

汽车以太网总线测试方案



未来就在眼前

猜猜这是什么



XP-何小鹏 V 皇冠

11分钟前

分享下小鹏汇天飞行汽车T2的一张正式图片。图片还感觉不强烈，那天我在VR中的试乘体验让我太兴奋了！和鹏友自行驾驶一飞冲天的体验是怎样？如何克服空中驾驶的心理障碍？相信99%的鹏友都没有实际经验。在2021，在x3.0之外，相信包括飞行等多个创新探索点都值得鹏友们的期待😄

📌 收起 | 🔍 查看大图 | ↶ 向左旋转 | ↷ 向右旋转



议程

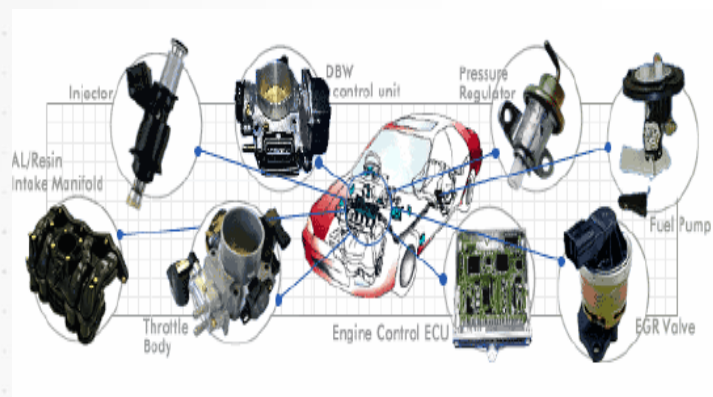
- 朝气蓬勃的汽车电子技术
- 是德科技汽车串行总线解码方案
- 汽车总线未来发展趋势和是德科技的测试方案



