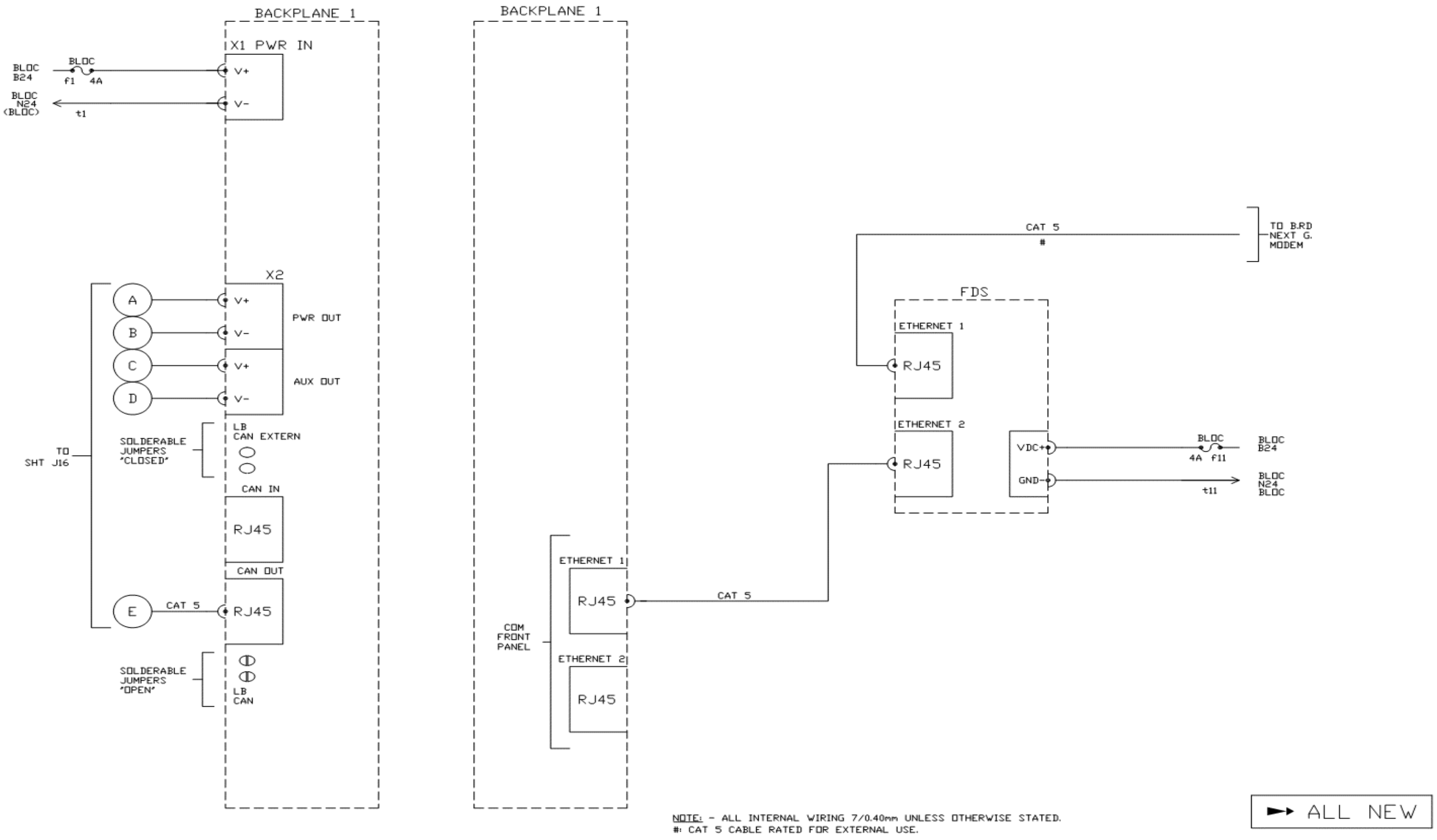
7.1 Axle Counter Overview



