Keysight Technologies
Efficient Testing of Automotive Serial Buses
- CAN, LIN, MOST® and FlexRay™

Application Brief

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

Introduction

Since autonomous vehicles are being developed, a multitude of sensor signals is burdening a car's serial bus systems together with a growing volume of multimedia data. No matter if you look at the Local Interconnect Network (LIN), Controller Area Network (CAN), FlexRay or Media Oriented System Transport (MOST) buses, the data travelling between growing numbers of nodes is always subject to many distorting influences. Besides the electromagnetic radiation and capacitive loading of cables, the frequency response of connector interfaces also heat and mechanical stress may degrade the signals.

Reliability is a must for the safety sensitive systems responsible for collision prevention, speed sensing, oil temperature control and ABS management to only name a few.

Also for the less sensitive systems and subsystems, it is crucial that the data reaches its destination node in time without being corrupted. For this purpose thorough stress testing on the physical layer is indispensable in the development phase of a vehicle. To test the robustness of the electronic systems in the prototype cars is by far more expensive and time-consuming.

A measurement setup with a mixed signal oscilloscope and a pulse pattern generator combined with a function and an arbitrary generator is a natural fit for these types of measurements.

Reliable and Repeatable Physical Layer Tests with the 81150A or 81160A Pulse Function Arbitrary Noise Generator

Ideal and arbitrary bit shaped pattern

In general, physical layer receiver test focuses on providing a worst case signal to a FleyRay/CAN/LIN/MOST device and detecting whether the receiver is able to detect the signal properly; thus a known pattern has to be sent to the FlexRay receiver in order to compare it with the results received.

The Keysight 81150A and 81160A pulse function arbitrary noise generators with arbitrary bit shaped pattern option allow emulating overshoot, asymmetric delay, and duty cycle distortion, up to 120 Mbit/s and 330 Mbit/s or 660Mbit/s respectively. Patterns can be easily set up and distorted at your fingertips.

The pattern option for the 81150A contains an activation of 16 Mbit pattern memory per channel. The 81160A pattern options feature 4 Mbit per channel on a 1-channel instrument and 2 Mbit per channel on a 2-channel instrument.

Functionality like initialization sequences and three level signals help to set up the device into test and debugging mode. Proven stress tests with pseudo random binary sequences (PRBS up to 2^{31}) give a new insight into the device – fast and cost effective.

Clock synchronization

Clock synchronization can be verified by adjusting the frequency of the generator, adding jitter, and changing the position of the individual frames that are being generated.

