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Issue	I
Date	June 2002

Signalling Works Test Specifications and Historical Test Value Data (formerly RT/E/C/I 1724)

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 Code of Practice

Signalling Works Test Specifications And Historical Test Value Data

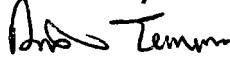
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ISSUE	DATE	COMMENTS
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IMPLEMENTATION

The Implimentation date is June 2002.

COMPLIANCE

Compliance is required from June 2002 and is mandatory upon Railtrack and its contractors.

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1. Purpose

This Code of Practice has been produced in support of GK/RT 0209 and Company Specification RT/E/S/11221. The contents are designed as examples of Test Specification content that might be employed to ensure that suitable and sufficient testing has been carried out to Infrastructure products during the process of Signalling Works Testing.

2. Scope

The contents are of relevance to all who are engaged in, or manage, signalling works testing on Railtrack controlled Infrastructure.

3. Test Specifications

3.1 Introduction

It is vitally important that personnel engaged in testing activities are clear about the performance criteria required for such tests. The performance criteria include:

- The reason for the test;
- The content of the test; and,
- The parameters of the test (e.g. Train shunt value, detection setting parameters).

The principle purpose of testing is to ensure that the requirements of the design and production parameters have been met. The rigorous application of Test Specifications enables a formal demonstration that all the requirements of the specification, design and production have been fully addressed in the build and implementation of the system.

These present test specifications describe the general actions to be undertaken for a range of activities, however they are not exhaustive.

3.2 The Contents of this Code Of Practice

This Code of Practice is divided into five sections:

- The Code of Practice;
- A range of example test specifications;
- Guidance on the content requirement for non-specific systems;
- Guidance on SSI and IECC testing; and,

- Retained Test Values for heritage products where such values may not be recorded in any other Railtrack document.

3.3 Format of Test Specifications

The format used in Appendix A will generally meet the requirements for Railtrack Infrastructure with grandfather rights (i.e. in operation on the main-line railways prior to 1994). However, users are cautioned to ensure they meet the specific need of the situation, equipment and environment.

The objective of this Test Specification is to ensure a direct relationship between the activity requirements and the sign-off requirements of the test certificate. Hence the same headings are used in both. This relationship will give a tester confidence in the extent and implication of any activity being positively signed for. It is critical that this objective is retained in any new or modified certificates or specifications.

For new and novel systems covered by a safety-case, the safety-case will require the production of test specifications that demonstrate that the commissioned system meets the requirements of the system and Product Specifications. Such Test Specifications may take other formats appropriate to the situation provided the requirements of GK/RT0209 are met.

Test Specifications are required to contain the following information:

- objectives of the test;
- details of the determining requirements from which the test was derived and which the test is required to substantiate;
- initial and final conditions where this may influence the result;
- a description of the test activities to be performed; and,
- results expected and acceptance criteria (eg outputs correspond to inputs; measurements are within specified parameters; application logic functions in accordance with design requirements).

This Code of Practice must be read in conjunction with RT/E/S/11221 Signalling Works Testing and RT/E/C/11722 Good Practice Test Certificates and Related Forms.

3.4 Contents of the Guidance Section

Appendices B and C contains information which may prove useful in determining the testing required for certain non-specific systems and SSI/IECC. It has been reproduced from previous withdrawn documents and may not reflect current requirements.

4. Definitions

Technical definitions are provided in RT/E/G/11730.

A glossary of general signalling terms is given in GK/RT0002. A glossary of Testing specific definitions is given in GK/RT0209. Where no definition is included in RT/E/G/11730, then that given in GK/RT0209 or GK/RT0002 shall be used.

Safety terms are defined in GH/ZC0002.

5. Reference Documentation

RT/E/S/11221 Signalling Works Testing

RT/E/S/11655 Management of Signalling Wire and Cable Insulation Degradation

RT/E/C/11722 Good Practice Test Certificates and Related Forms

RT/E/G/11730 Signalling Works Testing

GH/ZC0002 Safety Terminology

GK/RT0209 Testing and Commissioning of Signalling and Telecommunications Systems

Other references are provided in each of the appended Test Specifications. These lists are not exhaustive.