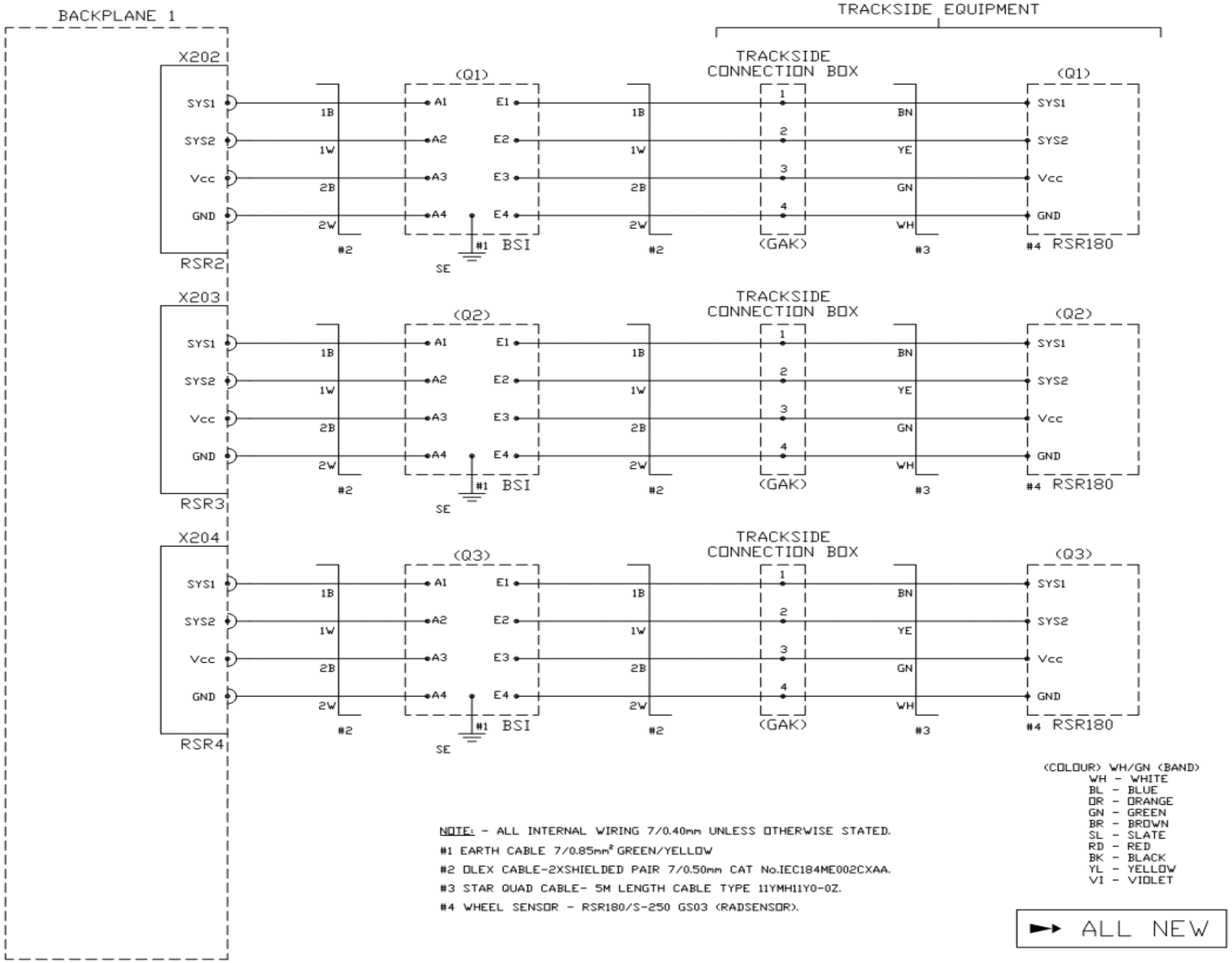
7.2 Cardfile Design



