Fenix
RAIL SYSTEMS

500 FenLock Control System

FS-DES-STD-05
Version 1.0

1. Abbreviations & Acronyms

Term	Definition
CCTV	Closed Circuit Television
CCU	Central Control Unit
FCS	Facility Control System
Disbox	Disconnection Box
DPPS	Depot Personnel Protection System
EMC	Electromagnetic Compatibility
EU	European Union
FTN	Fixed Telecommunications Network
HD	High Definition
HMI	Human-Machine Interface
I/P	Input
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LOPS	Locally Operated Point System
NR	Network Rail
O/P	Output
REB	Relocatable Equipment Building
RSSB	Rail Safety and Standards Board
RSP	Route Setting Panel
SIL	Safety Integrity Level
SPT	Signal Post Telephone
TD	Train Describer
TOC	Train Operating Company
UPS	Uninterruptible Power Supply
Vac	Volts, alternating current
Vdc	Volts, direct current

2. Introduction

2.1 Executive Summary

This document provides the system description for the FenLock 500 Facility Control System (FCS) for use in depots, intermodal facilities, yards and other non-mainline applications. The 500 DCS is the most advanced system of the series, providing a full Signalling solution and includes Vehicle recognitions and auto routing.

	Description
100	Point Machines operated by individual plungers located by each set of points, combined with a Points Position Indicator (optional).
200	Point Machines operated from a Point Setting Panel, one switch per point. Position of points indicated on panel. Points Position Indicators provided with optional plunger to operate points locally.
300	Point Machines operated centrally from a Route Setting Panel (RSP) or VDU. Points in a route operated by a single button. Optional PPIs, axle counters for train detec- tion plus limited interlocking e.g. for an interface to a mainline system, provision of a slot or Shunters Acceptance.
400	Point Machines, standard NR GPL signals controlled from a Route Setting VDU. Axle counter train detection provided to give a full but simplified interlocking, e.g. signals won't clear unless points in correct position and axle counter sections clear. Able to relay interface with NR signalling functions, other Depot Protection Systems, CCTV sys- tems etc. Suitable for remote operation. Additional features.
500	Features all the above including Point Machines, standard NR GPL signals controlled from a Route Setting VDU. Axle counter train detection provided to give a full interlocking plus additional functionality and integration, Train identity remote control operation.

Fenix Rail Systems recommend the FenLock 500 FCS for its centralised depot control features and Auto Route Setting flexibility, The system recognises the train or unit using Vehicle ID technology using and standardised interface to Network Rail (NR) mainline interlockings and Depot Personnel Protection Systems (DPPS).

Practical Scenario: Automatic Route Setting in a Rail Freight Yard
At **Intermodal Freight Yard OR Port Terminal** a continuous flow of trains arrive carrying containers for transfer between rail and road transport. The yard operates several reception sidings, sorting lines, and departure tracks, all controlled via the **FenLock 500** system displayed on the Visual Display Unit (VDU) in the control office.

Scenario in Action

1.Train Arrival

1. An inbound freight service, *Train 6M45*, approaches the yard from the main line.
2. The **FenLock 500** automatically recognises the train through its integrated **vehicle recognition system** (using RFID tags or train reporting numbers).
3. Based on the train's ID, the system retrieves pre-defined operational data — including its destination, required unloading point, and onward service schedule.

2.Automatic Route Allocation

1. The system automatically selects the correct **arrival route** for the train — in this case, **Reception Siding 3**, which has been pre-assigned for trains carrying containerised freight for local road transfer.
2. The FenLock 500 checks the route is clear and safely sets all **points and signals** to guide the train from the main line to the correct siding.
3. The controller can monitor the process in real time on the VDU, but no manual input is required unless intervention is needed.

3.Shunting and Transfer Operations

1. Once the train is safely berthed, shunting locomotives begin to move wagons to the **container handling area**.
2. The FenLock 500 again uses vehicle recognition to identify each wagon and automatically sets short internal routes for shunting movements, minimising delays and manual switching.

