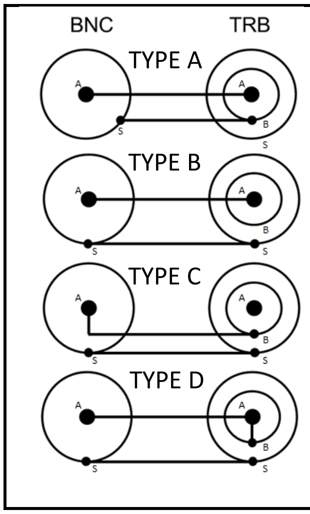
MOHR™

MOHR Test & Measurement LLC
2105 Henderson Loop, Richland, WA 99352
(888) 852-0408 sales@mohrtm.com

Application Note AN-2016-2

1553B Data Bus Cable Compression Damage Detection through Transformer Couplings

The MIL-STD-1553B data bus is a shielded, twisted-pair communications system encountered in a number of avionics and military platforms. Stub cables from various types of instrumentation pass digital serial data to the bus through DC-blocking isolation transformers known as couplers. One common form of damage to the 1553 Data Bus cables involves the deformation of the outer shield, conductors and insulator by means of compression or impact. The MOHR CT100 Series portable TDR Cable Analyzers in conjunction with the MOHR Mil-Std-1553 TRB Adapter Kit are ideal instruments for locating compression damage both before and after transformer couplings.



TYPE A: BNC Pin to TRB Inner Conductor
BNC Shield to TRB Outer Conductor
NOT USED FOR COMPRESSION DAMAGE

TYPE B: BNC Pin to TRB Inner Conductor
BNC Shield to TRB Shield
Best for Detecting Damage in Special Cases

TYPE C: BNC Pin to TRB Outer Conductor
BNC Shield to TRB Shield
Best for Detecting Damage in Special Cases

TYPE D: BNC Pin to TRB Inner & Outer Conductor
BNC Shield to TRB Shield
Best for Detecting Initial Location of Damage

Figure 1 – MOHR MIL-STD-1553B TRB Adapter Kit Schematics

Compression Damage Test Setup

A typical compression damaged cable will show a detectable change in impedance between a non-damaged cable and a damaged cable at the point of compression or impact. The amount of impedance change may be small, but the use of filtering and analysis tools available on the CT100 TDR and in the CT Viewer Software will enhance this detection capability. A test bus cable in conjunction with a steel compression fixture ½ inch wide was used to generate the traces analyzed in this application note. Figure 2 shows the block diagram for the test setup. Figure 3 shows the compression mechanism used to create the damage to the data bus cable. The cable shown in Figure 3 is being compressed to 50% of its diameter.

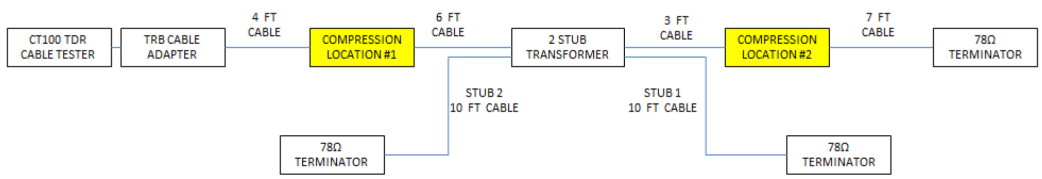


Figure 2 – Test Setup Block Diagram

Figure 3 – 50% Compression

Compression Damage at Compression Location #1 (In front of Transformer)

Detection of compression damage in front of a transformer is identical to detecting compression damage in any other type of cable. Using MOHR Adapter Type D, Figure 5 shows a very readily identifiable compression fault with the magnitude of the impedence difference between the traces proportional to the amount of compression on the cable.

