TROUBLESHOOTING INTEGRATED FLIGHT DECKS

BY KIM WIOLLAND

Troubleshooting current-day avionics systems does present some challenges because the level of integration and complexity can vary from aircraft to aircraft. The technician must step back and evaluate each individual system and how it plays into the entire flight deck design.

As with most aircraft today, the flight deck has become less congested with individual components and much more integrated. One should initially consider using a block diagram approach with the multitude of component and sensor inputs, then isolate down from there. The random failures of components and their systems always will be present, but will happen less frequently because the reliability on the current-day systems is so high.

Modular integrated systems are the dominant architecture today in the new aircraft and have replaced the earlier integrated systems composed of dissimilar avionics components. The earlier systems, while still integrated, were from multiple manufacturers with different levels of technology in each.

Systems evolution has brought us a common level of embedded technology with such things as the primary flight display with internal gyro and air-data computer. These current levels of embedded systems and integration has resulted in less exposure to internal box details, thus the technician's insight can be limited, regardless of the size of his library.

Confronted with this scenario, we can still apply the basics, confer with the equipment manufacturer and, with some due diligence, get beyond any frustration arising in the troubleshooting process. System integration does not always lend itself to simplicity of operation in all cases, so a careful methodical approach is important.

Technicians should take advantage of this technology and the software tools embedded within each system. A few examples include installation configuration menus; fault logs with embedded time stamps; and serial interfacing to laptops for system diagnosis, such as in the KAP140 autopilot. Bearing in mind, all the advantages the technology brings, the answers don't always come easily.

Gathering Information

Gathering information is the first step in any troubleshooting process, and it remains an important first step here as well. The debriefing session with the pilot can certainly dictate the level of information you may need to resolve the problem. After debriefing, let the pilot show you the problem and pay attention to his actions as they may be leading indicators as to why the problem exists.

The technician also should confirm if the owner has a current set of avionics installation drawings as they are always a welcome tool to any troubleshooting and are rarely appreciated until a failure occurs. You should impress on the owner the value of a specific drawing set with any installation your shop completes, as it will save him money in the end.

If no drawing sets are available, then a review of the current equipment list and aircraft logs may provide some valuable insight into what remote type equipment also is installed. If your shop is familiar with the aircraft, some of these questions are easily answered.

Evaluating the Problem

After the initial information gathering, you should have better insight into what specific system or component you need to concentrate on troubleshooting. I find it best to get all systems up and running initially. Once the problem is identified, then start isolating system components.

The systems configuration menus normally can provide confirmation on the bus methods used to integrate each system within the flight deck. If there is a mix of newer equipment with some legacy systems, there may be interface boxes as well to complete the link.

It is always good practice to stimulate whatever outputs the components allow you to in order to confirm specific functions. The technician should make notes of what he finds and contrast those with what information the pilot offered.

Technicians should exploit any component in the system that allows them to view real-time data, as in the Sandel SN3308 EHSI. This instrument incorporates both dvm and diagnostics pages, which can be of significant help when diagnosing this particular system.

Circuit breakers also may be pulled to generate lost communication messages or simulate failed sensors. Even turning off receiver and transmitter ports on some specific components should cause a response elsewhere, which can help narrow down the search for the problem. This initial cockpit evaluation should be done prior to disturbing any equipment, thus establishing a baseline from which to work.

Investigating Deeper

If the initial evaluation has left you with no solution to the problem, it's time to dig a little deeper. If you have the luxury of swapping out any components in the system, do it prior to contacting the manufacturer for discussion of your problem as this is a common first question.

Having completed your initial evaluation of the problem, you now are armed with some specific information and in a position to contact the manufacturer. This call can accomplish several things. One, it should confirm the currently interfaced equipment is compatible. Secondly, it can eliminate certain components as being the source of the problem.

As always, the service representative may have some knowledge of your problem based on another dealer's input or his own unique insight. Although the manufacturer may only suggest what you already have tried, don't overlook this step. Remember, the field service representative is not always able to view the problem from inside the box but rather from a system perspective. Ultimately, the technician in the field must come up with the proper tools, troubleshooting techniques and the best information available to resolve the problem.

If the problem appears hardware or wiring related, one of your best tools is a breakout cable. Each shop should evaluate what breakout cable requirements it has and put those slow days to good use as these cables are a very useful tool. With these cables giving you pin-out access to a system component, you are ready for some dynamic testing of any discrete wires or busses between system components.

The next two pieces of equipment you are most likely to need are a handheld meter and a scope to analyze any signal problem.

Data Busses

With the dominance of the data bus in today's avionics, let's look at what we can expect to see on a few of them.

The aircraft data networks and the discrete bus interfaces used in these aircraft provide for a more healthy aircraft by transferring system status among the various components and, in some cases, generating specific smart warnings or messages. Important to any troubleshooting, the technician should have a general understanding of what some of this data looks like.

