

示波器在汽车电子 行业的应用



源自HP，精于Agilent，开拓于Keysight



1939–1998: 惠普时代

一家从电子测量业务起家的公司



1999-2013: 安捷伦时代

从惠普拆分，成为世界领先的测试测量公司

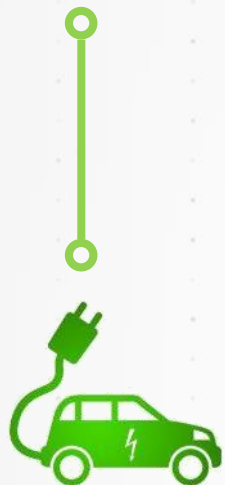
2013年9月宣布公司拆分



2014: 是德科技开始运行

100% 专注于电子测量领域

汽车发展趋势



新能源汽车

- **Technology:** Battery, Motor, MCU
- **Participant:** OEMs, Battery manufacturers:



25EV

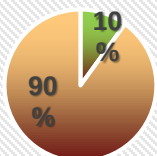
Year:2020



Produce 600k EV/HEV

Year:2020

- **Government(China):**



Annual sales over 30k units need to comply
Need to obtain 10% of credits for NEVs in 2019



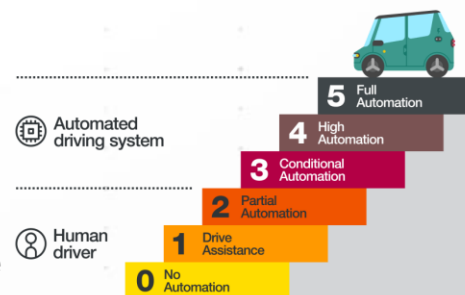
车联网

- **Technology:** DSRC, LTE-V
- **Participant:** Communication Enterprises, OEMs, Tier1, Government
- **5GAA:**

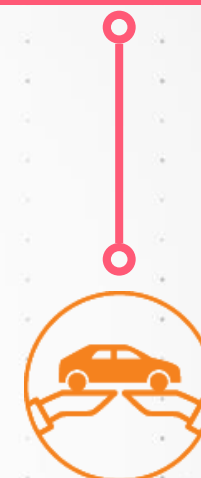


自动驾驶

- **Technology:** Sensor + Data fusion
- **Participant:** Communication Enterprises, OEMs, Tier1, Government
- **Level 5 Autonomous Cars**



Company Profile



共享汽车

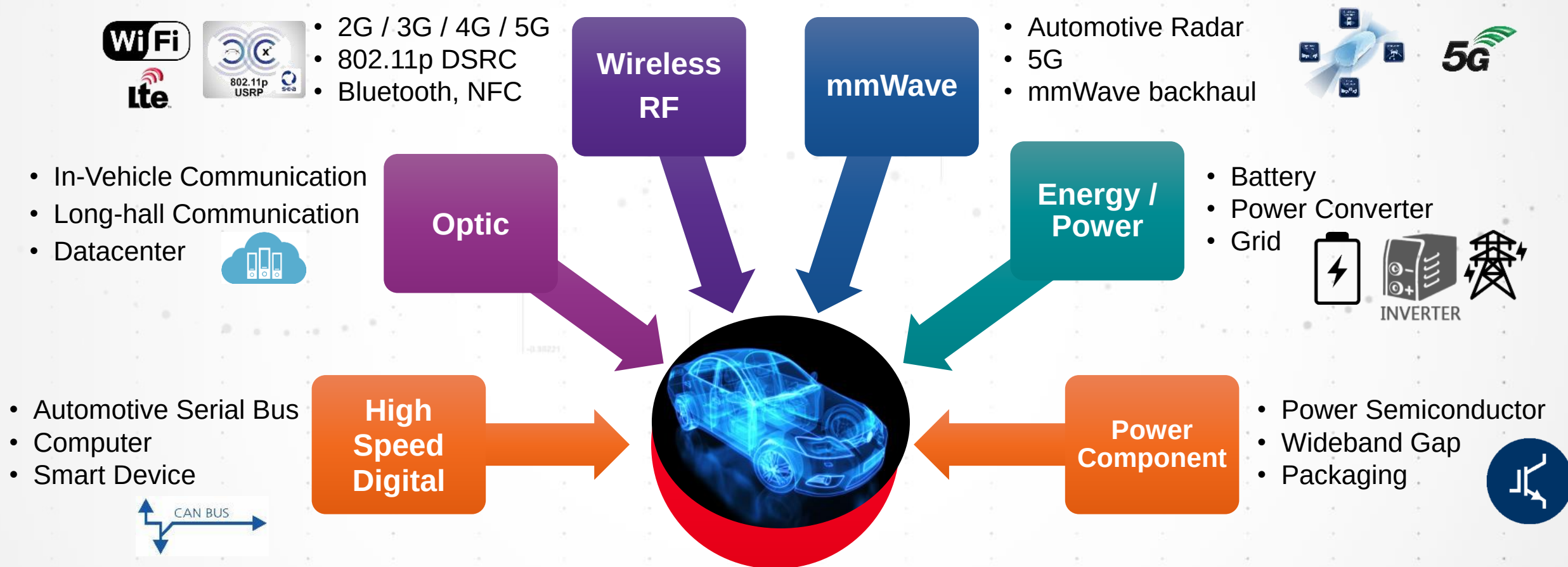
- **New business mode**

Sharing economy booms in China



跨领域的创新时代

KEYSIGHT HAS LONG STANDING EXPERTISE ON ALL DOMAINS



Our insight, Our solutions, Our focus

HARDWARE+SOFTWARE+PEOPLE=INSIGHT

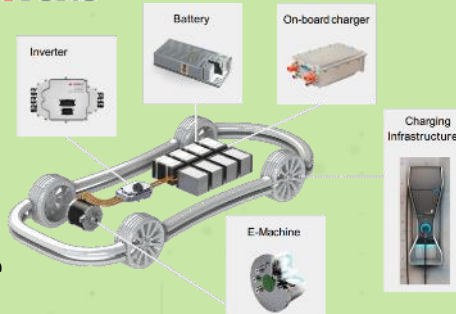


New Energy

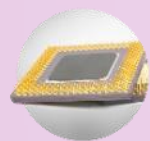
KEYSIGHT TECHNOLOGIES + scienlab = Energy solutions

Including:

BMS
Battery
Inverter
OBC
Charing Infrastructure



KEYSIGHT TECHNOLOGIES = Leading brand



Mobile
Chipsets



Devices



Network
Access



Core
Network



Data
Center

Connected Car



Company Profile

Services



KEYSIGHT TECHNOLOGIES = Accelerate Technology Adoption , Lower costs

One-Stop Calibration Services

Repair Services

Asset Management



KEYSIGHT TECHNOLOGIES = Comprehensive Solutions

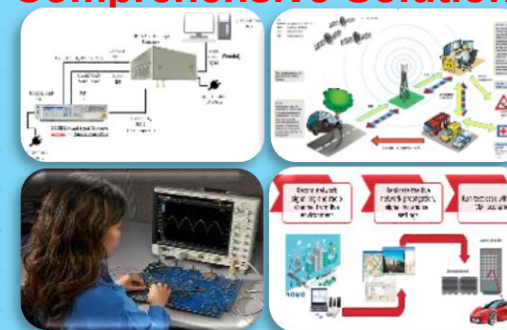
Radar

eCall

Car Ethernet

VDT

And More...



