Maintaining and Troubleshooting Digital Bus Avionics Systems

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As someone who has taught and written many classes and articles on avionics troubleshooting, I get a good number of questions on how to troubleshoot a digital bus. Digital bus avionics systems have been around for quite awhile now. For some of us who have taken delivery or are about to take delivery of an aircraft with multiple digital bus systems, this can be a daunting learning experience. Couple that to a host of old hardware based systems packaged in new architecture and now having become a software based system, lookout! Things are going to get interesting to say the least.

Before getting to far down the road, please remember that what we are writing is good information…**BUT** having said that, always refer to the appropriate OEM's Instructions for Continued Airworthiness (ICA) for actual troubleshooting and Return to Service procedures.

I have taught hundreds of avionics classes over the years (and I still do if you are interested), and one question that I am asked over and over is this, "What is the secret to troubleshooting an avionics system correctly the first time?" There really is no secret per se, thinking about the indications that are presented, good common sense, and following procedures never hurts.

The first step in any troubleshooting procedure is to identify the system believed to be at fault. In the case of avionics systems this is important to the extent that the cause and effect syndrome comes into play. System B is showing a fault because it relies on an input from System A. System B is showing the effect, but System A is the real culprit. My axiom that I have come to trust over the years is, "Whichever system is understood the least, will be blamed the most."

To begin troubleshooting any avionics system there are a few general rules that should always be followed:

1. The pilot has written up a squawk that a system is not working correctly or has failed. The first action that maintenance needs to do is identify the system. Remember our friends cause and effect.

2. The second action that maintenance needs to do is verify the squawk. Is the system in fact operating out of its normal parameters? Are all of the switches and circuit breakers in their correct operating positions? Before we can say that a system is not operating "correctly", we need to understand what "correctly" is. What flags and/or failure indications were displayed on the flight deck displays?

3. Is the squawk specific in nature or very general in its terminology? If need be, is the pilot available to shed additionally light on the problem?

4. Are the pilot and maintenance manuals for the aircraft and system the latest and greatest? Are the latest revisions to the manuals available? If your manuals are out of date, so might be your ability to troubleshoot correctly.

5. Is there a maintenance specialist who has been properly trained on the system in question? I don't mean in a two week aircraft familiarization class where only three hours were spent in

total on all the avionics systems. Something like, “This is an EFIS symbol generator, remember it as you will see it again sometime.” I mean a technician who has attended a factory school on the system to become qualified to troubleshoot and maintain the system to the LRU level. This person has also gone for refresher training every 24 or 36 months.

If the answer to any of these five rules is no, then you have put yourself at a serious disadvantage to getting it right the first time. What follows are some general tips on how to maintain and troubleshoot systems with digital buses and glass cockpits.

Cleaning and Repairs

When cleaning the front of a Liquid Crystal Display (LCD), a good rule to follow is to first remove particles of dust or dirt with pressurized dry air or a soft camel-hair brush. The display glass should only be cleaned with a soft, lint-free cloth and Isopropyl Alcohol or Neodal 1-5 (Alcohol Ethoxylate). Other cleaning solutions should not be used unless specified by the system’s OEM.

Replacement Parts

Although the LRU’s cannot generally be repaired in the field, some knobs, switches and controls can be field replaced if damaged. Generally these items are listed in the ICA and instructions for field replacement are also listed. Care should be taken not to lose fasteners and setscrews in the removal process.

Electro-Static-Discharge (ESD)

ESD is a problem once thought to be limited to bench repairs and component level maintenance. ESD is the spark you feel when you touch a door knob after walking across a carpeted floor. It is now known to exist everywhere and can damage electronic LRU’s during routine maintenance. Since more and more avionic systems are using a modular concept, (Honeywell’s Primus EPIC System on the AW139 as an example), there are a number of modules that are field replaceable and ESD prevention is of paramount importance.

Reduce the Risk

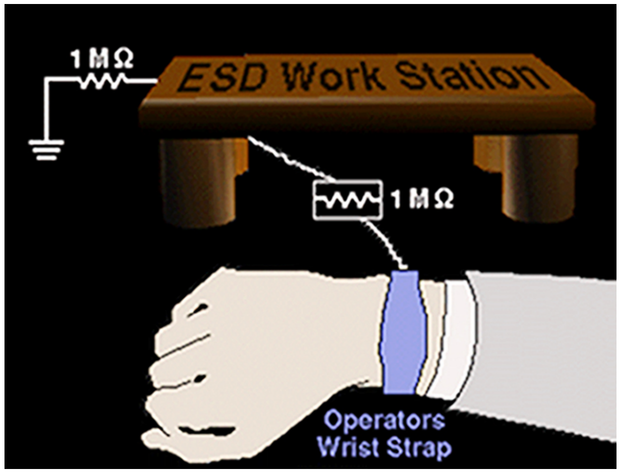
Always “ground” yourself before handling LRU’s or any avionics components. Touch a metal airframe part that you know is connected directly to the airframe ground prior to handling LRU’s. Continue to “ground” yourself occasionally as you move around in the aircraft or shop areas.

