

Module 5 Digital Brainstorm File

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MODULE 5.1 Electronic Instrument Systems

Engine parameters are displayed on ECAM OR EICAS
 The purpose of the EFIS controllers is to select Display type and Source
 The purpose of the command bars on an EADI is to show the direction the aircraft should fly
 EADI. (200 and below) has a rising runway
 Aircraft symbol (chevron or Line) is a fixed feature on the ADI
 HSI Information is invalid when warning flag is in view
 When aircraft is below the Glideslope the GS bug on the EHSI is above the centre mark

MODULE 5.2 Numbering Systems

Binary Number: 110010 is 50
 3 binary counters in cascade - the division is 8
 When 4 binary serial counters connected in series for frequency division, what is division factor? 16 (1=2, 2=4, 3=8, etc..)
 Hex 110 is in decimal 272
 Hex D in decimal 13
 1100 binary is in decimal 14
 Practice for figures that have been in exams!
 Convert 15 decimal to binary
 Convert 345 decimal to binary
 Convert "D" hexadecimal to decimal
 Convert 110 HEX to decimal
 Convert 110010 to decimal

B	i	n	a	r	y	Numbers	
64	32	16	8	4	2	1	
0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	2
0	0	0	0	0	1	1	3
0	0	0	0	1	0	0	4
0	0	0	0	1	0	1	5
0	0	1	1	0	1	1	27
0	1	1	0	0	0	0	48
1	0	1	1	1	0	0	92
1	1	1	0	1	0	1	117

The Hexadecimal Number System uses base 16, includes only the digits 0 through 9 and the letters A, B, C, D, E, and F
 To convert a hexadecimal number into a binary number, simply break the binary number into 4-bit groups beginning with the LSB and substitute the corresponding four bits in binary for each hexadecimal digit in the number.
 For example, to convert 0ABCD_{Hex} into a binary value, simply convert each hexadecimal digit according to the table above.
 The binary equivalent is 0ABCD_{Hex} = 0000 1010 1011 1100 1101_{Bin}

To convert a binary number into hexadecimal format is almost as easy. The first step is to pad the binary number with leading zeros to make sure that the binary number contains multiples of four bits. For example, given the binary number 10 1100 1010, the first step would be to add two bits in the MSB position so that it contains 12 bits. The revised binary value is 0010 1100 1010.
 The next step is to separate the binary value into groups of four bits, e.g., 0010 1100 1010. Finally, look up these binary values in the table above and substitute the appropriate hexadecimal digits, e.g., 2CA.

16 ³	16 ²	16 ¹	16 ⁰
4096	256	16	0

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MODULE 5.3 Data Conversion

A data message containing 1s and 0s is called a digital signal
 An analogue signal has either quantity or a physical position

MODULE 5.4 Data Buses

A Bus controller initiates data on the MIL STD 1553b data bus
 MILSTD 1553B system is controlled by a Bus controller located in one of the Remote terminals
 ARINC 429 Language is BCD or Binary notation or Discrete.
 An ARINC 429 word label format is octal (Bits 1 8) read in reverse
 ARINC 429 word data field is in A BCD Format
 ARINC SDI bits are Bits 9 and 10
 ARINC 573 is used for flight data recorders
 ARINC 629 data bus uses twisted shielded pair (2 wires). and is Bi-directional
 ARINC 629 data bus terminals are connected by inductive coupling (Current mode coupler).
 ARINC 629 Terminal gaps are unique to user and determines priority
 ARINC 629 transmitters and receivers require a Multiplexer and a De-multiplexer (MUX & DEMUX) to convert data to serial format
 Maximum number of terminals connected to:
 ARINC 429 = 20.
 Mil Std 1553b = 31.
 ARINC 629 = 120
 The purpose of the parity bit is to ensure no errors occur during data transmission (error correction for resend of data package)
 The Parity bit is normally the Most Significant Bit (MSB). eg. the last bit
 The Parity bit checks for corruption of data word transmission
 Data bus cables are terminated with a 130 Ohm resistor

MODULE 5.5 Logic Circuits

Truth Tables:

AND-Gate			OR-Gate			NAND-Gate			NOR-Gate			Exclusive-OR		
A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
1	0	0	1	0	1	1	0	1	1	0	0	1	0	1
0	1	0	0	1	1	0	1	1	0	1	0	0	1	1
1	1	1	1	1	1	1	1	0	1	1	0	1	1	0