APPENDIX A EXAMPLE TEST SPECIFICATIONS

A1	Master Test Certificate
A2	Off-Site Wiring
A3/2	'Copper' Cables
A4	On-site Wiring
A5/1	Track Circuit Tests
A6/1	Point Tests (Traditional Operation)
A7	Signal Tests
A8	AWS Tests

AI Master Test Certificate

No Test Specification is required for the Master Test Certificate. AI is inserted here only to maintain the relationship between the following Test Specifications and their related Test Certificate numbering as defined in RT/E/C/11722. Refer also to RT/E/C/11722 for details of the Master Test Certificate.

A2 OFF-SITE WIRING

A2.1 Objectives Of The Test

The objective is to verify that the product meets the requirements of the installation and design specifications. Off-site refers to any location at which the activities undertaken as described in this Test Specification present no risk to the operational railway.

A2.2 Scope

This Test Specification is primarily directed at electro-mechanical systems, although some reference to SSI trackside equipment is included.

A2.3 Determining Requirements (may not be exhaustive)

RT/E/S/11303 Requirements for Signalling Installation.

RT/E/C/11720 Signalling Installation Handbook.

RT/E/C/11210 Signalling Installation.

RT/E/S/11129 Life Management of Signalling Relays.

RT/E/S/11630 BR930 Pin Code Allocations and Contact Arrangements.

Specific Engineering Details.

Manufacturers Requirements and Instructions.

A2.4 Initial And Final Conditions

No general requirements. Particular requirements will be recorded in the Test Plan.

A2.5 Technical Verification

A2.5.1 *Equipment identity*

Correct number/name is clearly visible, in accordance with the Signalling Installation Handbook.

Equipment check

This is a visual check.

- For installed equipment, confirm correspondence with the layout plan/profile diagram/wiring diagrams is as specified. Wiring and wiring routes must be considered as equipment.
- Equipment liable to damage in transportation must only be inspected when it is finally fixed on site.

- Layout discrepancies will be recorded on the test copy. Provided that they do not infringe specification or best practice, they may be tolerated after consultation with the design office.
- All equipment including SSI modules is as specified in the diagrams (including the modification state), is properly secured and meets the specified date/age criteria.

A2.5.2 Relay base pin codes / SSI polarising pins

Relay bases are of the correct configurations and labelled with the correct code number, as per the Signalling Installation Handbook.

Where unique identification (e.g. interlocking number, lineside equipment number) is achieved by presence/absence of pins and unique arrangements of wiring and looping, check that the arrangement conforms to the diagram.

For SSI module free connectors a check should be made that pins are only inserted where a wire is to be connected.

A2.5.3 Labelling complete

All equipment labels are present and secure.

A2.5.4 Wire count to diagram / TFM address verification, and continuity test

Wiring shall be checked at each termination point to ensure that the correct type, size and number of wires and permanent label are provided. The test shall be carried out with all wires terminated and relay connectors locked into their base positions, but with all relays and fuses removed and links disconnected.

SSI module free connectors should not be opened but test boxes should be used to allow continuity tests to take place to ensure that no pins are incorrectly in contact. The test should include verification of the address and modifier looping in the trackside functional module free connectors, and of the control centre identity number, and interlocking/trackside looping of long distance terminals where provided. (Care should be taken to avoid damage to these connectors.)

Verify the continuity of each wire between the wire s termination points. A continuity test uses an electrical continuity tester or physical tracing.

A2.5.5 Wire count to analysis

When an Analysis has been provided:

This wire count shall be carried out with all wires terminated and permanently labelled. The presence or absence of wires at each individual termination shall be checked to the contact analysis; thus any extraneous use of contacts/wires is found. Each termination shall be checked as being correctly labelled.

If internal cables are present then a check should be made to ensure that the correct cable core is terminated. All other terminating points must be examined to ensure that no wires are present.

Whilst making the wire count, a check must be made to ensure that all spades are locked in relay bases, all terminal nuts are tightened (whether they are in use or not) and that there are no loose nuts, washers, off-cuts or other superfluous metal objects.

Where no Analysis has been provided the risks associated with omitting a NULL count will be mitigated as required by the Test Plan.

A2.5.6 SSI Cubicle equipment check

All equipment is of the specified type, positioned and secured correctly.

A2.5.7 SSI Termination wire count

The cubicle shall be subject to a wire count. This shall be carried out with all wires terminated and permanently labelled. The presence or absence of wires at each individual termination shall be checked.

A2.5.8 Panel fascia check

Ensure that the fascia is an accurate representation of the design.

