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Date:	04 December 2010
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Module

Design and Application Rules – Thales Axle Counter Systems

Endorsement and Authorisation

For endorsement and authorisation, please refer to NR/L3/SIG/30082

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Issue record

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Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 5th March 2011.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

See NR/L3/SIG/30082.

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1 Purpose

This standard contains a technical description of the Thales AzLM axle counter system and gives guidance on the design and application rules for the equipment when used on Network Rail managed infrastructure.

2 Thales AzLM Typical System Configuration

2.1 Overview

The AzLM is a multiple section axle counter system. Example configurations are shown in Figure 1. Regardless of configuration the system comprises of two main components:

- The Trackside Detection Point;
- The Axle Counter Evaluator.

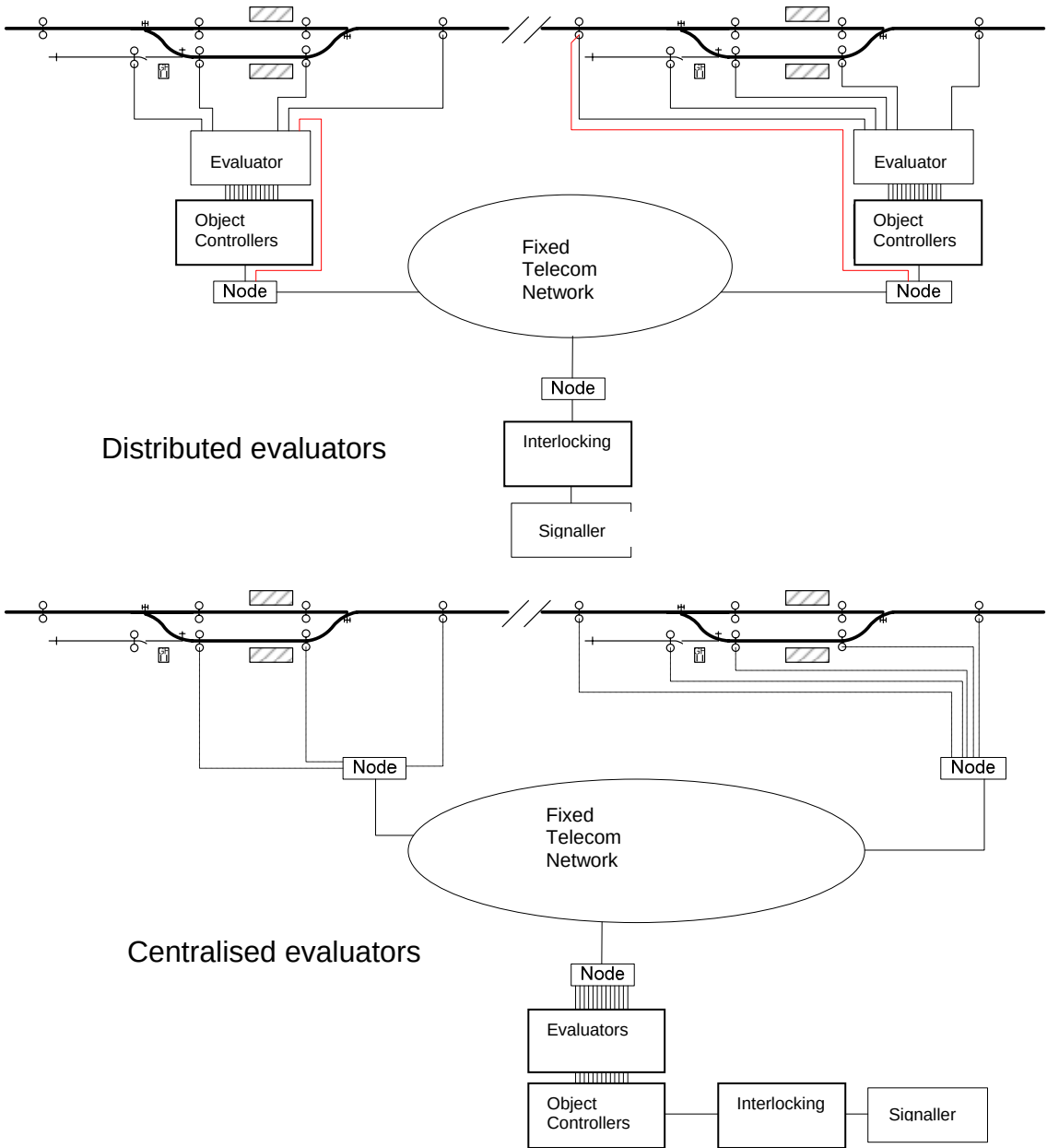


Figure 1 – Examples of Axle Counter System Configuration

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2.1.1

The Trackside Detection Point (known as Zp30H) comprises of two sets of rail contacts, Sk1 and Sk2, and a trackside housing, EAK30H, containing an electronic unit, E-Es 30H. Each rail contact set has a transmit head, Tx, and a receive head, Rx. As each detection point has two sets of rail contacts the axle counter system is able to tell which way the train is travelling.

2.1.2

The E-Es 30H energises the Tx heads, detects and counts the wheel pulses from the Rx heads, monitor the rail contacts, runs self tests and transmits telegrams every 200ms containing the axle count and supervision information to the evaluator. The EAK30H counts axles passing over the heads and transmits this count and direction information digitally to the evaluator, along with other diagnostic status information.

2.1.3

The detection points are connected to the evaluator via a data transmission link (see section 2.7). The detection point is capable of being powered from the evaluator via the same data link, or from a local power supply.

2.1.4

The evaluator comprises duplicated power supply cards, duplicated vital computer (CPU) modules, and serial I/O and parallel I/O cards. The duplicated vital computer modules carry out the same functions and compare the results. If the results are not in agreement then the evaluator will be shut down. The vital computer modules are configured to each evaluator using site specific data.

2.1.5

