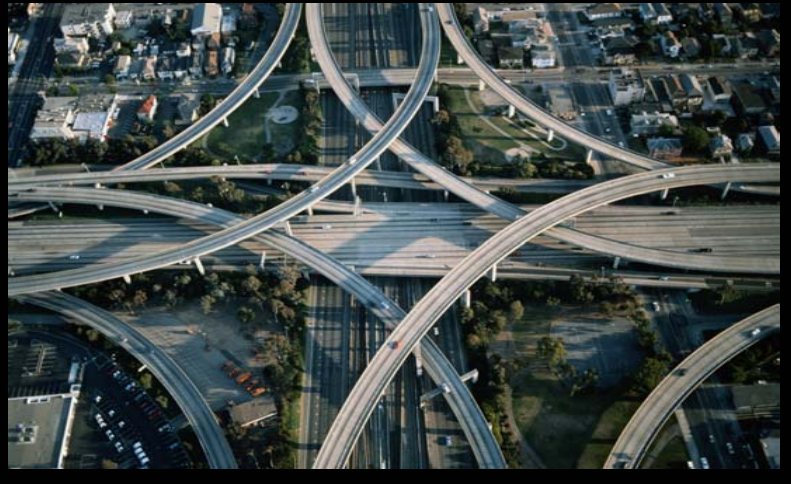
“Ensuring Robustness of Distributed Automotive Systems through Testing”

- Test To Correctness



Testing Exposition
Stuttgart, Germany
May 5, 2007

Cary Brown
Agilent Technologies
Technical Marketing Manager

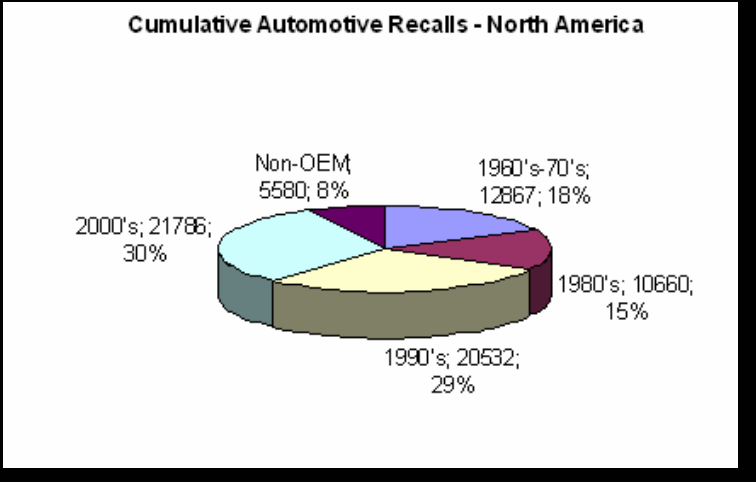
Are There Issues with Today's Vehicles?

10,000's of Defects are Claimed Annually

The Office of Defects Investigation (ODI) is an office within the National Highway Traffic Safety Administration (NHTSA). ODI conducts defect investigations and administers safety recalls to support the NHTSA's mission to improve safety on our Nation's highways. NHTSA is authorized to order manufacturers to recall and repair vehicles.

http://www-odi.nhtsa.dot.gov

The Office of Defects Investigation cumulative databases compiled as of March 27th, 2008, list over 70,000 effective recalls and 668,660 complaints linked to road vehicles purchased in North America. The information archived in the ODI database dates back to 1949, but shows an increasing trend for complaints and recalls during that past decade.



28.75% of historical North American recalls occurred for those vehicles produced during the 1990's, while vehicles produced during the 2000's have already accounted for 30.50 % of recalls.

What is the Effect of Consumer Realized Problems?

Warranty Costs

Poor Customer Satisfaction

Safety Risks

Ultimately a negative impact on the success of a company.

Where Do Errors Come From?

- Design
- Variances in Design Specification Interpretation
- Software Architecture
- Communication Driver Reliability
- Software Implementation
- Hardware Implementation
- Testing

How Big is The Problem?

- According to a McKinsey study from Spring 2006 *titled:*

  "Getting Better Software into Manufactured Products"

Network communication was identified as the greatest contributing cost source when repairing defects in manufactured vehicles.

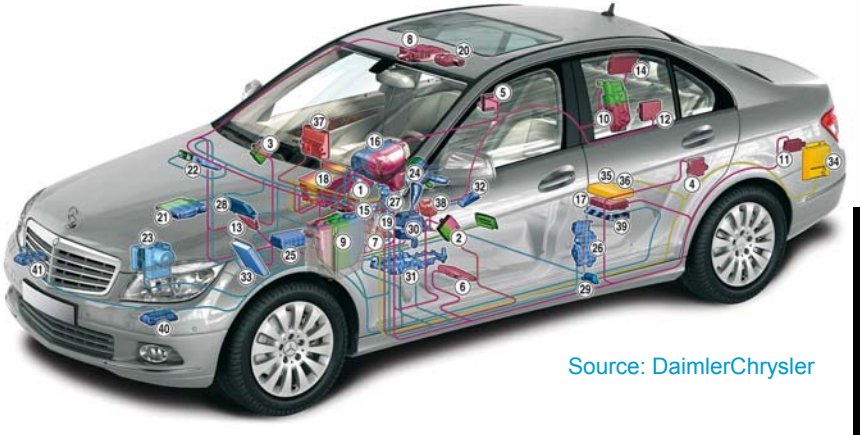
Top 3 Areas Where R&D Should Focus to Improve Automotive System Design (source: Mercer 2006)

