BY AL INGLE

This month, we continue our series on serial busses. Having previously discussed evolution, protocols (synchronous and asynchronous), and time and frequency domain characteristics, we now can focus on popular serial busses found in our industry.

All serial busses suffer the effects of distributed inductance and capacitance over the length of the conductors between the source and the load. Inside of equipment and for short runs of cable, neutral keying is commonly used to combat these effects. In neutral keying, the "0" state is 0 Volts and the "1" state is a positive voltage, such as 5 V dc. However, as the length of the connecting cables increase, they begin to resemble transmission lines. This causes the time to transition from state to state to increase, increasing the length of the "0"s and "1"s. This is called bias distortion.
Additionally, longer lines are more susceptible to picking up noise, which makes it harder for the receiver to properly decode the message. Because of these shortcomings, bipolar keying may be used. Bipolar keying uses one polarity (for example +V) for a logic "1" while a logic "0" is the opposite polarity (-V in this example). This means the decision threshold at the receiver is 0 V dc. Any positive voltage is taken as a "1" and any negative voltage is taken as a "0."

EIA-RS-232

The common serial bus protocol RS-232A is a bipolar, asynchronous, single-ended bus, which was designed to operate in an office environment. Although there are a few exceptions, the logic levels are typically from +3 V to +25 V dc for a logic "0" and between -3 V dc and -25 V dc for a logic "1." The top data rate specified is 20 kbps, but with advances in technology, speeds of up to 115 kbps can be achieved. Because of its need to share its signal return path with a host of other currents, its useful distance is limited.

RS-422/CSDB

RS-422 and CSDB (commercial standard data bus) are serial protocols similar to RS-232 except they utilize fully differential data lines. Differential data offers the advantage of the elimination of common grounds (and attendant ground loops and common mode errors). In Figure 1 (below), Channel 1, the upper trace, is the CSDB "A" line, while Channel 2, the center trace, is CSDB "B." The lower trace, resultant A-B, is the signal received. Note that these logic levels (0 to 7 V dc peak) allow for a substantial margin of error in the event the aircraft cables are exposed to high intensity radiated signals and currents.

The CSDB interface operates on a bus frequency of 12.5bps or 50bps. The maximum line-to-line and line-to-ground receiver capacitance is 600 pF. The transmitter load capacity is set at 12,000 pF, allowing for between 1 and 10 loads. The mechanical interface uses a twisted shielded pair cable with a maximum length of 160 feet (50 meters). Data is transmitted in non-return to zero (NRZ) with a high line "B" indicating a logic "0" and a high line "A" indicating a logic "1." A logic "0" defines the start bit, while a logic "1" defines the stop bit. A message block consists of 1 address byte followed by any number of data bytes.

The output voltage levels range between +3.0 V dc to +5.0 V dc for transmitting signals. The receive voltage levels range between +2.0 V dc and +6.0 V dc. See Figure 1 (below) and Figure 2 (on the following page).

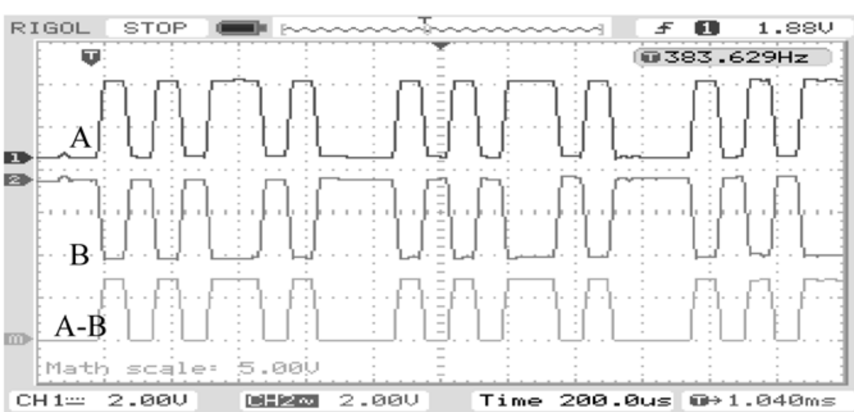

Figure 1 CSDB Databus (CTL- 92 Control Head)

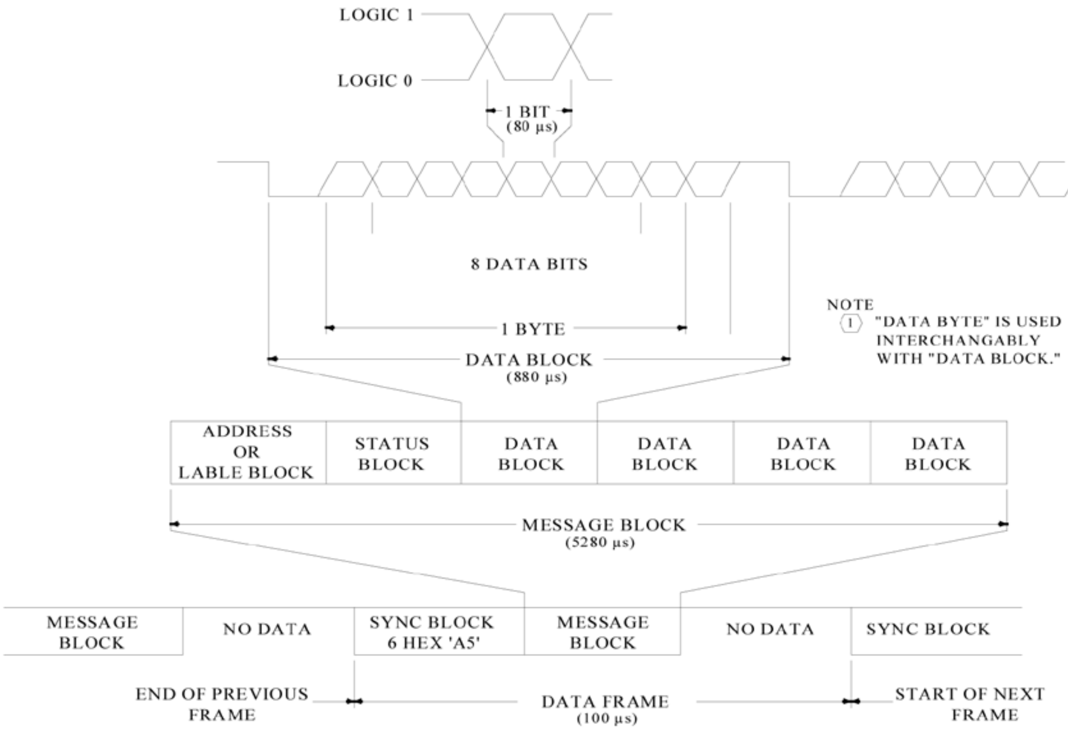

Figure 2: CSDB data structure example

ARINC 568

ARINC 568 is a synchronous, three-signal (sync, data, strobe or enable) serial bus, which became popular in the 1970s. Mechanically, it employs a twisted shielded pair similar to the CSDB format. The Bendix/King three-wire data bus, also popular since the 1970s, is synchronous but differs in that it is single-ended and return-to-zero (RTZ). Figure 3 shows the ARINC 568 used in the Collins DME 40 as depicted on an oscilloscope. Note that the actual data in real life is reversed in order of significance.

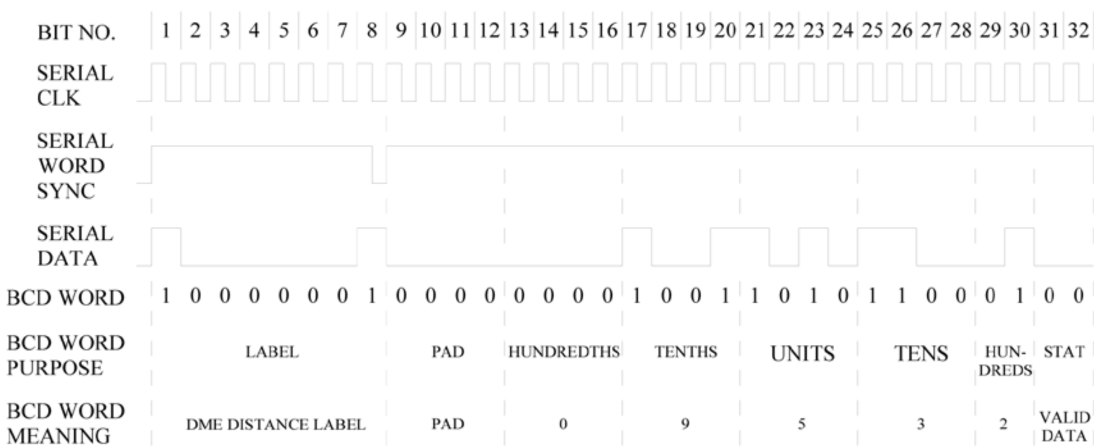

Figure 3: Typical 32-bit serial word waveform

Next Month: More serial busses.

REFERENCES:

- "General Information," Rockwell Collins DME 40 CMM 523-0770174-00411A Figure 9, pages 1-15.
- "Standard Interface Busses," The 2007 ARRL Handbook for Radio Communications, pages 5.70-5.71.
- Commercial Standard Data Bus, www.interfacebus.com