Data from the detection points is received via the serial I/O cards. These pre-processor cards recover the serial detection point data from the ISDN signal and transfer it to the vital computer modules (CPU). The industrial standard CAN bus is used to interface the pre-processors to the vital computer modules. Each serial I/O card is assigned to one or two detection points and occupies one I/O slot in the evaluator.

2.1.6

The track occupancy information is output from the vital computer modules via the CAN bus to the parallel I/O cards. Each parallel I/O card has two voltage free relay contacts for controlling an output to interface with the Network Rail signalling system. On SSI schemes this output is fed directly into the SSI TFM at all locations except, occasionally, level crossings where the relay contacts are used to control a repeat relay (TPR) to interface with the level crossing circuitry. Additionally, the parallel I/O card has two vital inputs which are used to reset the axle counter section remotely by the signaller.

NOTE The parallel I/O card only provides a TPR output which can be used to derive "clear" or "not clear" states. Therefore "not clear" would apply when the axle counter section status is "Occupied", "Disturbed" or is detected to have a technical fault, and the signaller is unable to differentiate between the three.

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2.1.7

The state of the in/out count total for an axle counter section is held in the CPU memory. It is therefore possible to remove and replace a parallel I/O card without affecting the state of the section. When replaced, the card will energise or de-energise the TPR output in accordance with the CPU memory.

2.2 Evaluator

The AzLM evaluator is able to receive wheel count and direction data from many detection points and output the status information for many axle counter sections to the interlocking. Thales produces evaluators with two or three processors, depending on whether redundancy is required, but only two processors are required to provide the vital function of the system. Network Rail applications use the less complex two processor (two out of two) arrangement with redundant power supplies which provides for high levels of system availability.

2.2.1

For Network Rail applications the evaluator uses a parallel interface to the interlocking (either RRI or SSI via a hardwired TFM interface). A serial interface is available but is only designed for use with the Alcatel DB solid state interlocking.

2.2.2

Two types of AzLM evaluator CPU arrangements are currently accepted (see section 4.2) and in use on Network Rail applications, both having a facility to be remotely monitored:

- SC410 processor (not used for any new installations);
- Pentium processor.