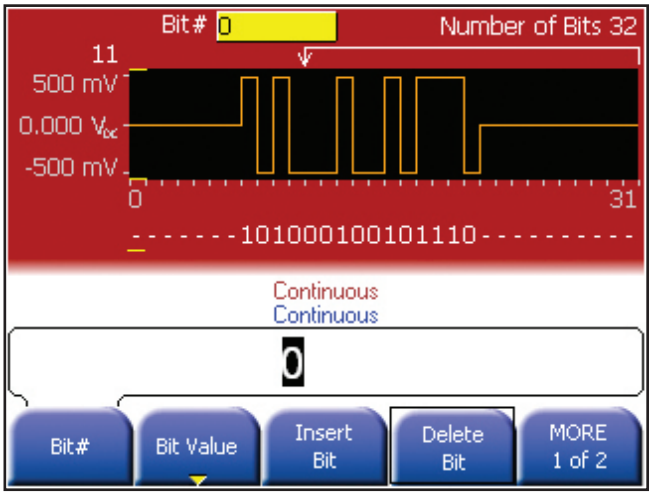

Figure 1. Ideal pattern without any distortion on 81150A

Figure 2. Distorted pattern generated by 81150A

Bridge the Gap Between Physical and Protocol Layer Test – In Real Time

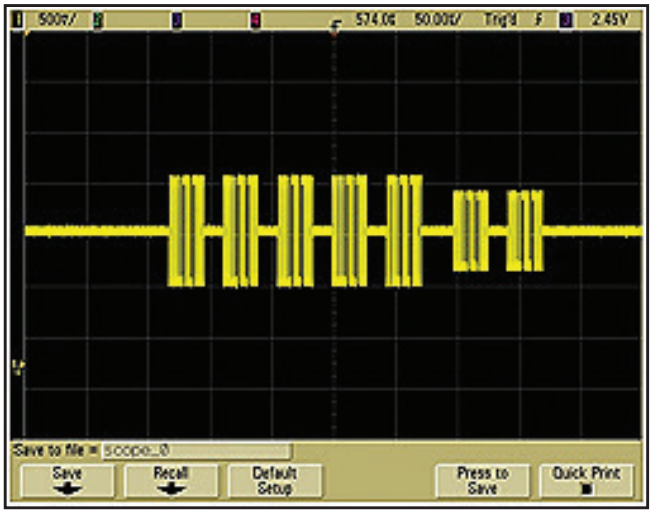

Figure 3. Two emulated nodes

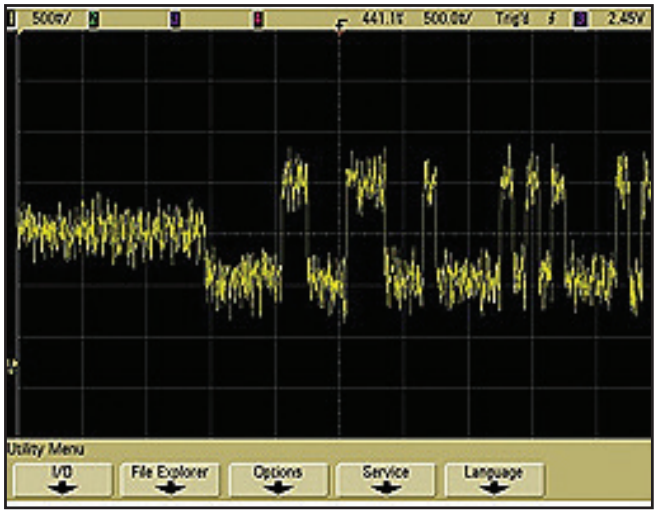

Figure 4.. Gaussian noise added to a FlexRay frame

Receiver sensitivity

Varying the differential output voltage level of the pattern generator, adding asymmetric delay, and varying the rise and fall times allows testing the sensitivity of the receiver. In order to verify a receiver's glitch rejection capability (majority voting) the generator can add glitches of adjustable amplitude and duration at deterministic points within a frame. Timing variations between nodes can be simulated. Typical robustness tests are:

- Changes of amplitude, offset violations
- Added noise or glitches
- Synchronization failures

The Keysight 81150A and the 81160A can emulate one or more nodes on the CAN, LIN, MOST or FlexRay bus, and can either act as a startup node or synchronize itself onto a running cluster using its external triggering capability.

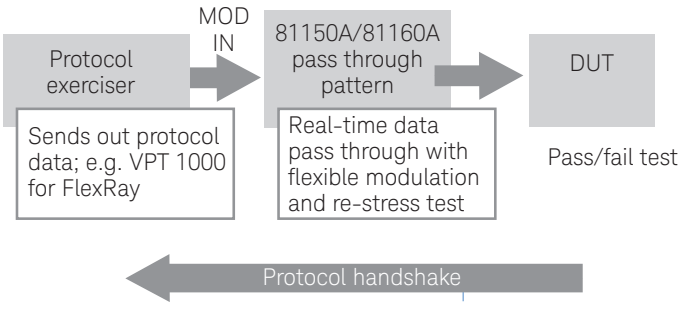

Figure 5. Distortion added to protocol data

Increase your test efficiency by combining physical layer with protocol layer tests

In addition to memory based internal data pattern and algorithmically generated PRBS patterns, digital data can be supplied from an external source, such as a protocol exerciser. The 81150A and the 81160A can pass through and re-shape the data in real-time.