4.Departure Preparation

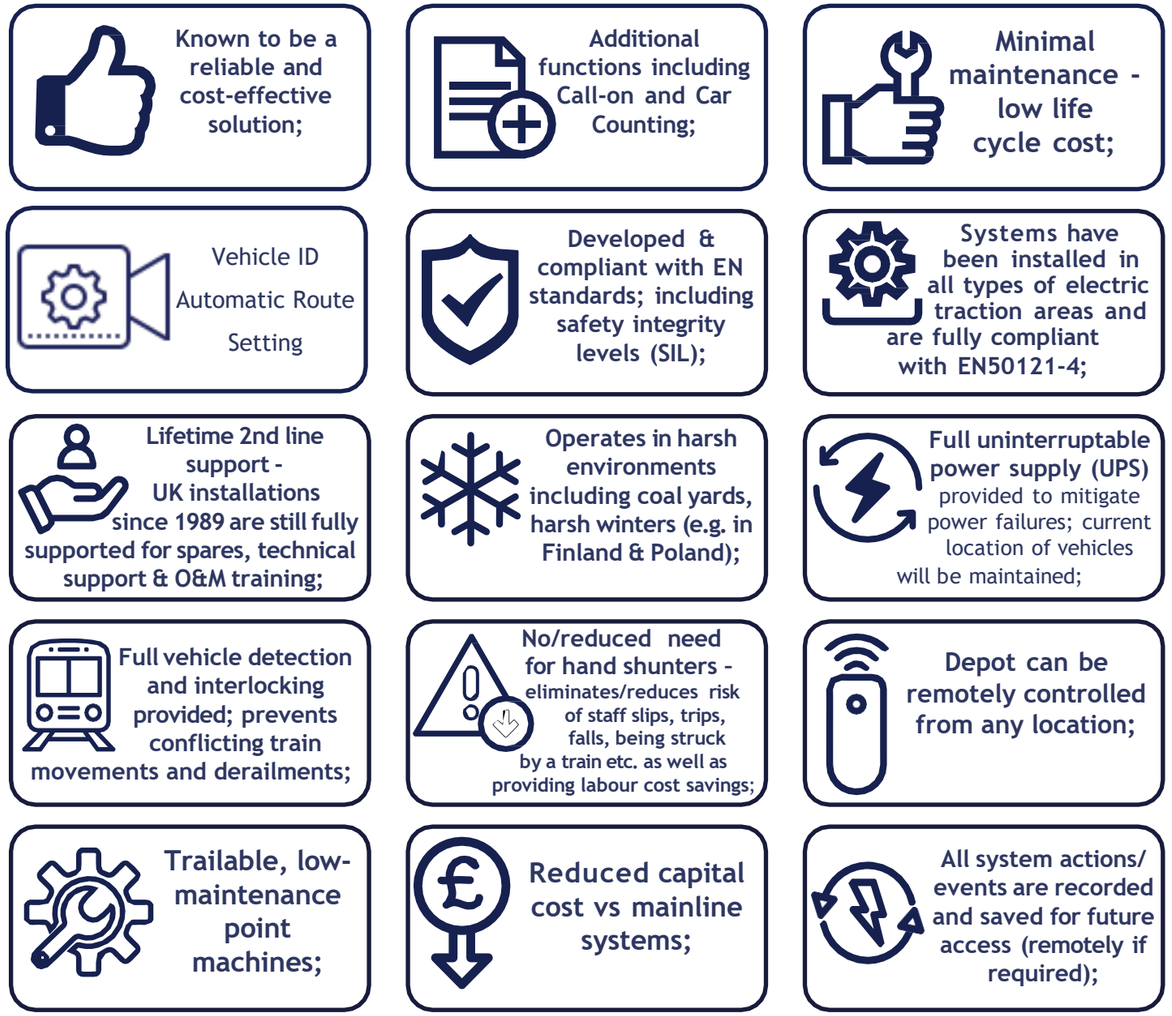
1. Later, when outbound trains are ready, the system automatically identifies the consist and sets the correct **departure route** towards the main line.
2. The control system ensures that all points and signals are correctly aligned and that no conflicting movements exist.

Benefits

- **Efficiency:** Reduces controller workload and eliminates repetitive manual route setting.
- **Accuracy:** Ensures each train is routed to the correct siding or terminal automatically.
- **Safety:** Prevents route conflicts and reduces the chance of human error.
- **Traceability:** Vehicle recognition provides a digital record of all train and wagon movements within the yard.

