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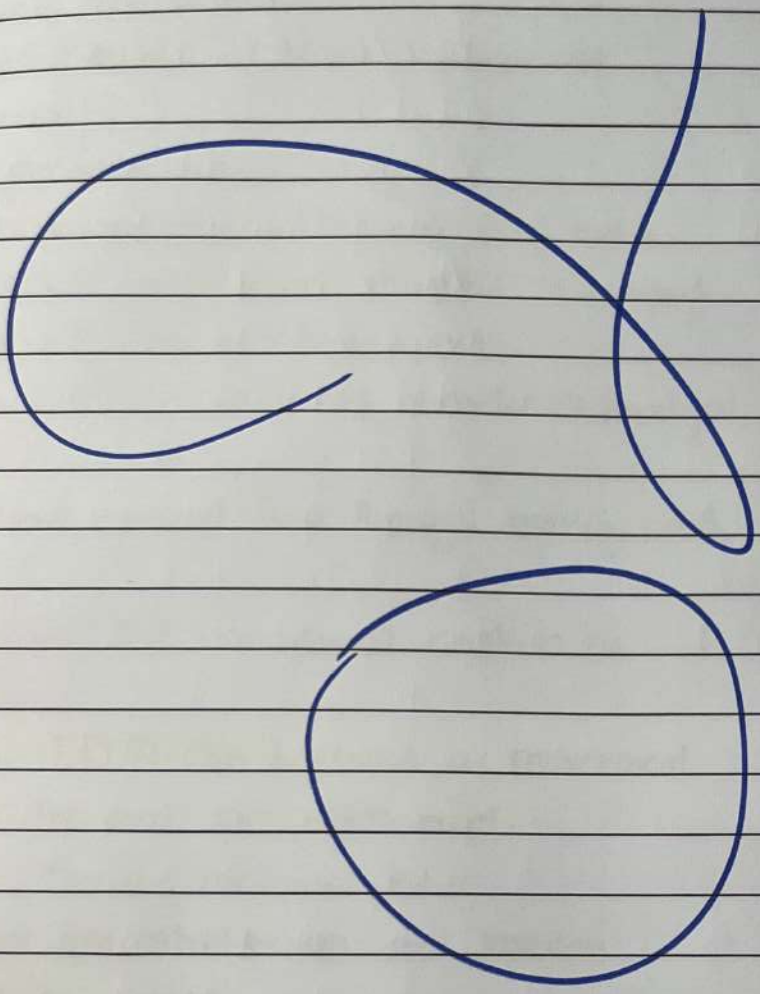

EDM

~~A~~ JArsonval use permanent magnet

Electrodynamometer Meter movement

used to measure
Alternating or direct voltage and current
operate like :
permanet magnet moving coil meter,
except permanent magnet is replaced by air core electromagnet.
The field of electrodynamometer is developed by
same current flow through moving coil.

because this movement contain no iron,
The EDM can be used as movement for Ac and DC instrument.
Ac can be measured by
connecting stationary and moving coil in series.
current through coil reverse,
magnetic field produced by stationary reversed also, direct relationship.
for either Voltmeter or Ammeter
EDM is too expensive.

Component :
-> fixed coil
-> pointer
-> moveable coils
-> control spring
-> shunt
-> moving iron segment.

NO: DATE:

Moving iron vane meter

Another basic type of meter is moving iron vane meter.
uses to measure either
Ac or Dc
depend on
induced magnetism for it's operation
it utilizes the principle of repulsion between two concentric iron vanes, one fixed and one movable, placed inside solenoid
-> pointer attached to the movable vane

Basic operation:
when current flow thru coil:
-> two iron vane become magnetized
-> North poles are at upper end and south poles are at lower end of one direction of I.
like poles repel each other:
This create unbalanced forces that cause the movable element to turn against the spring force

Design feature:
-> movable vane : rectangular
fixed vane : tapered
This design allow for relatively uniform scale.

