

## **Unit 34: Fault Diagnosis and Maintenance of Communications Equipment**

**Unit code:** J/502/3041  
**QCF Level 3:** BTEC Specialist  
**Credit value:** 9  
**Guided learning hours:** 60

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### **Aim and purpose**

This unit will give learners an understanding of the techniques used when determining and handling faults and maintaining communication systems.

### **Unit introduction**

Learners will be expected to use manufacturers' data and performance specifications in order to ensure that once repaired, the equipment will meet the full manufacturer's performance specification.

The unit will develop learners' understanding of the function, features and characteristics of electronic measurement and optical test equipment. They will also gain practical experience of their use when carrying out electronic testing and measurement in a range of communications applications. This will include selecting, connecting and operating different types of test equipment and the application of measurement techniques.

Learners will gain an understanding of specialised telecommunications test equipment and will be able to use a variety of electronic measurement equipment.

The unit also examines common testing methods and errors inherent in the test instruments used. Particular attention is paid to ensure that the test procedure, as well as the test and measurement equipment used, is fit for purpose and properly calibrated. Learners will gain an understanding of the effects of instrument characteristics such as accuracy, display resolution and loading and how these affect the measured quantity.

## Learning outcomes and assessment criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

### On completion of this unit a learner should:

Learning outcomes	Assessment criteria
1 Be able to diagnose communications equipment fault conditions with the aid of test instruments and record results	1.1 select and use test instruments to take measurements from two different pieces of communications equipment 1.2 carry out fault diagnosis on two pieces of faulty communications equipment and record and interpret the results 1.3 explain the importance of a test specification as an aid to ensuring the validity and consistency of measurements
2 Understand the principles of calibration and configuration of electronic test equipment	2.1 describe the principles and need for the calibration of a communications equipment test instrument 2.2 explain the health, safety and configuration issues that need to be considered when connecting test equipment to communications equipment under test conditions
3 Understand the need for scheduled maintenance, maintenance procedures and the responsibilities of a technical support team	3.1 explain the requirement for communications equipment maintenance schedules and reports 3.2 describe a maintenance procedure for a given piece of communications equipment 3.3 describe the role of technical support and customer care personnel within a communications operation

## Unit content

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### 1 Be able to diagnose communications equipment fault conditions with the aid of test instruments and record results

*Test instruments:* analyser eg network, protocol, spectrum; optical power meters; bit error rate test equipment; signal generator eg random noise, audio frequency (AF), radio frequency (RF), pulse, waveform/function; digital equipment eg counter/frequency meter, logic probe, logic pulser

*Communications equipment:* eg modems, bridges, routers, network cards, wireless or fibre optic systems and networks

*Fault diagnosis:* use of logical fault finding procedure eg input-to-output, output-to-input and half-split methods); characteristics and properties of test instruments eg impedance, capacitance, system loading effects; measurements eg test-point voltage/waveform, supply voltage/current, frequency/pulse repetition frequency (PRF), rise and fall time, distortion/noise; use of test specifications; effects of drift and temperature; awareness of potential hazards eg electrical, physical, anti-static hazards and safeguards (protection of self, others, equipment under test and test equipment)

*Recording and interpreting results:* data analysers/other performance monitoring equipment; documentation eg tabulation, spreadsheets for recording the history of system faults, bit error rate tables (BERT), reference materials (industry standards, manufacturers data sheets, performance specifications and other technical publications)

*Test specifications:* specifications for the conformance/validation testing of the equipment/system under test

### 2 Understand the principles of calibration and configuration of electronic test equipment

*Calibration principles:* procedures eg check, adjust, systematically standardise measuring instrument, set-up arrangement; reference standards eg Weston cadmium standard cell, standard resistors, standard inductor; theory eg accuracy, uncertainty; impact of calibration on quality, productivity and safety; applications eg during manufacture, following installation, periodic scheduled maintenance, in response to identified deviation, after repair or change in environment; terminology eg zero shift, range (or span) error, combined zero shift and range error, non-linearity

*Health and safety issues:* eg precautions to be observed when setting and adjusting mains supply voltages, replacing/charging/disposing of batteries, dismantling and reassembling equipment, removal/replacement of external and internal covers, making adjustments on 'live' equipment, continuity of earth (grounding or bonding) of electrical equipment, safety cut-outs and residual current device (RCD), earth leakage circuit breaker (ELCB)