1. Functional errors in mechatronic sub-systems
2. Errors in network communication
3. Software errors

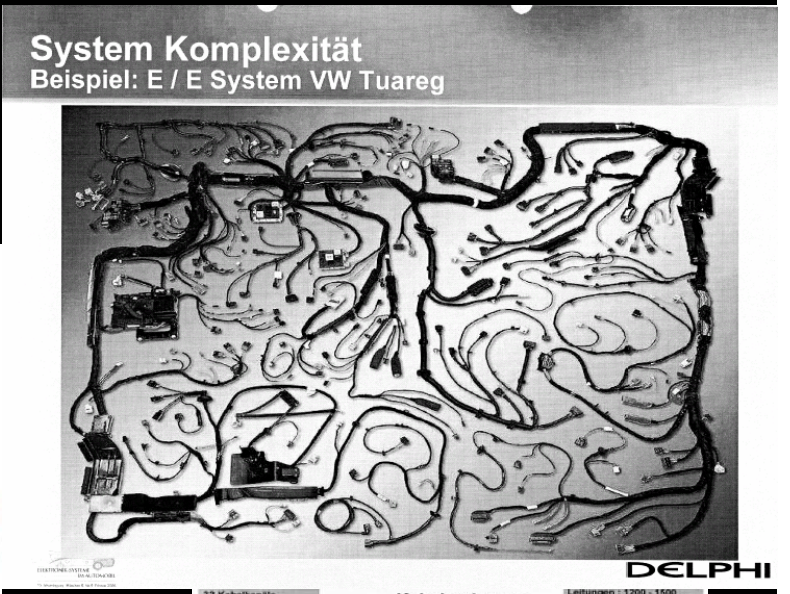
➔ These errors typically show up in functional test and integration test.

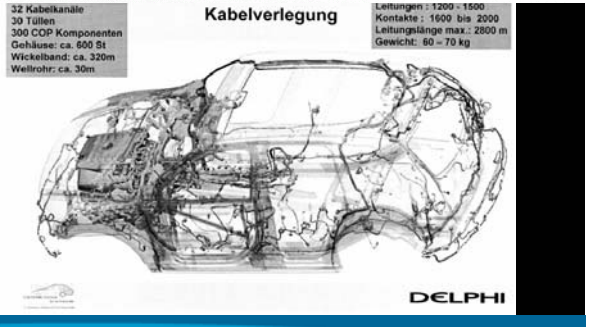
Why Do These Issues Go Undetected?
- Automotive Complexity

- Number of ECU's
- Feature Content
- Sharing of Data across Networks
- Inadequate Testing Time
- Weak Tool Performance



Source: DaimlerChrysler





Consideration of the Distributed Functions Where Signals Are Utilized

1000's of Functions exist in Vehicle Designs

Function Type	Example	Timing
Human Viewable	Lighting	100 ms
Human Audible	Locking	200 ms
Powertrain	Shifting	50 ms
Safety Critical	Airbags	10 ms

Function Interaction - Vehicle Speed Signal

Powertrain Torque Request

Adapative Cruise Control

Infotainment System

Anti-Lock Braking System

Electronic Stability Control

Locking Functionality (Security Locking Feature)

Power Management


In Vehicle Complexities
Are Your Signals Equipped with Navigation?

How Can We Fix the Problem?

- Through Testing Methods and Equipment

  - Scope of Testing must cover critical paths
  - Selection of Test Tools to meet Testing Needs
  - Standardization of Testing Libraries
  - Minimize Human Steps to reduce errors
  - Minimize Effort for Test Setup (across variants)
  - Automatic Identification of Issues
  - Automatic Isolation of Identified Issues

Improving control of these parameters will greatly enhance productivity and enable a higher degree of problem identification and correction… hence improving quality metrics.

Scope of Testing - Key problem areas:

Signal Integrity?

Noise Immunity?

Error Frame causes?

Are frames transmitted in accordance with specifications?

Are gateway processors maintaining schedule?

Do event sequences happen in correct order and timing?

Do vehicle functions meet timing requirements?

Why Kind of Tools Does Agilent Technologies Provide to Address These Problems?

Combining Robust Physical Layer with protocol measuring technologies delivers to a wide range of test criteria needs.

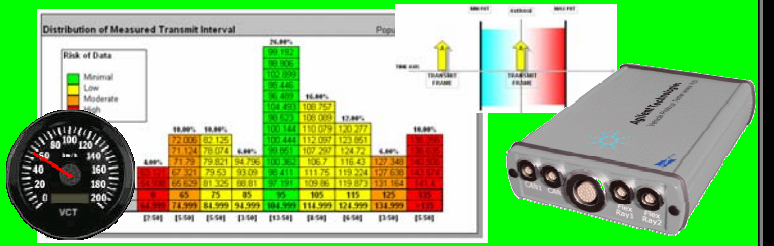
Scalable from Physical Layer Measurements to Data Link Layer Communication up to Application Layer Testing.

Agilent Automotive Tools

Scalable from Physical Layer Measurements to Data Link Layer Communication up to Application Layer Testing.

Protocol & Application

Analysis & Simulation



Physical

Analysis

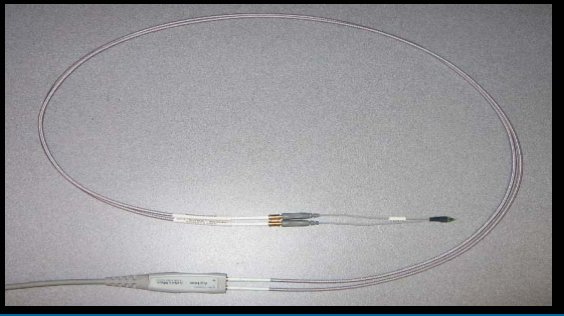
Noise Injection

Agilent Offers Flexible Solutions

Web Based Tool Interfaces Enable Access anytime & anywhere

Portability – Battery Operated

Extreme Conditions - Environmental chamber probe testing up to 155 degrees C.

