Fenix
RAIL SYSTEMS

300 FenLock Control System

FS-DES-STD-03
Version 5.0

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
PSP	Points Setting Panel
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 300 Control System (DCS) for use in depots, intermodal facilities, yards and other non-mainline applications. The FenLock 300 FCS is the second-most advanced system of the series, providing an interlocked depot control system without a full signalling system.

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 recommend the FenLock 300 (FDS) for large, complex depots where a single point of control is required and where a full signalling system is too thorough.

Fenix Rail Systems are a provider of FenLock Systems in the UK, working in partnership with our strategic supply chain to deliver a range of services and solutions for UK depots. Some existing UK installations are:

- Northampton Gateway Intermodal FenLock 400 system (2024)
- Daventry International Rail Freight Terminal 400 system (2023)
- Nexus Gosforth Depot Newcastle New Build facility (2023/24)
- Bombardier Central Rivers extension. Modification to an existing 400 installation (2001) to provide an additional stabling road (2018)
- Chilterns Banbury Depot, Banbury. 400 installation with 7 point ends, fully interlocked with signals and interfaced to the mainline (2016-17)
- Alstom Golders Green Depot, London. A London Underground application (2006)
- Chilterns Wembley Depot. 400 installation incorporating 8 point ends (2004)
- Alstom Morden Depot, London. 400 installation .A London Underground application with 32 point ends (2004)
- ABP Immingham Depot. 400 installation incorporating 10 points and 1 Route Setting Panel (2002)
- Siemens Southampton Depot. 400 installation incorporating 10 points indicators and approximately 25 axle counters (2002)
- Bombardier Central Rivers Depot, near Derby. 400 installation incorporating 29 point ends, point position indicators throughout and axle counters (2001)

2.2 Overview of Benefits

The main benefits of the 300 system are:

- Known to be a reliable and cost-effective solution;
- Additional functions including Call-on and Car Counting;
- Minimal maintenance - low life cycle cost;
- Over 1,000 systems worldwide since 1984;
- Developed & compliant with EN standards; including safety integrity levels (SIL);
- Systems have been installed in all types of electric traction areas and are fully compliant with EN50121-4;
- Lifetime 2nd line support - UK installations since 1989 are still fully supported for spares, technical support & O&M training;
- Operates in harsh environments including coal yards, harsh winters (e.g. in Finland & Poland);
- Full uninterruptable power supply (UPS) provided to mitigate power failures; current location of vehicles will be maintained;
- Full vehicle detection and interlocking provided; prevents conflicting train movements and derailments;
- No/reduced need for hand shunters - eliminates/reduces risk of staff slips, trips, falls, being struck by a train etc. as well as providing labour cost savings
- Route setting panel or VDU (option)
- Trailable, low-maintenance point machines;
- Reduced capital cost vs mainline systems;
- All system actions/ events are recorded and saved for future access (remotely if required);

3. Operational overview

3.1 General Operational Overview

The FenLock 300 system is presented to the operator in one or both of two ways. The first option is by using a Visual Display Unit (VDU), as shown in figure 1. Any equipment controllable by the user can be clicked with the mouse using the left-click for standard operation, and a right-click for failure/ administrator roles.

As an additional feature, the software can be configured to show a car count, which is achieved by taking the axle count and dividing by the number of axles per car/carriage/coach (typically 4). This is visible in Figure 1, circled in blue. This becomes of benefit when permissive working is specified as it allows the operator to see the remaining stabling capacity. Figure 1 shows an example of this feature.

Each interlocking request also features a yes/no option to complete the operation. This is to prevent accidental requests. Fault messages and degraded mode operations provide an additional pop-up image and window and each must be acknowledged before the system executes a new request.