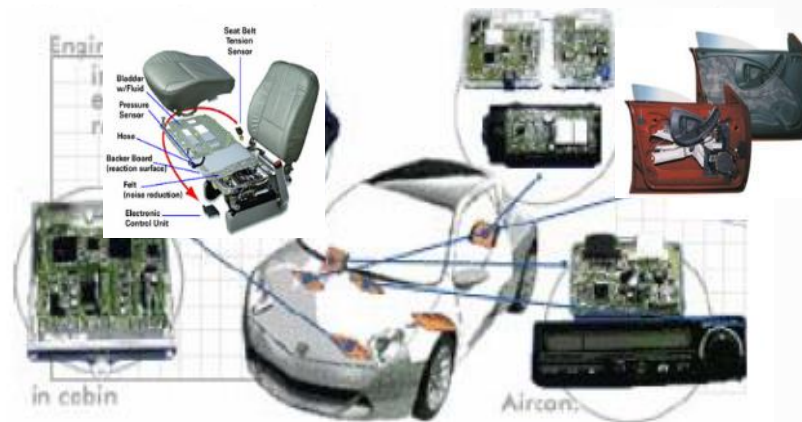
朝气蓬勃的汽车电子行业

高速发展的汽车电子总线

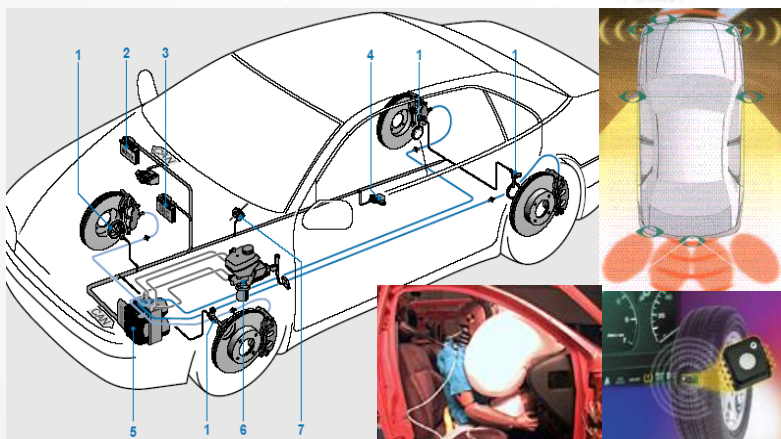
动力控制单元



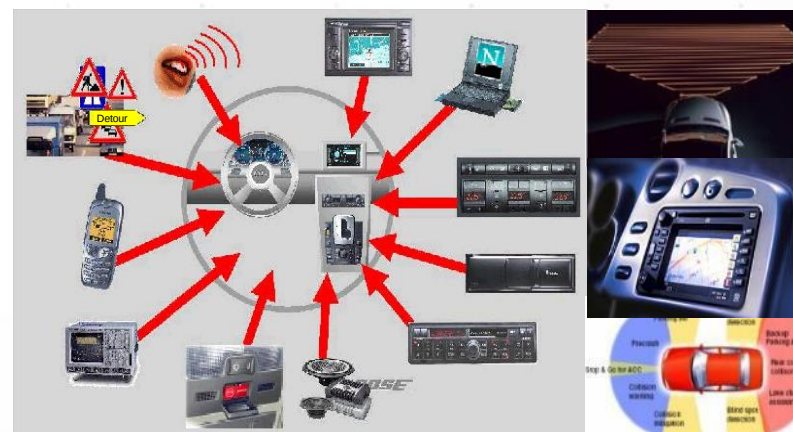
车身电子



主/被动安全设备

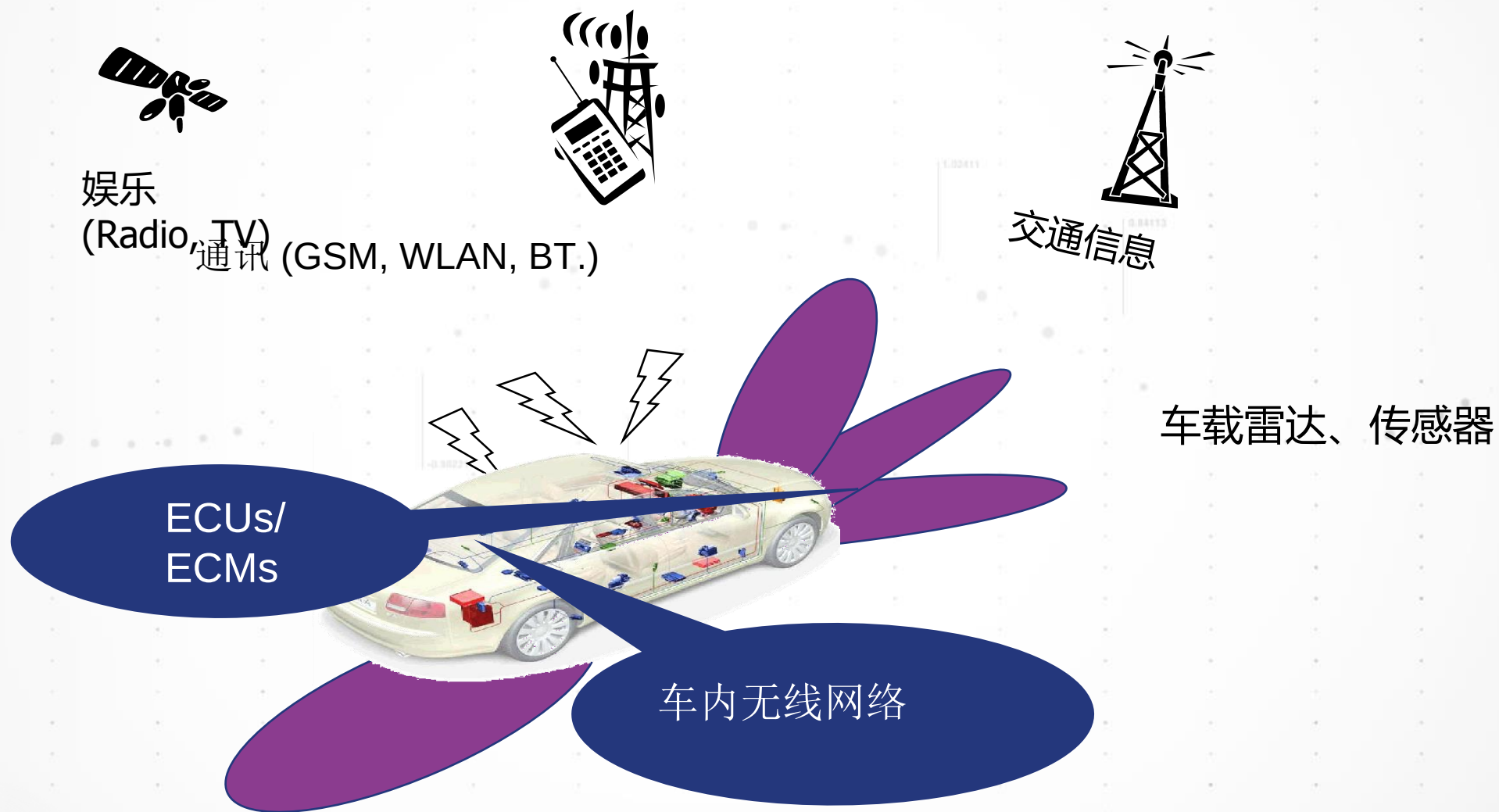


通信和车载娱乐设备



是德科技的测试领域涵盖车内和车外的部件及系统

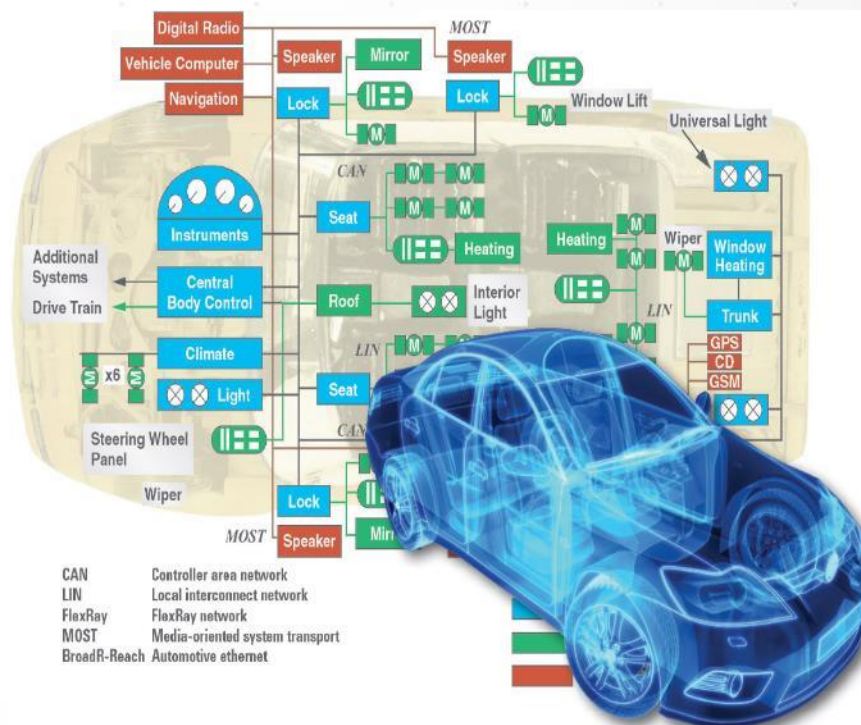
终端可以是手机，也可以是....