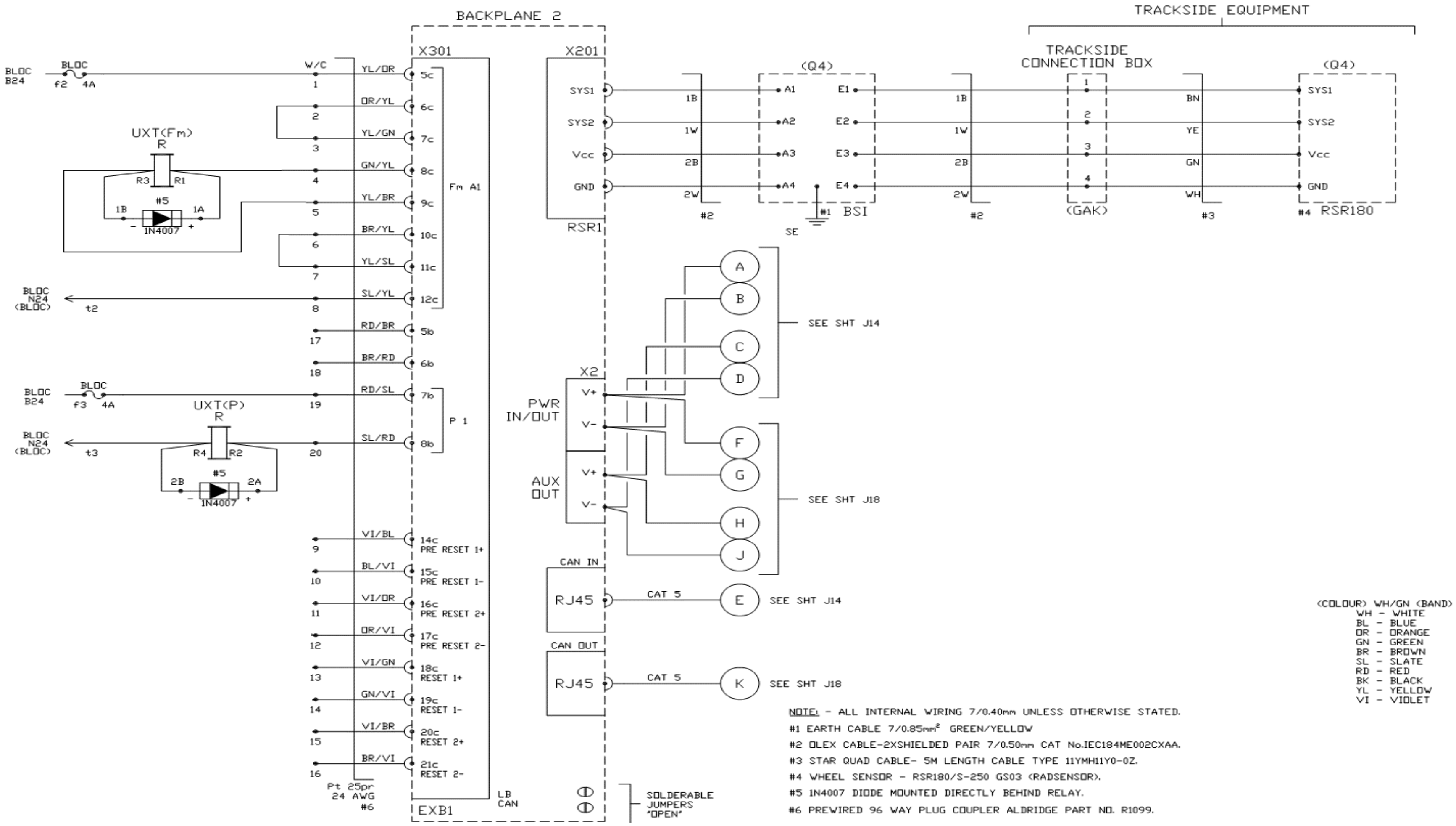
7.3 Ethernet Connections, including FdS where used.