Autonomous Driving



议程

- 汽车总线发展史
- 是德科技汽车串行总线解码方案
- 是德科技汽车总线一致性测试方案

汽车总线发展史

汽车里本来没有总线



汽车总线发展史

用的线多了，就有了总线

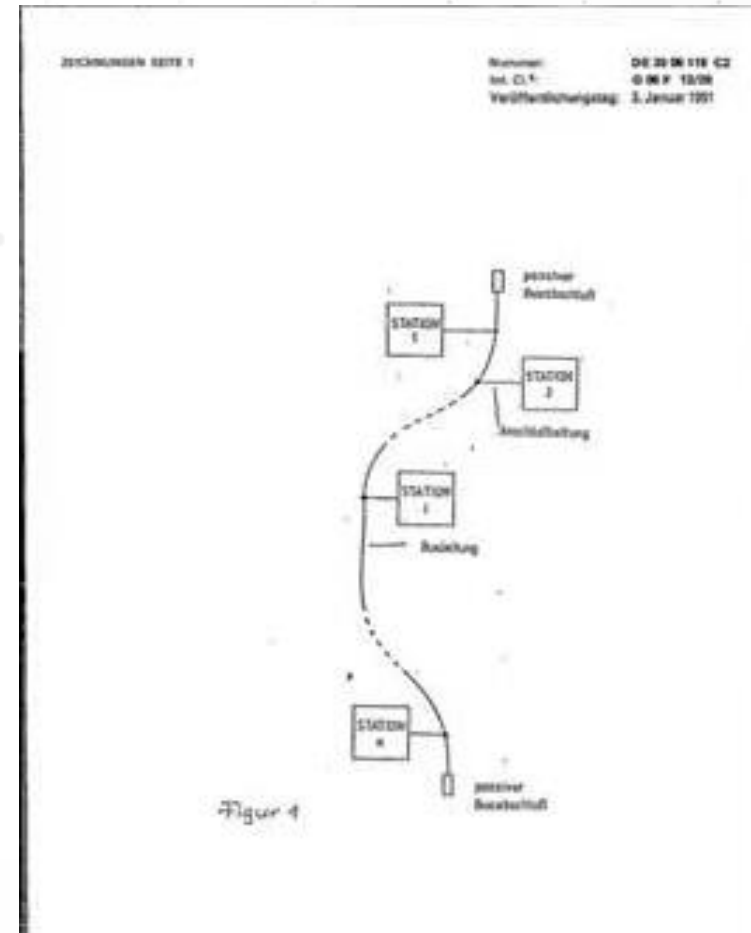
20世纪80年代

导线长度近2000米
电气节点1500多个



汽车总线发展史

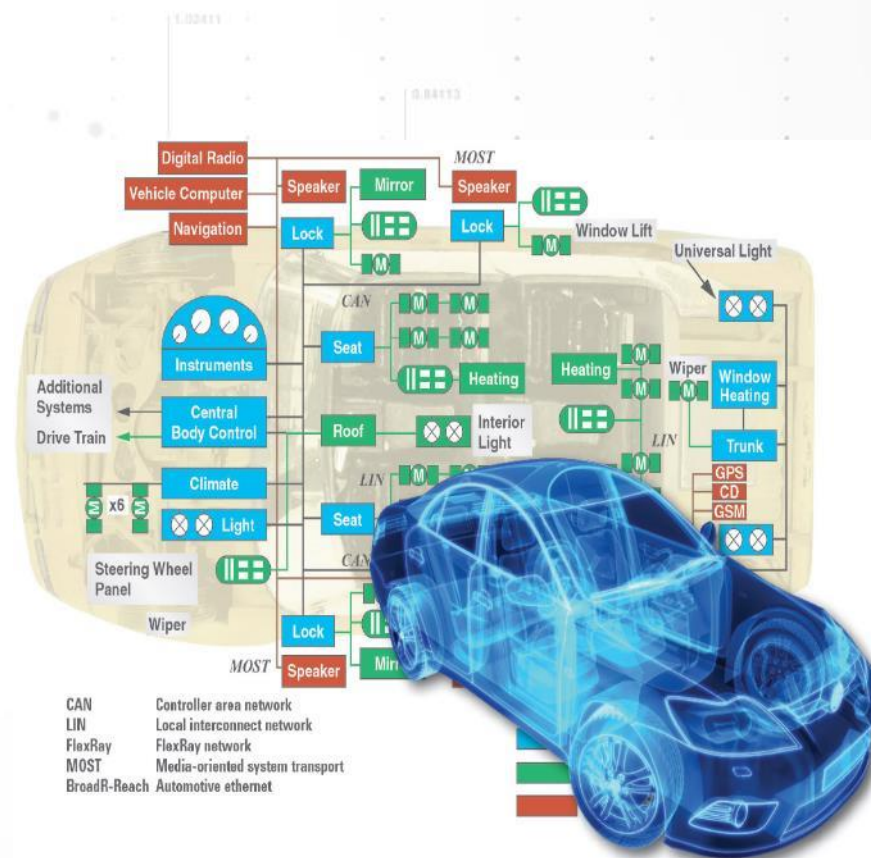
CAN 总线起源



汽车总线发展史

汽车总线概览

- I²C
 - SPI
- } ECUs 的芯片间通信(10Mb/s)
- RS232/UARTs – 软件下载(20Kb/s)
 - LIN-座位,镜子,窗户,车灯等的控制(19.2Kb/s)
 - CAN/CAN FD
 - FlexRay
 - CXPI
- } 动力总成, 底盘控制, 辅助驾驶, 刹车防抱等. (1-10Mb/s)
- SENT – 传感器(100Kb/s)
 - MOST – 导航/娱乐信息系统/视频(150Mb/s)
 - BroadR-Reach – 导航/娱乐信息系统/视频 (100Mb/s)

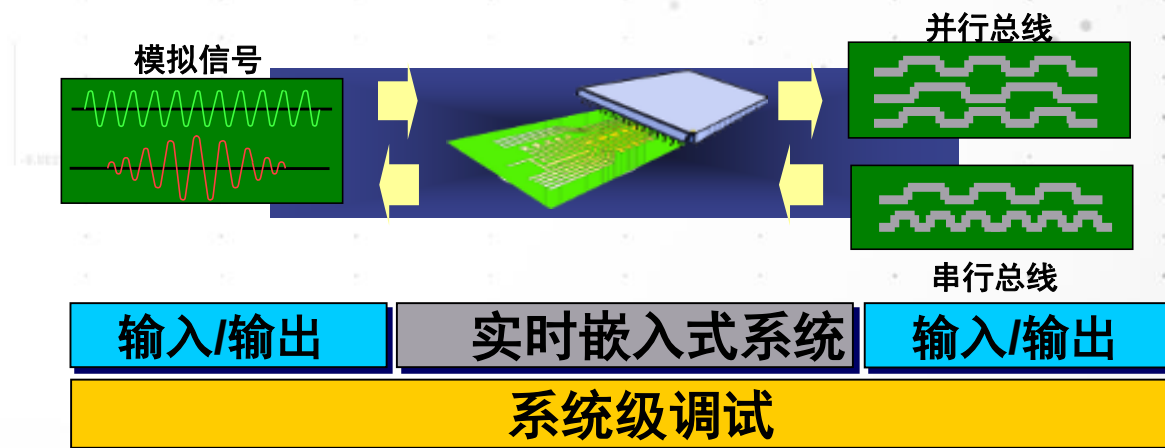
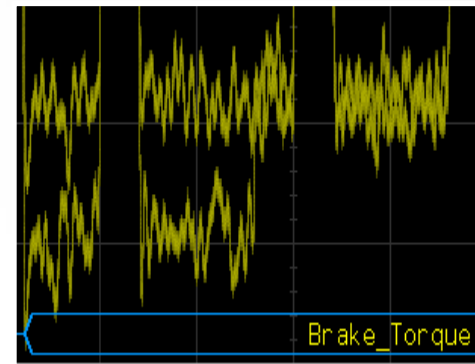


是德科技汽车串行总线解码

为什么需要总线解码？

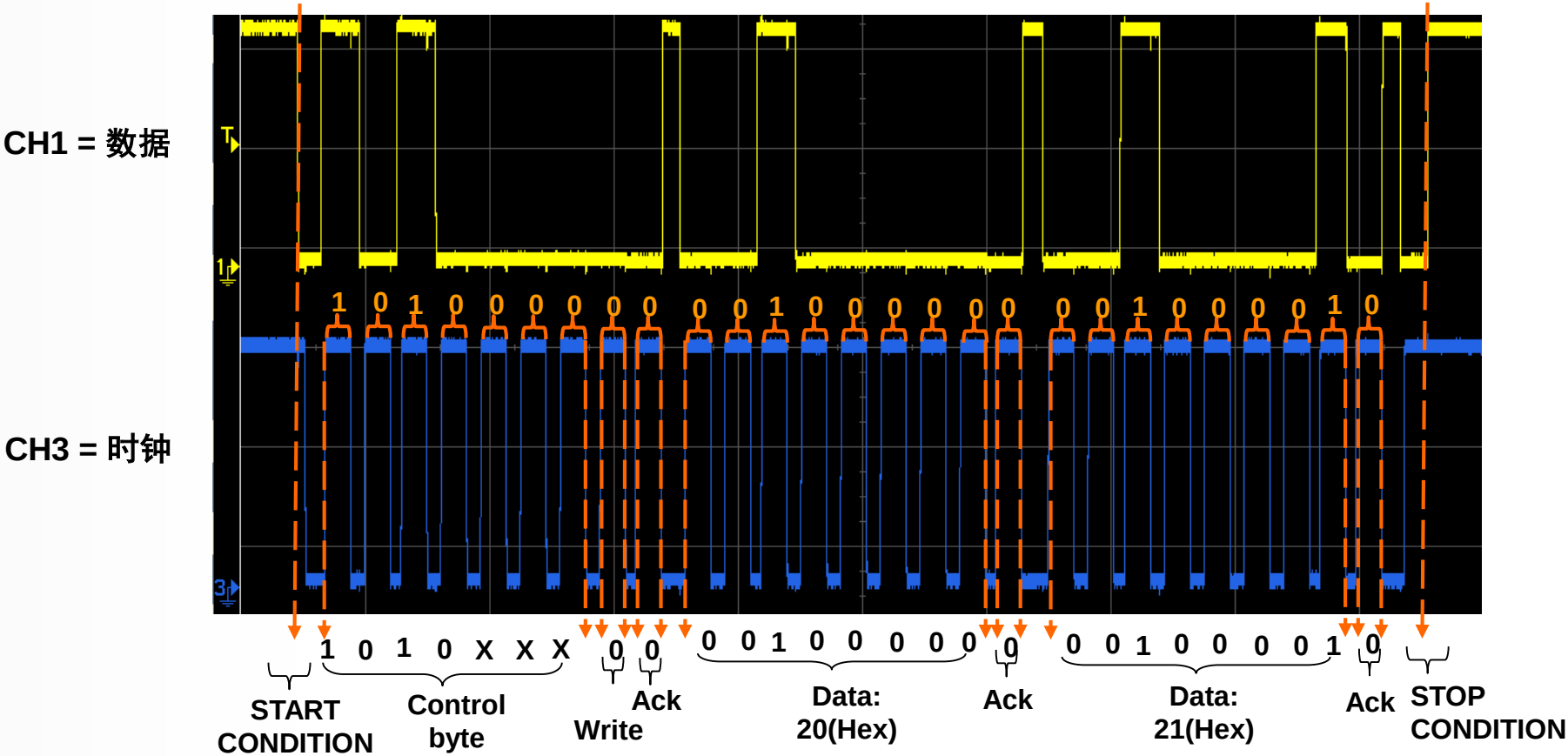
这是一个非常低速的总线，怎么可能出问题？

- 时间相关的物理量测量与协议内容
 - 过渡时间, 电压, 噪声, 每一位的时间等.
 - 眼图模板测试
- 跟踪总线数据到出错位置
 - 是否传送了准确的数据显示?
 - 是否捕获了一个错误?
 - 是否数据出错了?
 - 多长时间...?
 - 多久出现?
- 时间相关的系统级交互
 - 串行到数字接口
 - 串行到模拟接口