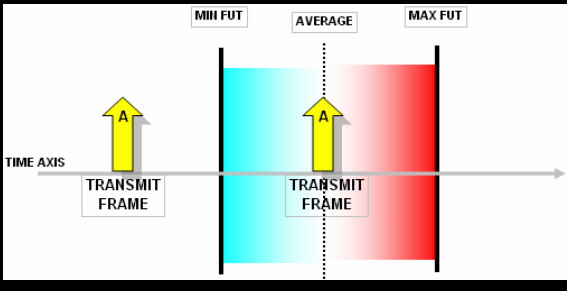


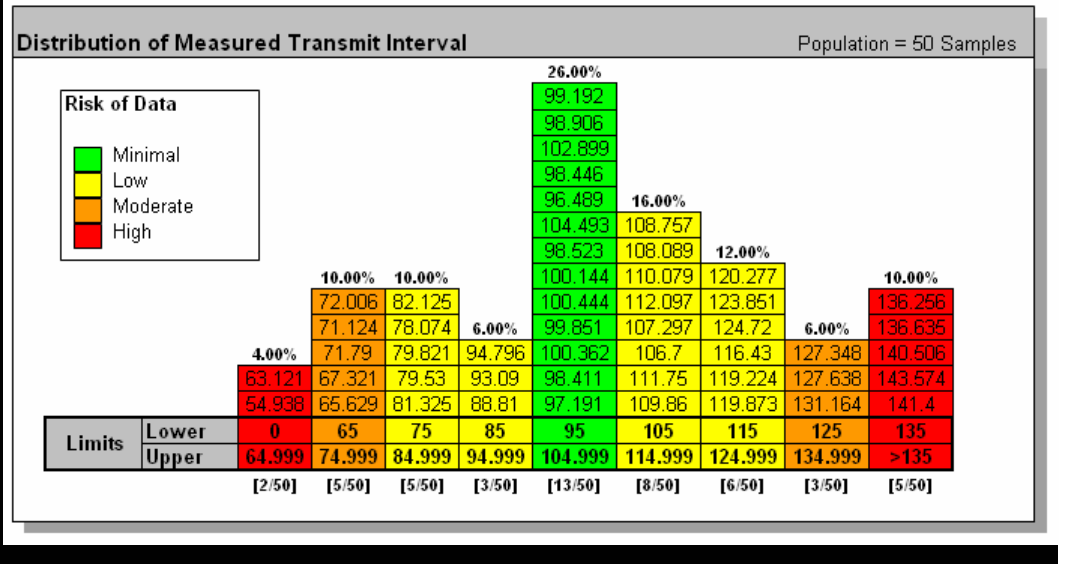
Measuring Robustness in Terms of Risk

The variability can be categorized in degrees of risk.

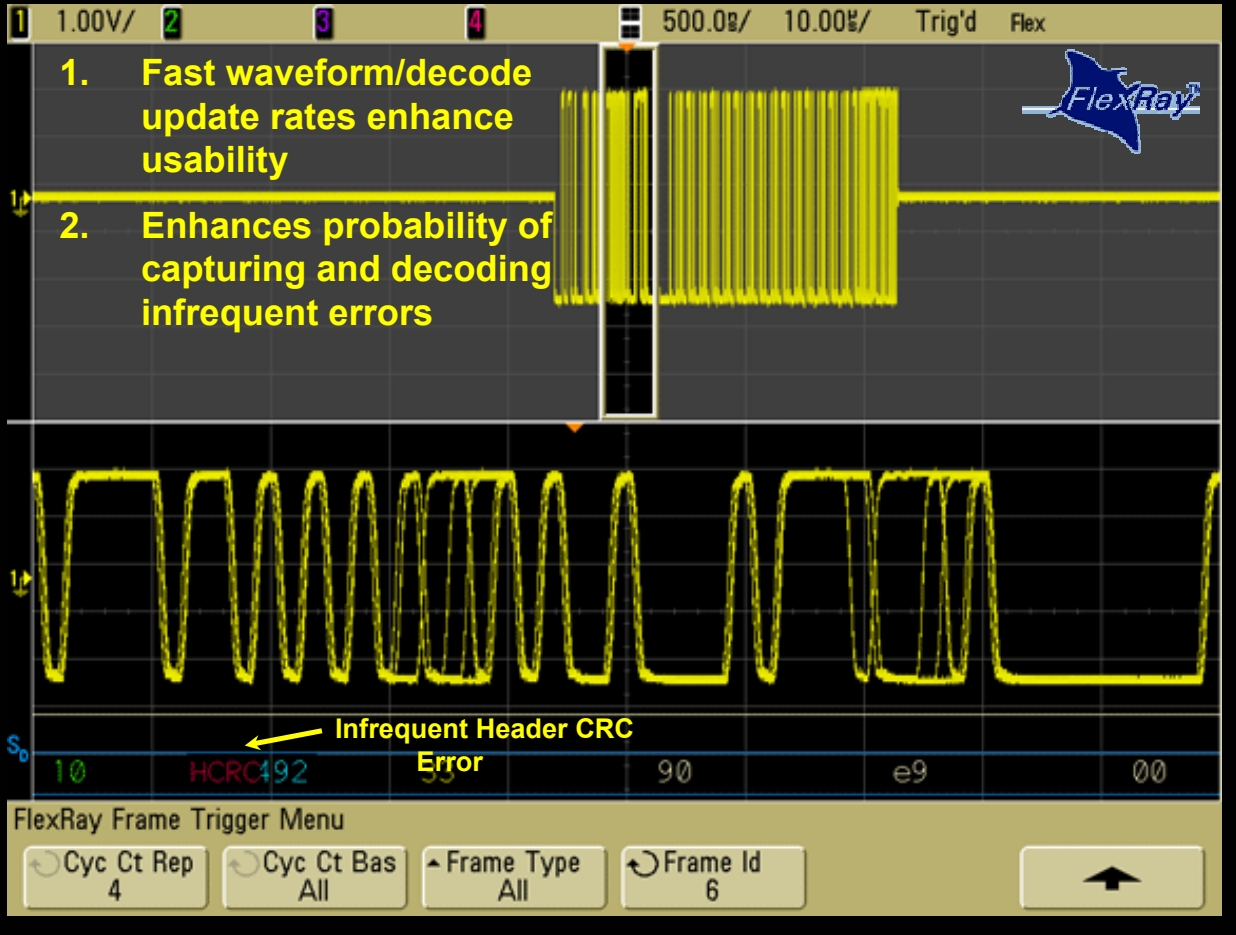
Risks Needs To Be Eliminated

Risk Range	Deviation from Mean	Variability Limits	
		Min	Max
Minimal Risk	<5%	>95ms	<105ms
Low Risk	<25%	>75ms	<125ms
Moderate Risk	< 35%	>65ms	<135ms
High Risk	>=35%		

