Signalling Maintenance Testing Course

Student Handout

Signalling Maintenance Testing Course

Module 1 - Implement Core Testing Skills During Signalling Maintenance

Handout

1. Module aim

Teach and assess the necessary knowledge and skills to

- implement core testing skills during signalling maintenance.

2. Who should attend this course?

Team leader of a signalling maintenance and faulting team.

Technical support staff.

Supervisors and maintenance engineers.

Signalling works leading installers.

Any other groups who require maintenance testing skills.

3. Experience required to attend this course

Experience of:

- fault finding (or assisting) on signalling equipment,
- circuit reading,
- relay identification,
- relay inspection,
- cable core number and colour identification.

Use of a:

- multimeter,
- insulation tester,
- bell/buzzer unit.

4. Signalling maintenance testing training

Signalling maintenance testing training consists of 12 discrete training modules:

1 Implement core testing skills.
2 Undertake cable and wire testing.
3 Undertake earth testing.
4 Undertake aspect testing.
5 Undertake point testing.
6 Undertake block testing.
7 Produce a new maintenance test plan.
8 Prepare a method statement for specific operationally equivalent alterations.
9 Undertake the diversion of a circuit.
10 Provide release of controls for one train.
11 Undertake signalling maintenance testing on mechanical locking systems.
12 SFI.

5. Competence requirements

Competence and certification is required from module 1 before competence can be gained from the remaining modules.

The minimum level of competence is:

- implement core testing skills.

6. Course structure

The SMTH full course teaches and assesses modules:

- 1, 2, 3, 4, 5, 6, 7 and 9.

Modules 8, 10, 11 and 12 are optional add ons.

7. Module 1 aim

To teach and assess the necessary knowledge and skills to:

- implement core testing skills during signalling maintenance.

8. Module 1 objectives

At the end of this module you will be able to:

- implement core testing skills which include:
  - Selecting and using test plans appropriate to the circumstances,
  - Identifying and taking appropriate action were a suitable test plan does not exist,
  - Identifying where a method statement is required for the work,
  - Wire counting,
  - Temporary labelling of wires,
  - Maintaining proper documentation of work undertaken,
  - Ensuring that work is done correctly through independent testing,
  - Implementing approved safety procedures for all work including defined checks.

9. Module 1 structure

Signalling maintenance testing training module 1 consists of six training sessions:

1 Introduction.

2 Identify scope of work, correct testing procedures and documentation.

3 Complete and deal with test records.

4 Complete and deal with pre-planning lists.

5 Understanding of signalling maintenance handbook technology, safety procedures to be followed when the work involves links and fuses, and error reporting procedures.

6 Carry out a wire count and apply temporary labelling to wire terminations

The content of session 1 is covered in the previous pages of this handout.

10. Session 2

Identify scope of work, correct testing procedures and documentation.

11. Session 2 objectives

At the end of this session you will be able to:

- state what are the component documents of the SMTH and describe the scope of SMT,
- state who is qualified to carry out maintenance testing and explain the principle of independence of testing,
- explain the meaning of the following terms:
  - like for like replacement
  - missing equipment replacement
  - temporary diversion of circuits
    and classify the nature of work as the testing of one of these categories,
- define operationally equivalent alterations and state those which are permitted within the scope of SMT,
- explain the requirements for test plans suitable for the work,
- select suitable test plans from the SMTH for a given work situations,
- explain how to obtain new test plans where non exists,
- explain how to obtain additions to a test plan where the test plan used is deemed to be deficient,
- explain how to obtain a method statement for operationally equivalent alterations.

12. Component documents and the structure of the SMTH

Figure 1 illustrates the component documents of the signalling maintenance testing handbook.

You should familiarise yourself with the book and learn how to navigate it.

There are also many references to the S&T maintenance specifications shown in Figure 2.

You should be aware that parts of the SMTH are group standards and others are codes of practice. A group standard is mandatory, code of practice is not mandatory but considered best practice. However, for JARVIS facilities purposes the whole of the handbook is mandatory.

13. Purpose of the SMTH

Defines the mandatory tests and procedures necessary to:

- ensure that the replacement or renewal of previously working signalling equipment is tested with sufficient depth and independence to assure safe working when returned to service.

Refer to SMTH (GK/RT 0231) Part B1.

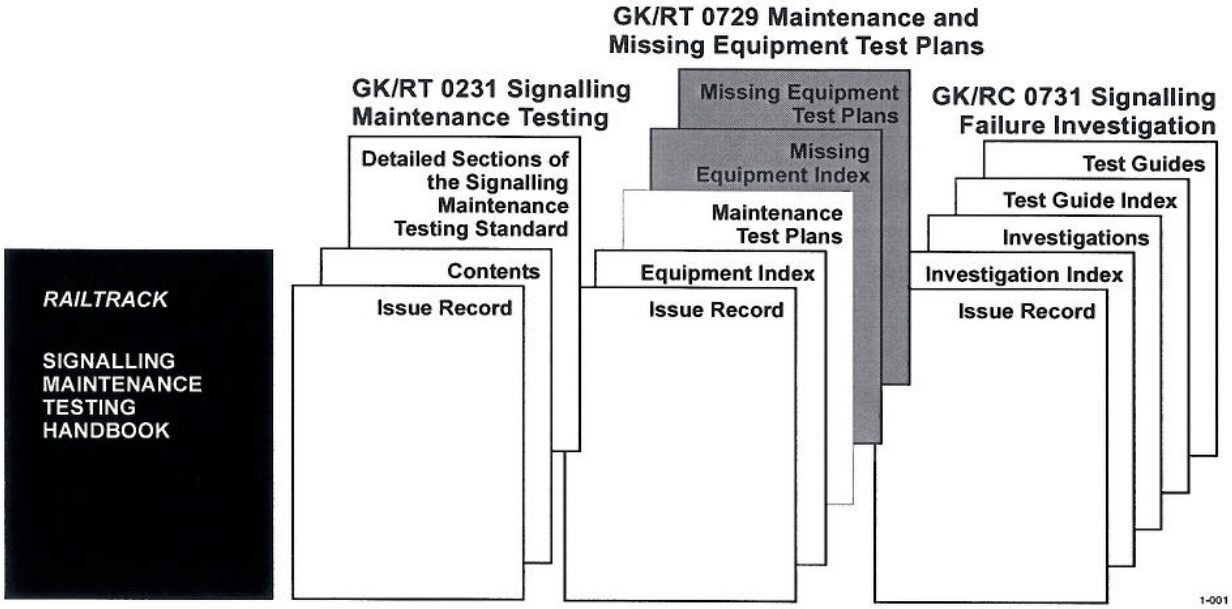


Figure 1 - Component documents of the SMTH

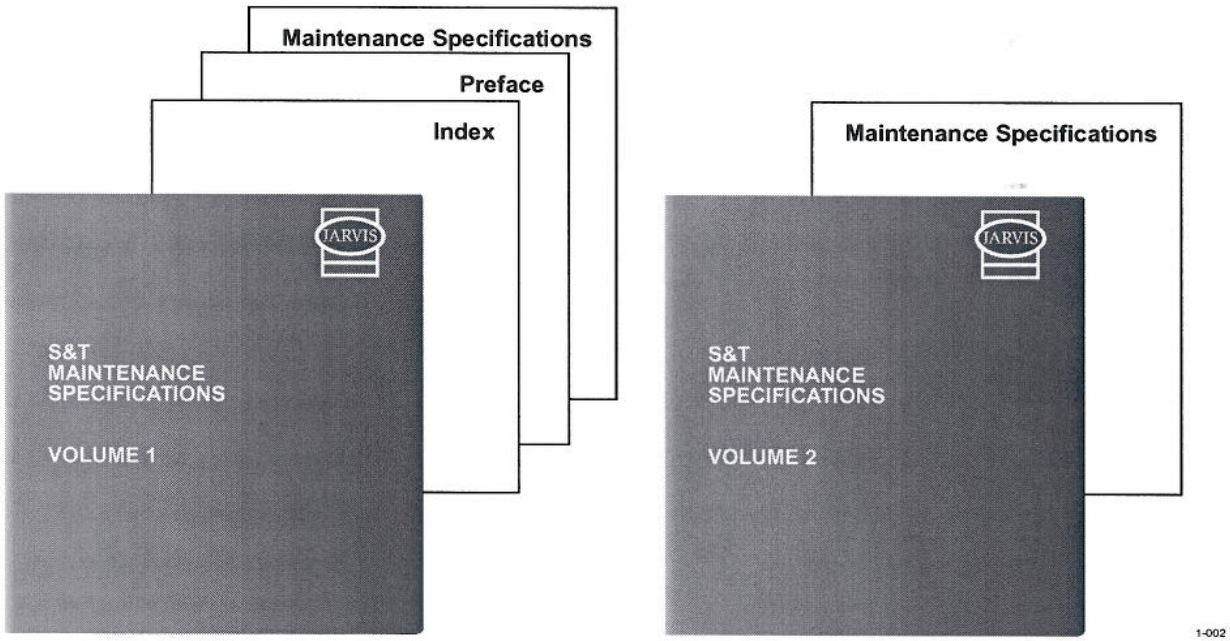


Figure 2 - A closely related document

14. Scope of the SMTH

Applies to the testing of all alterations to previously working and commissioned signalling systems during:

- maintenance,
- renewals, and
- faulting,

where the design remains unchanged.

Alterations may take the form of:

- like for like replacement of equipment,
- replacement of missing equipment, and
- temporary diversion of circuits,

and normally apply to individual items of equipment.

The SMTH may be applied to multiple items as long as the principles are followed.

The SMTH is based on the principle that the equipment was tested properly at commissioning and has been working correctly.

The design may therefore be taken to be correct and the work shall not require a change to diagrams unless permitted in the maintenance test plan or required as a result of correlation.

When testing alterations where:

- the installation is new, or
- the design has changed
  (except where allowed for as a specific operational equivalent in Part B Appendix A.4),

the signalling works testing handbook must be used.

Refer to SMTH (GK/RT 0231) Part B2 and Part B Appendix A.1.

Where would it not be appropriate to use the SMTH for testing purposes?

Record your answer below

15. SMTH Definitions

The SMTH lists certain definitions that you should be familiar with. Refer to SMTH (GK/RT 0231) Part B3 and make yourself familiar with them.

16. Objective of maintenance testing

To ensure that the signalling equipment is safely returned to service. Refer to SMTH (GK/RT 0231) Part B4.

17. Who can carry out maintenance testing?

Testing shall only be carried out by competent staff.

A maintenance tester shall be in overall charge of the testing.

The maintenance tester shall:

- determine the extent of the work,
- confirm that the work can be undertaken using the SMTH, and
- decide which test plans are appropriate.

Figure 3 shows the certificate of competence which list all the maintenance testing categories. Your certificate shall be endorsed for that category of testing you are required to carry out.

Refer to SMTH (GK/RT 0231) Parts B5, B5.1, B6, and B6.1.

Refer also to SMTH (GK/RT 0231) Part B3.

18. Independence of testing

Independent checking shall apply throughout maintenance testing, except where it is specifically exempted on the maintenance test plan.

The maintenance tester shall be wholly responsible for ensuring that the work is restored to use in a safe condition.

The maintenance tester cannot carry out (but may assist) the work which will subsequently be verified by the testing.

This does not prevent the maintenance tester from either leading the fault diagnosis or directing the installation work.

Refer to SMTH (GK/RT 0231) Part B6.2.

Refer also to SMTH (GK/RT 0231) Part B3.

JARVIS TRAINING MANAGEMENT No. Signal and Telecommunications Engineer				
SIGNALLING MAINTENANCE TESTER				
NAME:-				
A	is required to act as a Signalling Maintenance tester & has demonstrated the following competencies during formal assessment			
		Competent YES or NO	Valid until	Assessment type O = Oral P = Practical
1	Core Testing Skills			
2	Cable & Wire Testing			
3	Earth Testing			
4	Aspect Testing			
5	Point Testing			
6	Block Testing			
7	Produce a new Maintenance Test Plan			
8	Prepare a Method Statement for Specific Operational Equivalent Alterations			
9	Undertake Diversion of a circuit			
10	Provide Release of Controls for One Train			
11	Undertake Mechanical Locking Testing			
12	SFI			
ASSESSOR			SIG.	
B	and is suitable to undertake Signalling Maintenance Testing in the competencies shown above.			
MANAGER			SIG.	
NOTE:- This certificate can be withdrawn or further training arranged at any time at the discretion of your manager.				

1-003

Figure 3 - Certificate of competence

19. Like for like replacement

The removal and restoration of an item of equipment, including a cable, in a previously working and commissioned system were the work does not change the design

This may involve restoring the original item of equipment or replacing it with an operationally equivalent new item

What tasks do you consider to be like for like replacements and not like for like replacements?

Make two lists.

Record your answer below.

Refer to SMTH (GK/RT 0231) Part B3.

20. Missing equipment

Equipment which was previously working and which is physically missing or separated from its normal position.

How is missing equipment dealt with?

Record your answer below.

Refer to SMTH (GK/RT 0231) Part B3 and Part B Appendix A.1.

[redacted]

27. Exemption to independence

There are certain exemptions to independent checking.

These will be stated on the maintenance test plan.

Look at SMTH (GK/RC 0729) Part C - Maintenance Test Plan EL08.

28. Exemption from SMTH

Maintenance and faulting adjustments and work which is non-safety related e.g. replace a concrete trough etc. are exempt from using a maintenance test plan.

List some examples below.

29. Exercise 1

The exercises below are designed to teach you how to use the equipment index to select the appropriate test plan(s).

For the scenarios below:

- determine the scope of work, and
- select the appropriate test plan or course of action.

The scenarios refer to location 209/178.

Scenario 1

The 240/110 volt transformer in case A has burned out blowing the location fuses.

PW Ø2
EL Ø2
~~CA Ø1~~ not necessary

Scenario 2

A fault were No. 6 signal is showing no light when it should be showing a green aspect is traced to a high resistance contact A3 - A4 on 6 DR in case A.

EL ∅ 5 or EL 13

Scenario 3

A derailed train has run into location 209/178 case B causing extensive damage. The location (case B) needs to be completely renewed.

Signal Works or Method statement

Scenario 4

A failure of a number of track circuits is traced to location 209/178. Vandals have broken into case A and removed relays T83 TR, T83 TPR, and T84 TR.

TC ∅ 1 M
EL ∅ 8 M

Scenario 5

A fire has totally destroyed location 209/178 Case A and case B.

Signal Works

Scenario 6

A complete failure of all three aspects on No. 12 signal is due to a cut tail cable.

Record your answers below.

CA ∅ 4

30. Test plan CA 01

Maintenance test plan CA 01 was written for removing and replacing a single wire or cable core rather than the equipment itself were a specific test plan exists and will contain the relevant parts of CA 01.

For example, CA 01 would be appropriate when removing a cable from a rail during a rail change.

It would not be appropriate when changing a signal head.

Refer to SMTH (GK/RT 0231) Part B Appendix A.4.

31. Test plan steps which cannot be carried out

Maintenance test plan steps which are required but cannot be carried out shall be noted as part of the record of test and advised to the local manager, whose permission shall be obtained before equipment is returned to service

Refer to SMTH (GK/RT 0231) Part B5.2.

32. Test plan considered to be deficient

If a test plan is considered deficient in any way, details shall be noted as part of the record of test and any additional tests carried out before the equipment is returned to service.

The query shall be reported to the local manager as soon as possible.

Refer to SMTH (GK/RT 0231) Part B5.2.

33. Exercise 2

During routine maintenance a technician cannot obtain a reasonable shunt value on TC 77 Track Relay. This was traced to a faulty track feed set in location 209/178 Case B.

The track feed set needs changing.

Without referring to your handbook write down in the space below the procedure you will follow before, during, and after changing the feed set. Also write down any tests you will carry out.

Record your answer on the next page.

Before check like for like
" good condition
Wire count
Labelling
Test track to SMS

After check installed correctly
Wire count
check labbling

TC02 Not damaged
Wire count
Wiring safe insulation
Labelling
existing unit isolated

installed correctly
wiring replaced as labled
Wire count
links & dome nuts
terminations secure & protected
input/output voltages
Earth test
Test output voltage when connected
rail polarity correct is drawing
Test track
check correctly labled

In principle what you have done is to write a test plan.

Check how it compares with maintenance test plan TC 02 in your handbook.

34. Writing a new test plan

Where no suitable maintenance test plan exists for the work to be undertaken, and unless an exemption is stated, a new maintenance test plan shall be produced by the maintenance tester.

Before use, the new maintenance test plan shall be checked by a maintenance tester who has not been involved in writing it.

This check shall be undertaken on site with reference to the equipment concerned except where the person concerned is sufficiently familiar with the equipment.

On completion of the work and testing, the new maintenance test plan should be forwarded as part of the record of test.

The local manager shall arrange to have the equipment re-tested if the maintenance test plan is considered deficient.

The local manager is responsible for ensuring the test plan is forwarded to the infrastructure controller.

The same procedure shall apply to the production of new missing equipment test plans.

Refer to SMTH (GK/RT 0231) Part B5.2 and Part B Appendix B.

35. Testing using site records

If, when needed for fault rectification or renewal work:

- diagrams are available but have an unsigned and undated amendment which affects that work, or
- if a difference is discovered between the wiring being worked on and the diagram, or
- site records are missing,

STOP advise shall be sought from the local manager.

36. Exercise 3

Study the following scenarios along with the diagrams provided and select the appropriate test plans and/or procedures.

Once you have finished check your answer with the instructor.

Write in the space below each scenario the maintenance test plan(s) (if any) that are required.

1. On a maintenance visit the strength and polarity meter reading on 89 inductor would only reach the yellow. The electromagnet needs changing.

2. The signal lamp in the yellow aspect in number 6 signal is on stand-by and requires replacing.

3. During an insulation test of cable RL 1b it is found that the first 6 way terminal block is causing low readings and requires changing.

EL06

4. While carrying out routine maintenance in case A it is found that 89 ECR plug in relay base is cracked and needs changing.

~~EL07~~ EL12

5. During civil engineer's relaying operations number 6 signal head is damaged by a crane but still attached to the signal post. The head needs changing.

SG01

6. While walking along the track investigating a track circuit failure, the technician sees a broken bond wire and decides to replace it.

Not Required

7. The rectification of a track circuit failure requires the track circuit tail cables from the rails feeding T83 TR to be changed.

EA03

[redacted]

37. Session 3

Complete and deal with test records.

38. Session 3 objectives

At the end of this session you will be able to:

- state when to use the logbook,
- complete a logbook entry for a given task,
- describe the arrangements for custody of the current logbook and sheets,
- state how a full logbook is dealt with.

39. Requirement to record testing

The maintenance tester shall complete a record of the testing carried out and forward it to the local manager at the first opportunity after the end of the shift.

Refer to SMTH (GK/RT 0231) Part B7.5 and Part B Appendix C.

40. Logbook requirements

The logbook is to be used to record the basic details of all work where a maintenance test plan is used except were specifically exempted.

The logbook must be used for recording slipped links but will exclude details associated with adjustments.

Figure 7 gives an example of a typical logbook entry.

Refer to SMTH (GK/RT 0231) Part B7.5 and Part B Appendix C.

Place: Barton Mills	**Date :** 5/6/91
	Time : 14.20
	Fault No : 0721
Equipment (inc. serial nos):	54 'A' PTS
	HW Machine
	65321B
Details of work:	Replace Motor
Maintenance Test Plans used:	PC02
Work done by:	A. N. Other
Work tested by:	A. Tester

1-006

Figure 7 - Typical logbook entry

41. Exercise 4

For the given scenarios below complete the Logbook entries.

Assume today's date-and time.

The work has been carried out by William Jones and tested by you.

Once you have finished your instructor will go through the exercise.

The following scenarios relate to Location 209/178.

l. A failure is traced to no 50 Volt supply on the busbars in case A, caused by a blown fuse. The BX 110 Volt fuse needs changing. (Fault No. 516.)

2. No light in the red aspect of number 6 signal is found to be due to a faulty lamp holder. The lamp holder requires changing. (Fault No. 214.)

3. A failure where number 6 signal will not change to a proceed aspect is due to the wire between link D12 to 6 HR R1 being cut, probably chewed by rats. (Fault No. 867.)

Three blank Logbook sheets are provided on the following pages for your answer. It is probably a good idea to use pencil first and then go over in pen when you are sure your answer is correct.

Place: 209/178 Loc Newtown

Date : 23/7/1
Time : 2030
Fault No : 516

Equipment (inc. serial nos): 3 X 110V Fuse

Detail of work: Replace Fuse

Maintenance Test Plans used: EL02

Work done by: W Jones
Work tested by: N Whelan

Notes:

1-024

Place: E Sig Newtown

Date : 23/7/1
Time : 2040
Fault No : 214

Equipment (inc. serial nos): Red Aspect Lamp holder

Detail of work: renew lamp holder

Maintenance Test Plans used: EL05 / EL04

Work done by: W Jones
Work tested by: N Whelan

Notes:

1-024

[redacted]

Place: 6 Signal Newton

Date : 24/7/1
Time : 0840
Fault No : 687

Equipment (inc. serial nos): Wire from Link D12 to GHR R1

Detail of work: Replace wire

Maintenance Test Plans used: CA03

Work done by: W Jones
Work tested by: N Whelan

Notes:

1-024

[redacted]

42. Logbook questions

Before you move on think about the following questions.

What happens to logbook top and bottom sheets?

Top sheet to sup to be retained
Bottom sheet to be kept in book

What happens when testing cannot be completed?

steps completed to be written into notes section of logbook & top copy handed to tester completing test

How are full logbooks dealt with?

Retained by tester for records

43. Logbook top and bottom sheets

Logbook top sheets are test records and shall be dealt with in accordance with SMTH (GK/RT 0231) Part B7.5.

Logbook bottom sheets are retained in the book.

Figure 8 illustrates.

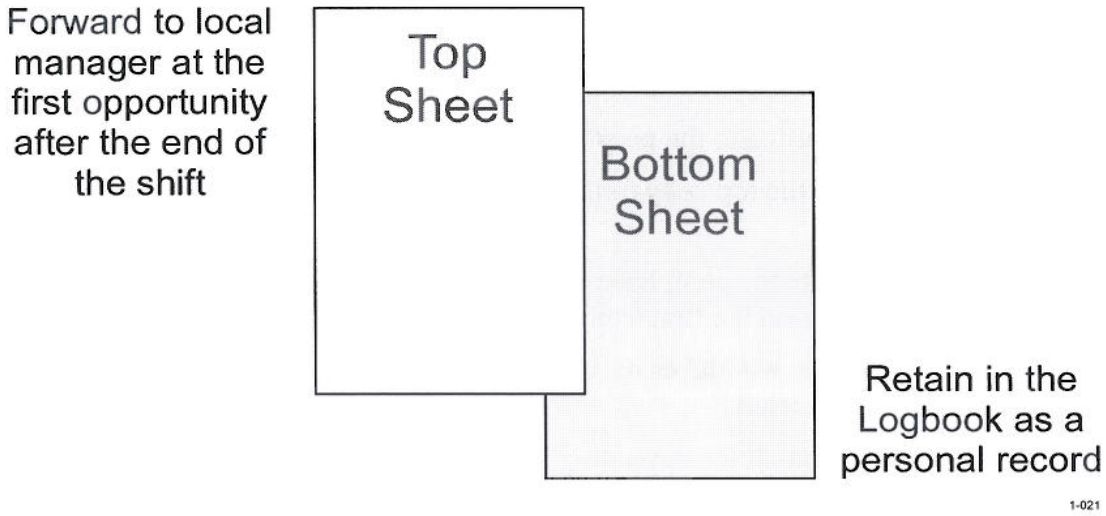


Figure 8 - Logbook sheets

44. Logbook entry

Only the team member designated as the maintenance tester needs to complete a logbook entry.

45. Where testing cannot be completed

If work is partially tested when the work is directly or indirectly handed over to someone else to complete, the record of test shall be completed for the testing that has been done.

A copy shall be forwarded to the person continuing the testing.

During the hand over the top copy of the logbook shall be handed on to the next maintenance tester.

The logbook must state the completed steps of all test plans used and be signed and dated by the maintenance tester on the first team.

The maintenance tester who takes over must make an entry in the logbook for all the steps completed by the first team.

Then go on to carry out all the remaining steps and record these in the logbook.

Figure 9 gives an example of the logbook entries.

SMTH (GK/RT 0231) Part B5.4.

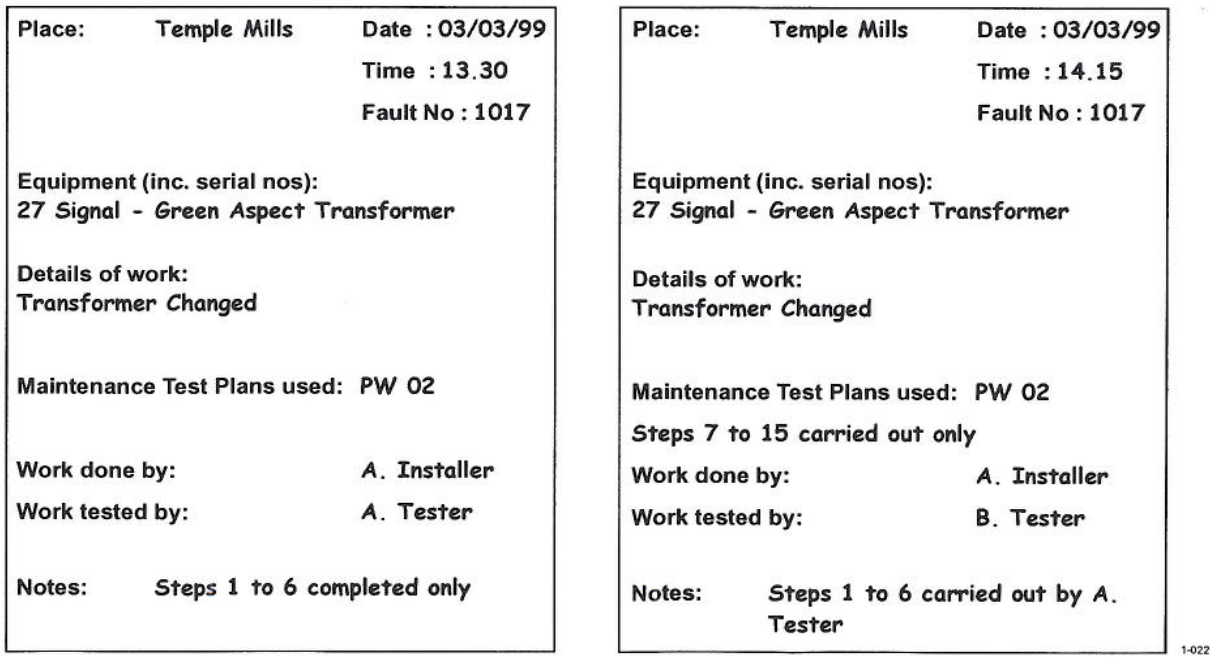


Figure 9 - Tester A to tester B

46. Full logbooks

Full logbooks may be retained by the maintenance tester as a personal record.