是德科技汽车串行总线解码

“原始”的解码方法



若发现不是我们想看的指令？则需要重新采集一次，重复人工解码！



是德科技汽车串行总线解码

最全面的串行总线解码方案

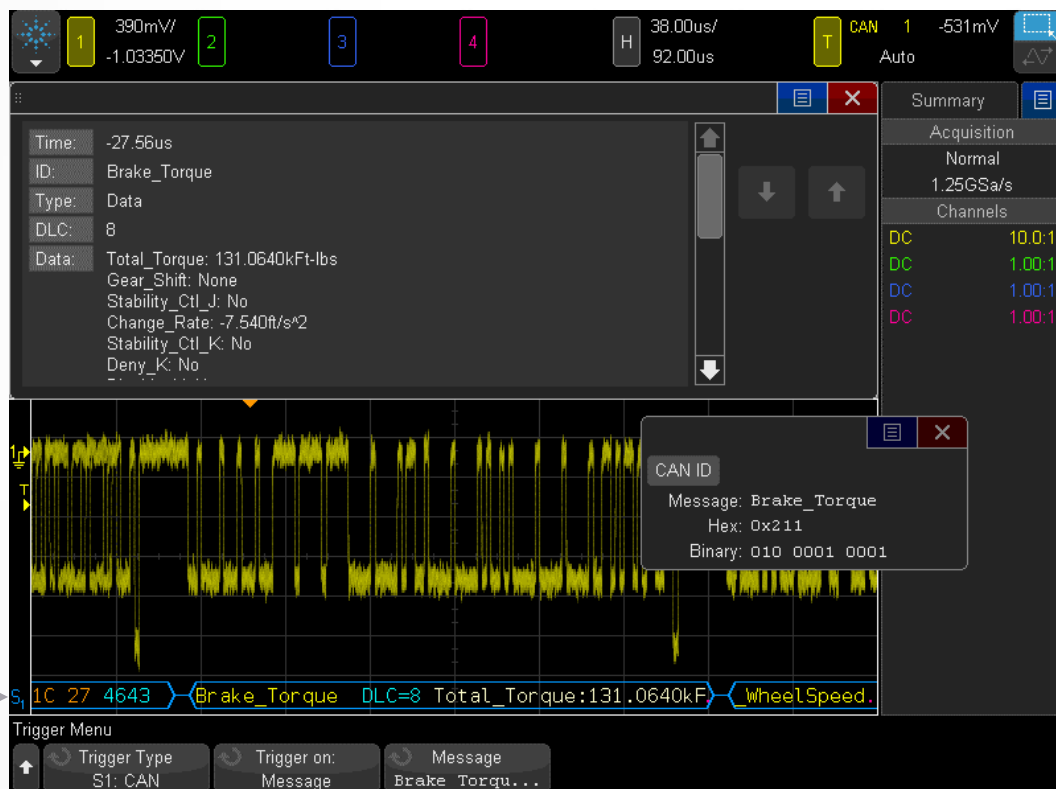


是德科技汽车串行总线解码

CAN-DBC符号触发及解码

CAN-dbc 可以将一串“二进制数”转换成“人类语言”

列表式解码



同步式解码

“消息” (符号翻译帧 ID) = Brake_Torque (刹车扭矩)

“信号” (符号翻译数据位):

全部扭矩: 131.0640k ft-lbs

齿轮移位: None

转换率: -7.540 ft/sec²

是德科技汽车串行总线解码

DBC文件是什么？

英文全称：.dbc (data base CAN) 文件 ...

- 每个特定的车辆及CAN总线都有相应的.dbc文件
- 是ASCII码格式的文件，后缀名为.dbc
- 定义“消息”和“信号”。
- 包含下列项目：
 - “信号”起始位 # 和长度
 - 各种转换描述
 - 单位 (rpm, gal, psi, etc.)
 - 最大 & 最小预警值
 - 状态编码值
- 可以用字处理软件(例如NotePad)来编辑, 但是一般还是推荐用Vector's CANdb++ 软件工具来编辑.

```
BO_ 2190911837 EngineData: 5 Engine
SG_ Fuel : 8|8@1+ (0.01,12) [0|21] "gal" Gateway
SG_ Temp : 24|8@1+ (0.2,135) [-50|150] "C" Gateway
SG_ Speed : 32|8@1+ (0.1,2900) [0|8000] "rpm" Gateway

BO_ 189 ABS: 8 Brakes
SG_ Frnt-R : 7|1@1+ (1,0) [0|1] "" Gateway
SG_ Frnt-L : 2|1@1+ (1,0) [0|1] "" Gateway
SG_ Rear-R : 11|1@1+ (1,0) [0|1] "" Gateway
SG_ Rear-L : 10|1@1+ (1,0) [0|1] "" Gateway
SG_ FR-Pressure : 40|8@1+ (.1,105) [0|200] "psi" Gateway
SG_ FL-Pressure : 32|8@1+ (.1,105) [0|200] "psi" Gateway
SG_ RR-Pressure : 56|8@1+ (.1,105) [0|200] "psi" Gateway
SG_ RL-Pressure : 48|8@1+ (.1,105) [0|200] "psi" Gateway

BO_ 127 Airbag: 1 Emergency
SG_ Frwd-impact : 7|1@1+ (1,0) [0|1] "" Gateway
SG_ Rear-impact : 6|1@1+ (1,0) [0|1] "" Gateway
SG_ Left-impact : 2|1@1+ (1,0) [0|1] "" Gateway
SG_ Right-impact : 0|1@1+ (1,0) [0|1] "" Gateway

BO_ 000 Steering: 4 Steering
SG_ Lock : 20|1@1+ (1,0) [0|1] "" Gateway
SG_ Angle : 24|8@1+ (0.03,45) [0|48] "deg" Gateway

CM_ "CAN communication matrix for power train electronics
*****
implemented: turn lights, warning lights, windows";

VAL_ 189 Frnt-R 0 "Unlocked" 1 "locked" ;
VAL_ 189 Frnt-L 0 "Unlocked" 1 "locked" ;
VAL_ 189 Rear-R 0 "Unlocked" 1 "locked" ;
VAL_ 189 Rear-L 0 "Unlocked" 1 "locked" ;
VAL_ 127 Frwd-impact 0 "Deployed" 1 "Armed" ;
VAL_ 127 Rear-impact 0 "Deployed" 1 "Armed" ;
VAL_ 127 Left-impact 0 "Deployed" 1 "Armed" ;
VAL_ 127 Right-impact 0 "Deployed" 1 "Armed" ;
VAL_ 000 Lock 0 "on" 1 "off" ;
```

某车厂dbc文件

是德科技汽车串行总线解码

CAN-DBC符号触发及解码的好处？

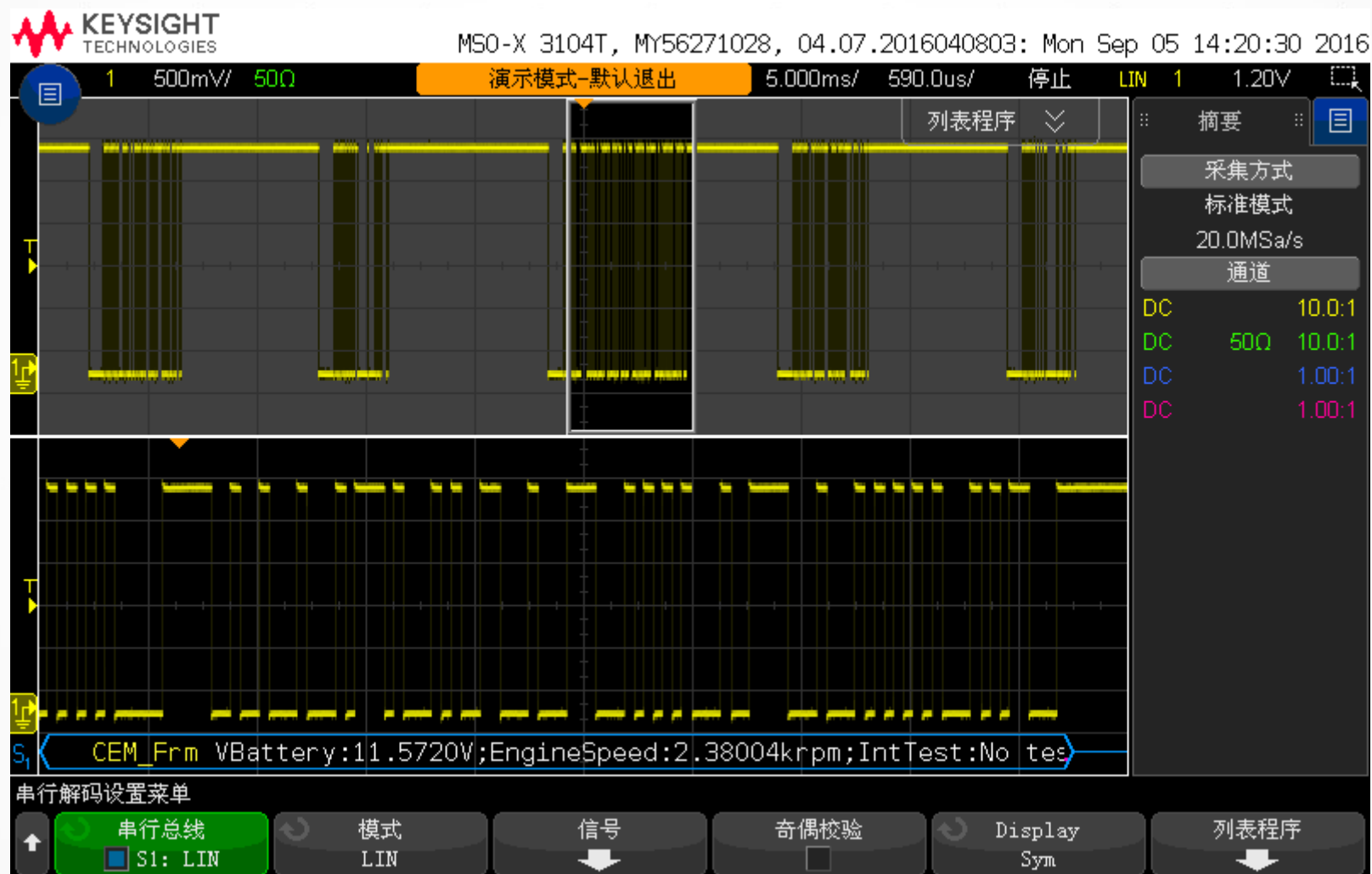
- 方便的翻译捕获到的数据
- 方便直观的设置触发(只要在消息列表中选择就可以了，而不需要输入复杂的16进制码)
- 可以使VECTOR'S CAN总线分析仪和示波器更好的交互触发和分析数据,解决问题
- 提高产品调试的效率及缩短产品推向市场的时间



EngineData DLC=5 Fuel:12.32gal;Temp:136.60C;Speed:2.901

是德科技汽车串行总线解码

LIN符号解码



是德科技汽车串行总线解码

基于符号解码的触发功能

MSO-X 4154A, MY55440412, 04.08.2016061900: Thu Jul 14 22:55:21 2016

触发于 : 退出。 H 75.00us/ -184.0us T CAN 1 -1.09V 停止

串行总线 1

时间

数据 CRC 错误

1;Temp:1...	0B11	

摘要

采集方式

标准模式

1.25GSa/s

通道

DC 1.00:1

DC 1.00:1

DC 1.00:1

DC 1.00:1

消息

✓消息和信号 (非 FD)

触发菜单

触发类型 S1: CAN

触发于 : Msg & Sig (no...