2.2.3

The evaluator configuration can be varied:

- A single euro 19" subrack, which houses two CPU cards, two power supply cards, and has capacity for ten I/O cards. In this arrangement the evaluator is called an ACE-2-10;
- Adding a second subrack to increase the I/O capacity by upto sixteen additional I/O cards. In this arrangement the evaluator is called an ACE-2-26 (see Figure 2);
- Adding a third subrack and an additional sixteen I/O cards. In this arrangement the evaluator is called an ACE-2-42.

NOTE An evaluator comes as a unit and subracks cannot be added to convert, say, an ACE-2-26 to an ACE-2-42.

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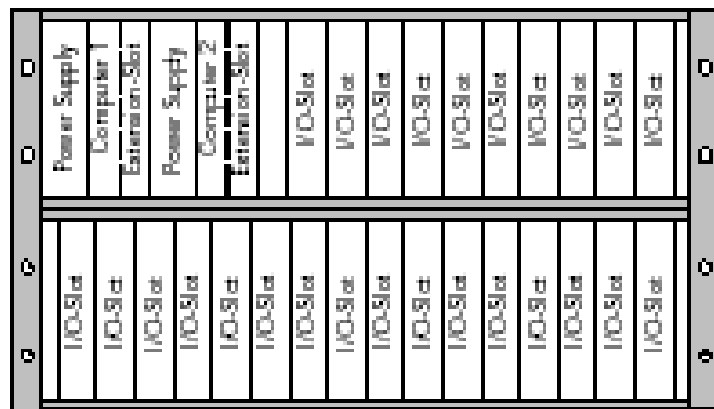


Figure 2 – Example of ACE-2-26 Configuration

2.2.4

There are two types of I/O cards, serial and parallel, but either can fit in any I/O slot. The data in the CPU cards configures the slot to the appropriate card. A serial I/O card can be connected to two detection points; a parallel I/O card provides a relay interface to the interlocking for a single axle counter section, including the section clear and reset functions. Blanking plates are required to cover unused slots.

NOTE The blanking plates are necessary to comply with EMC requirements.

2.2.5

Duplicated power supply cards are within the subrack so no separate power supplies or terminations are required.

2.2.6

There is no electrical connection between two evaluators, even if they are in the same cabinet. Any required interface is achieved at the EAK30H where there are two data link connections to allow communication to two evaluators if required (shared detection point).

2.2.7

On the front of each evaluator CPU there is a diagnostic PC port. Thales require the diagnostic PC to be isolated from the mains. A 230V socket should be available near the front of the evaluator cabinet so that a lead to the diagnostic PC does not trail across the REB floor when in use. A label should be attached to the socket to alert the user of a diagnostic PC to the need for isolation.

NOTE Many laptop PCs have free-standing ac-dc converter power units that are double insulated and have full galvanic isolation between the ac and dc sides. These can also operate from a 110V supply without adjustment so it may be possible to provide a 110V outlet in the evaluator cabinet fed from a small 1:1 (110V ac) isolation transformer.

2.2.8

Each CPU card in the evaluator has a button on the front (recessed to avoid accidental operation) which can be used to re-initialise the whole evaluator. This clears the CPU memory, but does not reset axle counter sections (all of which are forced to the disturbed state).

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2.3 Evaluator Data

Data is generally very straightforward, even for the largest evaluators. The bulk of the data is concerned with allocating detection points/sections to I/O cards, and detection points to sections.

2.3.1

The evaluator is data configured with site-specific data and core programs stored on a single memory device per CPU. SC410 cards use EPROM memory and Pentium cards use Compact Flash memory. Evaluator data is written using a data preparation tool based on Microsoft Access and a single image is produced for each evaluator. Arrangements for evaluator data preparation and control are described in NR/L3/SIG/30082 Module 003.

NOTE The data preparation tool is an aid to the input process and has no validated safety integrity. Therefore, the output ASCII file printout needs to be checked rather than the data tool printout.

2.4 Reset

Each axle counter section in an evaluator can be programmed to accept conditional, unconditional or preparatory reset. Only two types of reset can be applied per parallel card and therefore per axle counter section.

