Passive TDR for Active Buses

Advantages:

- Increases bus reliability
- Reduces maintenance costs
- Pin-points location of problem
- Shortens time to fix bus problems
- Continued testing during operation
- Detects problems before functionality is damaged

Solutions for Mil-Std-1553

Sital Technology LTD. provides world-class products and expertise for communication bus applications in the avionics, aerospace and automotive industries. Sital embeds its vast experience and proficiency in its products which include the widely used Mil-Std-1553 and ARINC 429 IP cores, components, boards and testers, as well as uncommonly used protocols such as H009, WB194 and French DigiBus. Sital also provides CAN bus testing devices and applications. Sital's bus technologies and expertise improve robustness and efficiency at lower cost, space and resource utilization.

The founders of Sital are veterans of the Israeli Air Force and are experts in Mil-Std-1553, CAN and other bus applications.

SITAL Technology

Making Mil-Std-1553 Wires Testable and Reliable

Sital's Passive TDR (pTDR™) technology is capable of detecting wiring problems such as disconnections, short-circuits, and others, whether they are constant or intermittent.

pTDR is a Passive Time Domain Reflectometer (TDR) technology, which constantly measures reflections of energy on an operating Mil-Std-1553, CAN or similar bus.

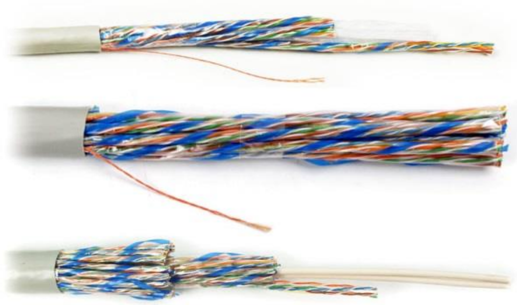
pTDR technology runs during normal system operation without disturbing the standard bus activity.

A standard TDR device sends pulses of energy to the bus and measures the reflected signal. Reflections are created from wiring faults such as disconnections, shorts or lack of proper termination. The time it takes for the signal to travel to the fault and back to the TDR is related to the location of the fault. However, a TDR cannot run while the system is operating, simply because it would be confused by the on-going transmissions on the bus, and also because it may disturb the standard communication.

pTDR does not transmit any pulses to the bus. Instead, it monitors the existing communications and measures reflections created by the normal transmissions. If there are wiring faults then signals will be distorted in certain ways that are related to the location of the fault. The main distortion is related to the width of transmitted bits. For example, in Mil-Std-1553 bits width is 1uS. A distorted bit can last for an additional few nano-seconds, according to the location of the fault. pTDR measures the distortions and reports the additional length of each bit. We call this additional length a "***tail***".

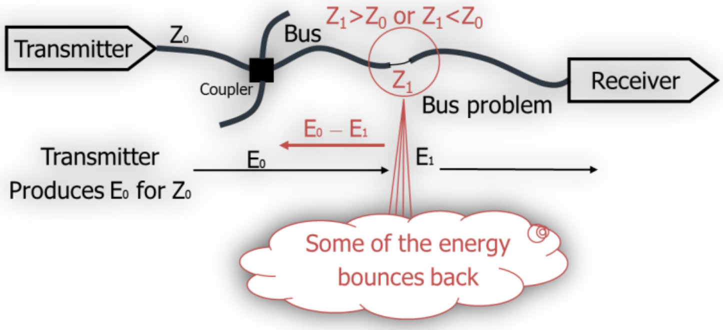
The Sital pTDR system constantly reports tails from all Remote Terminals (RTs) on the network. In a correctly performing bus the tails from all RTs will be small and uniform. Changes in the tails indicate a bus fault.

Tail measurements are constantly performed on every message and updated on every frame. Therefore, even a very short disconnection event will be reported.



How Passive TDR Works?

Serial data buses are built of electrical wires for transferring data from one unit to another. Data is actually a string of electrical signals, or energy, which is transmitted from one unit, spread through the wires and received by other units.



Impedance

When all wires and units are properly connected the transmitted energy is absorbed by the units on the bus and by the termination resistors at both ends of the bus. In order for the energy to spread equally through the bus, all wires, units and terminators must have the same electrical impedance (Z_0), and therefore data buses are designed for specific impedance that matches the frequencies, type of signals and amount of energy that travels through the bus.

A Mil-Std-1553 bus, for example, is designed for an impedance of 78 ohm. CAN bus is designed for 120 ohm. Any change of impedance in the bus will result in distortion of the signals travelling through the bus.

In most cases, changes of impedance are caused by a disconnection on the bus (infinite impedance), a short circuit (zero impedance) or a missing termination resistor (high impedance).

Reflections

The signals travel in the wires at a speed close to the speed of light. When the energy meets a point of different impedance it bounces back and travels in the opposite direction. This reflection is added to the transmitted signal and distorts it.

Reflections are actually the same transmitted signal, but at lower power and shifted in time.