消息 EngineData ...

信号 Speed

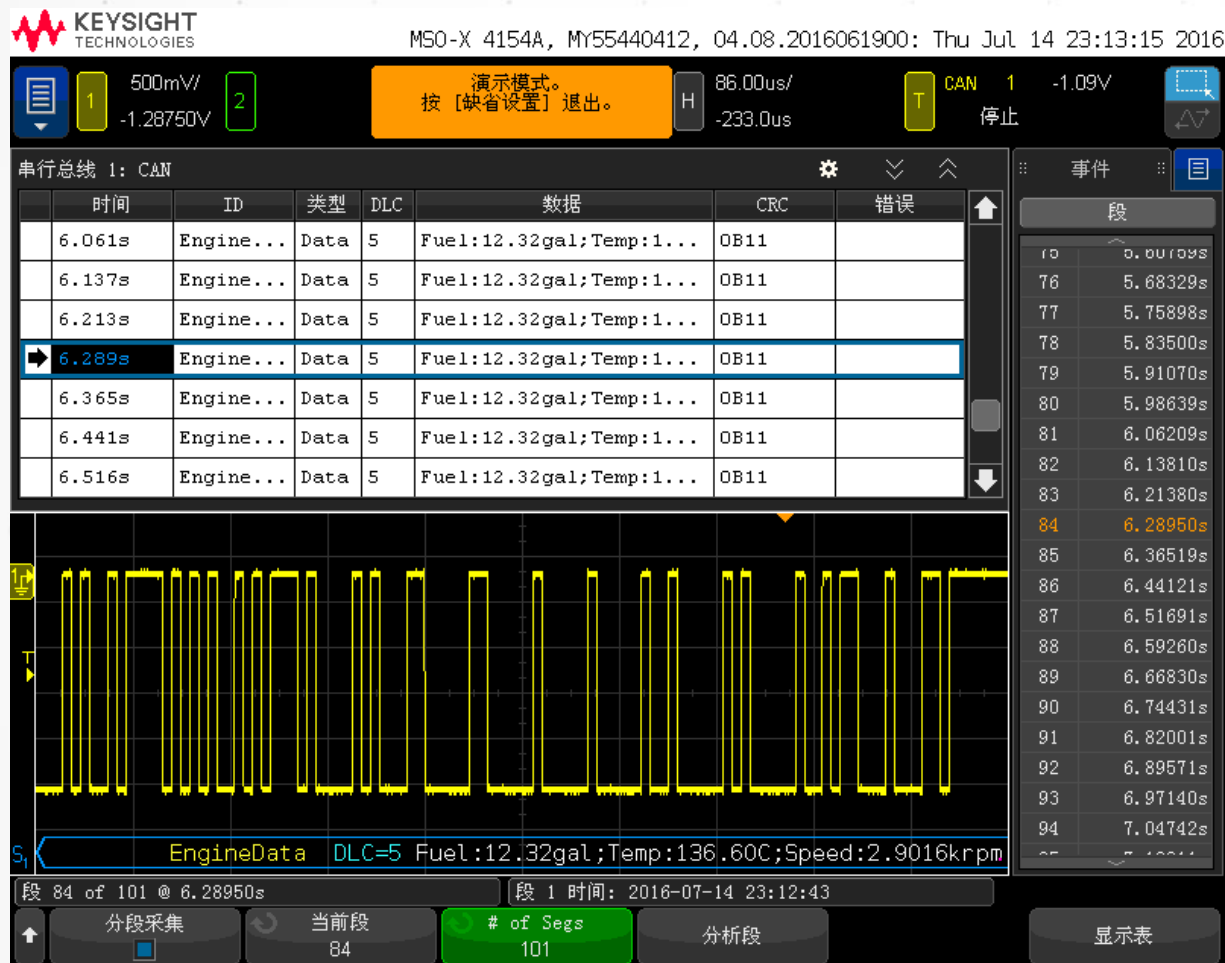
值类型 变量

值 2901.6rpm

波形图显示 CAN 信号，下方显示解码后的数据：:136.60C;Speed:2.9016krpm 0B11

是德科技汽车串行总线解码

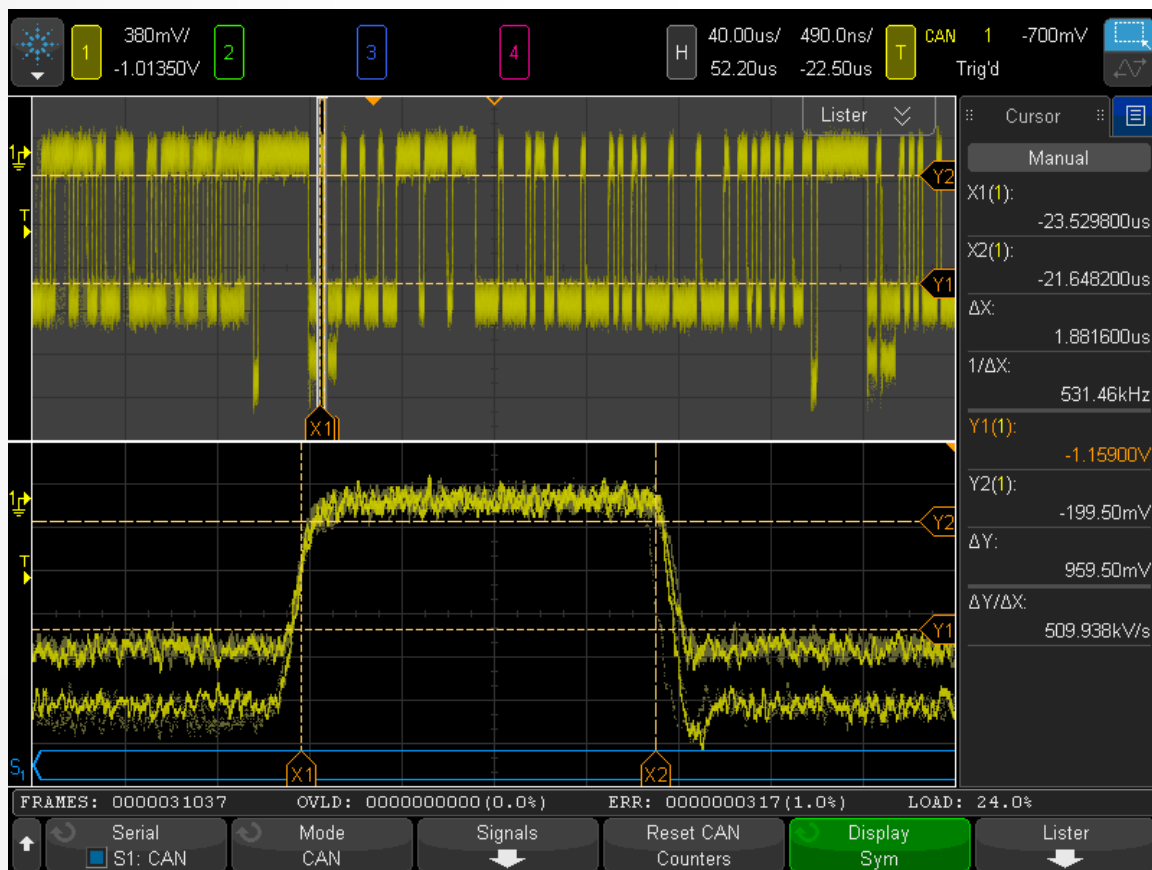
质量的保证：连续触发功能（分段存储）



- 支持最多1000个满足条件的波形连续触发
- 极大的提高工程师解决复制异常信号的效率

是德科技汽车串行总线解码

质量的保证：信号质量测试的终极武器

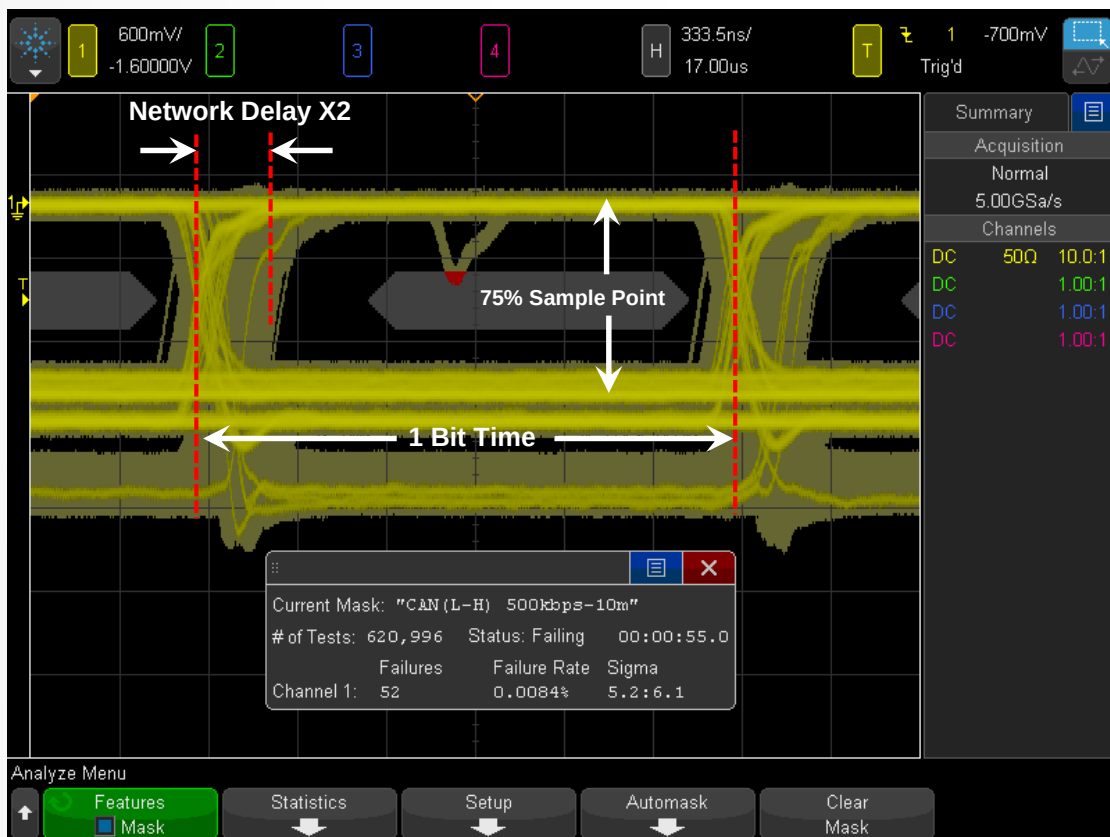


- 上升沿和下降沿的时序都正确吗？
- 幅度满足最小输入检测电平要求吗？

眼图模板测试可以测量所有位的信号整体质量

是德科技汽车串行总线解码

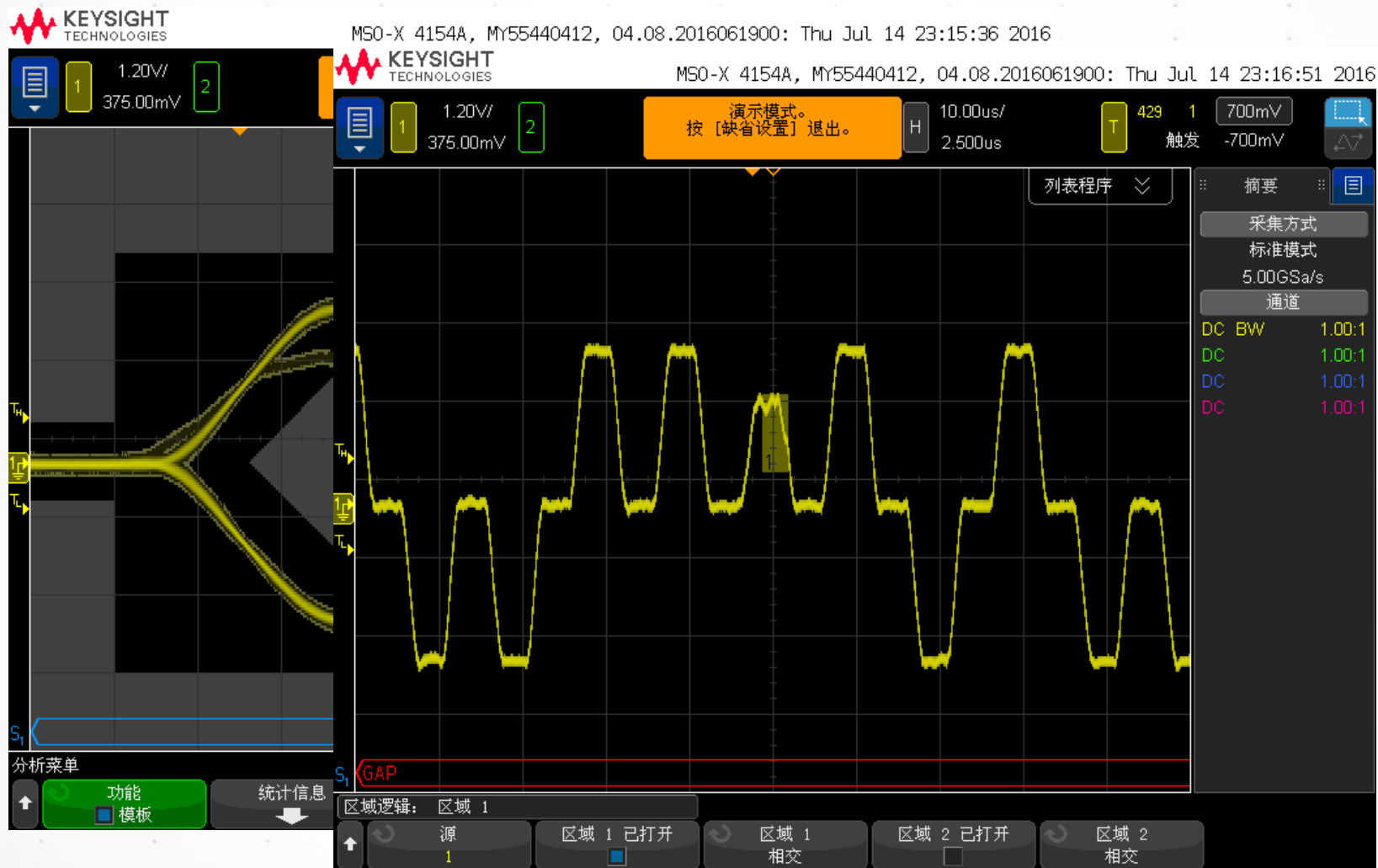
质量的保证：CAN 眼图模板测试



- CAN 物理层信号质量测试
- 显示最坏情况幅度的变化(噪声, 毛刺, 低幅度,等)
- 显示仲裁位和响应位时序延迟 (主要由网络延迟决定)

