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HVI Track Circuits (formerly RT/E/PS/11756)

This temporary front sheet facilitates change to the new Network Rail Standards referencing nomenclature.

The Ref above will be formally allocated to this standard when it is next changed in the meantime the contents, date and issue number of this Network Rail Standard are **UNCHANGED and with immediate effect it should be referred to as “(new ref) formerly (old ref)”.**

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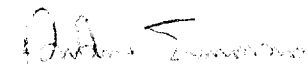
RAILTRACK COMPANY

PRODUCT SPECIFICATION

HVI TRACK CIRCUITS

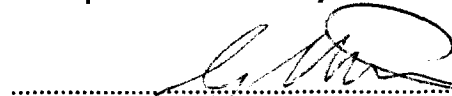
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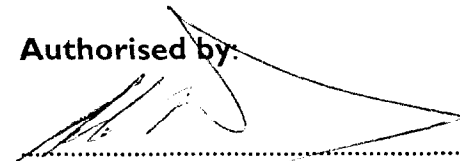
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Summary

This Company Specification states the minimum requirements for Alstom High Voltage Impulse (HVI) track circuits. It includes lifecycle requirements from design, safety and environmental through to installation, testing and maintenance.

Issue/Revision Record

Issue	Date	Comments
1	December 2000	New Specification. The contents are based on Railway Group Code of Practice GK/RC0756 which is to be transferred to Railtrack PLC in February 2001.
2	August 2001	Clause 6.2.1 modified: To install only modified receiver units during new works in AC

Implementation

The requirements of this Specification shall apply to all HVI track circuits supplied for use on Railtrack controlled infrastructure on or after 4 August 2001. The following document is superseded:

Superseded Document

RT/E/PS/11756 issue 1 December 2000 HVI Track Circuits

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I INTRODUCTION

I.1 PURPOSE

This Product Specification gives details of best practice in respect of Alstom High Voltage Impulse (HVI) track circuits, in order to achieve the requirements of RT/E/S/11752.

I.2 SCOPE

The contents of this Product Specification apply to all Alstom High Voltage Impulse track circuits and shall be read in conjunction with RT/E/S/11752. The following forms of HVI track circuit are included:

- HVI track circuit for d.c. electrified lines,
- HVI track circuit for a.c. or dual electrified lines,
- HVI track circuit for non-electrified lines.

I.3 INTRODUCTION

The Alstom High Voltage Impulse track circuit is significantly different from other types of track circuit. It has features that are very beneficial in its application under certain operating requirements. Its design is based on the continental practice of centralised equipment rooms with remote lineside transmission.

I.4 FEATURES

The HVI track circuit can only be used as a jointed track circuit and, dependent on the bonding configuration, can be used on electrified or non-electrified lines. The track circuit requires a power supply for the transmitter, but a power supply is not required at the receiver/track relay. The high peak voltage used in the operation of the track circuit will break through railhead contamination and enable the track circuit to be satisfactorily shunted by vehicles.

The HVI track circuit is immune to a.c., d.c., train borne electrical systems and external electrical systems. The performance of the track circuit can be affected by neighbouring HVI track circuits. This mutual interference is prevented in the design process by the provision of electrical stagger between adjoining track circuits.

HVI Track Circuits

The track circuit settings are calculated during design, and are shown in the wiring diagrams. After the initial setting up, no further adjustments are required.

2 APPLICATION AND CONSTRAINTS

2.1 APPLICATION

The application of HVI track circuits fulfils the basic requirement for continuous train detection, with particular suitability in areas of heavy rail contamination. (The high peak voltage of the track circuit waveform, means that the HVI track circuit can be used with advantage on track with poor rail surfaces.)

Where additional integrity is required, e.g. for the operation of automatic level crossings (not locally monitored), they shall be used in conjunction with some other type of train detection device.

The use of HVI track circuits is only cost effective where their functional capabilities are of benefit, e.g. through S&C in dual electrified areas, or where heavy rail contamination exists.

2.2 CONSTRAINTS

The following constraints apply to the use of HVI track circuits, in addition to the general restrictions given in RT/E/S/11752:

Note: The length restrictions and interface delay constraints currently applied, may require reassessment for the introduction of new types of rolling stock.

2.2.1 Operating Category

Inherent in its operation, the HVI track circuit has a very long drop-away time and is categorised as Operating Category C, requiring two slow to pick-up track repeat relays (TPRs) in relay based signalling systems, or extra delay data in Solid State Interlocking (SSI) and other data driven systems.

Reference shall be made to Part F of RT/E/S/11752 for interface delay requirements between adjacent track circuits.

2.2.2 Track Circuit Lengths

The following maximum lengths apply:

- dual electrified areas 200m*
- d.c. electrified areas 200m*
- a.c. electrified areas 300m
- non-electrified areas (single rail bonding) 300m
- non-electrified areas (double rail bonding) 1200m

* in terminal platforms, this may be increased to 300m, with the agreement of the infrastructure controller.

There are special constraints on minimum length relating to operating time.

A 'Category C' track circuit (see section 3.4) shall be occupied for at least 550ms when any route is used at permissible speed, as described in RT/E/S/11752, Part F, section 6. This gives rise to a minimum track circuit length, effective where the permissible speed exceeds 70mph, as follows:

Permissible Speed	Minimum Length	Permissible Speed	Minimum Length
<75mph	18.3m	100mph	25m
75mph	19m	105mph	26m
80mph	20m	110mph	28m
85mph	21m	115mph	29m
90mph	23m	120mph	30m
95mph	24m	125mph	31m

2.2.3 Track Circuit Interrupters

HVI track circuit bonding shall not be wired in series with track circuit interrupters. A separate relay circuit shall be provided in accordance with RT/E/S/11764.

2.2.4 Electrified Areas

HVI track circuits are immune from d.c. and a.c. traction currents, although length restrictions and interface delay constraints need to be applied to avoid wrong side failures due to large traction transients.

In a.c., d.c. and dual electrified areas, the HVI track circuit can only be used in single rail bonding configuration.

General track circuit restrictions in electrified areas are given in RT/E/S/11752, in addition to the following:

- a) Traction return cross bonding must be provided at all insulated rail joints (IRJs) in the traction return rail. The traction return rails in adjacent terminal platforms shall also be bonded together at the buffer stop end (see Part F of RT/E/S/11752).
- b) In electrified areas, double rail reed or TI.2I track circuits must not be allowed to be surrounded by an area of HVI single rail track circuits, e.g. on a loop line, as described in the appropriate Track Circuit Product Specification.
- c) In conductor rail electrified areas, protection boarding shall be fitted where specified in Part C of RT/E/S/11752.
- d) In a.c. electrified areas, the traction return rail shall, wherever practicable, be positioned on the cess side to enable structure bonds to be kept short.

2.2.5 Interfacing with Other Types of Track Circuit

When abutting with other types of track circuit, IRJs are required on both rails. Since the sharing of a common rail with other types of track circuit is thereby precluded, interfaces within S&C layouts are not achievable.

In addition, the HVI track circuit has the potential to falsely energise d.c. track circuits (including diode track circuits, but not a.c. immune types) or non-phase sensitive a.c. track circuits (e.g. WR quick release track circuits). Therefore, the only permissible interface with non a.c. immune d.c. track circuits or non-frequency selective a.c. track circuits is at the feed end of the susceptible track circuit. (This applies to either end of the HVI track circuit.) As the relay of the diode track circuit is at its feed end, then the permitted interface is at the diode end only.

Reference shall be made to Part F of RT/E/S/11752 for interface delay requirements between adjacent track circuits.

2.2.6 Electromagnetic Interference

Special considerations must be given to the installation of HVI track circuits when used with SSI, TI.2I or reed equipment to avoid interference (see the section 6.3 on Environmental Requirements).

2.2.7 Electrical Staggering and Balancing

Abutting HVI track circuits shall generally have opposite polarities, as specified in section 3.3. Where practicable, the common rail shall also be balanced to earth, as described in section 3.4.

3 FUNCTIONAL REQUIREMENTS

3.1 PRINCIPLE OF OPERATION

3.1.1 Rail Voltage Waveform

The HVI track circuit operates by applying a short high voltage impulse to the rails at relatively long intervals. The asymmetric operating waveform has the shape of a high peak voltage (termed the positive polarity). A proportion of this is reflected back as a reverse voltage of much lesser amplitude (termed the negative polarity). The amplitude ratio of the polarities is typically 7:1, a typical feed end rail voltage waveform is shown in Figure 1.

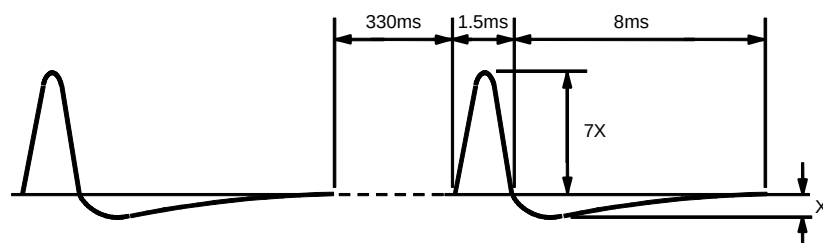


Figure 1

3.1.2 Feed End

A basic representation of how the equipment is arranged is shown in Figure 2. The waveform is generated by charging a capacitor to a high voltage and then discharging it through a thyristor and matching transformer into the track. The inductance of the feed and relay end transformers, together with that of the rails, causes the positive pulse to be followed by a negative undershoot. The transmitter is fed from a Power Supply Unit (PSU), which requires a 110V 50W a.c. power supply, from which the current is constant whether the track circuit is occupied or not. The design of the transmitter ensures that the waveform is not reflected back to the power supply.

3.1.3 Track Equipment

The operating waveform requires connection to the rails through a track transformer. On electrified lines, the track transformer requires a protective resistance in series with the track winding to prevent the traction current saturating or damaging the winding. This resistance has scope for adjustment, but in the British application, adjustment is not required.

3.1.4 Receiver/Relay End

At the receiver/relay end, the energy from the track transformer is rectified and directly drives the track relay, hence a power supply is not required at the relay end. The positive and negative parts of the waveform are rectified separately and applied to different windings on the relay. The relay has a magnetic circuit which ensures that it can only pickup if the applied voltages are in the correct ratio (i.e. the track waveform is correct).

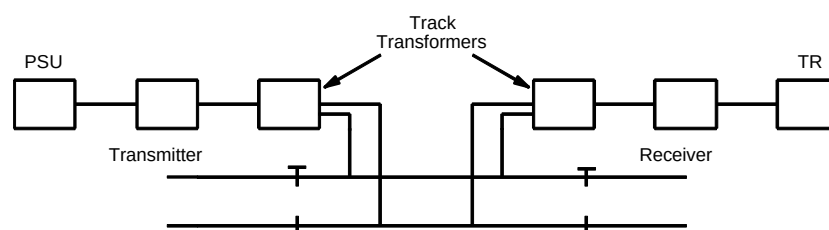


Figure 2

3.2 BONDING REQUIREMENTS

The limits of HVI track circuits shall be defined by IRJs in at least one rail. In single rail mode, IRJs are provided in the insulated rail. In double rail mode, IRJs are provided in both rails. General details of bonding arrangements are contained in RT/E/S/I 1752, the following being applicable to HVI track circuits:

3.2.1 Electrified Lines

Single rail configuration shall be used, implemented with Standard series bonding on the insulated rail and parallel Yellow traction bonding on the common rail (i.e. the traction return rail). In this mode, it shall be accepted that the traction rail bonding precludes detection of rail breakage in the common rail.

3.2.2 Non-electrified Lines

The preferred configuration is double rail, implemented with Standard bonding on both rails.

Only where the double rail configuration is impractical, generally at S&C, the single rail mode may be used. This shall preferably be implemented with series bonding on both rails, although in complex S&C the common rail may need to be parallel bonded. The series bonded rails shall be fitted with Standard bonding and only the parallel bonded rail with Yellow Standard bonding.

3.3 ELECTRICAL STAGGER

Since the waveform is considered to have positive and negative peaks, the necessary protection against IRJ failure is achieved by ensuring that abutting track circuits have opposite polarities.

The only permitted exception to this rule is at IRJs where two feed ends abut.

3.4 COMMON RAIL BALANCE

Where a group of track circuits share a common rail, it is necessary to achieve an approximate balance whereby the aggregate current flowing from the common rail into the ballast approaches zero. To prevent a residual polarity building up on the common rail, there shall be, as near as possible, an equal number of +ve and -ve feeds to the common rail.

The requirement for electrical stagger tends to also fulfil the requirement for common rail balance, but the provision shall be checked. However, where there is a conflict, other bonding safety rules take precedence over balancing the common rail.

4 PHYSICAL REQUIREMENTS

4.1 EQUIPMENT AND CIRCUITRY

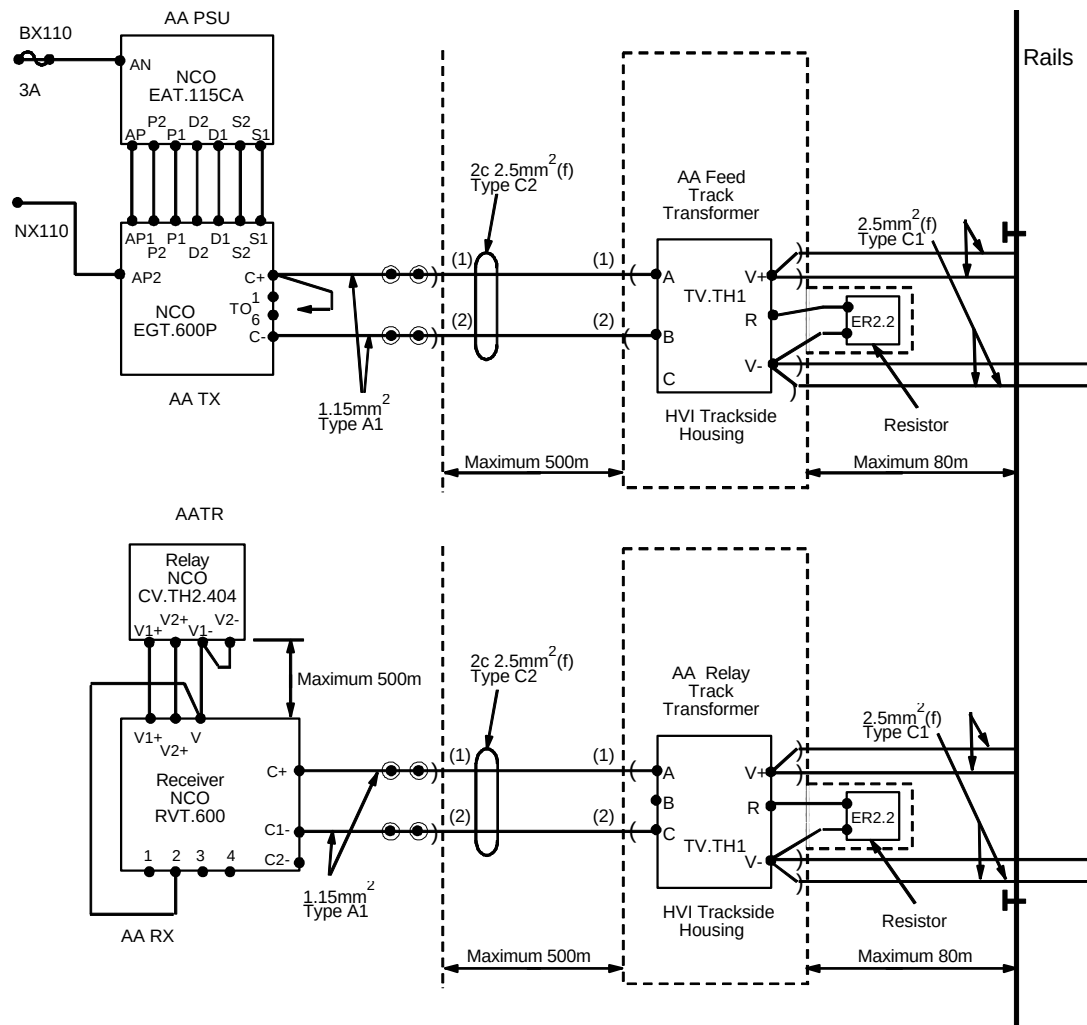
There are three different configurations of HVI track circuit, the equipment and circuitry for each being shown in Figures 3 to 5, respectively:

- HVI track circuit for d.c. electrified lines,
- HVI track circuit for a.c. or dual electrified lines,
- HVI track circuit for non-electrified lines.

All internal wiring shall be in standard 0.75mm² Type A cable, except the connections from the receiver and transmitter to their associated links which shall be 1.15mm² Type A cable.

For the routing of wires and cables see section 6.3; for shrouding see section 7.2.1.

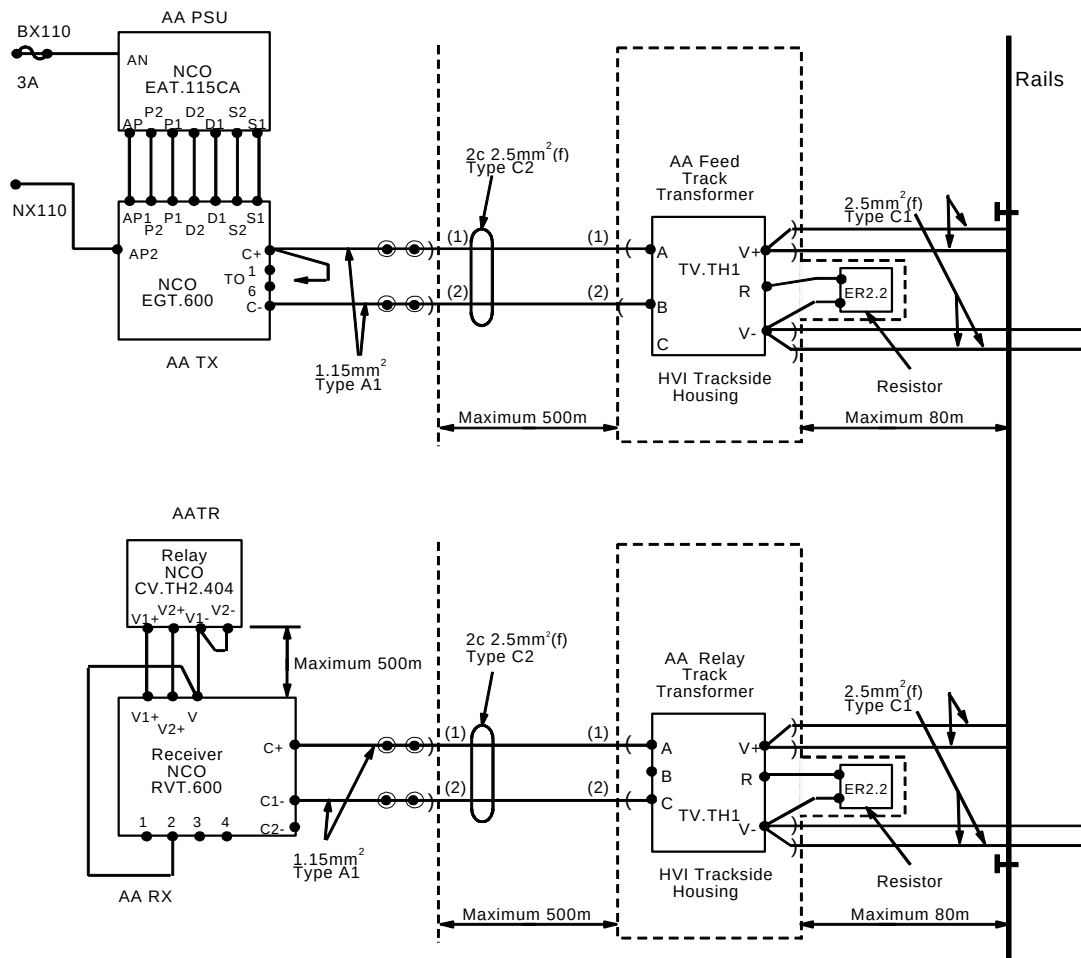
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- | | |
|-----------------------|----------------|
| a) Power supply | NCO.EAT.115CA |
| b) Transmitter | NCO.EGT.600P |
| c) Track transformers | TV.TH1 |
| d) Resistors | ER2.2 |
| e) Receiver | NCO.RVT.600 |
| f) Relay | NCO.CV.TH2.404 |

Figure 3 - HVI Track Circuit on D.C. Electrified Lines

HVI Track Circuits



- | | |
|-----------------------|----------------|
| a) Power supply | NCO.EAT.115CA |
| b) Transmitter | NCO.EGT.600 |
| c) Track transformers | TV.TH1 |
| d) Resistors | ER2.2 |
| e) Receiver | NCO.RVT.600 |
| f) Relay | NCO.CV.TH2.404 |

Note: for details of the RT/SIN/067 receiver modification in a.c. areas, see section 6.2.1.

Figure 4 - HVI Track Circuit on A.C. and Dual Electrified Lines