2.4.1

The evaluator requires a reset pulse to have a duration of between 0.5 seconds and 6 seconds in order for it to be acted on.

2.4.2

The evaluator will respond to a reset request based on the axle counter section status:

- The reset request will be rejected and an error message generated where the status is "Clear";

NOTE This status means that the equipment is working satisfactorily and the section memory has a count of zero. This is the state when the number of axles counted in equals the number counted out. It is also the state after successful reset.

- The reset request will be rejected and an error message generated where there is a technical fault with the equipment which inhibits counting of axles.

NOTE This includes complete loss of communication between evaluator and EAK30H, e.g. due to a cable break, or loss of power to the evaluator. Once repaired, the section will go to the "Disturbed" state, however the the additional protection given by the conditional reset is lost and the reset effectively becomes unconditional.

- A reset request will be accepted where the status is "Occupied", though with conditional reset an occupied section can only be reset if the last axle counted was leaving the section;

NOTE An "Occupied" status means that the equipment is working satisfactorily and the section memory has a count greater than zero. This is the state when the number of axles counted in is greater than the number counted out.

- A reset request will be accepted where the status is "Disturbed".

NOTE This means that the equipment is operating correctly but has had some form of unexpected occurrence. This includes detection of a small wheel, e.g. a trolley, or other metal object that has disturbed the magnetic field between the rail contact heads but which has not

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been registered as a valid count, or an interruption to the communication between the evaluator and EAK30H which has caused the evaluator to potentially miss counting axles. A "Disturbed" section can be reset regardless of the numbers of axles registered. The evaluator also declares all sections as "Disturbed" when initially powered up;

2.5 Housing and Layout

The evaluator is either housed in a free-standing cabinet or rack mounted. In either case this needs to be installed in a secure building or REB. Thales specifies the acceptable evaluator operating temperature range to be -25°C to $+55^{\circ}\text{C}$.

2.5.1

An evaluator cabinet is 2000mm H x 600mm W x 600mm D. This includes the adjustable feet, plinth and ventilation gap at the top and it will therefore fit beneath the overhead cable route of racking constructed to BRS-SM440. Access is required to the front and rear of the cabinet.

NOTE A suitable position is alongside the wall before the first cable rack, which should then be used for the axle counter external cable terminations to minimise the serial I/O cable lengths.

2.5.2

The weight of the cabinet is not sufficient to maintain sufficient stability, and the feet need to be drilled and screwed to the REB floor.

2.5.3

A cabinet can house more than one evaluator and has the physical capacity for upto approximately eight subracks in total, but should be confirmed with Network Rail and Thales. The heat dissipation of the evaluators is a significant factor in determining the number that can be accommodated in a cabinet and sufficient air gaps are required above and below each where sharing a cabinet. A typical REB layout is shown in Figure 3.

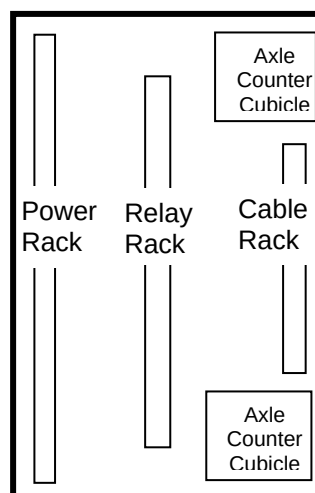


Figure 3 – Typical REB Layout With Two Axle Counter Evaluator Cubicles

2.5.4

The dimensions of evaluator subracks are specified in manufacturer documentation.

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2.5.5

Cable access is through the top of the cabinet, where there are three cable clamp bars. The power wiring for each evaluator runs first to the evaluator power supply filter. Wires from the filter to the evaluator backplane are included with the filter unit. All cables and wires for the I/O cards are run directly to cage clamp terminals on the appropriate evaluator backplane.

2.5.6

There is a row of miniature circuit breakers and terminals at the top of the cabinet. These are provided for the use of other railway administrations, and are not used by Network Rail applications.