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)
 - 车载以太网

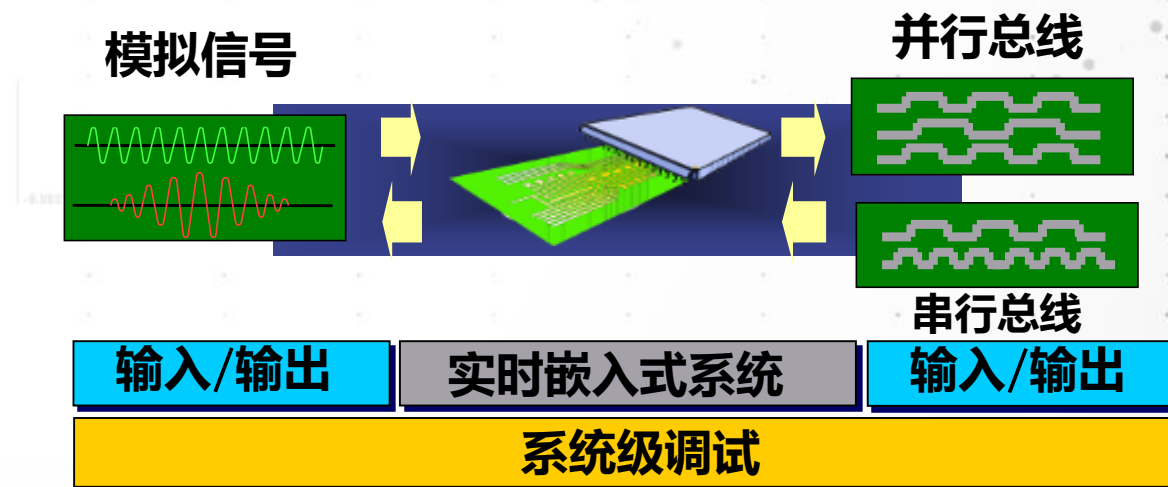
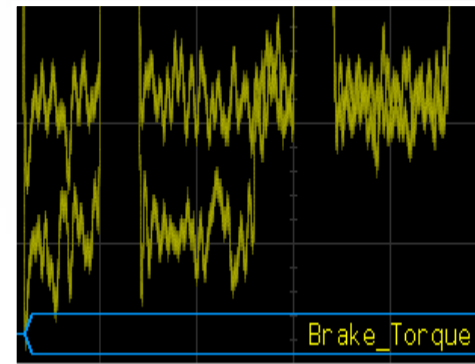