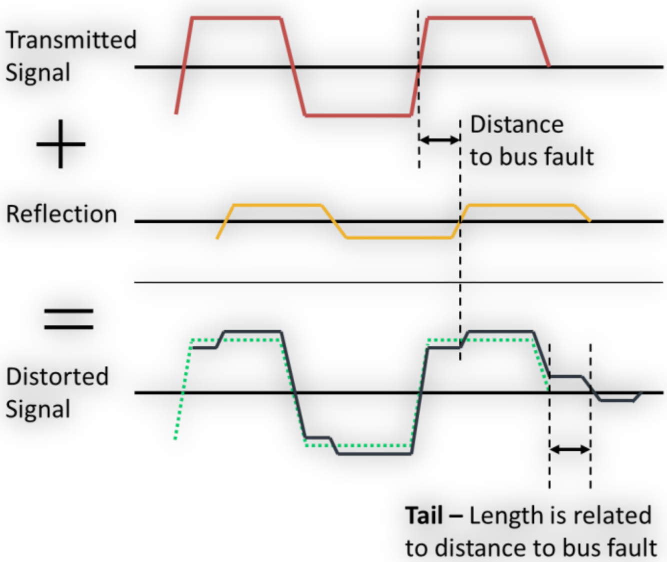
The time shift is related to the location of the bus fault and the point of measurement.

Tails

Tails are the distortion of signals at the end of each message, caused by reflections.

While messages are being transmitted to the bus, it is very hard to detect and measure the reflections. However, a protocol-aware system can detect the extra length of energy after a message transmission ends.

The length of the tails is related to the location of the transmitter, the fault and the system that measures the signals.

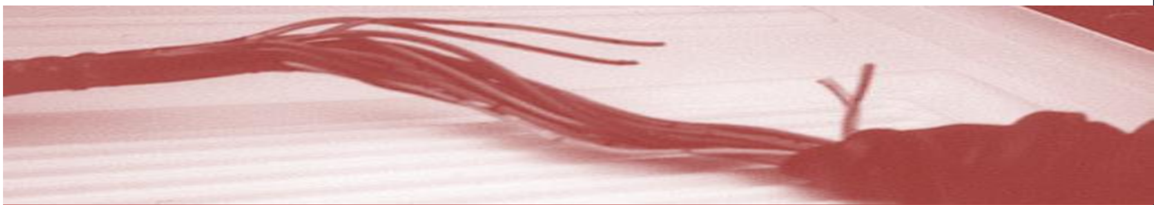


"The current situation is that each system on the aircraft performs its own built-in-test (BIT) and reports its own problems. But there is no mechanism for performing BIT to the bus wires or reporting wiring problems when they occur. Our technology adds a great level of reliability to the bus, without interfering with the bus activity and without adding any complexity to the system."

Ofer Hofman - CTO

"Our pTDR™ technology is already implemented on CAN bus and used by automotive manufacturers for detecting wiring faults on vehicles during manufacturing, maintenance and operation. We are excited to enable our avionics and automotive customers to enjoy this technology, add value to their products and make safer aircraft and vehicles."

Duli Yariv – VP Sales & Marketing



Sital Key Products and Benefits

Sital provides Mil-Std-1553, EBR1553, ARINC429 IP cores for FPGA, in various configurations and interfaces

Mil-Std-1553 components - protocol terminals, transceiver IP and transformers

1553, ARINC 429 and many other protocol interface boards - PMC, PCI, PC104+, cPCI, VME, etc.

Testers for 1553, H009, WB194, with USB interface or any other form factor

Sital Technology Ltd.

Tel: +972-9-7633300

Fax: +972-9-7663394

Email: info@sitaltech.com

Web: www.sitaltech.com

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pTDR Operation

In serial data buses only one unit transmits at a time. Mil-Std-1553 bus is controlled by a Bus Controller (BC) and CAN is controlled by a set of message IDs that define the priority of a message.

A protocol-and-system-aware test system can determine which unit transmits data at any given time.

Tail Length

In cars, aircraft and any other system with a data bus, units are spread across the system and connected by wires. A Mil-Std-1553 network consists of backbone cables and couplers, connected via stubs to units on the network.

When a fault occurs, the tail length depends on the location of the fault, and is related to the location of the transmitter and the pTDR monitoring unit.

A transmitter that has a short wire to the fault causes a short tail and a transmitter far from the fault causes a long tail.

Bus Topology

The combination of tails from various sources provides meaningful information regarding the actual location of a fault.

Just as a GPS receiver performs triangulation between various satellites, a Passive TDR system can perform similar triangulation between the various tails, which are the result of transmission from the various terminals on the bus.

In order to be able to pin-point the location of a fault, the system must be aware of the topology of the bus, length of cables and location of terminals.

Without this topology information the system can still indicate if the bus is healthy or not. However, the bus topology is required for indicating the actual fault location.

pTDR Implementation

Sital's testers, boards and IP cores include the means for measuring tails. Tail measurements are provided for each Terminal by a set of SW accessible registers.

A user can employ the provided tails to determine whether or not the bus is "good". When the bus is good, the system can store the "OK values" and compare them to the tails values during operation.

If a wiring fault occurs then tails values will change and provide an immediate indication of a bus fault. Since pTDR measures the tails for every message, then even if the fault lasts for a very short period of time it will still be reported.

If the topology of the network is known to the tester or monitoring terminal, then the Sital algorithm for fault location can be implemented to indicate the actual location of the fault.

pTDR implementation does not require any changes to the network, terminals or data transmissions. It uses the existing terminals and messages.

pTDR technology for detecting wire faults is available on the full range of Sital products: testers, IP cores and interface boards.