是德科技汽车串行总线解码

利用区域触发快速寻找眼图失败的根源



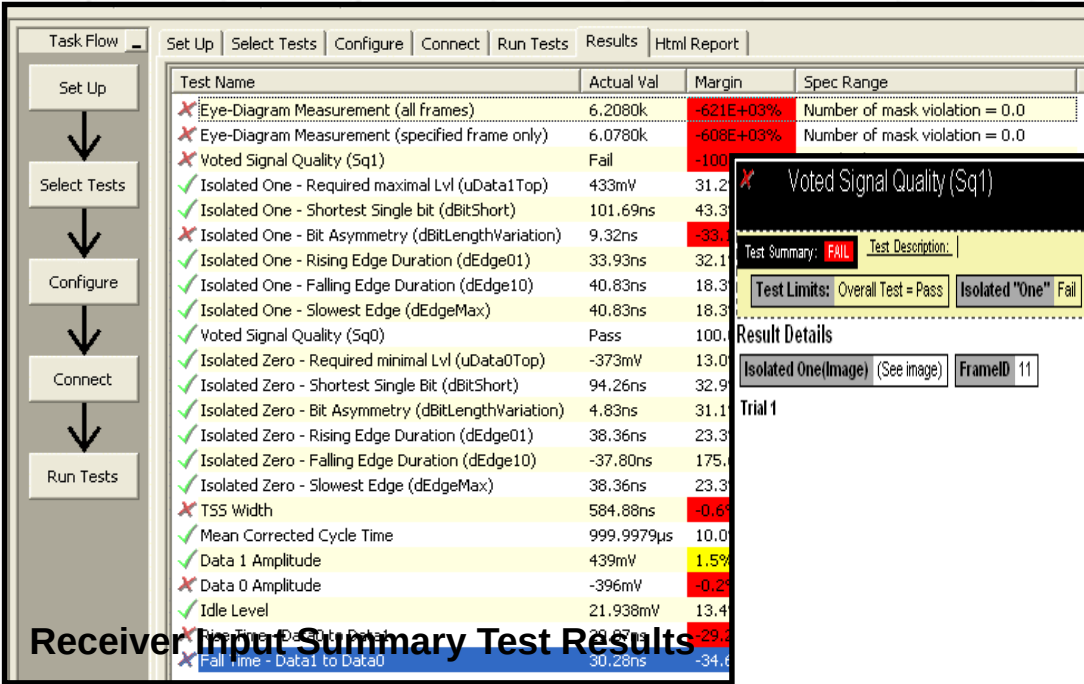
是德科技汽车串行总线解码

双总线解码

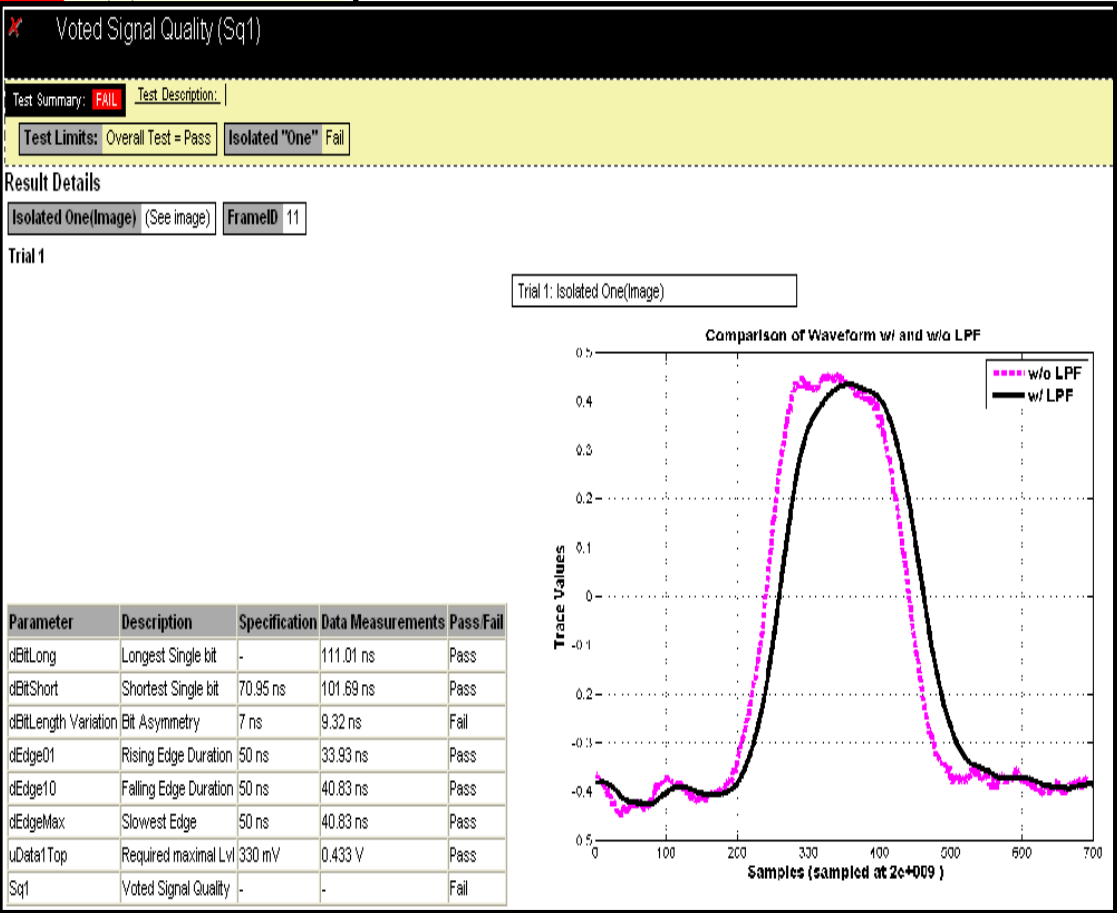


是德科技汽车串行总线解码

FLEXRAY一致性自动测试软件



Isolated “1” Voted Signal Quality Test



是德科技汽车串行总线解码： Why Keysight

汽车电子串行总线的物理层/协议层测试：为调试故障发现故障原因而优化的示波器

- 为捕获偶发的汽车电子瞬态信号而**优化**：业内最快的波形捕获率(每秒100万次)
- 用示波器内部的**硬件对汽车电子实现解码**，可靠地捕获总线错误
- **最全面的总线解码**示波器支持最新的CXPI，NRZ等
- **业内独有**：CAN 总线眼图模板测试、**CAN FD 眼图**模板测试
- **业内独有**：CAN 总线实时计数器，统计总线的帧和错误
- **业内独有**：同时在协议列表窗口，中在同一时基下，显示两种总线协议
- **业内独有**：支持SENT 触发
- **最低价位**：**CAN 符号解码 (.dbc)** 和**LIN 符号解码(.ldf)** 测试方案中，最低价位的选择
- **区域触发和分段存储**提供全强大的总线质量保证
- **业内独有**：Infiniium 示波器离线分析软件支持协议解码、抖动分析、用户自定义函数、仿真软件的数据