*Configuration issues:* pre-conditions and checks to ensure that communications system/equipment is safe to test and instruments safe to use; test equipment set-up eg procedures for powering up equipment, use of the equipment manufacturer's procedures, using commissioning guides, 'hot' and 'cold' standby equipment

### **3 Understand the need for scheduled maintenance, maintenance procedures and the responsibilities of a technical support team**

*Maintenance schedules and reports:* reactive and preventative maintenance eg advantages/disadvantages, cost implications, impact of equipment failure; maintenance schedules eg a chart that shows various preventative maintenance activities and frequency of maintenance; help desk information and statistics; compilation of technical reports and maintaining statistical records eg maintenance/repair history, calibration/re-calibration

*Maintenance procedures:* calculation of mean time to failure (MTTF), mean time between failure (MTBF) and mean time to repair (MTTR) figures; fault reporting procedures; first and second line maintenance procedures; prevention of fault escalation; hot and cold standby equipment *Technical support:* team organisation eg roles and management, working practices and availability, expertise; use of test laboratories and network simulation; the role of the equipment expert

*Customer care:* importance of maintaining customer satisfaction eg customer care systems to maximise the customers' satisfaction with your business (including: how well your product or service matches customer needs, the value for money you offer, efficiency and reliability in fulfilling orders, professionalism and friendliness and expertise of staff, how well customers are kept informed; records eg customer/product details, fault history, diagnostic guides, dealing with repeat fault handling

## Essential guidance for tutors

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### Delivery

Delivery of this unit should concentrate on the practical application of fault-finding and the test and measurement of communications equipment and systems. As a result, it is important to allocate sufficient hands-on time in order to develop the skills and understanding associated with learning outcomes 1 and 2.

Appropriate attention must be given to health, safety and welfare arrangements throughout the delivery of this unit. This should include the awareness of potential hazards to be avoided (eg electrical, physical, anti-static) and safeguards to be adopted for the protection of self, others, the equipment being tested and the test equipment used when carrying out performance tests and fault-finding.

Wherever possible learners should be given opportunities to discuss and reflect upon their practical activities to help them improve their learning and skill development.

The emphasis of the unit is on giving learners the necessary skills to apply a systematic approach to the testing and maintenance of communications technology systems and equipment.

It is likely that the unit will be delivered through a programme of lectures, demonstrations and a high degree of practical work involving the use of equipment, documentation and computer-based software and hardware. There is no set order in which the learning outcomes should be delivered and it is possible that centres/tutors will be able to see a number of possible approaches to delivery. Centres may well make their choice of delivery plan based upon the resources available to them (eg workshop facilities/access, staffing, equipment, levels of integration with other units, etc).

Whichever approach is taken should ensure the coherence of the unit as a whole is maintained and that learners are given opportunities to work with as wide a range of equipment and maintenance procedures as possible.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

### Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments. The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
<p><b>Introduction to the unit</b></p>
<p><b>Be able to diagnose communications equipment fault conditions with the aid of test instruments and record results:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on safe working practices</li> <li>• whole-class exercise – tutor presentation on communications equipment, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on test instruments, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on test specification, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on recording and interpreting test results, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on fault finding, followed by practical exercises</li> <li>• a mixture of directed learning and practical exercises, with access to practical resources and suitable technology.</li> </ul>
<p><b>Assignment 1 - Testing, testing...</b></p>
<p><b>Understand the principles of calibration and configuration of electronic test equipment:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on safe working practices</li> <li>• whole-class exercise – tutor presentation on calibration procedures and standards, followed by practical exercises and directed research</li> <li>• whole-class exercise – tutor presentation on the application of calibration procedures, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on the setting up of test equipment, followed by practical exercises</li> <li>• a mixture of directed learning and practical exercises, with access to practical resources and suitable technology.</li> </ul>

Topic and suggested assignments/activities and/assessment
<p><b>Assignment 2</b> - Always have an explanation ready</p>
<p><b>Understand the need for scheduled maintenance, maintenance procedures and the responsibilities of a technical support team:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on safe working practices</li> <li>• whole-class exercise – tutor presentation on maintenance scheduling, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on maintenance reports and records, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on maintenance procedures, followed by directed research</li> <li>• whole-class exercise – tutor presentation on technical support, followed by directed research and practical exercises</li> <li>• whole-class exercise – tutor presentation on customer care, followed by directed research and practical exercises</li> <li>• a mixture of directed learning and practical exercises, with access to practical resources and suitable technology. Role play for exploring technical support and customer care issues.</li> </ul>
<p><b>Assignment 3</b> - Keeping it working</p> <p><b>Assignment 4</b> - Show that you care</p>

### Assessment

Evidence for the learning outcomes may be collected through a series of well-planned assignments, practical activities and projects. The results of practical activities, involving tests and measurements, can be presented in the form of a spreadsheet. Evidence from the workplace can also be incorporated provided that this evidence is appropriate and authenticated as the learner's own work. Integrative assignments may help to reinforce relevance and could be used effectively to link this unit with other units in which the understanding and skills gained could be applied.