Amplifier		NOT-Gate	
A	B	A	B
0	0	0	1
1	1	1	0

AND gate is 1 when inputs are BOTH 1
 To create a NOT gate from a NOR or a NAND gate connect inputs together
 An AND gate requires two positive voltages to operate
 An AND gate represents two switches in series
 An OR gate represents two switches in parallel
 OR gate output is 1 unless all inputs are 0
 NOT gate output is always opposite of input
 NOT gate output is 1 when all inputs are 0
 NAND gate output is 1 unless all inputs are 1
 excl-OR output is 1 when inputs are different
 excl-NOR output is 1 when inputs are equal
 NOT gate = single input NAND (or NOR), made by joining all inputs together
 AND gate = NAND followed by a NOT
 OR gate = NOT of each input followed by a NAND
 NOR gate = OR followed by a NOT
 3 binary counters in cascade - the division is 8
 3 binary serial counters connected in series for frequency division, what is division factor? 16 (1=2, 2=4, 3=8, etc..)
 Inputs to a NOR gate inverted it becomes an AND gate

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MODULE 5.6 Basic Computer Structure B2 only

ALU is the Arithmetic Logic Unit and can perform binary addition, subtraction, multiplication, division and also perform various logical comparisons
 Control Sequencer controls and supervises the activities of the microprocessor
 Accumulators provide storage registers, as the ALU can only operate data from one or two registers at a time
 Data or instruction registers are a temporary storage of a data word for data received from the data bus
 Address registers are a temporary storage device of a data word in memory or IO used for the current operation
 Instruction decoder analyzes the contents of the data register & controller-sequencer supplies the appropriate programme for the operation
 Clock is for precise timing of events and may be a crystal, external clock or an LC-tuned circuit
 CPU or Microprocessor is a Central Processing Unit and contains ALU, Control Sequencer, Data & Address Registers, Accumulators, Instruction Decoder and the Clock
 IO-Modules are In-Out modules and are the link between the CPU and the peripheral devices such as printers, keyboard, storage devices, monitor etc...
 Serial port can only transport one bit at a time - parallel port can transport e.g. 8 bits at a time in parallel
 RAM is Random Access Memory = volatile memory - lost when switched off
 ROM is Read Only Memory = non-volatile memory - is not lost when computer is switched off

MODULE 5.7 Microprocessor B2 only
 EPROM is erasable programmable read only memory

MODULE 5.8 Integrated Circuits B2 only

MODULE 5.9 Multiplexing

Multiplexed data is serial data
 ARINC 629 transmitters and receivers require a Multiplexer and a De-multiplexer (MUX & DEMUX) to convert data to serial format
 The TX/RX of ARINC 629 is MUX/DEMUX

MODULE 5.10 Fibre Optic

Function of Data links is to convert electrical input signal to an optical signal, to transmit the optical signal over the optical fibre and to convert the optical signal back to an electrical signal.
 Parts used in a data link are transmitter (LED or Laser Diode), optical fibre (including connector, cable, splice and connector) and receiver (PIN Diode or Avalanche Diode and signal conditioning circuit). The signal in the cable can be distorted, weakened due to absorption, dispersion and scattering in the fibre optics wave guide. Noise (causes weakening of the signal) can disturb the quality of the electrical signal. Cables are classified as single and multi mode fibres. Loss is the decrease of light in respect of input (may be caused by impurities in the fibre material). Loss is measured in dB/km. Low-Loss optical fibres have less impurities and are made of a high-Silica-Core. Multi mode Cables have nowadays a loss (attenuation) of 0.5 dB/km at a wavelength of about 1300nm, whereas single mode cables have loss of 0.25 dB/km at a wavelength of about 1500nm (year 2000). Single mode cables have less loss and are used for long-haul systems. Aircraft tend to use multi mode system cables over short distance e.g in a LAN with multiple connections.
 Advantages of using fibre optical systems:
 System Performance, Economical - low installation - and cost per channel.
 Size and weight and environmental advantages e.g temperature, corrosion, immune to noise
 EMI (do not need a common ground), less signal losses, less bit errors, more rugged and less restrictive in harsh environment www.JAR66.de
 Fibre optic light source is normally a Laser sometimes an LED
 Fibre optic data in a cable is transmitted by reflection
 Fibre optic data is sent by modulating the frequency of a Laser beam
 Fibre optic core material is glass or silicone
 Fibre optic cable connection is normally an end to end connection
 The signal in the cable can be distorted, weakened due to absorption, dispersion and scattering in the fibre optics wave guide
 Main disadvantage of a Fibre Optic data bus is that connections are difficult to join
 Cables are classified as single and multi mode fibres
 Fibre optic has a very large bandwidth
 Fibre optic cables are protected from HIRF/EMI by using optical isolators at the connection ends
 Advantages of using fibre optical systems:
 System Performance, Economical - low installation - and cost per channel.
 Size and weight and environmental advantages e.g temperature, corrosion, immune to noise
 EMI (do not need a common ground), less signal losses, less bit errors, more rugged and less restrictive in harsh environment