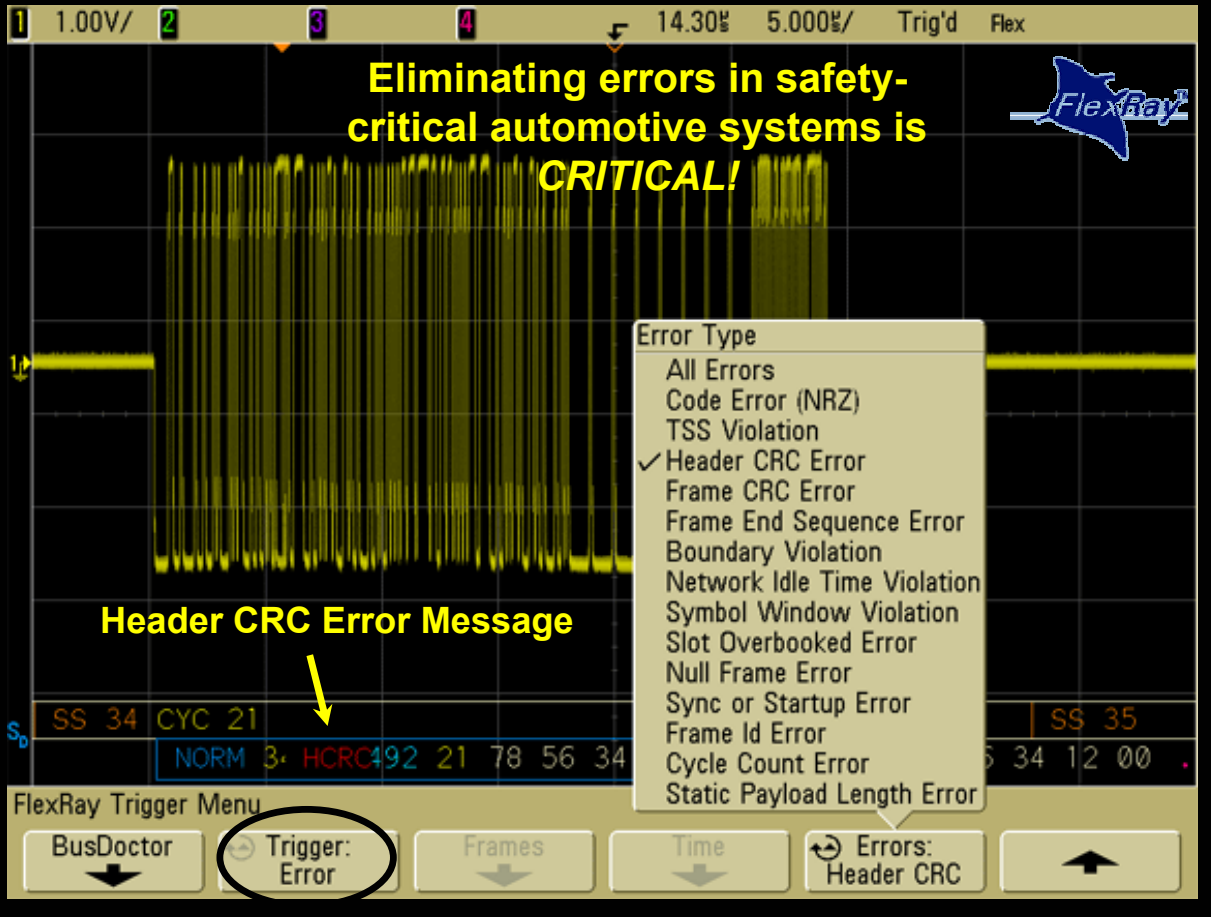




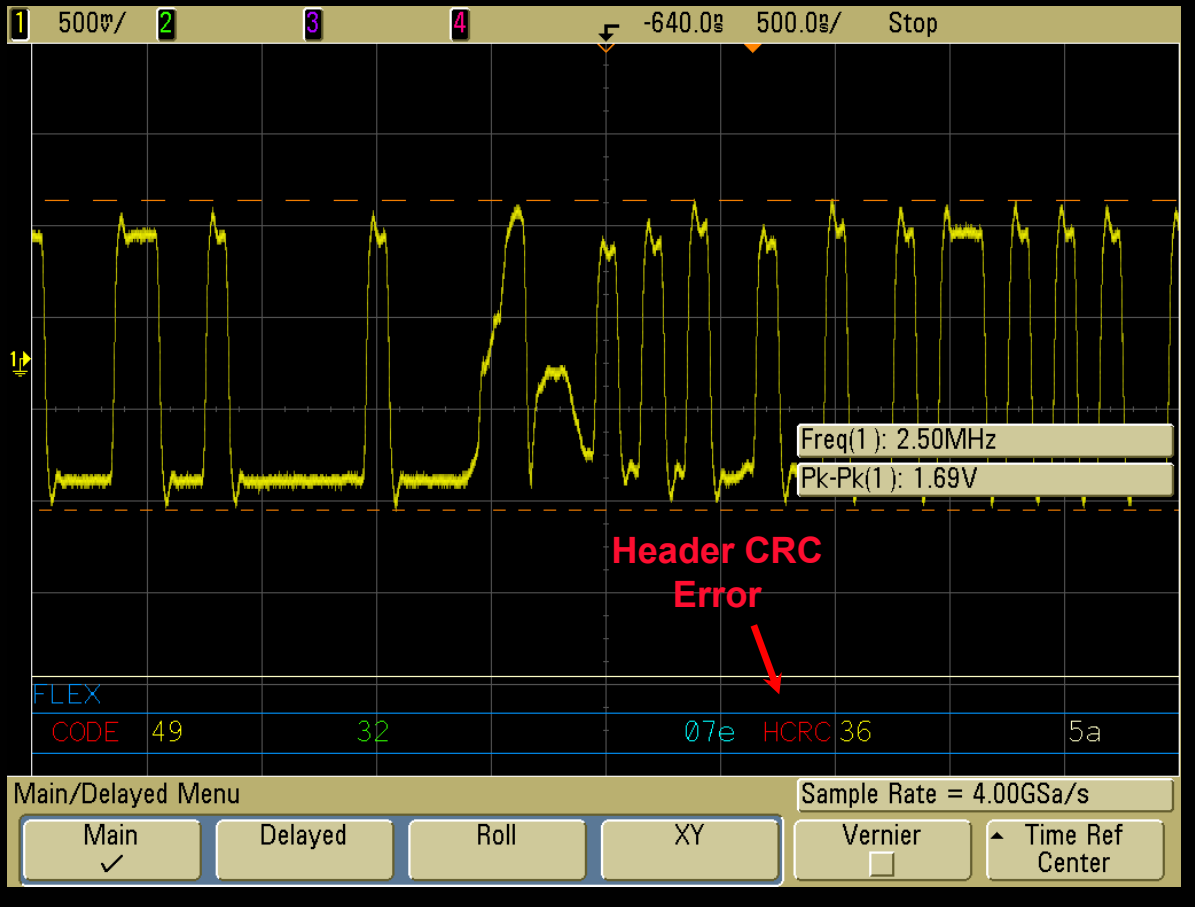
Eliminate Risks – High Speed Hardware Decoding



