Oscilloscopes in Aerospace/Defense

Debugging ARINC 429 serial buses

Agilent's InfiniiVision 3000 and 4000 X-Series oscilloscopes provide ARINC 429 triggering and decoding, as well as eye-diagram mask test capability to help you accelerate debug of your ARINC 429 buses.

The differential 12.5 kbps and 100 kbps ARINC 429 serial buses are widely used today in a broad range of commercial aircraft including many Boeing and Airbus aircraft, as well as future Chinese commercial aircraft currently under development. Due to the harsh electrical environment of commercial aircraft, testing the quality of received and transmitted signals is very important. The primary measurement tool that engineers and technicians use today to test the signal integrity of serial buses is an oscilloscope. But capturing and measuring the electrical characteristics of ARINC 429 signals have been a difficult and tedious process using conventional analog or digital oscilloscopes. Setting up a scope to trigger and synchronize on specific transmitted or received words often requires an external synchronization signal or guessing at a specific trigger hold-off setting. And then to determine the message transfer information of captured and displayed communication packets/words requires a commonly used visual "bit-counting" technique, which is slow and prone to errors.

Although ARINC 429 bus monitors/protocol analyzers can provide the high-level protocol layer information regarding transfer of data, they tell you nothing about signal integrity. The answer to this dilemma (scope versus bus monitor) is to use a scope that is also able to intelligently trigger on and decode ARINC 429 signals.

Figure 1 shows the display of an Agilent InfiniiVision X-Series scope capturing and decoding a stream of ARINC 429 serial bus traffic. All captured words are decoded and displayed in a time-correlated trace below the captured waveform showing the label field decoded in octal, 2-bit SDI and SSM fields decoded in binary, and the data field decoded in either hexadecimal or binary (user-selectable). In addition, the scope can display a tabular list of decoded data in the upper half of the scope's display.

The trigger condition for this particular measurement was to trigger on words with a label value of 076 (octal). This word is shown at center-screen. The next captured word was decoded as a GAP error word (color-coded in red). Using the scope's timing cursors, we can see that time between these two words was less than the minimum gap time specification of 4 bit times. With this information provided by the scope, it should now be much easier for the avionics engineer or technician to troubleshoot the root cause of this error.

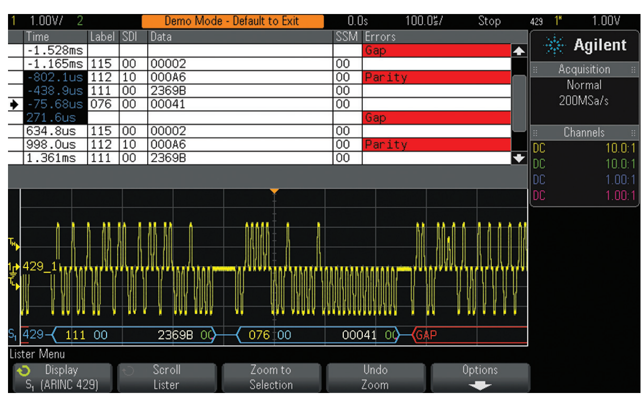

Figure 1: Decoding a differential ARINC 429 bus using an Agilent InfiniiVision X-Series oscilloscope reveals timing and parity errors.

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In addition to providing decoded words time-correlated to captured waveforms, another useful tool to verify the signal integrity of an ARINC 429 bus is to perform an eye-diagram mask test. Eye-diagram testing is used in a broad range of today's serial bus applications. An eye-diagram is basically an overlay of all bits captured by the scope to show when bits are valid and not valid. This provides a composite picture of the overall quality of a system's physical layer characteristics, which includes amplitude variations possibly due to transmission line affects, reflections, system noise, over-shoot, ringing, signal edge timing, and jitter.

Figure 2 shows an ARINC eye-diagram mask test performed at the input of a remote receiver. The scope repetitively captures and overlays all 32 bi-level RZ bits of every word. In this example, we can see some bits failing the mask test due to bit timing shift and reduced amplitude. This is an indication that we probably have a signal integrity problem in our system.

Figure 2: Testing the signal integrity of a differential ARINC 429 serial bus using eye-diagram mask testing.

The upper, lower, and middle regions that define the waveform "keep-out" area of the ARINC 429 mask shown in Figure 2 are based on published ARINC 429 minimum and maximum input amplitudes, rise/fall times, and clock tolerance specifications.

Agilent's InfiniiVision 3000 and 4000 X-Series oscilloscopes

If you are in the market today to purchase your next oscilloscope, Agilent Technologies' 3000 and 4000 X-Series oscilloscopes come in various bandwidth models ranging from 100 MHz up to 1.5 GHz. These scopes come with a standard 3-year warranty, as well as an industry-first 2-year recommended calibration cycle. When purchased with the DSOX3AERO/DSOX4AERO option, these scopes provide MIL-STD 1553 and ARINC 429 serial triggering and decoding. Eye-diagram mask testing of your ARINC 429 bus is also available with the DSOX3MASK/DSOX4MASK mask test option. Agilent provides various ARINC 429 mask files that can be downloaded at no charge. For probing your differential ARINC 429 bus, Agilent recommends the N2791A 25-MHz differential active probe.

To learn more about Agilent's InfiniiVision 3000 and 4000 X-Series oscilloscopes and mixed signal oscilloscopes, go to www.agilent.com/find/infiniivision

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