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MODULE 5.11 Electronic Displays

X = Horizontal Y = Vertical art the CRT axis
 The primary colours of a CRT are Red Green and Blue (RGB).
 Colour CRT have three guns, these are Red, Green and Blue.
 Ramp or Sawtooth waveform is used in the deflection field for electrostatic deflection
 Trapezoid waveform is used in the deflection field for electromagnetic deflection
 A Trapezoidal waveform counteracts the magnetic coil effect in a CRT
 50/60Hz frequency creates raster effect on a CRT
 LCD displays have the advantage over CRT because they require no internal cooling

MODULE 5.12 Electrostatic Sensitive Devices

When working on ESDS equipment wear a wrist strap. (If on aircraft and no facility for wrist strap, when replacing LRUs, do not touch the electrical pins). Protection against the effects of HIRF is ensured by aircraft bonding leads
 Unshielded conductors should be enclosed in a metal conduit that is bonded to the aircraft
 ESDS bags are sealed by a fold over top and seal with self adhesive ESDS label

MODULE 5.13 Software Management Control

AWN 43 deals with Aircraft Field Loadable Software (previously in AWN 45A)
 Responsible for software changes is the DESIGN AUTHORITY MANUFACTURER
 Control of software is by MANUFACTURER
 Function of priority bit is identify
 computer self-test is by programmed & necessary routines
 The purpose of DO-178B / ED-12B is Software Considerations in Airborne System and Equipment Certification ED-12B is successor of ED-12A
 Definition of level 1 software is CRITICAL
 What document is related to software management? DO 178/12A. (See for changes)

Module 5.14 Electromagnetic Environment

Fibre optic cables are protected from HIRF/EMI by using optical isolators at the connection ends
 Earth loops are prevented from forming by grounding only one end of cable screen

Internal Study Material from www.EASA66.com

MODULE 5.15 Typical Electronic/Digital Aircraft Systems

EFIS compares left and right cockpit displays by comparators within Symbol Generators
 An EFIS with 3 Symbol Generators uses the 3rd Symbol Generator for standby
 Earth rate is approximately 15 dgr per hour
 Basic IRS has three accelerometers and gyros
 IRS Laser ring gyros provide detection of rate of movement about aircraft axis
 Aircrafts present position and heading is required prior to an IRS alignment
 IRS computes distance from accelerations by two successive integrations
 In an IRS the accelerometers are mounted 90 dgr to each other
 FMS operational program is updated every 28 days. A single failure in a Fly by wire system will have no effect on the system
 LAF operates in turbulent condition and will result in ailerons moving symmetrically upwards
 Roll control in FBW is achieved by both ailerons and spoilers
 FBW control surfaces are electrically controlled, hydraulically activated
 Outputs of a Digital ADC are TAS, IAS, Mach No, Altitude, TAT and SAT
 Air Data Computer is also ADC or DADC: Air Data Computers outputs are to EICAS, FMC, EFIS and IRU
Internal Study Material from www.EASA66.com

Outputs from digital ADC: TAS,IAS,Mach No,Altitude, TAT,SAT
ADC feed Alt-FMS-Secondary radar
FMS system gives warning indications for Take off and landing warnings
ACARS MU front panel test button is pressed all lights on for 3 sec, then all off 3 sec, green lights on.