Eliminate Risks – Robust Error Analysis



Eliminate Risks – Identify Causes of Error Frames



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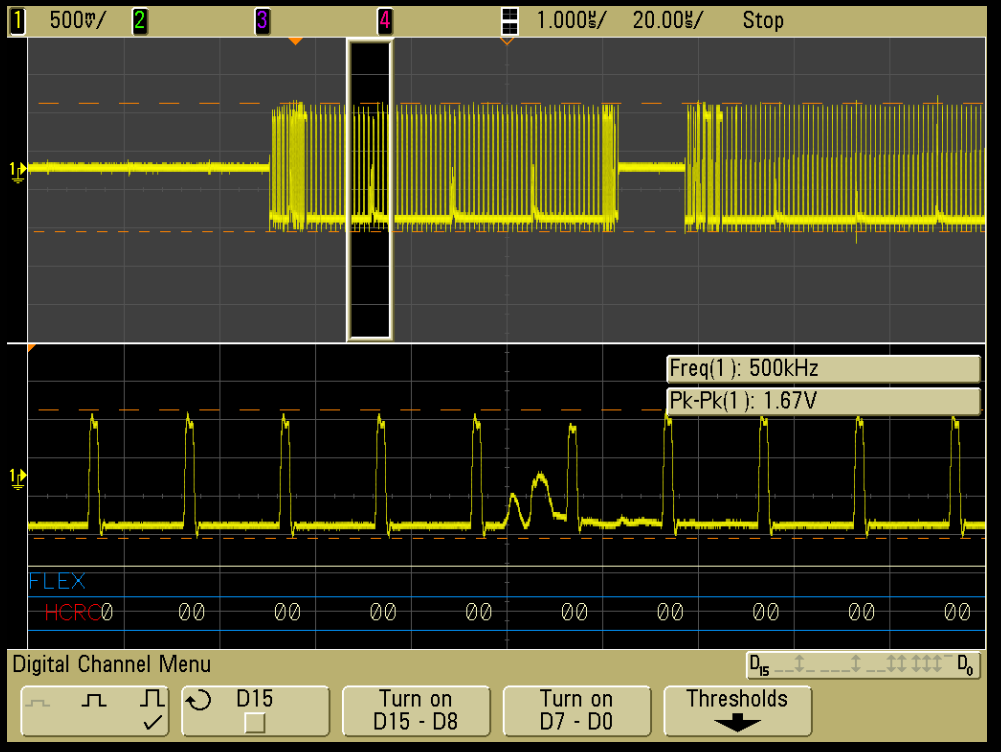
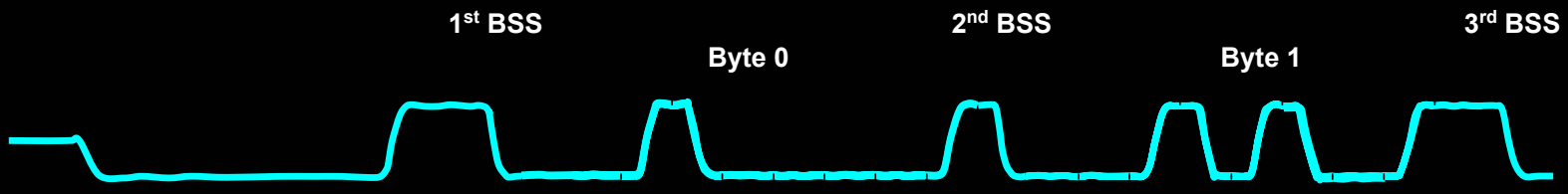
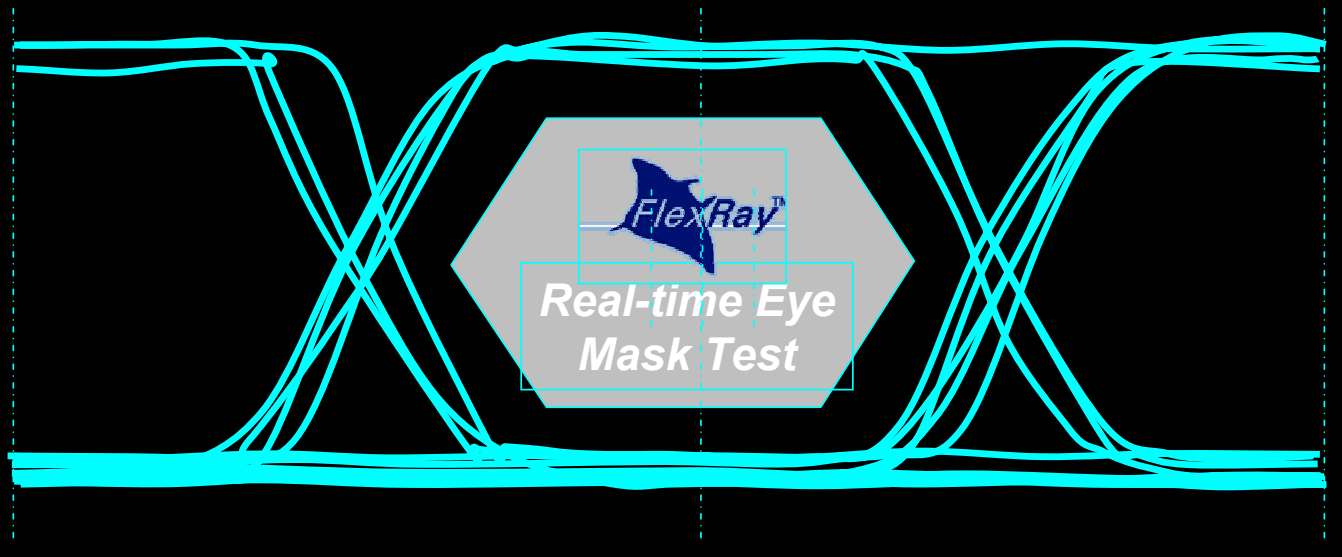