2.2 Overview of Benefits

The main benefits of the 500 system are:

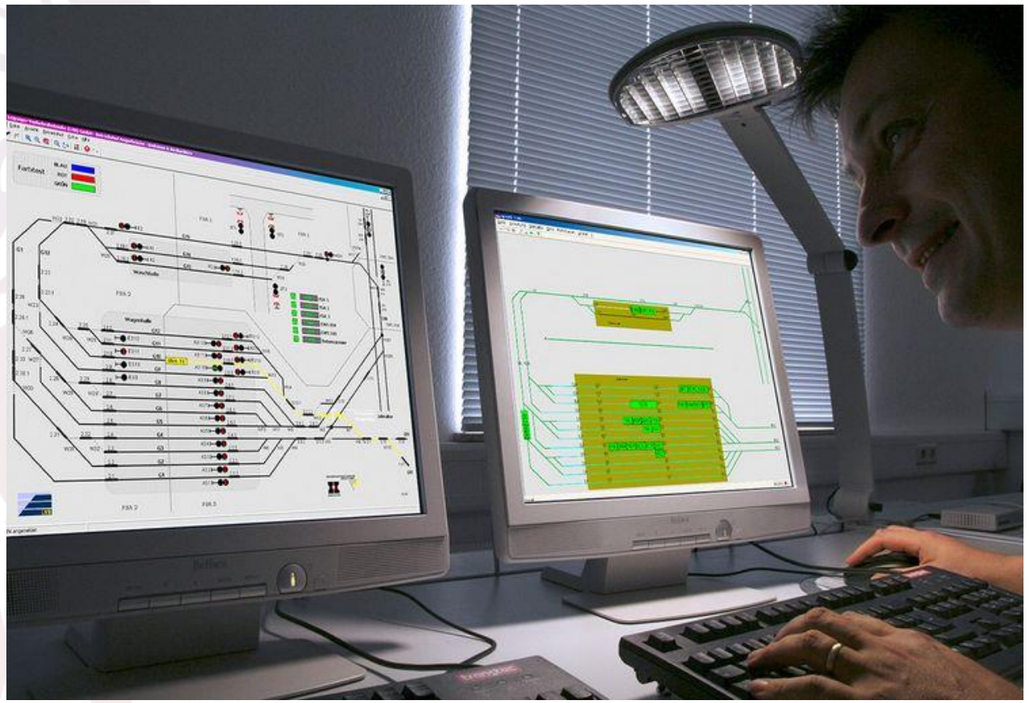


3. Operational overview

3.1 General Operational Overview

FenLock 500 System Overview

The FenLock 500 system is displayed on the Visual Display Unit (VDU) located in front of the user. It represents an upgrade to the FenLock 400, retaining all the features of the previous model while introducing enhanced functionality. The key advancement in the FenLock 500 is its vehicle recognition capability, which allows the system to automatically identify the vehicle and assign the correct route without manual input. This automation improves efficiency, reduces operator workload, and minimises the potential for routing errors.



3.2 Example of Operation

The most commonly used function on a FenLock 400 system is setting a route which is performed by 5 mouse clicks However the 500 system enables auto route setting by recognition ot the train it can set the required route without any intervention from the operator.

Train Enters the train facility ,

Vehicle Identity system reads the train ID

Verification of the route signal at the end of the desired route,

Interlocking Checks Required Route Clear Set Locked and Detected

Train Routed to destination for processing

Other equipment can be indicated and controlled by status indicators which are pop up boxes showing green for on and red for off, examples including:

- Mainline/other signalling system interface relay sent/ received status;
- DPPS road protection or electrification isolation status;
- Points heating controls and status;
- Level crossing barrier or warning sequence status.
- SPAD Alert and recording
- Locked Gate/Doors
- Simulator (Optional)
- Emergency Replacement Indications

3.3 Background Operations

The system automatically records each action taken on the system into an activity log. Each log entry includes the date, time, location and operator. Some items may include (non-exhaustive):

- Failure of wayside equipment;
- The successful setting a route or interlocking request;
- The unsuccessful setting of a route or interlocking request; and
- A change in interface relay or other equipment state.

The log can be downloaded from the interlocking or viewed on the VDU and is generally an aid to fault finding exercises.