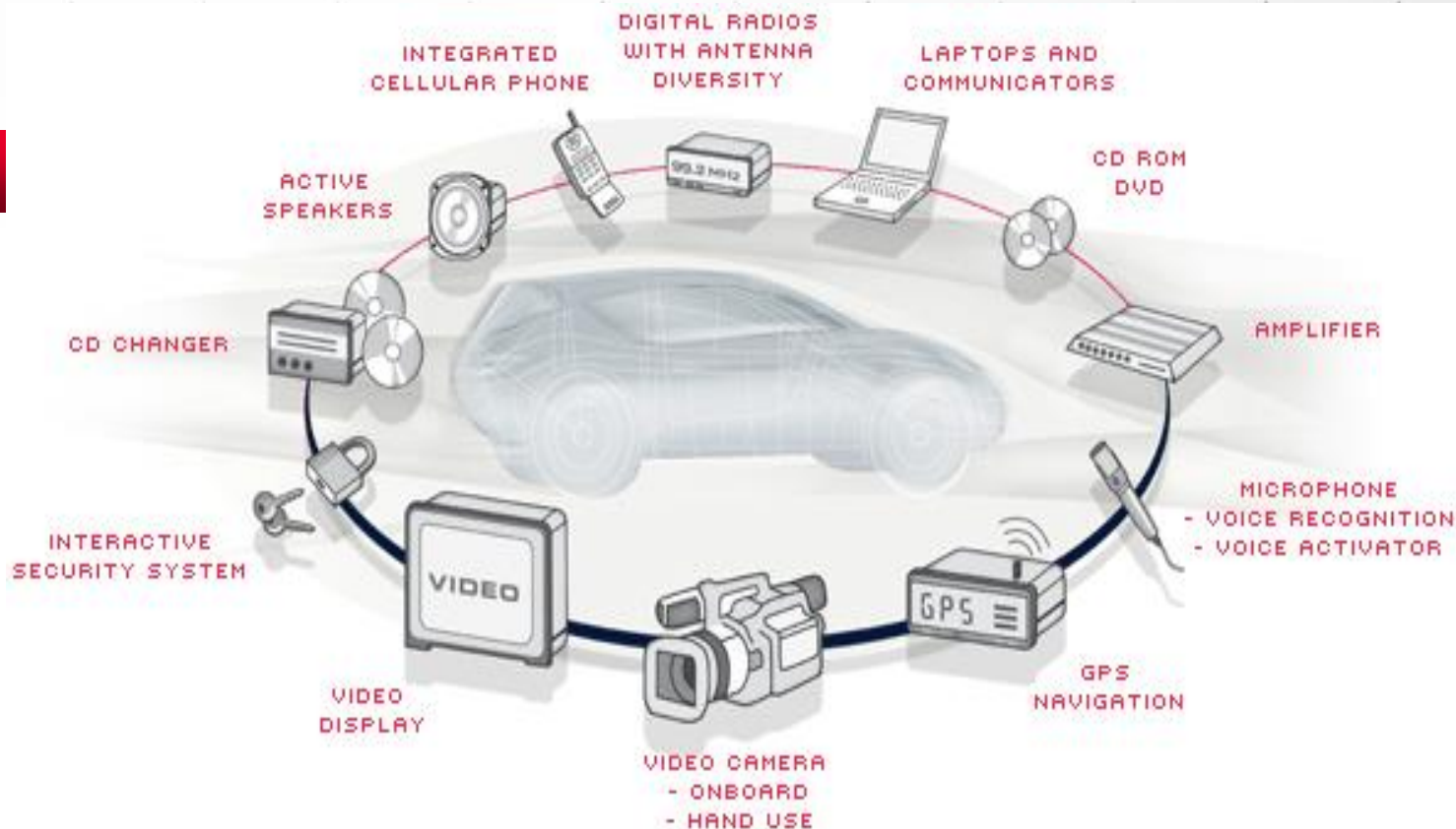
汽车总线一致性测试

MOST 总线



MOST

- Media Oriented System Transport
- 音频, 视频, 数据 (以太网)
- 环形拓扑结构
- MOST25 / 50 / 150 标准
- SMSC 商标现在由Microchip公司拥有



MOST150 (2007)

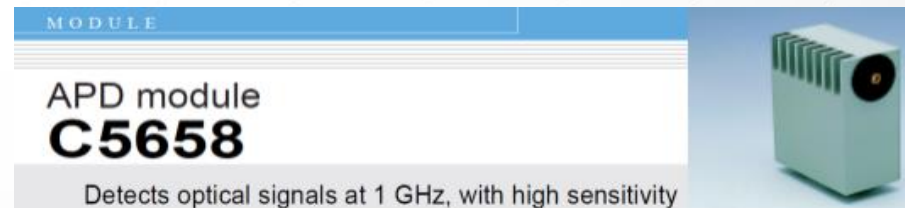
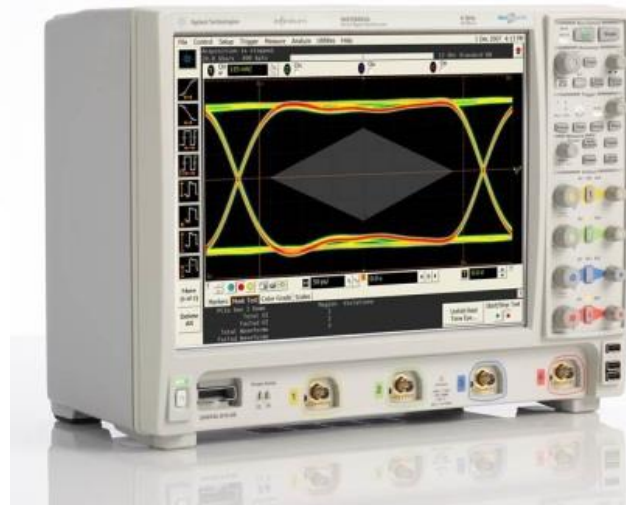
- 光纤或电缆传输
- 即插即用, 最多级联64个设备
- 数据速率 = 147 Mb/s
- 每帧3072位
- 帧速率 ~44.1 KHz (帧 UI = 3.291 ns)

汽车总线一致性测试

MOST一致性测试

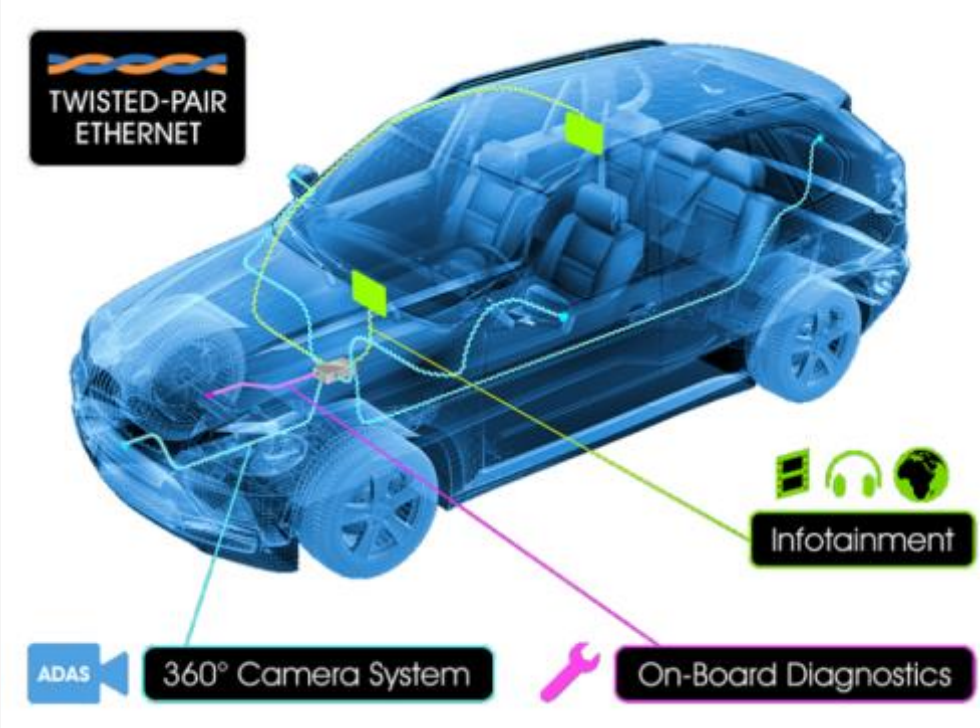
适用于Infiniium系列示波器，订货号N6466A

- S 系列, 9000 A/H, 90000A/Q, Z系列
- 所需示波器带宽
 - MOST50: 500 MHz 或更高
 - MOST150 : 1 GHz 或更高
- 探头
 - N2750A InfiniiMode 探头
 - 或1130A 1.5GHz 差分探头, E2678A插孔式连接附件
 - MOST150 SP2消光比测试需要一直流耦合的光电转换器
- 脉冲函数发生器(SP4测试需要)
 - MOST压力测试码型的产生