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Scale and measurment:
when no current flows:
→ movable vane in opposite larger portion of fixed vane, resulting zero scale reading
Magnetization strength depends on:
→ The strength of magnetic field, which is influenced by current flowing through coil.
force repulsion:
→ greater opposite the larger end of fixed vane
→ movable vane moves toward the smaller end, proportional coil current.
Current type:
Instrument operate on both DC and AC circuits:
The repulsion direction remain the same regardless of current flow ~~flow~~ direction
Mechanical damping:
Achieved using Al vane attached to the shaft, moving in restricted air space.
Usage of Ammeter and voltmeter
Ammeter:
Coil wound with few turn of large wire to carry rated current.
Voltmeter:
→ Solenoid wound with many turn of small wire
→ portable voltmeter have self-contained series resistance for up to 750 volts
→ higher range use external multipliers.

Accuracy and limitation
→ can measure DC
→ but may have errors due to residual magnetism
what can minimize errors
→ reversing connection
→ averaging reading.
Ac circuit:
0.5 %.
Advantage:
→ low cost,
→ no I connected to moving element
Disadvantage:
→ high reluctance to magnetic circuit require more power for full scale deflection compared to d Arsonval
→ no used in high resistance low power circuit

Varmeter:

Apparent power:
→ Volt X Ampere in Ac circuit
→ Combination:
Truepower: Does the work
Reactive power: Does no work and is returned to the line
Reactive power
→ measured in Vars (VAR)
→ Kilovars (Kilovolt-ampere, abbreviated: KVAR)
→ wattmeter when connected, measure Q and called varmeter.

NO: DATE:

wattmeter:

→ Electrical power:
→ is the product of I and V
requiring two elements in wattmeter:
1. current element
2. voltage element
→ are usually of the EDM type
→ movable coil with series resistance form voltage element
→ stationary coil constitute current element.

working principle:

The strength of field around potential coil depend on:
→ amount of current flowing through it
→ the load voltage applied across coil
→ the high resistance in series with it.
The strength of field around I coil depend on:
The amount of current flowing through it
The meter deflection is proportional to the product of:
→ The V across potential coil
→ The I through current coil.

Frequency measuring oscilloscope:-

Overview of oscilloscope:

→ oscilloscope is crucial electronic measurement tool.
→ allow user to see and measure various waveform characteristic:
- phase relationship
- Amplitude
- Duration

Basic operation:

→ comes in different configuration but their basic operation is similar
→ most common type: use cathode-ray tube (CRT) for display

Cathode Ray tube:

is vacuum instrument with several key component.
Electron gun: Emit narrow and focused beam of electron
phosphorescent coating: Applied to the back of screen it emit light when struck by electron beam.

Component of CRT

1. Heated cathode: Emit electron
2. control Grid:
→ control flow of electron
→ determine intensity of electron beam based on V applied
3. Acceleration Anode:
↑ the speed of electron
4. focusing Anode:
Narrow electron beam a fine point
5. screen surface:
Act as anode to assist in accelerating the electron beam.

Deflection plates

The vertical and horizontal deflection plates bend the electron beam to position it on the screen

NO: DATE:

Voltage effect on Deflection plates:

Neutral / zero V: No effect on the electron beam.

Negative V: Repels the electron beam, driving it away from the plate.

positive V: Attract the electron beam, drawing it toward the plate.

Beam positioning

Different V combination on the deflection plates result in various beam positions on the screen, as illustrated.

Horizontal Deflection:-

A saw tooth voltage:

→ is generated internally

→ This voltage is applied to the horizontal deflection plates.

→ start at −V and ↑ to a +V at constant rate.

→ Causes electron beam to move from left side of screen to the right, if sweep rate fast enough the resulting display appears as straight line.

→ is repetitive signal.

→ The frequency of saw tooth determine sweep rate of the beam.

When saw tooth reaches end of its sweep:

→ The beam returns to the left side.

→ This return period called flyback, during which beam is blanked out and does not trace anything.

Vertical deflection

If saw tooth signal is applied to the vertical plate it will produce vertical line

→ The beam will trace from the bottom to the top of the screen.

Tracing A Sin wave

Reproducing a sine wave on the oscilloscope involves Both vertical and horizontal deflection plates

When sine wave voltage signal is applied to the vertical deflection plates:

→ The beam oscillate up and down on screen

→ The height of beam movement above centerline depends on peak value of V.

While the horizontal plate

→ sweep the beam from left to right

→ The vertical plate apply sine wave V, allowing the input signal to be traced on the screen.

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Control features on Oscilloscope

There are many different types of oscilloscope, Apart from screen and on/off switch,

Horizontal position:

→ Allow for adjustment of horizontal position of the beam

→ use this control for reposition the waveform display for better viewing or measurement

Vertical position:

→ moves traced image up or down

→ help in making better observation and measurment

focus

→ control the electron beam as it travel and converges on screen

→ When in sharp focus, the beam is narrowed to fine point, avoiding a fuzzy appearance

Intensity

→ Refer to the brightness of trace

→ controlling flow of electron on the screen varies the intensity.

important: Do not keep intensity too high for extended testing or when beam is motionless, this can Damage screen

Second/division

→ time based control that set horizontal sweep rate

→ select time interval that division on each horizontal represent

C seconds, milliseconds or microseconds

10ms, 4 division => 40 ms

Volt / division:

→ used to select voltage interval that each division on vertical scale represent

10, mV, peak value 4 divi

then peak value in V:

$4 \times 10 = 40$ (mV = 40)

Trigger:

→ provide synchronization between saw tooth horizontal sweep and applied on vertical

→ Ensure that waveform on screen appear stationary and does not drift

Basic Circuit Troubleshooting

Troubleshooting:

is systematic process that involve:

1. Recognizing the symptoms of problem
2. identifying the possible cause
3. Locating the ~~fault~~ Failed component or connection in circuit

To be proficient at troubleshooting, technician must:

→ understand how the circuit operate

→ know how properly use the test equipment

Definitions

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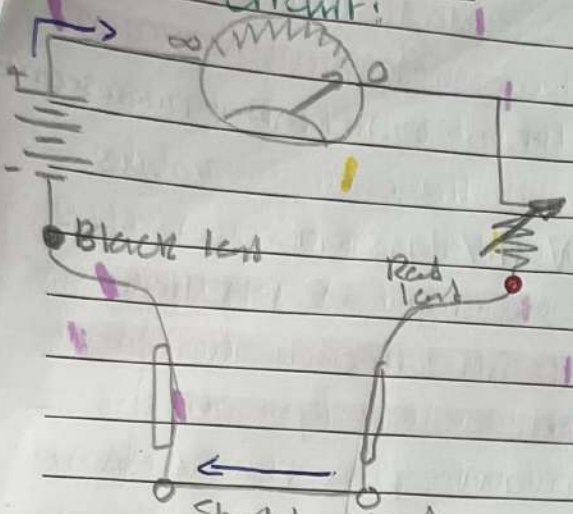
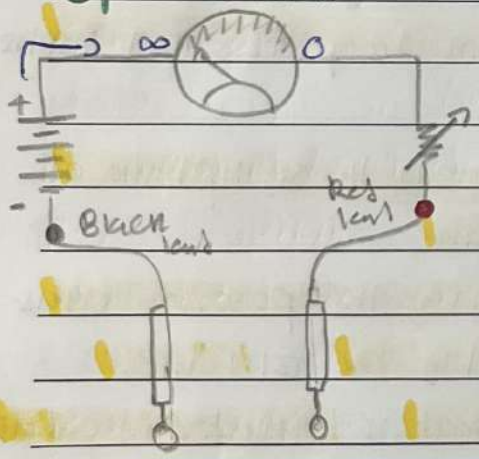
Short circuit:



→ An unintentional low R path between two component or between component / contacts and ground

→ usually create high current flow, which can burn out or damage the circuit conductor or component

Open circuit:



→ A circuit that is not complete or continuous path.

→ Represent infinitely large R

→ switch are common device used to open and close circuit

→ circuit may open due to component failure, such as light bulb or burned out Resistor.

continuity:

→ being continuous, uninterrupted, or connected together

→ The opposite of circuit that is not broken or does not have an open discontinuity

→ the opposite of continuity, indicating that a circuit is broken or not continuous

Part 2. Avionic General test equipment

NO: DATE:

Built-in test Equipment

Overview

-> Avionics maintenance, electronic troubleshooting and repair of avionic line Replacement unit (LRUs) is done by B-2 technicians

-> BITE (Built-in test Equipment) is crucial for avionics testing, especially for B-1 engineer.

Features of BITE

-> is found on all modern aircraft

-> it can be:

- Built in to individual LRUs
- parts of computerized central maintenance system.

-> The system may include several BITE electronic units for testing multiple LRUs.

Functionality:

BITE sends and receives signals to:

-> Detect faults

-> isolate faults

-> Verify operating parameter after repair or replacements.

- Fault detection is continous, once fault is found, isolation sequence starts to identify the issue.

Display and communication:

- BITE display are accessed via control display unit (CDU) located on flight deck and in the avionic compartment
- Flight management system (FMS) may integrate the central maintenance computer interface on same CDU panel used by flight crew.
- Faults and corrective action can be printed and downloaded electronically.
- Automatic Aircraft Communication Addressing and Reporting system (ACARS) sends maintenance data to ground station during flight, allowing for quick repair upon landing.

Wireless communication:

modern ~~digital~~ diagnostic system allow for wireless troubleshooting using:

- WiFi
- Cellular
- satellite technologies

Detected BITE systems:

ADC
- Air Data computer

AA
- Antiskid - Autobrake
- ARINC
- HF communication

HCR
WR
- Window Radar

WH
- window heat

- lighting
- fuel quantity

AT
- ATC transponder

ADF
- Automatic Direction finder
- Hydraulic management

- Inertial Reference system
- Electronic flight instrument

- Oxygen measuring Equipment
- fire and overheat

integrated systems:
→ modern aircraft electronics are part of an integrated system connected via data bus.
→ malfunction may only be evident when the unit is installed and integrated with other avionics

classification by function:
ATE can also be classified by function into two basic categories:

1. Generators:
→ provide a known signals or stimulus to the Tested unit.
→ often interact with ~~stg~~ unit and relase the test signal after certain condition are met
→ More sophisticated generators are referred to test sets

2. Analyzers:
→ Determine if the output of the unit is within design tolerance
→ can be shop or portable
→ common type include:
Multimeters: measure V, I, R
many modern multimeter can measure f, C, T
Oscilloscopies: Visualize electrical signals
f Domain Analyzer: include Spectrum analyzer, modulation meter, and distortion meters.

Modern Analyzing Techniques

~~→~~ > many modern Aircraft utilize computer based analyzing

NO: DATE:

→ Technician can connect portable laptop computer to processing and displaying information
→ in some cases, adapter units allow direct access to digital data bus.

Avionics Test Equipment

General safety:
→ Every piece on ATE must be operated according the manufacturer instructions.
→ Technicians should be aware of the dangers of high V and electrocution of using test equipment on both energized and non-energized avionics.

Oscilloscope:

→ measures variations of parameter as a function of time and displays them on a screen
→ Typically measures V and other parameters obtained by processing the V signal
→ useful for indicating rapid variation such as:
1. Ac V 2. pulses 3. Spikes 4. complex waveform
→ primary used in bench testing of equipment and rarely on actual aircraft.

~~Time~~ Domain Reflectometer (TDR)

NO: DATE:

→ Used to check standing waves in transmission lines

→ Similar in appearance to an oscilloscope (unit)

→ The trace signal indicates:

1. An open or short
2. Distance along Transmission line where the open or close occurs (read from the graticule)

Can indicate if cable is pinched or frayed:

→ pinch condition appears as dip due to added impedance

→ Fray causes the trace to drift up

• These condition often appears as minor dips or rises in the trace signal

Spread Spectrum Time Domain Reflectometer (SSTDR)

→ perform same function as TDR and provide same information

Advantages of SSTDR:

- Ease of use
- Greater precision
- portability

→ SSTDRs do not interfere with digital circuit, and the aircraft circuit do not affect the diagnostic results

→ can be as small as digital multimeter and directly indicate whether the circuit is open or shorted.

→ Also indicate how far down a transmission line the issue is located (in feet or meter)

→ Helps technicians go directly to the location for repair or replacement.

pitot static Test Equipment

→ must be test periodically to ensure accurate information to the flight crew

Typical instrumentation includes:

- Altimeter
- Vertical speed indicator
- Airspeed indication

Optional feature may include:

- Chronograph
- pressure indicator for test unit pitot and static pressure

Two types of diagnostic equipment for testing the pitot static systems:

→ manual operation using small hand pump to change system pressure

→ Electrical operation to change system pressure

Overview

→ aircraft maintenance manual provide guidelines for safety connecting and testing aircraft

→ Test equipment manufacturer include instructions for proper connection and operation

→ Technicians must ensure that equipment and aircraft limitations are not exceeded to prevent damage to avionics system.

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Equipment Calibration & Connection

- pitot-static test equipment must be calibrated and checked for compliance before testing.

The equipment typically includes:
A test kit or box with valves and indicators.

Connection process
- use hoses and fitting from kit to connect to the aircraft
- Block off appropriate static ports with tape or approved covers.

Preparing the Aircraft:

- in some transport category aircraft, the system must be "fooled" into thinking it is a flying configuration.
- Always refer to the aircraft manual for the correct configuration for testing.
- connect test equipment hoses to their respective locations, ensuring they are placed to avoid interference.

Conducting the test:

- perform function test focusing on:
  - → Airspeed → vertical ascent / descent rates
- stay within aircraft and equipment limitation
- Electronic pitot static testers are available with:
  - → Digital displays
  - → programmable limit to prevent damage.

Troubleshooting:

if the system fails:

1. check that all the ports are sealed and the aircraft is configured correctly.
2. review the aircraft logbook for recent maintenance on avionics components
3. inspect for loose fitting around component
4. use another test unit to rule out tester issues.
5. if problems persist, replace defective indicators or check fitting in pitot static system

→ Always record the result in logbook or work card.

post test procedures:

→ remove blocking covers and tape used during testing.
→ store all equipment carefully to avoid damage to hoses

Specialized Test Equipment

→ Each unit of communication and navigation electronic equipment can be tested with specific electronic testing device.
→ using specialized devices simplifies testing and troubleshooting
→ Example:
IFR 4000 tests VHF Nav/Com radio bands

88 Test Equipment

Calibration Standard

Important of calibration

-> using uncalibration test equipment can lead to inaccurate results

-> Test equipment must be suitable for intended unit.

Calibration standards

TECS must be traceable to:

- National institute of standard and Technology. (NIST)
- Standard established by test equipment manufacturer (TEM)
- Standard of the country of manufacturer for foreign equipment

Technician Responsibility:

- Ensure that the test equipment used is as specified by manufacturer or equivalent
- Compare specifications of recommended test equipment with those proposed by repair facilities
- Test equipment must perform all normal test and check all parameters of equipment under test.
- Accuracy should meet or exceed manufacturer recommendations.

Calibration intervals:

-> vary by equipment type, environment, and usage.

-> Accepted industry practice is usually one year.

-> Consider manufacture recommendation and past calibration history for acceptance.

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Note:

if manufacture manual lack a specific test procedures, coordinate with manufacture to develop acceptable procedure before use.

Functional Checks:

Responsibility:

- The pilot in command must ensure all equipment is functioning properly.
- Engineer also share this responsibility, especially after repair or replacement.

procedures:

- familiarize with intended use of the equipment
- perform thorough operational checks according to the manufacturer instruction.