

# Unit 76: Aircraft Computers and Electronic Systems

<b>Unit code:</b>	<b>A/600/7235</b>
<b>QCF Level 3:</b>	<b>BTEC Nationals</b>
<b>Credit value:</b>	<b>10</b>
<b>Guided learning hours:</b>	<b>60</b>

## ● Aim and purpose

The unit will extend learners' knowledge of digital logic systems which they will apply to aircraft computers. Learners will study the operation and interfacing of aircraft data buses and computer components.

## ● Unit introduction

This unit will develop learners' knowledge and an understanding of the hazards, procedures and aircraft operating environment that influence the handling and associated maintenance of delicate aircraft electronic equipment and systems. Many modern aircraft electronic systems have their own built in test equipment (BITE) and the ability to interrogate these systems using BITE and interpret the resulting information that is displayed, is again an essential skill for aircraft maintenance engineers so, the knowledge and procedures necessary to perform these tasks is covered in the final two outcomes of the unit.

This unit, together with its prerequisite units identified above, covers completely the underpinning knowledge of the European Aviation Safety Agency (EASA) Part-66 module 5. In addition, this unit will also be useful for those pursuing a career as Maintenance Technicians with the armed forces.

## ● Learning outcomes

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

- 1 Understand computer data, electronic and fibre optic data buses, computer structure, operation and component interfacing
- 2 Know the safety hazards and precautions associated with the maintenance and control of microelectronic devices, computer software and electromagnetic environments
- 3 Understand the principle of operation of electronic flight deck displays and the function of their associated electronic instrument systems
- 4 Understand the arrangement of electronic aircraft systems and the use of built-in test equipment (BITE) and on board maintenance systems.

# Unit content

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## 1 Understand computer data, electronic and fibre optic data buses, computer structure, operation and component interfacing

*Computer data:* form of analogue and digital signals; operation and application of analogue to digital (ADC) and digital to analogue (DAC), ADC and DAC data inputs and outputs

*Fibre optics:* advantages and disadvantages of fibre optic systems; circuit component layout and handling precautions (cable, light guides, couplings, connectors); basic operation of an optical data bus (such as the STANAG 3910 system)

*Electronic data buses:* format, specification, operation, signal transmission and interfacing of typical aircraft electronic data buses (the aeronautical radio incorporated (ARINC) 429, the ARINC 629, the military standard (MIL STD) 1553B)

*Structure, operation and component interfacing:* common terms eg software, hardware, integrated circuit (IC), core memory, decoder, language, machine code, routine, byte, bit, PROM; the digital computer eg basic operation, computer component function, operation and interfacing, input section, central processing unit CPU (arithmetic logic unit, register section, control and processing unit and clock), memory and read only memory sections (RAM and ROM), computer outputs; use of medium, large and very large integration

## 2 Know the safety hazards and precautions associated with the maintenance and control of microelectronic devices, computer software and electromagnetic environments

*Electro-static sensitive devices:* safety hazards and precautions (handling, static damage, grounding, component labelling, storage and transportation, on-aircraft maintenance precautions)

*Software management control:* know outline procedures for software certification and modification

*Electro-magnetic environment:* influence on maintenance of electronic systems eg subject to a high intensity radiated field (HIRF), lightning strike, electromagnetic interference; use of electromagnetic compatibility and lightning protection

## 3 Understand the principle of operation of electronic flight deck displays and the function of their associated electronic instrument systems

*Flight deck displays:* operating principles of light emitting diodes (LEDs), liquid crystal displays (LCDs) and cathode ray tubes (CRTs)

*Associated electronic instrument systems:* function, display modes and display selection methods for eg electronic attitude direction indicator (EADI), electronic horizontal situation indicator (EHSI), engine indicating and crew alerting (EICAS), electronic centralised aircraft monitoring (ECAM) systems

#### 4 Understand the arrangement of electronic aircraft systems and the use of built-in test equipment (BITE) and on board maintenance systems

*Electronic aircraft systems:* general arrangement and displays of aircraft electronic systems eg aircrew alerting system (ACAR), ECAM, electronic flight instruments systems (EFIS), EICAS, global positioning system (GPS), inertial navigation system (INS), traffic alert and collision avoidance system (TCAS), ground proximity warning system (GPWS), flight data recorder system (FDRS)

*System tests:* carry out BITE tests on selected systems eg ECAM, EFIS, EICAS, GPS, FDRS systems

*On-board maintenance systems:* function, layout and operation of eg central maintenance computers, data loading systems, electronic library system, printing, structural monitoring (damage tolerance monitoring), aircraft maintenance analysis (AIRMAN) system

