North Hills™ Signal Processing Corp.

DBT300 User's Manual

6851 Jericho Turnpike, Suite 170
Syosset, NY 11791

Phone: (516) 682-7740
Fax: (516) 682-7704

E-Mail: NHSales@northhills-sp.com

Revision 6.28.2013

Table of Contents

Figures

Tables

North Hills' Model DBT300 1553B Network Tester User's Manual

INTRODUCTION

The DBT300 Data Bus Tester allows a user to easily troubleshoot, characterize or test MIL-STD-1553B data bus networks. The Tester detects shorts, opens, crossovers and shorts-to-shield on the bus and stubs. Tests are conducted from the Line Replaceable Unit (LRU) ends of the stub cables. In the DC resistance mode, the Tester can be used as a general purpose ohmmeter with a range of 0 to 199.9 Ohms.

Newly incorporated features provide capability to measure return loss (RL) and insertion loss (IL) in a data bus network and benchmark network characteristics. The test frequency for both RL and IL is 1MHz. The LCD reading is in dBs for RL and IL with a resolution of 0.1dB. The characteristic impedance of the internal RL Bridge is 77.0 Ohms. IL can be measured between any two stubs using the Remote Unit which is included.

The DBT300 Remote Unit is used to check cabling for the Phase/Crossover test and measuring Insertion Loss. A master rotary switch on the unit turns it on or off and sets the output of the unit to either the Phase/Crossover or Insertion Loss mode.

NH16746MA DBT300, MAIN UNIT
WEIGHT: 550 grams
(Including protective boot)

NH16746R DBT300, REMOTE UNIT
WEIGHT: 360 grams
(Including protective boot)

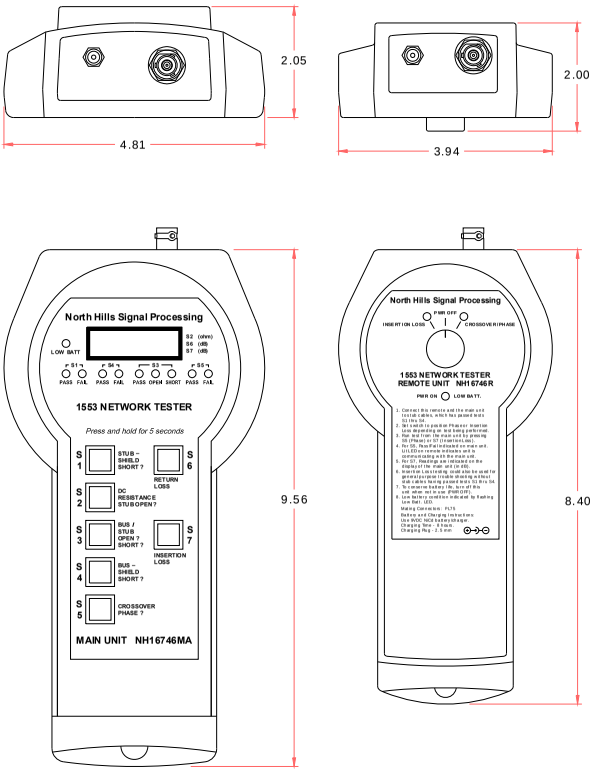
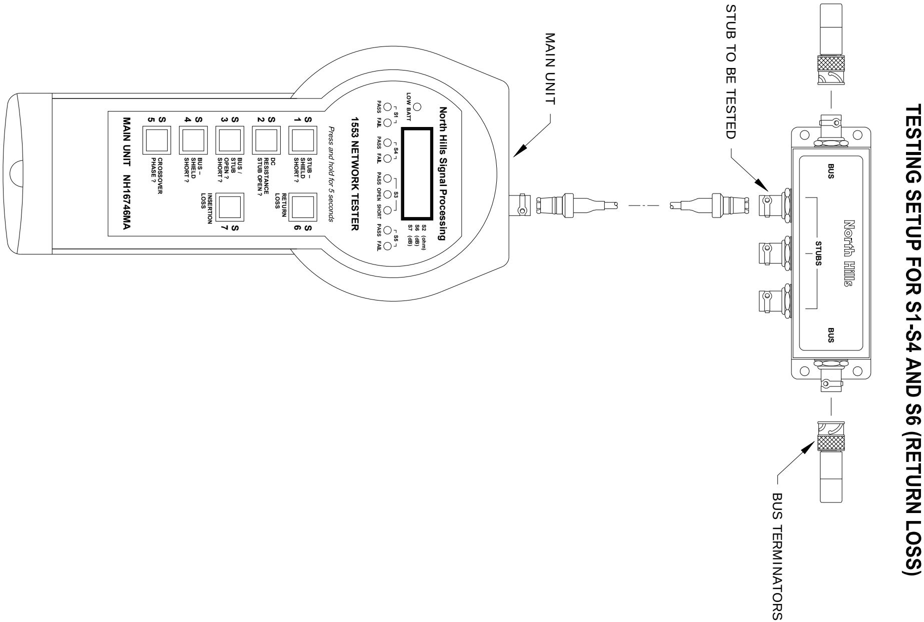