汽车总线一致性测试

BROADR-REACH 总线



	100bT 以太网	BroadR-Reach
差分对数量	2	1
连接方式	RJ-45	用户自定义
频率	80 MHz	66.3 MHz
电平	多电平	PAM3 (高-低)
数据速率	100 Mb/s	100 Mb/s
终端匹配	100 Ω	100 Ω

2012年3月标准被批准

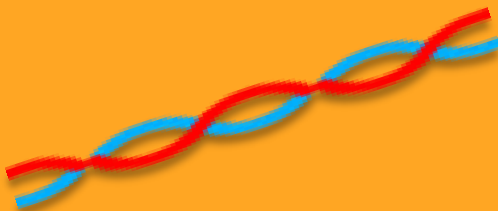
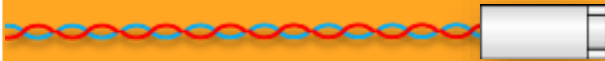


OPEN = One Pair Ethernet (BroadR-Reach联盟)



汽车总线一致性测试

BROADR-REACH 总线

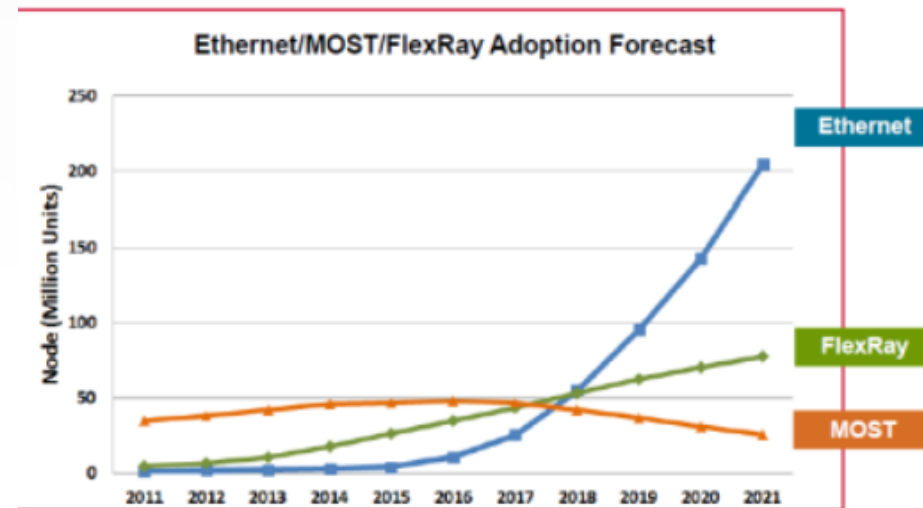
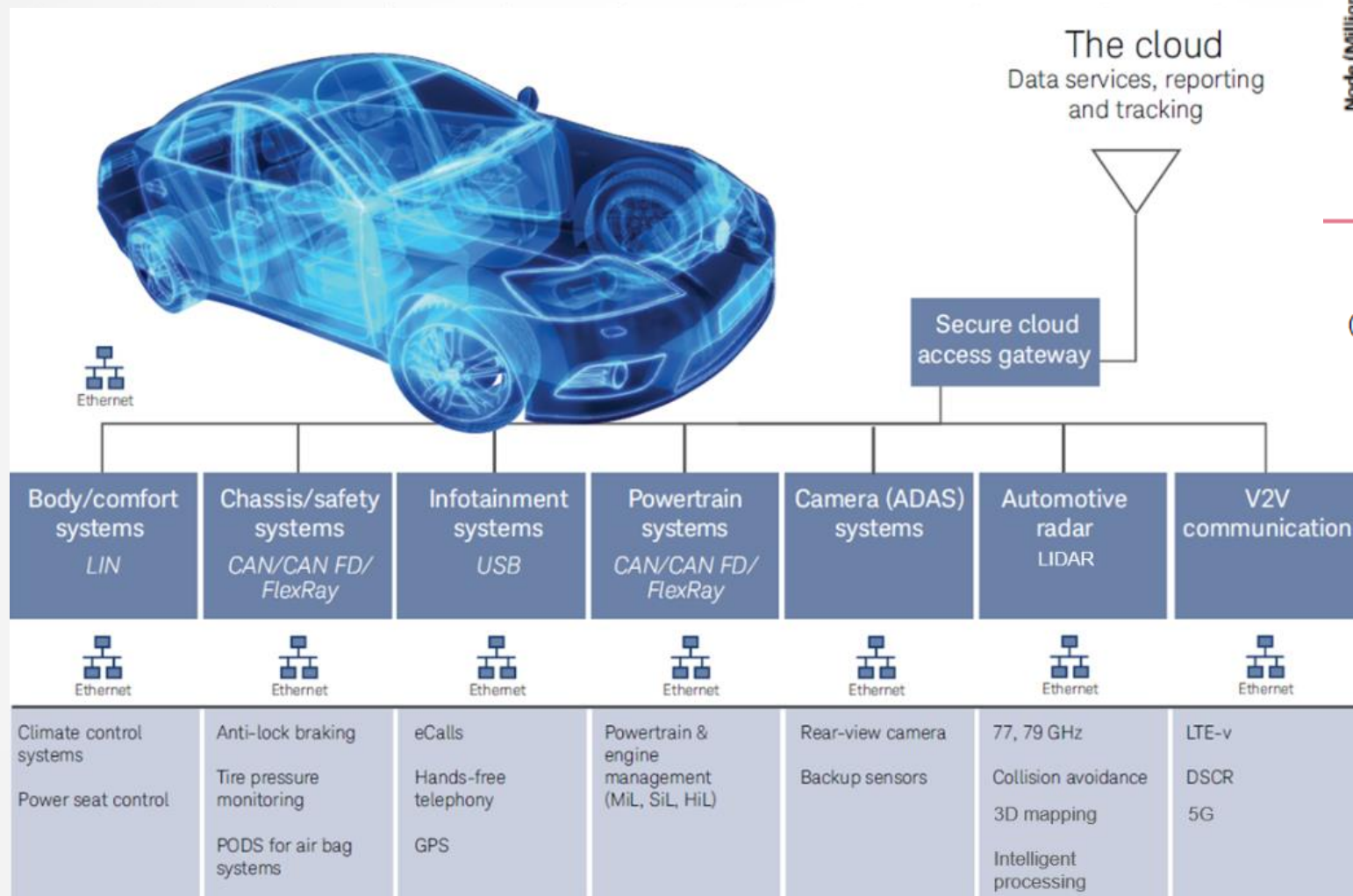
连接方式对比	电缆	连接头 (2 ends, on-board and cable)
标准以太网		
BroadR-Reach		

降低连接成本约 80%*

减少线缆重量约 30%*

汽车总线一致性测试

BROADR-REACH 总线的将来

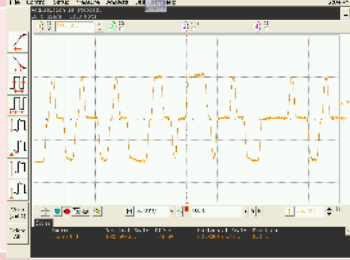
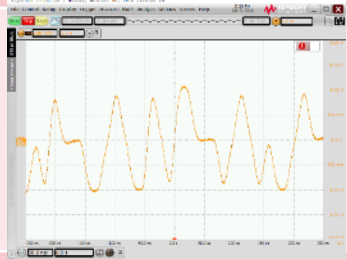
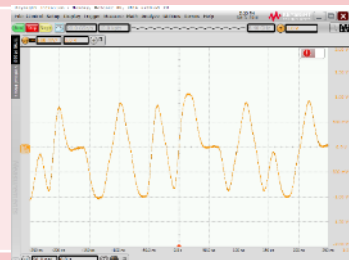
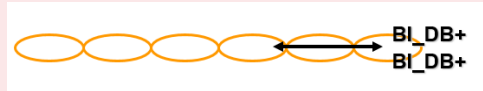


Ethernet adoption forecast

(Source: High-speed automotive bus demand estimates 2015 by Strategy Analytics)

汽车总线一致性测试

100BASE-TX VS 100BASE-T1

	Ethernet 100BASE-TX (IEEE802.3)	Automotive Ethernet 100BASE-T1 (IEEE802.3bw)	Automotive Ethernet 1000BASE-T1 (IEEE802.3bp)
Data Rate	100 Mbps	100 Mbps	1000 Mbps
Signal	MLT3 	PAM3 @ 66.667 Mb/s 	PAM3 @ 750 Mb/s 
Modulation	4B5B	4B/3B	80B/81B
Length	100 m	15 m	
Connector	RJ45	Not Defined Depending on OEMs and models	
Cable	Two Twisted Pair Single Direction 	One Twisted Pair Bi Directional 	

汽车总线一致性测试

100BASE-T1 VS 1000BASE-T1

	100BASE-T1	1000BASE-T1
IEEE standard	802.3bw	802.3pb
Data rate	100 Mbps	1000 Mbps
Symbol rate	66.66 MHz	750 MHz
DUT clock	66.66 MHz	125 MHz
Coding	PAM3	PAM3
Disturbing signal (TM4)	5.4 Vpp @ 11.11 MHz	3.6 Vpp @ 125 MHz
Length	15 m (copper)*	15 m (copper)*

*40m is also supported for the link segment in applications requiring additional physical reach (industrial and automation controls and transportation – aircraft, railway, bus, heavy trucks.)