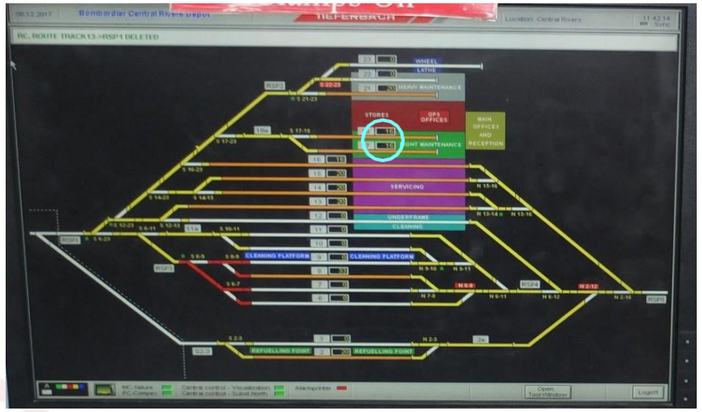


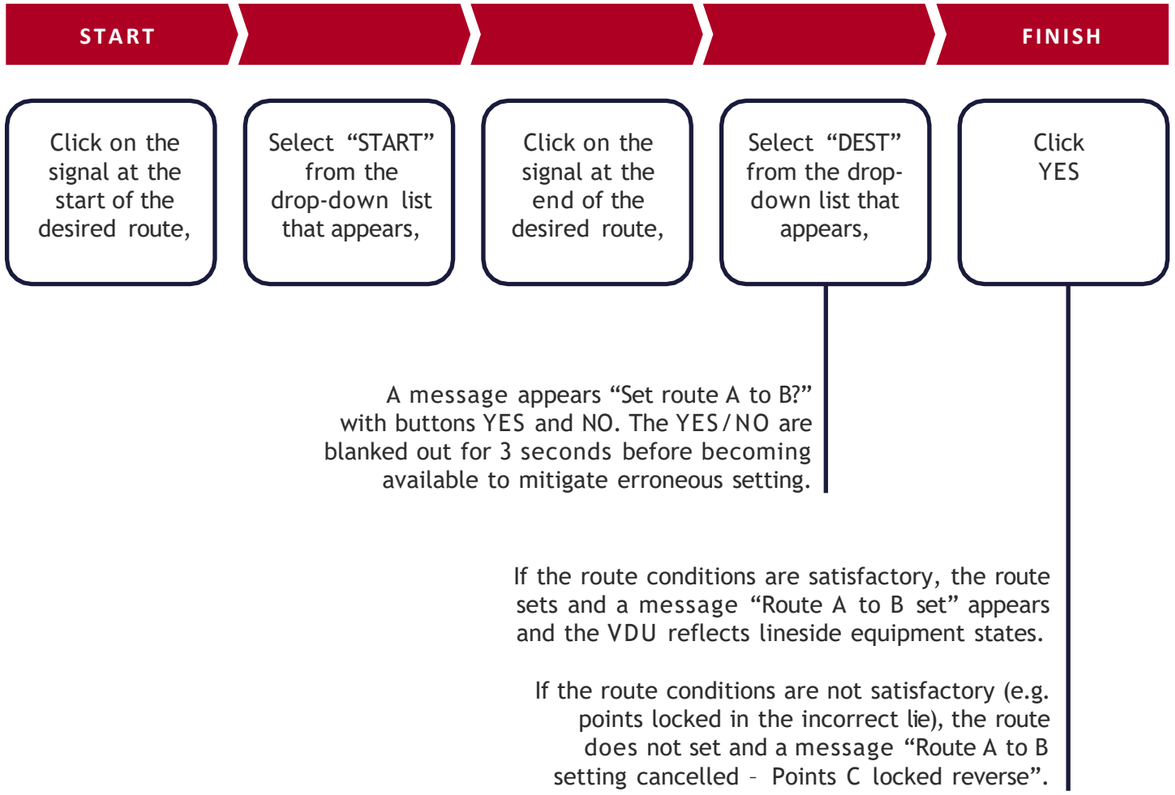
Figure 1 - 300 VDU, Central Rivers Depot, UK. The car counting feature is on all roads, the count on roads 17 and 18 are circled in blue.

The second option is to use one or multiple Route Setting Panels (RSP) which are installed at strategic locations within the depot area. From these, the operator can create, lock and cancel routes that are within the jurisdiction of that RSP.