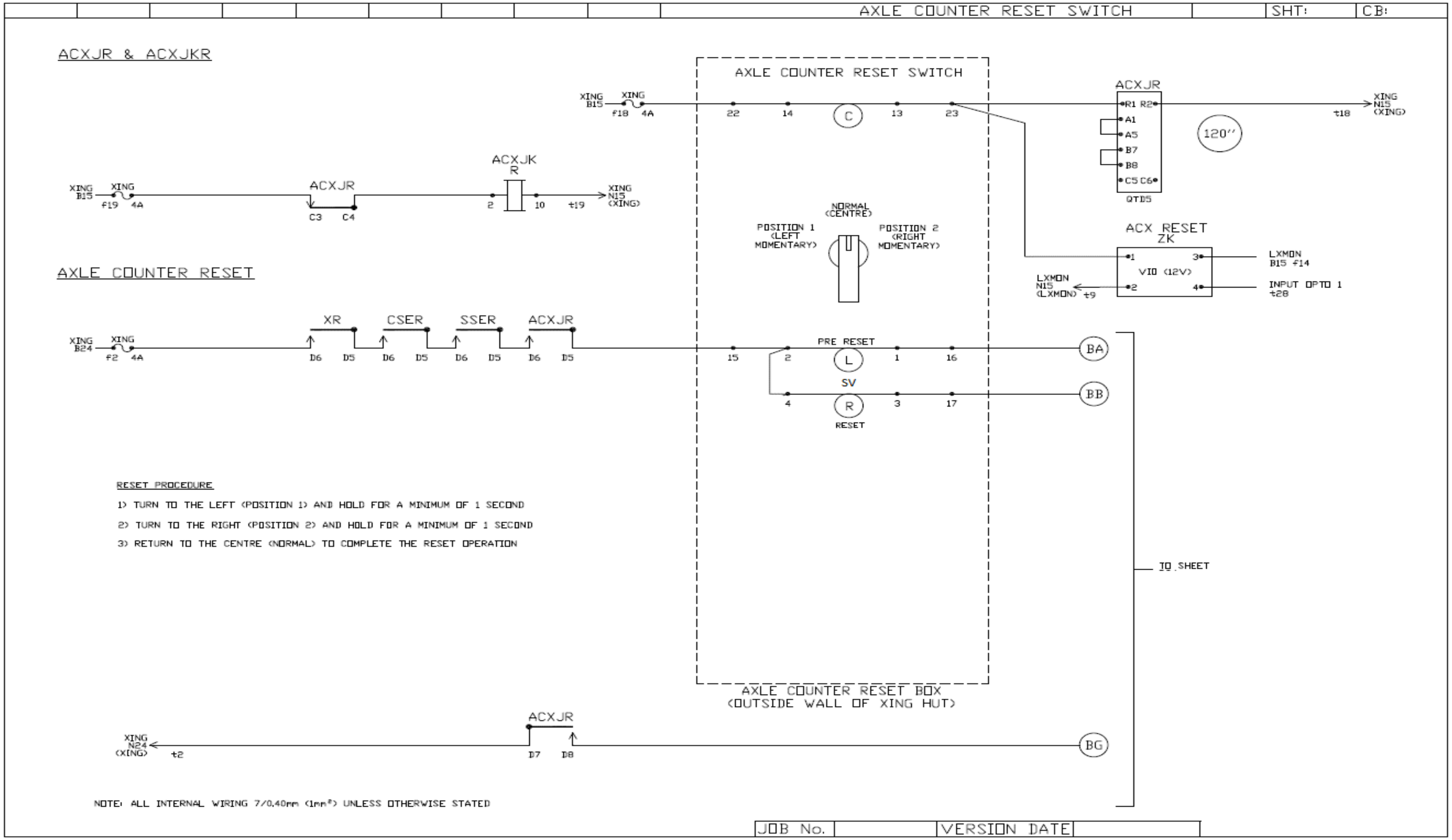
7.4 Trackside Equipment Connection arrangement