3.4 Multiple VDUs

There is flexibility in having multiple operator's desks (i.e. two separate VDUs in separate locations). The same connection applies and is via a secure and reliable network (ethernet) cable. The multiple VDU setup is configured in such a way that it is possible for only one of the terminals to be designated the master at any one time. A secure function is built into the user interface to enable the hand-over of control and uses a multiple action command to permit the currently active master to designate another terminal as the new master.

4. System overview

System Characteristics

This section describes, in brief, the purpose of each section of the FenLock 500 system

1. System Purpose

The primary function of all **FenLock systems** is to provide a **signalling interlocking** — a safety-critical function designed to prevent conflicting train movements and to ensure a **safe state** is achieved in the event of a system failure.

The **FenLock 500**, like its predecessors, fulfils this purpose while incorporating additional automation features, such as **automatic route setting** and **vehicle recognition**, to enhance operational efficiency and safety.

The system is operated via the **Visual Display Unit (VDU)**, which serves as the **Human-Machine Interface (HMI)**.

From this interface, the operator can:

•Make interlocking requests (e.g. setting routes or releasing points)

•Monitor system status in real time

•Control auxiliary systems such as CCTV and communication links

When a route-setting request is made through the VDU:

1.The request is passed to the **interlocking logic**.

2.The interlocking checks the current status of the **wayside equipment** — including track circuits, point machines, and other set routes.

3.The system either **approves** or **rejects** the request based on safety and availability criteria.

4.If approved, the interlocking updates the **route and equipment states** accordingly, allowing a single safe train movement.

3. Centralised Control Philosophy

The **FenLock system** supports a **centralised control philosophy**, meaning that all signalling and communication functions are available to the operator from one location.

In a typical installation (as shown in *Figure 2*), the **Depot Signaller's Control Desk** includes:

•The **VDU** for signalling control and monitoring

•**CCTV control equipment and displays**

•**Telephony interfaces** to Signal Post Telephones (SPTs), Train Operating Companies (TOCs), and mainline control centres

4. Mainline Functional Interface

Integration with the **mainline signalling system** is an increasingly important feature of modern depot and yard control systems.

This follows the introduction of the following industry standards:

•**Network Rail Standard NR/L2/SIG/30009/C320**

Interface between Running Lines and Sidings or Depots (Compliance date: 1st December 2018)

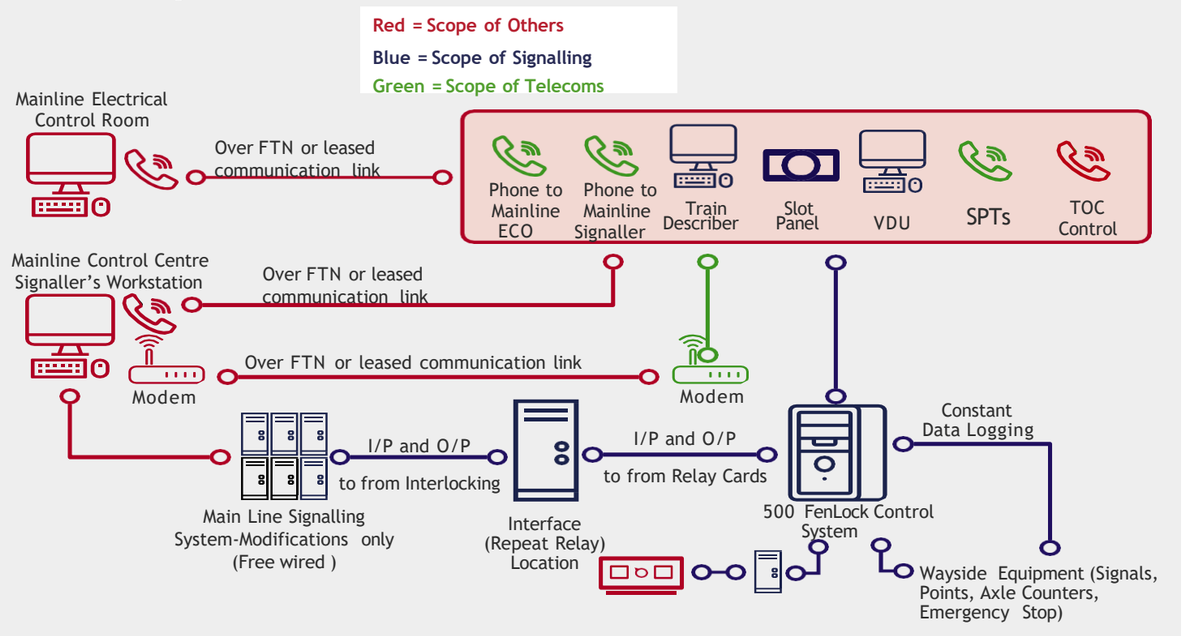
•**RSSB Guidance Note GIGN7621**

Development and Design Considerations of Passenger Rolling Stock Depots (Released: September 2018)