Figure 1: DBT300 Main and Remote Units



<u>Figure 2</u>: S1 - S4, S6 Test Setup

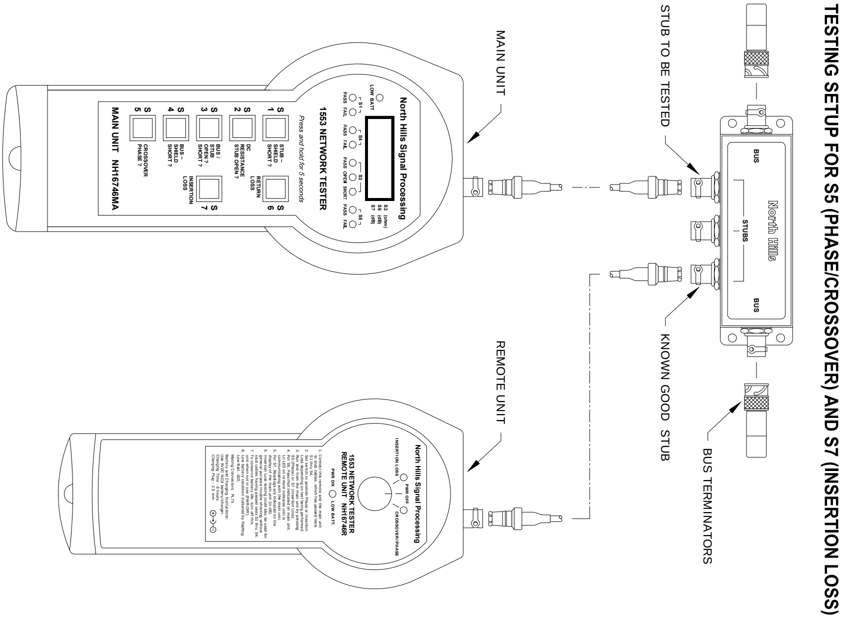


Figure 3: **S5 (Phase/Crossover), S7 (Insertion Loss) Test Setup**

OPERATION

There are seven (7) press-to-test buttons. See Figure 1 above. Testing begins when an appropriate button is depressed. The button should be held down for approximately five seconds to allow the test circuit to stabilize. **Tests must be performed in the proper sequence (S1 through S7) for unambiguous results.** Tests S1 to S5 are generally sufficient to troubleshoot hardware problems. S6 (Return Loss - "RL") and S7 (Insertion Loss - "IL") are useful for network design or as a reference to check on network changes over time, if they have been previously recorded. The seven buttons/tests are:

<S1> Stub-to-Shield Short? - Go/No-Go LED:

This is a DC insulation resistance test. Any resistance between conductors and shield less than 50K Ohms will constitute a short-to-shield. It can also be used with the Bus-to-Shield Short test to differentiate between bus and stub failures. This test will only detect shorts-to-shield on the stub or cable it is connected to. This test cannot be used in systems which have a DC path-to-shield/ground (e.g., MACAIR buses). These buses will show a stub conductor-to-shield short on this test. For these systems, a stub conductor-to-shield short will manifest itself as a bus conductor-to-shield short (S3) and a bus terminator fault only on the faulty stub. See Figure 2 above.

<S2> DC Resistance-Stub Open?

This test measures DC resistance from 0 to 199.9 Ohms (the value is displayed on the tester's Liquid Crystal Display (LCD)). This function is useful for continuity testing. When used on the stub cable, the test will verify continuity of the path between the stub cable and the transformer. The value measured will be the cable resistance plus the transformer winding resistance. It is typically 1 to 5 Ohms. This test detects an open cable, connector or transformer winding. On the bus, readings can be compared on the "A" and "B" buses. Resistance values for total bus measurements will be in the 4 to 80 Ohm range, depending on the

length of the bus, the gauge of the bus conductors and number of stubs. Each stub is roughly equal to a 120-Ohm resistor in parallel with the terminator, i.e., a 20-stub bus without terminators will have a resistance of approximately 6 Ohms (120/20) plus the cable wire resistance. See Figure 2 above.