汽车串行总线解码

为什么需要总线解码？

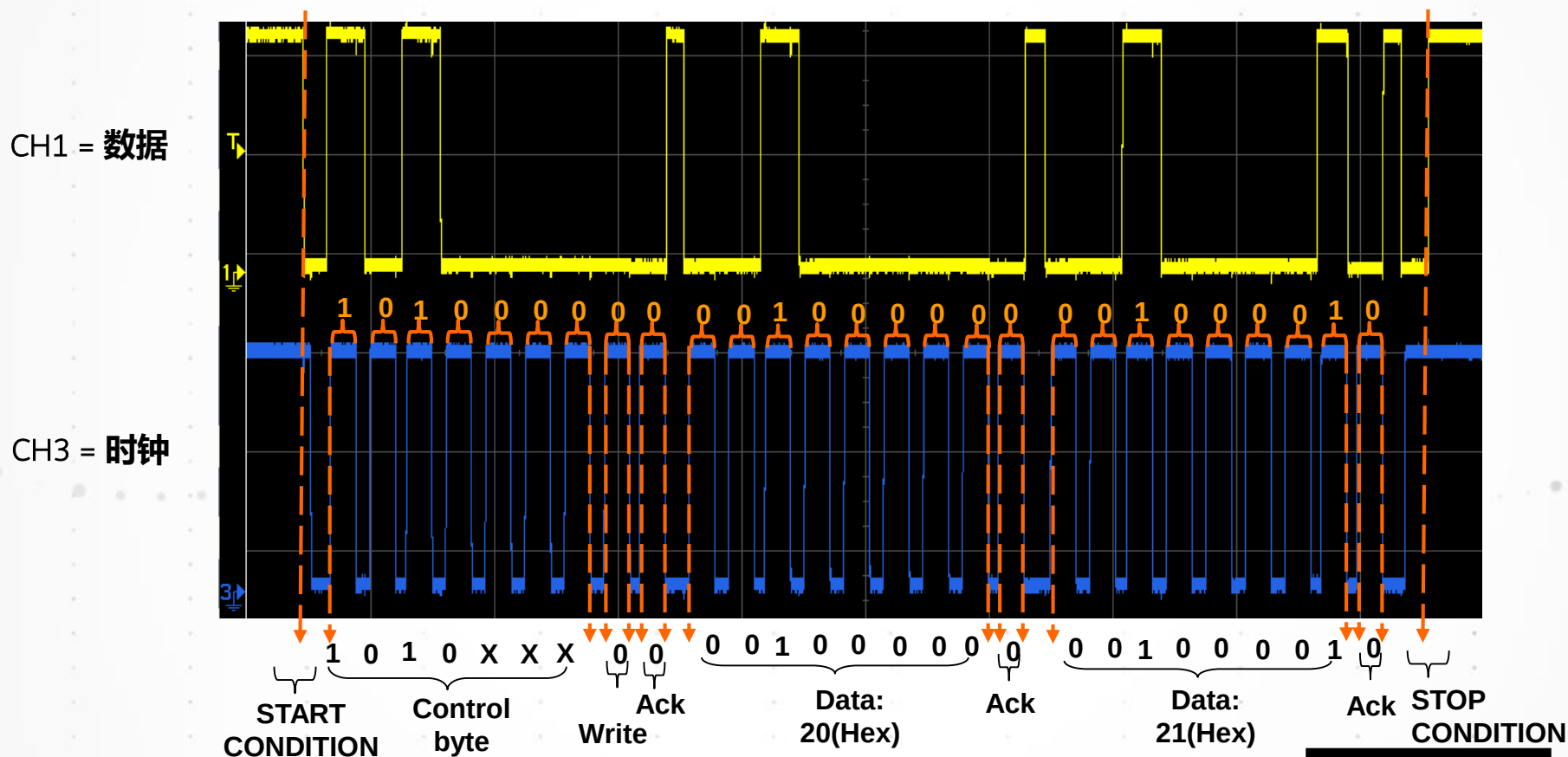
这是一个非常低速的总线，怎么可能出问题？

- 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



汽车串行总线解码

“原始”的解码方法

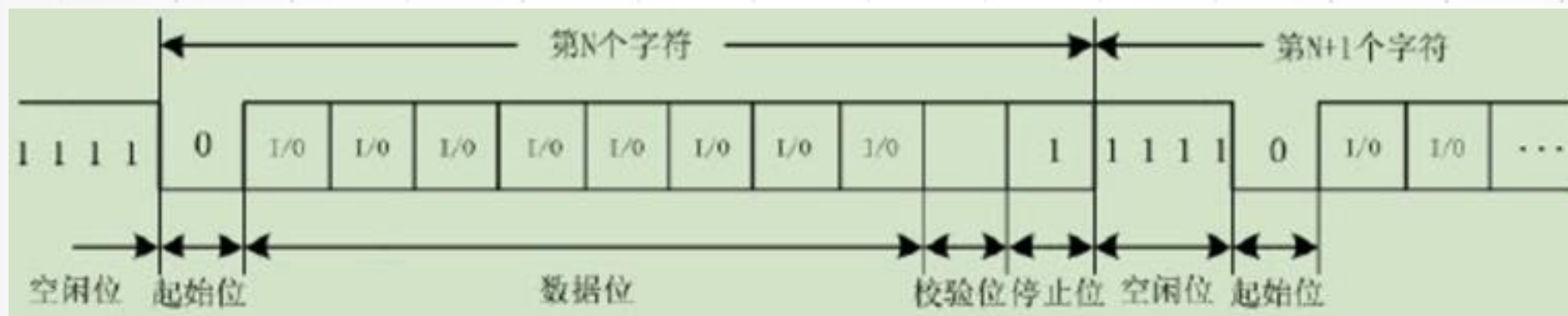


若发现不是我们想看的指令? 则需要重新采集一次, 重复人工解码!



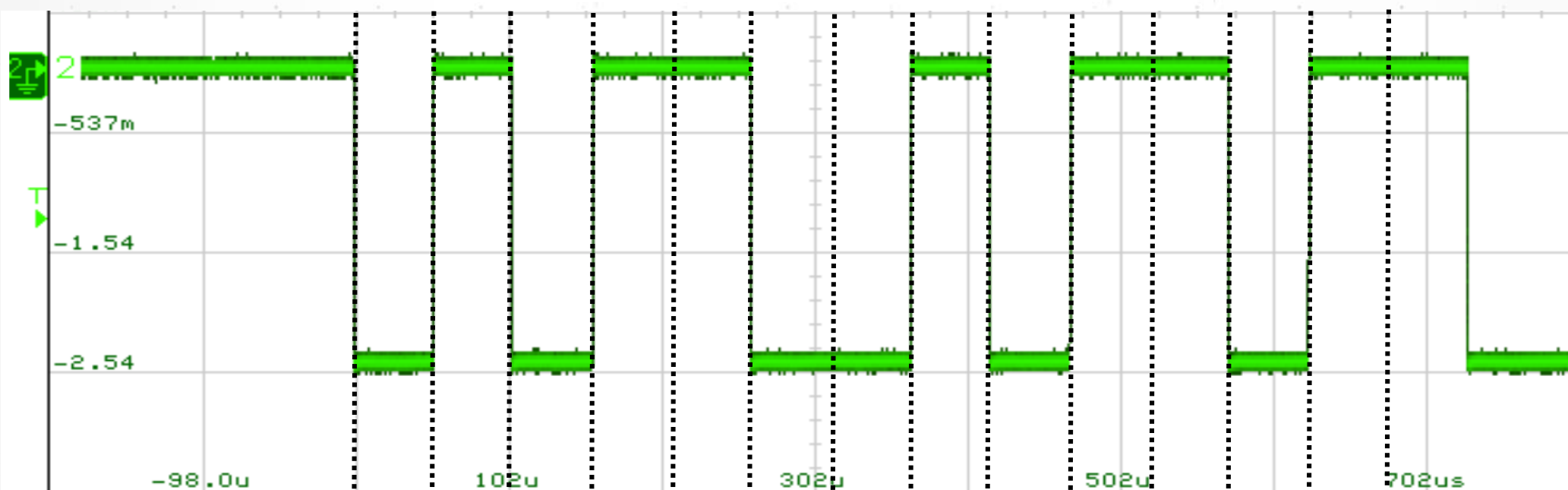
汽车串行总线解码

基于示波器的串行数据触发及解码



总线配置:

- 极性高空闲
- 波特率: 19.2kb/s
- 数据位: 8
- 奇偶校验: 奇
- 最高有效位

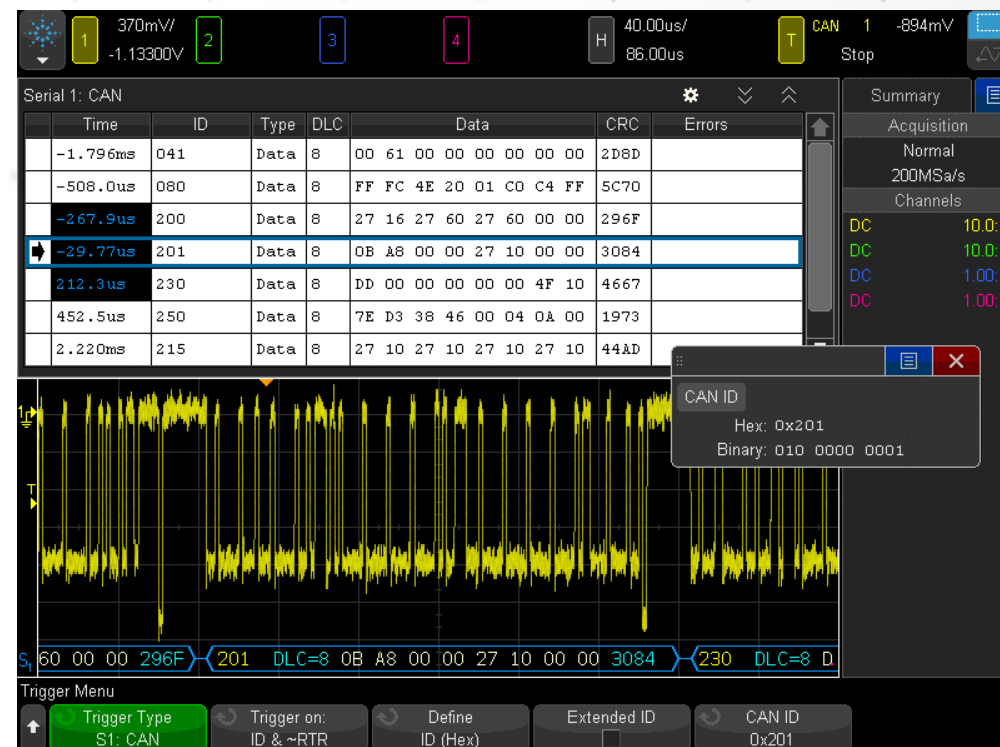


汽车串行总线解码

抽象的16进制

非符号解码: 帧 ID = 201, 数据 = 08 A8 00 00 27 10 00 00

201代表什么? 一长串数据又代表什么?



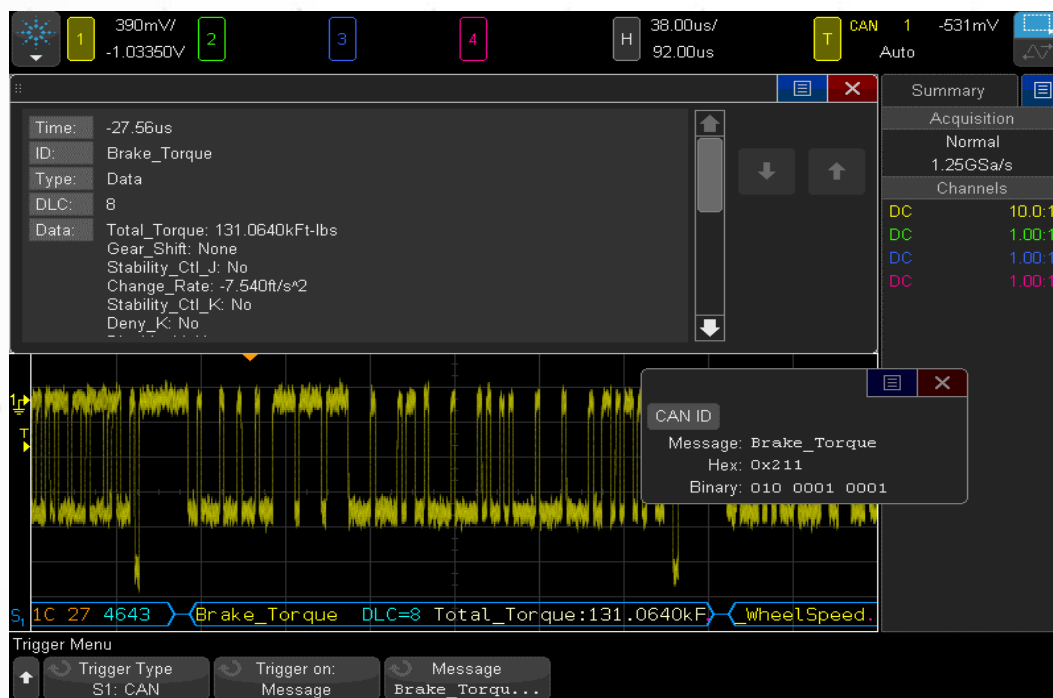
汽车串行总线解码

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

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.