2.5.7

There are vertical cable ducts on the left and right side at the back of the cabinet, provided as part of the cabinet. Any horizontal ducts and fixings have to be installed as required. Additional vertical ducts may be required near the top of the cabinet to segregate cables and wires. There is no requirement for wiring or ducts at the front of the cabinet.

2.5.8

There are cage clamp terminals on the backplane in blocks corresponding to each I/O card slot. Subrack 1 always has the blocks numbered from X01-X10. When provided, subrack 2 is labelled X01-X16, and subrack 3 is labelled X17-X32. Therefore, for an ACE-2-26 and ACE-2-42, subracks 1 and 2 have terminal blocks with the same numbers, and care needs to be taken to identify which subrack is being referred to. In addition, more than one evaluator in a cabinet will appear identical.

2.6 Power Supply

A power supply (PSU) and battery pack will fit on one shelf of a standard BRS-SM440 rack. Connections to the units are via a removable plate at the top. If two shelves are provided with equipment on both, the units on the lower shelf should not be in line with the units above in order to facilitate easy access to the top of the units.

2.6.1

A voltage free contact is provided on the PSU as a monitoring output. This is not used when the 650/230V changeover circuitry is provided, as both supplies are monitored already, and the absence of both indicates the battery is in use.

2.6.2

The required PSU output rating is assessed as $ACE + (ISOL)SR + PDCU$, where:

- ACE is the power required by the evaluator itself, including I/O cards. The maximum power for a fully populated evaluator is 55W for the ACE-2-10, 95W for the ACE-2-26, and 135W for the ACE-2-42.
- (ISOL)SR is the total power required to maintain all these circuits, which is 3W per relay, plus the loss in the 330Ω resistor.
- PDCU is the total power required by the detection points supplied from this PSU. This can be between 7W and 11W per EAK30H depending on version

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and configuration, plus line losses and 10% losses in the 100V or 110V dc/dc converters. A precise calculation is required. There is a maximum permissible circuit resistance of 240Ω. This equates to 4.28km cable length with 0.9mm conductors, and a pro rata calculation for the actual cable length for each rail contact will give the loss.

NOTE Different power ratings exist for later versions of equipment. Care needs to be taken when replacing equipment that the correct versions are installed or that the power requirement is re-considered.

2.6.3

Power to the EAK30H is normally 100/110Vdc coupled onto the ISDN line at the evaluator via a Power Data Coupling Unit (PDCU). The PDCU will block the 100/110Vdc connected to the external side and allows the same pair to be used for data from (and power transmission to) the detection point. A detection point shared by two evaluators can only be powered from one evaluator through the line 1 ISDN input at the EAK30H. 100/110Vdc is not to be coupled onto a PDCU if that ISDN line is connected to input 2 of a shared EAK30H.

2.6.4

The PDCU is manufactured by Thales specifically for the AzLM. The PDCU is a 1:1 transformer designed to pass the 10-70kHz data signal, with overvoltage protection on the external side. The overvoltage protection comprises:

- A 315mA fuse in one leg of the external ISDN line. The PDCU fuse 315mA anti surge fuse is available from Farnell Order No 150986;
- An MOV connected between each leg of the ISDN line and the PDCU common earth terminals 3 & 6.

NOTE1 According to the version of PDCU used it may or may not require a connection to earth. If an earth is required it needs to be attached to terminals 3 or 6 to provide overvoltage protection on the axle counter data link. The overvoltage protection consists of a 315ma fuse in one leg with a metal oxide varistor between both legs of the data link and earth.

NOTE2 The PDCU has a plastic case and does not require an equipotential earth bond. There is no disconnectable link on a PDCU. All connections are screw terminals, which will accept conductors up to 2.5mm² (stranded) or 4mm² (solid).

2.6.5

PDCUs are 75mm H x 45mm wide x 54mm D and clip onto DIN standard top hat rails. The units will normally be mounted on horizontal rows to make the connections to the earth busbar as short and as straight as reasonably practicable. Screw terminations are provided along the top and bottom of the unit and, following experience, a spacing of 40mm is recommended between the unit and the cable route above and below to provide reasonable access to the wires.