These documents promote a design approach where **voice communication is minimised**, and train movements between depots/yards and the mainline are conducted using **formalised signalling interfaces** rather than radio or telephone instructions.

A **safe method of working** for such interfaces is achieved by:

Creating **dedicated routes** to and from the mainline, Controlling these routes through the **mainline signalling system,** Implementing a **slotting arrangement** managed by the depot operator to ensure coordinated control and prevent conflicting authorities.



The DPPS interface allows safe movements of trains into and out of areas where there is a risk of injury from train-human interaction due to increased human activity in a depot area or collision with track mounted equipment, such as in a maintenance shed or wheel lathe. A slotting arrangement, controlled by the DPPS operator, can allow or block movements into or out of the area dependent on the conditions within the DPPS area. This interface can be made to work automatically in the event that no staff are present.

The system is highly scalable. It is capable of providing control and indication for train facilities of significant complexity. This is due to the modular interlocking and wayside architecture enabling the overall system to be separated into multiple substations. Logical division of the interlocking is recommended for installations with over 60 items of signalling equipment. Equipment counts higher than this are possible but, depending upon the depot layout, this could be to the detriment of system processing speed.

All systems are compatible with relevant EU EMC standards to all traction types. Outdoor equipment has a temperature operating window of at least -40°C to +70°C. and CENELEC Safety Integrity Level Up to SIL 4

The axle counters can be safely traversed at speeds of up to 100mph although a typical depot speed limit is usually less than 15mph.

4.1.2 Central Control Unit (CCU) and Central Processing Unit (CPU)

The **Central Control Unit (CCU)** is the *"heart and brain"* of the **FenLock 500** system.
Certified up to **SIL 4**, it is supported by an **uninterruptible power supply (UPS)** to prevent data loss in the event of a power interruption. Should a total power loss or UPS failure occur, the **internal memory** of the CCU is retained, ensuring no loss of operational data.
The CCU is responsible for **collecting and distributing data** to all **wayside equipment** and transmitting this information to the **Central Processing Unit (CPU)**.
The **CPU** contains the **interlocking data**, which is **bespoke to each installation**. This data defines the specific safety logic and operational rules for that site. The interlocking can be configured to comply with **any country's signalling principles**, offering full flexibility to accommodate operational features such as:
Permissive working
Long route setting
And other site-specific signalling modes (non-exhaustive)
This architecture ensures the FenLock 500 can be adapted for a wide range of operational environments while maintaining the highest levels of safety integrity.

Figure 3 -System show here

The CCU is largely maintenance free, with no scheduled upgrades unless required by facility expansion. The system performs self-diagnostic routines which flags untoward occurrences and failures. Upgrades to the software can be implemented by installing a new CPU, which allows for easy installation of new roads, signals and points etc.

The system boasts a modular design philosophy which is created from high grade industrial components, thus increasing the availability of spare parts and reducing maintenance costs. The system is constantly performing self-checks on the circuits and reporting faults, which means that malfunctioning units can be swapped very quickly and easily. The metal plates on the front (see figure 1) can be taken off, exposing the card beneath. This card has a part number and pin-code, meaning only a card of that type can replace the original.

2. System Architecture

1. Equipment Housing

1. Overview

The FenLock 500 system is installed within location cabinets, which are preferably housed indoors—such as in a control room or REB (Relay Equipment Building)—to facilitate ease of maintenance. However, external installation is also possible where required.Unlike conventional NR (Network Rail) location cabinets, the FenLock 500 cabinet is mounted on a swinging frame, allowing access from only one side. The frame consists of two columns of eight 19-inch racks, although typically, only up to seven racks are utilized. This configuration allows sufficient space for cable routing and access at the base of the cabinet.Mounted on these racks are the control and processing cards responsible for handling wayside information, along with the Central Control Unit (CCU) and Central Processing Unit (CPU).