60 kHz Switching Power Supply Noise

FlexRay Decode Shows HCRC Error

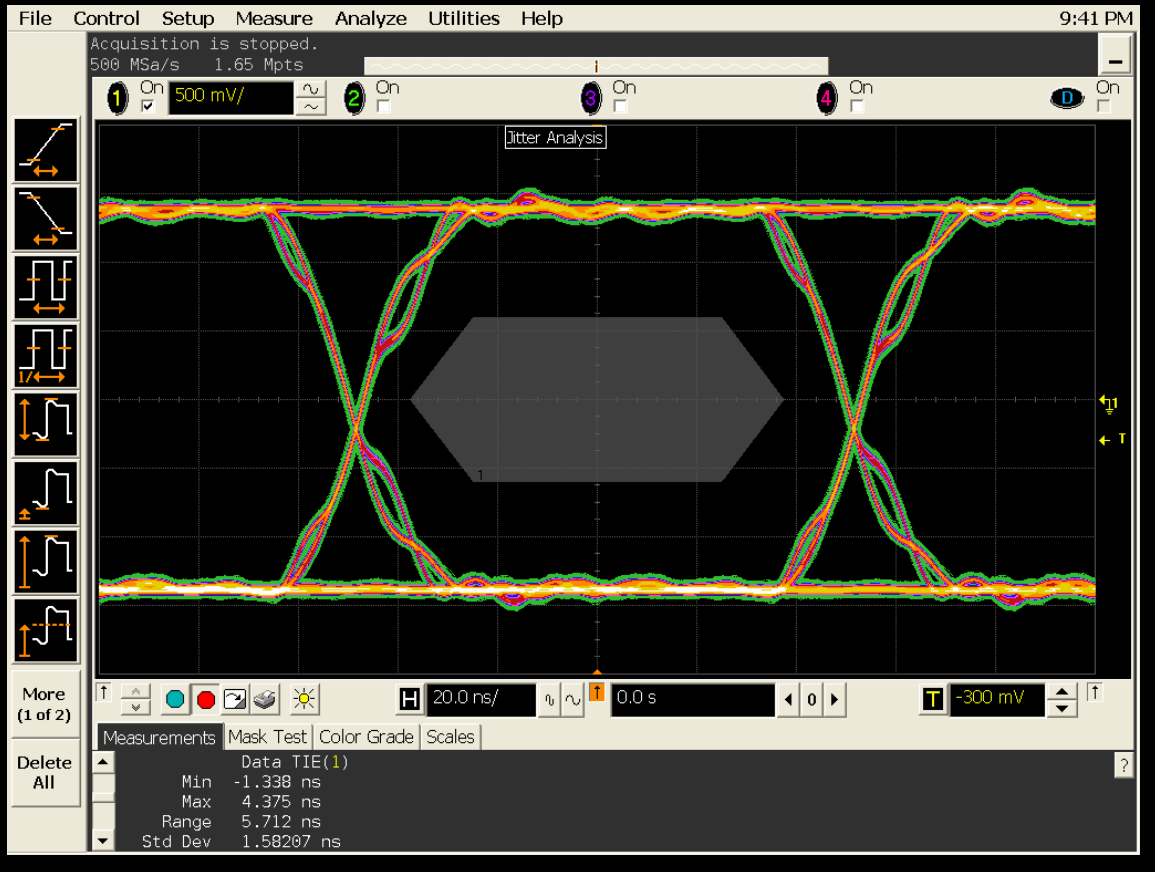
Eliminate Risks - Ensuring Signal Integrity





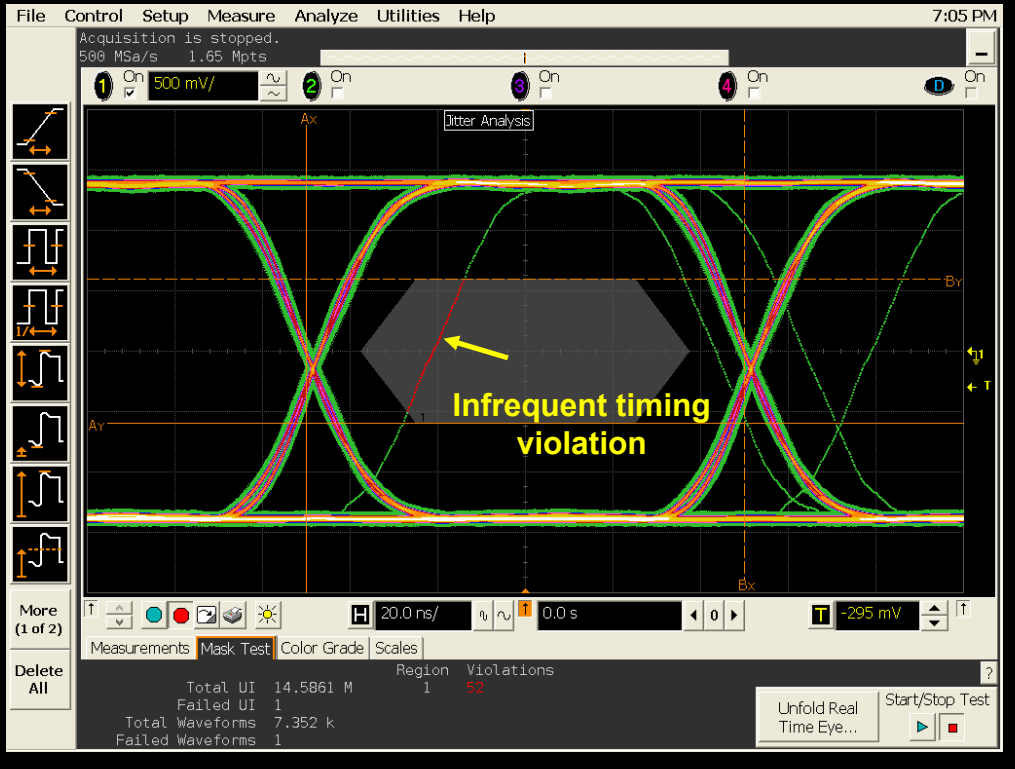
Signal Integrity - FlexRay Real-time Eye-Diagram