The standards most widely used are RS-232, RS-422, RS-485, ARINC 429, ARINC 453, ARINC 561/568 and the Collins CSDB. The RS-232 standard, which was born in the 1960s, still is serving us well. Single-ended busses like RS-232, even with their limitations, are still widely used due to the simplicity of their implementation. The CSDB scheme, while specific to Collins and also single-ended, utilizes RS-422, which is a balanced differential signal transmitted in an asynchronous format.

A differential signal where either signal line complements the other is effective in a noisy signal environment. The presence of some noise is not uncommon and should not cause loss of data in most cases when a signal of this type is used. As shown in the first screenshot (Figure 1), digital noise is present on this DGS-65 digital heading output and, while it may not be typical, it does present a good example.

Another legacy bus still used today, although to a lesser extent, is the ARINC 561/568 standards. This format utilizes three signals (commonly referred to as 6 wire) consisting of

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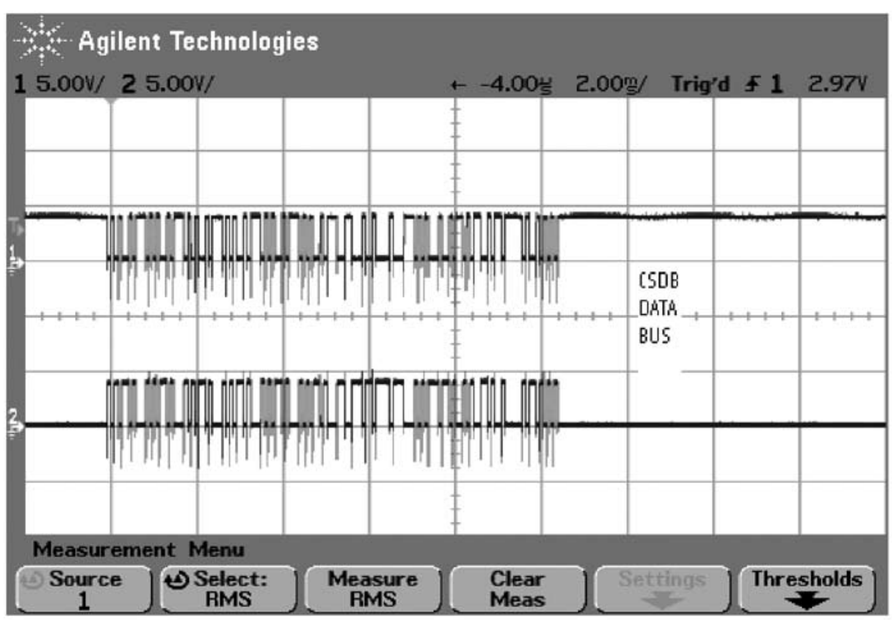

Figure 1

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clock, sync and data lines.

This scheme is used mostly to drive distance readouts on electromechanical HSIs, DME indicators, some early EHSI displays and older long-range navigation systems. The clock line is a continuous 50 percent duty cycle frequency in the range of 11 to 12.5 kHz, so this screenshot (Figure 2) is taken only of the sync and data lines. The data line is a 32-bit field with the first eight bits designating which type of data follows, either 561(long-range distance) or 568 (DME distance).

If your oscilloscope has the ability to freeze-frame and expand in time, great; the main concern is just data presence at this point. Once the bus operation is confirmed, it may just come down to compatibility and/or configuration. Regarding this standard, the KLN900 has multiple different configurations available when interfacing to the older electromechanical instruments based on their display range and decimal usage.

With this in mind, it is clear some problems may just require a simple reconfiguration. This standard is shown in Figure 2 and depicts ARINC 568 data as indicated by the presence of both label bits 1 and 8, while ARINC 561 data would be represented when only bit 8 is transmitted.

The ARINC 429 is the most widely used bus type as the standard form of communication for integrated systems. This bus also is represented as a 32 bit field with each line complementing the other. Transmitter repetition rates will vary depending on the specific label transmitted and, in some equipment like the KLN90B, a burst of multiple labels will be sent all at once.

Let's look at some specifics to this bus that may help in troubleshooting. The transmitter output impedance is specified to be 75 ±5Ω divided equally between line A and line B to provide a balanced output. The receiver differential input impedance should be 12kΩ, then less as you add receiver nodes — however, never less than 400Ω, even when the system incorporates the maximum capacity of 20 nodes.