2.6.6

In cases where an evaluator will require too many PDCUs to fit on one row of the cable rack the following arrangement is recommended:

- Row 1 – Evaluator 1 remote detection points;
- Row 2 – Evaluator 1 local detection points;
- Row 3 – Evaluator 2 remote detection points;

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- Row 4 – Evaluator 2 local detection points.

NOTE The units within a row are in alphanumeric order for ease of reference.

2.6.7

Thales specify the detection point power supply to be 100/110Vdc if powered through the data line from the evaluator. A specially designed 60/100V or 60/110V dc/dc converter is used:

- To step up the voltage, so that the effect of volt drop in the cable to the EAK30H is less significant;
- To de-couple the 60V power supply to the evaluator from the unclean environment of the lineside circuits.

2.6.8

Dc/dc converters are manufactured by Zentro-Elektrik Pforzheim but provided by Thales. These are connected in parallel to provide redundancy but each shall be capable of supporting the required total load.

NOTE1 Output fusing to protect the converter is not required. The converters provide a 100/110V output when the nominal 60V input is within the range acceptable to the evaluator (43-72V), and will therefore be compatible with the 69V PSU output.

NOTE2 The termination block on the dc/dc converter has a changeover contact symbol by terminals 4,6,8. The representation of this contact is ambiguous. It actually shows the position of the contact when the unit has no power.

2.6.9

The dc/dc converters are 220mm W x 120mm H x 210mm D overall, and can be shelf mounted (or rack mounted using suitable brackets). To avoid additional heat generation within the evaluator cabinet, these are mounted within the REB racking. The wiring connection is at the rear, and there is an output voltage indication and adjustment at the front. Access is therefore required to both sides of the units, and they should be mounted accordingly, e.g. on the centre racks of the REB rather than the power wall.

NOTE The terminations on the dc/dc converter are screw terminals on a plug coupler provided with the converter. This allows the converter to be changed without the wiring being disturbed. The terminations will take a 6mm² wire.

2.6.10

At the EAK30H, the 100/110Vdc is decoupled by the EAK30H without the need for any separate PDCU or isolating transformer. The ISDN line from the supplying evaluator needs to be connected to terminals t3 and t13 on the EAK30H. There is electrical isolation between the two data line inputs at the EAK30H and any power on the other ISDN line input will be rejected by the EAK30H.

2.6.11

It is not always possible to power the EAK30H from the evaluator. The distance between the two may cause too high a volt drop in the cable, or there may be an isolating transformer in the data line that blocks the dc supply. In these circumstances ISDN/V24 converters can be used as line repeaters or it is necessary to provide a local power supply. The power is not coupled onto the data line, and PDCUs are not provided in the location. A nominal 60Vdc is connected to t1 & 11 on

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the EAK30H and the straps that would otherwise be used between certain terminals are not used. The second pair of the 2pr tail cable can be used for the power.

2.7 Detection Points

The EAK30H at the trackside provides the interface between the evaluator and rail contacts. An EAK30H has two pairs of ISDN terminations to allow communication with one or two evaluators. The terminations on the EAK30H are all cage clamp terminals.

2.7.1

The EAK30H has a unique 15-bit binary address code, which is set up on duplicated DIP-switches on the base PCB of the unit. This allows each unit to be specifically identified by the evaluator and permits many vital circuits to be run in one telecomms specification cable, in accordance with RT/E/C/11600. The EAK30H includes an Analogue card controlling the rail contact and an Evaluator card.

NOTE The DIP-switches are not easily accessible and require the removal of a least one card to gain access. A firm, positive action is required for operation. For a wrong side failure to occur, an error would be required in the axle counter data and on both sets of DIP switches (which need to have identical settings). It is therefore not necessary to seal the switches.