Based on Recovered Receiver Clock



Eliminate Risks - FlexRay "Stop-on-failure" Mask Test

Based on Recovered Receiver Clock



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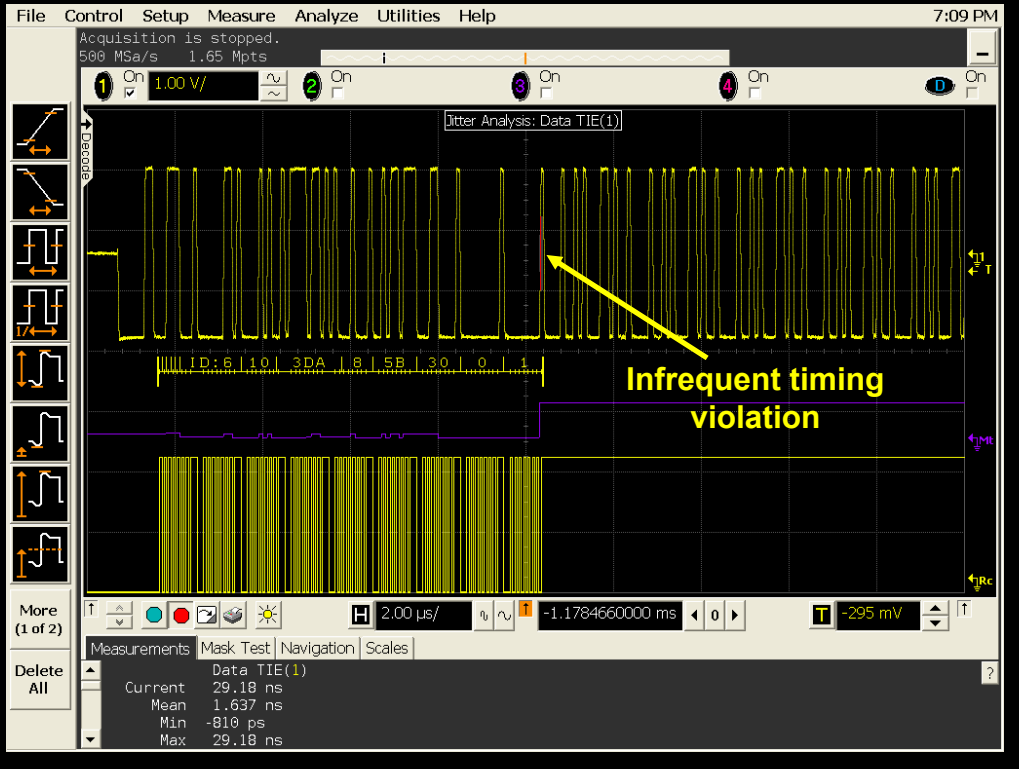
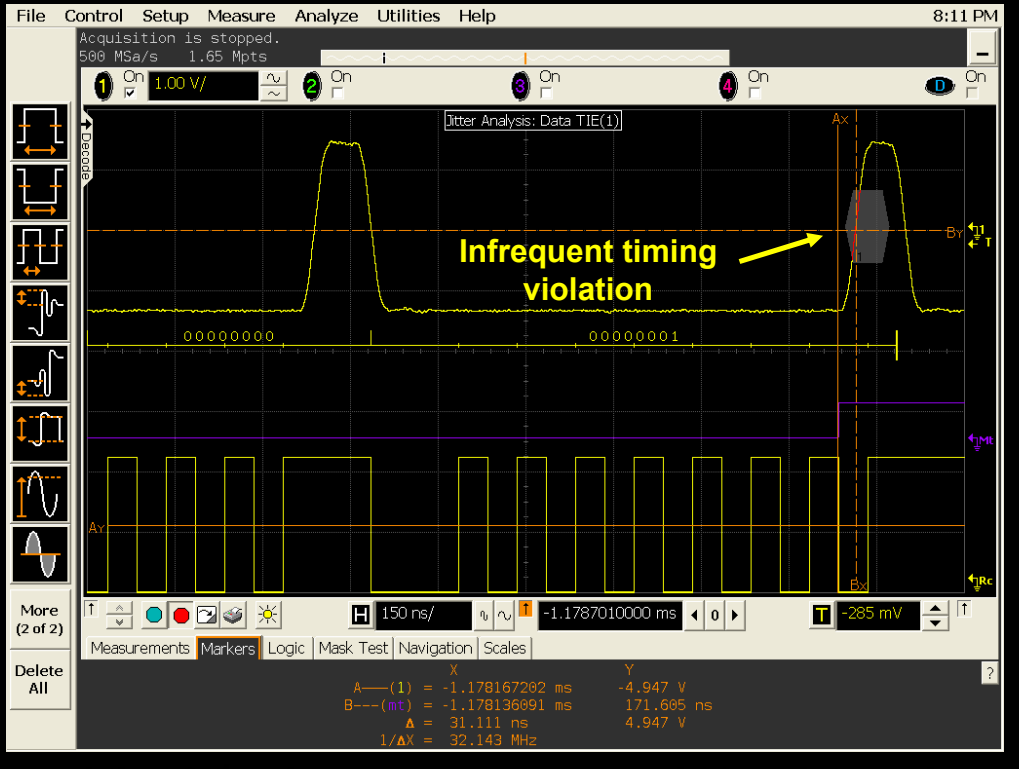
Eliminate Risks - FlexRay Mask "Unfolded" to 1st Violation

Based on Recovered Receiver Clock



Eliminate Risks - Scope's timebase expanded on mask violation *Based on Recovered Receiver Clock*



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Eliminate Risks - Verification of Boundary Stability

Eliminate Risks –
Programmable Testing Stimulus

Pulse Generator

1µHz – 120 MHz pulse with variable rise/fall time
Trigger and Clock up to 120 MHz
Coupled / *uncoupled* channels

