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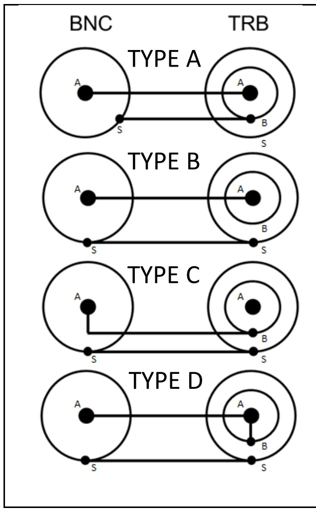
Application Note AN-2016-1

1553B Data Bus Cable Fault Detection Through Multiple 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. Many applications for the 1553 data bus use TRB triaxial connectors as a quick connect attachment between components. The MOHR CT100 Series portable TDR Cable Analyzers in conjunction with the MOHR TRB Triaxial Adapter Kit are ideal instruments for locating impedance changes through coupling transformers and identifying their associated fault types.

The MOHR TRB Triaxial Adapter Kit allows for connections to the shield and individual conductors in 1553 data cables, aiding in the identification and location of multiple fault types on 1553 data bus Lines. In addition to the TRB adapters, multiple gender changers and terminations are provided in the kit. Figure 1 shows the four types of BNC to TRB adapters and their internal connections.



TYPE A: BNC A to TRB A
BNC Shield to TRB B
Best for open conductor detection

TYPE B: BNC A to TRB A
BNC Shield to TRB Shield
Best for conductor to conductor short detection

TYPE C: BNC A to TRB B
BNC Shield to TRB Shield
Best for conductor to conductor short detection

TYPE D: BNC A to TRB A&B
BNC Shield to TRB Shield
Best for Conductor to Shield Short and Shield Disconnect Detection

Figure 1 – MOHR TRB Triaxial Adapter Kit Schematics (P/N CTA20100)

Figure 2 – Mohr CT100B TDR Cable Analyzer and MOHR TRB Triaxial Adapter Kit (P/N CTA20100)

Broken conductor detection beyond two transformer couplings (open fault)

A typical usage scenario for the TRB Triaxial Adapter Kit is the detection of an open fault (broken conductor) on a 1553 main bus cable at a location beyond two transformers. The proper test methodology is to connect the TRB cable adapter(s) to the unpowered 1553 data bus cable and then connect the adapter to the CT100. It is very important to connect to the CT100 as the last step to prevent the discharge of static or capacitive voltage into the CT100. A broken conductor can easily be detected with adapter type A, however, types B and C may also be used to detect open conductor faults with similar results.

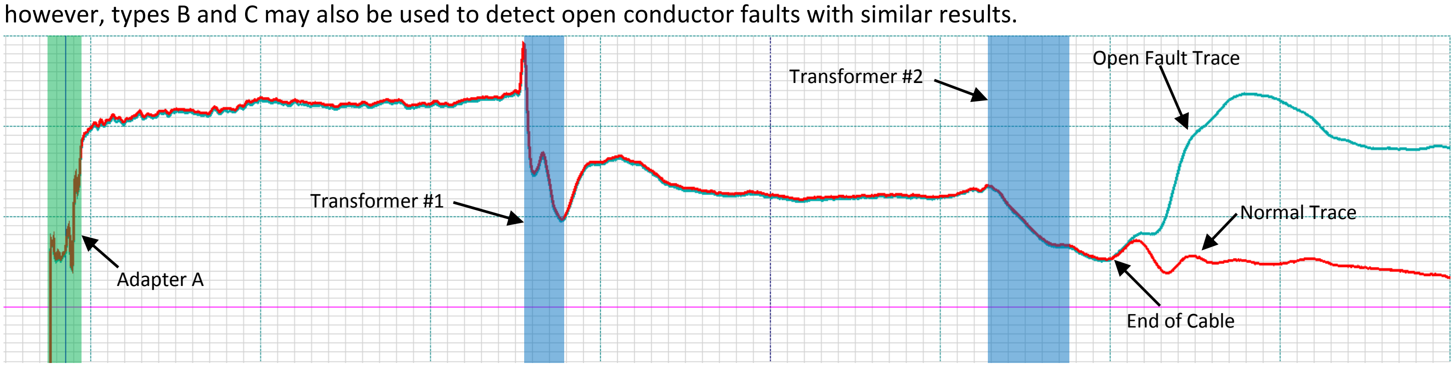


Figure 3 – Open conductor fault detection using Adapter A through two transformer couplings (transformers shown in shaded blue boxes)

Figure 3 above shows a system of two transformers on the main bus, with a three foot cable extending beyond the second transformer. An open fault (broken conductor) is initiated at the end of this extension cable. This data was taken using the MOHR Adapter type A with a resolution of 0.1 cm per division. The transformers are easily detected as there is a sharp negative impedance change in the trace at each transformer. The red trace in Figure 3 shows the "Normal" trace with no fault in the system. The blue trace shows a cable with a broken conductor located at the end of the three foot extension of the main bus and is easily detectable by the sharp increase in impedance in relation to the normal trace.

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Fault detection beyond three transformer couplings (short between shield and conductor)

A second use case shows the ability to detect a short between one conductor and the cable shield at a location beyond three transformers using adapter type D. Figure 4 shows the location of each of the three transformers as blue shaded bands. A short between the shield and conductor is initiated at a location 24 inches beyond the third transformer as shown by the blue trace. The normal (non-shorted) trace is shown in red. The fault is detectable as a sharp decrease in impedance at the fault location.