2.7.2

The EAK30H is fitted on a mounting post with a base that is normally buried in the ground but which can be bolted to a solid surface if necessary. A 0.9m high post is normally used but a 0.4m post is also available but, for Network Rail applications, should be used for surface mounting only. The detection point will resist damp conditions and Thales specifies that the housing is sealed to IP55. If a detection point is in an area liable to flooding the EAK30H should be sited clear of the anticipated water level.

NOTE Where necessary a clamp and RKB221 padlock can be fitted to the EAK30H for security. The clamp is available from Thales but is not normally provided and should be specified on the Detection Point Siting Form.

2.7.3

Each Sk30H rail contact comprises two pairs of detection heads (Sk1 and Sk2), with each pair comprising a transmitter head (tx) and receiver head (rx). A magnetic field is generated over the rail head by the transmitter head, and detected at the receiver head, with the axis of the head at a specific angle to the magnetic field. When a train passes between the transmitter and receiver heads, the field is distorted and this causes the wheel to be detected. Similarly if a detection head is dislodged from the rail, the magnetic field is affected and will be detected as a right side failure. Figure 4 depicts a SK30H head fitted to the rail with one picture showing the view from the outside of the track and another showing a cross section through the rail.

2.7.4

Any metallic object is likely to be detected:

- 'Detected' means that either of the receiver heads (rx) have registered the presence of an object that may, or may not, be a wheel;
- The object only registers as a 'count' if both of the receivers (Sk1 rx and Sk2 rx) detect the object within certain defined parameters. The count held in the

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EAK30H evaluator card will be incremented when detection at Sk1 preceeds Sk2 (or decremented if detection at Sk2 preceeds Sk1);

- Software algorithms at the EAK30H evaluate each valid count and unless this happens the detected object will cause the EAK30H status to be set to a disturbed state which is included in the telegram to the evaluator.

NOTE The set up and adjustment of rail contacts, and consideration of different rail types, is described in NR/L3/SIG/30082 Module 002. The detection head that is first passed by an axle in the reference direction is defined as Sk1 (Tx1/Rx1) and the second as Sk2 (Tx2/Rx2).

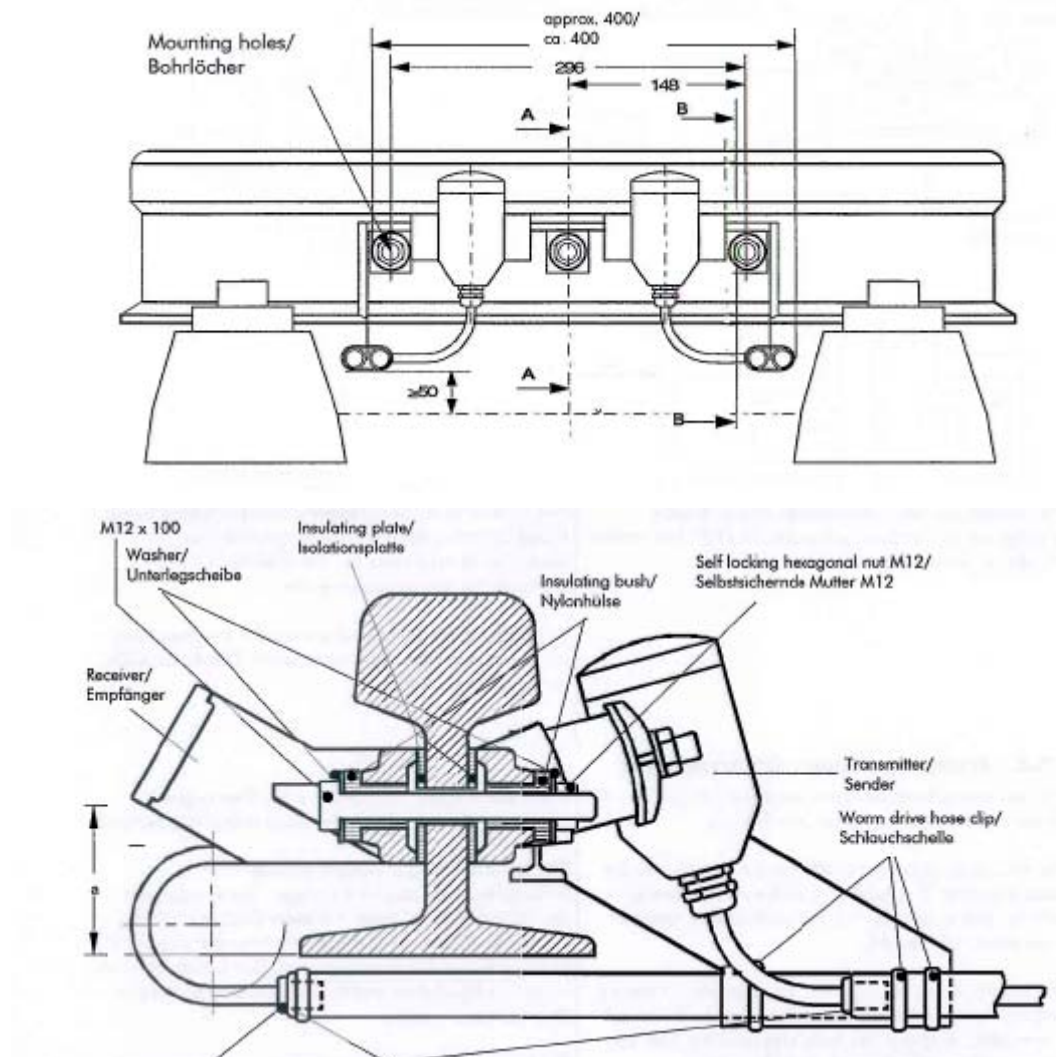


Figure 4 – Detection Head Fitted to Rail

2.7.5

A detection point will operate satisfactorily if a wheel is stationary over the rail contacts. However, there is the possibility of a right side failure caused by the first detected wheel rocking back and forth across the rail contacts, e.g. where trains join and split in a station (see NR/L2/SIG/30081 section 5.7.1 and NR/L3/SIG/30082 Module 001 concerning the assessment of standage).

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2.7.6

The Sk30H rail contacts are designed to withstand temporary submersion in water due to flooding.

2.8 Transmission

The data transmission between EAK30H and evaluator uses a product specific message protocol layer superimposed upon a standard ISDN transmission line protocol (not compatible with commercial ISDN). The signal is broadband in the 10-70 kHz range. An example of the ISDN layout is shown in Figure 5. This circuit shows the interface for two ISDN lines, between the line pairs and the ISDN modem electronics, including connections for line powering (+U and -U).

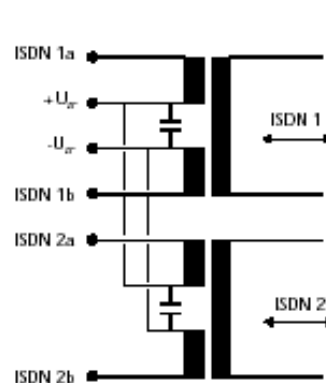


Figure 5 – Example ISDN Layout

2.8.1

The ISDN layer is a duplex system. It is designed to accept interruptions of up to 492ms before correspondence is lost between the two ends of the line, and will also tolerate repeated bursts of short duration. The ISDN layer does not include any protocol that is specific to the axle counter system. It only manages the transmission of the messages generated by the equipment. The performance of the ISDN component of the evaluator / EAK30H transmission has been proven by Thales tests. The tests included isolated interruptions of various durations, and rapidly repeated short duration interruptions.

2.8.2

The message communication between the EAK30H and evaluator is simplex. The evaluator does not request information, but expects a message to be received from each individual EAK30H every 200ms. If the communication channel is interrupted for more than a designated period, e.g. 500ms for a system using dedicated cabling, the evaluator will declare the detection point failed and the sections associated with the detection point will then be declared disturbed. For this example, it is therefore possible for the evaluator to receive two corrupt telegrams without failing a detection point or section, and this gives a high level of fault tolerance, especially to transients.

NOTE A reaction time can be set within the evaluator data to accommodate different transmission systems and provide tolerance for system switching. See also section 2.10.