

How to Measure Return Loss and Insertion Loss Using the DBT300 Tester

Application Note

The new, upgraded DBT300 adds the capability of testing network Return Loss and Insertion Loss. These tests cannot be done using a DBT100A. In this application note we will look at some useful information that can aid in taking these two measurements.

Return Loss:

The return loss bridge in the DBT300 has a characteristic impedance of 77.0Ω. Its test signal is 1MHz, balanced and sinusoidal. The 1MHz signal is the highest frequency seen in a MIL-STD-1553 Data Bus Network, so this is usually considered the worst case. See Figure 1 below for setup.

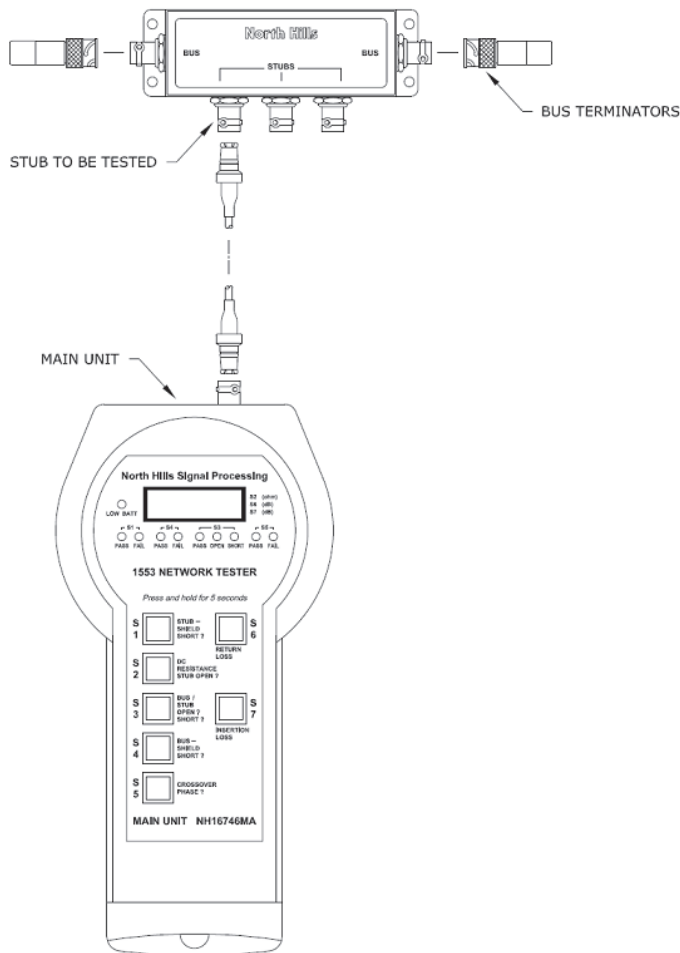
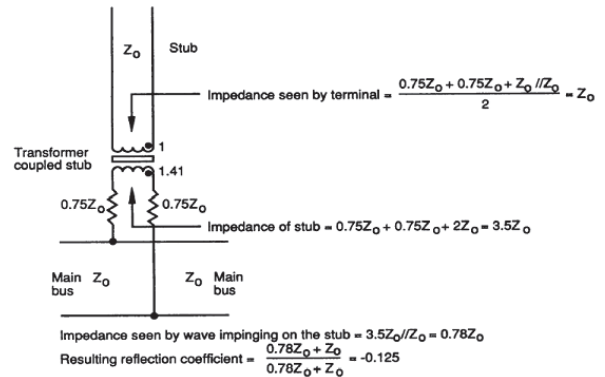


Figure 1: Return Loss Setup

Typical impedances for an ideal transformer-coupled stub with zero bus or stub cables lengths would be the following as referenced from MIL-HDBK-1553:

A direct-coupled stub would have the following impedances:



The following table correlates return loss and pure resistances:

Return Loss (dB)	Loads (Ω)		
	< 77.0	> 77.0	Tolerance (Ω)
00.0	SHORT	OPEN	--
-10.0	40.0	148.2	+71, -31
-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

Insertion Loss

The insertion loss test requires the connection of the Remote Unit to another stub and the Remote's rotary switch in the Insertion Loss position. The Remote's output test signal is a 1MHz, balanced sine wave having an amplitude of 1Vrms (2.8Vp-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 insertion loss in decibels. 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:

$$I.L.(dB) = 20 \text{LOG} \left[\frac{V_{\text{main_unit}}}{V_{\text{remote_unit}}} \right]$$

The typical IL value measured from stub to stub for a transformer-coupled or direct coupled coupler with short bus and stub cables

(≈ 3 ft.) would be about -12.0dB. This would correspond to a drop in the output stub signal amplitude to approximately $\frac{1}{4}$ of what was applied to the input stub. The table shown below has some Insertion Losses with their corresponding linear voltage drops from stub to stub.

Intersion Loss (db)	Voltage Drop Ratio
00.0	1.00
-10.0	.316
-12.0	.250
-15.0	.178
-20.0	.100
-26.0	.050
-30.0	.0316
-40.0	.010

A quick check of the Remote and Main Units' 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 3k Ω . This simulates a typical equipment load that would be attached to a stub port. A typical Insertion Loss setup to a coupler is shown in Figure 2

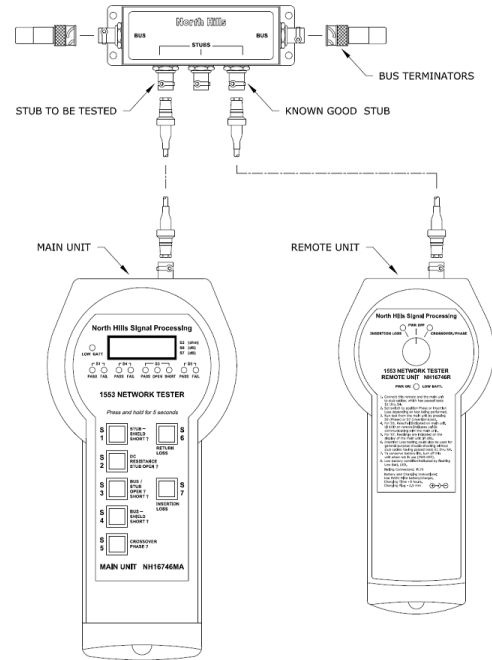


Figure 2: Insertion Loss Setup (Typical)

The following table illustrates test results and basic Data Bus Network troubleshooting:

Test Result Failures, Basic Data Bus Network Troubleshooting							
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)	-	-	Lower than Normal	>30.0dB
Terminator open or missing	-	-	Open (Fail)	-	-	Lower than Normal	
Bus conductor or Terminator shorted	-	-	Short (Fail)	-	-	Lower than Normal	>40.0dB
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)	-	1.0-1.5 Ω	Short (Fail)	-	-	~00.0 dB	>40.0dB



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