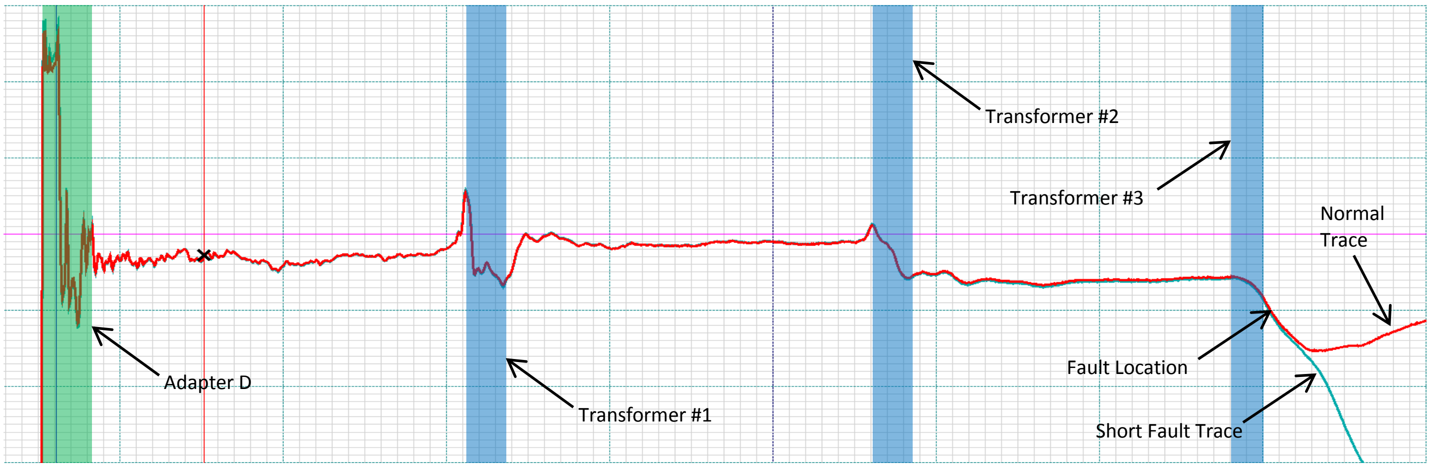

Figure 4 – Conductor shorted to shield fault detection through three transformer couplings using adapter D

Disconnected shield fault detection beyond three transformer couplings (open)

A third use case shows the ability to detect a disconnected shield on the main 1553 data bus cable at a location 24 inches beyond the third transformer in a three transformer bus line using adapter type D to detect the fault as shown in Figure 5 below. Each transformer is clearly located as shown with the blue shaded bands. The trace with the disconnected shield is shown in blue, with the normal trace shown in red in the top traces of figure 5. The disconnected shield fault is easily detected as a sharp increase in impedance at the far end of the cable.

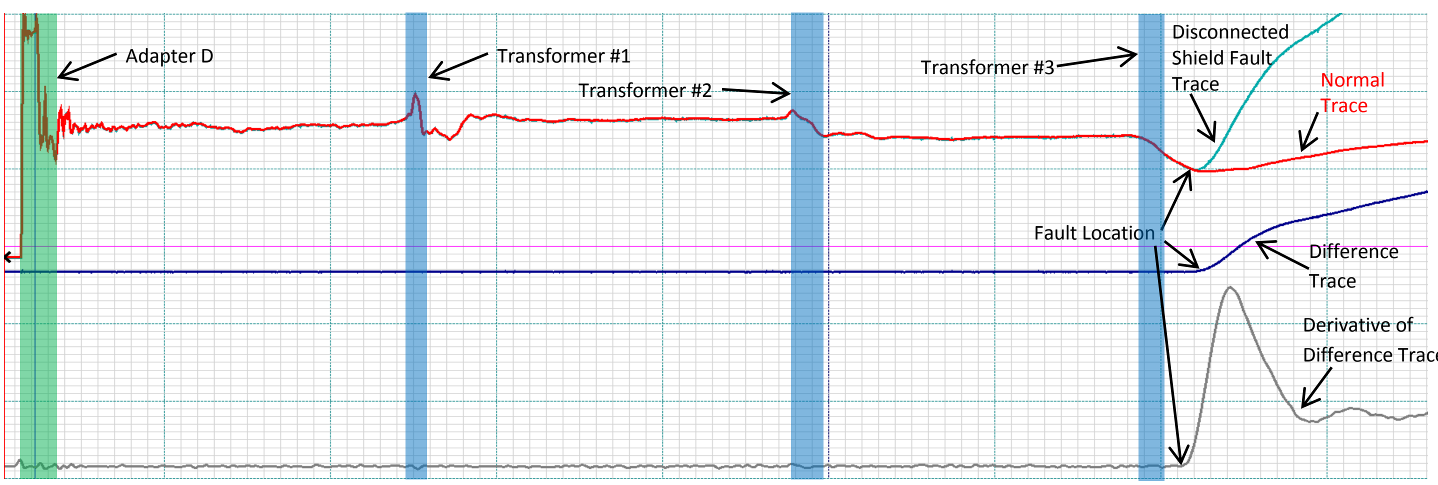

Figure 5 – Disconnected shield fault through three transformers with difference trace and derivative of difference trace for fault location

There is a level of familiarity and experience involved in discerning faults if a prior (normal) trace is not available for comparison. If a normal trace is available, the detection of faults becomes a routine operation of capturing data using the same parameters as the original (normal) trace scan, then using either on-board trace difference within the CT100, or using the external CTViewer PC-based software provided with each CT100 to compare the traces. Using either method, a difference trace can be generated, clearly highlighting the conductor fault as shown in figure 5.

When a difference trace is noisy or does not show as clear of a detection threshold as presented in figure 7, a derivative plot of the difference trace can yield clearer results as shown in Figure 5 with the grey trace.