288
Digital Critical inputs per rack

86
Digital Critical outputs per rack

CENELEC
Safety Integrity Level
Up to SIL 4

An additional external cabinet can be provided for terminating and distributing the incoming power supply. This cabinet is smaller than the cabinets depicted in Figures 3 and 4. The UPS can also be located for electrical convenience within this cabinet. The UPS is typically specified for axle counting back-up purposes and not for signal and points power, but it can be specified for any purpose, voltage or time period to suit specific project requirements.

Figure 4 - Vital Processor used for all FenLock 400 and 500 Systems

4.2.1.2 External

The external cabinets are mounted on a stainless-steel base, which is directly buried into the ground. The base allows for cable entry and exit and features removable panels to allow access for maintenance and to provide protection to the cables entering the base of the cabinet. Cables are attached directly to the bottom of the cabinet by suitably rated cable glands and armour can be earthed.

External location cabinet (frame open)

4.2.1.3 Internal

The racks and frames are also compatible with indoor application, where a glass fronted cabinet can be mounted to the floor or wall within a designated building, or within a relocatable equipment building (REB). This is beneficial as a centralised system offers easier maintenance (access to all of the system in one location, protected from weather, reduced cost of exterior cabinets, concrete bases etc.)

Figure 7 - Wall mounted internal location cabinet (undergoing factory testing)

4.2.2 Point Machine

The FenLock 500 system uses low-maintenance trailable point machines which are robust and mounted in the four foot. The machine can be installed in approximately 80 minutes and tested and commissioned in under two hours, saving considerable time and cost on site compared to rival machines. It is mounted on two cross members which clamp to the outside foot of the rail and the overall height of the machine is below the standard BS113 rail running height. A six-foot mounted version is also available, depending on client requirements/site layout restrictions.

Figure 8 - Point machine installation

The detection and power are supplied by a single cable, with a minimum of 5 cores. The power supply is currently a three-phase 400Vac supply, although a 120Vdc variant is in development. The maximum cable feed length is 1000m when using a 1.4mm2 cable, or 500m when using a 0.9mm2 cable.

The points machine features an internal mechanism allowing the machine to be safely used in a trailing direction without damaging the components. The machine can be installed with a plate which allows the integration of a standard six-foot mounted back drive. In the event of a power failure, the machine can be operated manually by inserting a key to engage manual operation and then turning a crank handle. Various throw lengths and times can be specified and supplied.

The machine requires minimal maintenance at an interval of every 6 months, which is limited to the exterior of the machine. This is normally to account for vibration and wear in the turnout. It includes adjustment of the detection rods and maintenance of the screw thread to prevent rusting, in addition to re-torquing the bolts.

When an over-running and/or a trailing move is detected, if safe and in combination with the axle counter system, the points automatically throw the points to the non-trailing position to prevent damage to the infrastructure/train.

The machine is driven by an electric motor which is geared down to drive the switch blades by two rods. The rods feature a spring mechanism to prevent breaking when the machine is trailed. The detection is achieved by four micro switches attached to two detection rods.

4.2.3 Points Position Indicators

These are not provided for FenLock 400 or 500 Systems

4. VDU/Control Panel

1. VDU

The purpose of the VDU is to be the HMI to the depot controller enabling safe control of train movements with indication of track and wayside system status. The information displayed and colours on the VDU can be customised to the client's requirements, although typically the colours are to NR standards.

Figure 9 - VDU at Gosforth Depot

Depending on the size of the depot, one or multiple LCD (being SD or HD) monitors are provided along with a compact desktop computer, mouse and keyboard. All other signalling and telecommunications equipment (e.g. slot panel, train describer, emergency alarms and telephones) should be mounted locally to the VDU, in order to achieve centralised control for all movements.

4.2.4.2 Control Panel

Due to the increased complexity of facilities using FenLock 400 and 500 systems, and the ease of operation and updating provided by the VDU (Visual Display Unit) interface, separate control panels are not required for FenLock systems above the 300 series.