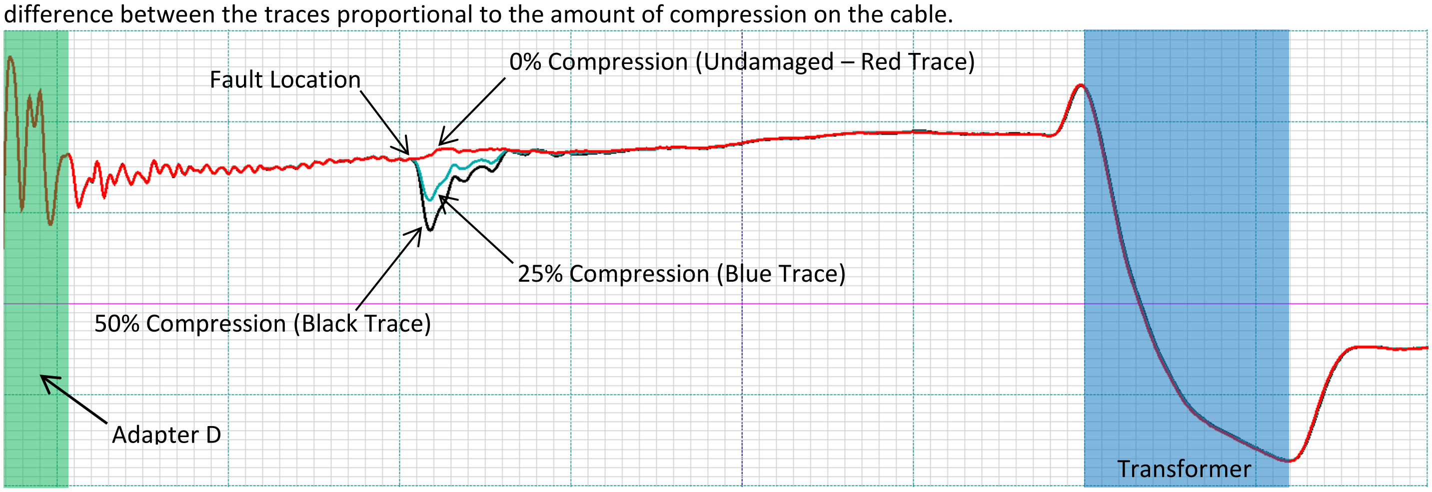


Figure 5 - Compression Damage 48 inches from Start of Cable (Before Transformer) using Adapter Type D

As shown, compression damage to a cable prior to a transformer can be easily detected even if a normal (undamaged) trace is not available. Even small compressions may be determined in this manner by looking for anomalies in the linearity of the trace.

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Compression Damage Detection beyond transformer couplings (Compression Location #2)

Identification of compression damage beyond a transformer coupling using TDR or VNA cable analyzers has been historically accepted as impossible due to the loss of signal bandwidth at the transformer. The capabilities of the MOHR CT100 Series TDR Cable Analyzer and CT Viewer Software make this type of detection possible for minimally trained personnel, providing they understand the characteristics of a damaged cable trace.

Figure 6 shows typical overlaid traces of the 1553 Data Cable Bus using Adapter Type D for undamaged cable and cable compressed by 25% and 50% of its diameter. The compression damage is not readily apparent due to the vertical scaling of the traces.

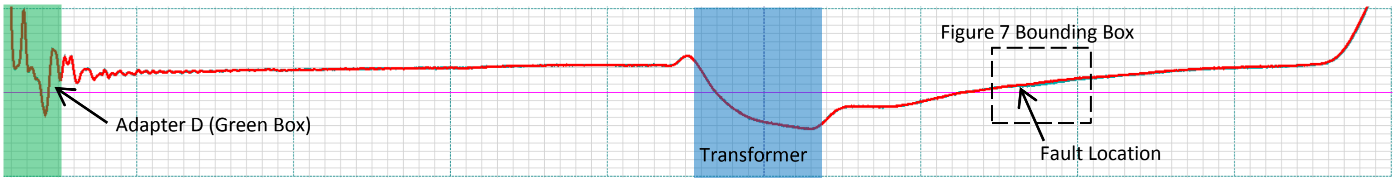

Figure 6 – Compression Damage 36 inches beyond Transformer using Adapter Type D (Autofit)

By increasing the vertical gain and shifting the horizontal position to focus in on the area bounded by the black dotted box in Figure 6, the compression damage becomes apparent, as shown in Figure 7.

