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Issue	I
Date	December 2000

Westinghouse Signals FS2600 Track Circuits (formerly RT/E/PS/11760)

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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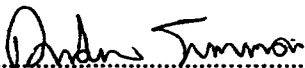


RAILTRACK LINE PRODUCT SPECIFICATION

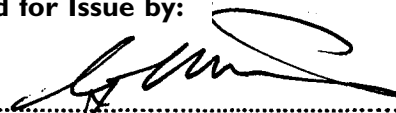
WESTINGHOUSE SIGNALS FS2600 TRACK CIRCUITS

Endorsement and Authorisation

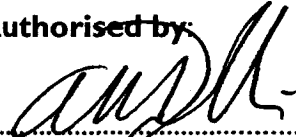
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Summary

This Line Specification states the minimum requirements for Westinghouse FS2600 track circuits. It includes lifecycle requirements from design, safety and environmental 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/RC0760 which is to be transferred to Railtrack Line in February 2001.

Implementation

The requirements of this Specification shall apply to all Westinghouse Signals FS2600 track circuits supplied for use on Railtrack controlled infrastructure on or after 3 February 2001. It shall also apply to the alteration and maintenance of existing Westinghouse Signals FS2600 track circuits from the same date. The following document is superseded:

Superseded Document

GK/RT0760, Issue 1, June 98 - Westinghouse Signals FS2600 Track Circuits

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I INTRODUCTION

I.1 PURPOSE

This Product Specification gives details of best practice in respect of Westinghouse Signals FS2600 track circuits in order to achieve the requirements of RT/E/S/11752.

I.2 SCOPE

The contents of this Product Specification apply to FS2600 track circuits. The more general requirements can be found in RT/E/S/11752. Safety issues specific to FS2600 applications are included; general safety issues are contained in RT/E/S/11752 and other relevant Railtrack standards.

I.3 INTRODUCTION

The FS2600 track circuit has been developed and manufactured by Westinghouse Signals Ltd. who own all intellectual rights to the FS2600 product. The contents of this specification are based on information supplied by Westinghouse Signals Ltd. and incorporate subsequent Railtrack experience.

The FS2600 range of track circuit equipment is designed to replace existing VTI vane relay a.c. track circuits in d.c. electrified areas. The FS2600 system provides greater immunity to traction current interference than the VTI system it replaces.

Some existing track circuits in d.c. traction areas are 50Hz a.c. type utilising VTI vane track relays, where the limits of each track circuit are defined by insulated rail joints (IRJs). A transformer is used to inject a signal into one end of the track circuit and a phase-sensitive vane relay at the other end is held energised if the track circuit is unoccupied.

The FS2600 system replaces the feed transformer with a transmitter (Tx) and the VTI relay with a receiver (Rx). Additionally, tuning capacitors are required to resonate the impedance bonds at the track circuit frequency of double rail track circuits.

2 APPLICATION AND CONSTRAINTS

2.1 APPLICATION

The application of FS2600 track circuits fulfils the basic requirement for continuous train detection.

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 FS2600 track circuits is only cost effective where their functional capabilities are of benefit, e.g. to give d.c. traction immunity.

2.2 CONSTRAINTS

FS2600 equipment is designed for use on single rail (see note in section 2.2.2) or double rail jointed tracks; in plain line and through switches and crossings (S&C), subject to the following constraints, in addition to the general restrictions given in RT/E/S/11752:

2.2.1 General

- a) The minimum distance between FS2600 track circuits and 25kV a.c. electrified railway line shall be 3km.
- b) Due to their very slow to pick-up characteristics, FS2600 track circuits have special interface delay requirements and limitations on minimum length. The Rx pick-up delay is 1290ms to 1685ms; the drop-away delay is 550ms to 1000ms. Time delays must be considered during the design stage of schemes utilising FS2600 track circuits. The rules to be applied are covered in section 3.3.
- c) There are proximity restrictions in the positioning of FS2600 track circuit equipment and cabling, due to interference. Details are given in section 6, Environmental Requirements.
- d) FS2600 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/PS/11764.
- e) Restrictions exist for the application of the FS2600 system over level crossings due to inductive losses occurring with some level crossing surface units. Refer to the Infrastructure Controller for guidance.

- f) There are special restrictions when abutting with other types of track circuit, due to interference. In addition, 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. The effects of interference are minimised by the application of the following limitations:
- g) The FS2600 system shall not be installed on any line where overlay track circuits are in use or on any line parallel to a line where they are in use.
Note: 10kHz rail circuits are used extensively by London Underground.
- h) FS2600 track circuits shall not abut Reed track circuits. An individual safety assessment shall be made to justify the minimum distance between FS2600 track circuits and Reed track circuits at each boundary. The assessment shall be approved by the Railtrack Safety Assessment Panel.
- i) An FS2600 channel 10 track circuit shall not abut a T1.21 frequency E track circuit and there shall be a minimum of two pairs of insulated rail joints between track circuits using these channels on the same line.
- j) An FS2600 channel 10 track circuit shall not be parallel to a T1.21 frequency E track circuit unless there is one or more intervening track between the relevant FS2600 and T1.21 track circuits. There shall not be any direct negative bonding connecting the relevant FS2600 and T1.21 track circuits.
- k) An FS2600 channel 1 track circuit shall not abut a T1.21 frequency D track circuit and there shall be a minimum of two pairs of insulated rail joints between track circuits using these channels on the same line.
- l) An FS2600 channel 1 track circuit shall not be parallel to a T1.21 frequency D track circuit unless there is one or more intervening track between the relevant FS2600 and T1.21 track circuits. There shall not be any direct traction return bonding connecting the relevant FS2600 and T1.21 track circuits.
Note: Direct traction return bonding implies either a direct cable connection from one track circuit impedance bond or resonant bond plate to another (or traction rail for a single rail track circuit) or a cable connection via the negative busbar in a substation or track paralleling hut.

2.2.2 Single Rail Track Circuits

Note: At present, the use of FS2600 track circuits in single rail mode has not been approved. The guidance in this specification in relation to single rail track circuits is given for use when approval has been obtained. Any further constraints applied as part of the approval shall also be applied.

- a) Single rail track circuits may be between 18m and 200m in length, with a maximum spur length of 40m. The cable connecting the Rx to the rail may be up to 300m long with a maximum loop resistance of 5Ω . The cable connecting the Tx to the rail may be up to 120m long with a maximum loop resistance of 2Ω .
- b) In electrified areas, double rail reed or T1.21 track circuits must not be allowed to be surrounded by an area of FS2600 single rail track circuits, e.g. on a loop line, as described in the appropriate Track Circuit Product Specification.
- c) In electrified areas, 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/I 1752).
- d) In conductor rail electrified areas, protection boarding shall be fitted where specified in with Part C of RT/E/S/I 1752.

2.2.3 Double Rail Track Circuits

- a) Double rail track circuits may be between 50m and 1200m long. The cable connecting the Rx to the impedance bond may be up to 760m long with a maximum loop resistance of 12Ω . The cable connecting the Tx to the impedance bond may be up to 150m long with a maximum loop resistance of 2.5Ω .
- b) Double rail a.c. track circuits are not suitable for use in S&C.
- c) Impedance bonds are always required for double rail track circuits in electrified areas. FS2600 track circuits are not permitted for use in 50Hz a.c. or dual electrified areas. General track circuit restrictions in electrified areas are given in RT/E/S/I 1752, but the following additional rules apply:
- d) The minimum distance permitted between impedance bonds is 10m and the maximum distance is 800m (see RT/E/PS/I 002 for traction cross bonding intervals).
- e) Track circuits may contain not more than one intermediate impedance bond.
- f) All impedance bonds must be fitted with a tuning capacitor as part of the FS2600 installation (see RT/E/PS/I 002).

3 FUNCTIONAL REQUIREMENTS

3.1 PRINCIPLES OF OPERATION

3.1.1 TRANSMITTER

The Tx generates a frequency shift keyed (FSK) signal which is fed to the rails at one end of a track circuit. The Tx output is derived from three crystal oscillators; one of which provides a low frequency modulation signal, and the other two provide an upper and lower shift frequency. The modulation frequency is used to switch the output between the upper and lower shift frequencies. Thus, the FSK waveform consists of the upper shift frequency alternating with the lower shift frequency at a rate determined by the modulation frequency. The Tx maintains the output voltage within safe limits.

The FSK output at each of ten carrier frequencies is modulated by 15.6Hz. Three output voltage levels are available to suit the type of track circuit.

3.1.2 Receiver

The Rx is connected to the rails at the other end of the track circuit from the Tx and carries out an analysis of the signal which it receives from the rails. If the Rx determines that the signal is of correct form and sufficient level, the circuit is proved clear and a twin-coil relay built into the Rx is energised. If the signal is not of the correct FSK waveform or not above the threshold level, the track circuit is assumed to be occupied. The relay has four front contacts which are closed to indicate that the track circuit is clear, and two back contacts which are closed when the track circuit is occupied.

Note: Front and back contacts being open at the same time indicates an internal fault in the Rx.

If there is a train in the track circuit, the axles provide a shunt path for the signal so that the Rx receives a greatly attenuated input. The Rx therefore allows the track relay to be de-energised and the circuit is considered occupied. Similarly, if there is a failure of the equipment, the track relay is de-energised and again the track circuit is considered to be occupied.

3.1.3 Single Rail Track Circuit

Note: At present, the use of FS2600 track circuits in single rail mode has not been approved.

For single rail track circuits, the Tx output is fed directly to the rails via a 15-20 μ F capacitor which blocks the d.c. traction current. Similarly, the Rx input is connected to the rails via an internal 3.3 μ F capacitor as shown in Figure 1.

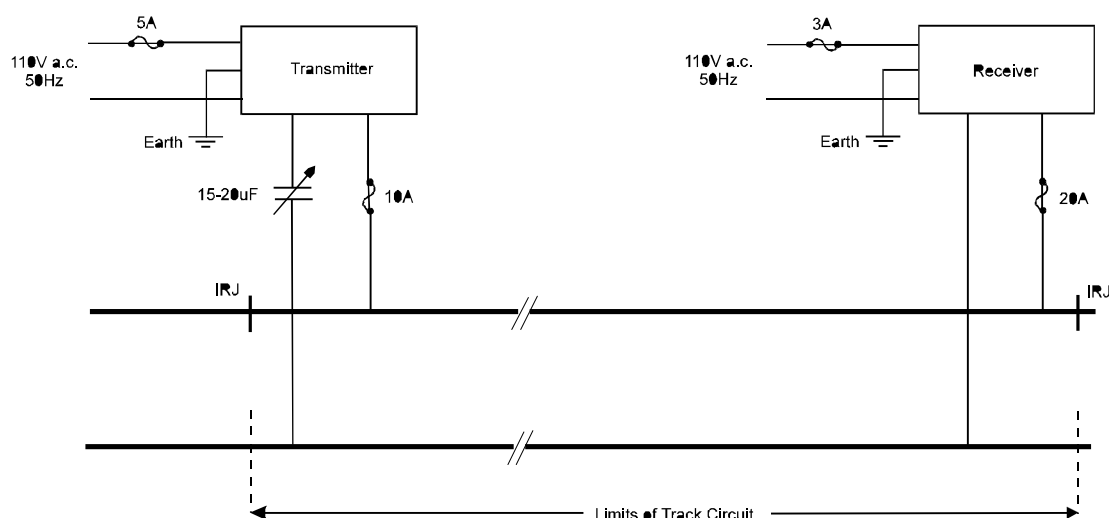


Figure 1

3.1.4 Double Rail Track Circuit

On double rail track circuits, the traction current by-passes the IRJs via impedance bonds, while the track circuit current is contained entirely within the limits of the track circuit. The track circuit signal from the Tx is passed to the rails via an auxiliary coil on the impedance bond. A fixed value tuning capacitor in the impedance bond terminal case is used to tune the auxiliary coil of the impedance bond to the operating frequency (i.e. the carrier frequency) of the track circuit. The peak impedance of the tuned impedance bond in isolation is approximately 13Ω . When installed in a track circuit, this impedance is reduced.

Similarly, at the other end of the track circuit, the signal from the rails is passed to the Rx via the auxiliary coil on the impedance bond. A capacitor is again included to tune the bond to the operating frequency. The centre tap of the impedance bonds may be connected to the centre tap of impedance bonds on an adjacent track, or may be returned directly to the substation. A double rail track circuit is shown in Figure 2.

Further information on impedance bonds is given in RT/E/PS/1002.

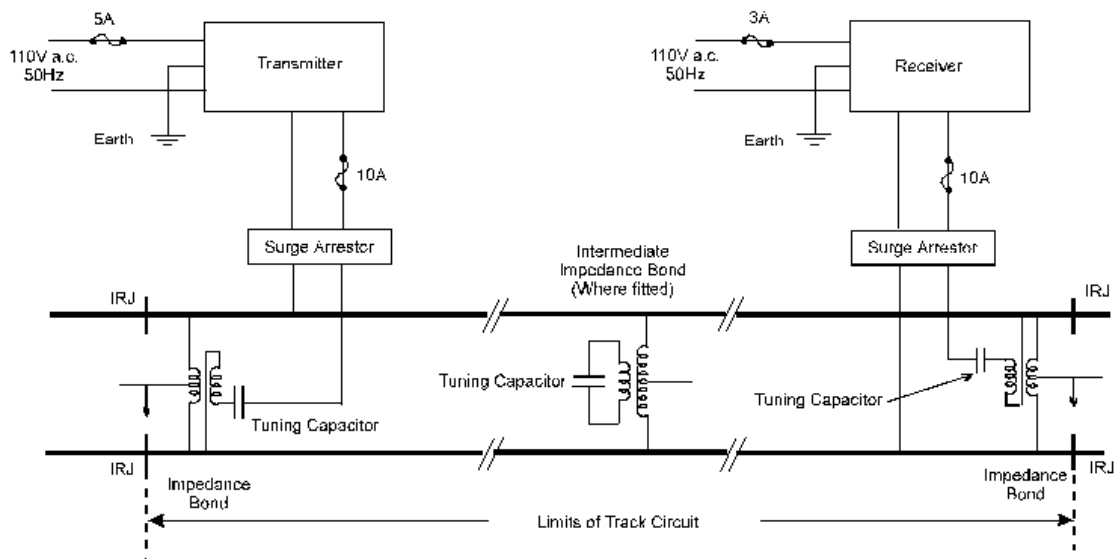


Figure 2

An intermediate impedance bond may be used either to balance the return currents in the two rails or to return current to the substation directly or via an adjacent track. Again a capacitor is used to resonate the auxiliary coil at the operating frequency of the track circuit.

3.2 BONDING REQUIREMENTS

The limits of FS2600 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/11752, the following being applicable to FS2600 track circuits:

The preferred configuration is double rail, implemented with series bonding on both rails to traction standards.

Only where the double rail configuration is impractical, such as in S&C or short track circuits, the single rail mode may be used. This shall preferably be 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. The special requirements for long spurs are given in RT/E/S/11752.

Note: At present, the use of FS2600 track circuits in single rail mode has not been approved.

3.3 OPERATING CATEGORY AND INTERFACE DELAY REQUIREMENTS

A timing category has yet to be specified for the FS2600 track circuit.

- a) When in an area controlled by a Free Wired or Geographical Interlocking (GEC or Westpac), unless restricted by another clause, the FS2600 track circuit may abut other track circuits as shown in Figure 3.

TRACK CIRCUIT	COMPATIBLE	BANNED (NON-COMPATIBLE)
FS2600	FS2600 FS2600 + 1 TPR TI.2I HVI VTI + 2 TPRs	VTI VTI + 1 TPR Category B* Category B* + 1 TPR
FS2600 + 1 TPR	FS2600 FS2600 + 1 TPR FS2600 + 2 TPRs TI.2I HVI VTI(SP) VTI + 2 TPRs	VTI VTI + 1 TPR Category B* Category B* + 1 TPR
FS2600 + 2 TPRs	FS2600 + 1 TPR FS2600 + 2 TPRs VTI(SP) VTI(SP) + 1 TPR TI.2I	All other combinations

* As defined in Part F of RT/E/S/11752

- Notes:**
- (1) The only TPRs to be considered are the BR933 type.
 - (2) The use of FS2600 with more than one TPR shall be avoided where it is practicable to remove TPRs or on new installations.

Figure 3

- b) The minimum length for any other combination of an FS2600 track circuit following either a VTI(SP) or an FS2600 + 2 TPRs in a running direction shall be determined using the table in Figure 4.

PERMISSIBLE SPEED	FS2600 FOLLOWING FS2600 + 2 TPRs	FS2600 FOLLOWING VTI(SP) FS2600 + 1 TPR FOLLOWING VTI(SP) + 1 TPR FS2600 + 2 TPRs FOLLOWING VTI(SP) + 2 TPRs	FS2600 FOLLOWING VTI(SP) + 1 TPR FS2600 + 1 TPR FOLLOWING VTI(SP) + 2 TPRs	FS2600 FOLLOWING VTI(SP) + 2 TPRs
(mph)	Min. Length (metres)	Min. Length (metres)	Min. Length (metres)	Min. Length (metres)
100	125	152	179	206
90	110	137	161	185
80	95	122	143	165
70	79	106	125	144
60	64	91	107	123
50	49	76	89	103
40	34	61	72	82
30	19	46	54	62
20	N/A	30	36	41
15	N/A	23	27	31
10	N/A	N/A	N/A	21

Figure 4

- c) If the combination is not covered by the tables in Figures 3 or 4, an individual safety assessment is to be produced and recorded. The following factors need to be determined:

Number of slow to pick TPRs (BR933) for the VTI(SP) = S_V

Number of slow to pick TPRs (BR933) for the FS2600 = S_F

Number of additional repeat relays for the VTI(SP) = N_V

Number of additional repeat relays for the FS2600 = N_F

up to and including the first used in interlocking.

Note: Relays operated in parallel from the same contact count as one.

VTI(SP) transmission time = T_V

FS2600 transmission time = T_F

(i.e. the time taken for any transmission systems (FDM, TDM, etc.) to operate. Usually, $T_V = T_F$ for adjacent track circuits).

The time difference, T is calculated as follows:

$$T = (N_V - N_F) \times 0.2 + (S_V - S_F) \times 0.6 + 0.2 + (T_V - T_F)$$

The **maximum** speed (metres per second) that the train can pass over the track circuit is multiplied by T to obtain the **minimum** track circuit length (metres) for the FS2600 track circuit. A typical calculation is given as an example:

A VTI(SP) track circuit has two TPRs (BR933) and three additional TPRs and is direct wired. An FS2600 has one TPR (BR933) and no additional TPRs but is transmitted over an FDM system with a 0.3 second response time. This would give the following values:

$$S_V = 2, S_F = 1, N_V = 3, N_F = 0, T_V = 0, T_F = 0.3$$

$$\text{Therefore; } T = (3 - 0) \times 0.2 + (2 - 1) \times 0.6 + 0.2 + (0 - 0.3) = 1.7 \text{ seconds.}$$

If maximum speed = 60mph (27 metres per second),

$$\text{minimum length of FS2600 track circuit} = 27 \times 1.7 = 46 \text{ metres.}$$

- d) Where several track circuits are combined to form one longer track circuit, and the individual sections are not separately used for interlocking purposes, these rules need not be applied to the individual sections although an assessment shall be made and recorded to ensure that at least one section always remains occupied. The boundaries of the first and last section with adjacent track circuits are considered in the assessment.
- e) When in an area controlled by Solid State Interlocking (SSI), unless restricted by another clause, the FS2600 track circuit (with or without extra delay data) may abut track circuits as shown in Figure 5. The equivalent shall be determined for other data driven systems.

TRACK CIRCUIT	COMPATIBLE	BANNED (NON-COMPATIBLE)
FS2600	FS2600 FS2600 + extra delay VTI (SP) VTI + extra delay TI.2I HVI	VTI Category B*
FS2600 + I TPR	FS2600 FS2600 + extra delay VTI (SP) VTI (SP) + extra delay VTI + extra delay TI.2I HVI	VTI Category B*

* As defined in Part F of RT/E/S/11752

Figure 5

- f) In SSI areas, FS2600 track circuits without extra delay data may follow a VTI (SP) + extra delay when, in the direction of running, the FS2600 is no longer than identified in Figure 6. The equivalent shall be determined for other data driven systems.

PERMISSIBLE SPEED (mph)	FS2600 TRACK CIRCUIT FOLLOWING VTI (SP) + EXTRA DELAY Max. Length (metres)
100	224
90	201
80	179
70	156
60	134
50	112
40	89
30	67
20	45
15	34
10	22

Figure 6

3.4 CHANNEL ALLOCATION

3.4.1 General

A range of ten channels is available for the FS2600 system. The following rules apply in allocating channels:

- a) Consecutive track circuits must not be of the same channel except where the Txs abut and the two track circuits are either both single rail or both double rail.
- b) Cross bonded double rail track circuits are permitted provided one of the following conditions is met:
 - They are different channels
 - They are the same channel and are cross bonded Tx to Tx
 - They are the same channel and are cross bonded Rx or intermediate bond to Rx. The track circuit Rx bonded is less than 500m in length without intermediate impedance bonds.
 - They are the same channel and are less than 500m in length and none of the cross bonded track circuits has an intermediate impedance bond.

Reference can be made to the layouts shown in Figure 16.

- c) Intersecting tracks (as at bridges) if cross-bonded, must be treated as cross-bonded tracks described in b) above.
- d) Where IRJ failure could cause energy from one track circuit to energise another of the same channel (even in the presence of a train shunt), then protection must be provided. This is by the use of detection pairs or, additionally for single rail track circuits, transpositions at the end of the track circuit. Detection pairs or transpositions indicate the leakage of energy past an IRJ by one or both track circuits in the pair failing right side. There must be at least two independent detection pairs or transpositions between two track circuits of the same channel.

Note: A detection pair is a pair of FS2600 channels whose signals are close together in frequency. If a signal from the Tx of one channel of the detection pair is detected by the Rx of the other channel, that Rx will de-energise the output relay. The pair is described as a detection pair because the effect is to detect failed IRJs.

A transposition is illustrated in Figure 7:

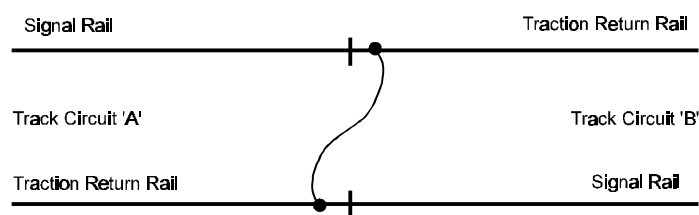


Figure 7

Channel numbers and detection pairs are shown in Figure 8:

CHANNEL	CARRIER FREQUENCY (HZ)	DETECTION PAIRS
1	388.8	2, 3
2	403.2	1, 3, 4
3	417.6	1, 2, 4
4	432.0	2, 3
5	441.6	6, 7
6	456.0	5, 7, 8
7	470.4	5, 6, 8
8	484.8	6, 7
9	494.4	10
10	508.8	9

Figure 8

- e) Where an FS2600 track circuit abuts a section of double rail jointless track circuit, ensure that none of the other extremities of the double rail jointless section abuts an FS2600 track circuit of the same channel. Where an FS2600 track circuit abuts a section of single or double rail jointed track circuit, one or both of the following must be ensured:
- None of the other extremities abuts FS2600 track circuits of the same channel (except where two Tx's are located together)
 - At least two IRJs, whose failures are detectable, separate the FS2600 track circuit from any other FS2600 track circuit of the same channel.
- f) Track circuits of the same channel on parallel tracks must be separated by at least one other set of rails and, for double rail track circuits, must have no more than 250m of parallelism. For single rail track circuits, there is no limit on parallelism.

3.4.2 Examples of Channel Allocation

3.4.2.1 Plain Line

A typical channel allocation for plain line is shown in Figure 9:

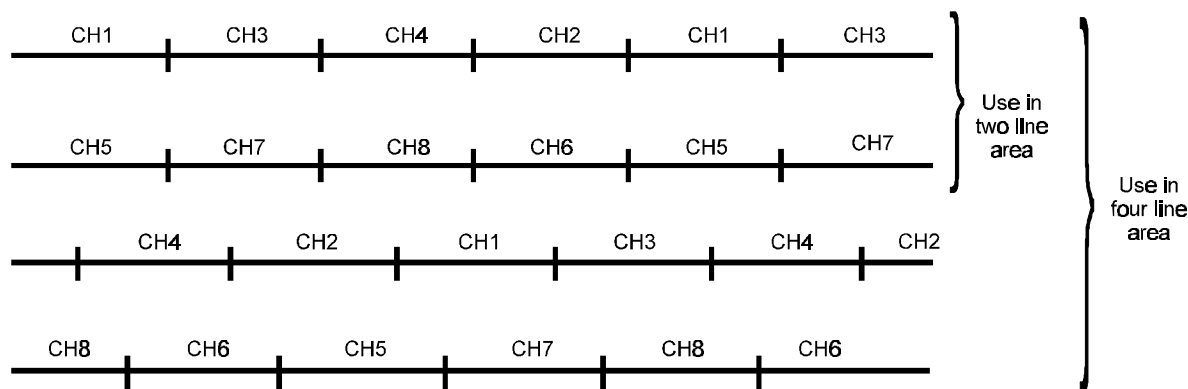


Figure 9

3.4.2.2 Switches and Crossings

In Switches and Crossing (S&C) areas, a similar channel allocation is adopted to maintain the sequence and comply with the rules given in this specification. A typical allocation is shown in Figure 10:

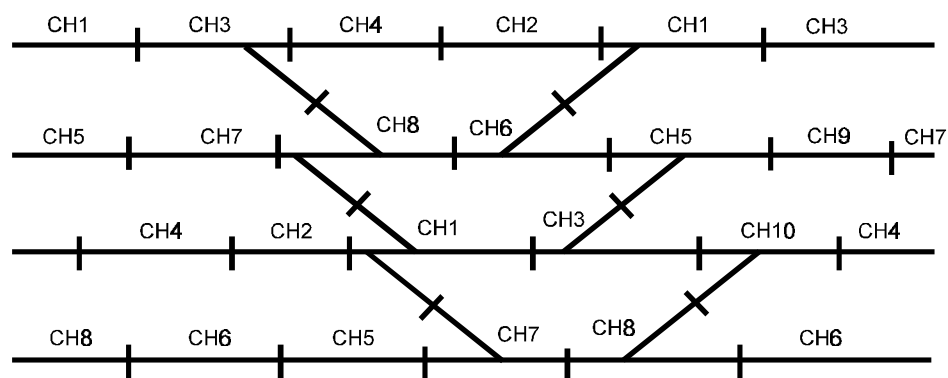


Figure 10

A typical channel allocation for a more complex arrangement is illustrated in Figure 11:

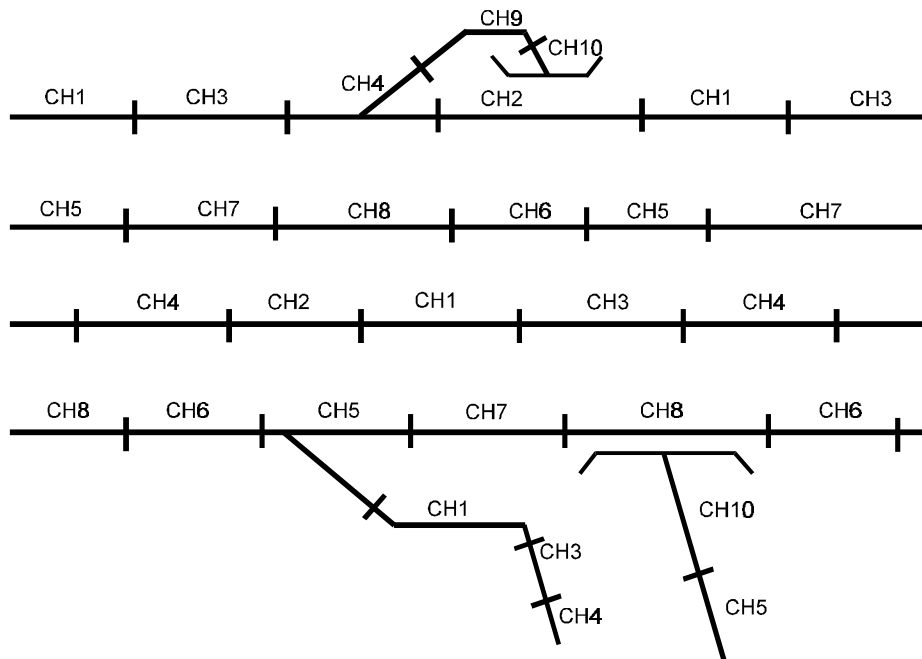


Figure 11

3.4.3 Permitted and Prohibited Layouts

3.4.3.1 Double Rail Track Circuits

Note: In areas with three or more tracks, it is better to use a minimum of three intervening channels to avoid future problems with cross-bonding.

The following rules must be applied when allocating channels:

- a) Before a channel may be repeated in a line of route, a minimum of two other channels must intervene with at least two independent detection pairs. Figure 12 shows permitted layouts:

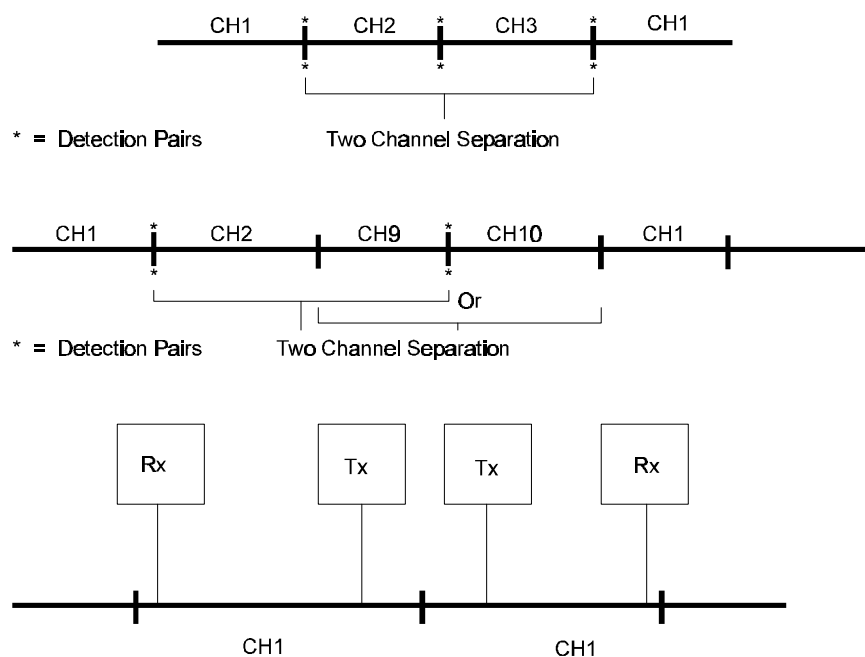


Figure 12

Figure 13 shows two prohibited layouts:

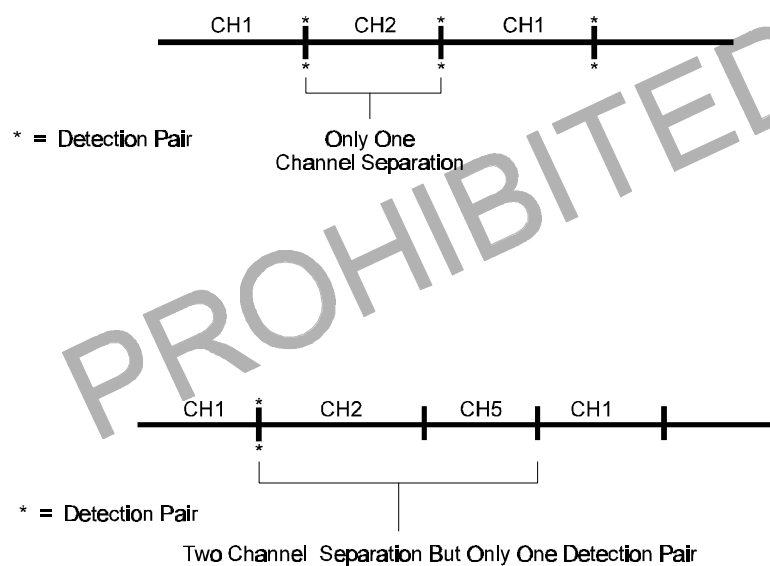


Figure 13

- b) For lateral channel repetition, at least one other set of rails must intervene and the maximum permitted parallelism is 250m. Track circuits which cross in the vertical plane at approximately right angles have no restriction.

Figure 14 shows permitted layouts:

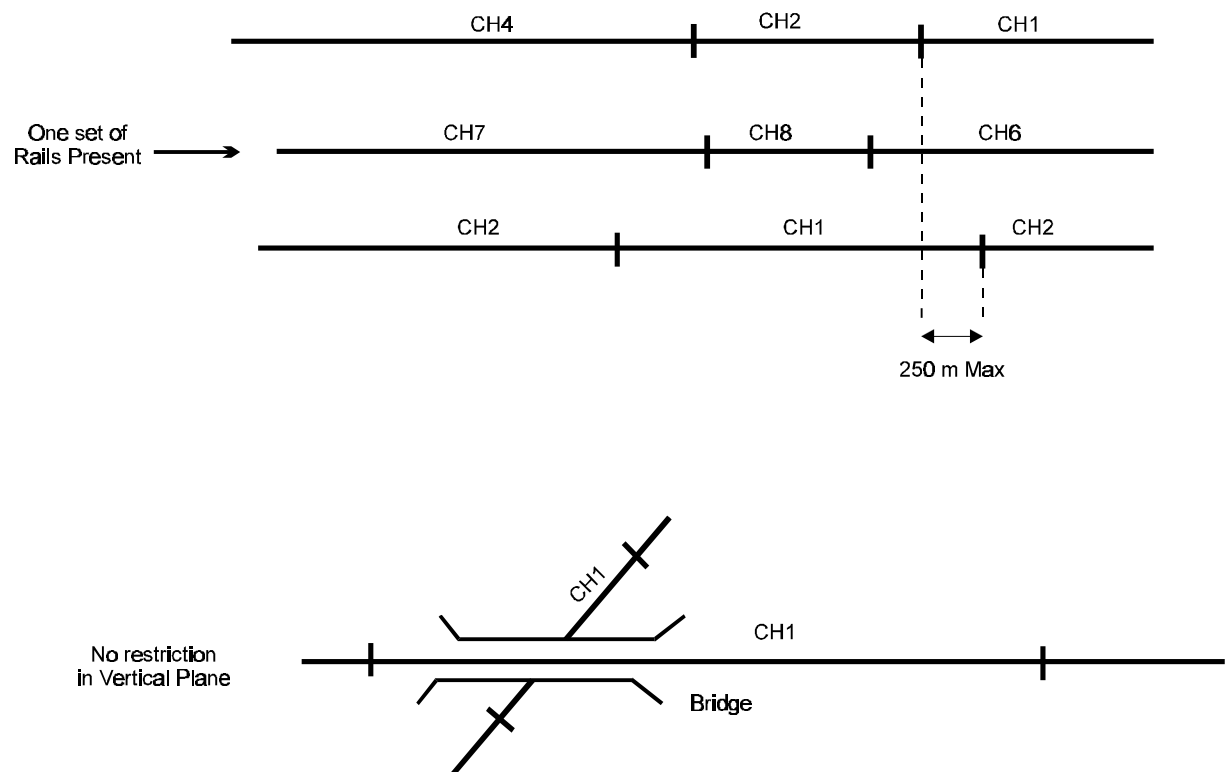
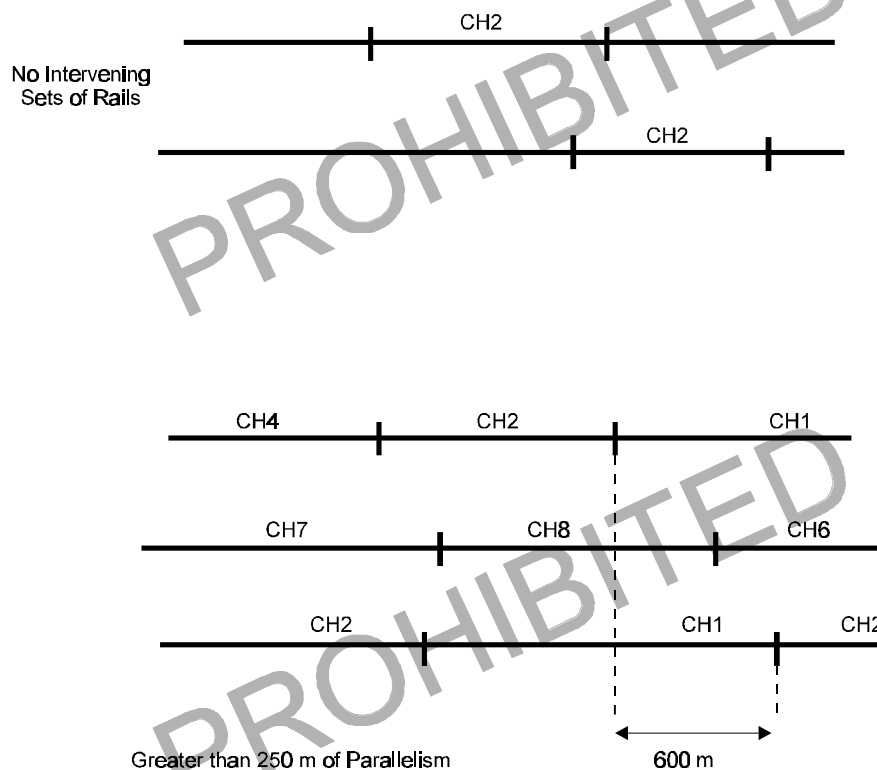
**Figure 14**

Figure 15 shows prohibited layouts:

**Figure 15**

- a) No track circuit may be cross-bonded to a double rail track circuit of the same channel except at Tx to Tx bonds or as described in section 3.4.1(b). Figure 16 shows permitted layouts.

Westinghouse Signals FS2600 Track Circuits

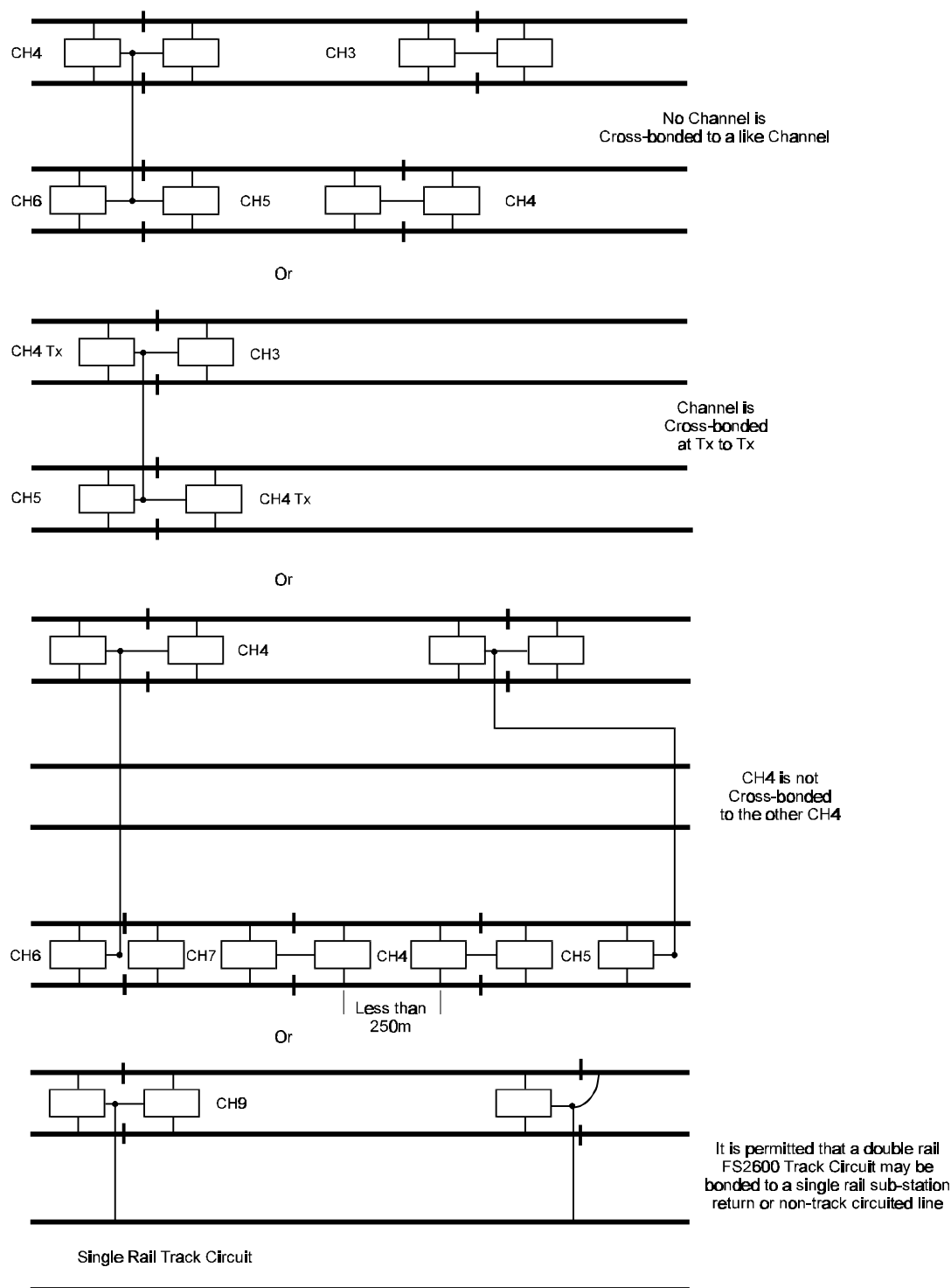


Figure 16

3.4.3.2 Single Rail Track Circuits

Note: At present, the use of FS2600 track circuits in single rail mode has not been approved.

Note: The following rules apply over all possible directions whether there are signalled movements over them or not:

- a) Before a channel may be repeated in a line of route, a minimum of two other channels must intervene with at least two independent detection pairs or transpositions at the end of the track circuit. Permitted layouts are shown in Figure 17:

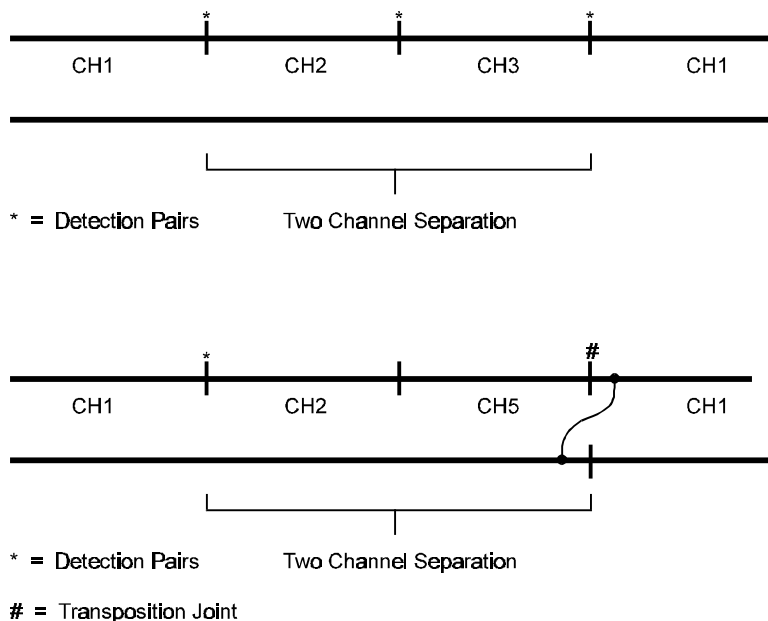


Figure 17

A prohibited layout is shown in Figure 18:

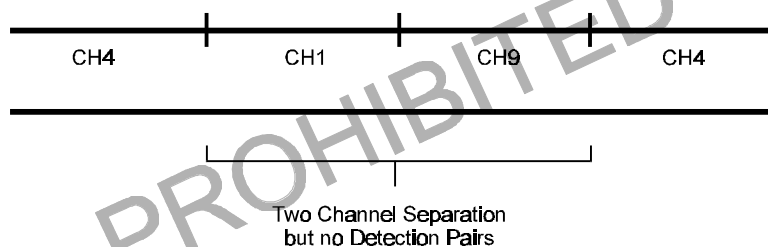
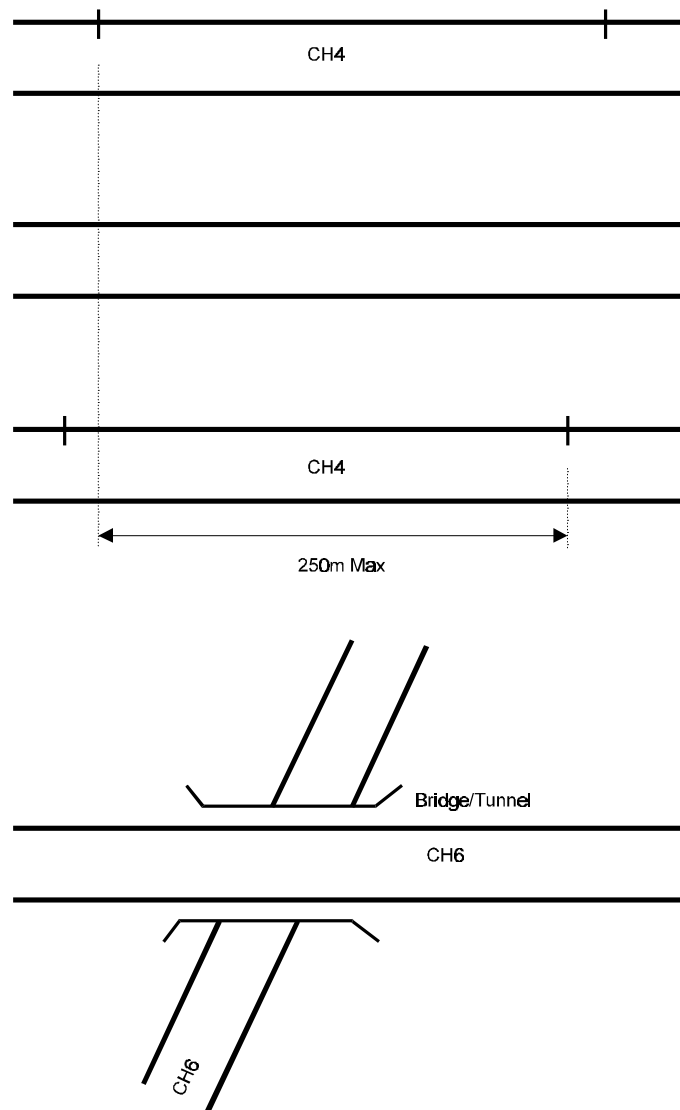
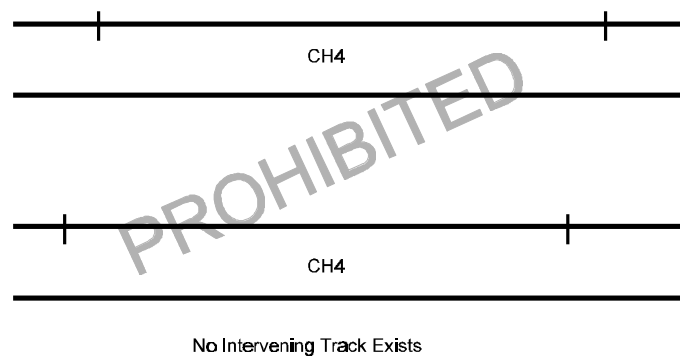


Figure 18

- b) A Tx may abut a Tx of the same channel at a single IRJ. Refer to section 3.4.1(a).
- c) For lateral channel repetition, at least one other set of rails must intervene. Track circuits which cross in the vertical plane at approximately right angles have no restriction. Permitted layouts are shown in Figure 19:

**Figure 19**

A prohibited layout is shown in Figure 20:

**Figure 20**

3.4.3.3 Double Rail to Single Rail Track Circuits

Note: The preceding rules appertaining to double rail and single rail designs are to be applied on each side of the IRJs respectively, as shown in Figure 21:

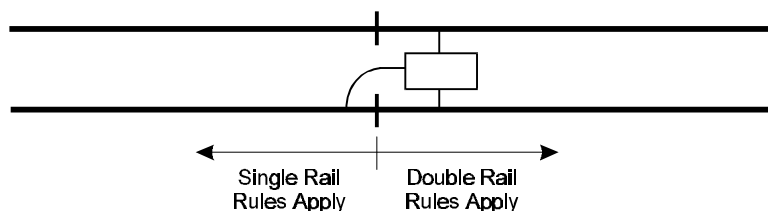


Figure 21

The following rules must also be applied:

- a) A Tx may not abut a Tx of the same channel at double rail to single rail IRJs. See Figure 22.

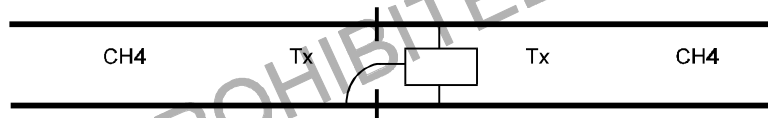
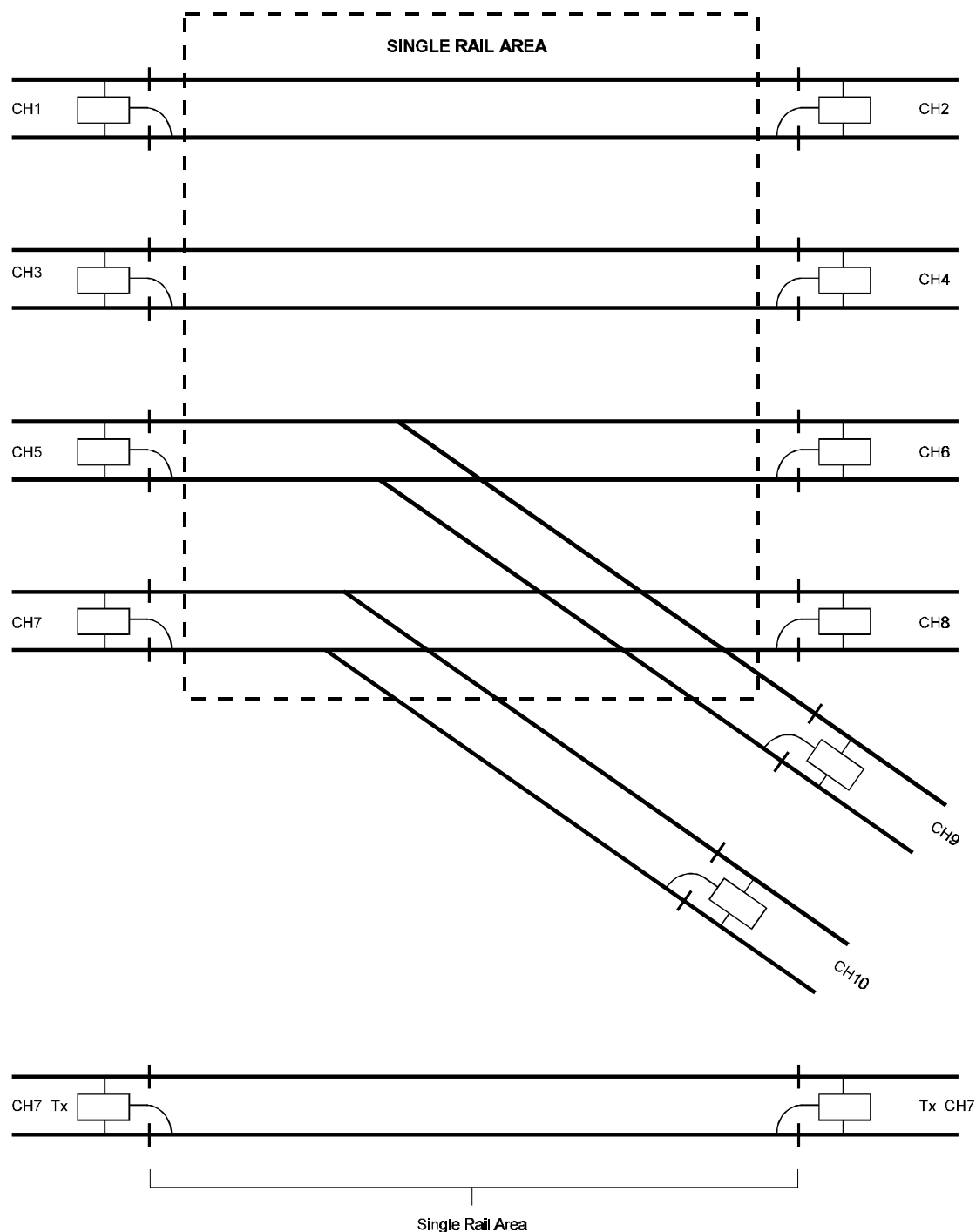