汽车串行总线解码

CAN-DBC符号触发及解码的好处？

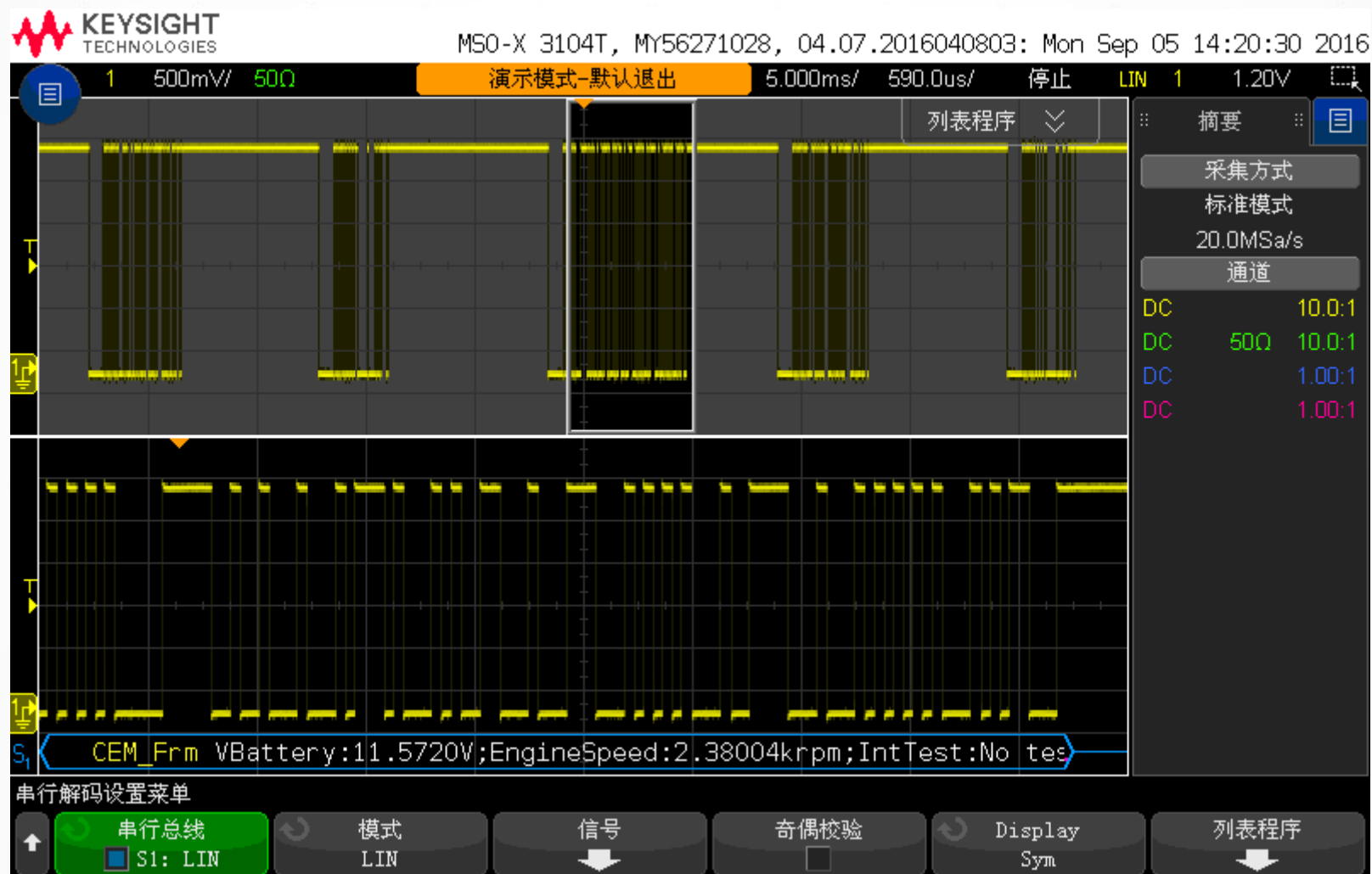
- 方便的翻译捕获到的数据
- 方便直观的设置触发(只要在消息列表中选择就可以了,而不需要输入复杂的16进制码)
- 可以使VECTOR'S CAN总线分析仪和示波器更好的交互触发和分析数据,解决问题
- 提高产品调试的效率及缩短产品推向市场的时间



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

汽车串行总线解码

LIN符号解码



汽车串行总线解码

基于符号解码的触发功能

KEYSIGHT TECHNOLOGIES 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

触发菜单

- 触发于 :
- EOF - 帧结尾
- 远程或者数据帧ID
- Data Frame ID (non-FD)
- 数据帧 ID 和数据 (非 FD)
- 数据帧 ID 和数据 (FD)
- 远程帧ID
- 错误帧
- 示波器将在确认位为隐性 (高) 时触发
- 格式错误
- 填充错误
- CRC Field Error
- 规格错误 (确认或格式或填充或 CRC)
- 所有错误
- BRS 位 (FD)
- CRC 分隔符位 (FD)
- ESI 位有源 (FD)
- ESI 位无源 (FD)
- 过载帧
- 消息
- ✓ 消息和信号 (非 FD)

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

:136.60C;Speed:2.9016krpm 0B11

触发类型 S1: CAN

触发于 : Msg & Sig (no...

消息 EngineData ...