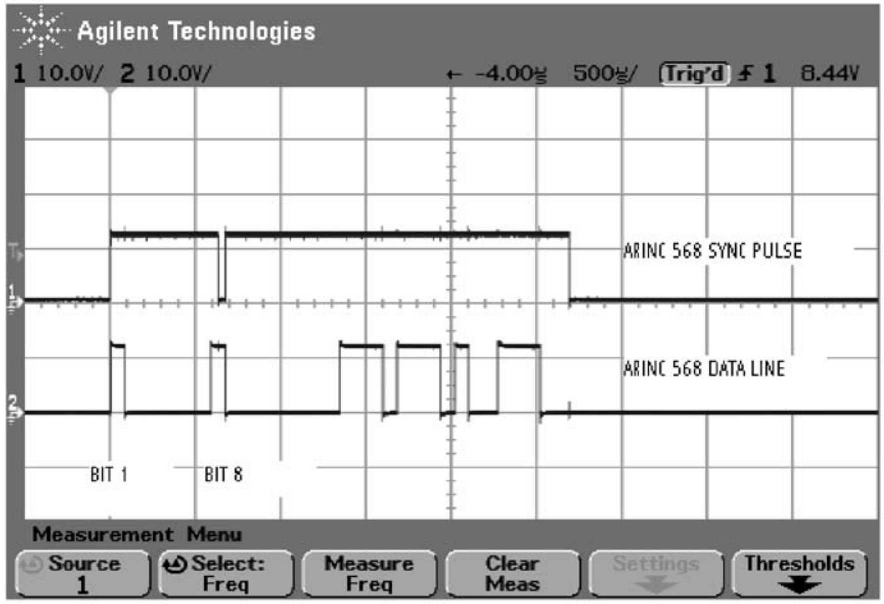

Figure 2

These receiver impedance values reflect a typical differential amplifier receiver and if opto-isolators or other methods are employed, your readings will be different. Just reading across the wire pair from either end with a meter may indicate an open circuit while only requiring a single technician. This may prove beneficial in finding spread pins or partially racked components, which is always a possibility.

The next screenshot (Figure 3) represents a single ARINC 429 word for the purpose of clarity.

Now, with a little more insight as to what some of these signals might look like, the technician can confirm their presence on each respective bus as the situation dictates.

Another important consideration to be pointed out with this screenshot is the null state. The null state or period between words on both lines is returned to zero; therefore, if you detect a railed state on either line, especially if no data is present, you likely have a failed unit. If your troubleshooting takes you to the point of confirming bus activity with a breakout cable, then these screenshots should prove helpful. In a worst case scenario where you find activity but a lack of some specific data being presented to the pilot, a bus reader will be required to confirm presence of a specific data set.

Final Steps

Armed with this information, the avionics technician should then ring out any wiring in question and perform some signal analysis on any bus in question. The inability to run a lot of this newer equipment on the bench for the majority of shops dictates troubleshooting in the aircraft be more detailed.

In some cases where signals are present, you still may need a bus reader to perform a capture of what specific information is on the bus in question. Some systems will vary the bus content based on what equipment type it is interfaced to — this becomes even more important when previously undocumented interfaces exist.

An assumption previously made about unit configuration may need to be re-evaluated, as well if your troubleshooting indicates an otherwise normal system. A second review of the systems installation manual, bus specifications and recent software updates are things not to be overlooked. Some common problem areas never change regardless of system complexity.

A few common problems include:

- Discrete chassis strapping.
- Contact spreading, which can lead to intermittents.
- Open signal grounds.
- Poor racking of equipment.
- Incorrect port assignment on the unit's installation configuration pages.
- Poor cable routing, which can place undo stresses at the rack connector and improper calibration when systems are married together in the aircraft.

Embracing this new technology is not hard to do because it brings so much information to the aircraft in terms of systems and airspace awareness. While the pilot enjoys the benefits of all this technology, the technician awaits the challenges these systems will bring. ❑

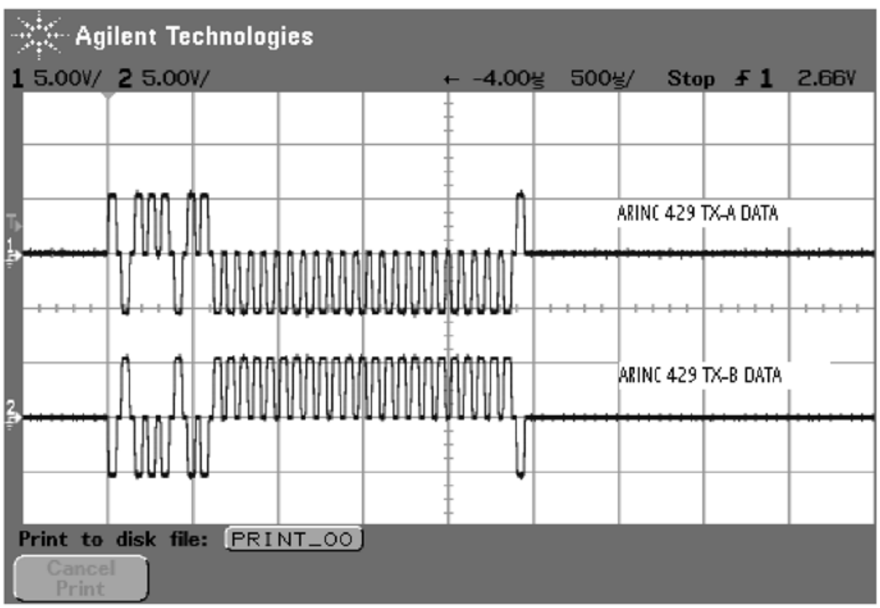

Figure 3