<S3> Bus Terminator or Stub Open or Short? – Go/No-Go LED:

This button looks for shorts and opens on the bus or stub conductors. Bus and stub open failures can be differentiated by first testing the stub (see Step S2 above). Bus and stub short failures can be differentiated with S6 (RL). If S6 reads close to 00.0dB (< -1.0dB), then it is a stub-related short. A bus short would have an RL much higher or closer to -20dB. If you suspect that a bus cable between couplers is open or shorted, the IL test (S7), can be used to verify that fault. Open or shorted buses will have an IL greater than -40dB. Bus or stub testing is done through the stub port. See Figure 2 above.

<S4> Bus-to-Shield Short? - Go/No-Go LED:

This test checks for shorts between the high or low conductor to the shield on the bus cable. The test is performed from a stub and detects a short-to-shield on the stub or a short-to-shield on the bus. To differentiate, you must use the Stub Short-to-Shield Test (see Test S2 above), which only tests for stub-to-shield shorts. If Test S1 passes and Test S3 fails, the short is on the bus. If both tests fail, the short is on the stub. See Figure 2 above.

<S5> Phase Test/Crossover-Go/No-Go LED:

This test requires a connection between the Remote Unit and another stub cable with the remote switch in the "Crossover / Phase" position. The test determines if there are phase reversals (wiring crossovers) of the conductors between the Remote Unit and the Tester.

In the “Phase Test/Crossover Test,” the Main Unit interrogates the Remote Unit, which in turn responds as indicated by the XMT LED on the remote lighting.

This remote signal is detected by the Main Unit and phasing is checked. If the test passes, it shows that not only is the phasing correct but also the two transformers in the loop between the Main and Remote Units are good. See Figure 3 above.

<S6> Return Loss (RL) Measurement:

This test measures RL of any load connected to the test port. The characteristic impedance of the internal RL Bridge is 77.0 Ohms. The test frequency is 1MHz. The LCD display is in decibels. The RL measured looking into a stub of a typical North Hills transformer coupler, with correct bus terminators and with short bus and stub cables, is generally greater than -30dB. Increases in stub and bus cable length generally reduces RL. See Figure 2 above.

Very low Return Losses, < -15dB, could be the cause of a problem. If pigtails and alligator clips are used to connect to a test load, keep the leads as short as possible (2" Max) to avoid errors.

<S7> Insertion Loss (IL) Measurement:

This test measures the IL between any two stubs. This test requires the connection of the Remote Unit to one of the stubs and the Remote's selector switch must be set to the "Insertion Loss" position.

The injected test signal is a 1MHz, balanced sine wave having an amplitude of 1Vrms (2.82Vp-p). The Remote Unit is a fixed-voltage source with a source impedance of less than 2 Ohms. The Main Unit's LCD displays the IL in decibels (dBs). The specifications for a coupler in MIL-STD-1553B list the output signal amplitude as between 18 and 27Vp-p. The minimum sensitivity for the input to a coupler is listed as .86Vp-p. Using this as a guide, the minimum IL from stub to stub would be approximately 20*Log (.86/18) = -26.4dB, and may be a cause of concern as this value corresponds to the minimum MIL-STD-1553B requirements. See Figure 3 above.

Summary of Tests S1 through S5:

The first step in testing any network is to verify the presence of a good stub. To do this, connect the Tester's Main Unit to a convenient stub, preferably one of the end stubs, and perform tests S1 through S4. If a failure is detected, correct that problem before proceeding to the next test, because the failure will affect the accuracy of subsequent tests. Once this stub has passed tests S1 through S4, remove the Main Unit and replace it with the Remote Unit. Turn the Remote Unit's rotary switch to "Crossover."

Now connect the Main Unit to the next stub to be tested and perform Tests S1 through S5. If Test S5 passes, then the phasing on both stubs and the bus between them is good. Leaving the Remote Unit on the first stub, continue testing the remaining stubs.

Note: Testing must be performed in the order S1 through S5 and each failure must be repaired as detected, rather than continuing the testing, to avoid incorrect results on subsequent tests.

Return Loss, Insertion Loss Measurements:

After running through tests S1 to S5 and being confident that any problems have been corrected, you can then proceed to perform tests S6 (RL) and S7 (IL).