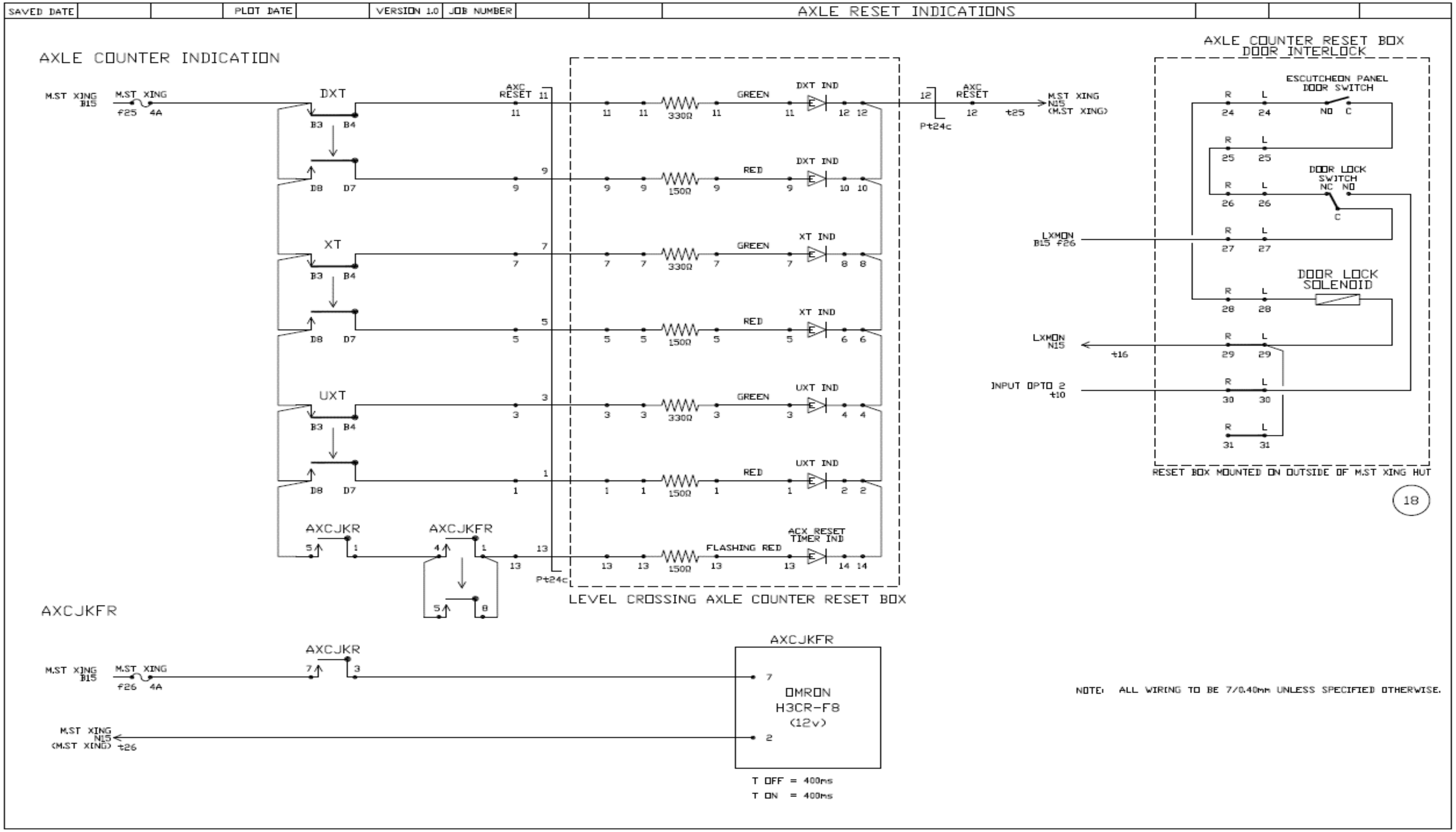
7.5 Relay outputs (Quad and Single), Reset inputs, Power and CAN Bus jumpering.



