Application Note AN-005

Connecting the 1553 Bus

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Introduction

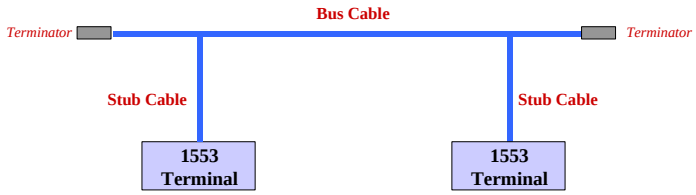
The MIL-STD-1553 data bus is a relatively simple network protocol used to share data between avionics subsystems. Unfortunately, simple mistakes and misunderstandings of bus connections often lead to system integration problems and wasted time.

The purpose of this Application Note is to provide the basic information to connect a 1553 network properly. 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. For information on the MIL-STD-1553 protocol refer to the "MIL-STD-1553 Tutorial" document available from Intelligent Platforms Embedded Systems, Inc. Additional information can also be found in MIL-HDBK-1553A.

Basic 1553 Topology

The basic 1553 network consists of a BUS with a number of STUBS that connect the terminals to the bus. The bus must be terminated at both ends. The following diagram shows a very simple 1553 network:



MIL-STD-1553 does not specify a maximum bus length, but as a general rule, try to keep your bus length under 100 feet. You can go longer but may have to deal with issues associated with propagation delay and transmission line effects.

There are two methods for connecting stubs to the bus – transformer coupling or direct coupling.

Transformer Coupling

Transformer-coupling is the preferred method because it isolates the stub from the bus. With transformer coupling a short on one stub will not bring down the entire bus.

A transformer-coupled bus uses bus couplers to connect stubs to the bus. Transformer-coupled stubs should not exceed *20 feet* in length.

Direct Coupling

Direct-coupling is sometimes used but *should be avoided if at all possible*. MIL-STD-1553B, Notice 2 specifically states that direct-coupling shall not be used on US Army or Air Force applications.

A direct-coupled bus uses "T" connectors to connect stubs to the bus. Direct-coupled stubs should not exceed *one foot* in length.

Some of the most common bus problems are caused by use of direct coupling, often with stub lengths that are too long.

Rules to Remember

Always use transformer coupling. Avoid direct coupling.

Keep transformer-coupled stubs below 20 feet in length. If you must use direct-coupled stubs, then keep the stub length below one foot.

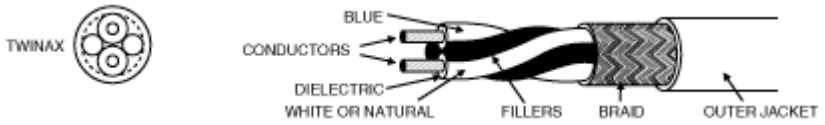
Keep the bus length below 100 feet, if possible.

1553 Network Components

Before you can begin building your network, you must understand what components are needed.

1553 Cables and Connectors

The cables used for 1553 bus and stub 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 Bus Terminators

The 1553 bus *must* be terminated at *both* ends. Use a 78 Ohm, 2W, 1% resistor for termination. A typical 1553 bus terminator is shown in the following illustration:

Again, terminators are *not* optional. A common mistake is to leave off one or both terminators on the bus.

1553 Bus Couplers and T Connectors

A *transformer-coupled* bus uses a bus coupler like the one shown in the following illustration:

The bus coupler shown here is a *two-stub* coupler. It has two stub connections (on the side). The bus connections are on the ends. Bus couplers are available with one to eight (or more) stub connections. Be careful not to confuse bus connections with stub connections – a common mistake is to connect stubs to the bus connections or vice-versa.

A *direct-coupled* bus uses T connectors rather than bus couplers to connect stubs to terminals on the bus. A typical T connector is shown in the following illustration:

Remember that direct-coupled stubs should not be longer than one foot. Another common mistake is to use long stubs with direct coupling.

RFI Caps

In many situations you can leave unused stub connections open. However, in some environments it is good to use an RFI cap to limit radio frequency interference and to keep out dust, dirt, etc. This is basically a metal cap that closes the shield over the unused stub connection, as shown in the following illustration:

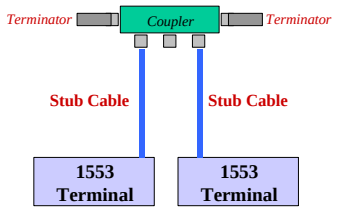
Note: Do *not* try to use terminators as caps on unused stubs. A terminator on a stub puts a 78 Ohm load on the stub, which is a *much* lower impedance than a normal RT would add. If you don't have RFI caps, leave the unused stub connections open.