2. Example of Operation

1. VDU Operation

The most commonly used function on a 300 system is setting a route which is performed by 5 mouse clicks:



3.2.2 RSP Operation

The RSP is presented as push buttons mounted on a steel panel, rather than on a screen. However, the process for setting a route is not dissimilar.

START → **FINISH**

The operator inserts and turns a key to power up the RSP, checking that the “running” lamp is lit correctly

The operator then presses the button for the route that they wish to set;

The “route” white LED begins to flash as the route begins to set,

The “route” white LED becomes steady when the route is set successfully,

The “lock” red LED shows when route setting is not possible.

To cancel the route, the operator presses the “delete” button and the appropriate “route” button simultaneously.

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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 of 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

1. System Characteristics

1. Overview

This section describes, in brief, the purpose of each section of the 300 system

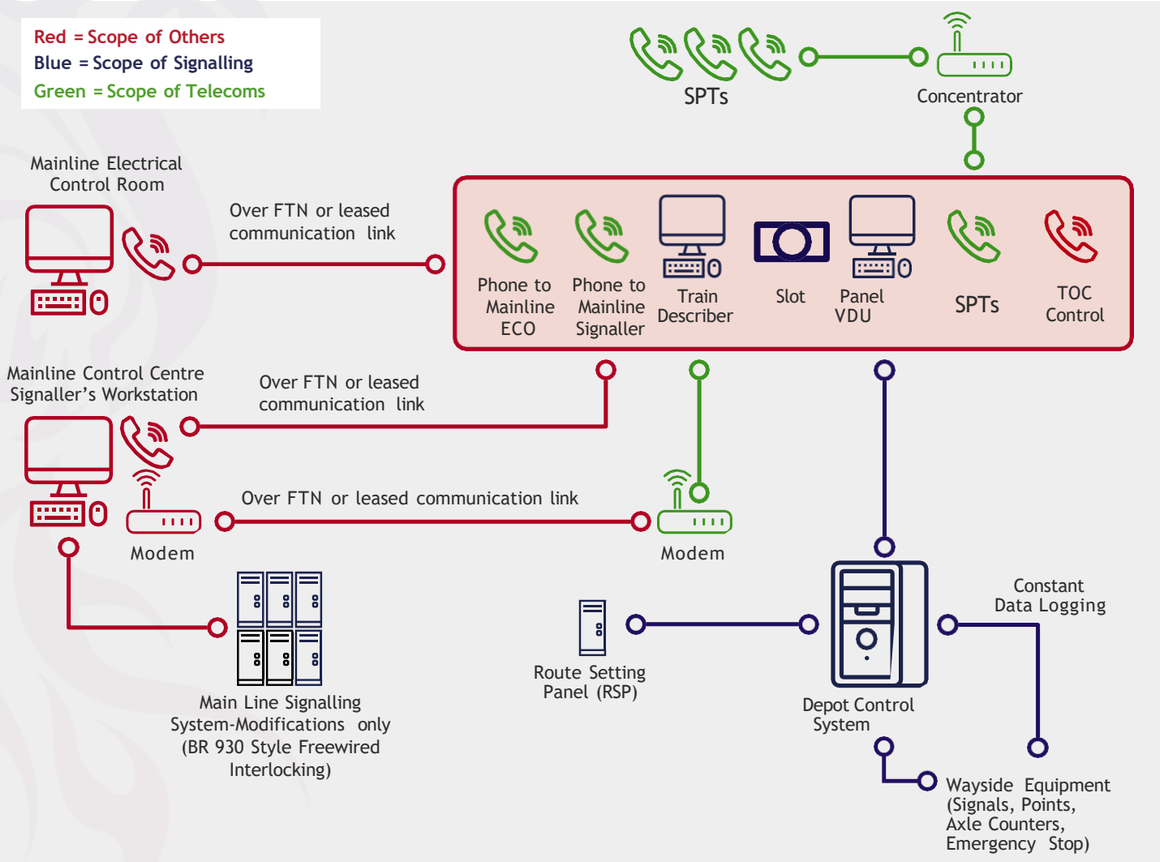


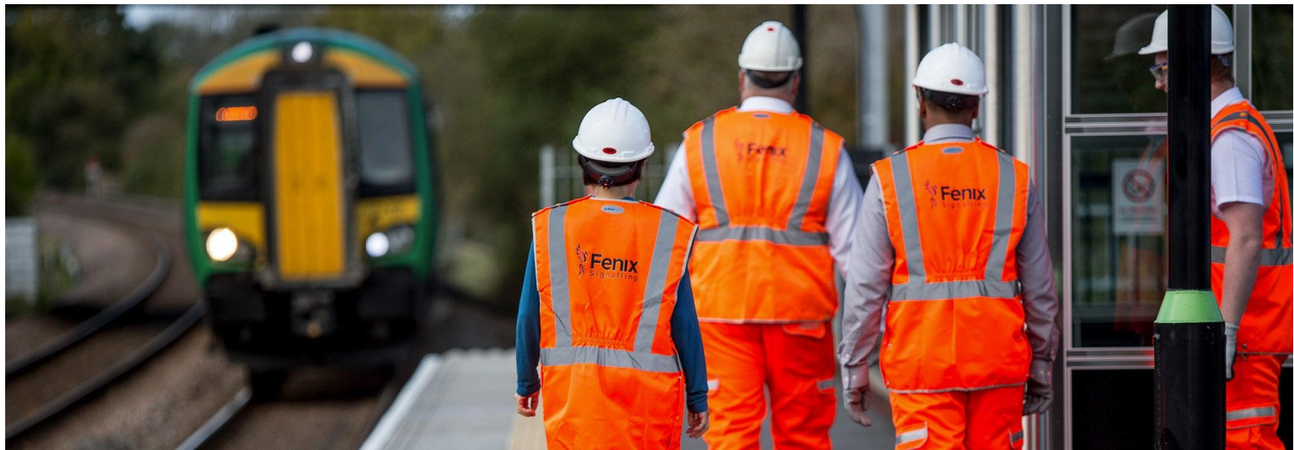
Figure 2 - System block diagram of a typical 300 depot installation

The main function of the Depot Control System is to provide a basic but comprehensive interlocking. The interlocking is designed to prevent conflicting train movements and to provide a safe state in the event of a failure. The VDU is the human-machine interface (HMI) from which the operator can make interlocking requests. This request (route setting etc.) will go through the interlocking, which analyses the status of the wayside equipment (track sections, point machines, other set routes etc.) and approves/rejects the request. If the request is approved, the route state and wayside equipment state changes to allow one train movement.

The philosophy of a centralised control is achieved by providing all controls available to the operator within one location. Using Figure 2 as a typical installation, the "Depot Signaller's Control Desk" is the location of all signalling and communications devices available to the operator.