## Assessment and grading 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 for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P1</b> explain the operation of an ADC and a DAC converter, sketch and describe the input/output signals to these devices and give an electronic circuit use for each	<b>M1</b> explain the format, specification, operation, signal transmission and interfacing of the ARINC 629 and compare its specification and functions with the ARINC 429 and MIL STD 1553B	<b>D1</b> investigate the system arrangement and methods of display, selection and warnings offered by ECAM systems and report on the range and nature of the display functions, the warnings covered and their impact for pilot workload
<b>P2</b> describe the layout, detail the advantages/disadvantages and handling precautions for a typical aircraft fibre optic system and explain the basic operation of an optical data bus	<b>M2</b> detail the function and explain the operation and interfacing of the arithmetic logic unit, control and processing unit, register section, memory sections and clock, within a computer	<b>D2</b> investigate the nature, functions, interfacing, communication methods and general operation of the AIRMAN on-board maintenance analysis system and report on your findings.
<b>P3</b> explain the format, specification, operation and interfacing of a radio incorporated (ARINC) 429 aircraft data bus	<b>M3</b> explain the nature of the design protection methods used to mitigate the effects of lightning strikes and the subsequent maintenance actions that need to be taken after such a strike	
<b>P4</b> define the terms software, decoder, integrated circuit, core memory and routine and explain the basic operation of a digital computer, from inputs to outputs	<b>M4</b> explain the functions, nature of the displays and the general arrangement of the EICAS system for a modern gas turbine powered transport aircraft.	
<b>P5</b> detail the handling and on-aircraft maintenance hazards/safety precautions for sensitive electro-static devices and describe the outline procedures for software certification and modification		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P6</b> describe the maintenance procedures that should be adopted when an aircraft electronic system has been subject to electromagnetic interference		
<b>P7</b> explain with the aid of diagrams the operating principles of LEDs, LCDs and CRTs		
<b>P8</b> state the function and describe the display modes and display selection methods for an electronic attitude direction indicator and an electronic horizontal situation indicator		
<b>P9</b> describe the arrangement and function displays for two electronic aircraft systems		
<b>P10</b> carry out a BITE diagnostic test on an aircraft electronic system [SM3]		
<b>P11</b> produce a block schematic diagram and from it, explain the layout and functions of a typical on-board structural monitoring system.		

**PLTS:** This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

<b>Key</b>	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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# Essential guidance for tutors

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## Delivery

This unit aims to give learners an understanding of the logic and micro-electronics of aircraft computers. Learners will gain an understanding of the maintenance implications for sensitive micro-electronic devices and the built-in test equipment maintenance of aircraft electronic systems and their associated displays. As such, a practical, hands-on approach should be used throughout the delivery of the unit. Learners will need access to aircraft computer components and electronic systems related hardware, particularly for learning outcome 4, where learners will need to check avionic systems and their associated display readouts using on-board built-in test equipment. It is unlikely that centres will have access to this equipment on site and therefore the unit is likely to only be delivered successfully by centres who work closely with a Part 147 organisation (having a ground simulator or live aircraft), a military establishment or a recognised aircraft operator or repair organisation, where access to the hardware is available.

This unit builds on and broadens the knowledge contained in *Unit 4: Mathematics for Technicians*, *Unit 6: Electrical and Electronic Principles* and *Unit 75: Aerospace Electronic Devices and Circuits*, and learners should have completed all three of these prerequisite units before they start this unit.

This unit has been designed to complete the Part-66 module 5 knowledge for both potential mechanical and avionic maintenance engineers and tutors should take into account the needs of the cohort when delivering the unit content.

For learning outcome 1, learners need to recognise the form of analogue and digital signals and explain the operation and aircraft application of the ADC and DAC in electronic systems. This might best be delivered through a laboratory demonstration or experiment. The appropriate hardware and circuit diagrams should be available when learners are considering fibre optic systems and data buses, the circuit diagrams for fibre optic systems and aircraft data buses may be obtained from specialist maintenance manuals or other associated reading material, all of which should be readily available for use by the learner. The computer component hardware and circuitry is likely to be available in the centre and this should be utilised when considering computer structure and component interfacing.

When discussing electro-static sensitive devices and the electro-magnetic environment, learners should identify the use of lightning conductors, electrostatic wicks and the methods used to ensure electrostatic compatibility. This should be achieved through learners seeing these devices first-hand on-board an aircraft, in order that they are able to understand the hazards and precautions to be taken when carrying out maintenance operations on these devices and systems. Learners should also be made aware of the importance and nature of the procedures that are in place to safeguard computer software, when first certified and when subject to modification. Example procedures and/or other sources of written information should be readily available.