In doing RL, any load such as a stub, bus, terminator or cable, connected to the Main Unit's test port, will show a reading based on the standard Return Loss formula:

$$R.L.(dB) = 20LOG\left[\frac{Ztest - 77.0}{Ztest + 77.0}\right]$$

A chart of Return Loss vs. purely resistive loads for Z_0 = 77.0 Ω may be useful for comparison and is shown in Table 1 below.

Return Loss (dB)	Loads (Ω)		
	< 77.0	> 77.0	Tolerance (Ω)
00.0	SHORT	OPEN	--
-10.0	40.0	148.2	+71, -37
-20.0	63.0	94.1	+17, -14
-30.0	72.3	82.0	+/- 5
-40.0	75.5	78.6	+/- 1.5
-50.0	76.5	77.5	+/- .5
-60.0	76.8	77.2	+/- .2

Table 1: Return Loss

In a typical coupler stub measurement with short (≈ ≤ 3 ft.) bus/stub cables as shown in Figure 4 below, the Return Loss would generally measure about -30dB. The ideal or calculated RL would be -40dB. The difference is usually due to transformer winding resistances, core loss and shunt inductances from other stubs.

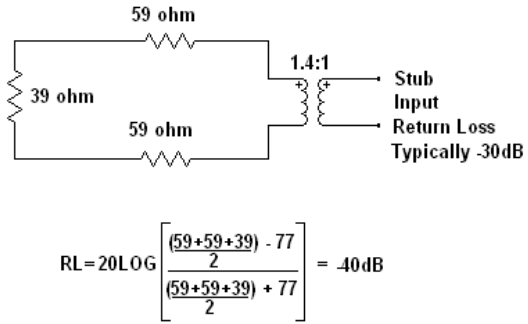


Figure 4: Stub Return Loss Calculation

For RL, any loads attached to any of the other stubs, while taking a measurement which will not be present during real-life operation, will affect the reading.

For IL measurements, the reading on the LCD is 20 times the Log of the ratio of the voltage at the input port of the Main Unit to the voltage at the output port of the Remote Unit, or:

$$I.L.(dB) = 20LOG\left[\frac{Vmain\_unit}{Vremote\_unit}\right]$$

The typical insertion loss value measured from stub to stub for a transformer-coupled coupler with short (≈ ≤ 3 ft.) bus and stub cables would be approximately -12.0dB. This would correspond to a drop in the output stub signal amplitude to approximately ¼ of what was applied to the input stub.

The chart shown in Table 2 below has some Insertion Losses with their corresponding linear voltage drops from stub to stub.

Insertion Loss (dB)	Voltage Drop Ratio
00.0	1.00
-10.0	0.316
-12.0	0.250
-15.0	0.178
-20.0	0.100
-26.0	0.050
-30.0	0.0316
-40.0	0.010

Table 2: Insertion Loss

A quick check of the Remote Unit and Main Unit's Insertion Loss functionality is to plug the Remote Unit directly into the Main Unit with the 3' cable provided in the kit (Part Number NH14017-060).

The insertion loss reading should be 00.0 +/- .2dB. With no input at all, the Main Unit should read more than -60.0dB. The Main Unit's insertion loss input impedance is 3KΩ. This simulates a typical equipment load that would be attached to a stub port.

TROUBLESHOOTING

To ring out a bus for the first time after installation or rework, follow the procedures described above. Start at one end of the bus and work your way to the end fixing each fault as it is detected. Most faults will be in the connector terminations and splices, if any. It is not uncommon for Bus A and Bus B to be interconnected.

If the bus has been working and suddenly does not, it is not likely to have a Phase Test failure (S5).

Faults on the bus are best isolated and located by a process of successive elimination. Put the Remote Unit on a working, unused stub not located between the used stubs of the bus and start with the Tester Main Unit at the suspected problem stub.

Perform tests S1 through S5 fixing any failures found. Repeat this on the other used stubs. When both/all used stubs pass all tests, put the Remote Unit on one of used stubs and test the other used stubs with the Main Unit. If/when these tests pass, then the bus is OK. If system problems persist after all involved stub problems have been corrected and the tests passed, the problem is either in the equipment or the involved stubs have not been fully/correctly identified.

When the number of involved stubs is large it is indicative of a bus fault rather than a stub fault. In this case the fault can be localized by successive approximation, successively halving the bus, i.e., put the Tester Main Unit on the middle stub, then half way to either end and keep splitting the distances in half until you have narrowed the location of the fault to a segment between two adjacent stubs. It can be very helpful to segment the bus by disconnecting all the feed-through connectors on the bus itself. Don't forget these segments will have only one or no terminators in place. The cable itself can be further checked by using the S2's ohmmeter function to check for continuity and or shorts (make an adapter cable with pigtails and alligator clips to access the connector contacts as desired).