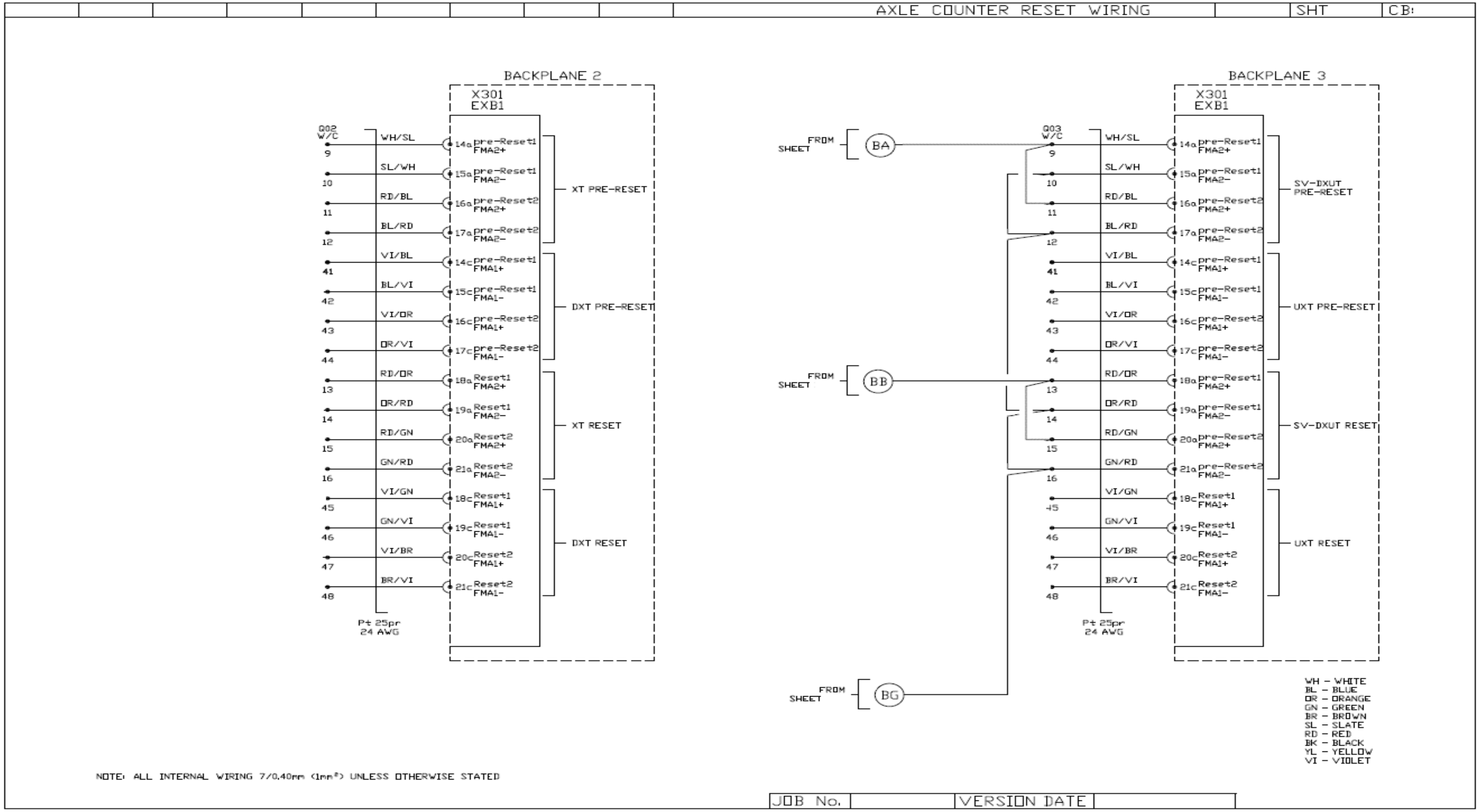
7.6 Axle Counter Reset Switch arrangement – Sheet 1



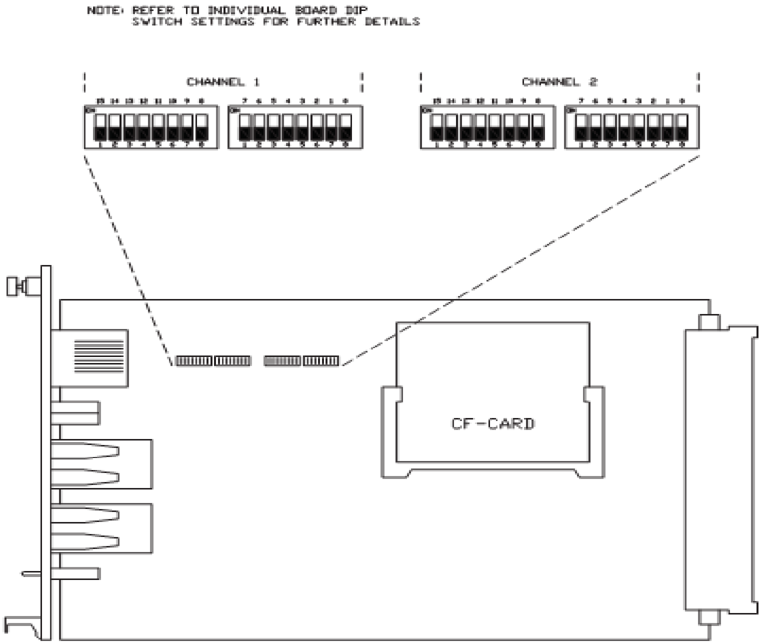
7.7 Axle Counter Reset Switch arrangement – Sheet 2