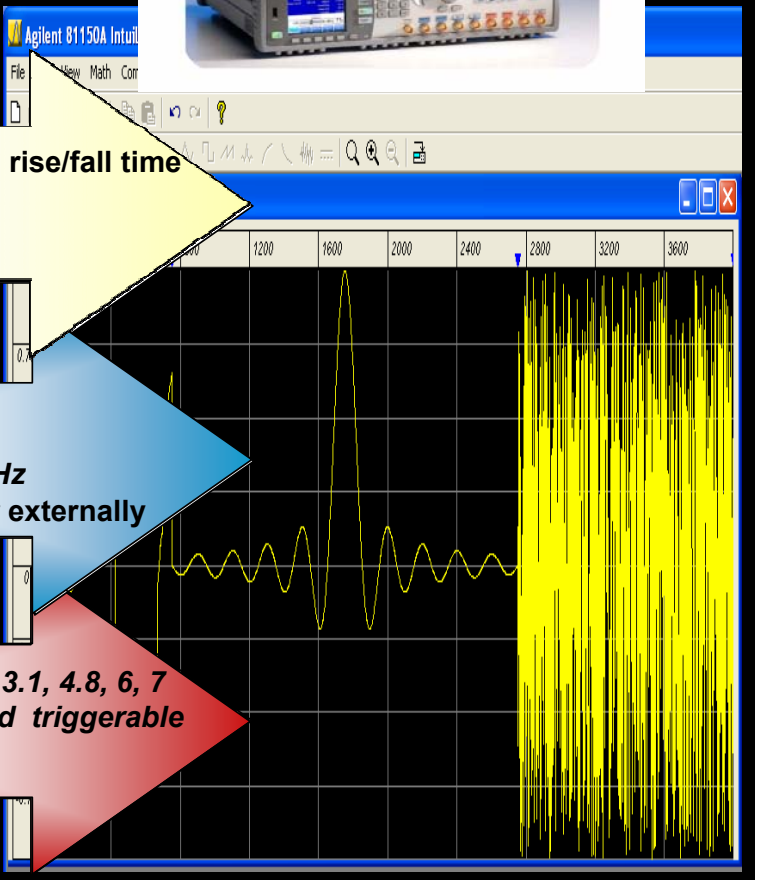
Function Arbitrary Generator

1µHz – 240 MHz sine
14 bit, 2 GSa/s arbitrary waveforms
FM, AM, PM, FSK, PWM up to *10 MHz*
modulation frequency, internally or externally

Unique

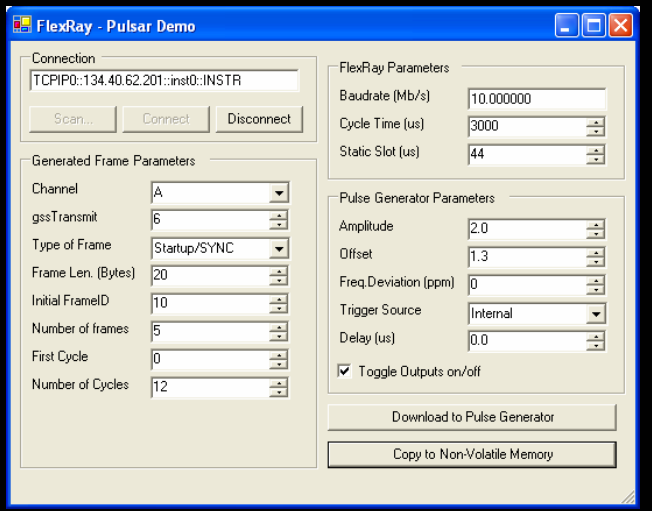
Noise Generator

Crest factor (Peak/RMS) selectable 3.1, 4.8, 6, 7
Noise type: repeatable, random and triggerable
Signal repetition >> 26 days

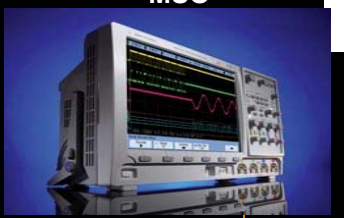


FlexRay Receiver Test

Customer requirement: Simulates a participant on the bus to test receivers and stress the bus in regards to timing, noise and glitches.



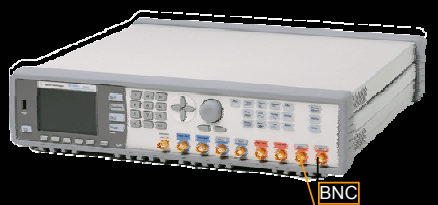
MSO



BNC

VPT 1000

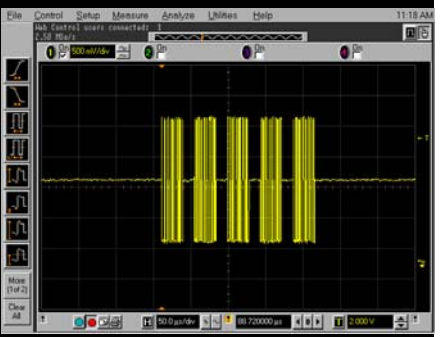
81150A Pulse F.A.N.



BNC

DB9 Connector

100 Ohm Termination



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Agilent Tools Summary

Agilent 81150A; Programmable Waveform Stimulus

CAN/LIN/FlexRay Stimulus; High Timing Accuracy;
Test Communication Reliability; Inject Noise Conditions

MSO 6000/7000; Network Decoding Mixed Signal Oscilloscopes

CAN/LIN/FlexRay Triggering & Real-time Decode
Segmented Memory for Automotive Serial Applications

VPT 1000; Network Protocol Testing/Analysis

CAN/FlexRay Frame and Signal Measurements
Standalone Data Recording

Agilent provides compelling tool sets which deliver unique solutions designed to be efficiently configured and powerful enough to identify ALL FlexRay physical layer and protocol related issues.

Agilent provides the tools needed for ensuring networking robustness - quality

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Come by the booth and let us show you how Agilent products can help you to address your testing needs.

- Oscilloscopes: http://www.home.agilent.com/agilent/product.jspx?nid=-34750.0.00&cc=US&lc=eng
- Network Analyzers: www.agilent.com/find/vpt1000
- Pulse Generators: http://www.home.agilent.com/agilent/product.jspx?cc=US&lc=eng&pageMode=OV&pid=1287544&ct=PRODUCT&id=1287544
- Logic Analyzers: http://www.home.agilent.com/agilent/product.jspx?nid=-536902500.0.00&cc=US&lc=eng
- DVS Automotive Product Support: dvs-automotive_support@agilent.com
- AiA (Customer viewable): www.agilent.com/find/automotive-test


Mirror
Speaker
Lock
Seat
Heating
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Instruments
Central
Body Control
Climate
Light
Lock
Seat
Heating
Lock
Mirror
Q&A