Connecting the Network

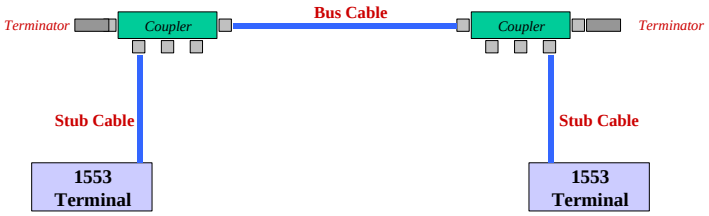
Once you have gathered all your 1553 network components, you can put the network together. This section shows a transformer-coupled network, but if you must use a direct-coupled bus, you may use T connectors rather than the bus couplers shown in the diagrams below.

Connecting Two Terminals

For simple lab tests you may want to setup a very simple network to allow two devices to talk to each other. Typically, one terminal is a bus controller, and the other a remote terminal. This can be done with a single coupler with two or more stub connections as shown below:



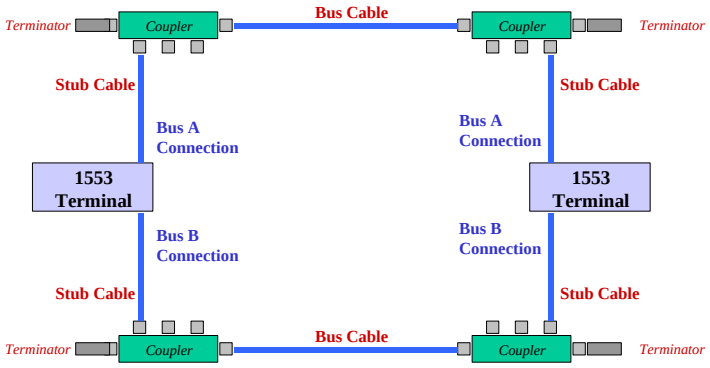
In the configuration shown above, the entire *bus* is inside the bus coupler. This is equivalent to using two separate couplers as shown in the following illustration:



This is the *bare-minimum* 1553 network connection. A common mistake seen with basic connections between two devices is that someone tries to connect a cable from one device to another (with no terminators or couplers).

Dual-Redundant Networks

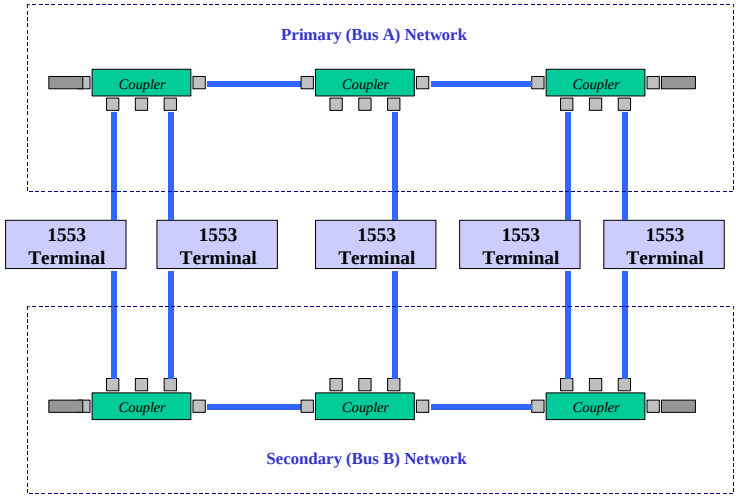
So far we have only shown single network connections. Most 1553 networks are dual-redundant, with a primary and secondary bus (bus A and bus B). To connect a dual-redundant bus, duplicate the network connections on the secondary bus as shown in the following illustration:



Be careful to keep the two networks separate – another common mistake is to inadvertently connect bus A and bus B together.

Building a Larger Network

Of course, you can have more than two terminals on your network. The next illustration shows an expanded dual-redundant network, with five terminals.



As you add terminals to your network, you can easily expand on the basic topology. Just remember to keep your stub lengths under 20 feet (or under one foot for direct-coupled stubs), and try to keep your bus length under 100 feet (don't use a 300 foot cable where a 20 or 50 foot cable will do). If you must use a longer bus, be prepared to deal with transmission line issues and propagation delay.