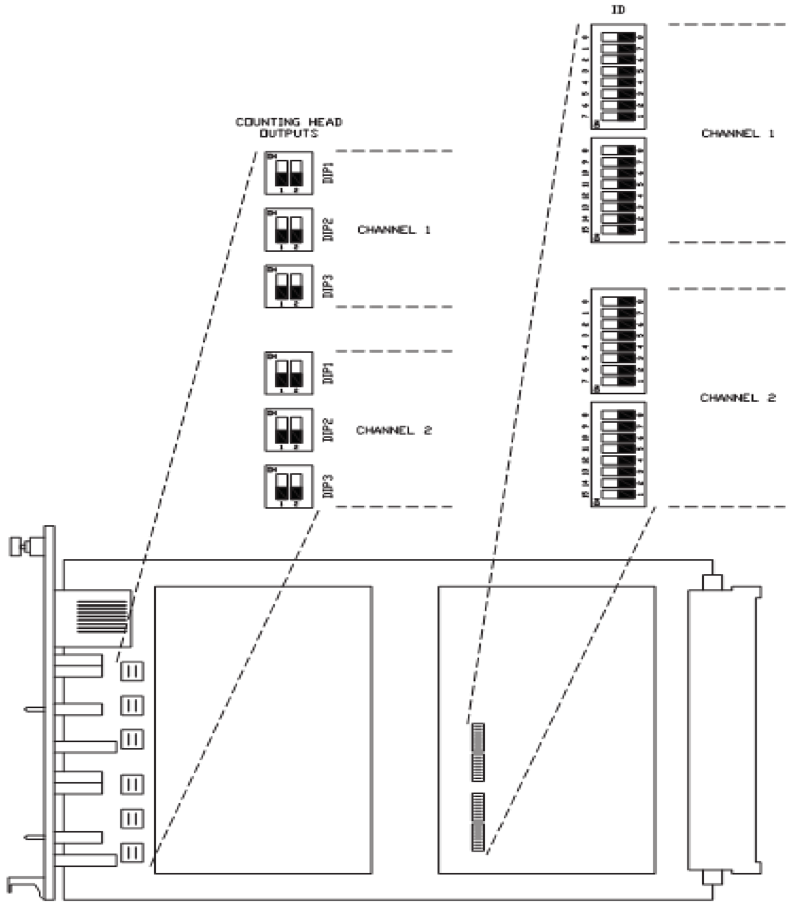
7.8 Axle Counter Pre-Reset / Reset wiring on I/O EXB



7.9 DIP Switch settings sheet 1 – General Layout

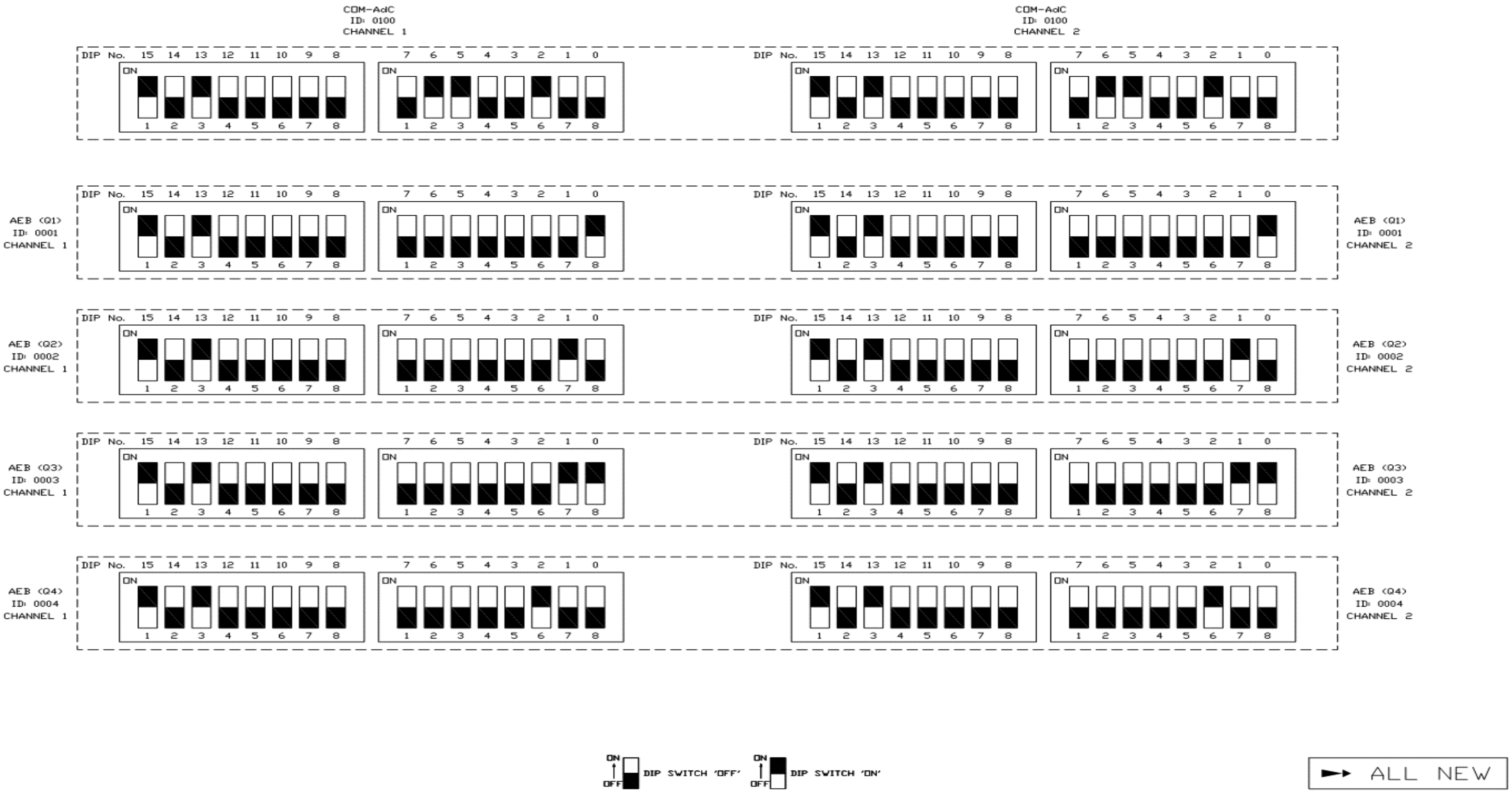


DIP SWTICHES OF THE COM-AdC / COM-XXX

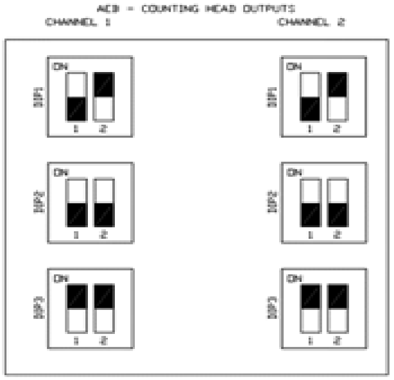


DIP SWTICHES COUNTING HEAD OUTPUTS
AND ID OF THE AEB

7.10 DIP Switch settings sheet 2 – Actuals based upon Design



7.11 DIP Switch settings sheet 3 – Actuals based upon Design



Preferred DIP Switch Settings for Counting Head Outputs - both Channels

DIP1
No Magnetic Rail Brake Supression
Active Dynamic Occupied Status Extension

DIP 2
System Outputs

DIP 3
Analogue Double Usage OFF

►► ALL NEW

7.12 Redundant DC Power Supply Arrangements