A practical hands-on approach should be adopted when delivering learning outcomes 3 and 4 of the unit. Therefore access to a 'glass-cockpit' aircraft or similar, or to an engineering ground simulator is considered essential. This is especially necessary when learners carry out a BITE test/check on an aircraft electronic system and interpret screen displays and output information, from the system. Learners will benefit particularly from a live aircraft or simulator that is powered up so that they can view the outputs, cautionary messages and warnings, for example from an aircraft's ECAM system. Having the appropriate maintenance documentation and system schematic diagrams to hand at the same time will also enable learners to appreciate the layout and operation of many of the systems listed in learning outcome 4.

## 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><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• introduction to unit content, scheme of work and methods of assessment</li><li>• explain the form, operation and application of analogue and digital data inputs and outputs</li><li>• explain the layout, operation and advantages and disadvantages of fibre optic systems</li><li>• explain the operation and interfacing of electronic data buses</li><li>• explain computer structure, operation and computer interfacing.</li></ul> <p><i>Practical workshop activities:</i></p> <ul style="list-style-type: none"><li>• practical investigation of component hardware and circuitry.</li></ul> <p><i>Individual learner activities:</i></p> <ul style="list-style-type: none"><li>• use of maintenance manuals and circuit diagrams.</li></ul>
<p>Prepare for and carry out <b>Assignment 1: Computer Data, Data Buses and Computer Architecture</b> (P1, P2, P3, P4, M1, M2).</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• describe the safety hazards and precautions associated with electro-static sensitive devices</li><li>• describe the procedures for software certification and modification</li><li>• describe the electro-magnetic environment and how it relates to the maintenance of electronic systems.</li></ul> <p><i>Site visit:</i></p> <ul style="list-style-type: none"><li>• view lighting conductors, electrostatic wicks and methods used to ensure electrostatic compatibility on-board an aircraft.</li></ul>
<p>Prepare for and carry out <b>Assignment 2: Electro-static, Electromagnetic and Computer Software, Safety</b> (P5, P6, M3).</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• explain the operation of flight deck displays</li><li>• explain the function display modes and display selection methods for associated electronic instrument systems.</li></ul> <p><i>Site visit:</i></p> <ul style="list-style-type: none"><li>• view flight deck displays and associated systems on-board an aircraft.</li></ul>
<p>Prepare for and carry out <b>Assignment 3: Electronic System Displays</b> (P7, P8).</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• explain the arrangement and displays of aircraft electronic systems</li><li>• demonstrate system testing using built-in test equipment</li><li>• explain the function, layout and operation of on-board maintenance systems.</li></ul> <p><i>Practical activities:</i></p> <ul style="list-style-type: none"><li>• carrying out BITE tests on aircraft systems.</li></ul>
<p>Prepare for and carry out <b>Assignment 4: Electronic Aircraft Systems and BITE Maintenance</b> (P9, P10, P11, M4, D1, D2).</p>
<p>Feedback on assessment and unit evaluation.</p>

## Assessment

The assessment evidence for this unit can be developed through a combination of theoretical and practical assignments, investigations and formal written assessments. Verbal questioning and observation of practical activities would be a useful way of attaining evidence, particularly for some of the criteria needed to meet learning outcomes 3 and 4.

The method of assessment preferred by national legislative bodies relative to the aerospace industry involves the use of multiple-choice questions. Many centres may have existing banks of multiple-choice questions designed to prepare and test learners for EASA Part-66 avionic module examinations. Where learners are aiming to achieve recognised licensed status, this method of assessment could be adopted as a means of supporting and checking learning. Multiple-choice questions should not, however, be used as assessment instruments for the purposes of this unit.

With the relatively large number of pass criteria required to satisfy this unit, it is likely that at least four assessment instruments will be required. The assessment strategy should be carefully considered so that it does not place an unduly heavy assessment burden on learners or the tutor.

Wherever possible, the evidence should be handed in at the end of an assignment. This will help control authenticity of evidence and also keep the assessment activities for the pass criteria short, sharp and relevant. The ability to work safely in an aircraft electronic/avionic environment should be paramount and centres should ensure that learners are adequately briefed concerning the hazards that exist and the safety procedures that need to be followed.

### Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading 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 method
P1, P2, P3, P4, M1, M2	Computer Data, Data Buses and Computer Architecture	A technician needs to explain to a new apprentice the operation, layout and component interfacing of computer data, electronic and fibre optic data buses, computer structure.	Written assignment.
P5, P6, M3	Electro-static, Electromagnetic and Computer Software, Safety	A technician needs to explain to a new apprentice the safety precautions a for sensitive electro-static devices and the maintenance procedures for systems subject to electromagnetic interference.	Written assignment.

Criteria covered	Assignment title	Scenario	Assessment method
P7, P8	Electronic System Displays	A technician needs to explain to a new apprentice the operating principles, arrangement and function of flight deck displays and associated instruments.	Written assignment.
P9, P10, P11, M4, D1, D2	Electronic Aircraft Systems and BITE Maintenance	A technician needs to demonstrate and explain to a new apprentice the function, layout and testing of aircraft electronic systems.	Practical assignment supported by observation records and a written report.

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

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

Level 1	Level 2	Level 3
		Mathematics for Technicians
		Electrical and Electronic Principles
		Aircraft Instruments and Indicating Systems
		Aerospace Electronic Devices and Circuits

This unit has strong links with some of the other units in the programme, particularly *Unit 4: Mathematics for Technicians*, *Unit 6: Electrical and Electronic Principles*, *Unit 75: Aerospace Electronic Devices* and *Unit 85: Aircraft Instruments and Indicating Systems*, which are all prerequisite units for aircraft mechanical maintenance engineers as well as those pursuing a career in avionic maintenance. Collectively, the pre-requisite units and their addendum material, together with this unit, cover all necessary knowledge requirements for EASA Part-66 Module 5.

The unit will also contribute to the essential evidence required by those undertaking aircraft engineering apprenticeship programmes and will also be useful for those in training with the armed forces.

Unit 122 Removing and Replacing Avionic Indication and Gauging Components in Aircraft Systems

Unit 129: Removing and Replacing Components of Aircraft Navigational and Computing Systems

## Essential resources

A considerable amount of computer hardware and access to a live aircraft or simulator will be needed in order for learners to meet the assessment criteria. The following hardware and documentation is considered essential to fully meet the unit aims and to meet the requirements of the external regulatory bodies:

- digital computer equipment and components and associated circuit boards, as detailed in the unit content for learning outcome 1
- operational aircraft/ground engineering simulators
- data books and manufacturers' specifications
- maintenance manuals or air publications.

## Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI – University of Warwick) – [www.warwick.ac.uk/wie/cei/](http://www.warwick.ac.uk/wie/cei/)
- Learning and Skills Network – [www.vocationallearning.org.uk](http://www.vocationallearning.org.uk)
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – [www.stemnet.org.uk](http://www.stemnet.org.uk)
- National Education and Business Partnership Network – [www.nebpn.org](http://www.nebpn.org)
- Local, regional Business links – [www.businesslink.gov.uk](http://www.businesslink.gov.uk)
- Work-based learning guidance – [www.aimhighersw.ac.uk/wbl.htm](http://www.aimhighersw.ac.uk/wbl.htm)

## Indicative reading for learners

### Textbooks

Eismin, T – *Aircraft Electricity and Electronics* (McGraw-Hill, 1994) ISBN 0028018591

Moir, I and Seabridge, A – *Civil Avionics Systems* (John Wiley & Sons, 2006) ISBN 0470029293

Tooley, M – *Aircraft Digital and Computer Systems* (Butterworth Heinemann, 2006) ISBN 0750681381

Tooley, M – *Electronic Circuits: Fundamentals and Applications* (Newnes, 2006) ISBN 0750669233

Wild, TW – *Transport Category Aircraft Systems* (Aviation Theory Centre, 1990) ISBN 0891003630

## Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	managing time and resources when carrying out a BITE test on aircraft electronic systems.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

## ● Functional Skills – Level 2

Skill	When learners are ...
<b>English</b>	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	explaining the operation of an ADC and a DAC converter describing the function of aircraft fibre optic systems explaining the operation and interfacing of a radio incorporated aircraft data bus using diagrams to explain the operating principles of LEDs, LCDs and CRTs explaining electronic attitude direction indicators and an electronic horizontal situation indicators.
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching and investigating aircraft electronic systems and components
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	explaining the operation of an ADC and a DAC converter describing the function of aircraft fibre optic systems explaining the operation and interfacing of a radio incorporated aircraft data bus using diagrams to explain the operating principles of LEDs, LCDs and CRTs explaining electronic attitude direction indicators and an electronic horizontal situation indicators.