Internal Study Material from www.EASA66.com

The manufacturer is responsible for the OP-programme of an FMS
EIS control panels are physical interfaces between the crew members and the EIS
CMC (Central maint computer) work to PERFORM IN FLT & GND TESTS, BITE
EFIS compares leftright cockpit displays by comparators within the Symbol Generators
Modern ADC gives information to Flight control computer, Air Data Instrument, Engine systems
ADC give information too - EICAS
DADC output goes to IRMP: Inertial Reference Mode Panel
CAC can be tested in air and on ground
Serial to parallel and vice-versa is called Multiplex-De-Multiplex
Engine indications are sent to FDR via ARINC 573
FDR outputs go to the recording unit
FDR input on an EFIS system goes directly to the flight data recorder
FDR inputs are IAS & FWD ACCELERATION
FDR start recording on helicopters when Rotor brake released or when engine starts

The sequence of software designation is software requirement, coding, testing and integrate with hardware.
Level 1 & 2 software modification should be involved the related design organization.
the resistance of wrist strap is one megohm or higher.
Values of ESDS wrist-strap are 250K(OHMS) 1.5 M (OHMS)
ESDS wrist resistance 1 mega ohm.
ESDS bags are sealed by ESDS LABEL
ESDS symbol on a LRU mean DO NOT TOUCH PINS OR LEAVE EXPOSED
FMC tunes the VOR frequency automatically.
FMS controlling and warnings are displayed on EICAS
FMS alerting modes are MSG, FAIL & OFST
IRS computes distance from accelerations by 2 successive integrations
FMS operational program is updated Every 28 days
Engine parameters are displayed on ECAM
Waveform created by electron beam in a CRT, look like prior to contact with screen, if deflected by plates is RECTANGULAR
Deflection field if electrostatics used is RAM P or SAWTOOTH WAVEFORM
Primary colours of CRT are RED GREEN ,BLUE

Internal Study Material from www.EASA66.com

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FMS system gives warning indications for Take off and landing warnings
ACARS MU front panel test button is pressed all lights on for 3 sec, then all off 3 sec, green lights on.
The manufacturer is responsible for the OP-programme of an FMS
EIS control panels are physical interfaces between the crew members and the EIS
CMC (Central maint computer) work to PERFORM IN FLT & GND TESTS, BITE
Command bars are moved the correct amount by instrument feedback
Manufacturers protect against ESDS by using extractor clips
HF aerials are protected against lightning strikes by a spark gap
To stop earth loops forming you earth only one end
When considering HIRF protection (EMC) you bond, screen and use interference suppression
Primary cause of HIRF are BROKEN STATIC WICKS
HIRF: a manufacturer should ensure all unshielded cables are PUT IN METAL CONDUITS
Manufacturers protect against HIRF by MAKING the LRU CASE THICKER
VOR and ILS are indicated on the EHSI
EHSI information (heading hold) is invalid when FLAG IS IN VIEW
EADI (200ft & below) has rising runway

ADC is an analogous-digital converter Air Data Computer is also ADC or DADC: Air Data Computers outputs are to EICAS, FMC, EFIS and IRU
Outputs from digital ADC: TAS,IAS,Mach No,Altitude, TAT,SAT
Number 3 symbol generator is it used for STANDBY
CRT: X-PLATE MOVES HORIZXONTAL, Y-PLATES MOVES VERTICAL
WHAT is deflection field if electromagnetic deflection is used - TRAPEZIOD WAVEFORM
What counter acts magnetic coil effect in a CRT - TRAPEZIOD WAVEFORM
What frequency creates raster effect on CRT? - 50/60Hz (b737 uses 40Hz)
EFIS compares leftright cockpit displays by comparators within the Symbol Generators
Modern ADC gives information to Flight control computer, Air Data Instrument, Engine systems
ADC give information too - EICAS
DADC output goes to IRMP: Inertial Reference Mode Panel
CAC can be tested in air and on ground
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Engine indications are sent to FDR via ARINC 573
FDR outputs go to the recording unit
FDR input on an EFIS system goes directly to the flight data recorder
FDR inputs are IAS & FWD ACCELERATION
Engine indications are sent to FDR - SOURCE ISOLATED
A Helicopter FDR starts when ENGINES are RUNNING

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ARINC 539 is for FDR
ARINC429 has 32 bits
ARINC429 is twisted-pair shield
The parity bit for on ARINC 429 bus checks for corruption, during Tx of a word - error check
ARNIC 429 word label SDI is at 9120 BITS
ARNIC 429 word label is in OCTAL
ARINC 629 is one bus bi-directional
Data coupled to an ARINC 629 databus by an inductive E coupling
Maximum number of LRUs that can be connected to ARINC 629 is 120
A current mode coupler contains an E core, purpose of E core is to COUPLE SIGNAL TO DATA BUS
A bus cable is twisted pair of wires with and has a 130 OHMS RESISTOR AT BOTH ENDS
The TX/RX of ARINC 629 is MUXDEMUX
Maintenance format used on GROUND ONLY
Terminal gap on ARINC 629 is a Unique to Transmitter
ARINC 629 bus has 2 wires
ARINC 629 characteristic is DATA TX BOTH DIRECTIONS ALONG DATA BUS
MIL1553B BUS CONTROLLER initiates the data
ARINC 429 language is BCD or binary notation or Discrete
ARINC 629 TERMINAL GAP is unique to user & determines priority
Max number of terminals to: ARINC 429 = 20 ARINC 629 = 120 Mil Std 1553= 31
Mil-Std 1553b is controlled by Bus Controllers situated in one of the remote terminals

EPROM is erasable programmable read only memory
FMC give discrete warnings
typical application of CRT is weather radar

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Fibre optic core material is glass or silicone
responsible for software changes is the DESIGN AUTHORITY MANUFACTURER
AWN 43 deals with Aircraft Field Loadable Software
Control of software is by MANUFACTURER
Function of priority bit is identify
computer self-test is by programmed & necessary routines
The purpose of DO-178B / ED-12B is Software Considerations in Airborne System and Equipment Certification ED-12B is successor of ED-12A

Definition of level 1 software is CRITICAL
Central Processing Unit (CPU), in a computer , microscopic circuitry that serves as the main information processor in a computer .
Fibre Optics Function of **Data-links** is to convert electrical input signal to an optical signal, to transmit the optical signal over the optical fibre and to convert the optical signal back to an electrical signal.
Parts used in a data-link are transmitter (LED or Laser Diode), optical fibre (including connector, cable, splice and connector) and receiver (PIN Diode or Avalanche Diode and signal conditioning circuit.
Fibre optic data is transmitted by **laser emission** & refraction & reflection!
The signal in the cable can be distorted, weakened due to absorption, dispersion and scattering in the fibre optics waveguide.
Attenuation: Optical loss of power. Attenuation is measured in dB loss per length of cable. Attenuation is usually caused by absorption and scattering.
Absorption: One cause of attenuation where light signal is absorbed into the glass during transmission.
Scattering: A second cause of attenuation. Scattering occurs when light collides with individual atoms in the glass.
Noise (causes weakening of the signal) can disturb the quality of the electrical signal.

Cables are classified as **single and multi-mode** fibres.
Cable loss is the decrease of light in respect of input (may be caused by impurities in the fibre material). Loss is measured in dB/km. Low-Loss optical fibres have less impurities and are made of a high-Silica-Core. Multi-mode Cables have nowadays a loss (attenuation) of 0.5 dB/km at a wavelength of about 1300nm, whereas single-mode cables have loss of 0.25 dB/km at a wavelength of about 1500nm (year 2000).
Single mode cables have less loss and are used for long-haul systems. Aircraft tend to use multi-mode system cables over short distance e.g in a LAN with multiple connections.

Advantages of using fibre optical systems: System Performance, Economical - low installation - and cost per channel. Size and weight and environmental advantages e.g temperature,corrosion, immune to noise EMI (do not need a common ground), less signal losses, less bit errors, more rugged and less restrictive in harsh environment, Safety due to lack of sparks.
// Data security. ...
Fibre optic cable whose end is parallel with another fibre optic cable but not touching is called END TO END FIRING
To prevent HIRF entering a fibre optic cable USE OPTOISOLATER COUPLINGS
Advantage of single mode fibre optic cable over ordinary cable is the LARGE BANDWIDTH
Fibre optic data is sent by Modulating frequency of a LASER BEAM Fibre optic cables are protected from HIRFEMI by using? Optical isolators at connection ends

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Binary Number: 110010 is 50
3 binary counters in cascade - the division is 8
When 4 binary serial counters connected in series for frequency division, what is division factor? 16 (1=2, 2=4, 3=8, etc..)
AND gate is 1 when inputs are BOTH 1
To create a NOT gate from a NOR or a NAND gate connect inputs together
Hex 110 is in decimal 272
Hex D in decimal 13
1100 binary is in decimal 14
If a signal has quantity & physical position it is ANALOGUE

Dot MatrixLED construction is 4x7 OR 5x9 ROLLING END DISPLAYS
A single failure in FBW system has no effect
LAF operates in turbulent condition and will result in? Ailerons moving symmetrically up-downs
Roll control in FBW is achieved by Both ailerons & spoilers

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