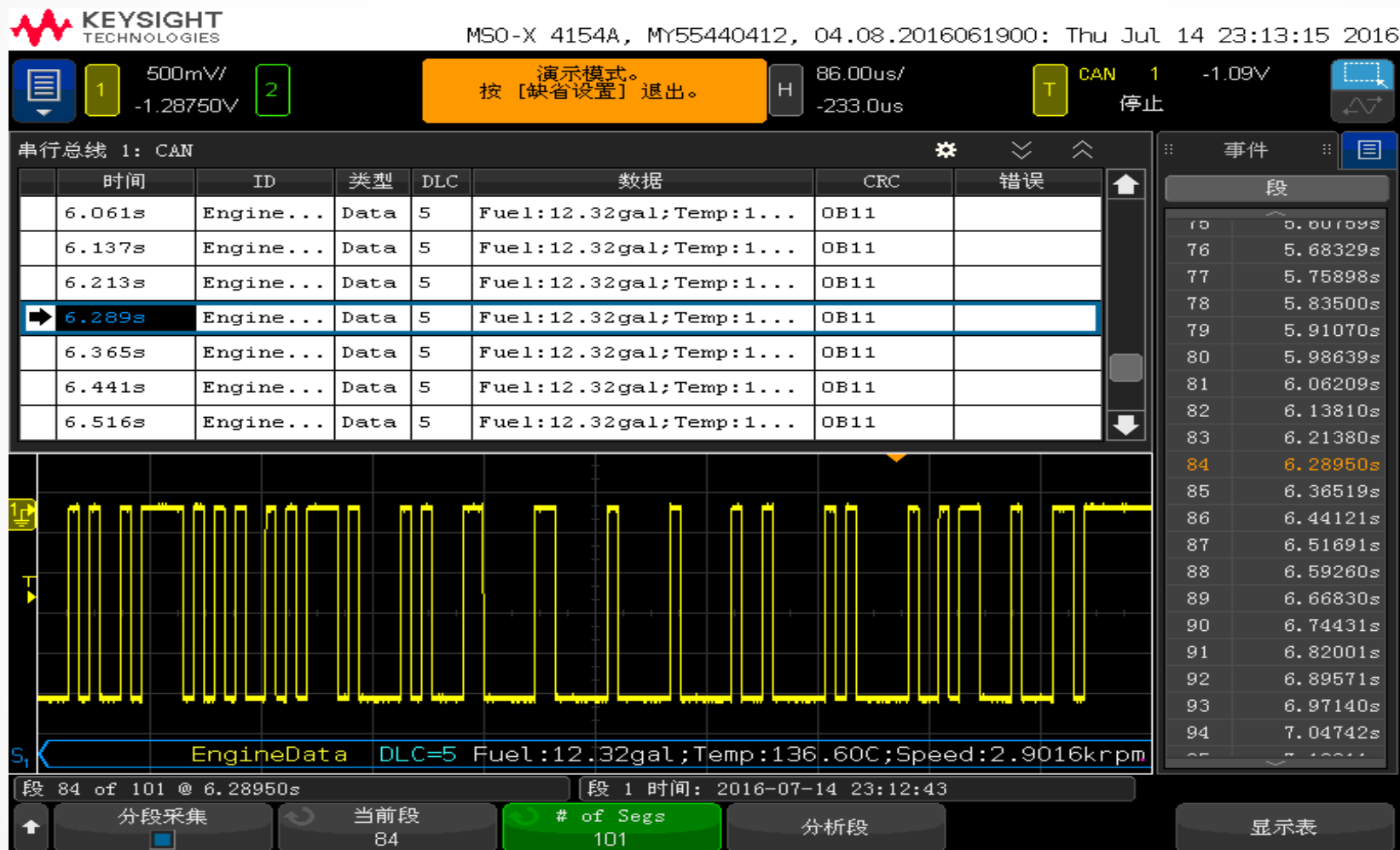
信号 Speed

值类型 变量

值 2901.6rpm

汽车串行总线解码

质量的保证：连续触发功能（分段存储）



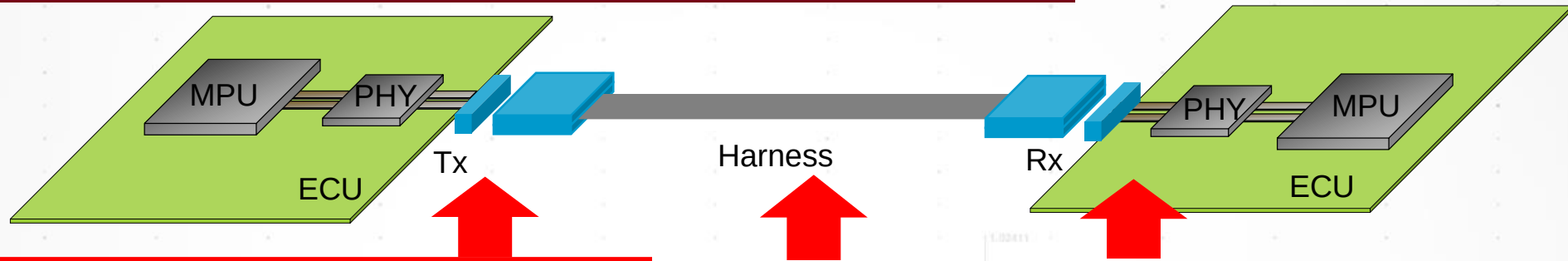
汽车串行总线解码

双总线解码



Overview of 100Base-T1 Compliance Test

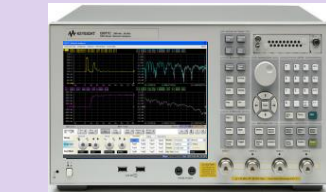
100BASE-T1



Transmitter



S series Scope
for Signal Quality



E5071C Network Analyzer
for S11

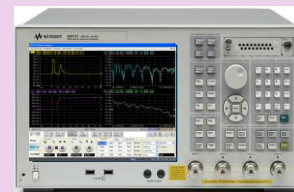


Custom Test Fixture



N6467B / E6961A / E6960A
Compliance Test Software

Harness Connector



E5071C opt TDR



E6963A Compliance Test Software



Custom Test Fixture

Receiver



M9010A + M3302A

Under Development

E6962A Rx Test Software



Custom Test Fixture

车载以太网发射机一致性测试

支持的标准

automotive Ethernet 10BASE-T1S compliant to IEEE 802.3cg

automotive Ethernet 1000BASE-T1 compliant to IEEE 802.3bp specifications

automotive Ethernet 100BASE-T1 compliant to IEEE 802.3bw

automotive Ethernet TC8 compliant to OPEN Alliance subcommittee TC8 ECU transmitter specifications