Figure 22

- b) When a double rail area is restarted beyond a single rail area, irrespective of the track circuit designs within the single rail area, the double rail track circuits must ALL be of different channels unless the track circuits of the same channel are fitted with Tx's at the boundary. Permitted layouts are shown in Figure 23:

**Figure 23**

- c) Two Tx's may face each other at the double to single rail abutments, and may be on different lines as shown in Figure 24:

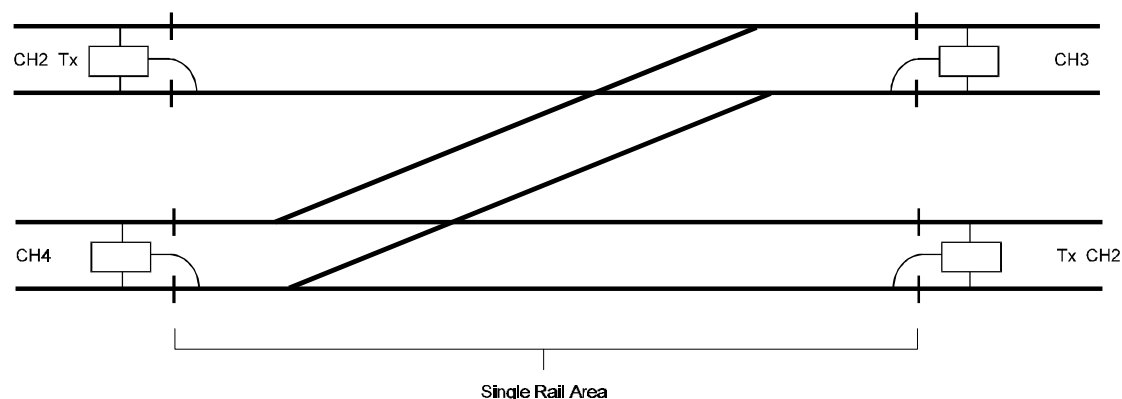


Figure 24

- d) A Tx may not face a Rx of the same channel across a junction. A prohibited layout is shown in Figure 25:



Figure 25

- e) The channel allocation spacings in the double rail areas must be continued with the single rail area being totally ignored for this purpose.

3.4.3.4 Integration and/or Abutment with other Track Circuit Designs

The channel allocation is to be continued through the matrix of other design track circuits which are ignored for this purpose.

4 PHYSICAL REQUIREMENTS

4.1 CABLING

In lineside apparatus housings, wiring between tail cables and Tx or Rx must be double insulated twisted pair cable, (max. 75mm pitch).

Tx and Rx tail cables must be 2c 2.5mm²(f) to RT/E/PS/00005.

4.2 WIRING DIAGRAMS

The following guidelines apply to all FS2600 wiring diagrams:

- Lineside apparatus housing and equipment building layout drawings must show the position and channel of each Tx and Rx.
- Lineside apparatus housing and equipment building wiring diagrams must show the connections to each Tx and Rx. In the case of the Rx, an additional connection must be shown for an earth on terminal 36. All other Rx connections shall be unchanged from the VTI relay, subject to contact allocation.

Note: Connecting an earth wire to the Rx and the Tx is desirable to ensure reliable operation in the presence of transient interference. If an earth is not available, the earth terminal shall be connected to the racking or the lineside apparatus housing metal work.

- In the case of the Rx, the connections to the contacts shall be in accordance with Figure 26.

CONTACT NUMBER & SYMBOL		
13		14
23		24
33		34
43		44
15		16
45		46
		36

Figure 26

d) In the case of the Tx, the connections shall be in accordance with Figure 27.

TX TERMINALS	PURPOSE
1 2	Nominal Output Voltage 18 V for Single Rail Track Circuits
3 4	Nominal Output Voltage 100 V for Double Rail Track Circuits with NO Intermediate Bond
5 6	Nominal Output Voltage 200 V for Double Rail Track Circuits with an Intermediate Bond
7	Not Used
8	Voltage Adjustment Tap 115 V
9	Voltage Adjustment Tap 105 V
10	Voltage Adjustment Tap 95 V
11	Voltage Adjustment Tap Common
12	Not Used
13	Earth
14	BX110 Supply
15	NX110 Supply

Figure 27

e) The following VT1 items are not required and shall be removed:

The adjustable capacitor from double rail track circuits, track resistors and transient suppressor units which are connected across the vane relay inputs on some track circuits and stabilising rectifiers which may be fitted to single rail track circuits. An isolating transformer may be fitted between the tail cable fuse and the relay input on some track circuit installations. These transformers are fitted at the discretion of the Infrastructure Controller to overcome excessive d.c. negative traction interference. They are not required for the FS2600 installation and are also to be removed.

f) All lineside apparatus housing wiring, including earth connections, shall be in 0.75mm² Type A cable to RT/E/PS/00005 except where double insulated twisted pair cable is required for Tx and Rx connections.

g) Tail cables shall be 2c 2.5mm² (f) Type C cable to RT/E/PS/00005.

- h) Surge arrestors must be mounted at the point at which the tail cables enter or leave a lineside apparatus housing or equipment building. The breakdown voltage for the surge arrestors shall be in the range 1200V to 1800V d.c.

Typical wiring diagrams are shown in Figures 28 to 31:

Figure 28 shows the wiring diagram of the feed end of a double rail track circuit with intermediate impedance bond:

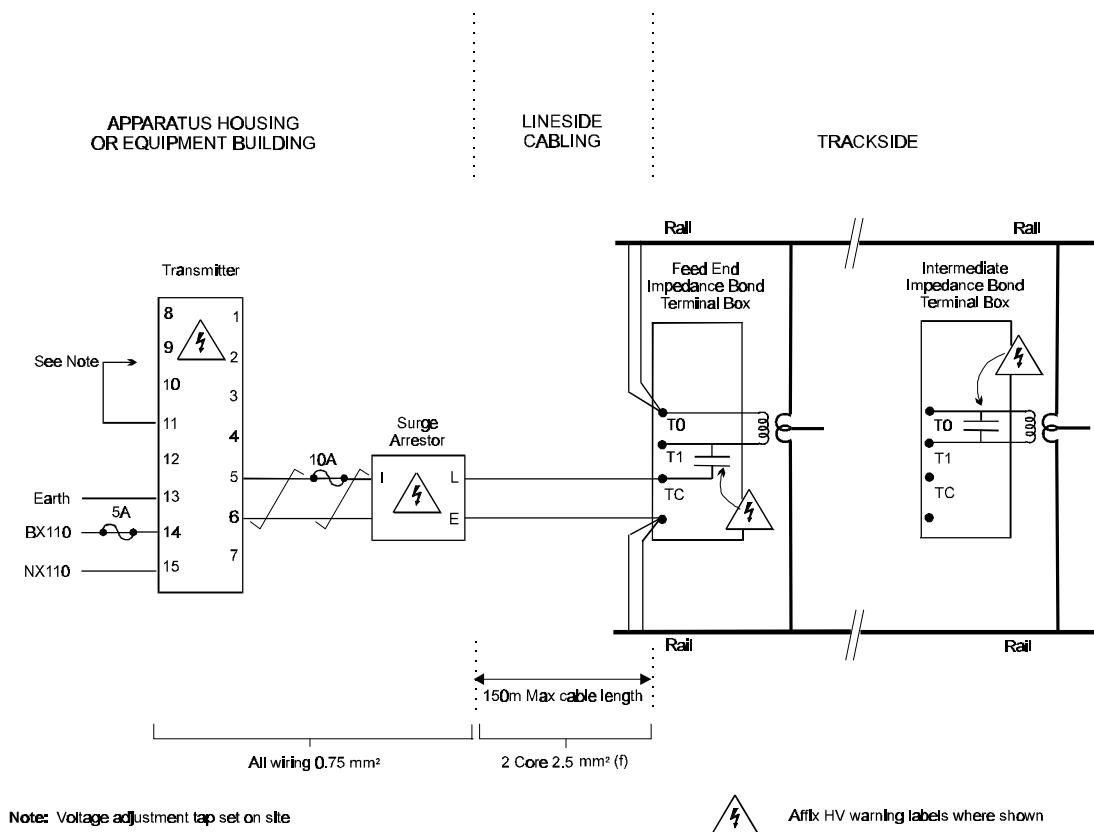


Figure 28

Figure 29 shows the wiring diagram of the feed end of a double rail track circuit without intermediate impedance bond:

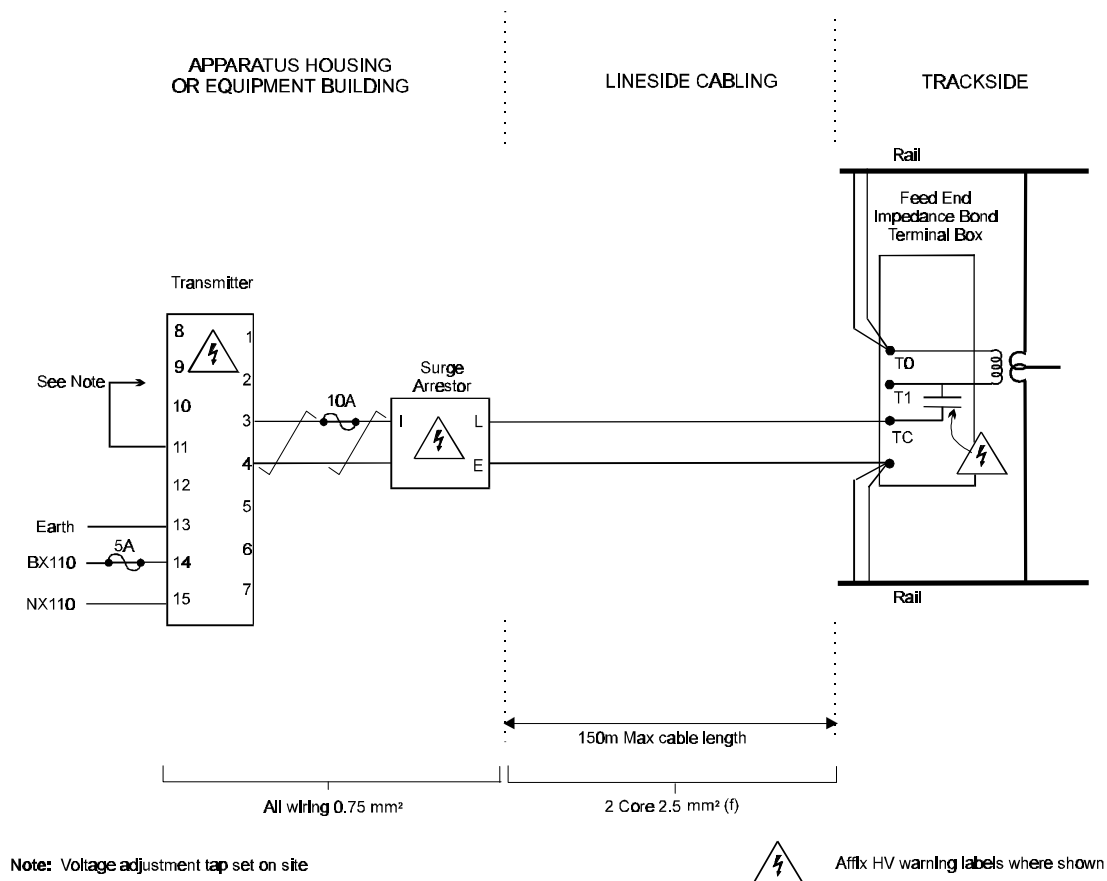
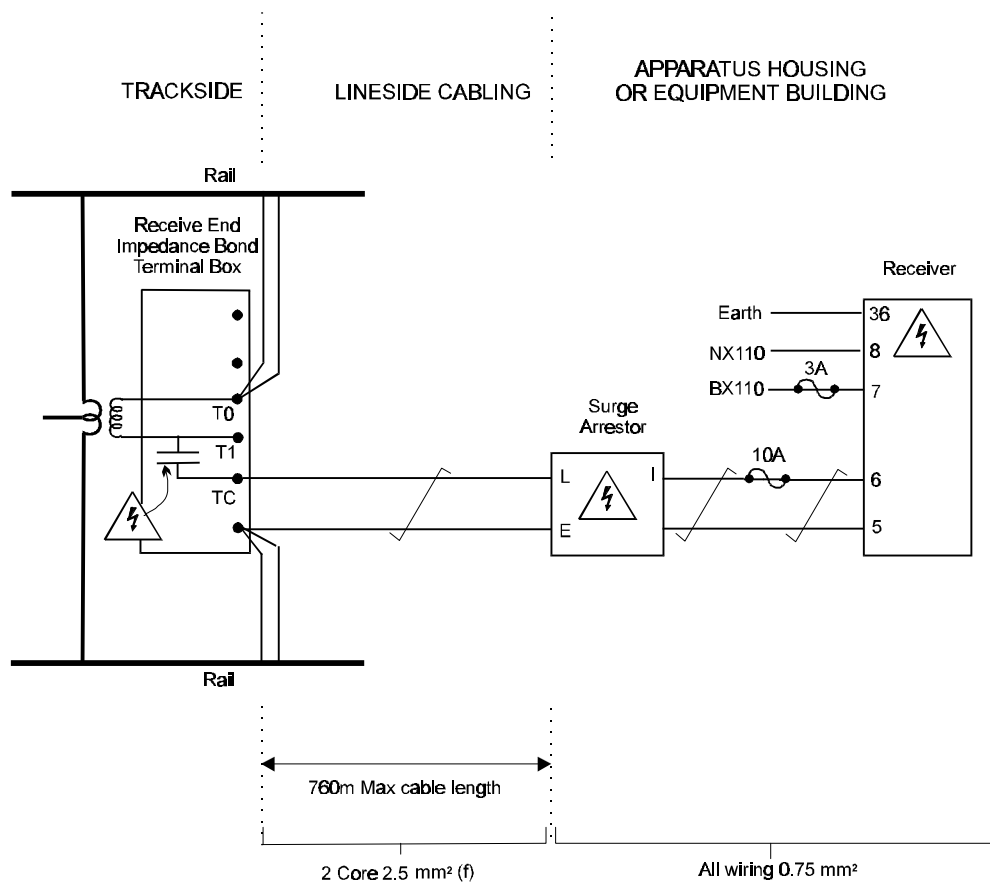


Figure 29

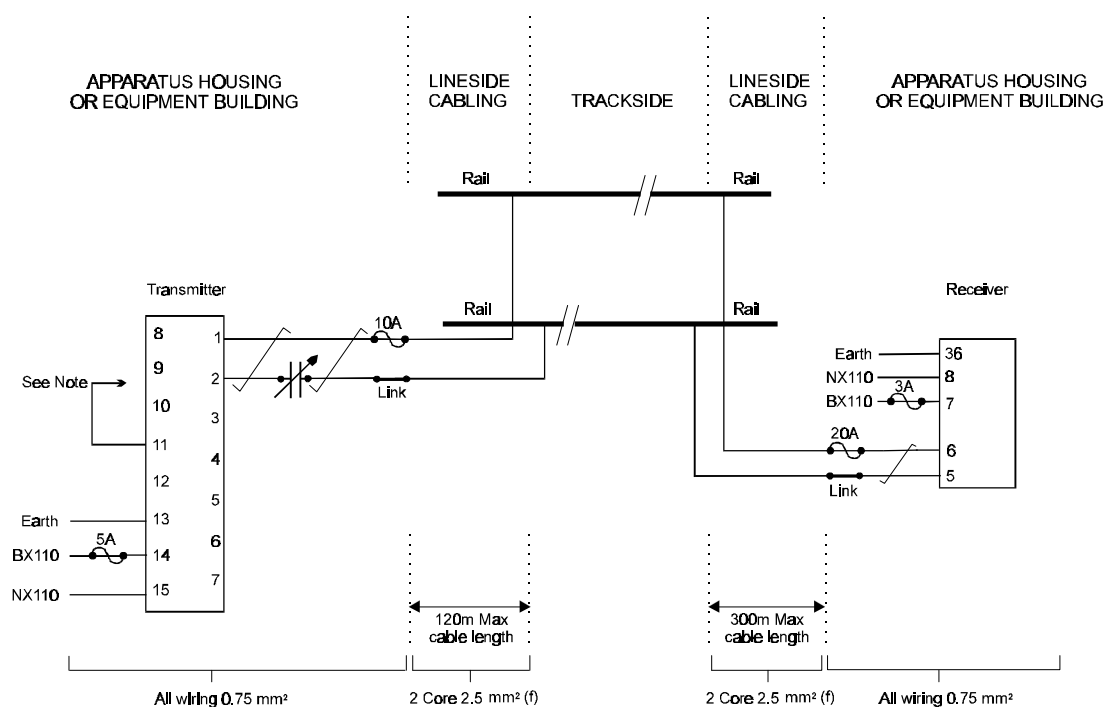
Figure 30 shows the wiring diagram for the Rx end of a double rail track circuit:



Affix HV warning labels where shown

Figure 30

Figure 31 shows the wiring diagram for a single rail track circuit:



Note: Voltage adjustment tap set on site

Figure 31

4.3 TRANSMITTER

The FS2600 Transmitter (Tx) is housed in a case 136.5mm (height) x 136.5mm (width) x 225mm (depth) and weighs 3.5 kg. The case comprises a steel shroud with front and rear faces fabricated in pressure die cast aluminium. A carrying handle is provided on the side of the front face. The Tx may be mounted directly to lineside apparatus housing racking or, via a bracket, on a wooden backboard. All electrical connections for the Tx are made via a 15-way terminal block on the front face of the Tx.