汽车总线一致性测试

100BASE-T1 TRANSMITTER TESTS

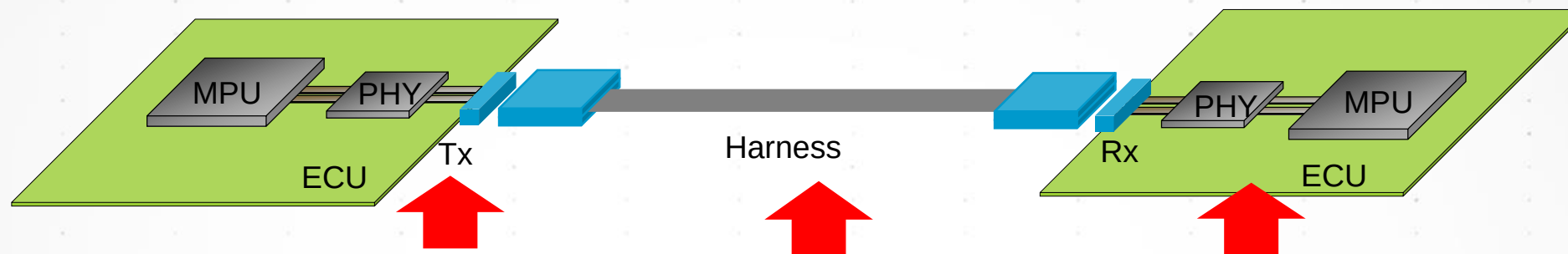
Category	Test mode	Test Items	Test Description	Measurement Equipment
Transmitter 100Base-T1 IEEE Std 802.3bw-2015	Test mode 1	5.4.1	Transmitter Output Droop	Oscilloscope (1GHz or better, 20Mpoints)
	Test mode 2	5.2	Transmit Clock Jitter	Oscilloscope
	Test mode 2 and 3	5.4.3	Transmitter Timing Jitter Master TxOut Jitter (test mode 2) Slave TX-TCLK Jitter (test mode 3)	Oscilloscope
	Test mode 4	5.4.2	Transmitter Distortion	Oscilloscope + AWG
	Test mode 4	8.2.2	MDI Return Loss	+ Vector Network Analyzer
	Test mode 5	5.4.4	PSD (Power Spectral Density)	Oscilloscope / Spectrum Analyzer (1GHz)
	Test mode 5	96.5.6 (IEEE)	Transmitter Peak Differential Output **	Oscilloscope

汽车总线一致性测试

1000BASE-T1 TRANSMITTER TESTS

Category	Test mode	Test Items		Measurement Equipment
Transmitter 1000Base-T1 IEEE Std 802.3bp-2016	Test mode 1	97.5.3.6/97.5.2	TX_TCLK Frequency	Oscilloscope
	Test mode 1	97.5.3.3	Transmit Clock Jitter (MASTER/SLAVE)	
	Test mode 2	97.5.3.6/97.5.2	Transmit Clock Frequency (MASTER)	Oscilloscope
	Test mode 2	97.5.3.3	MDI Output Jitter (MASTER)	
	Test mode 4	97.5.3.2	Transmitter Distortion	Oscilloscope + AWG
	Test mode 4	97.7.2.1	MDI Return Loss	+ Vector Network Analyzer
	Test mode 5	97.5.3.4	PSD (Power Spectral Density)	Oscilloscope + Spectrum Analyzer (1GHz)
	Test mode 5	97.5.3.5	Transmitter Peak Differential** Output	Oscilloscope
	Test mode 6	97.5.3.1	Transmitter Output Droop	Oscilloscope (2.5GHz or better, 20Mpoints)

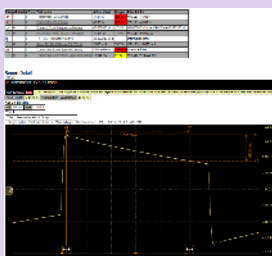
汽车总线一致性测试



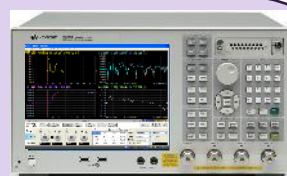
Transmitter



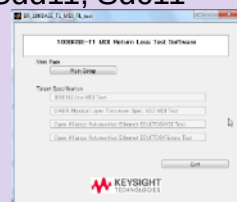
S series Scope
for Signal Quality



N6467B
Compliance Test Software

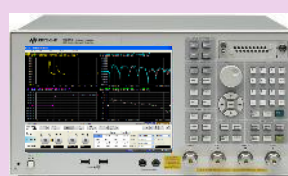


E5071C Network Analyzer
for Sdd11, Sdc11



E6964A MDI Compliance Test
Software

Link Segment



E5071C opt TDR

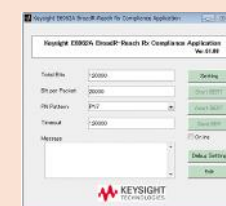


E6963A Compliance Test Software

Receiver



M9010A + M3302A

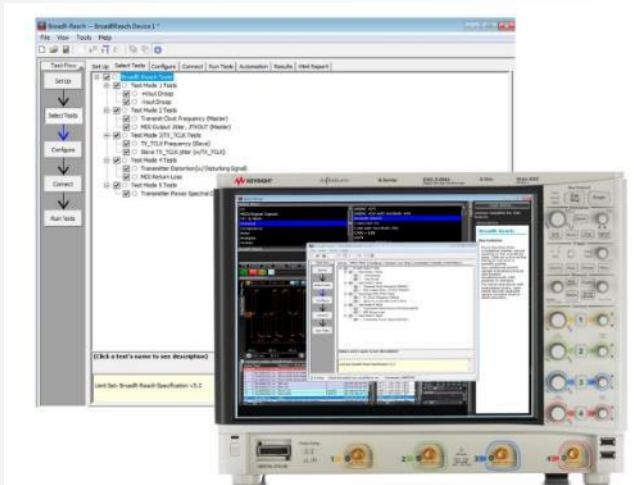


E6962A Rx Test Software

汽车总线一致性测试

UNIQUE TEST COVERAGE

Transmitter



E6961A Automotive Ethernet Transmit

- ❖ Complete 1000BASE-T1 & 100BASE-T1 compliance
- ❖ Industry-first Protocol trigger & decode

Solution components

- Oscilloscope, ENA, Spectrum Analyzer, AWG
- Fixtures, cables, adapters
- Software

Link Segment



E6963A Automotive Ethernet Link Segment

- ❖ Industry-first 100% test coverage harness & connector
- ❖ Guided test setup and pass/fail report with margin analysis

Solution Components

- ENA Vector Network Analyzer
- Cables and adapters
- Software

Receiver



E6962A Automotive Ethernet Receiver

- ❖ Industry-first Bit Error Rate verification
- ❖ Easy-to-follow setup and pass/fail report generation

Solution Components

- PXIe mainframe, controller, digitizer and AWG
- Cables and adapters
- Software

汽车总线一致性测试

E6961A 汽车以太网100BASE-T1 AND 1000BASE-T1发送端测试软件

What is it?

- ❖ 1000BASE-T1 & 100BASE-T1 发送端一致性测试
- ❖ 行业第一个汽车以太网协议解码和触发软件
- ❖ 所有的软件，附件以及必须的硬件都在同一个型号下。

Why Buy?

- ❖ 保证汽车以太网100BASE-T1 或 1000BASE-T1 符合IEEE 标准
- ❖ 简单的测试设置和配置向导
- ❖ 带有余量分析的Pass/Fail 报告
- ❖ 节省测试时间



Hardware configurations are different for different tests

- Transmitter general setup = scope + compliance software + Ethernet test fixture
- Transmitter Power spectral Density test = scope + optional SA + Ethernet test fixture
- Transmitter Return loss test = scope + VNA + Ethernet test fixture
- Transmitter distortion test = scope + AWG + freq divider card + Ethernet test fixture

汽车总线一致性测试

测试结果

BroadR-Reach Test Report

Overall Result: **FAIL**

Test Configuration Details	
Device Description	
Disturbing Signal Source	33250A
Connection Type	Oscilloscope
Test Session Details	
Infiniium SW Version	04.20.0001
Infiniium Model Number	DSO9404A
Infiniium Serial Number	No Serial
Application SW Version	1.00
Debug Mode Used	No
Last Test Date	2013-04-15 15:51:13 UTC +08:00

Pass	# Failed	# Trials	Test Name	Worst Actual	Worst Margin	Pass Limits
✗	1	1	Transmitter +Vout Droop	55.38 %	-23.1 %	VALUE < 45.00 %
✗	1	1	Transmitter -Vout Droop	55.23 %	-22.7 %	VALUE < 45.00 %
✓	0	1	TX_TCLK Frequency (Master)	66.669190 MHz	31.1 %	66.660000 MHz <= VALUE <= 66.673333 MHz
✓	0	1	MDI Output Jitter, JTXOUT (Master)	23.293 ps	53.4 %	VALUE < 50.000 ps
i	0	1	TX_TCLK Frequency (Slave)	66.669150 MHz		Information Only
✓	0	1	TX_TCLK Jitter (Slave)	1.449 mUI	85.5 %	VALUE < 10.000 mUI
✗	1	1	Transmitter Distortion	19.35 mV	-29.0 %	VALUE <= 15.00 mV
✗	2	2	Transmitter Power Spectral Density	-46.412 dBm/Hz	-464.1 %	Overall = Pass

汽车中高速发展的总线技术

Looking under the Hood- Digital