Think of the benefits to the maintenance tester of retaining a personal record of logbook entries.

47. Session 4

Complete and deal with pre-planning lists.

48. Session 4 objectives

At the end of this session you will be able to:

- state when a pre-planning list is required,
- complete a pre-planning list,
- state how a completed pre-planning list is dealt a with.

49. Pre-planned work

Where time is available it is advisable to use the opportunity to pre-plan as much of the work and associated testing as possible.

Make a list of jobs that could be pre-planned.

Record your answer below.

It is obvious if work is pre-planned beforehand, it means materials and equipment can be ordered, staff can be arranged etc. Before any pre-planned work is undertaken a list a list of associated test plans must be prepared.

Refer to SMTH (GK/RT 0231) Part B Appendix C2 and review the procedure for pre-planning work.

It may also be necessary to obtain a method statement for a specific operationally equivalent alteration.

Refer to SMTH (GK/RT 0231) Part B Appendix A.

50. Maintenance test plan list

The maintenance test plan list is approved for pre-planning work.

If the same maintenance test plan is to be used several times, for example changing say 7 relays of the same type, then it is permissible to put change relay x 7.

The top copy of the partially completed maintenance test plan list is taken to site and used by the maintenance tester. The bottom copy remains with the pad as a record of the planned work.

Figure 10 gives an example of a partially completed maintenance test plan list.

Refer to SMTH (GK/RT 0231) Part B Appendix C2.

MAINTENANCE TEST PLAN LIST

SITE: NEWTOWN STATION **DATE:** 2/3/99 **COMPILED BY:** J. Davis

CONTROLLING SIGNAL BOX	LOC. NO. OR EQUIPMENT ROOM	EQUIPMENT	DETAILS OF WORK	MTCE. TEST PLAN NO.	PERSON DOING WORK	PERSON TESTING
NEWTOWN	LOC. 209/178	ALL RELAYS IN CASE 'A'	REPLACE 6HR	EL08		
			" 6DR	EL08		
			" 6ECR	EL08		
			" 12HR	EL08		
			" 12DR	EL08		
			" 12ECR	EL08		
			" 89HR	EL08		
			" 89DR	EL08		
			" 89ECR	EL08		
			" 83TR	TC01		
			" 83TPR	EL08		
			" 84TR	TC01		
			" 84TPR	EL08		
ALTERATIONS TO LISTED WORK						

1-009 **SIGNATURE OF PERSON IN CHARGE ON COMPLETION:** ..... **TIME & DATE:** .....

Figure 10 - Maintenance test plan list

51. Deviation to pre-planned work

The pre-planning list should be amended by the maintenance tester to detail any change in the actual work undertaken or deviation from the listed maintenance test plans.

Refer to SMTH (GK/RT 0231) Part B Appendix B2.

52. Completed pre-planning lists

The completed maintenance test plan list must be signed and dated by a certificated maintenance tester to show that logbook entries and the maintenance test plan lists are correctly completed.

They must be forwarded with the associated logbook top sheets to the supervisor at the first opportunity after the end of the work.

The bottom signature says that the list has been completed correctly.

The Logbook top sheet is the document that confirms that the testing has been completed.

The supervisor will check and retain this sheet.

If any of the work particularly any deviation is considered inadequate the supervisor must arrange for the work to be retested.

Refer to SMTH (GK/RT 0231) Part B Appendix C2.

53. Exercise 5

Study the following scenarios and make out the maintenance test plan lists as directed in each scenario.

Once you have finished, your instructor will go through the exercise.

The following scenarios relate to Location 209/178.

1. You have been requested by your supervisor to find a quiet period during the week to renew 6 I T/J, 12 I T/J and 89 I T/J.

Partially complete a maintenance test plan list as required by the maintenance testing handbook before starting the work.

Once you have partially completed the maintenance test plan list assume that the work has been correctly carried out by Peter Jones and tested by you.

Complete the maintenance test plan list.

Assume today's date and time.

2. Cable RL 2b to walk in location hut 209/300 has been damaged by rodents and requires changing. This has been scheduled for next Sunday.

Partially complete a maintenance test plan list as required by the maintenance testing handbook before starting the work.

Once you have partially completed the maintenance test plan list assume that the work has been correctly carried out by Alan Nelson and tested by you.

Complete the Maintenance Test Plan List.

Assume today's date and time.

MAINTENANCE TEST PLAN LIST

SITE: Newtown DATE: 24/7/1 COMPILED BY: N Whelan

CONTROLLING SIGNAL BOX	LOC. NO. OR EQUIPMENT ROOM	EQUIPMENT	DETAILS OF WORK	MTCE. TEST PLAN NO.	PERSON DOING WORK	PERSON TESTING
Newtown	209/178 loc	All AWS T/J's	Renew 6 I T/J " 12 I T/J " 89 I T/J	PW$1 PW$1 PW$1	PJones " "	N Whelan " "
ALTERATIONS TO LISTED WORK						

SIGNATURE OF PERSON IN CHARGE ON COMPLETION: N Whelan TIME & DATE: 0945 24/7/1

1-025

MAINTENANCE TEST PLAN LIST

SITE: Newtown DATE: 24/7/1 COMPILED BY: N Whelan

CONTROLLING SIGNAL BOX	LOC. NO. OR EQUIPMENT ROOM	EQUIPMENT	DETAILS OF WORK	MTCE. TEST PLAN NO.	PERSON DOING WORK	PERSON TESTING
Newtown	209/178 and WILH 209/3$$	37 core 1/$·85 Cable RL 2b	Remove & Renew Cable	CA$3	A Nelson	N Whelan
ALTERATIONS TO LISTED WORK						

SIGNATURE OF PERSON IN CHARGE ON COMPLETION: N Whelan TIME & DATE:

1-025

[redacted]

54. Session 5

Understanding of signalling maintenance handbook terminology, safety procedures to be followed when the work involves links and fuses, and error reporting procedures.

55. Session 5 objectives

At the end of this session you will be able to:

- define the following terms in relation to checks:
  - correct type
  - damage
  - safe insulation
  - correct installation
  - isolation
  - correct labelling,
- describe the safety procedures for work involving links and fuses,
- state the requirements for the testing of signalling circuits in cables shared with the telecomms function,
- explain how to establish whether values measured and conditions observed during checks are normal or acceptable,
- state when unacceptable or abnormal values and conditions need to be reported and describe the reporting procedure,
- explain how to decide on remedial action for dealing with errors, inconsistencies and ambiguities which are identified.

56. Defined checks and tests

Many maintenance test plans require the maintenance tester to carry out certain checks or tests on equipment.

Without referring to your handbook write down your definitions of check and test in the context used by the signalling maintenance handbook.

Record your answers below.

Check

Visually inspect

[redacted]

Test

Test with Equipment, gauges

Refer to SMTH (GK/RT 0231) Part B3 for the definitions of check and test.

Look these up in the SMTH to see how they compare with your definitions.

Look at maintenance test plan AW03 (Figure 11) and identify the defined checks and tests.

you will see that where a check or test has been called for within a test plan this will be shown in italics.

Lower case italics refer to defined checks and upper case italics refer to defined tests.

Refer to SMTH (GK/RT 0231) Parts C1 and C2, and Part C Appendices A and B.

REPLACE A TRAIN STOP/TRIP COCK TESTER

Includes: Hydraulic, pneumatic.

BEFORE INSTALLATION WORK

1 *Check* replacement unit is *not damaged* and is *correct type*.
2 *WIRE COUNT* existing unit to the wiring diagram.
3 *Check* existing wiring has *safe insulation*.
4 *INSULATION TEST* replacement unit (Minimum 2M.Ohm terminals to case).
5 *Check* existing wiring and hoses are *correctly labelled*.
6 *Check* existing unit is *isolated* from the supply.

AFTER INSTALLATION WORK

7 *Check* replacement unit is *correctly installed*.
8 *Check* wiring is replaced as labelled.
9 *WIRE COUNT* replacement unit to the wiring diagram.
10 *Check* terminations are secure and suitably protected.
11 *Check any links* and red dome nuts are secure and correctly replaced.
*12 *Test* voltage with supply restored.
13 *Check* wires, cables and hoses are clear of moving parts and are secured.
14 *Check* hoses as installed as labelled.
15 *EARTH TEST* supply where designed to be earth free.
16 *Test* (gauge) any associated treadles [Height below rail level, timing (SMS)]. **(TRIP COCK TESTERS ONLY).**

REPLACE A TRAIN STOP/TRIP COCK TESTER

AFTER INSTALLATION WORK (Continued)

*17 *Test* down detection with arm proving linkage disconnected. **(TRAIN STOPS ONLY).**
18 *Test* (gauge) unit (Height above rail level, positioning).
*19 *Test* detection corresponds with the arm position for both up and down positions of the train stop arm **(TRAIN STOPS ONLY).**
*20 *Test* detection corresponds with the indication for both the raised and operated positions of the ramp/treadle arm **(TRIP COCK TESTERS ONLY).**
21 *Check*, or arrange for, *correct labelling* of unit.

1-012

Figure 11 - Maintenance test plan AW 03

What do you consider a fair definition of:

- checking equipment is electrically isolated during work,
- checking for adequate labelling.

Record your answers below.

1 check there is no voltage on the equipment

2 check the location & function is correctly labled and that wiring is uniquely & clearly labled

Refer to SMTH (GK/RT 0231) Part C Appendix A and check your answers.

57. Working with cable cores and links

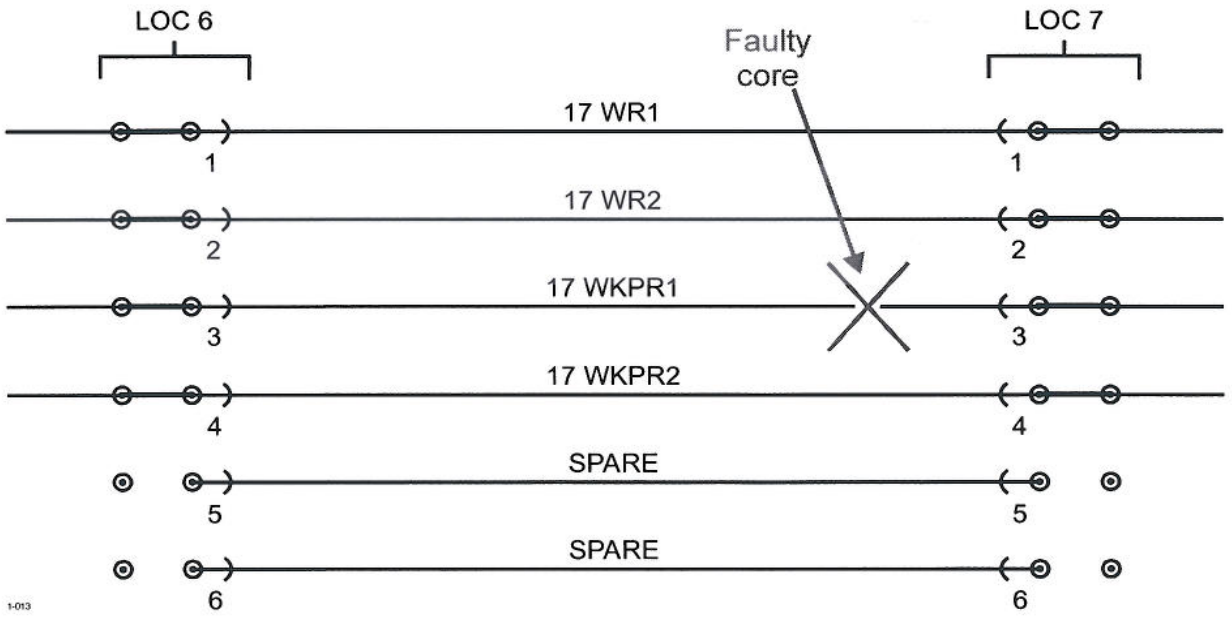


Figure 12 - Cabling and links

Suggest a solution or solutions to the problem shown in Figure 12.

Record your answer below and on Figure 12.

58. Working with links and red dome nuts

Where a terminal block and/or its links (and any red dome nuts) have to be removed during work, their original position must be recorded.

Where a link has to be slipped during the work this shall be recorded.

Any previously slipped links in the vicinity of the work shall be recorded to avoid inadvertent replacement.

Where a link or connector has to be removed or slipped during the work and must not be replaced, this shall be recorded. Suitable reminder arrangements shall be made on site, such as the fitting of red dome nuts to terminals.

On completion of work a check shall be made to ensure the configuration of links and any red dome nuts is correct.

Where cable cores are spare and unused by any circuit or function, any links fitted to the terminal blocks at either end shall be removed.

Where testing is handed on to a different team the details outstanding slipped links shall be forwarded to the person taking over.

Refer to SMTH (GK/RT 0231) Part C5.

59. Diversion of a cable core

Figure 13 illustrates the procedures when working with cable cores, links and red dome nuts.

Refer to SMTH (GK/RT 0231) Part C5.

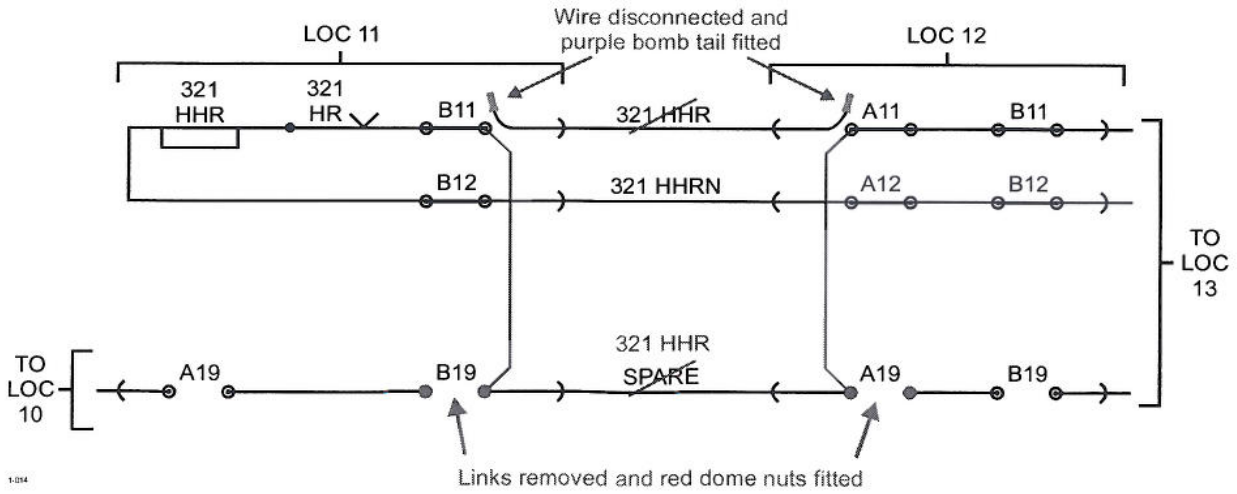


Figure 13 - Use of red dome nuts

60. Working with fuses

Fuses removed for isolation purposes should be dealt with in the same way as links slipped during the work.

61. Signalling circuits in cables shared with telecomms functions

Signalling circuits in cables shared with telecomms functions must be identified and tested in accordance with local procedures.

Refer to SMTH (GK/RT 0231) Part C4.

62. Session 6

Carry out a wire count and apply temporary labelling to wire terminations.

63. Session 6 objectives

At the end of this session you will be able to:

- identify occasions when a wire count is required,
- wire count relay bases to wiring diagrams and contact analysis sheets,
- wire count a selection of equipment, other than relays, to include fuses, links and terminal blocks to circuit diagrams,
- record the results of the wire count,
- state the procedure for dealing with wire count errors,
- identify wires requiring temporary labels,
- affix temporary labels,
- remove temporary labels.

64. When is a wire count required?

Many test plans require a wire count both before and after installation.

Where a wire count is required it will be shown on the test plan in capitalised italics.

Look at the example maintenance test plan EL 12 shown in Figure 14.

Remember a wire count is carried out when a test plan requests it.

REPLACE A PLUGBOARD

Includes: Plugboard for all plug in components.

BEFORE INSTALLATION WORK

1 *Check* replacement plugboard is *not damaged* and is *correct type* (Pin code).

2 *WIRE COUNT* existing plugbord to the wiring diagram.

3 *Check* existing wiring has *safe insulation*.

4 *Check* existing wiring is *correctly labelled*.

AFTER INSTALLATION WORK

5 *Check* replacement plugboard is *correctly installed*.

6 *Check* wiring is replaced as labelled.

7 *Check* connections are securely locked in the plugboard.

8 *WIRE COUNT* replacement plugboard to the wiring diagram.

9 *Check* item of equipment fitted to the plugboard is *correctly installed* and the retaining clips in place.

*10 *Check* with the Maintenance Test Plan for the item of equipment fitted to this plugboard and carry out steps marked with an asterisk "*".

NOTE: If the affected plugboard forms part of a track feed circuit carry out steps marked an asterisk "*" on the appropriate Maintenance Test Plan for the track feed equipment.

11 *Check*, or arrange for, *correct labelling* of unit.

1-015

Figure 14 - Maintenance test plan EL 12

65. What is included in a wire count?

What do you think a wire count is and what does it achieve?

Record your answer below.

Wire count, is to ensure the equipment is correctly wired to the drawings

Refer to SMTH (GK/RT 0231) Part C Appendix B1 and check your answer.

When wire counting, care must be taken to include all relevant equipment e.g:

- cable links,
- fuses,
- bus bars,
- equipment terminations etc.

The wire count must be carried out with all wires terminated.

66. How to carry out a wire count

Refer to Figure 15.

Every wire terminated on the affected piece of equipment should be checked, first by checking the number of wires connected to each termination point on the equipment and then ensuring this corresponds with the number of wires indicated on the wiring diagram.

By using this method, if an extra wire or wires are terminated on spare positions this will be found along with any extra wires on terminations already in use.

If a wire count is performed by first looking into the wiring diagrams to check how many wires should be attached to the relevant termination point, and then checking the equipment, then only termination points which are in use are checked. Hence, extra wires on spare terminations will never be detected.

67. How to use an analysis sheet

Refer to Figure 17.

A wire count to analysis sheets is not sufficient on its own but must be used in conjunction with a wire count to wiring diagrams.

First perform the wire count to the wiring diagram and then check that the result corresponds with the analysis sheet.

68. Recording a wire count

It is not necessary to record the details of our wire count for auditing purposes, for example, by ticking the wiring diagrams. The wire count may be recorded if it assists the maintenance tester in performing the test.

The use of the wire count grid sheet is optional and is used when the maintenance tester considers it will help in carrying ate a wire count.

An example of a wire count grid sheet is shown in Figure 16.

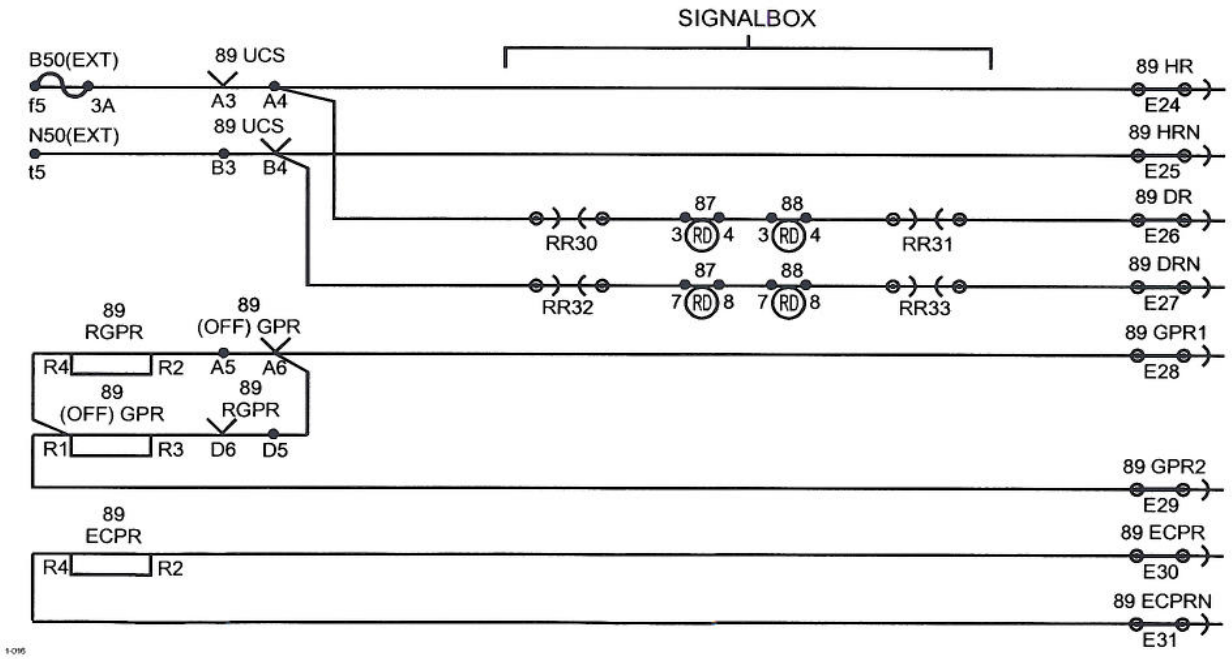
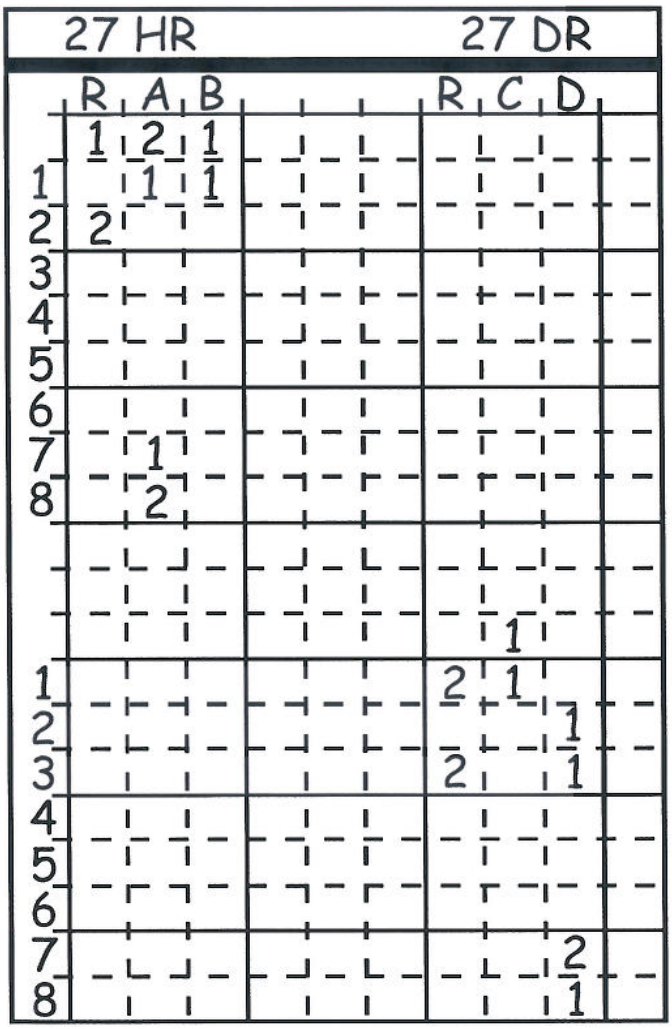


Figure 15 - Typical circuitry

SIGNALLING MAINTENANCE TESTING HANDBOOK

WIRE COUNT GRID SHEET

Copy and store in binder pocket for use as required



1-019

Figure 16 - Example wire count grid sheet

72. Requirements for a temporary label

The temporary diversion of circuits means the short term reallocation of cable cores, relay contacts, or emergency repositioning of an item of equipment which has been operating correctly.

Any temporary labelling should not damage either wires or equipment and shall be removed on completion of the work to avoid confusion.

A temporary label is fit for service when it uniquely marks or identifies the wire or cable core and corresponds to the wiring diagram.

A wire is correctly labelled when it is uniquely marked or identifies and its label corresponds to the wiring diagram.

It is essential that everyone likely to be involved in the work or testing must understand the labelling system adopted.

List a few examples of when temporary labels may be required.

Record your answer below.

when there are no labels attatched, are illegable.

List the different types and different methods of affixing temporary labels.

Record your answer below.

Paper tags tied with string, insulation tape

When should temporary labelling be removed?

Record your answer below.

to keep things tidy, unecessary

Discuss your answers with your instructor.

73. Session 7

Other signalling maintenance testing procedures and considerations.

74. Session 7 objectives

At the end of this session you will be able to:

- explain how to identify when testing activities are outside limits of competence and authority and state what action to take in this situation,
- state the factors affecting an individual's performance and the potential consequences of working outside limits of competence,
- explain how to establish whether values measured and conditions observed during checks are normal or acceptable,
- state when unacceptable or abnormal values and conditions need to be reported and describe the reporting procedure,
- explain how to decide on remedial action for dealing with errors, inconsistencies and ambiguities which are identified.

75. Exercise 6

Read the following scenario.

You are a maintenance and faulting technician working on a large point renewal job where worn out Westinghouse Style 63 points are being replaced by new GEC HW 2000 points.

The job started at its scheduled time of 23.00 hrs on Friday evening and is scheduled to finish 04.00 hrs on Monday morning.

You successfully completed your first weekend shift 07.00 hrs to 17.00 hrs on Saturday and are nearing the completion of the Sunday shift of 07.00 hrs to 17.00 hrs.

You are quite pleased with your performance both installing new cables to the new point machines and testing a colleagues work who has also been installing cables. You now feel like a valued member of the team, now that you are allowed to test after recently completing signalling maintenance testing modules 1 to 4. You are especially pleased by a pat on the back for you and your colleague from your supervisor. This is for completing your own work well before schedule, and picking up and completing some extra work, because two other staff have reported in sick.

You are now looking forward to tomorrow when you will return to the Doncaster Training Centre to completing signalling maintenance testing modules 5, 6, 7 and 9, and maybe on the next big job you will be allowed to do more testing.

Your dreams are interrupted by a very red and flustered supervisor. You are surprised by a distinct change in her attitude. It is quite obvious that things are not going well, which is confirmed when she blurts out "We'll never bloody finish for 4 o' clock." You are even more surprised when she says to you and your colleague "get your butts down to the transport cafe and get some grub down you, and don't worry about the cost, get a receipt and bang it on your expenses." "Why." You ask, to which she urgently states. "I need you to stay on until the job is finished" "I'm going to take the kids bowling tonight." You reply. "Never mind that, I need you here. Besides I'll make it worthwhile. Grab my mobile phone, ring the missus and make the necessary arrangements." "But what about the time with my kids." To which the retort is. "You'll be spending plenty of weekends with the kids if you don't bail me out tonight."

As you walk away you think, what the hell, the money will really come in useful. And as you walk down to the transport cafe thinking about what to do with your windfall and what to eat, the edge seems to wear of your tiredness.

When you get back your supervisor pounces out of nowhere. "Got your SMTH, good. You'll need these method statements." As you struggle not to drop the pile of papers thrust into your hand you ask. "Well! What am I doing." "You're in charge of testing the points. We aim to finish about 6 o' clock in the morning."

As she walks away muttering things about me having it easy and how she has to go and pacify the bloody operating department, You think, surely this isn't right.

In your syndicate discuss the scenario.

What are the possible consequences of the subsequent actions you make take as a result of this scenario? Consider all possibilities.

What action or actions should you take?

Record your answers on a flipchart and discuss them with the rest of the group. You can also record your answers in the space below.

Can't test own work

[redacted]

76. Answers to exercise 6

What is wrong?

It is clear that you are being asked to work outside the limits of competence and authority. You are not qualified to carry out signalling maintenance testing on points.

You are also being asked to work longer hours than allowed.

You will also be burdened with extra physical and mental stress resulting from the extra workload and long hours, and the worry of testing something you are not competent and authorised undertake.

It is very likely that you will make a mistake. This could result in an accident causing injury and even loss of life.

You may even get away with it this time. Will this make it easier to break the rules next time?

And what about that training course on Monday morning, do you really want to miss that.

What should you do

Politely but firmly refuse to do the work clearly stating your reasons.

Don't allow yourself to be intimidated. It is not you who is in the wrong.

If necessary take your case to a higher authority.

In general

Know your limits of competence and authority.

Do not exceed them.

Refer to SMTH (GK/RT 0231) Parts B5, B5.1, B6, and B6.1.

Refer also to SMTH (GK/RT 0231) Part B3.

There will be a lot of other points raised as a result of your syndicate exercises. Take the opportunity to record them. Use the space below.

Read module 2

77. Exercise 7

Think about the following questions:

1. How do you establish whether values measured and conditions observed during checks are normal or acceptable.
2. What unacceptable or abnormal values need to be reported.
3. What is the reporting procedure.
4. How do you decide on the remedial action for dealing with errors, inconsistencies and ambiguities which are identified during testing.

In your syndicate discuss the answers to the questions.

Record your answers on a flipchart and discuss them with the rest of the group. You can also record your answers in the space below.

In smith
When out of smith spec
Escalate to Sup
Follow Smith

78. Answers to exercise 7

Question 1

Certain values and conditions will be absolute such as **no**, **none** and **fully**, and there will be no doubt as to whether these are normal and acceptable.

Certain values are listed SMTH (GK/RT 0231) Part C, Appendix E - Useful Values.

The SMTH is used in conjunction with S&T Maintenance Specifications which will also detail normal and acceptable values and conditions.

Another useful source will be an equipment specific handbook, such as the point equipment and train detection handbook.

Special Investigation Notices may contain relevant information.

If in doubt - ask.

Question 2

Where the SMTH directs you to report them, such as in the defined test B1 - wire count. If a wire count error is found in the "before" section of the maintenance test plan you must advise the local manager. Both the D.C. and A.C. earth tests detail circumstances unacceptable or abnormal values need to be reported. Another example is detailed in SMTH (GK/RT 0231) Part B7.

Other unacceptable or abnormal values which cannot be rectified legitimately and tested or retested using SMTH will need to be reported.

When in doubt - report it.

Question 3

Anything that needs to be reported shall be reported by the maintenance tester to their local manager. Local manager is defined in SMTH (GK/RT 0231) Part B3.

If in doubt - ask.

Question 4

Certain remedial actions are defined in the SMTH, such as in the defined test B1 - wire count. If a wire count error is found in the "after" section of the maintenance test plan the work must be corrected and independently retested. Both the D.C. and A.C. earth tests detail remedial action when an earth fault is found. They may be located by methodical disconnections.

The SMTH is used in conjunction with S&T Maintenance Specifications which will also detail remedial action.

Another useful source will be an equipment specific handbook, such as the point equipment and train detection handbook.

Special Investigation Notices may contain relevant information.

If in doubt - ask.

In general

A lot of what has been discussed in the answers is common sense. It should however, be remembered that this list is not exhaustive and is no substitute for your experience and judgement.

There will be a lot of other examples as a result of your syndicate exercises. Take the opportunity to record them. Use the space below.

Signalling Maintenance Testing Course
Module 2 – Undertake Cable and Wire Testing
Handout

1. Module 2 aim

Teach and assess the necessary knowledge and skills to:

- undertake cable and wire testing.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 2 objectives

At the end of this module you will be able to:

- state the requirements and objectives of cable and circuit tests,
- establish the identity and location of cables, cable cores, wires and circuits to be tested in given situations,
- describe methods of isolating cables, cable cores and wires prior to continuity testing and insulation testing,
- isolate cables, cable cores and wires to be tested,
- conduct the following tests:
  - cable function test
  - continuity test
  - insulation test

  demonstrating correct selection, connection and use of tools,
- state the requirements for personal safety relevant to:
  - cable function test
  - continuity test
  - insulation test,
- describe the use of aids to performing tests,
- explain how to establish whether measured values and observed conditions are normal or acceptable,

- establish the identity of the following errors, inconsistencies and ambiguities:
  - labelling errors and omissions
  - insulation errors
  - short circuit
  - open circuit and transposition faults
  - continuity errors
  - wire count errors

  and describe appropriate remedial action for dealing with each,
- state when unacceptable or abnormal values and conditions need to be escalated by reporting and describe the reporting procedure,
- describe how to complete the record of test for cable and wire testing.

4. Basic elements

There are three basic elements to the testing of cables:

- continuity test,
- insulation test,
- cable function tests.

5. When to carry out cable tests

These tests are called for on many maintenance test plans mainly when a cable or wire is jointed, renewed or a length added. Also when a cable core is brought into use.

Where these tests are required they will be shown on the test plans in capitalised italics.

Look at the example on maintenance test plan CA 03. (Figure 1.)

6. What the cable tests achieve

Without referring to the SMTH, in your own words write down the purpose of each of the following tests and what they achieve:

- continuity test,
- insulation test,
- cable function test.

Record your answers in the space below.

Continuity test,

Ensure there are no disconnected cores or crossed cores or shorts

Insulation test,

Ensure that the cores are insulated from each other + Earth

Cable function test.

Ensure that the correct piece of equipment is operated when called + no stray voltages

Refer to SMTH (GK/RT 0231) Part C, Appendices B2, B3, and B6 and check your answer.

RENEW A CABLE/WIRE

Includes: **Line wires.**

Excludes: **Renewing a cable/wire with intermediate terminations, links or contacts.**

BEFORE INSTALLATION WORK

.....

4 *WIRE COUNT* existing cable/wire to the wiring diagram.

.....

7 *CONTINUITY TEST* all cores in the replacement cable/wire **(EXCLUDING TRACK CIRCUIT CABLES)**.

AFTER INSTALLATION WORK

.....

13 *INSULATION TEST* replacement cable/wire or insulated line wire **(EXCLUDING TRACK CIRCUIT CABLES)**.

.....

15 *WIRE COUNT* replacement cable/wire to the wiring diagram.

.....

17 *CABLE FUNCTION TEST* the affected circuits **(LINE WIRES AND MULTICORE CABLES EXCLUDING TAIL CABLES).**

2-017h

Figure 1 - Maintenance test plan CA 01

7. Identification and location of cables/cable cores

Once the fault has been repaired or the renewal completed then testing will be carried out. The maintenance tester will have to determine exactly what has to be tested. It is important that the maintenance tester is able to use the diagrams to determine the extent of the testing.

Any cable which has been jointed, had a length added, or renewed will require all the cores within it to be tested. Also any spare core in a cable that has been brought into use will also require testing.

Study Figure 2 and Figure 3.

Figure 2 is a typical example of a cable plan. In this case a
19 core 1/0.85mm signalling cable and a 2 core 7/0.67mm power cable and the various locations are shown.

Using a cable plan to determine what cables run where will make life much easier.

Figure 3 shows a typical cable core plan. A cable core plan shows what circuits are carried by each core in a cable.

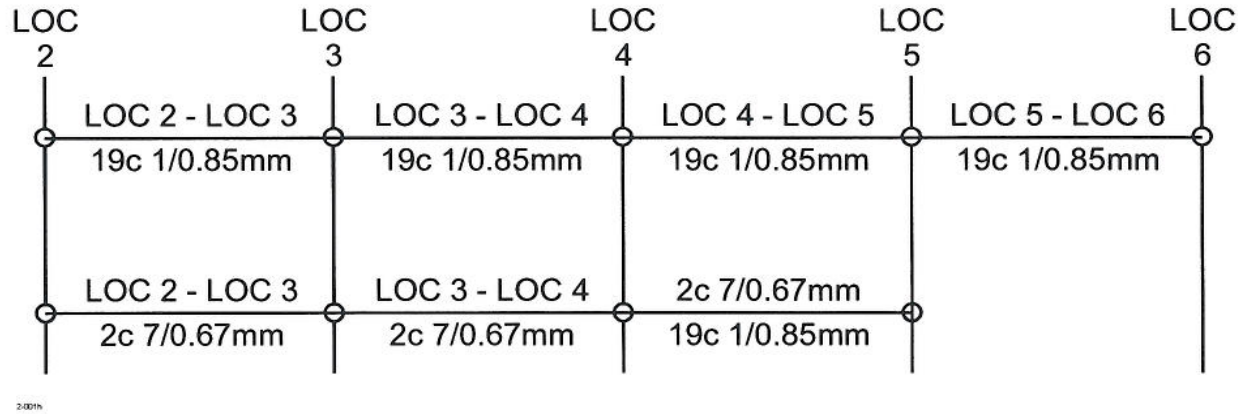


Figure 2 - Cable plan

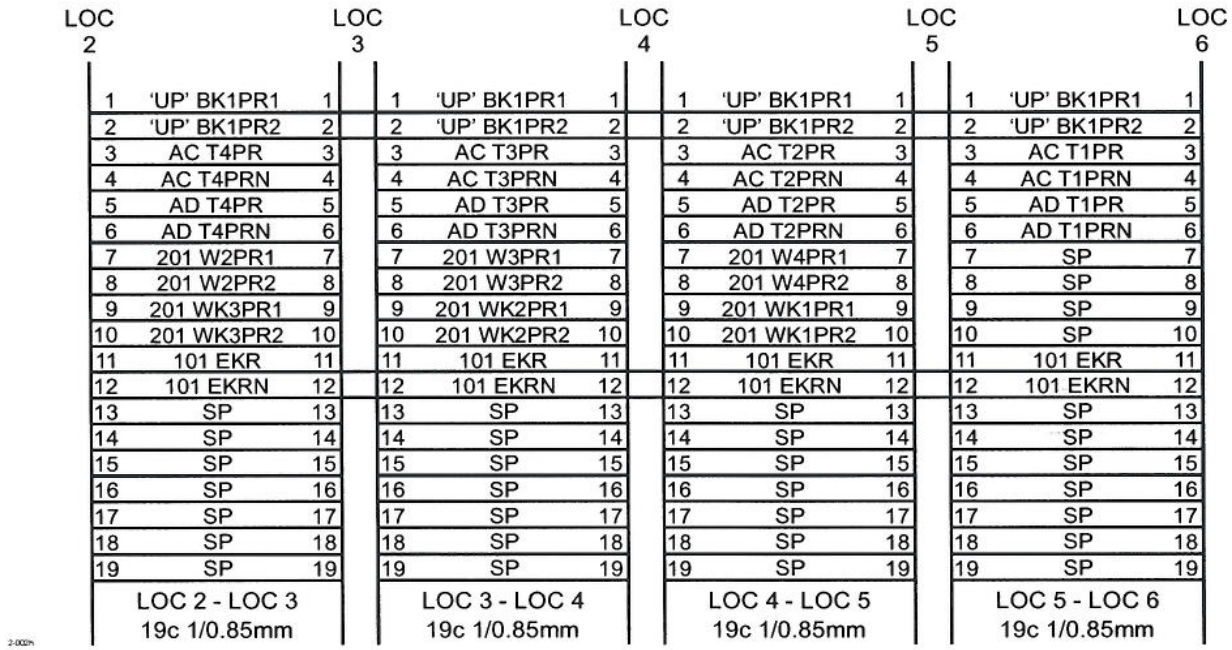


Figure 3 - Cable core plan

8. Exercise

Refer to Figure 2.

By inspecting the diagram see if you can identify what cables call into a location, terminate in a location, and continue to and from locations shown on other diagrams.

Record your answer in the space below.

Discuss your answer with your instructor if you require help.

Refer to Figure 3.

Look at cores 1 and 2. The lines representing them are continuous from Location 2 to Location 5.

What does this mean.

Record your answer in the space below.

There are no controls in the locations affecting these circuits

Discuss your answer with your instructor if you require help.

9. Isolating a cable/cable core

Suitable methods of isolating a cable/cable core prior to continuity testing and insulation testing include:

- Slipping links;
- Removal from termination point. (This is only necessary were there are no links.) The wire will need to be insulated using a method outlined in the general instructions to S&T staff GI E52.

Without referring to the general instructions to S&T staff, in your own words write down methods you consider to be suitable and non suitable for insulating a wire.

Record your answers in the space below.

Suitable methods

Silicon sleave, insulation tape & bag plastic bag taped to each individual core

Non suitable methods

leave it hanging
multiple cores together

Check your answer with the general instructions to S&T staff GI E52.

10. Test instruments

What test instruments would you use for cable testing? Make a list of suitable and non suitable test instruments.

Record your answer in the space below.

Suitable

Continuity test

~~Meter~~ DVM
Buzzer
Battery / cell

Insulation test

Megger
~~Meter~~ DVM

Cable function test

~~Meter~~ DVM

Non suitable

Megger

Buzzer

Megger
Buzzer

Refer to SMTH (GK/RT 0231) Part C, Appendices B2, B3, and B6 and check your answer.

11. Potential cable faults

Figure 4 shows the makeup of a typical signalling cable. It also shows potential faults which can develop over the life of the cable. It also should be borne in mind that these faults can also be found in new cables.

The typical faults include:

- open circuit/continuity fault, i.e. break or high resistance in the core,
- core to core fault, i.e. low insulation resistance between cores,
- core to earth fault, i.e. low insulation resistance between a core and earth.

All these faults under the right circumstances could produce a wrong side failure.

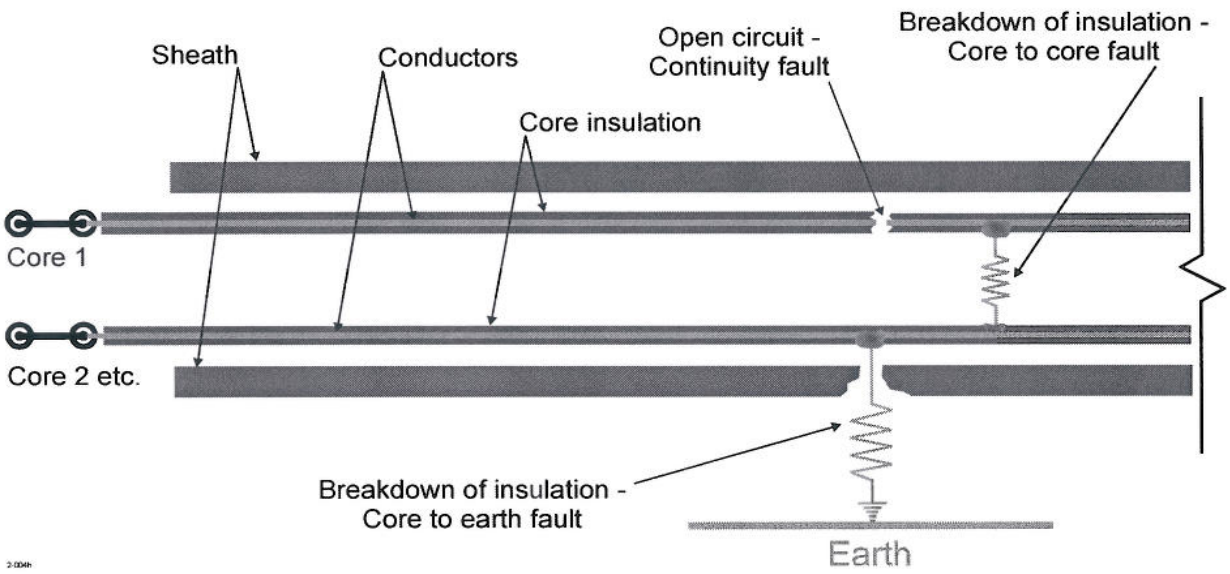


Figure 4 - Potential cable faults

12. Continuity test

The method of carrying out a continuity test is described in SMTH (GK/RT 0231) Part C, Appendix B2.

When a continuity test has to be carried out on a cable core a practical method of carrying out this test is to:

- loop two cable cores together at one end of the cable, and
- connect a test instrument to the same cores at the other end.

This is shown in Figure 5. In a multicore cable, it is practical to use one core as the common, say core No. 1 and use it to test the other cores. Again this is shown in Figure 5.

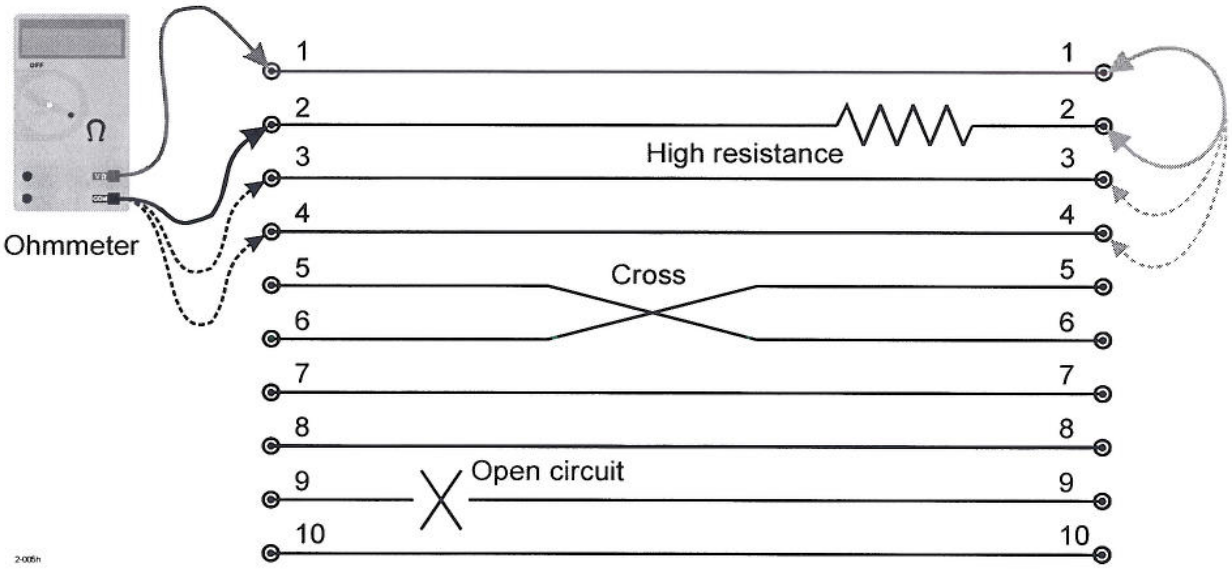


Figure 5 - applying the continuity test

What results will you get if you apply the continuity test to the cable cores in Figure 5.

Record your answer in the space below.

Check your answer with your instructor.

13. Correspondence of a 2 core cable

Use your handbook as a reference and draw on Figure 6 the correct way to test the correspondence of the 2 core cable shown.

Check your answer with your instructor.

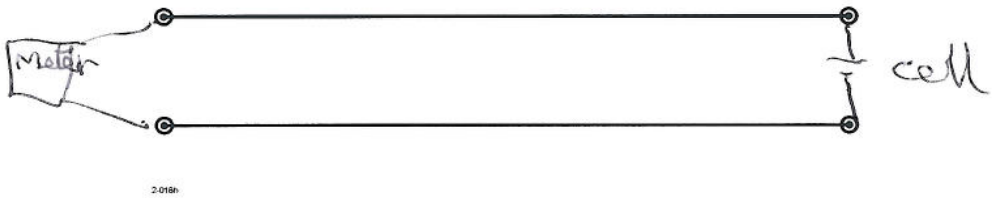


Figure 6 - Correspondence of a 2 core cable

14. Proving the integrity of a test earth

The core to earth test (discussed later in these notes) requires the use of a test earth connection. This may be already provided, if not you will have to create one. It is essential that this connection has a low resistance path to earth.

The integrity of the test earth can be proven as shown in Figure 7

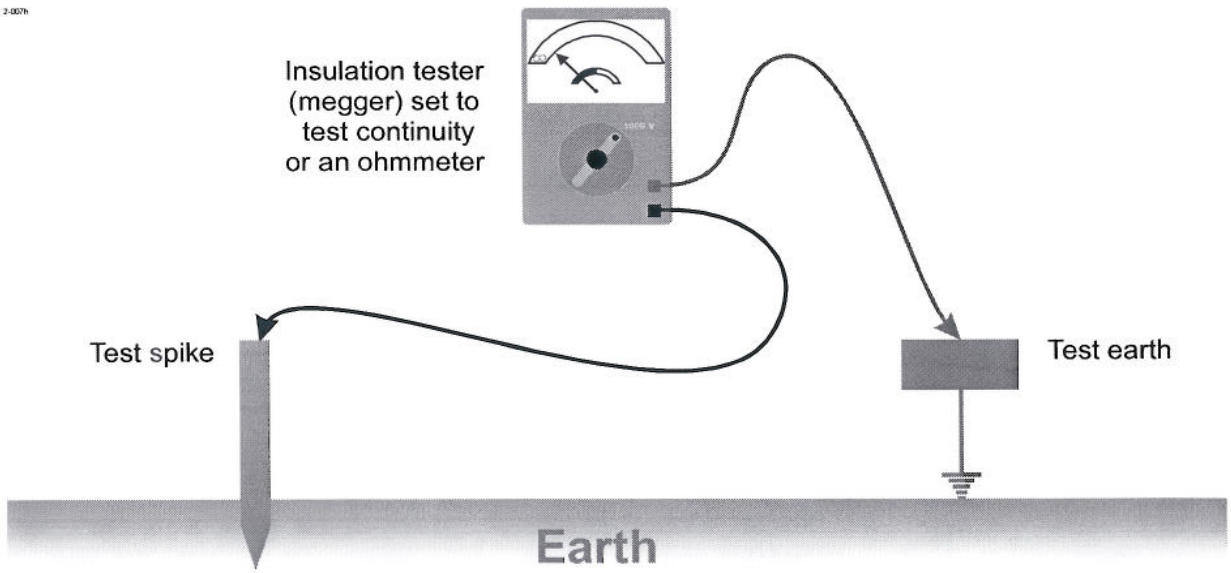


Figure 7 - Proving the integrity of the test earth

15. Insulation tests

The method of carrying out insulation tests is described in SMTH (GK/RT 0231) Part C, Appendix B3.

Core to earth test

Each core is tested individually as shown in Figure 8 and Figure 9.

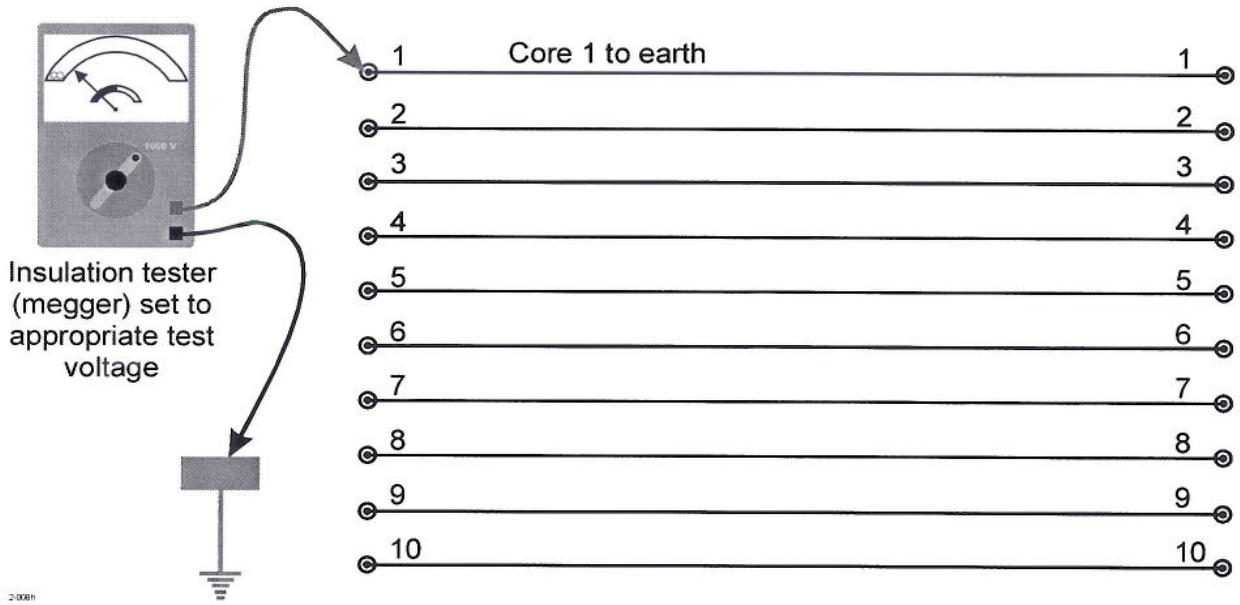


Figure 8 - Insulation test - core 1 to earth

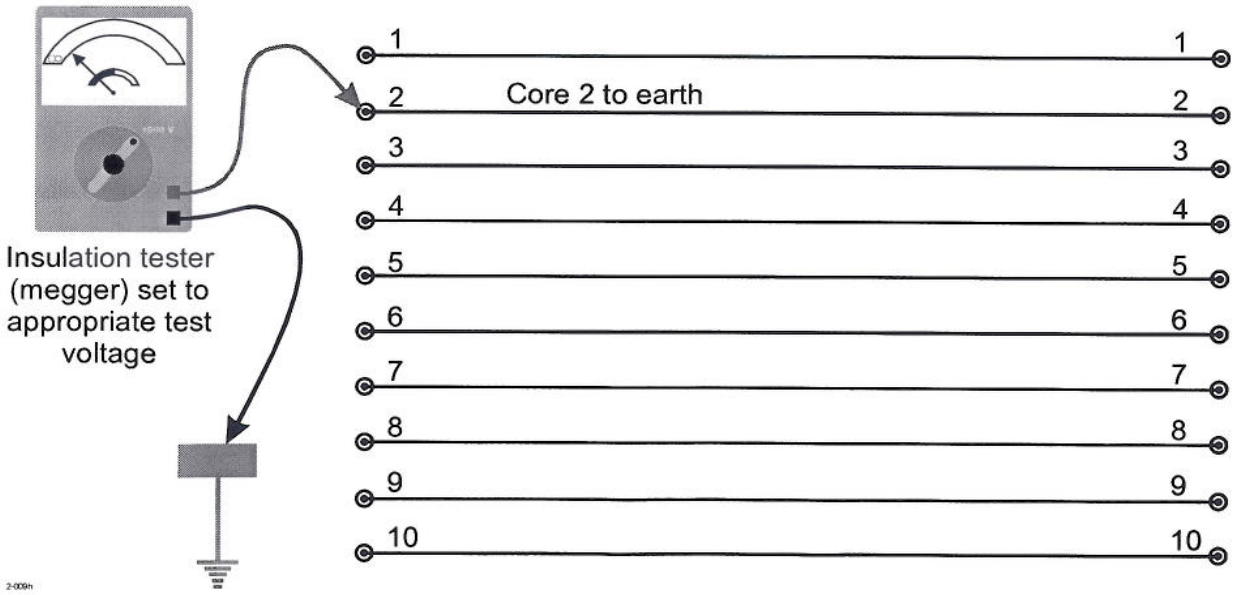


Figure 9 - Insulation test - core 2 to earth

Core to core

Each core is tested to all other cores bunched together as shown in Figure 10 and Figure 11.

The cores are bunched together using the approved 24 way insulation test straps.

Don't forget to put the unused clips in the bag.

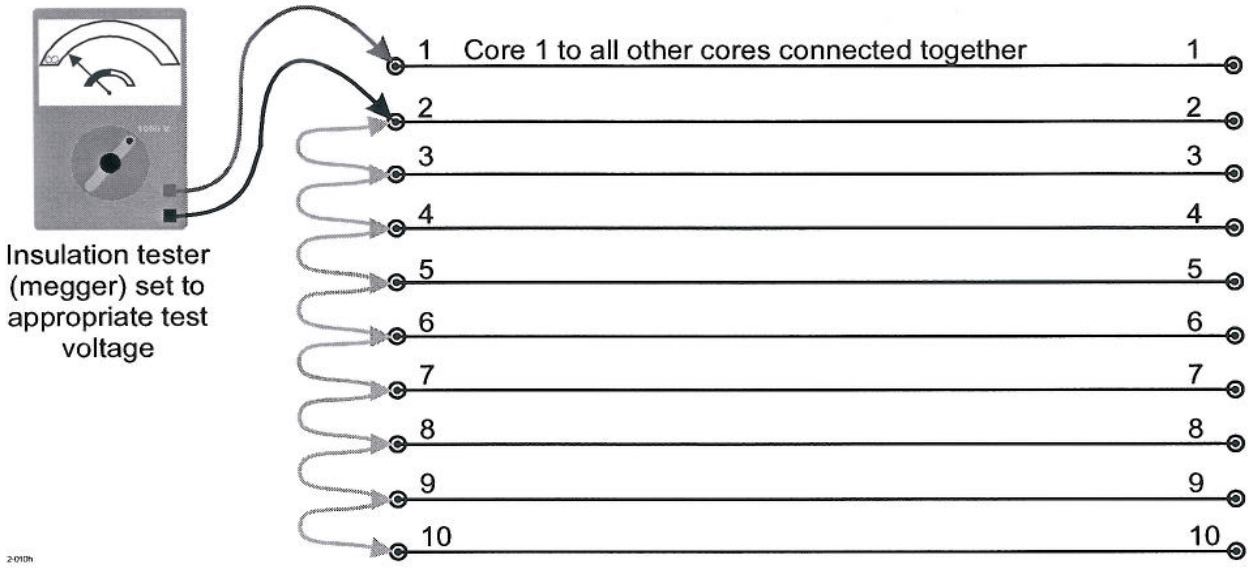


Figure 10 - Insulation test - core 1 to all other cores

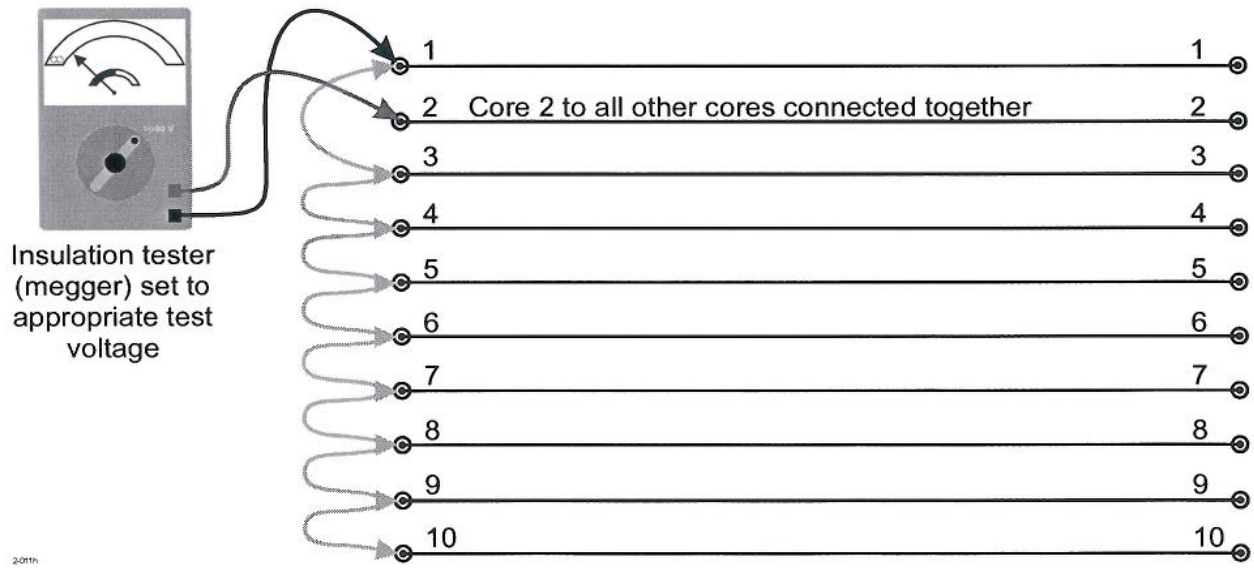


Figure 11 - Insulation test - core 2 to all other cores

What do you think the reason is for bunching all other cores together for every core tested?

Record your answer in the space below?

To reduce time taken to test & ensure all possible readings are taken as well as obtaining the ~~full cable~~ insulation resistance for the whole cable

An explanation is provided over the page using Figure 12.

If there are any aspects of this you do not understand discuss them with your instructor.

Figure 12 shows a typical arrangement where controls are fed out onto cable cores.

In this example core 5 has three insulation faults, one between core 7, another between core 9 and finally between core 11.

Each of these faults on their own may be acceptable. However, the combination of these three faults will provide an unacceptable insulation fault.

Imagine if 311 WPR is de-energised and 312 WPR, 313 WPR and 314 WPR are energised this will provide a fault path of 1/3 M Ohm from the B50 busbar to cable core 5. This could result in the function being controlled by 311 WPR being falsely fed.

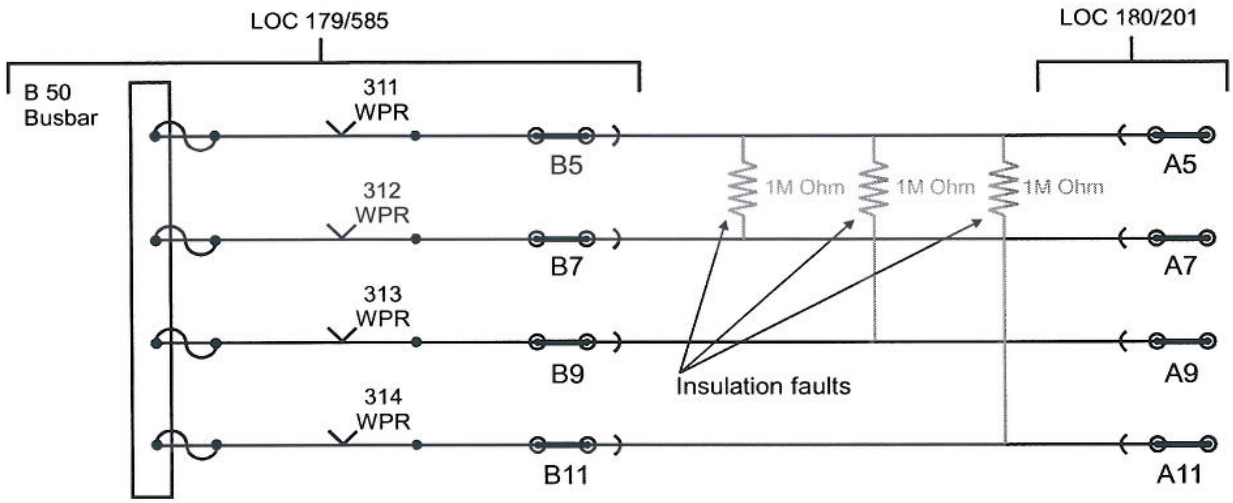


Figure 12 - Parallel insulation faults providing an overall low resistance

16. Cable function test

The method of carrying out a cable function test is described in SMTH (GK/RT 0231) Part C, Appendix B4.

Carrying out the test

Study Figure 13. It shows typical faults which a cable may have after fault rectification or renewal.

Apply the cable function test to Figure 13 and find the steps which will reveal each of the faults. Also detail how the fault would show up during the testing.

Record your answer in the space after the diagram on the next page.

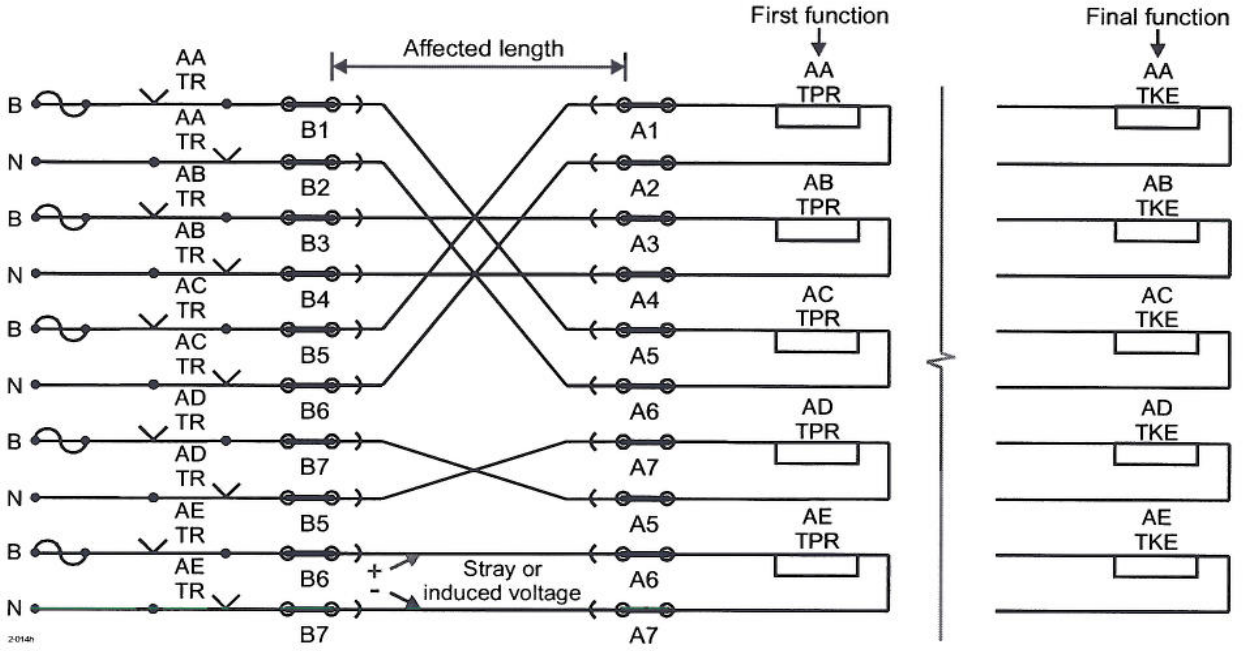


Figure 13 - Cable function test - typical faults

Check your answers with your instructor.

Belt and braces

You may find that other tests you may have carried out will have located a fault before you get to the cable function test. For example, the cause of stray voltage may be found by the insulation test, however, if it is an induced voltage rather than the result of poor insulation it will not. It is always better to be safe than sorry.

What other faults that will be located by the cable function test will be located by another test.

Record your answer in the space below.

Check your answer with your instructor.

Double cross

In the example in Figure 14 a cross had been inadvertently introduced into a section of cable.

To compensate for this a second cross was deliberately introduced in a different section of cable. Therefore, the operation of the final function will correspond to the operation of the first control.

Everything is OK until the length (or part length) of cable containing the first cross is replaced.

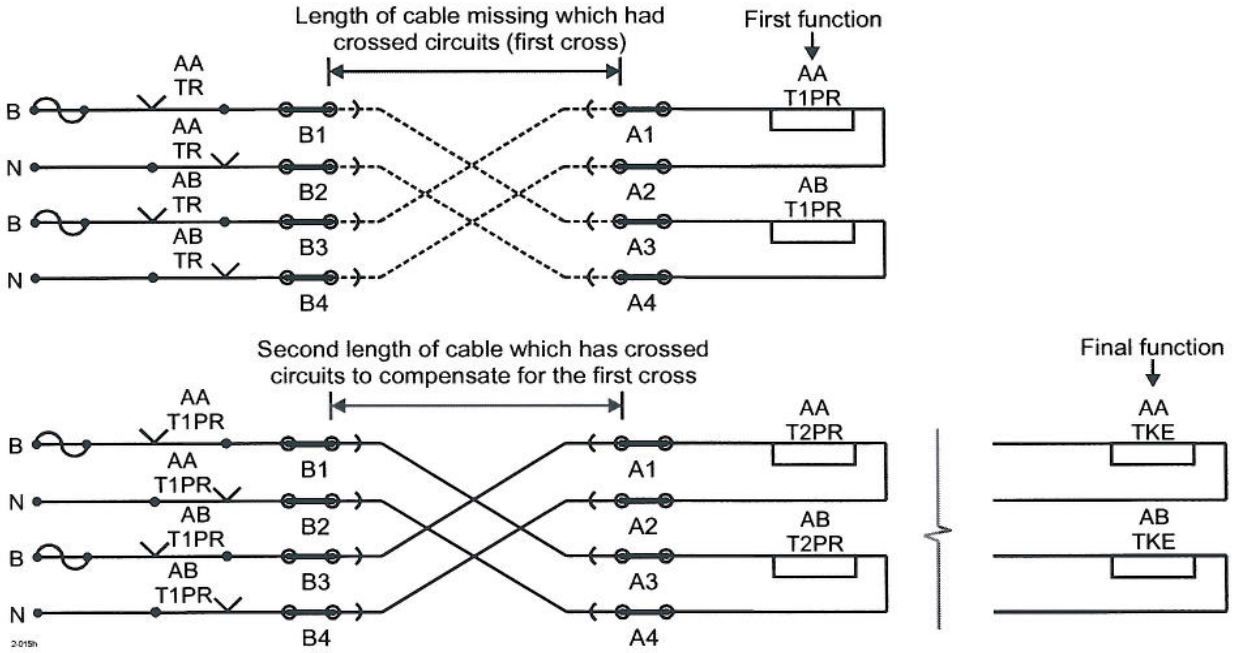


Figure 14 - Typical circuit with a double cross

A serious problem arises when the cable is replaced as shown in Figure 15.

The cable itself may test OK. i.e. continuity, insulation, etc. but in fact what has happened is the second cross is now causing the wrong final function to operate.

It is therefore essential that when a length of cable is jointed or replaced the cable function test is properly carried out. This is especially true if a length of cable goes missing, because there is no way to determine whether it had a cross (or crosses) or not.

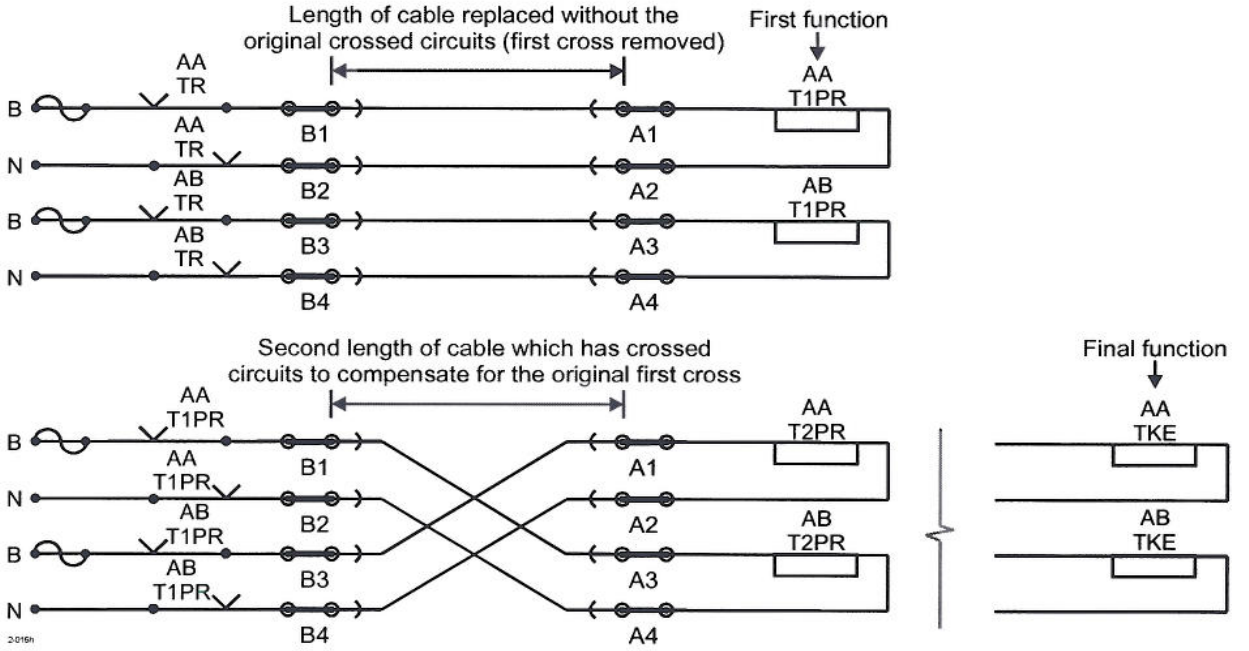


Figure 15 - Typical circuit - wrong function operates

17. Records

After the testing has been completed, it is necessary to fill in the cable record card because the results may differ to those already on the card.

This could lead to confusion at a later date if the results differed to those on the card.

The card should also be endorsed that a joint has been made or a length added, etc.

18. Temporary diversion of circuits

The temporary diversion of a circuit will require testing before being returned into service.

Where this is a diverted cable core it will require all the three cable tests described in this section.

Maintenance test plan CA 05 details the procedure.

The supervisor keeps a record of the used spare cores which should only be diverted for one month, unless dispensation is given by the engineer. In which case new drawings should be issued and endorsed "temporary wiring" until the cable fault is rectified.

Signalling Maintenance Testing Course
Module 3 – Undertake Earth Testing
Handout

1. Module 3 aim

Teach and assess the necessary knowledge and skills to:

- undertake earth testing.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 3 objectives

At the end of this module you will be able to:

- state the requirements and objectives of the different earth tests,
- select and conduct earth tests for given circumstances, demonstrating correct selection, connection and use of test instruments,
- state the requirements for personal safety relevant to the following tests:
  - earth test DC (up to nominal 120V)
  - earth test AC (up to nominal 110V),
- explain how to establish whether measured values and observed conditions are normal or acceptable,
- state when unacceptable or abnormal; values and conditions need to be escalated by reporting and describe the reporting procedure,
- describe how to complete the record of test for earth testing.

4. Basic elements

There are two basic elements to power supply (earth testing):

- A.C. earth test,
- D.C. earth test.

5. When to carry out earth tests

These tests are called for on many maintenance test plans.

Where these tests are required they will be shown on the test plans in capitalised italics.

Look at the example on maintenance test plan PW 02. (Figure 1.)

REPLACE A TRANSFORMER

Excludes: All track circuit feed equipment.

BEFORE INSTALLATION WORK

.....

2 *WIRE COUNT* existing transformer to the wiring diagram.

.....

AFTER INSTALLATION WORK

.....

9 *WIRE COUNT* replacement transformer to the wiring diagram.

.....

11 *EARTH TEST* supply and outputs.

3-001h

Figure 1 - Maintenance test plan PW 02

6. What the earth tests achieve

Without referring to the SMTH, in your words write down the purpose of each of the following tests and what they achieve:

- A.C. earth test,
- D.C. earth test.

Record your answers in the space below.

To find out if there is a potential (Earth) path for stray voltages to operate unenergized circuits

Refer to SMTH (GK/RT 0231) Part C, Appendices B5 and B6 and check you answer.

[redacted]

7. Suitable test instruments

What test instruments and equipment would you use for earth testing?

Make two lists. One for **suitable** and one for **non suitable** instruments and equipment.

Record your answers in the space below.

Suitable

Megger, PVM, AC Earth Tester, 150k Ω Shunt

ELD

Non suitable

Buzzer

Refer to SMTH (GK/RT 0231) Part C, Appendices B5 and B6 and check you answer.

8. How to carry out the earth tests

Earth Test (D.C. up to nominal 120V)

Refer to SMTH (GK/RT 0231) Part C, Appendix B5.

Connect the DC voltmeter as shown Figure 2 to test for an earth fault on the **negative** busbar.

Connect the DC voltmeter as shown Figure 3 to test for an earth fault on the **positive** busbar.

In both the tests DC busbar tests, a DC voltmeter connects one leg to a busbar and one leg to earth. If an earth fault is present, the it will be indicated by a reading on the meter.

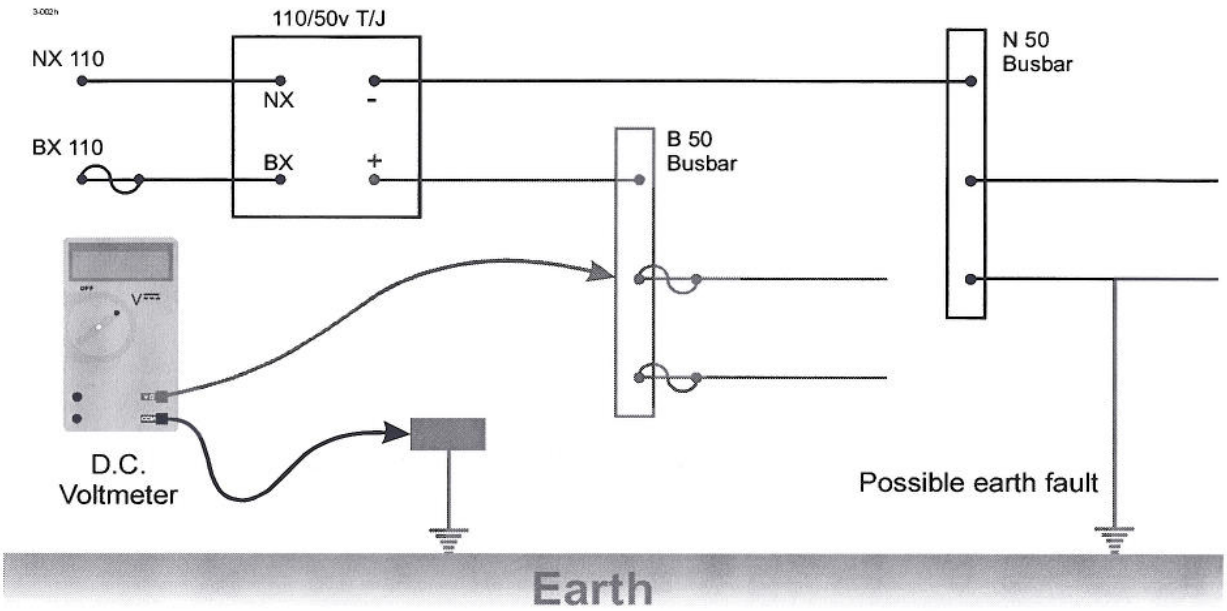


Figure 2 - Checking **negative** DC busbar for possible earth fault

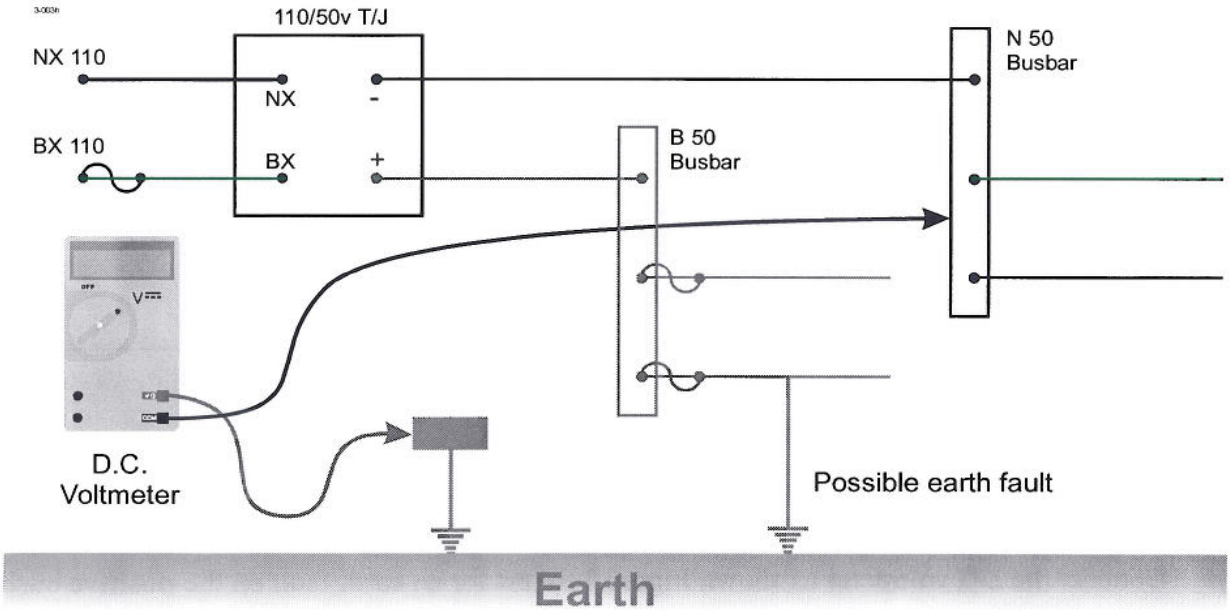


Figure 3- Checking **positive** DC busbar for possible earth fault

Earth Test (A.C. up to nominal 110V)

Refer to SMTH (GK/RT 0231) Part C, Appendix B6.

Figure 4 is basically the diagram shown in your handbook for the A.C. earth test. It also shows the secondary transformer winding for the A.C. supply.

The test is carried out using the A.C. busbar earth test adapter.

This test takes simultaneous values from both BX and NX busbars.

The A.C. earth test works by applying a D.C. voltage (9v battery in the A.C. busbar earth test adapter) to the BX busbar and earth. An earth fault will complete the circuit and a current will flow, causing a reading on the meter. Note in the case of the NX busbar the D.C. current (indicating an earth fault on the NX busbar) will flow via the secondary winding of the transformer.

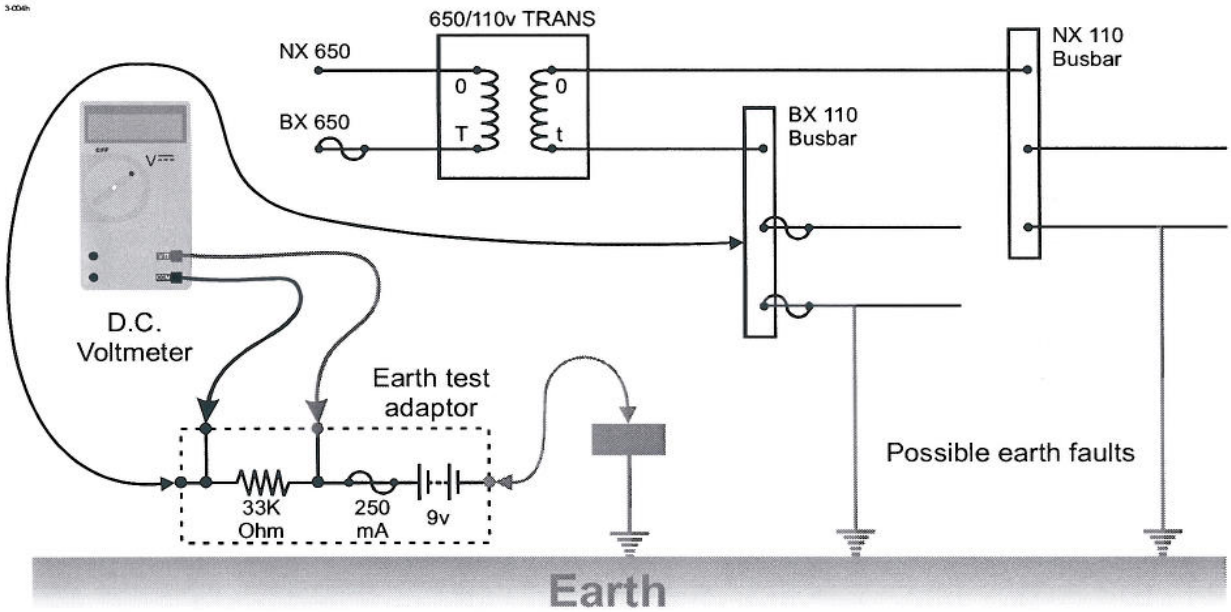


Figure 4- Checking AC busbars for possible earth faults

9. Acceptable and safety value readings

Each of the defined earth test has a table of acceptable and safety value readings.

Refer to SMTH (GK/RT 0231) Part C, Appendices B5 and B6.

Ensure you understand haw to apply these values.

10. Unacceptable readings

If an unacceptable reading or readings is found, then the handbook will direct you on how to proceed.

Refer to SMTH (GK/RT 0231) Part C, Appendices B5 and B6.

11. Exercise

Using your handbook check the readings in Figure 5 and Figure 6 and state the action you will take in each case.

Record your answers below.

i Record on test card

Example D.C. earth test readings

Busbar Voltage	V1	V2	V1 + V2
12v	0.8	0.9	1.7
12v	2.3	2.6	4.9
12v	0.7	1.4	2.1
12v	1.5	0	1.5
120v Point Machine (Internal)	12	12	24
	8	8	16
	3	4	7
120v Point Machine (External)	-	-	36
	-	-	7
50v Point Detection	-	-	17
	-	-	5

Figure 5 - Example D.C. earth test readings

Example A.C. earth test readings

VB	V1 + V2
9	18
8.6	3
8	12
9	1.25
8.2	7.38
9.1	17.6

Figure 6 - Example A.C. earth test readings

Signalling Maintenance Testing Course
Module 4 – Undertake Aspect Testing
Handout

1. Module 4 aim

Teach and assess the necessary knowledge and skills to

- undertake aspect testing.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 4 objectives

At the end of this module you will be able to:

- Explain the meaning of the following terminology associated with aspect testing:
  - correspondence
  - adequate sighting
  - extraneous lighting,
- Establish the identity and location of signals to be tested in given situations,
- Conduct aspect tests, demonstrating correct selection, connection and use of tools,
- State the requirements for personal safety relevant to aspect testing,
- Explain now to establish whether measured values and observed conditions are normal or acceptable,
- State when unacceptable or abnormal values and conditions need to be escalated by reporting and describe the reporting procedure,
- Establish the identity of the following errors, inconsistencies and ambiguities:
  - control relay correspondence
  - SSI telegram correspondence
  - signal box indication correspondence
  - lamp control circuit faults
  - signal sighting problems

  and describe appropriate remedial action for dealing with them,
- Describe how to complete the record of test for aspect testing.

4. When to carry out an aspect test

An aspect test is called for within many maintenance test plans.

Where these tests are required they will be shown on the test plans in capitalised italics.

Look at the example on maintenance test plan SG 01. (Figure 1.)

The aspect test is a starred test therefore, for example, when a cable is changed feeding a signal head, the maintenance test plan for the cable will call for the starred item(s) on the maintenance test plan for the signal head to be carried out.

REPLACE A SIGNAL HEAD

Includes: **Colour light, Position light, Junction indicator, stencil indicator, Theatre type indicator, All fibre optic signals.**

Excludes: **Searchlight, electro-mechanical banner.**

BEFORE INSTALLATION WORK

.....

3 *WIRE COUNT* existing signal head to the wiring diagram.

.....

AFTER INSTALLATION WORK

.....

11 *WIRE COUNT* replacement signal head to the wiring diagram.

.....

*20 *ASPECT TEST* signal.

.....

NOTE: Sighting forms, where provided include specific details on signal alignment and configuration.

4-001h

Figure 1 - Maintenance test plan SG 01

5. What the aspect test achieves

In your own words sate what the aspect test achieves.

Record your answer below.

Refer to SMTH (GK/RT 0231) Part C, Appendix B7 and check you answer.

6. Definition of terms

The aspect test refers to certain terms. In your own words write down the definition of each. Record your answer in the space below each definition.

Correspondence to control relay or telegram

Correspondence to repeat relay or telegram

Correspondence to signalbox indication

Adequate sighting

Extraneous lighting

Refer to SMTH (GK/RT 0231) Part B3 and check you answers.

7. How the aspect test is applied to typical signal circuitry

Apply the aspect test to 192 signal. Refer to SMTH (GK/RT 0231) Part C, Appendix B7 – Aspect test and work through the tests using Figure 2 and Figure 3. Assume that the signal head has been changed.

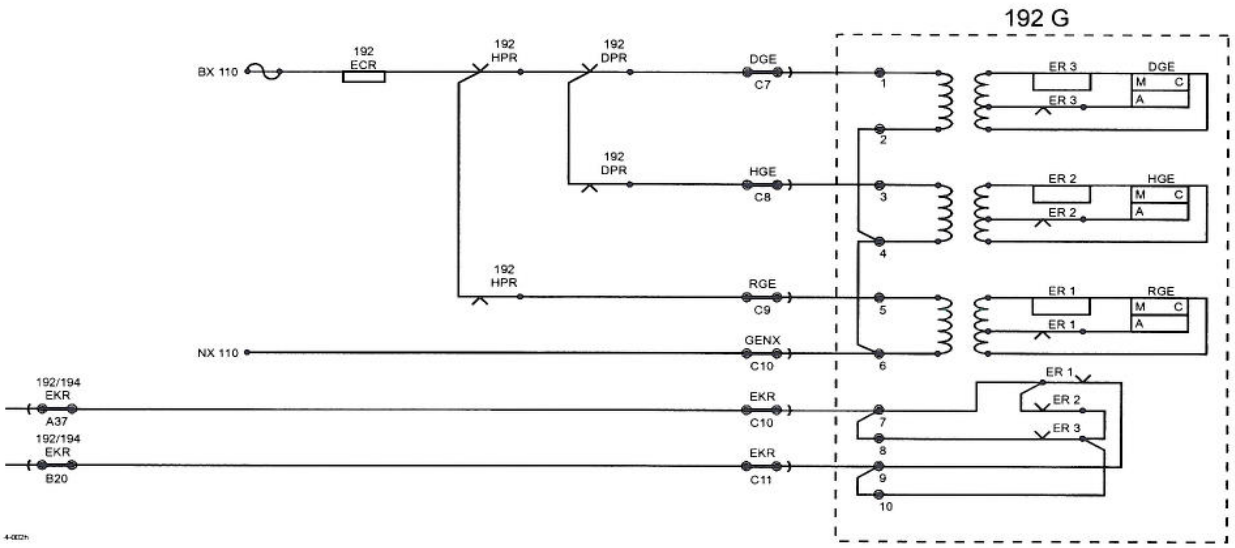


Figure 2 - Aspect circuitry

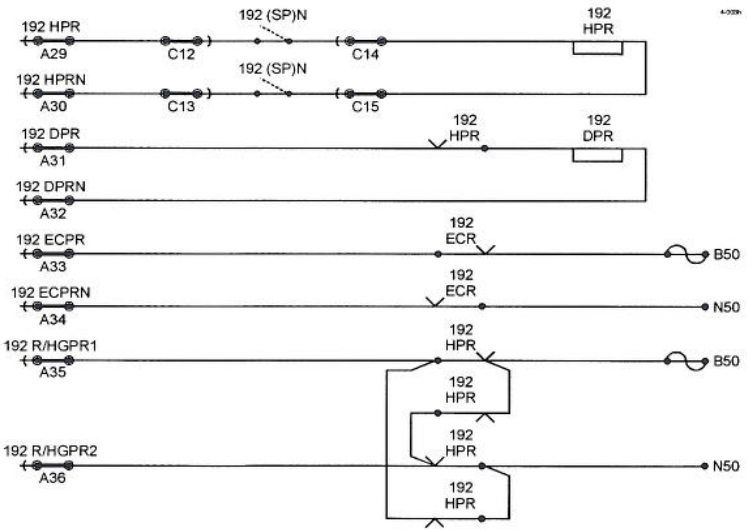


Figure 3 - Line circuits

8. Exercise

Study Figure 4 and Figure 5. Refer to SMTH (GK/RT 0231) Part C, Appendix B7 – Aspect test and write down the steps which will reveal the errors in the circuitry or equipment. Also write down how each error will show up e.g. no light.

Record your answer in the space below.

1 step 1

2 step ~~3~~ 4

Check your answers with your instructor.

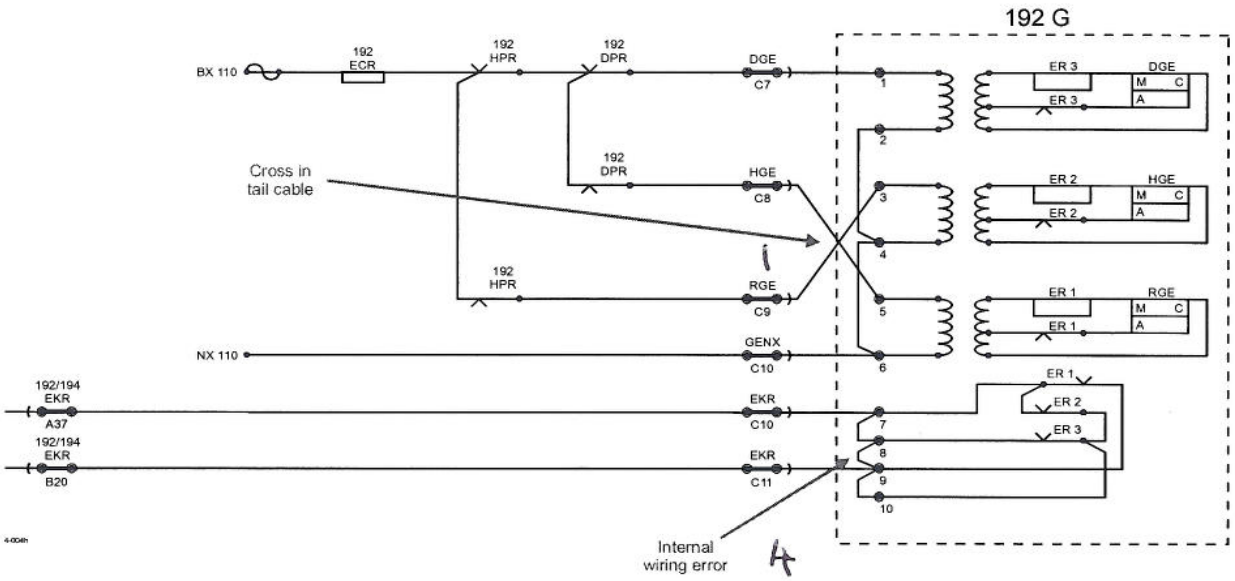


Figure 4 - Wiring errors

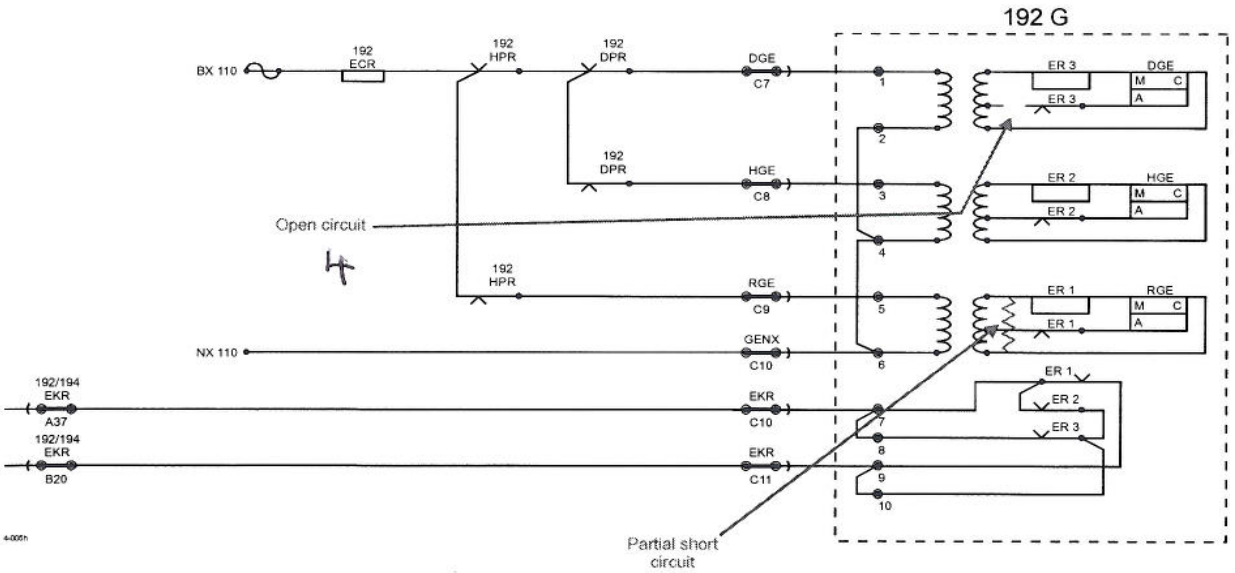


Figure 5 - Equipment errors

Signalling Maintenance Testing Course

Module 5 – Undertake Point Testing

Handout

1. Module 5 aim

Teach and assess the necessary knowledge and skills to

- undertake point testing.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 5 objectives

At the end of this module you will be able to:

- define the following SMTH terminology associated with point testing:
  - affected end
  - place
  - line
  - turnout
  - direction
  - lie of points,
- state the requirements and objectives for:
  - detection
  - correspondence and
  - out of correspondence tests,
- explain how to establish the identity and location of each end to be tested in given situations,
- state the number of times point detection contacts should be broken,

- conduct the following tests:
  - correspondence test
  - detection test
  - out of correspondence test

demonstrating the correct selection, connection and use of tools including the correct selection and use of a point permutation chart grid,

- state the requirements for personal safety relevant to:
  - correspondence test
  - detection test
  - out of correspondence test,
- explain how to establish whether measured values and observed conditions are normal or acceptable,
- state when unacceptable or abnormal values and conditions need to be escalated by reporting and describe the reporting procedure,
- establish the identity of the following errors, inconsistencies and ambiguities:
  - detection errors
  - correspondence errors

and describe appropriate remedial action for dealing with each,

- describe how to complete the record of test for point testing.

4. When to test

A point detection and correspondence test is called for within some maintenance test plans usually when control and detection circuitry has been disturbed.

Where these tests are required they will be shown on the test plans in capitalised italics.

Look at the example Maintenance Test Plan PC 01 shown in Figure 1.

5. Point tests

The point detection and correspondence test comprises three separate tests:

- correspondence test,
- detection test, and
- out of correspondence test.

What are your definitions of each of the tests?

Record your answers below.

1 To ensure ALL ends of points operated

Compare your answers to SMTH (GK/RT 0231) Part C, Appendix B8 - Point Detection and Correspondence Test.

REPLACE A COMPLETE POINT MACHINE

Includes: **Electric and electro-pneumatic point machines, Chair Locks, Separate A.C. point controller units.**

Excludes: **Clamp locks.**

BEFORE INSTALLATION WORK

.....

2 *WIRE COUNT* existing unit to the wiring diagram.

.....

AFTER INSTALLATION WORK

NOTE: Where any plug coupler is used check that no metallic dust exists between the two halves before reconnecting the plug couplers.

.....

10 *WIRE COUNT* replacement unit to the wiring diagram.

.....

15 Test (gauge) point detection [(SMS)] **(CHAIR LOCKS, ELECTRIC AND ELECTRO-PNEUMATIC POINT MACHINES ONLY)**.

16 Test facing point lock [Facing point lock test (SMS)] **(CHAIR LOCKS, ELECTRIC AND ELECTRO-PNEUMATIC POINT MACHINES ONLY)**.

*17 *POINT DETECTION TEST AND CORRESPONDENCE TEST* affected ends.

NOTE: Separate A.C. pont controller units must be treated as a separate affected end for correspondence and detection tests.

5-016h

Figure 1 - Maintenance test plan PC 01

6. Point permutation grids

These grids should be used in conjunction with the defined test once you have decided the affected ends etc. (Affected ends are defined later.)

These are provided in your handbook as tick sheets.

A completed example of a tick sheet is shown in SMTH (GK/RT 0231) Part C, Appendix B8 - point detection and correspondence test.

These grids are used in conjunction with the out of correspondence test.

You will always start by normalising all ends of points and then for each step in the permutation grid you will carry out the checks in steps 2 to 6 of the defined test.

Step seven tells you to move on to the next step in the permutation grid, and again carry out the checks in 2 to 6 of the defined test.

As you can see you will carry out steps 2 to 6 for each step in the permutation grid.

It is straight forward if you take your time and use the permutation grid.

Figure 2 below shows example of point permutation grids.

	END 1	
No.		TICK
1	0	

	END 1	END 2	
No.			TICK
1	0	0	
2	0	1	
3	1	0	

	END 1	END 2	END 3	
No.				TICK
1	0	0	0	
2	0	0	1	
3	0	1	0	
4	0	1	1	
5	1	0	0	
6	1	0	1	
7	1	1	0	

5-004h

Figure 2 - Point permutation grids 1 - 3 ends

7. Definition of terms

The point detection and correspondence test uses certain terms that you must understand in order that you may carry out the test properly.

Place

This is the actual place where the work is carried out. For example, in Figure 3 the actual place where the work is carried out is Rudheath Junction.

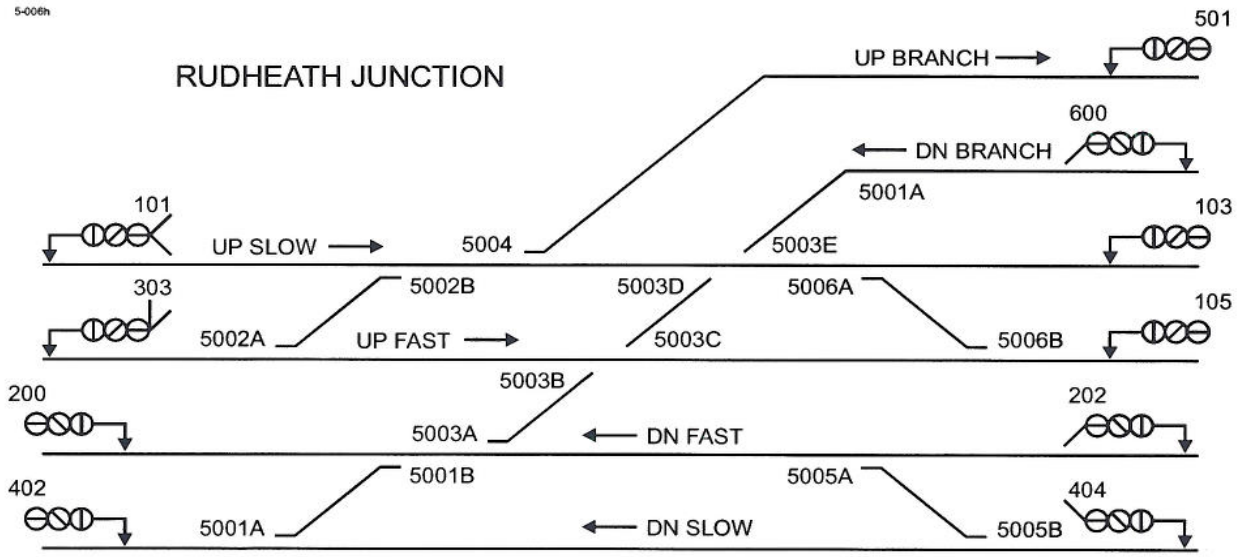


Figure 3 - Complex layout of points

Line

If you were working on 5005A points the line you would be on is the down fast.

What line would you be working on if you was working on the other points?

Record your answer below for each end.

Turnout direction

Consider 5004 points. The straight route through the points in the facing direction will take the train along the up slow. Therefore, the turnout direction will be through the points in a facing direction will take the train along the up branch. In this case for 5004 points the turnout direction can be described as 'to the left onto the up branch'.

How will you describe the turnout direction for the other points?

Record your answer below for each end.

Lie of points

This is described as left hand switch normally Closed (LHSNC) or right hand switch normally Closed (RHSNC) This is illustrated in Figure 4 and Figure 5.

To determine this, first, look at the points when they are in the normal position, second, check which switch blade is closed, whichever that is, is the normally closed switch.

Points are shown on the layout or track plan in the normal position, this is indicated by a continuous line; the broken line shows the reverse direction.

Reporting the position of the points

When reporting the position of points it is essential that you do not lead the person you are reporting to.

Therefore, you should use the terms left hand switch closed and right hand switch closed. Don't forget to face the toe of the points when viewing the switch blades.

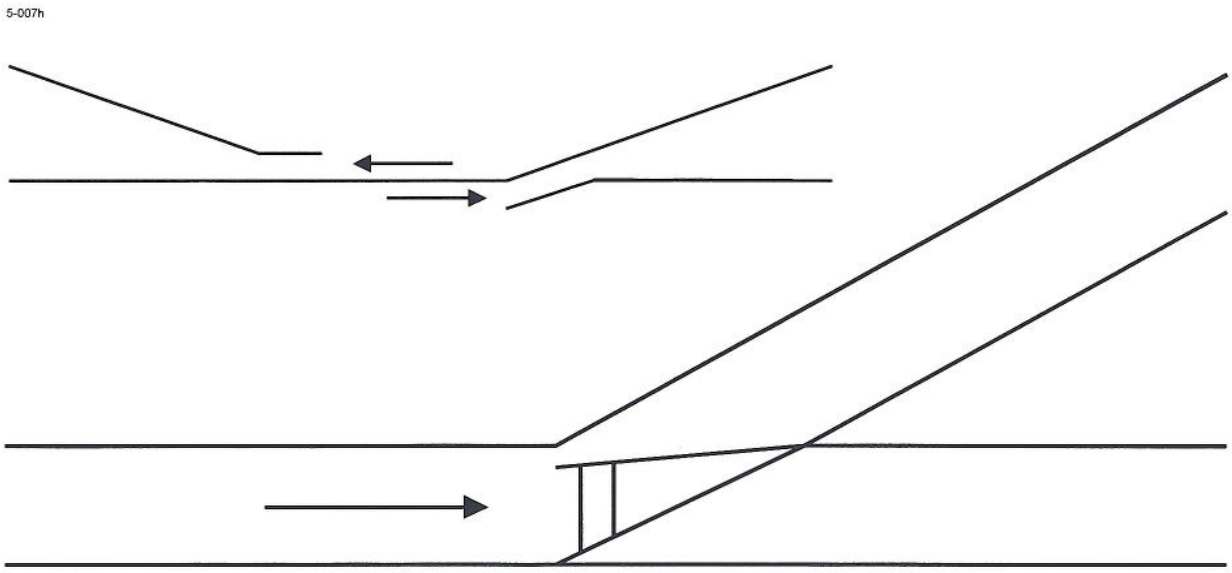


Figure 4 - Right hand switch normally closed

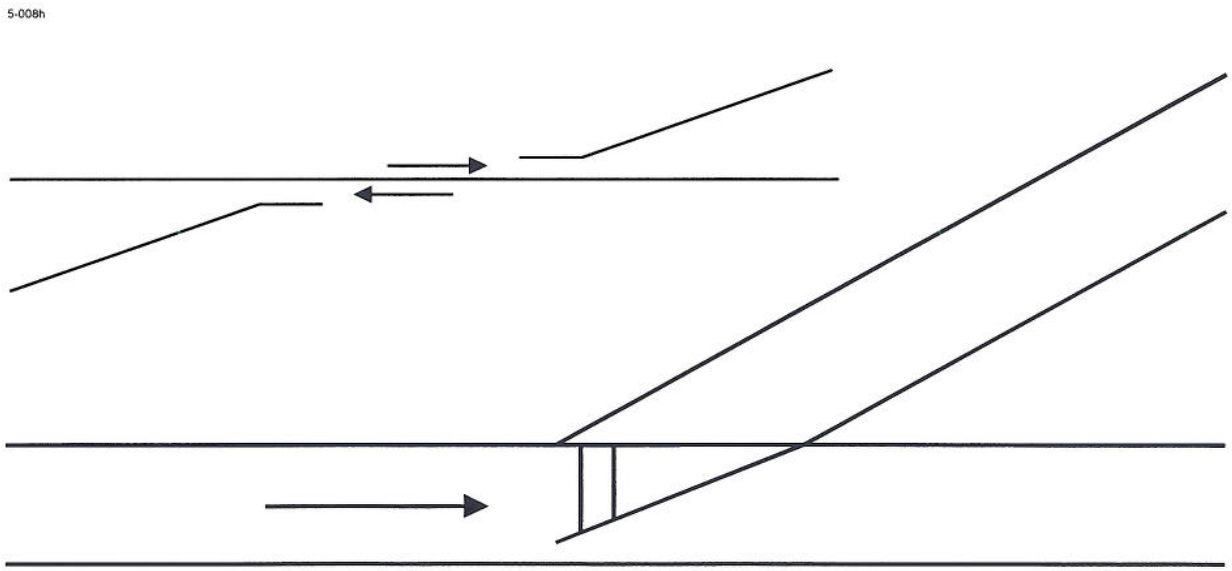


Figure 5 - Left hand switch normally closed

8. Affected end

When testing points it is essential you know what ends of points you should test. In order to determine this, you must understand the term 'affected end'.

Refer to SMTH (GK/RT 0231) Part C, Appendix B8 - Point Detection and Correspondence Test.

Study Figure 6 and Figure 7.

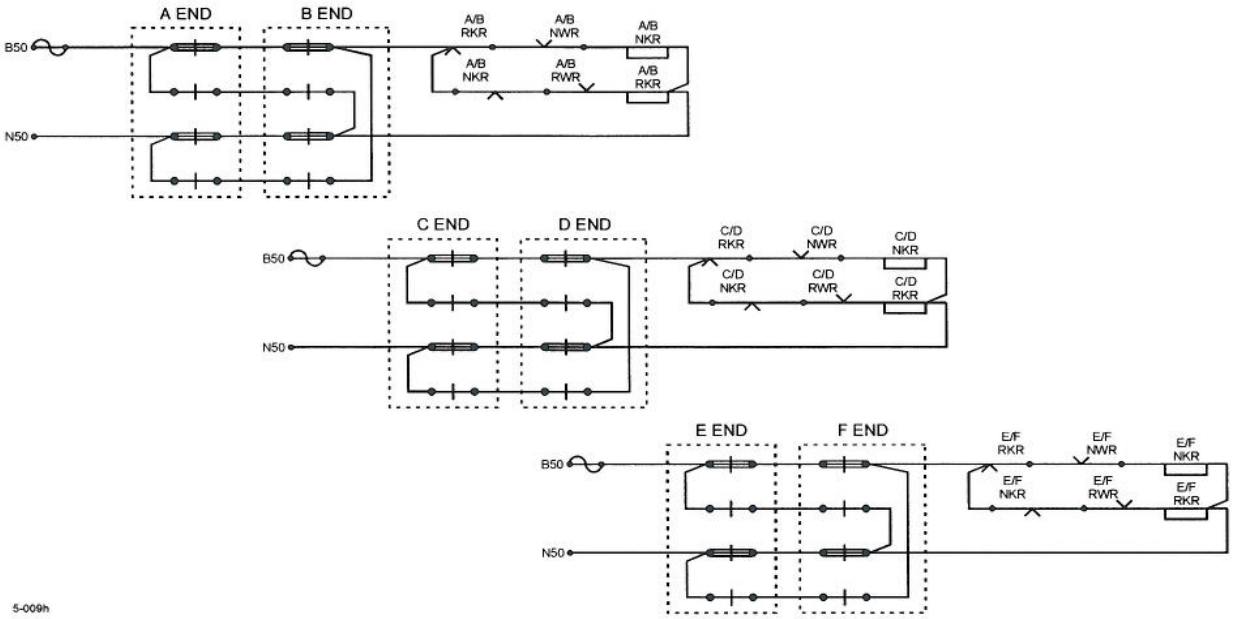


Figure 6 - Split detection

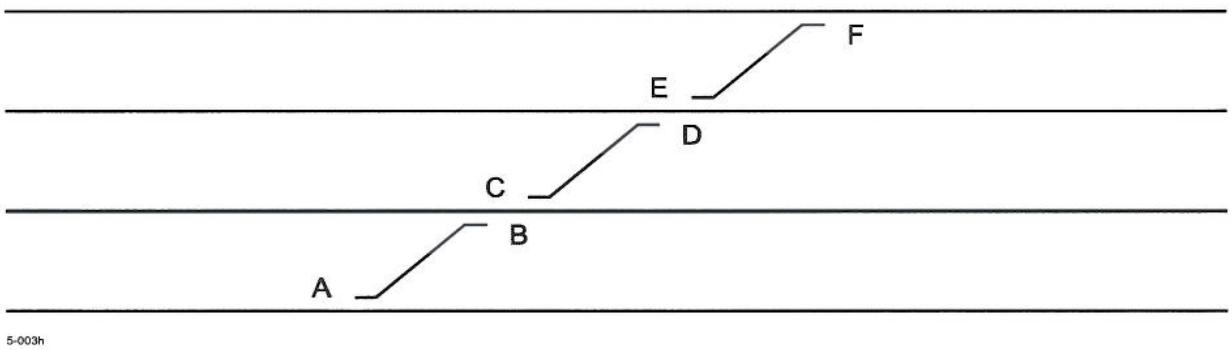


Figure 7 - 6 ended point layout

For the following examples write down:

- the affected,
- the ends that require testing, and
- the tests carried out,

for each of the following scenarios.

1 Point machine on A end has been renewed.

2 Detection cable between C and D ends has been renewed.

3 2 core cable between B & N supply to E end.

Record your answers on the next page.

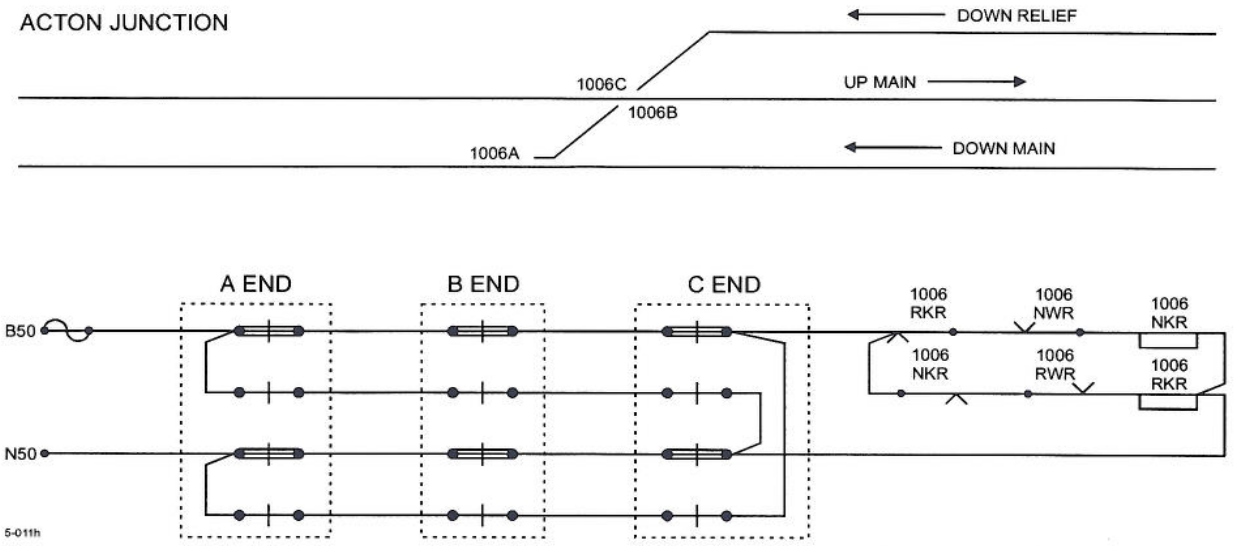


Figure 8 - 3 ended detection circuit

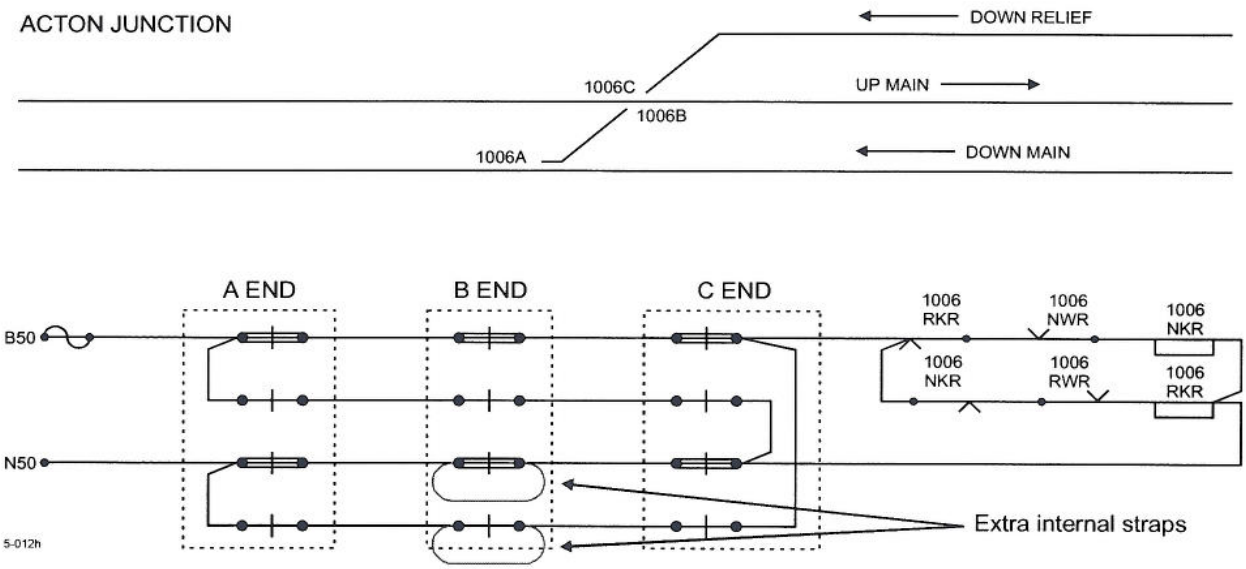


Figure 9 - Equipment error 1

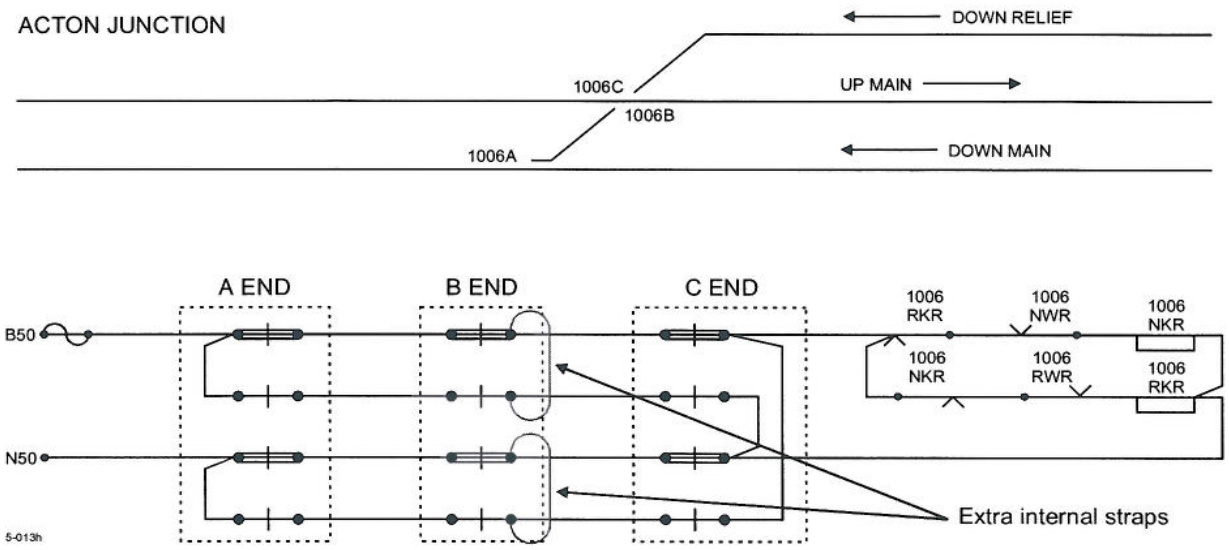


Figure 10 - Equipment error 2

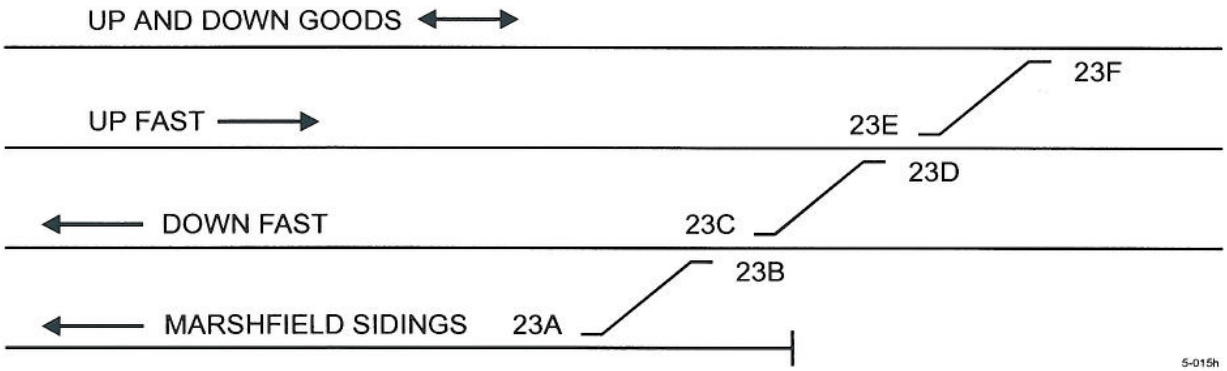


Figure 11 - 6 ended point layout

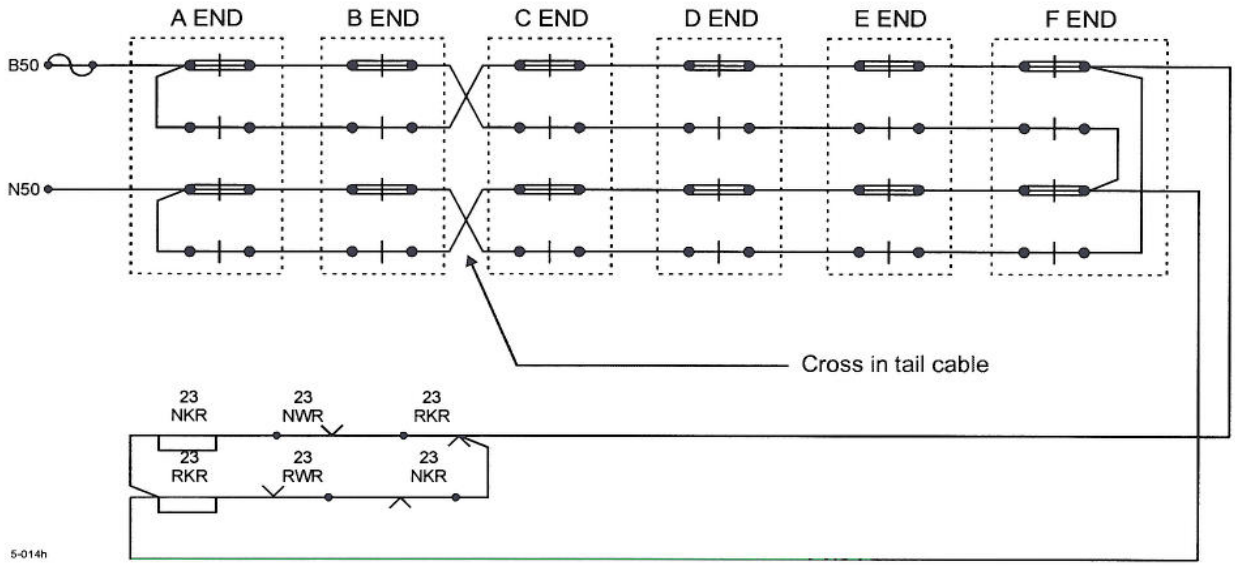


Figure 12 - Cabling error 1

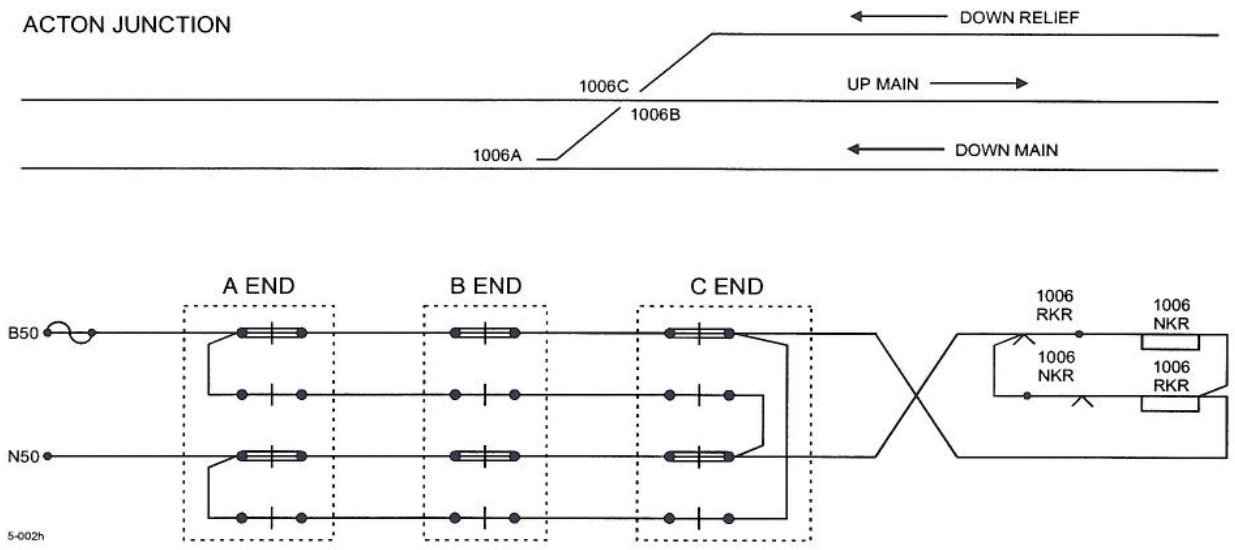


Figure 13 - Cabling error 2

Signalling Maintenance Testing Course

Module 6 – Undertake Block Testing

Handout

1. Module 6 aim

Teach and assess the necessary knowledge and skills to

- undertake block testing.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 6 objectives

At the end of this module you will be able to:

- define the following terminology:
  - home normal proving
  - distant on proving
  - compulsory train on line
  - one acceptance block
  - line clear release
  - berth track,
- state the requirements and objectives of each of the following tests:
  - absolute block controls test
  - tokenless block controls tests (BRB, open/sealed cancel, and direction lever types)
  - token and tablet block controls tests
  - no-signalman key token block controls test
  - absolute block recovery test
  - tokenless co-operative cancel test (direction lever type),
- explain how to establish the identity and location of the block system equipment to be tested in given situations,
- select the correct defined test and carry out block testing on given systems,
- explain how to establish whether observed conditions are normal or acceptable,
- state when unacceptable or abnormal conditions need to be escalated by reporting and describe the reporting procedure,

- establish the identity of errors, inconsistencies and ambiguities and describe appropriate remedial action for dealing with them,
- describe how to complete the record of test for block testing.

4. Operation of the 3 position block

The standard block instrument is of the three position type.

Indications being:

- line clear,
- normal,
- train on line.

The block indicator works on the change of polarity principal. Positive to line gives train on line (T.O.L.), negative to line gives line clear (L.C.). With no voltage to line the indicator stands at line blocked (normal) (Figure 2).

Figure 1 shows a typical 3 position block arrangement. In this case Signalbox A controls a section of line known as the:

- block section.

The block section extends from the starting signal of Signalbox B to the home signal of Signalbox A. The entrance to the block section is controlled by Box A.

This means that before a train can enter the block section, the starting signal has to be released by Box A by giving Box B a line clear.

So in principle, by using the polarity changing circuit as in Figure 2 indications can be given to the signalbox in rear as to the state of the line.

For example:

- normal (NOR) - no train in section or accepted,
- line clear (LC) - able to accept a train, or
- train on line (TOL) - train in section.

The principle behind absolute block is that:

- at any one time, only one train is allowed to enter a block section.

Essentially this stops trains running into the back of one another.

By inspection of the circuitry in Figure 2 to achieve this, certain other features need to be included.

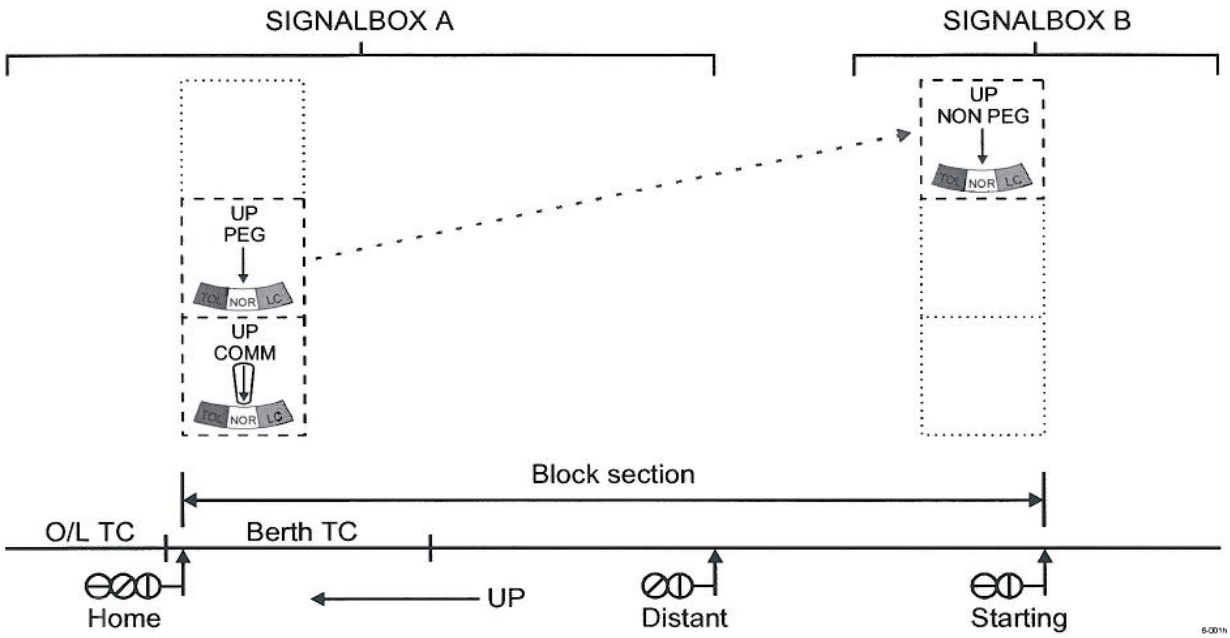


Figure 1 - 3 position block

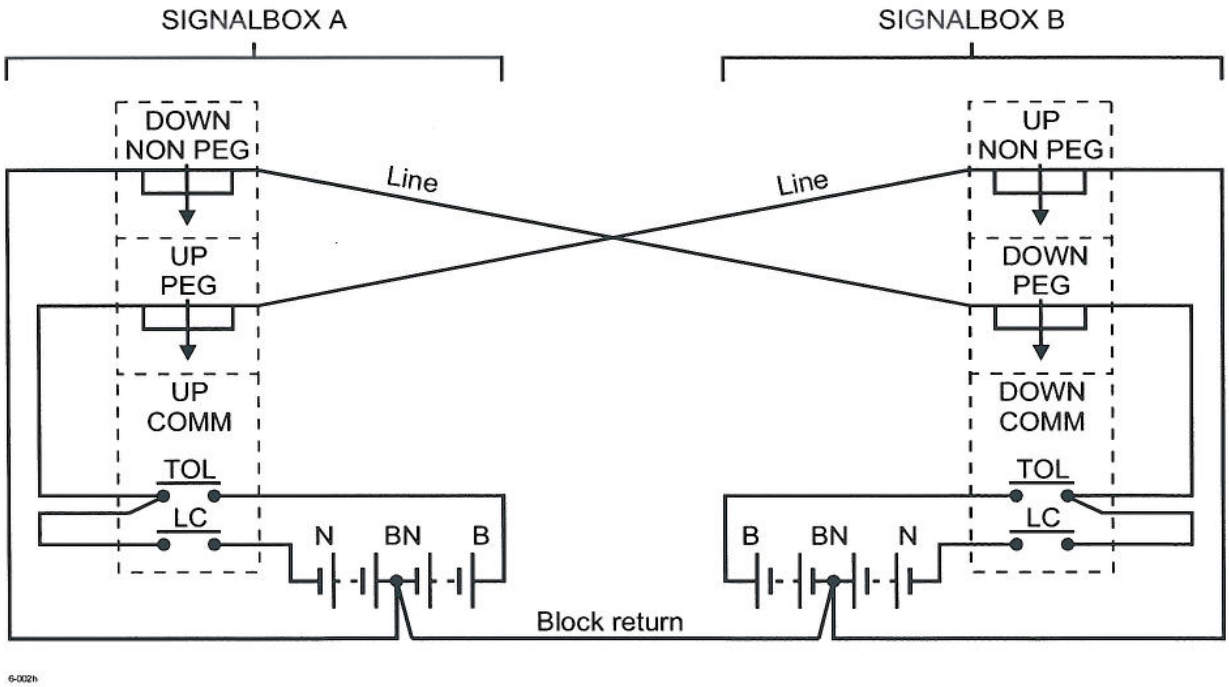


Figure 2 - 3 position block - basic line circuits

5. Block controls

In Figure 3 it can be seen that two extra controls have been added in the line clear path of the basic block circuitry.

These are:

- home normal proving ensures home signal levers are normal before a line clear can be given,
- distant on proving ensures the distant signal is on before line clear can be given.

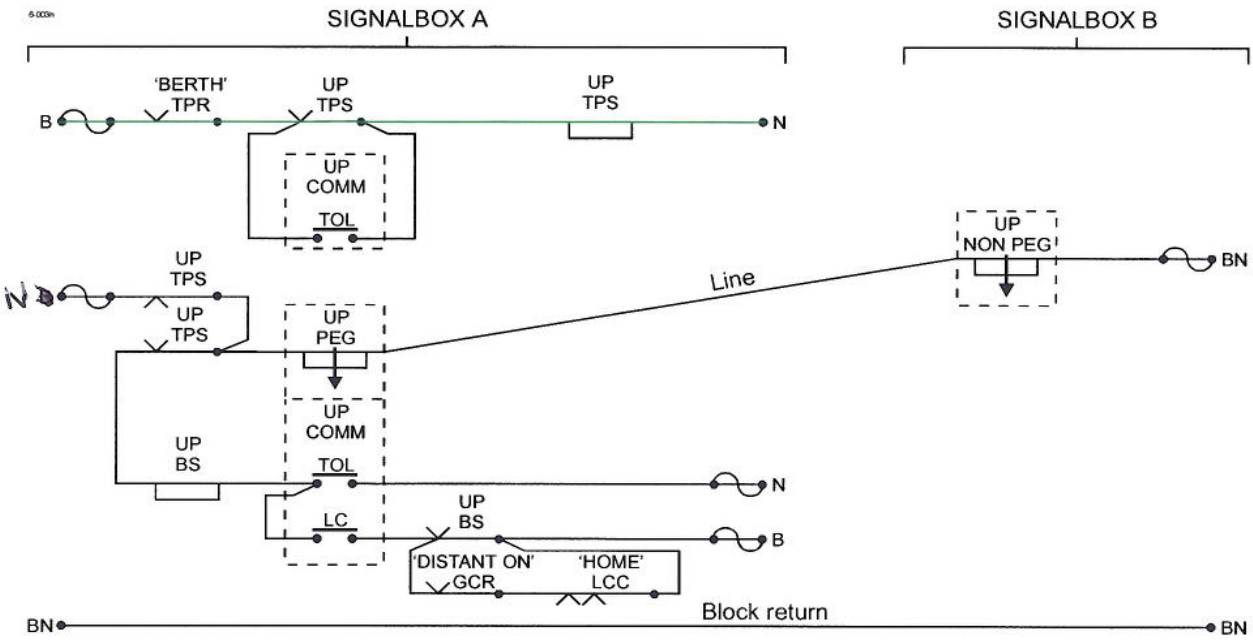


Figure 3 - 3 position block - other control circuits

The BS or block stick relay allows the home and distant signals to be pulled off (breaking the 'DISTANT ON' GCR and the 'HOME' LCC contacts) while maintaining the line clear.

6. Compulsory train on line

Another feature shown in Figure 3 is:

- compulsory train on line.

This will set the block to train on line when a train arrives at the berth track circuit to the home signal when the block instrument is still pegged at line clear.

This feature is achieved by a front contact of the 'BERTH' TPR breaking and de-energising the TPS.

When the compulsory train on line feature has operated, the block can only be restored to normal or pegged to line clear again, by first turning the commutator to train on line after the berth track circuit has cleared.

7. One acceptance block

Figure 4 details a further addition to the block system already discussed. Extra circuitry only allows one line clear to be given. If a line clear is given by mistake or not required and the commutator is turned back normal, or train on line, a second line clear cannot be given. Obviously, this could be very restrictive if the line clear was cancelled for genuine reasons. To overcome this a time release is provided. The essential feature of this, is that while the signaller is waiting for the release, it allows time to think why the line clear was cancelled in the first place. Is there a train already in section?

However, if a line clear is given and a train legitimately passes through the section, the system will reset and a second line clear can be given.

This feature is known as:

- one acceptance block, or
- welwyn control.

Figure 7 summarises the operation of this system.

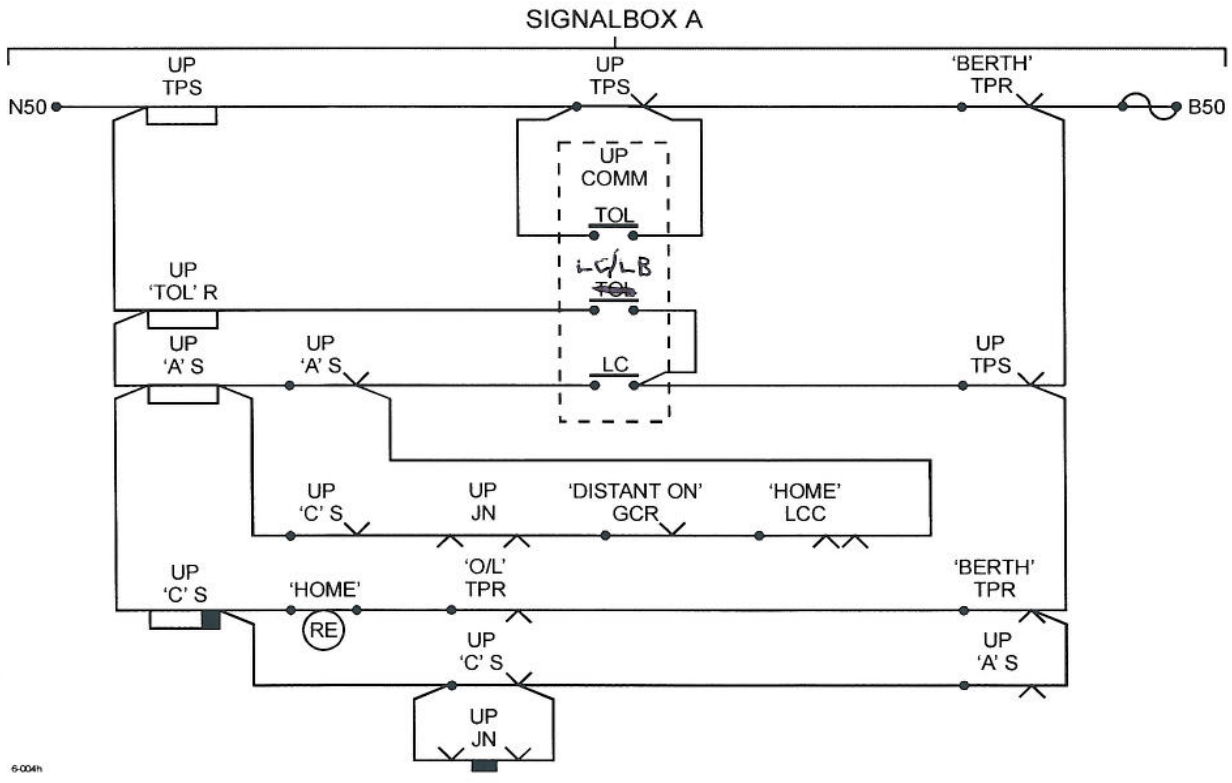


Figure 4 - One acceptance block

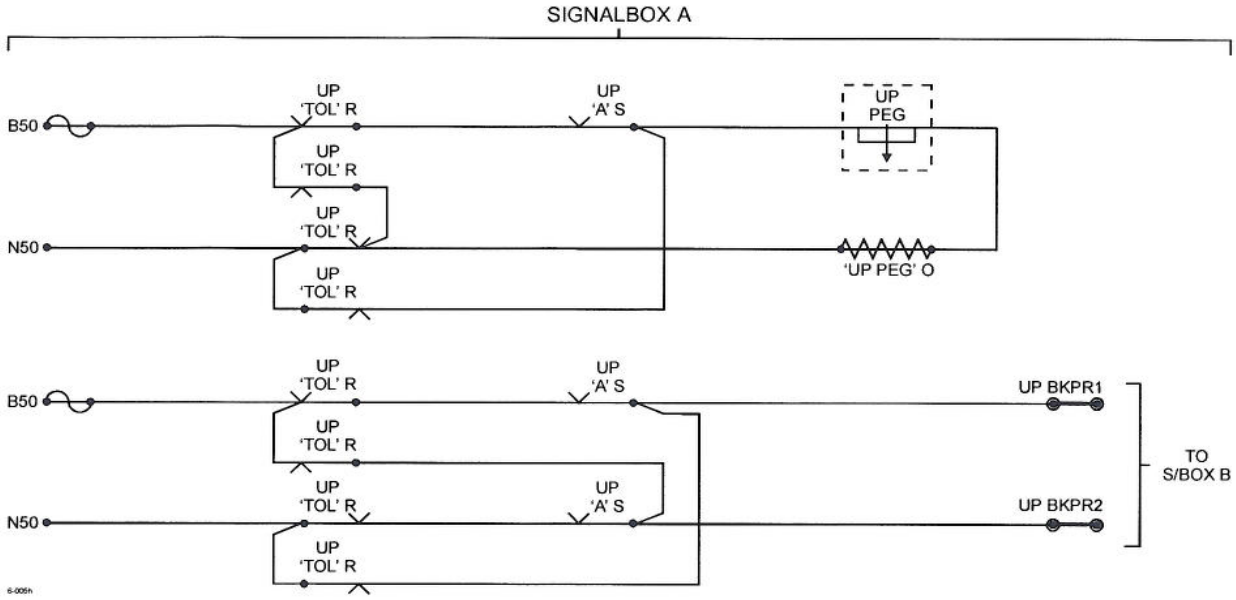


Figure 5 - Line circuits - sending box

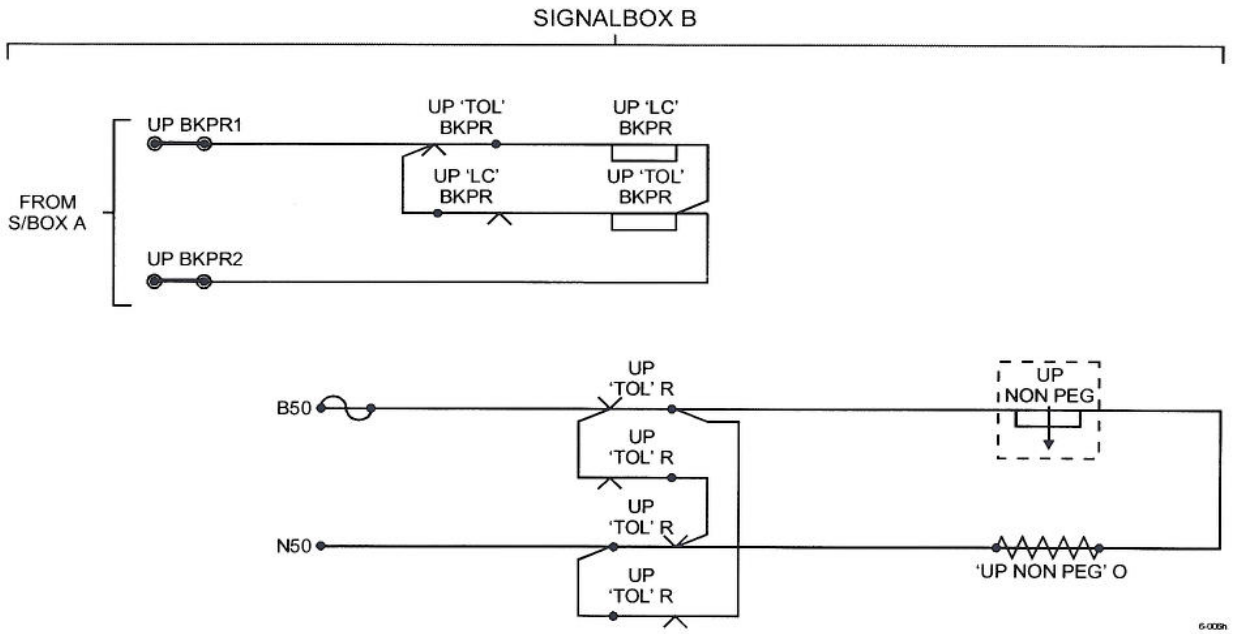


Figure 6 - Line circuits - receiving box

Figure 5 above details the local indicator circuitry and the line circuitry feeding out to the receiving signalbox. You will see that these are pole changing circuits which are self explanatory.

Figure 6 above details the indicator and line circuitry at the receiving signalbox. Again these are pole changing circuits which are self explanatory.

	Action/state	Relays Drop	Relays Pick	Line Voltage
1.	Line blocked.	A	C TPR TPS	0
2.	Line clear pegged, home lever normal and distant signal on.	C	A	+VE (LC)
3.	Home and distant signals pulled off.			
4.	Train on line pegged.	A		-VE (TOL)
5.	Train arrives (TPS will send TOL if not pegged at step 4). If home lever is not reversed C relay will not pick up.	TPR TPS		
6.	Train passes.		TPR	
7.	Distant and home signals restored to on position. (only if TOL is pegged)		TPS	
8.	Commutator is restored to normal.			

Figure 7 - Operation of the one acceptance block

8. Block release timer

As mentioned earlier a time release is provided to restore the block if a line clear has been given by mistake, or a train is cancelled.

The timer allows C relay to pick. This may take the form of a winding mechanism or a button to operate a timing sequence.

9. Line clear release

The circuit in Figure 8 shows another feature of block circuitry the 'one line clear one pull'.

In this circuit the starting lever release is controlled by the starting BS and the Up 'LC' BKR. The Up 'LC' BKR proves the block circuit in the Line Clear Position, the BS provides the 'one pull only' feature.

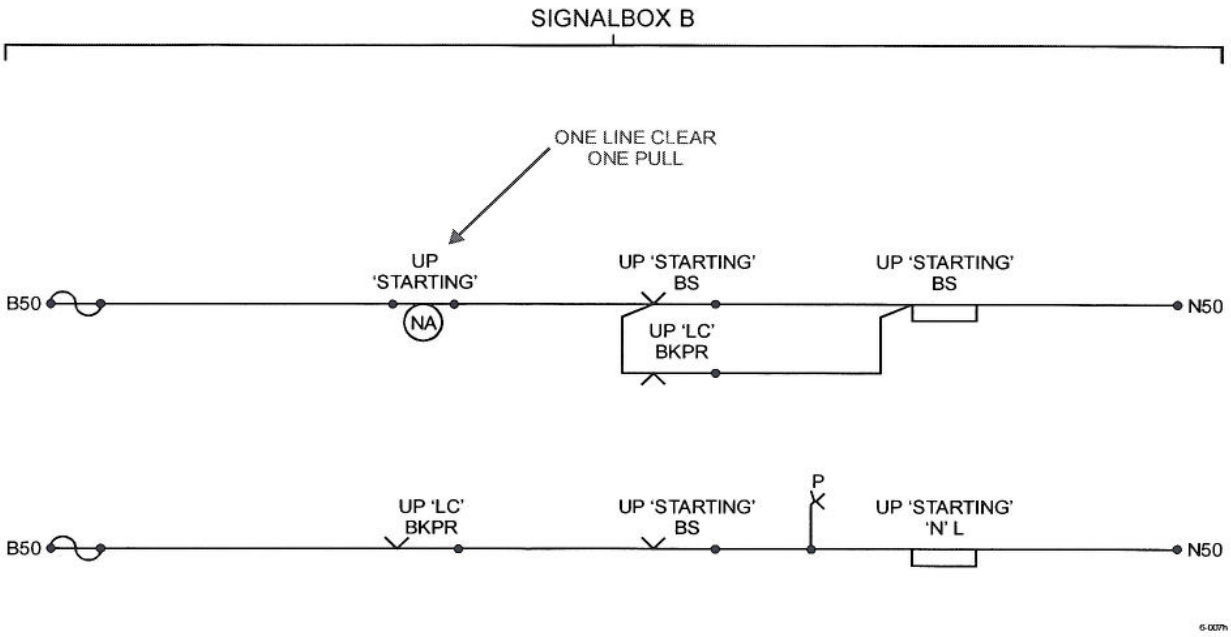


Figure 8 - Line clear release

10. Block tests

There are two basic elements to block testing:

- block controls test,
- emergency block recovery test.

These tests will be called for within a test plan as shown in Figure 9 and will be in capitalised italics.

11. Block controls test

This test will be called for, when for example, a block instrument or block switch has been changed (this only applies to absolute block).

Refer to SMTH (GK/RT 0231) Part C Appendices B9 – B15.

12. Emergency block recovery test

This test will be called for when, for example, a block winder is changed.

It can also be used to restore one acceptance block following the replacement of a block instrument, for example, in conjunction with a block controls test.

Refer to SMTH (GK/RT 0231) Part C Appendices B16.

REPLACE A BLOCK INSTRUMENT

Includes: **Tokenless Block, Block Bell.**

Excludes: **Token, Tablet, Staff, No-signalman key token, Intermediate token, Auxiliary and control instruments.**

NOTE: For the purpose of any wire labelling the block indtrument should be viewed from the rear.

BEFORE INSTALLATION WORK

.....

4 *WIRE COUNT* existing block instrument to the wiring diagram.

.....

AFTER INSTALLATION WORK

.....

11 *WIRE COUNT* replacement block instrument to the wiring diagram.

.....

*15 *BLOCK CONTROLS TEST* equipment **(NOT PERMISSIVE (FREE BLOCK) OR NON INTEGRAL BLOCK BELL).**

*16 *BLOCK RECOVERY TEST* equipment **(NOT PERMISSIVE (FREE BLOCK) OR NON INTEGRAL BLOCK BELL).**

6-008h

Figure 9 - Maintenance test plan BL 01

13. Purpose of the tests

The block controls test ensures:

- the correct operation of all absolute block equipment.

The block recovery test ensures:

- the block restoration circuitry is effective.

14. Exercise

Study Figure 10 and Figure 11. Using your handbook determine which tests and steps will find the errors.

Record your answer below.

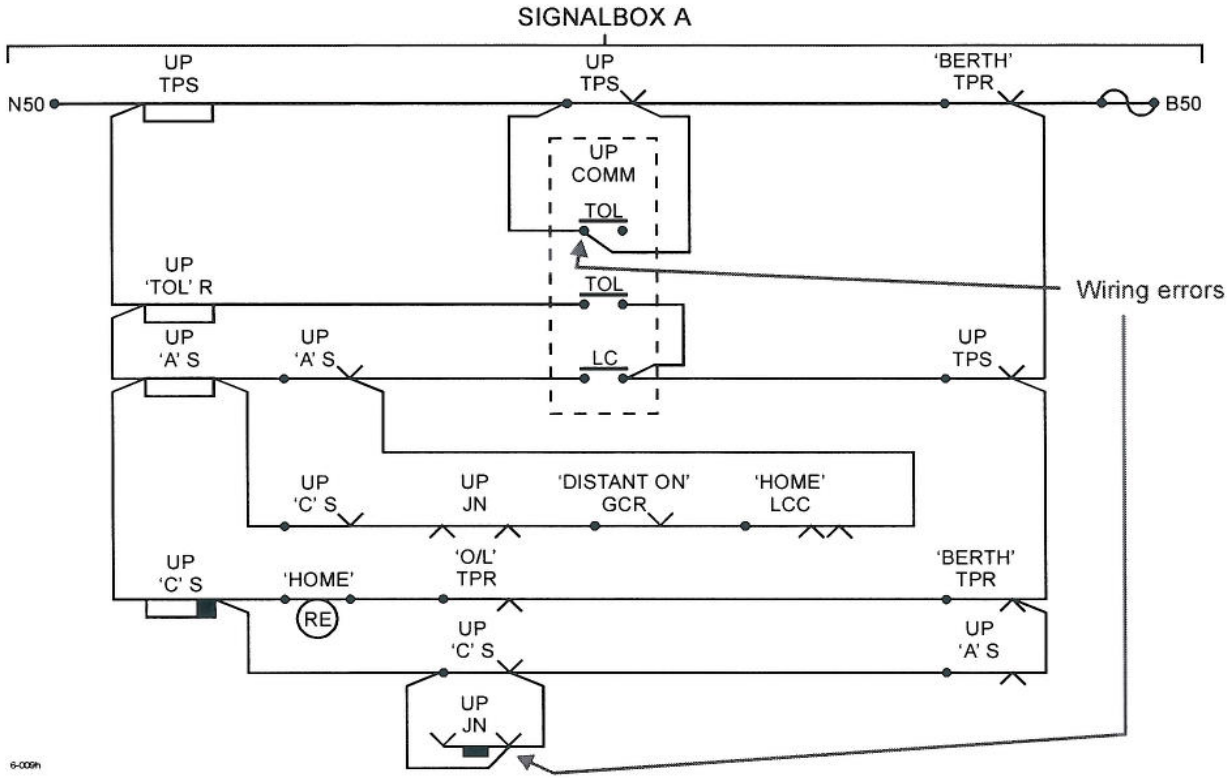


Figure 10 - Wiring errors

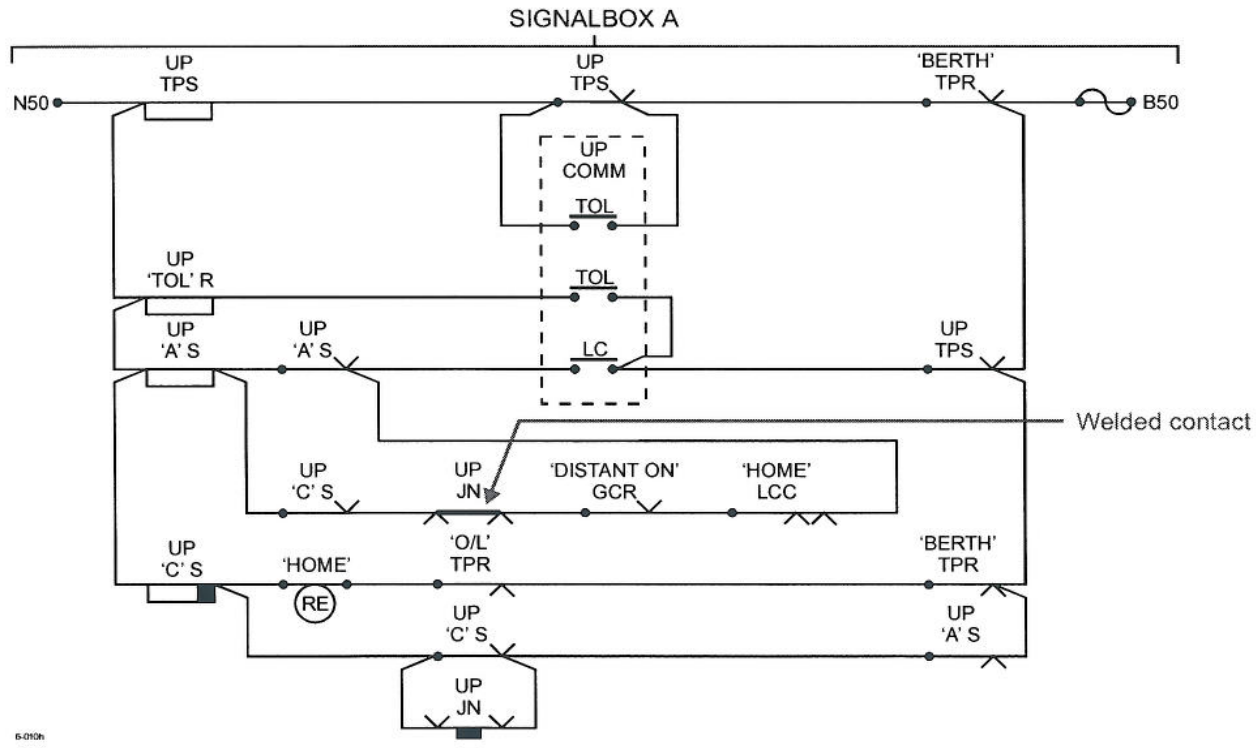


Figure 11 - Equipment error

15. Other block control equipment

It should be noted that these notes have dealt with one particular type of block control equipment. Namely:

absolute block.

You should be aware that there are many other types of block control especially that controlling single line sections. This is reflected by the number of block controls tests.

Signalling Maintenance Testing Course

Module 7 – Produce a New Maintenance Test Plan

Handout

1. Module 7 aims

To teach the necessary knowledge to:

- explain how to produce a new maintenance test plan.

Assess the production of a new maintenance test plan.

2. Pre-requisite

In the case of this module successful completion of module 1 - Implement Core Testing Skills During Signal Maintenance is a pre-requisite.

3. Module 7 objectives

At the end of this module you will be able to:

1. Explain when it may be necessary to produce a new maintenance test plan.
2. State the criteria for selecting the most suitable test plan to use as a basis for writing the new one in given circumstances.
3. Explain how to determine checks, defined checks and defined tests for the work.
4. Explain how to determine the sufficiency of a plan to assure the safe working of equipment.
5. State the criteria for the structure, format and title of a test plan.
6. Describe the SMT procedures for producing, checking and agreeing a test plan.
7. Describe the procedure for lodging a new plan after use.
8. Explain the procedure for dealing with uncertainty about the testing required and the validity of tests.

4. Exercise

This is an exercise where you will carry out a little research into the SMTH and subsequently deliver micro training sessions on each of the objectives above.

You will be split into eight groups/individuals and each allocated an objective. If there is less than eight delegates, then more than one objective will be assigned to a group/individual.

You are allowed 15 minutes to put together a micro training session to address your objective(s).

The answers need to refer to a SMTH reference with a possible short explanation.

You will then be required to deliver a short training session which should last no more than 2-3 minutes.

5. Answers

1. This is detailed in SMTH Part B5.3 – Testing where no maintenance test plan exists.

   The same procedure applies missing equipment test plans.

2. A statement in SMTH Part B, Appendix B2 Maintenance Test Plans states that new plans shall be produced using the appropriate existing as a guide.

   There is no laid down criteria as how to select the most appropriate existing plan. However, this should be a matter of common sense. It would be ridiculous, for example, to select a test plan for track circuit equipment when producing a new test plan for point equipment.

   Reference should also be made to SMTH Part B, Appendix B3 Missing Equipment Test Plans

3. The new test plan should contain all the relevant defined checks and tests from the appropriate existing test plan. Additional checks and tests shall be added as required.

   SMTH Part B, Appendix C2 – Defined Checks and SMTH Part B, Appendix C3 – Defined Tests will give guidance to the range of checks and tests used in the SMTH.

   Reference should also be made to SMTH Part B3 – Definitions.

   SMS checks and tests shall be added if required.

4. This should be satisfied by completion of items 3 and 6. However, all steps shall be taken to ensure nothing is missed in the new plan. There shall be no doubt by anyone involved in writing and checking it.

5. This is easy, it should follow the same format as any other test plan in the SMTH. Importantly it should have a unique title, exemptions, and before and after installation work steps.

6. This is detailed in SMTH Part B5.3 – Testing where no maintenance test plan exists.

   A new maintenance test plan shall be produced by a maintenance tester.

   Before use the new test plan should be checked by a maintenance tester not involved in writing it. Normally this will be undertaken on site with reference to the equipment concerned.

   If there is any doubt as to the testing required, the local manager shall be contacted.

7. This is detailed in SMTH Part B5.3 – Testing where no maintenance test plan exists.

   The local manager shall notify the infrastructure controller who in turn shall notify Railtrack

8. This is detailed in SMTH Part B5.3 – Testing where no maintenance test plan exists.

   The local manager shall be contacted.

   On completion of the testing the local manager shall arrange for the equipment to be re-tested if the test plan is considered to be deficient.

Signalling Maintenance Testing Course
Module 9 - Undertake Diversion of a Circuit
Handout

1. Module aim

Teach and assess the necessary knowledge and skills to

- undertake the diversion of a circuit.

2. Module objectives

After completion of this training module you will be able to:

- State the requirement for the identification and labelling of existing wiring that is diverted.
- State the requirement for securing and insulating isolated wiring.
- Explain how to ensure that only one cable and no intermediate controls are bypassed when alternative cable cores are to be used in a diversion.
- Describe how to achieve diversion of a circuit in the following:
  - Faulty cable core within a cable
  - Faulty cable to another cable.
- State what action to take when deferral of full testing is required.
- Describe how and when to make amendments to location diagrams, wiring plans/diagrams and circuit diagrams.

3. Who should attend this course?

Staff who are certified competent (or are currently undergoing training) in core testing procedures and require the necessary skills to undertake the diversion of a circuit should attend this course.

4. Source material

Part of the source material for this document has been derived from the Trainer Resource Material for Signalling Maintenance Testing produced in 1997 by WS Atkins Rail Limited.

5. Case study 1
Diversion of a circuit in a faulty core

You are called to attend a fault at Brightside South. The Signaller says that trains are being unnecessarily checked by a cautionary aspect at Signal 321 when it should be showing clear. Signal 321 is an automatic signal with the controlling relays in Location 11. On investigation, you discover the following state of affairs:

There is a fault in 321HHR circuit that is causing it to remain permanently de-energised. The circuit starts at Location 14, where your measurements indicate the correct voltage being fed out towards Location 11. However, you can detect no voltage being received at Location 11.

Please refer to Figure 1 and Figure 4.

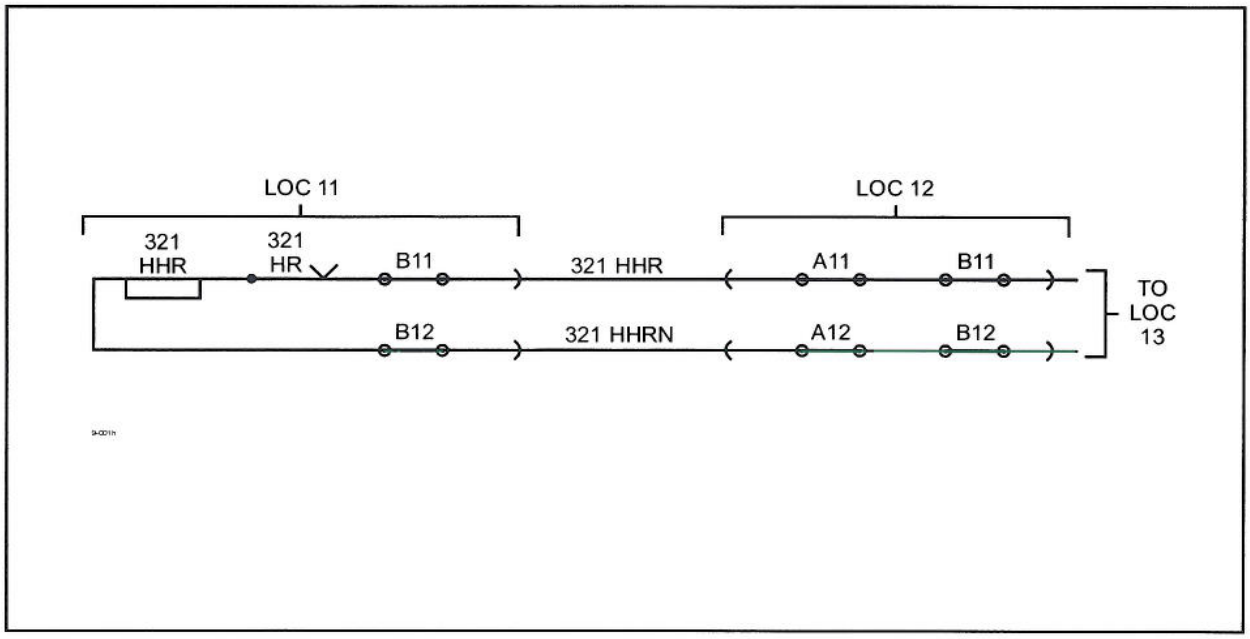


Figure 1 - Extract from Brightside South through circuits schematic

Q1 *What further tests should be carried out?*

Q1 Answer

In the case of a suspected cable fault you must identify exactly which cable is faulty. 321HHR circuit goes from Location 14 to Location 11 via a series of three cables. The problem could lie in any one of these. Alternatively, there might be a problem with the through-jumpering of the circuit at Locations 12 or 13.

With the circuit disconnected at the relay end (links B11 and B12 in Location 11 slipped) you need to carry out a series of voltage tests to establish the position of the fault more precisely. In this example we assume that you can detect the full circuit voltage across the outgoing links (A11 and A12) at Location 12. The conclusion from such a test result is that there is a cable fault (involving one or both legs of this circuit) somewhere between Locations 11 and 12.

Having concluded that a cable fault exists, first carry out a double-check to make sure that there is no possibility of there being any intermediate links, terminations or contacts present. In other words, check that you really are working on the two ends of the same cable. Then, from this point onwards further testing is carried out with the two pairs of links disconnected at either end of the suspect section. This means that the following links should be slipped:

Location 11: Links B11 and B12 disconnected

Location 12: Links A11 and A12 disconnected

To establish whether one or both cores of the circuit are affected, you will need to carry out a continuity test. This test will require a spare core in the cable (or another suitable cable) to provide a return path. Using this test we will assume that Core 11 of the cable shows a disconnection and Core 12 registers good continuity.

One remedial action for this situation will be to divert 321HHR circuit away from Core 11 of the cable to pass through an alternative core. The diversion will only be applied between Locations 11 and 12. However, before taking such a step, more testing will be necessary.

In fact, there are several choices for dealing with the situation from this point, and all will involve some disruption to the railway sooner or later. Your manager will need to decide on an action plan for clearing the fault. Therefore contact your manager and give a full and accurate report of the situation. If you have noticed any signs of damage to the cable, then obviously mention this. You will probably need to supply details of the other circuits carried in the cable. The manager will arrive at a decision and will direct the next steps to be taken.

Q 2 What are the alternative courses of action?

Q2 Answer

You have discovered that Core 11 of the cable between Locations 11 and 12 has developed a disconnection. The only safe assumption is that the cable has become damaged in some way. Until a complete cable test has been carried out, it cannot be assumed that all the facts are known. In this situation the main problem is very often the information that you don't yet know! It is quite possible that damage has affected more than one cable core.

A full cable test is the only way to find out what has happened. However, this will mean taking the cable out of service, with consequent disruption to railway operations.

Your manager will need to decide between the following options:

- Take the whole cable out of service immediately and arrange for a replacement cable to be installed.
- Leave the cable in service with the fault present (Signal 321 will still show a single yellow aspect) and arrange for a replacement cable to be installed.
- Take the whole cable out of service immediately to carry out full insulation and continuity testing of all cores. If the test results are satisfactory, re-instate the cable and undertake a circuit diversion for 321HHR.
- With the cable remaining in service, carry out a minimum test. In this example a minimum test, will mean insulation and continuity testing of all spare cores. If the test results are satisfactory, undertake a circuit diversion for 321HHR. Defer full testing of all cores for several hours (no more than 48 hours or 72 hours, depending on the circumstances).

If your manager decides to follow options 3 or 4 then the Signal Maintenance Tester should work to Maintenance Test Plan CA05, 'Divert a Faulty Cable Core'. It may be helpful to refer to this when reading onwards from this point.

Q3 What is a 'Minimum Test'?

Q3 Answer

Option 4 means undertaking insulation and continuity testing of all spare cores. This is an example of a 'minimum test'. In fact, a minimum test requires testing of all spare cores or 10% of cable capacity, whichever is the greater.

There is a 19 core cable running between Locations 11 and 12 and it carries five spare cores (Cores 1 to 4 and 19). Applying the 10% rule in this case would give us 1.9. In practice we take the whole number above, giving a value of two cores. But in this case we test all spare cores, because there are five of these. The effect of the 10% rule is that on cables that are almost full, some working circuits must be disconnected to test sufficient cores.

A minimum test requires a slight variation on the standard method for insulation testing. The point of the minimum test is that it is carried out whilst circuits going through the cable remain working. All results should be recorded. In brief the procedure would be:

Isolate all spare cores.

Test insulation between each spare core and all other spare cores connected together.

Test insulation between all spare cores connected together and earth.

Signal Maintenance Testing, Part C, Section B3 gives the details of a standard cable Insulation Test (for all cores).

Q4 How should the diversion be made?

Q4 Answer

Refer to Figure 2. In the following explanation the term 'alternative core' means the cable core into which the circuit has been diverted.

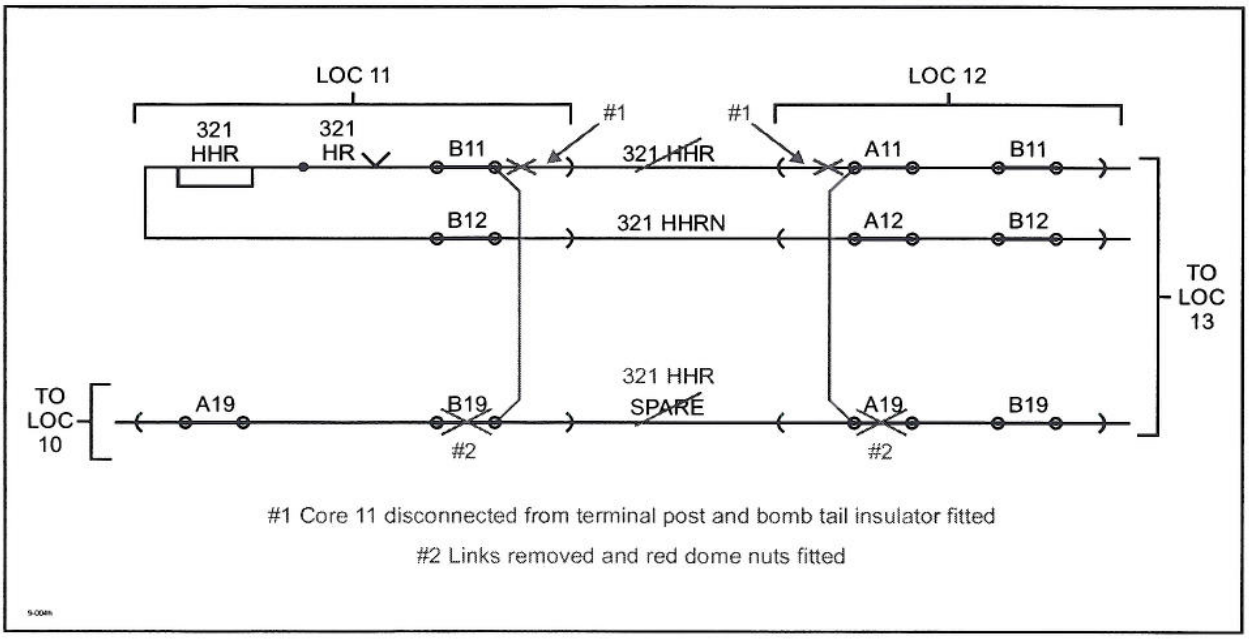


Figure 2 - Schematic view of the diversion

Diversion of a circuit to pass through an alternative core of a cable can only be made following satisfactory results from insulation and continuity tests. There are three tasks to be performed:

- Amend the site wiring diagrams.
- Make the wiring alterations.
- Carry out SMT testing, following Maintenance Test Plan CA05.

At least two competent people will be needed at the work site. The Signal Maintenance tester must take an independent role and therefore is not allowed to take part in any of the other activities (items 1 and 2). If only two competent persons are available at the work site it is permissible for Items 1 and 2 to be carried out by the same person.

The person amending the diagrams should first select a suitable alternative core for the diversion. There are five spare cores in the cable between Locations 11 and 12. Insulation and continuity testing have found that all are in good condition. Therefore any one of these could be chosen. In this example we select Core 19, because this will make for a slightly tidier core allocation, leaving two pairs of adjacent spare cores (1 to 4) for future work. Following CA05 the tester will need to carry out some independent preliminary checks on Core 19.

The site wiring diagrams must be amended in red, signed and dated. Figure 2 shows a typical amendment style. Be careful to amend any associated analysis sheets, such as link allocations and cable core plans. Alterations to the diagrams will be required at Locations 11 and 12. Immediately the site work has been completed, through to final testing, the exact details including insulation test values should be passed to your manager.

Next, at each end of the cable (in Locations 11 and 12) the following steps are carried out:

1	Verify that the cable links for the faulty circuit are disconnected at both ends. This means: Location 11: Links B11 and B12 disconnected Location 12: Links A11 and A12 disconnected
2	Remove the faulty cable core (Core 11) from its terminal post and cut off the exposed conductor. Apply a bomb tail insulator and secure the end of the faulty core tidily.
3	Completely remove the link on which the alternative core (good core) is terminated. This means: Location 11: Link B19 completely removed Location 12: Link A19 completely removed
4	Apply a single core red wire jumper from the faulty cable core terminal post to the alternative core terminal post. Ensure that this is routed so as to be clearly visible. Be careful to apply the jumper to the cable terminations (the cable side of the links).
5	Label the jumper clearly.
6	Apply a label to the alternative (good) core at the point where it is terminated.
7	To complete the installation work, apply a pair of red dome nuts, so as to prevent anyone else from mistakenly replacing the removed link. (A19 or B19 depending on which end of the cable you are working on.)

Finally the Signal Maintenance tester will carry out the 'After Installation Work' tests listed in CA05. Some of the tests can be carried out as the installation work proceeds. Completion of all tests, will require wiring amendments to be finished at both ends. During the Cable Function Test (towards the end of CA05) the circuit links for 321HHR will be re-instated. This means:

Location 11: Links B11 and B12 made up

Location 12: Links A11 and A12 made up

Comparing the original circuit with the modification you will notice that these two pairs of links perform the same function before and after the alteration. This is an important feature gained by applying the jumpers at the cable terminal posts, rather than on the internal side of the links. The diverted circuit will therefore be handed back into operational service with one cable core diverted between Locations 11 and 12.

6. Case study 2
Diversion of a circuit in a faulty cable to another cable

This Case Study provides some outline Action Plans for dealing with two fault Scenarios where parallel cabling has been installed. As in the previous Case Study, remember that your Manager must decide how such incidents are to be dealt with. Your responsibility is to report the facts accurately and refer to your Manager for a decision. Nevertheless it is important to understand some of the common pitfalls in more complex situations.

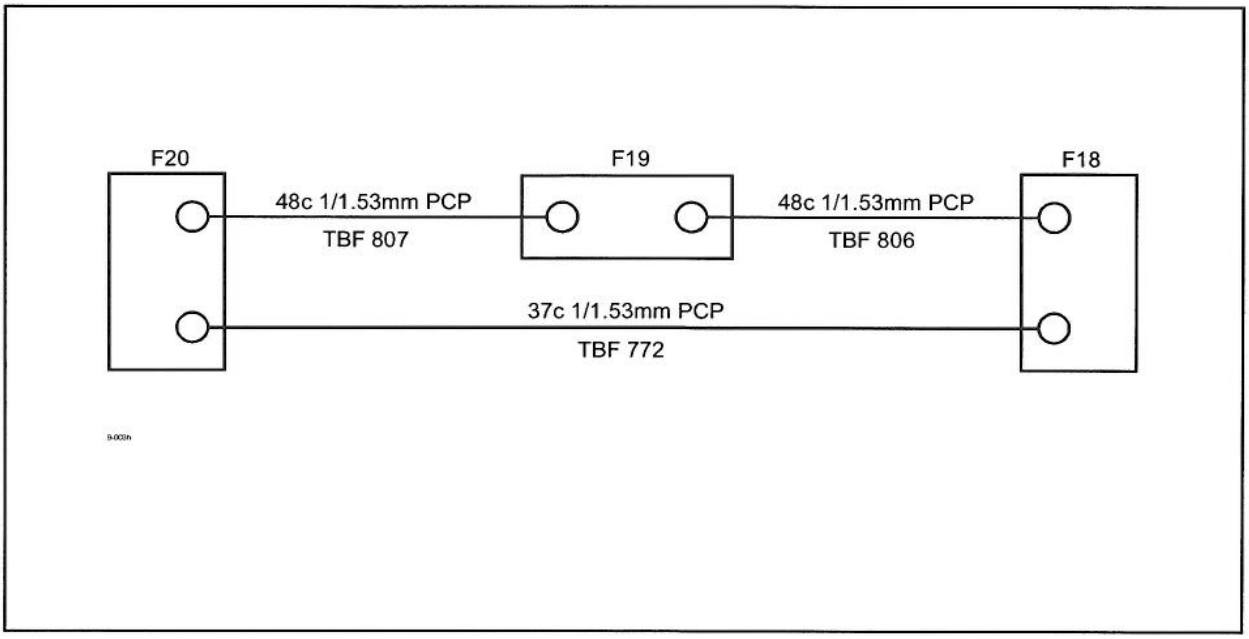


Figure 3 - Extract from Barchester IECC cable schematic

Refer to Figure 3. This diagram shows the arrangement of cables running between three Locations, F18, F19 and F20. Each Location is connected to its neighbour by means of a 48 core cable. In addition a 37 core cable runs direct from F18 to F20. For ease of reference, each cable in the locality has an identification number consisting of three digits prefixed by 'TBF'.

Scenario 1: Cable TBF772 develops a fault

Q1 What are the alternative courses of action?

Q1 Answer

In this case there are two alternative courses of action. Both are fairly straightforward and present no undue concern. Which action plan is adopted will depend on the extent of the cable damage and the extent to which the cables cores are in use

Action Plan 1A

Divert the affected circuit to a good spare core (or cores) in TBF772. This example will proceed along the lines of Case Study 1.

Action Plan 1B

Divert the affected circuit to a spare core (or cores) in TBF806 and TBF807. As with any diversion you will need to make sure that the alternative cores chosen are not in use for another purpose. In addition to checking in Locations F18 and F20, you will need to examine Location F19 to verify that through jumpering is in place, and that nothing else is connected to the selected cable cores.

Apart from checking the utilisation of spare cores at Location F19, this procedure does not present any particular hazards. The main point to bear in mind is that the original circuit went direct from F18 to F20. Therefore it is impossible for this diversion to create a situation whereby circuit controls in Location F19 become by-passed.

Scenario 2: Cable TBF807 develops a fault

Q2 What are the alternative courses of action?

Q2 Answer

Apart from installing a complete new cable (temporary or permanent) to replace TBF807, there is only one safe course of action here:

Action Plan 2A

Divert the affected circuit to a good spare core (or cores) in TBF807. This example will proceed along the lines of Case Study 1. The diversion would be applied at the two ends of cable TBF807 (in Locations F19 and F20).

Caution

Using a spare core (or cores) in TBF772 for the diversion is prohibited.

Employing TBF772 for the diversion would mean bypassing TBF806 and TBF807 together. However, Signal Maintenance Testing, Appendix C, Section C2 forbids this approach. It requires that 'a cable core diversion shall not bypass more than one cable at a time'. Obeying this rule means that there can be absolutely no chance of bridging out any vital circuit controls that might be applied at location F19.

LOC 11			LOC 12			LOC 13			LOC 14		
1	SPARE	1	1	SPARE	1	1	SPARE	1	1	SPARE	1
2	SPARE	2	2	SPARE	2	2	SPARE	2	2	SPARE	2
3	SPARE	3	3	SPARE	3	3	SPARE	3	3	SPARE	3
4	SPARE	4	4	SPARE	4	4	SPARE	4	4	SPARE	4
5	318 HR	5	5	318 HPR	5	5	318 HPR	5	5	318 HPR	5
6	318 HR N	6	6	318 HPR N	6	6	318 HPR N	6	6	318 HPR N	6
7	318 DR	7	7	318 DPR	7	7	318 DPR	7	7	318 DPR	7
8	318 DR N	8	8	318 DPR N	8	8	318 DPR N	8	8	318 DPR N	8
9	321 HR	9	9	321 HR	9	9	321 HR	9	9	321 HR	9
10	321 HR N	10	10	321 HR N	10	10	321 HR N	10	10	321 HR N	10
11	321 HHR	11	11	321 HHR	11	11	321 HHR	11	11	321 HHR	11
12	321 HHR N	12	12	321 HHR N	12	12	321 HHR N	12	12	321 HHR N	12
13	321 DR	13	13	321 DR	13	13	321 DR	13	13	321 DR	13
14	321 DR N	14	14	321 DR N	14	14	321 DR N	14	14	321 DR N	14
15	BK T1PR	15	15	BK T1PR	15	15	BK T1PR	15	15	BK T2PR	15
16	BK T1PR N	16	16	BK T1PR N	16	16	BK T1PR N	16	16	BK T2PR N	16
17	EKR	17	17	EKR	17	17	EKR	17	17	EKR	17
18	EKR N	18	18	EKR N	18	18	EKR N	18	18	EKR N	18
19	SPARE	19	19	SPARE	19	19	SPARE	19	19	SPARE	19
LOC 11 - LOC 12 19c 1/0.85mm			LOC 12 - LOC 13 19c 1/0.85mm						LOC 13 - LOC 14 19c 1/0.85mm		

Figure 4 - Extract from Brightside South cable core plan