A2.5.9 Panel Termination wire count

Any Panel (e.g. Control Panel) shall be subject to a wire count. This shall be carried out with all wires terminated and permanently labelled. The presence or absence of wires at each individual termination shall be checked.

A2.5.10 Panel Continuity test

Verify the continuity of each wire between the wire s termination points. A continuity test uses an electrical continuity tester or physical tracing.

Verify that each switch, button and indication corresponds with its input or output termination.

A2.5.11 Power Supply Equipment to correct specification

Ensure that:

- Equipment is of the type and rating specified in the design details.
- Fuse ratings and discrimination are as specified in the design details.
- Earthing and earth bonding is as specified.

A2.5.12 Power Supply To profile and secure

Equipment is installed as specified in the design details, is undamaged, and is properly secured.

A2.5.13 Power Supply Labelling complete

Equipment is correctly and securely labelled.

A2.5.14 Power Supply Wire count and continuity

Verify the continuity of each wire between the wire s termination points. A continuity test uses an electrical continuity tester or physical tracing.

A2.5.15 Trunking to specification

The trunking meets the mechanical and electrical requirements (refer to RT/E/C/11210: 2E05 for details).

A2.5.16 Modifications

Modifications required to new circuitry, not yet commissioned, but having already been tested shall be treated in the same manner as alterations to existing circuitry (refer to Apendix A4). Modifications to prewired locations having TC2/2 certification are to be treated in the same way, or are to have a complete retest to the new diagram, and reissue of TC2/2 for that location.

A2.5.17 Recording

Refer to the requirements of the Test Plan or Method Statement. For the Grid Box marking requirements refer to Section A4.

END

A3/2 COPPER CABLE TESTING

A3.1 Objectives Of The Test

The objective is to verify that the product meets the requirements of the installation and design specifications.

A3.2 Scope

A3.2.1 *Signalling Cables*

Including all signalling lineside and tail cables but excluding single core track circuit tail cables connected directly to the running rail.

A3.2.2 *Telecommunications Cables*

The testing of telecommunications cables carrying safety signalling circuits shall be carried out jointly with the engineer responsible for the telecommunications cable. The testing shall be carried out in compliance with Railway Group Standard GK/RT0105. (Any requirements for risk assessment required by the application of this Specification shall be referred to the engineer with overall charge of the project). Testing must take due cognisance of the requirements of the owner of the cable (which, in some circumstances, may not be the same as the owner of the signalling infrastructure).

A3.2.3 *Exclusions*

Any requirements for which the IEE Regulations would be more appropriate. In such cases the IEE Regulations must be consulted and employed as necessary.

This Specification does not cover any portion of a signalling circuit carried over a transmission system.

A3.3 Determining Requirements (may not be exhaustive)

RT/E/S/11303 Requirements for Signalling Installation.

RT/E/G/11720 Signalling Installation Handbook.

RT/E/C/11210 Signalling Installation.

RT/E/C/11213 Signalling Cable Equivalent Sizes.

RT/E/S/11171 Maintenance of Signalling Circuit Insulation.

GK/RT0105 The Transmission of Safety Related Information.

Specific Engineering Details.

A3.4 Initial And Final Conditions

Prior to testing the cable shall be laid in its final position (or other position if approved for construction). Before cable tests are carried out, all apparatus (including SSI datalink modules and terminating resistors) shall be disconnected, all links opened and fuses removed. New lineside cables shall be left in place to acclimatise for as long as reasonably practical before carrying out these tests.

A3.5 Technical Verification

A3.5.1 *Security and labelling*

A check shall be made to ensure that cables are correctly and securely terminated in the specified core numbering and/or colour sequence, in accordance with the Signalling Installation Handbook and design and, where required, the permanent labels are secure and correctly mark the core.

A3.5.2 *Electrical Tests*

Continuity tests and insulation tests (core to core / core to earth) shall be made on all cores of new signalling cables including internal, lineside, tail and power cables. These tests shall also be made on all spare cores in existing external cables where spare cores are intended to be brought into use. Where defective spare cores are discovered in working cables, the defect shall be reported to the Maintaining Organisation.

For multicore and power cables all insulation and continuity tests shall be made after their permanent installation and termination has been completed. For local or tail cables, the test may be carried out with only the location end terminated and with the equipment end prepared for termination where there is no disconnection point at the equipment end. For internal cables the test may be carried out prior to termination. Existing internal equipment room cables need not be tested. In relay rooms that are subject to wire degradation, special arrangements contained in RT/E/S/11655 apply.

- Test continuity and resistance of each conductor using a meter or suitable test instrument
- Test insulation between each core and earth.
- Test insulation between each core and all other cores in the cable.

The Testing Plan shall define the insulation resistance values to be worked to. The minimum acceptable values of insulation resistance for new cables are set out in RT/E/C/11210 (Appendix 2A10) and for existing cables in RT/E/S/11231 (Part C, Appendix E), unless alternative values have been specified by Railtrack.

The default minimum values of insulation resistance for new and existing cables is:

New lineside cables	50 Megohms
New tail cables	30 Megohms
Existing lineside cables	1 Megohm
Existing tail cable	1 Megohm

Table A3.1 Default values.

Table A3.2 shows conductor resistance for metric telecomm type cables commonly used for signalling purposes (copper conductor). For the resistance of signalling cable, see RT/E/C/11210, Appendix ID10 (a selection corrected for loop resistance is shown at Table A3.3).

Conductor Strands	Diameter mm	Single Core Resistance Ohms/Km
1	0.60	55.00
1	0.90	27.50
1	1.27	13.75

Table A3.2 Resistance for certain metric telecommunications cables

Table of Conductor Loop Resistance (twice the Resistance/Km) for Metric Signalling Cables (Copper Conductor)

Conductor Strand(s) Size (c.s.a.) mm ²	Maximum Loop Resistance Ohms/Km
0.75	49.6
1.15	34.6
1.5	24.4
2.5	15.12
2.5 (f) – (f) flexible conductors	16.42
10.0	3.68
16.0	2.32
35.0	1.06
70.0	0.54
95.0	0.39

Table A3.3 Loop resistance expressed by Nominal Area

Table of Conductor Loop Resistance (twice the Resistance/Km) expressed by number and diameter of wires

No. of Conductor Strands/ Strand Diameter mm	Maximum Loop Resistance Ohms/Km
1/0.85	66.4
9/0.30	63.4
1/1.13	36.4
16/0.30	35.6
1/1.53	19.92
50/0.25	16.42
7/0.67	15.12
1/1.78	15.12
7/0.85	9.4
7/1.04	6.22
7/1.35	3.68
7/1.70	2.32
7/2.14	1.468
19/1.53	1.058
19/1.78	0.782
19/2.14	0.540
19/2.52	0.390
37/2.03	0.308
37/2.25	0.252

Table A3.4 Loop resistance expressed by Number and Diameter of Wires

The test voltage for all new tail and lineside cables is 1000v unless otherwise stated (RT/E/C/11210: 2A10). Cables already in-service are permitted a lower test voltage: the test value will be specified in the test plan.

A3.3.3 Polarity

Circuits carried on two core cables shall be checked to ensure that the polarity conforms to the design. Verify the correct polarity of two-core lineside cables using a low voltage direct current source (e.g. a battery) connected to one end of the cable, and a voltmeter applied to each termination at the other end.

A3.3.4 Recording

The results of the cable tests shall be recorded on a cable test record sheet (refer to RT/E/C/11722 for an example).

The TIC will generally issue a copy of a prepared TC3/I (Master Cable Test Certificate) to the Engineer responsible for the installation, who will be responsible for compiling, completing after testing, and then returning all the TC 3/2s and TC 3/3s (wherever possible in advance of the commissioning) to the TIC for checking and subsequent completion of TC3/I.

When satisfactory results have been achieved complete the cable test certificate (TC3/2) for each length of cable and sign to certify that the specified values have been attained. If the minimum values cannot be obtained, the cable must not be commissioned. The tests recorded on TC3/2 do not require independence between the installation and testing activities.

Details of cable manufacturer and drum number be recorded on cable test certificates, in order to provide traceability.

END

A4 ON-SITE WIRING

A4.1 Objectives Of The Test

The objective is to verify that the product meets the requirements of the installation and design specifications. On-site refers to any location at which the activities undertaken as described in this Test Specification present any risk to the operational railway.

A4.2 Scope

This Test Specification is primarily directed at electro-mechanical systems, although some reference to SSI trackside equipment is included.

A4.3 Determining Requirements (may not be exhaustive)

RT/E/S/11303 Requirements for Signalling Installation.

RT/E/C/11720 Signalling Installation Handbook.

RT/E/C/11210 Signalling Installation.

RT/E/S/11129 Life Management of Signalling Relays.

RT/E/S/11630 BR930 Pin Code Allocations and Contact Arrangements.

RT/E/C/11600 Signalling and Operational Telecommunications Design: Technical Guidance - Part D

RT/LS/CAT005 Index of Typical Circuits

Specific Engineering Details.

A4.4 Initial And Final Conditions

No general requirements. Particular requirements will be recorded in the Test Plan.

A4.5 Technical Verification

A4.5.1 *Equipment identity*

Correct number/name is clearly visible, in accordance with the Signalling Installation Handbook.

A4.5.2 *Equipment check*

This is a visual check.

- For installed equipment, confirm correspondence with the layout plan/profile diagram/wiring diagrams is as specified. Wiring and wiring routes must be considered as equipment.

- Layout discrepancies will be recorded on the test copy. Provided that they do not infringe specification or best practice, they may be tolerated after consultation with the design office.
- All equipment including SSI modules is as specified in the diagrams (including the modification state), is properly secured and meets the specified date/age criteria.
- The trunking meets the mechanical and electrical requirements (refer to RT/E/C/11210: 2E05 for details).

A4.5.3 Relay base pin codes / SSI polarising pins

Relay bases are of the correct configurations and labelled with the correct code number.

Where unique identification (e.g. interlocking number, lineside equipment number) is achieved by presence/absence of pins and unique arrangements of wiring and looping, check that the arrangement conforms to the diagram.

For SSI module free connectors a check should be made that pins are only inserted where a wire is to be connected.

A4.5.4 Labelling complete

All equipment labels are present and secure.

A4.5.5 Wire count to diagram / TFM address verification, and continuity test

WIRE COUNT

Wiring shall be checked at each termination point to ensure that the correct type, size and number of wires and permanent label are provided.

CONTINUITY TEST

Verify the continuity of each wire between the wire s termination points. A continuity test uses an electrical continuity tester or physical tracing.

- On new installations the test is carried out with all wires terminated and relay connectors locked into their base positions, but with all relays and fuses removed and links disconnected.
- On existing working equipment this must be carried out before termination. The tester must oversee the termination of wires, ensuring that no false feeds can be created by interconnection with existing wires.
- On altered circuitry where the wire cannot be terminated until a commissioning, it must be checked as being present and ready for termination, suitably insulated and identified. At the time of commissioning this will then be rechecked to ensure the correct number of wires is terminated to diagram.

Ensure that no bare wire or cable ends are left exposed. RT/E/C/11210: ID20 specifies the protection methods.

The extent of wire counting to be carried out (e.g. relay or row or rack) will be specified in the testing plan.

SSI module free connectors should not be opened but test boxes should be used to allow continuity tests to take place to ensure that no pins are incorrectly in contact. The test should include verification of the address and modifier looping in the trackside functional module free connectors, and of the control centre identity number, and interlocking/trackside looping of long distance terminals where provided. (Care should be taken to avoid damage to these connectors.)

A4.5.6 Wire count to analysis

Where an Analysis is provided:

This wire count shall be carried out with all wires terminated and permanently labelled. The presence or absence of wires at each individual termination shall be checked to the contact analysis; thus any extraneous use of contacts/wires is found. Each termination shall be checked as being correctly labelled.

A check should also be made where appropriate that the correct cable core is terminated. All other terminating points must be examined to ensure that no wires are present.

Whilst making the wire count, a check must be made to ensure that all spades are locked in relay bases, all terminal nuts are tightened (whether they are in use or not) and that there are no loose nuts, washers, off-cuts or other superfluous metal objects.

Where no Analysis has been provided the risks associated with omitting a NULL count will be mitigated as required by the Test Plan.

A4.5.7 Final wire count

As a final check prior to commissioning, a final wire count shall be performed on all new and altered installations to a clean copy of the analysis, and any inconsistencies will be checked against the updated testing copies of the wiring diagrams. The Tester in Charge will determine the extent of this wire count.

Whilst making the final check, a check shall be made to ensure and that there are no loose nuts, washers, off cuts of other superfluous metal objects in the vicinity of working circuit terminations.

A4.5.8 Cables secure

All cables shall be secured as required by the Signalling Installation Handbook. (referenced in RT/E/C/11210; App 2E05)

A4.5.9 Equipment not damaged

This is a visual check.

- New and any adjacent equipment must be inspected to ensure that no damage or interference has taken place.
- Equipment liable to damage in transportation must only be inspected when it is finally fixed on site.

A4.5.10 Pre-wired TC 2/2 complete

Any pre assembled equipment (for example: relay racks, location cases) delivered to site in a pre wired condition shall be accompanied by a test certificate, detailing the tests undertaken so far, as well as the testing copy diagrams which have been used for recording these tests.

Each pre wired unsealed signalling component (e.g. signal heads, point machines) shall have certification that it has been tested. If this certification is not present, then the component shall not be commissioned into use until such certification is obtained, or the components are tested (refer to Appendices A6 and A7 for example requirements).

A4.5.11 Internal cable test

Refer to Appendix A3/2.

A4.6 Functional Testing

Ensure that before this commences, all external functions are either suitably masked or are disabled where they may affect the existing working railway, and that an inspection, wire count, continuity test and power supply test has been completed.

A4.6.1 Power supplies

Carry out tests to ensure that:

- The supply can be incrementally loaded with no unwarranted effects.
- Voltages are as specified both at the source and at the extremity of feeders. Where possible this test shall be carried out with the maximum load connected.
- Phasing and polarities are correct throughout the distribution feeders, including the phase relationship between main and standby power supplies.
- All switching and isolating devices, including associated indications, function as specified.

- There is no interconnection between the busbars of different supplies.
- Both main and standby supplies are capable of supporting the specified load.
- Main/standby changeover arrangements operate correctly for all specified power failure modes (e.g. High volts, Low volts, Frequency).
- Status indications and alarms operate as specified.
- Earth loop impedance is within specified limits.
- Earth fault detectors and associated indicators and alarms operate as specified.
Note: For safety-critical circuits the power supply must be earth-free (unless the Safety-case decrees otherwise)- refer to clause 4.6.5.
- Fuse discrimination is effective, and, as far as is reasonably practicable, the design has guarded against the inappropriate insertion of fuses/links in circuits for which they were not intended.

A4.6.2 Set to work procedures / circuit function or strap & function test / SSI exercise test

SETTING TO WORK

This is an informal activity to exercise the installation in order to identify any installation/equipment faults prior to the continuation of the formal tests. Operate all functions and ensure that the correct indication changes are obtained and ensure that there are no installation or equipment faults.

It may be necessary to provide a Test Desk. A list of controls operated by the test desk must be recorded in the Test Plan for the benefit of the Principles Tester(s).

CIRCUIT FUNCTION TEST

Circuit Function Testing shall be conducted as follows:

1. Connect a voltmeter across the end function of the circuit (e.g. relay coil, lever lock coil) or the outgoing terminals of the circuit. Where controls appear on either side of a device, both legs must be individually tested.
2. Apply a power supply to the start of the circuit/part circuit and observe voltage and polarity on the meter. Any power supply used for testing must be appropriately fused.
3. Set up all conditions within the circuit with switches/levers where appropriate. This may involve false feeding relays.
4. Each path to each end function shall be proved from the initiating fuse, or from each output of TDM, FDM, SSI or other remote control systems, by operation of each circuit function, observing the response of the meter and, where possible, the end function.

5. The meter shall register acceptable parameters for both the energised and non-energised states of the circuit.
6. The circuit function test shall exercise each circuit in turn to establish that it works correctly and to verify the presence of the necessary controls. Where controls appear on either side of a device, both legs shall be individually tested.

Straps or false feeds may need to be used to operate controls that cannot otherwise be segregated.

STRAP AND FUNCTION TEST

A strap and function test is a means of ensuring that all fuses, links, relay contacts, circuit controller contacts, inter-rack connections etc, are present within the circuit under test, and that the contacts are as specified and make and break in the designed position only.

Circuit Strap and Function Testing shall be conducted as for Circuit Function Testing with the following additions:

1. Prove in turn each fuse, contact, link and terminal by breaking down the condition, strapping the contact where appropriate, removing the strap and reinstating the condition, observing the response of the meter, and where possible the end function for each condition.
2. Where controls are wired in parallel, each path shall be selected in turn and all the conditions tested with all other paths broken. Unless absolutely necessary (e.g. pole change circuits), this shall not be by physical circuit disconnection.

Where controls appear on either side of a device, both legs shall be individually tested.

Inter-rack connections need not be separated, but can be proved by connecting the appropriate meter lead prod to them and breaking down and strapping an adjacent contact in the circuit.

INTEGRATION: THROUGH TESTING OF RELAY CIRCUITS

Follow the process described in Circuit Function or Strap and Function above as required by the Test Plan.

Each lineside circuit shall be tested from its own power supply to the final function.

All controlling functions, including those in intermediate locations, shall be proved to be effective.

Where the proving of controlling functions is to be carried out in stages this shall be clearly identified in the Testing Plan.

Where an existing circuit is being altered the Testing Plan shall identify the extent of testing which must be sufficient to ensure the integrity of the complete circuit.

INTEGRATION: THROUGH TESTING OF TRANSMISSION SYSTEMS

Follow the process described in Circuit Function or Strap and Function above as required by the Test Plan.

A4.6.3 Timers adjusted / sealed

Adjust the timer to the time specified in the Engineering Details and verify by operation. Ensure the set position is then secured against inadvertent movement (generally by the tightening of a lock-nut).

Prior to the end of the commissioning and after the run-time has been validated, timers employed for safety-related tasks should be sealed with an approved sealing tool imprinting the contractor's mark on the seal. The arrangement should be such that the sealed unit is restrained as well as being inaccessible to tampering.

The times for common tasks are to be found in RT/E/C/11600 Part F3.3.3.

A4.6.4 Trackside SSI modules sealed

Ensure all module seals are intact.

A4.6.5 E.F.D. test

The status of Earth fault detectors shall be monitored throughout the testing activity.

On power supplies not having Earth fault detectors earth tests shall be carried out at the commencement and end of each shift at each site where testing is being carried out. The results of these tests shall be recorded.

If any notifiable earth fault is detected on a site where any equipment is operational, the infrastructure maintainer shall immediately be informed and an investigation carried out to rectify the fault.

Provided there is no notifiable fault the Test Certificate may be endorsed at the end of the commissioning.

The following two test specifications detail the method for obtaining earth fault information.

EARTH TEST: (D.C. UP TO NOMINAL 120V)

This test is to ensure that equipment and power supplies (when designed to be) are

earth free. It ensures circuits cannot be falsely operated from spurious feeds. Any earth present may originate from bus bars or from equipment. Where an earth leakage detector monitors the equipment the test is not required, but the detector shall be checked for correct operation after any work.

For point machines, this test shall be undertaken whilst each machine is operating normal and reverse. For level crossings, this test shall be undertaken throughout the operational cycle.

Suitable only for appropriately calibrated electronic meter with input impedance of at least 1 M.ohm fitted with a 150K.ohm shunt.

1. Measure the d.c. voltage between the positive and negative busbars supplying the equipment to be tested. Record the voltage indicated (V).
2. With one meter lead connected to earth and the other to the positive busbar, record the d.c. voltage indicated (V1). The polarity of the indication can be ignored.
3. With one meter lead connected to earth and the other to the negative busbar, record the d.c. voltage indicated (V2). The polarity of the indication can be ignored.
4. Disconnect the meter and refer to the acceptable and safety values listed in Table A4.1 applicable to the actual busbar voltage (V). If the required busbar voltage is not listed select the nearest busbar voltage shown that is less than the measured voltage.

Actual Busbar Voltage	Maximum acceptable			Safety maximum		
	V1	V2	V1+V2	V1	V2	V1+V2
V						
10	6.0	6.0	8.0	7.5	7.5	9.0
11	6.6	6.6	8.8	8.2	8.2	9.9
12	7.2	7.2	9.6	9.0	9.0	10.8
20	12.0	12.0	16.0	15.0	15.0	18.0
22	13.2	13.2	17.6	16.5	16.5	19.8
24	14.4	14.4	19.2	18.0	18.0	21.6
42	25.2	25.2	33.6	31.5	31.5	37.8
46	27.6	27.6	36.8	34.5	34.5	41.4
50	30.0	30.0	40.0	37.5	37.5	45.0
100	60.0	60.0	80.0	75.0	75.0	90.0
110	66.0	66.0	88.0	82.0	82.0	99.0
120	72.0	72.0	96.0	90.0	90.0	108.0

Table A4.1 Acceptable & Safety Values (D.C.)

The recorded values of VI, V2 and VI+V2 are acceptable if they are **all less than or equal to** the maximum acceptable voltage values coloured yellow above.

If any of the recorded values of VI, V2 and VI+V2 are **more than** the maximum acceptable voltage values coloured yellow above then the local maintenance manager shall be advised and appropriate action arranged.

If any of the recorded values of VI, V2 and VI+V2 are **more than** the maximum safety voltage values coloured red above immediate action is required. If the fault cannot be cleared immediately the Infrastructure Controller shall be advised and decide the action to be taken.

All earth fault conditions are potentially serious and may be located by methodical disconnections.

END OF D.C. EARTH TEST

EARTH TEST: (A.C. UP TO NOMINAL 110V)

This test is to ensure that equipment and power supplies (when designed to be) are earth free. It ensures circuits cannot be falsely operated from spurious feeds. Any earth present may originate from bus bars or from equipment. Where an earth leakage detector monitors the equipment these tests are not required, but the detector shall be checked for correct operation after any work.

For point machines, this test shall be undertaken whilst each machine is operating normal and reverse.

Suitable only for appropriately calibrated electronic meters with input impedance of at least 1 M.ohm. The 150Kohm shunt must NOT BE USED with the meter when carrying out a.c. earth tests using the a.c. busbar earth test adaptor.

1. Connect the meter set to volts d.c. to the red and one of the black terminals of the a.c. busbar earth test adaptor (see Figure A4.1).
2. Connect the green and other black terminal of the a.c. busbar earth test adaptor together and measure battery voltage (**VB**). Ensure **VB** is no less than positive 8 volts, which shows that the earth test adaptor is working and that the meter is connected the right way round. If **VB** is less than 8 volts, the battery should be changed.
3. Remove the connection between the green and black terminals. Connect the green terminal of the adaptor to earth and the black terminal to either the BX or NX busbar. Record the d.c. voltage indicated (**VI**).

4. Reverse the leads to the selected busbar and earth so that the black terminal of the adaptor is connected to earth and the busbar is connected to the green terminal of the adaptor. Record the d.c. voltage indicated (**V2**).
5. Disconnect the test circuit and refer to the acceptable and safety values listed in Table A4.2 applicable to the actual adaptor battery voltage **VB**. If the required adaptor battery voltage is not listed select the nearest battery voltage shown that is less than the measured voltage.

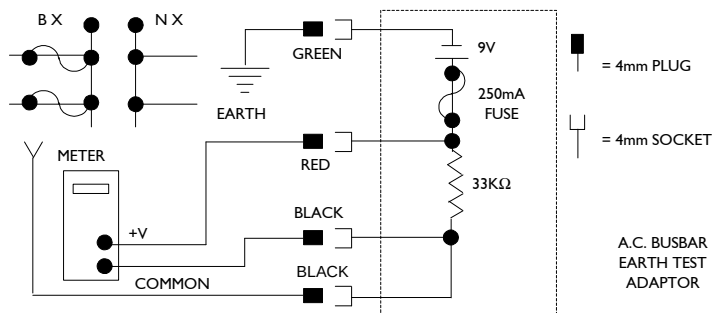


Figure A4.1 A.C. Earth Test Circuit

Actual Adaptor Battery Voltage	Maximum acceptable		Safety maximum	
	V1+V2	V1-V2 (*)	V1+V2	V1-V2 (*)
VB				
9	8.1	1.0	13.5	1.0
8.5	7.6	0.95	12.7	0.95
8	7.2	0.9	12.0	0.9

Table A4.2 Acceptable & Safety Values (A.C.)

Calculate V1+V2 and V1 V2 (*)

The calculated values of V1+V2 and V1 V2 (*) are acceptable if they are **both less than or equal to** the maximum acceptable voltage values coloured yellow above.

If either of the calculated values of V1+V2 and V1 V2 (*) are **more than** the maximum acceptable voltage values coloured yellow above then the local maintenance manager shall be advised and appropriate action arranged.

If either of the calculated values of V1+V2 and V1 V2 (*) are **more than** the maximum safety voltage values coloured red above immediate action is required. If the fault cannot be cleared immediately the Infrastructure Controller shall be advised and decide the action to be taken.

All earth fault conditions are potentially serious. If the difference between V1 and V2 is large, ie. V1 is hundreds of mV and V2 is Volts, a d.c. source is present. This indicates possible low insulation resistance. The fault may be located by methodical