4.2.5 Signals

The FenLock 400 and 500 Systems typically uses Network Rail approved LED Position Light shunt signals, showing red/red for danger, clearing to white/white at 45° for proceed, although the system can interface to most LED indicators, approved or bespoke.

These are typically mounted near ground level on a concrete plinth. Alternatively, the signals can be mounted on posts; this enables a train to stand closer to the signal, thereby increasing stabling room and capacity.

The signals are directly fed from the interlocking, as the cable is attached to a signal card within the location cabinet.

The signals are effectively maintenance free and only require inspection and cosmetic maintenance if necessary. Typically, signals are fed at 110Vac. However, the system can accommodate any signal type or indicator with a reasonable voltage requirement. The maximum feed length for a 2.5mm2 cable is over 10km.

Figure 11 - Post mounted LED position light shunt signal

4.2.6 Train Detection – Axle Counters

The axle counter for the FenLock 400 is Certifiable upto SIL-4 system which informs the operator of track occupancy and provides vital interlocking functions. A SIL-2 version is also available for when SIL-4 is not required however e the cost of a SIL 4 is now cost effective and is comparable to SIL2 systems.

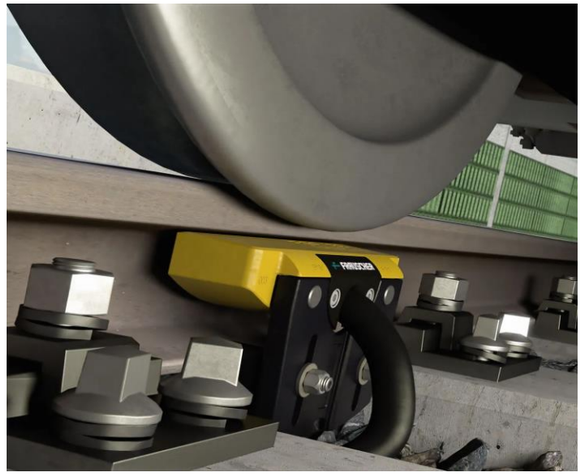


Figure 12 - Axle counter mounted on rail, and disbox (background)

The axle counter head is a dual proximity switch, designed and manufactured to detect the flange of the wheels passing over the switches. With each detected wheel, the axle counter counting card sends a package of data to the switching amplifier, which is within the location cabinet.

The cable connecting the axle counter to the disconnection box is a fixed tail cable, of varying lengths depending on specification. The cable from the location case to the disconnection box is usually a 2-pair telecoms-style cable, however if two axle counter heads are mounted close to each other, it is possible for the two heads to share a 4-pair (up to 5-pair) cable, as the axle counter head disconnection box allows this.

The axle counter heads require little maintenance; a biannual visual inspection for damage and clearance to the height below the railhead, an annual test and, if necessary, adjustment of the detection mechanism.

The axle counters can be located at a maximum of 2200m when using a 1.4mm2 cable under harsh EMC environments, or up to 8,600m when using a 1.4mm2 when using an earthed shielded cable.

4.2.7 Movement Authority

FenLock 400 and 500 is provided with Network Rail style ground position light signals. These provide movement authority for drivers in the same way that they do on the mainline. They also mark the end of the authority. Communication with drivers and the risk of confusion is thus much reduced with FenLock 400 systems.

4.2.8 Cable Routing

It is recommended to run two separate or segregated troughing routes, one for the point machine cables and signal cables, the other for axle counter and other data cables. This removes the chance of interference between the cables. If this cannot be achieved it is satisfactory if a 50mm air gap is maintained between the two cable sets.

Typically, copper cable cores are used. However, for cables used for data purposes (from the interlocking to the VDU, axle counters etc.) a fibre-optic cable can be specified.

In areas with harsh EMC environments, earthed cable sheathing may be required for long cable runs to maintain compliance and to mitigate voltage induction.

4.2.9 Power Supply

The 400 and 500 requires a 3-phase 400Vac supply to a separate power cabinet or enclosure where it is transformed down and/or distributed as required. The interlocking components predominantly run off 12V and 24V, with the exception of the signals (110Vac) and point machines (400Vac).

A 30 minute back up power supply is generally provided for the axle counter logic computer, to allow for axle count and train position memory, allowing a quicker recovery time/reducing downtime.