Note - when measuring continuity, a short will read 1 Ohm.

Also, bus cable resistance is approximately 26 Ohms/1000 ft., so a 100 ft. bus conductor will have 2.6 Ohms resistance and a 5.2 Ohms resistance for the loop.

It may be useful to make up an Insertion Loss and Return Loss table from stub-to-stub and for each stub for every entire Network. This could help later if a Network problem arises and troubleshooting needs to be done.

Network Name: _____ Date: _____

Stub 1 to	Insertion Loss (dB)	Return Loss (dB)
Stub 2		
Stub 3		
Stub 4		
Stub 5		
Stub 6		
Stub 7		
"		
"		
Stub N		

Table 3 – Network Reference Data

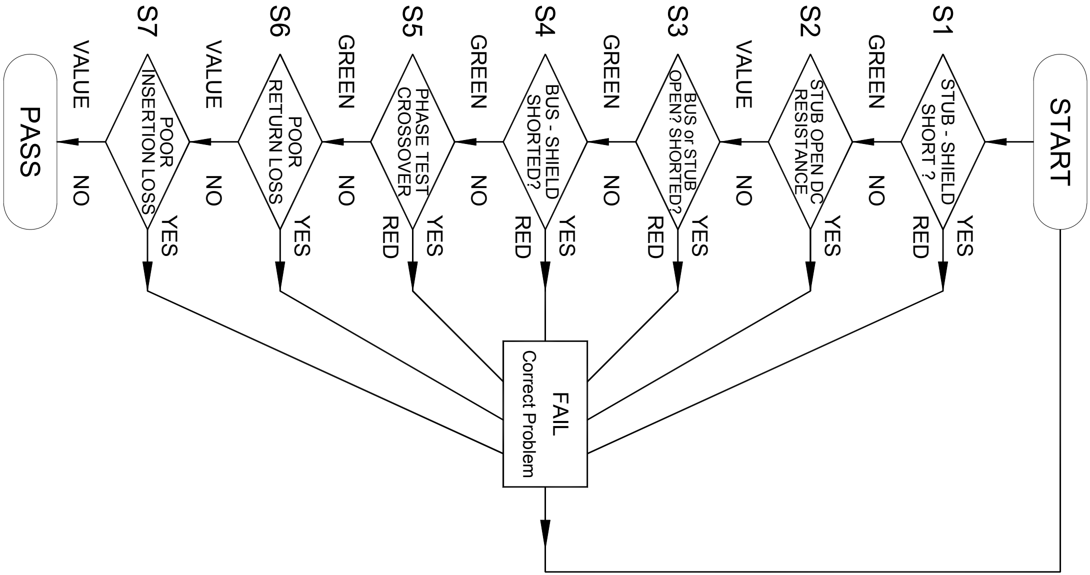


Figure 5: **Trouble shooting Flowchart**

FAULT	Test Buttons on Main Unit (Press and hold for 5 seconds)						
	<S1> Stub-Shield Short?	<S2> DC Resistance Stub Open?	S3 Bus or Stub Open? Short?	S4 Bus-Shield Short?	S5[1] Cross over Phase?	S6 Return Loss?	S7[1] Insertion Loss?
Stub conductor to shield short	Fail	-		-	-		-
Stub open, conductor or transformer	-	Meter out of range[2] (Fail)	-	-	-	~00.0dB	>40.0dB
Bus conductor to shield short	-	-	-	Fail	-		-
Bus conductor open	-	-	Open (Fail)	-	-	< Normal	
Terminator open or missing	-	-	Open (Fail)	-	-	< Normal	
Bus conductor or Terminator shorted	-	-	Short (Fail)	-	-	< Normal	
Phase reversal / hi-low swap	-	-	-	-	Fail	Normal	Normal
Open coupler transformer (Bus side)	-	-	Open (Fail)	-	-	~00.0dB	>40.0dB
Shorted coupler transformer (Bus/Stub Side)	-	1.0-1.5Ω	Short (Fail)	-	-	~00.0 dB	>40.0dB

[1] The crossover/phase and the insertion loss tests require the connection of the Remote Unit to another stub cable.

[2] The number one will appear on the far left of the DBT300 Main Unit's display screen.

Table 4: Test Results, Basic Data Bus Network Troubleshooting