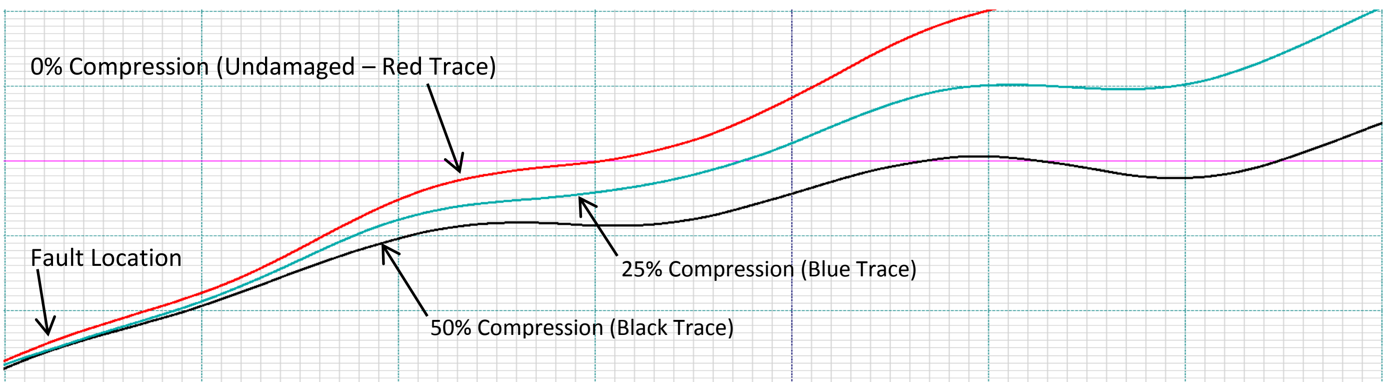

Figure 7 – Compression Damage 36 inches beyond Transformer using Adapter Type D (Zoomed in – Smoothed)

If an undamaged cable trace is available for comparison, the detection of compression faults through a transformer can be rapidly identified and located by following these steps:

1. Take a high resolution scan of the cable using the same adapter as the undamaged trace (most consistent results in testing have been obtained with Adapter Type D, but certain cases may require using types B & C, as well.)
2. Load both the undamaged and damaged cable traces into the CT100 or CT Viewer software and match Vertical and Horizontal Position and Scale.
3. Smooth all traces until noise is reduced and the traces look smooth (typically a factor of 40-80 in CT Viewer.)
4. Create a Difference trace between the undamaged and damaged traces. Smooth the Difference Trace.
5. Create a Slope (1^{st} Derivative) of the Difference Trace. Smooth the Slope Trace.
6. Increase vertical gain on the Difference and Slope Traces until a peak associated with the damage appears.

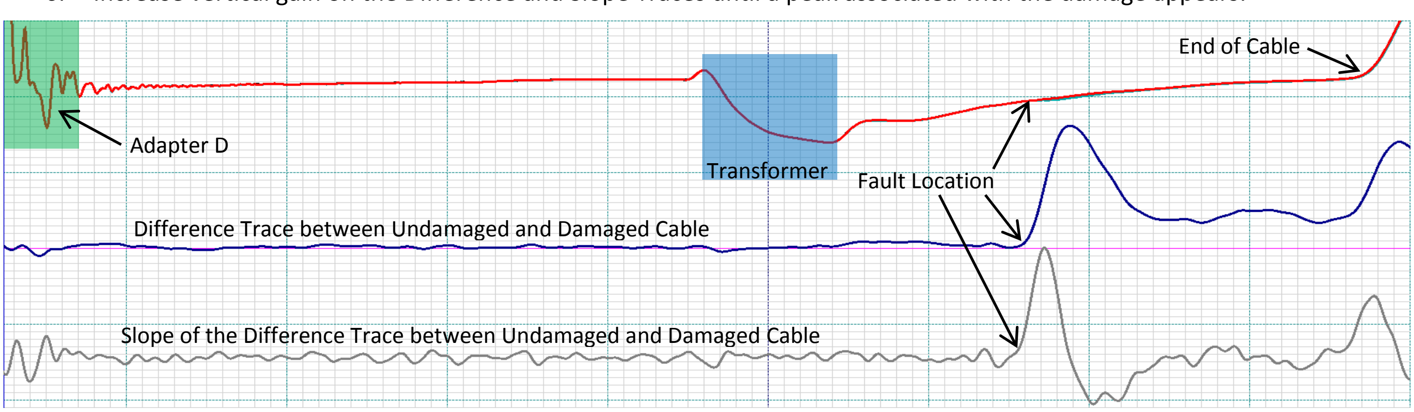

Figure 8 – Difference and Slope of the Difference Traces showing location of compression damage beyond a transformer.