4.2.10 Points Heating

A centralised points heating system can be integrated into the depot signalling system to show faults, warnings and system operation on the user's VDU. The system can also be turned on and off using the buttons on the VDU.

3. System Interfaces

1. Interfaces to Other Equipment

Relay cards are available to install within the card racks, allowing almost any technology to be interfaced to the interlocking. This may include:

- DPPS interfaces;
- Mainline interfaces;
- Manual gate controls;
- Level crossing barrier controls;
- Points heating controls.

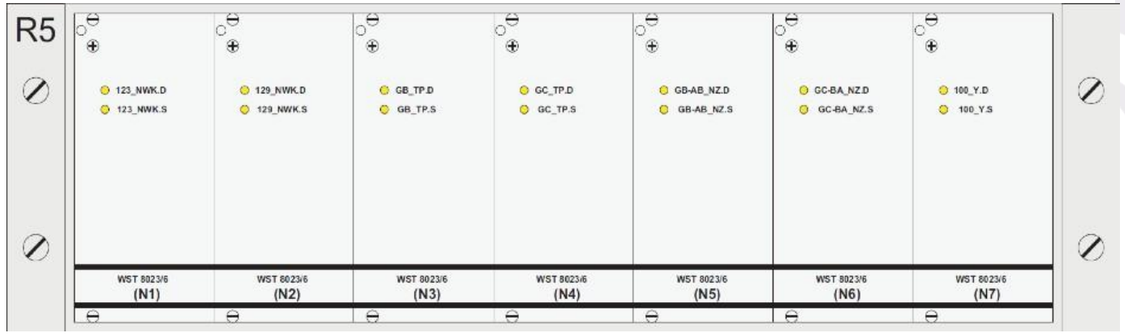


Figure 13 – SIL 2 Relay card rack for interface functions

Each relay card has two sets of two antivalent contacts (one set normally open, one set normally closed) meaning that double cutting contacts into the circuits can be achieved. For outgoing circuits to Network Rail location cases, a BR-spec transformer is used to provide earth-free power.

Should a different type of point operating equipment to section 4.2.6 be specified, the relay cards can be used to gather detection information from the points operating equipment.

4.3.2 Mainline Interlocking

The FenLock 400 and 500 system can be interfaced to any type of interlocking (such as but not exhaustive: electro-mechanical, relay, SSI or CBI) by implementing an interface. An interface functional specification shall be written beforehand to ensure all relevant functions are sent and received from each interlocking. Typically, a slot arrangement is required to ensure a systematic and operator handshake is achieved.

Emergency alarm systems can be integrated into the FenLock 500 VDU and interface. The system also features an emergency all signals on control button on the VDU.

Typically, a train describer does not interface with the FenLock 500 system as it is more efficient for the fringe signal box to perform this action, or the user to interpose headcodes into a separate TD monitor.

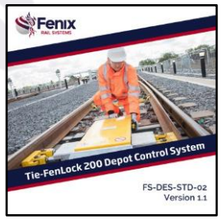
4.3.3 Depot Personnel Protection System (DPPS)

Typically, a slot or other equivalent acknowledgement is required from the DPPS designated person prior to a train movement. This slot is sent to the FenLock 400 system and integrated in the controls of the appropriate signal. The DPPS shall send a movement authority slot when it is safe for a train to move into a DPPS area, allowing the route setting and aspect clearance. If it is not given, the route cannot be set.

5. Further information and reading

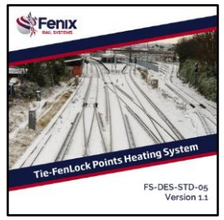
The 400 and 500 are the most advanced of the Train Facility options and therefore may not be suitable for all depot applications. Further information can be found for the 100, 200 and 300 series in the following documents:

FS-DES-STD-001 - 100 Depot Control System – System Overview



FS-DES-STD-002 - 200 Depot Control System – System Overview

FS-DES-STD-003 - 300 Depot Control System – System Overview



FS-DES-STD-005 - Points Heating System – System Overview

FS-DES-STD-006 - Points Monitoring System – System Overview

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Our offices are open from 08.30 to 17.30 each day. Key management can be contacted via the office landline 03300 580180 and mobile numbers are provided for convenience outside office hours. Your main contact with Fenix Rail Systems are as follows:

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