External patterns are input via the MOD-IN input on the rear panel of the instrument.

The pass through pattern feature and distortion works in real time, up to 10 Mbit/s and is limited to three-level signals. The set-up necessitates definition of threshold voltages to distinguish the levels from each other.

Summary

Signal integrity in automotive communication systems is influenced by many factors. The 81150A and 81160A pulse function arbitrary noise generators offers the flexibility to emulate most efficiently a vast range of scenarios:

- Any ideal and real-world signals from pulses, sine waves, Gaussian noise, arbitrary waveforms to any modulated signal
- Arbitrary bit-shaped pattern to emulate overshoot, asymmetric delay and duty cycle distortion up to 120 Mbit/s
- Pass-through pattern for combined physical layer and protocol test up to 10 Mbit/s

Ordering Information

Product	Description
81150A	
Option 001	1-channel 120 MHz pulse function arbitrary noise generator
Option 002	2-channel 120 MHz pulse function arbitrary noise generator
Option PAT	pattern generation up to 120 Mbit/s
81160A	
Option 001	1-channel 330 MHz pulse function arbitrary noise generator
Option 002	2-channel 330 MHz pulse function arbitrary noise generator
Option 330	pattern generation up to 330 Mbit/s
Option 660	pattern generation up to 660 Mbit/s

Complementary Products to Complete the Solution	
3000A and 3000T (with touch screen) X-Series InfiniiVision oscilloscopes, 100 MHz to 1 GHz	
4000 X-Series InfiniiVision oscilloscopes, 200 MHz to 1.5 GHz	
DSOX3AUTO DSOX4AUTO	CAN/ CAN-FD/ LIN trigger and decode software for InfiniiVision 3000 X-Series oscilloscopes CAN/ CAN-FD/ LIN trigger and decode software for InfiniiVision 4000 X-Series oscilloscopes
DSOX3FLEX DSOX4FLEX	FlexRay trigger and decode software for InfiniiVision 3000 X-Series oscilloscopes FlexRay trigger and decode software for InfiniiVision 4000 X-Series oscilloscopes
DSO3MASK DSO4MASK	Mask/ waveform limit test software with FlexRay and CAN eye-diagram mask test for InfiniiVision 3000 X-Series oscilloscopes Mask/ waveform limit test software with FlexRay and CAN eye-diagram mask test for InfiniiVision 4000 X-Series oscilloscopes
N2818A	200 MHz 10:1 differential probe with Autoprobe

Related literature	
81150A/ 81160A Pulse Function Arbitrary Noise Generator Data Sheet	5989-6433EN
InfiniiVision 3000 X-Series Oscilloscopes Data Sheet	5990-6619EN
IniniiVision 4000 X-Series Oscilloscopes Data Sheet	5991-1103EN
Serial Bus Options for InfiniiVision X-Series Oscilloscopes Data Sheet	5990-6677EN
Mask/ Waveform Limit Testing for InfiniiVision Series Oscilloscopes Data Sheet	5990-3269EN
Precision Digital Noise Application Note	5989-9364EN
FlexRay Physical Layer Eye-diagram Mask Testing Application Note	5990-4923EN
CAN Eye-Diagram Mask Testing Application Note	5991-0484EN
Debugging, LIN, CAN, CAN-FD, SENT and FlexRay Serial Buses Application Brief	5990-9275EN

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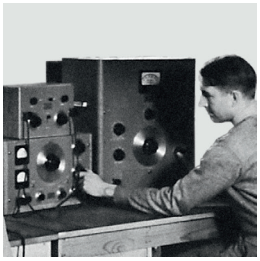

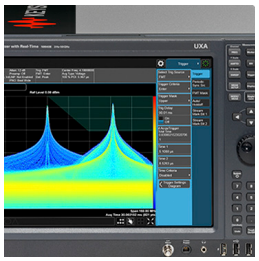

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