The mainline functional interface is becoming a more prevalent feature of depot designs following the introduction of the following documents:

- 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 - Guidance Note for the Development and Design Considerations of Passenger Rolling Stock Depots, released in September 2018



It has now been stated that train movements are to be less reliant on voice communications and that these should be avoided. Where a mainline interface is proposed a safe method of working shall be established. This can be achieved by creating specific routes to/from the mainline, controlling these routes using the mainline control system and a slotting arrangement under the control of the depot operator.

The system is highly scalable. It is capable of providing control and indication for depots 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 however, 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 -25°C to +45°C. The axle counters can be safely traversed at speeds of up to 60kph (~37mph) although a typical depot speed limit is usually less than 15mph.

4.1.2 Computer Based Interlocking

This is the "heart and brain" of the FenLock 300 system. The Central Control Unit (CCU) is **certifiable upto SIL-4 system** and is battery buffered by an uninterruptable power supply (UPS) to prevent power loss. In the event of a total power loss/UPS failure the internal memory is not lost. The CCU collects and distributes data to all wayside equipment and feeds the information to the Central Processing Unit (CPU). The CPU contains the interlocking data which is bespoke to each installation and the interlocking data can be written to adapt to and abide by any country's signalling principles with no limitations which may include permissive working or long route setting (non-exhaustive).

The operator's VDU is connected to the CPU, which takes the operator's inputs on the VDU or RSP and checks against the CCU interlocking data before granting or blocking the action requested by the operator.

All equipment is fed from and reports to an "interface card" which is mounted within the location cabinet/REB (see section 4.2.2). Each card communicates with other cards and the CCU.

Figure 3 - Interlocking cards (Wembley Depot, SIL 2 only System UK)

The CCU is largely maintenance free, with no scheduled upgrades unless required by depot 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 card, 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 4) 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 300 system is installed in location cabinets, preferably in internal housing such as a control room or REB for ease of maintenance but can also be externally located. Unlike typical NR location cabinets, these are mounted on a swinging frame and therefore provides access from one side. The frame is made up of two columns of eight 19" racks (although typically only a maximum of 7 are used to allow cable installation and access in the base of the location), on which the cards to control and process wayside information is mounted, as well as the CCU and 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 normally 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 - Design drawing of two 19" racks, controlling 4 point machines
Note systems show here is a typical SIL 2 system.

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.

Figure 5 - External location cabinet (frame closed)

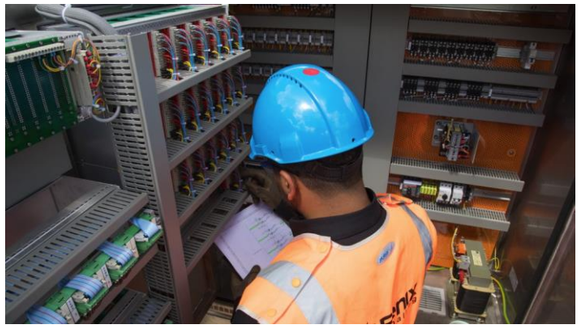


Figure 6 - External location cabinet (frame open)

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, no concrete bases etc.)

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

4.2.2 Point Machine

The 300 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 is 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 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 Indicator (PPI)

The PPI is a two sided, three aperture LED indicator which is capable of showing two positive indications. The first is the straight ahead route, with points correctly set. This is shown as two vertical white lights. The second is for the diverging route, which is two horizontal lights. When the points are in the process of moving, the “pivot” lamp flashes in an out-of correspondance state until detection is achieved.

In the event of a failure the PPI shall flash in this out-of-correspondance state until detection is achieved. This may occur if:

- A blockage is in the point blades and the machine motor times out
- Detection is lost after detection is made
- Loss of communication with the machine (power failure or cable break)

Figure 9 - Points Position Indicator

4. VDU/Control Panel

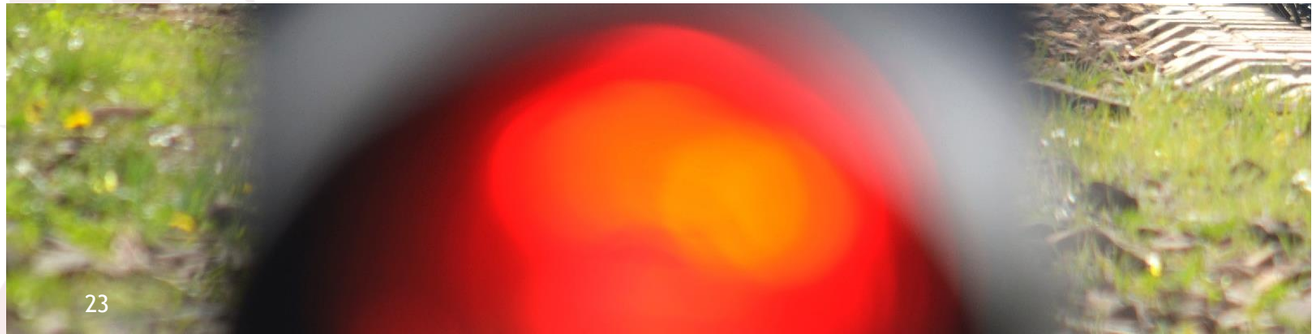
1. VDU

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 10 - VDU at Cologne Depot, Germany

Figure 11 - VDU at Banbury Depot, UK (NR slot panel to left)

Providing a VDU also inherently adds future provision for upgrade to a 400 system, as the 300 system uses a VDU system to control all movements. Wayside signals, their associated hardware and a software change are required to achieve this upgrade.



4.2.4.2 Route Setting Panel (RSP)

The RSP is another form of control for the depot operator, intended for use by a passing shunter or other designated person.

The RSP is normally mounted on a post, and houses a small amount of internal electronics and wiring, as the majority of interlocking is housed within the equipment housing (see section 4.2.2).

Each RSP is connected to the central interlocking, meaning that all information is exchanged between each RSP and conflicting movements cannot occur.

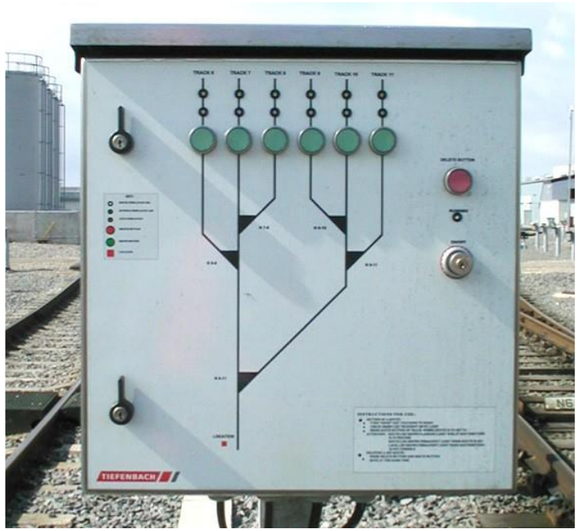


Figure 12 - Route Setting Panel

4.2.5 Signals

Not provided for 300.

4.2.5 Signals

Not provided for 300.

4.2.6 Train Detection – Axle Counters

The axle counter for the 300 is a SIL-4 system that 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.

Figure 13 - 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

Due to increased complexity of the control and area covered it is suggested that the term “shunter” is replaced by “Depot Operator” for 300 and 400. The Depot Operator will need to speak to the driver to tell the driver where and when to proceed

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, or a non-conductive barrier, is maintained between the two cable sets.

Typically, NR signalling 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. The point machine tail cables are provided with steel wire armour.

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

9. Power Supply

The 300 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.

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.

10. Points Heating

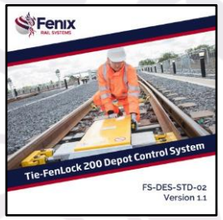
All systems are compatible with most points heating systems. If control of the points heating is required by the Depot Operator this can be added to the 300 VDU.

4.3 System Interfaces

When used with a VDU control system there are a variety of interfaces that can be provided in a similar way to those described in the 400 brochure. However, using Point Position Indicators instead of signals makes it much harder to interface than the 400 system. For this reason if several or complicated interfaces are required it is recommended that 400 is used. It is not normally practical to provide interfaces to a control panel.

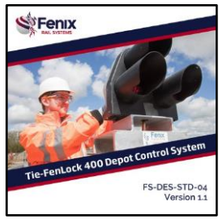
5. Further information and reading

The FenLock 200 is the second of the Five FenLock Systems and therefore may not be suitable for all facility applications. Further information can be found in the following documents:

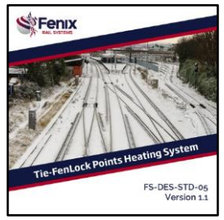


FS-DES-STD-002 - 200 Depot Control System – System Overview

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



FS-DES-STD-004 - 400 Depot Control System – System Overview



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

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

Fenix Rail Systems provide signalling system consultancy and turnkey delivery (design, procurement, installation, testing, commissioning, handover and O&M) in the UK and worldwide for both greenfield projects and brownfield projects requiring complicated stageworks. Project delivery in the UK is aligned with Network Rail standards and procedures.

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:

Craig Purcell

craig.purcell@fenixrailsystems.com

HQ 3 The Quadrant
Warwick Road
Coventry
CV1 2DY

www.fenixrailsystems.com

Tailored and Innovative
Signalling Control Solutions

Fenix
RAIL SYSTEMS

HQ 3 The Quadrant, Warwick Road, Coventry, CV1 2DY

Telephone 01926 358428

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