The ultimate solution for the ESD danger is to always maintain a “static-free” condition on your body. In the shop or at the repair bench, this can be accomplished by the use of an ESD approved wriststrap and grounding pin.

This is difficult in an aircraft so alternate solutions, such as airframe touching, must be practiced and maintained whenever handling avionics components.

New avionics designs on aircraft feature equipment cabinets and modular circuit card assemblies. The removal of these circuit cards while in the aircraft will greatly enhance the maintainability of the aircraft, but it will expose the circuit cards to an extreme ESD danger.

Future aircraft will require the use of grounding straps and ESD protective packaging during all maintenance functions.



Keep LRUs in their original Static Protection Packaging until ready for installation. Keep connector covers in place until just prior to installation. Place protective connector covers on LRUs as soon as they are removed from the aircraft mount.

LRU Troubleshooting/Fault Isolation

The most obvious place to start is where did the fault occur? Was it on a ground test, or in-flight? If the fault occurred in-flight, good communications between the flight crew and the maintenance department is essential to quickly and correctly determine what caused the fault.

Under what conditions did the fault exist?

What flight modes if any were operational? What was the aircraft doing, climbing, descending, straight and level, or following some flight guidance modes?

Completely describe the fault.

What system flags and annunciators were visible? Did any inputs from other systems fail to work?

If the system has a Crew Alerting System (CAS), were there any red messages?

Does the Fault Isolation section of the ICA cross-reference messages to a Central Maintenance Computer (CMC) page?

If the system is a dual system, it is possible to swap LRUs to verify that the problem follows an LRU. This helps to quickly isolate the problem to the LRU or aircraft wiring.

A quick power and ground check should be done if the failure of the LRU appears to be total and isolated to a specific LRU location.

Good operating practices for line maintenance procedures include turning off avionics and/or aircraft power prior to removing or re-installing LRUs in the aircraft. It is best to pull the circuit breakers on any equipment before removing the unit. Keep in mind that some LRUs may have more than one circuit breaker depending on the installation and electrical bus configuration.

Visually inspect the LRU for damage and examine the connectors (both the LRU and the aircraft side), for bent pins or other damage that would hinder installation.

Don't try to force fit the LRU. If the unit does not slide smoothly into its mounting tray, or the connector does not smoothly mate, it may be an indication of a mechanical problem or bent pin that needs to be resolved.

Data Bus Troubleshooting

Current data bus systems are quite robust, and if initially installed properly, they will give years of trouble free service. Since most data bus signals are very low in power, any change in bus impedance can become a problem. With helicopters operating in some pretty hostile environments, corrosion will most definitely create connector and bus problems.

There are many different types of data buses currently in use. Avionics Standard Communications Bus (ASCB), Aeronautical Radio Incorporated (ARINC), and the Commercial Standard Digital Bus (CSDB) are some of the more popular. There are others to be sure, but we don't have to list them all here.

Essentially a digital bus is at least one or more pairs of wires that carry information to and from and in-between avionics LRUs. Some buses can talk to numerous LRUs on just a twisted shielded pair of wires. Other buses require a twisted shielded pair of wires for each piece of data being transmitted and received. The digital bus carries data in a specific language. It is the design of the bus and the language used that determines the architecture of the bus. Troubleshooting a bus may be as simple as using a digital ohmmeter, or an oscilloscope and a signal generator may be required.

A great indication that a bus failure has occurred is when all LRUs on a particular bus show that they have failed. If only one LRU has failed and there is no CAS in the aircraft to give an indication of what the problem may be, then it could be the LRU or its connection to the bus that is at fault.

If the aircraft has a dual system, a good first step would be to take the suspect LRU and install it on the other system's side. It that LRU now works, the LRU itself is good and there is either a connection or bus problem on the suspect side. In this instance, a "bus sweep" is most probably required.

A bus sweep is simply an electrical examination of the data bus for opens, shorts, and correct terminations. The sweep is started by removing **ALL** the LRU's connected to the bus. The resistance across the bus is measured, and should be the specified value as called out in the aircraft's ICA Fault Isolation section. A Meggohmeter is employed to insure that there are no high resistance shorts between ground and each of the bus wires.

Another possible method involves the use of a DC signal generator and a portable dual trace oscilloscope. The signal generator outputs a fixed amplitude square wave at an appropriate frequency, and that is injected into the bus. The first trace of the oscilloscope monitors that the input to the bus is correct. Using the second trace, the technician checks the positions of all the bus interconnects on the suspect side. An open on the bus will show source voltage and a short will read 0 volts. In this fashion, a determination is made as to just where on the bus is the fault.

I hope that you will find this article useful and if you would like to see more troubleshooting articles, please let us know.