During the extensive practical work associated with this unit learners must be aware of the health and safety hazards applicable to test and fault diagnosis operations. This is particularly important when high voltage or laser diode light sources are in use.

1.1, 1.2 and 1.3 relate to learning outcome 1. For 1.1 and 1.2, learners should be able to select and use items from a range of test instruments (eg analyser, optical power meters, bit error rate test equipment, signal generator, digital equipment) appropriate for the measurement tasks undertaken. They then need to take a series of measurements (eg test-point voltage/waveform, supply voltage/current, frequency/pulse repetition frequency (PRF), rise and fall time, distortion/noise) on two differing items of communications equipment.

The equipment to be tested can include hardware and/or software. Items such as modems, bridges, routers or network cards are all appropriate for this task as are wireless or fibre optic systems and networks. Ideally, and with careful choice of measurement tasks, learners could demonstrate their ability to use most of the instruments listed in the unit content, although this is not essential. However centres should avoid too sparse a coverage and should not allow learners to use the same measurement instruments for the four measurement tasks associated with 1.1 and 1.2.

In the case of 1.1, it is assumed that the equipment under test will be in correct working order whilst, in the case of 1.2, the equipment will be faulty. Learners should keep records of all readings taken and use them for performance and fault diagnosis purposes as appropriate.

Evidence for 1.2 should include records and interpretation of data analysers or other performance monitoring equipment results and related documentation. This might include tabulated results, spreadsheets for recording the history of system faults, bit error rate tables (BERT) and learner's use of reference materials (industry standards, manufacturers data sheets, performance specifications and other technical publications). Both 1.1 and 1.2 will require tutor observation records of learners' ability and competence with the test equipment selected. In order to satisfy 1.3, learners must explain the importance of a test specification as an aid to ensuring the validity and consistency of measurements of the equipment/system under test. This should be set within the context of one of the measurement activities for 1.1 or 1.2. 2.1 and 2.2 relate to learning outcome 2. In order to satisfy 2.1, learners must be able to describe the principles of and need for the calibration of a piece of communications equipment. This should include the procedures carried out (eg check, adjust, systematically standardise measuring instrument, set-up arrangement), the reference standards used, the theory that has been applied and the impact of calibration on quality, productivity and safety for a given application (which could be one of the test undertaken for 1.1 or 1.2). Learners' work should make use of the correct terminology throughout.

For 2.2, learners must be able to explain the health and safety issues that need to be considered when connecting test equipment to communications equipment under test conditions. They also need to explain the configuration issues, which should include as a minimum the pre-conditions and checks to ensure that communications system/equipment is safe to test, how the instruments are determined to be safe to use and how the test equipment has been correctly set-up for use.

3.1, 3.2 and 3.3 relate to learning outcome 3. In order to satisfy the criteria learners must be aware of the need for preventative maintenance arrangements for communications systems and networks, the role of technical support teams and the need for customer care.

To satisfy 3.1 learners must be able to explain the requirement for communications equipment maintenance schedules and reports. This must cover all the aspects listed in the content.

For 3.2, learners must be able to describe a maintenance procedure for a given piece of communications equipment, eg a bridge or a router (alternatively a wireless or fibre optic communications device may be selected). Tutors need to ensure that the task set allows learners to address all the requirements of the content.

For 3.3, learners need to describe the role of technical support and customer care personnel within a communications operation. The context to be followed here is that a communication system/network is generally used to provide a service to a prescribed range of customers. The customers may be regarded as either internal (eg work colleagues or fellow employees from other departments) or external to the company/organisation (eg subscribers or network users).

Learners should investigate and describe the organisation of a technical support team, the use of test laboratories and network simulation and the role of the equipment expert. They also need to describe the role of customer care personnel and their importance maintaining the expected levels of customer satisfaction and maintaining records.

The evidence for this criterion is likely to come from either investigating a case study provided by the tutor or investigating the role of the technical support and customer care personnel of an organisation. This may be the organisation where the learner is employed or where they have the opportunity for work experience

**Programme of suggested assignments**

The table below shows a programme of suggested assignments that cover the pass criteria in the outcomes and assessment grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment methods
1.1, 1.2, 1.3	Testing, testing...	<p>You are required to test some equipment and report on the results. You will be supplied with a selection of test tools and test specifications.</p> <p>Write a short document explaining which tools you will use and the importance of the test specifications.</p> <p>The document must also state, and take account of, any potential hazards that might affect the testing.</p> <p>Working from the document, perform the tests and report your findings.</p>	<p>Witness statements.</p> <p>Observation records.</p> <p>Activity log.</p> <p>Report.</p> <p>Presentation.</p>

Criteria covered	Assignment title	Scenario	Assessment methods
2.1, 2.2	Always have an explanation ready	<p>Your supervisor asks you to expand the report that you produced in the testing assignment.</p> <p>Write a two new sections to the report that you created in Assignment 1:</p> <ul style="list-style-type: none"> <li>• a description of the calibration principles that you applied to one communications equipment test instrument and an explanation of why the calibration was needed</li> <li>• an explanation of the health, safety and configuration issues that you considered when connecting the tests.</li> </ul>	Report.
3.1, 3.2	Keeping it working	<p>You have been asked to create some training material on equipment maintenance, suitable for a new employee.</p> <p>The material must:</p> <ul style="list-style-type: none"> <li>• give an overview of preventative maintenance arrangements for communications equipment</li> <li>• give a detailed example for one piece of equipment.</li> </ul>	Web pages. Presentation. Booklet. Posters.
3.3	Show that you care	<p>Working from the scenario provided by your tutor:</p> <ul style="list-style-type: none"> <li>• state the technical support and customer care issues that you have identified</li> <li>• give some examples of good and poor practices</li> <li>• describe how some of the issues could be resolved.</li> </ul>	Report. Presentation.

### Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC in IT sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Systems Architecture	Systems Architecture
	Setting up an IT Network	Networking Principles
	Networking Principles	Computer Networks
	An Introduction to Communication Technologies	

This unit maps to some of the underpinning knowledge from the following areas of competence in the Level 3 National Occupational Standards for IT (ProCom):

- 4.7 Systems Design
- 5.1 Systems Development
- 5.3 IT/Technology Solution Testing.

#### Essential resources

Centres will require a communications workshop equipped with a range of test equipment, handbooks and manufacturers' literature. The test equipment should be sufficient in number to allow learners to carry out fault-finding exercises on an individual basis. A range of working and faulty electronic or optical communications technology systems, circuits, devices and components should be made available together with relevant manufacturer's service manuals, parts lists and drawings.

Appropriate safety equipment and a safe working environment must be provided for practical fault-finding activities. In most cases, a typical electronic workshop or laboratory should prove adequate. Earth leakage or residual current circuit breakers should be installed in order to protect learners in the case of electrical shock.

#### Indicative reading for learners

##### Textbooks

- Brindley K – *Starting Electronic 3<sup>rd</sup> edition* (Newnes, 2004) ISBN 07506638633
- Miller G – *Modern Electronic Communication* (Pearson, 2007) ISBN 0136154298
- Ross D – *Electronics for Dummies* (Wiley & Sons, 2009) ISBN 0470681787
- Sinclair I – *Practical Electronic Handbook* (Newnes, 2006) ISBN 0750680714

##### Websites

- [www.howstuffworks.com](http://www.howstuffworks.com)
- [www.webopedia.com](http://www.webopedia.com)

## Functional Skills – Level 2

Skill	When learners are ...
<b>ICT - Using ICT</b>	
Select, interact with and use ICT systems safely and securely for a complex task in non-routine and unfamiliar contexts	selecting and using test instruments to take measurements from communications equipment carrying out fault diagnosis on communications equipment
<b>ICT - Finding and selecting information</b>	
Use appropriate search techniques to locate and select relevant information	explaining the health, safety and configuration issues associated with communications equipment.
<b>ICT - Developing, presenting and communicating information</b>	
Combine and present information in ways that are fit for purpose and audience	explaining the requirements for communications equipment maintenance schedules and reports describing maintenance procedures for communications equipment describing the role of technical support and customer care personnel.