车载以太网发射机一致性测试

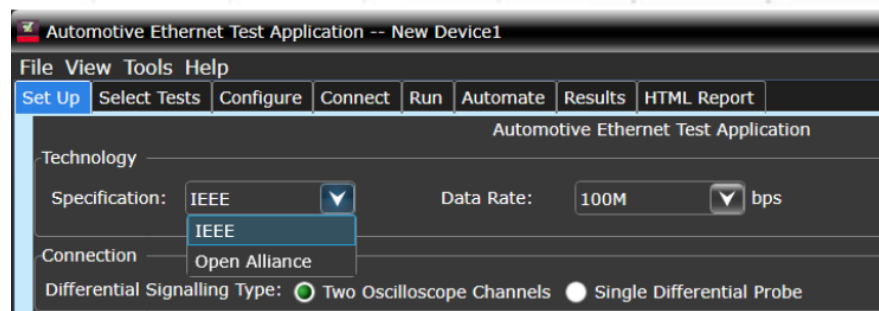
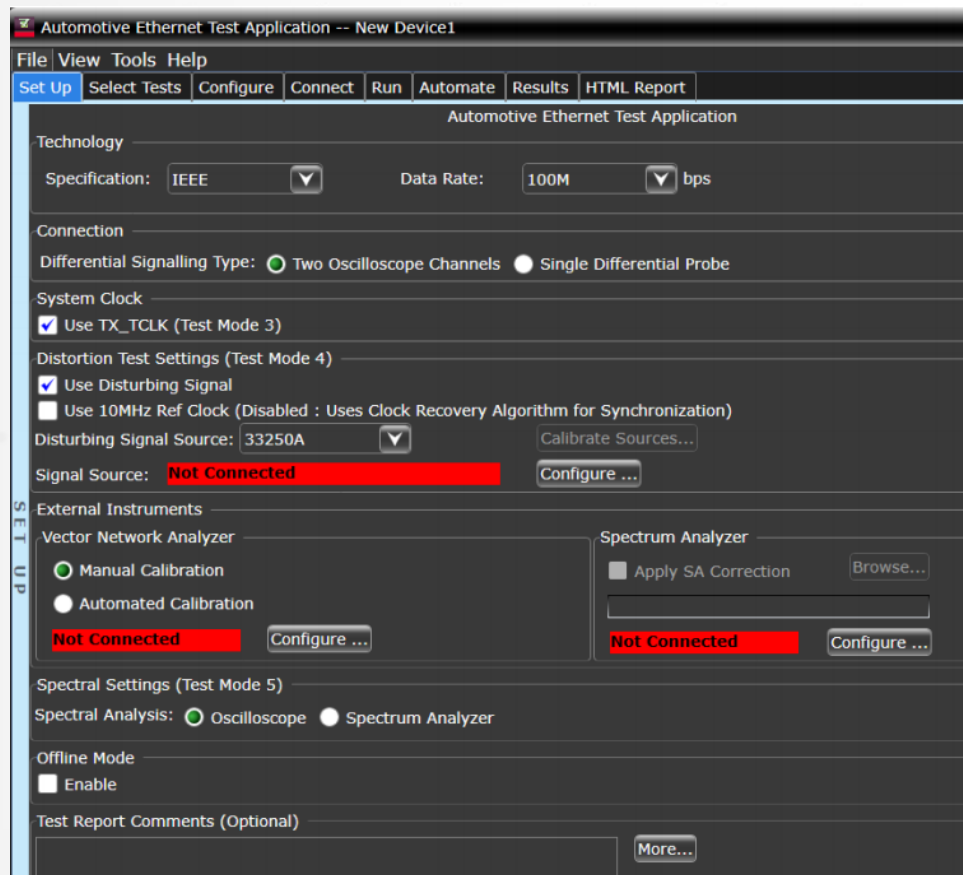
Test name	IEEE 10BASE-T1S	IEEE 100BASE-T1	OPEN Alliance ECU	IEEE 000BASE-T1
Transmitter output droop	147.5.4.2	96.5.4.1	2.2 OABR_PMA_TX_01	97.5.3.1
Transmitter distortion	N/A	96.5.4.2	2.2 OABR_PMA_TX_08	97.5.3.12
Transmitter timing jitter (master and slave)	147.5.4.3	96.5.4.3/ 96.5.4.5	2.2 OABR_PMA_TX_02	97.5.3.3
Transmitter power spectral density	147.5.4.4	96.5.4.4	2.2 OABR_PMA_TX_04	97.5.3.4
Transmitter peak differential	147.5.4.1	96.5.6 (IEEE test only)	N/A	97.5.3.5
Transmit clock frequency	N/A	96.5.4.5	2.2 OABR_PMA_TX_03	97.5.3.6 97.5.2
MDI return loss		96.8.2.1	2.2 OABR_PMA_TX_05	97.7.2.1
MDI mode conversion	N/A	N/A	2.2 OABR_PMA_TX_06	N/A
MDI common mode emission	N/A	N/A	2.2 OABR_PMA_TX_07	N/A

车载以太网发射机一致性测试

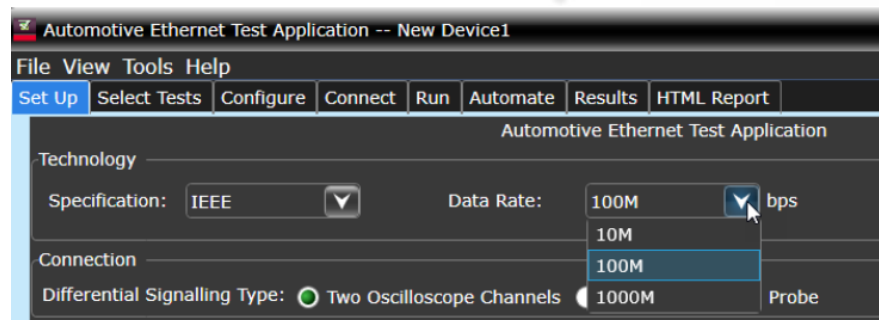
BW NEEDS FOR A 10/100/1000M TEST

Test name	10BASE-T1S	100BASE-T1	OABR ECU	1000BASE-T1	Measurement equipment
Transmitter output droop	147.5.4.2	96.5.4.1	2.2 _01	97.5.3.1	Oscilloscope 2.5 GHz* or better
Transmitter distortion	N/A	96.5.4.2	2.2 _08	97.5.3.12	Oscilloscope + function generator†
Transmitter timing jitter (master and slave)	147.5.4.3	96.5.4.3/ 96.5.4.5	2.2 _02	97.5.3.3	Oscilloscope 2.5 GHz ¹ or better
Transmitter power spectral density	147.5.4.4	96.5.4.4	2.2 _04	97.5.3.4	Oscilloscope 2.5 GHz ¹ or better (or spectrum analyzer 2 GHz or higher)
Transmitter peak differential	147.5.4.1	96.5.6 (IEEE test only)	N/A	97.5.3.5	Oscilloscope 2.5 GHz ¹ or better
Transmit clock frequency	N/A	96.5.4.5	2.2 _03	97.5.3.6 97.5.2	Oscilloscope 2.5 GHz ¹ or better
MDI return loss	N/A	96.8.2.1	2.2 _05	97.7.2.1	Oscilloscope + network analyzer
MDI mode conversion		N/A	2.2 _06	N/A	Oscilloscope 2.5 GHz ¹ or better+ network analyzer
MDI common mode emission		N/A	2.2 _07	N/A	Oscilloscope 2.5 GHz ