Application Note AN-003

Viewing the 1553 Bus with an Oscilloscope

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Introduction

In many cases, a 1553 bus analyzer or bus monitor is perfectly adequate for troubleshooting a 1553 network. However, there are times when you may need to use an oscilloscope to know *exactly* what is happening on your bus.

The purpose of this Application Note is to provide the basic information to connect an oscilloscope to the 1553 network and to describe the results of using the oscilloscope. This information is not specific to Abaco Systems products, but applies in general to 1553 networks.

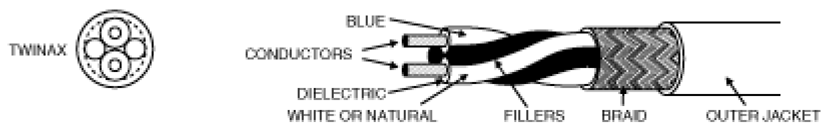
This Application Note assumes a basic knowledge of 1553 and usage of oscilloscopes. For information on the MIL-STD-1553 protocol refer to the "MIL-STD-1553 Tutorial" document available from Abaco Systems, Inc.

1553 Bus Cabling and Signals

Before you can begin to use an oscilloscope, you must understand what it is you will be connecting to and looking at.

1553 Cables

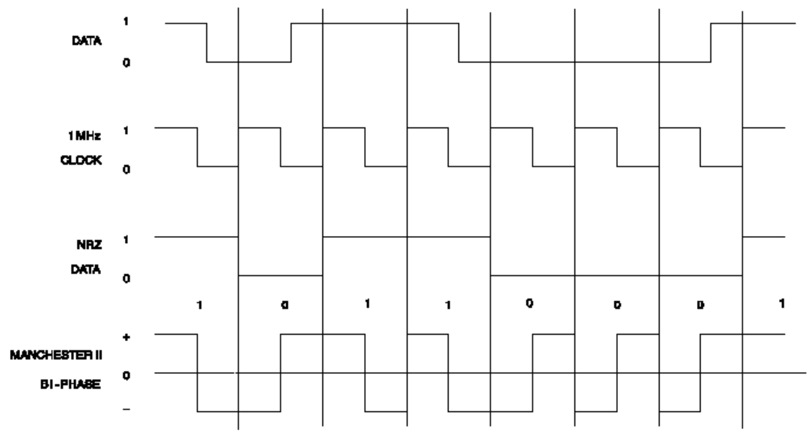
The cables used for 1553 stub and bus connections are two-conductor twisted pair wires with twin-axial connectors.



On the twin-axial connector, the center pin is the POSITIVE signal (blue conductor), and the ring is the NEGATIVE signal (white conductor). The shield is connected to ground.

1553 Electrical Signals

1553 bit encoding for all words is based on bi-phase Manchester II format. The Manchester II format provides a self-clocking waveform in which the bit sequence is independent. The positive and negative voltage levels of the Manchester waveform are DC-balanced (same amount of positive signal as there is negative signal). The Manchester waveform is shown below:

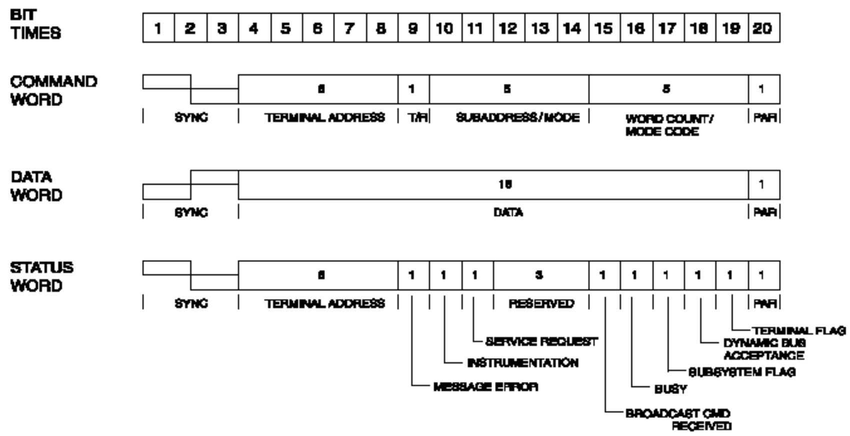


A transition signal occurs at the center of the bit time. A logic “0” is a signal that transitions from a negative level to a positive level. A logic “1” is a signal that transitions from a positive level to a negative level.

It is important to note that the voltage levels on the bus are not the signaling media, and that it is strictly the timing and polarity of the zero-crossings that convey information on the bus. For this reason the 1553 bus is extremely forgiving of conditions that cause the voltage levels on the bus to vary.

1553 Words

There are three types of words used with 1553 – COMMAND words, DATA words, and STATUS words. All words start with a SYNC pattern that is 3 bit-times long, 16 bits of the actual word, and 1 parity bit (odd parity).



Therefore, every word on the 1553 bus takes 20 bit-times (20 microseconds). For more information on 1553 words and messages, see the “MIL-STD-1553 Tutorial” document available from Abaco Systems, Inc.

Connecting and Configuring the Oscilloscope

This section describes how to connect and configure the oscilloscope.

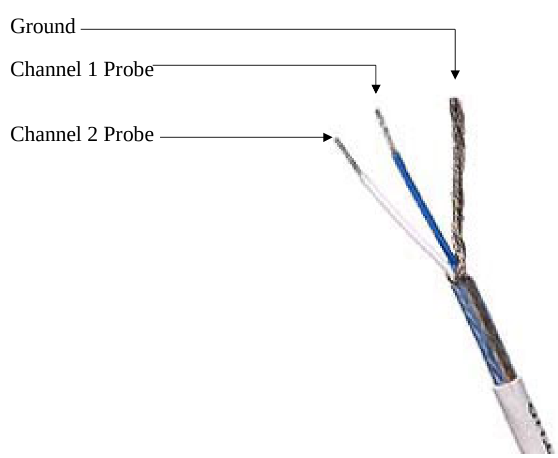
Requirements

To properly look at 1553 signals and measure voltages, you will need at least a 2-channel oscilloscope.

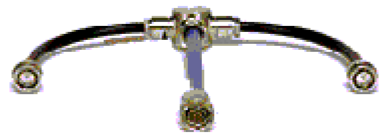
Connections

First, you need a way to connect from 1553 twin-axial cable to the BNC co-axial oscilloscope inputs. This can be as simple as cutting off the end of a stub cable and connecting oscilloscope probes to the wires.

Basically, you want Ground connected to the bus shield, Channel 1 of the oscilloscope connected to the POSITIVE (blue) conductor, and Channel 2 of the oscilloscope connected to the NEGATIVE (white) conductor.

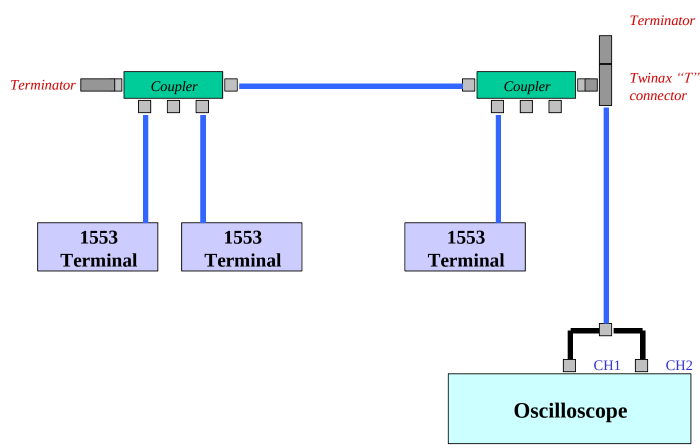


You can also buy adapter cables for this purpose. For example, MilesTek (www.milestek.com) sells the adapter cable shown below:

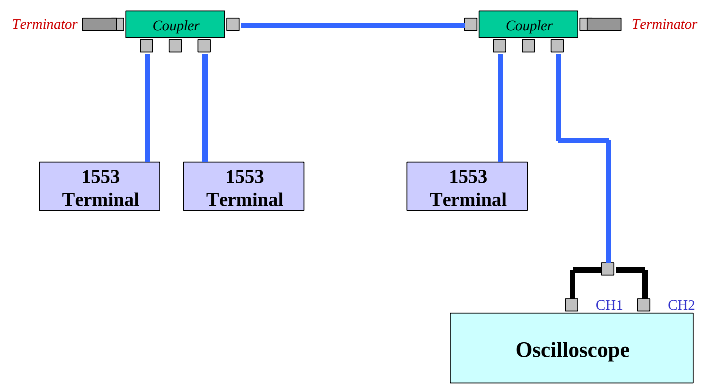


Once you have your adapter from the oscilloscope to the twin-axial cable, you need to connect it to your 1553 network. There are several ways you can do this, but in general you connect to the BUS or to a STUB. The examples below show connections to a transformer-coupled bus, but you can make the same type of connections if you are using a direct-coupled bus.

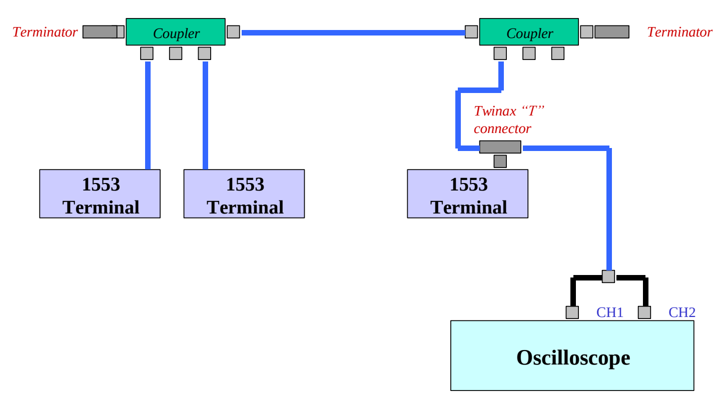
To connect to the BUS, use a twin-axial "T" connector. Remove the terminator at one end of the bus, connect the "T" connector in its place, connect the terminator to one side of the "T" connector, and connect your cable to the oscilloscope on the other side of the "T" connector.



To connect to a STUB, there are several options. The simplest method is to connect your oscilloscope cable to an unused stub connection on one of your transformer couplers.



Another STUB connection method is to use a “T” connector to attach to a stub connection. To do this disconnect the stub cable from either the 1553 terminal or the bus coupler, connect the “T” connector in it’s place, connect the stub cable to one end of the “T” connector, and connect your oscilloscope cable to the other end of the “T” connector.



Oscilloscope Settings

You need to configure your oscilloscope to show the differential signal between the POSITIVE conductor (channel 1) and the NEGATIVE conductor (channel 2). Therefore, you need to set your oscilloscope to display CHANNEL 1 MINUS CHANNEL 2.

Each 1553 word takes 20us, so set your time base to about 5 microseconds per division.

Depending on how your bus is configured, the output voltages of transmitting terminals, and where you are connected to the bus, the signal voltage could be anywhere from 1 volt to 21 volts peak to peak. Initially, set your oscilloscope to 1 volt per division.

Initially, set your oscilloscope to trigger on a rising edge on channel 1, somewhere around 100mV.

You should be able to see any 1553 traffic on your bus with the oscilloscope. If not, make sure you have traffic on your 1553 bus and press the AUTOSET button on your oscilloscope.

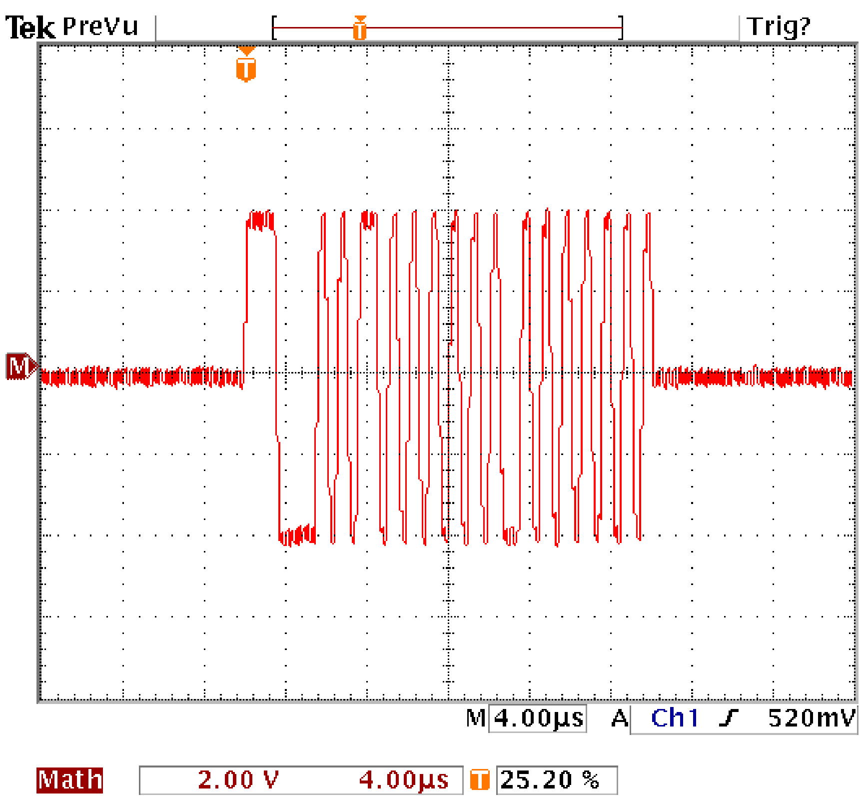
From now on, you can vary the voltage, time, and trigger settings to see the desired parts of 1553 words and messages. Work with it a bit to find the settings that work best for you.

Viewing 1553 Words and Messages

This section provides a few examples to show what you should expect to see with your oscilloscope on a 1553 network.

1553 Words

The following is an example of a single 1553 command word. The SYNC pattern is HIGH-LOW (command sync). The command word is 0x1FC0, which is 3-T-30-32, a RT to BC command to RT 3, subaddress 30, word count 32.



1553 Messages

In this example time scale has been increased to see an entire message. This example shows a BC to RT message with one data word.

The command word is 0x03C1 (0-R-30-1), a BC to RT command to RT 0, subaddress 30, 1 data word. The data word is contiguous with the command word (no gap between words) and has a value of 0x0000. The data word has a LOW-HIGH sync pattern, opposite that of command and status words. After the data word, you see the status response gap, followed by the status word with a value of 0x0000.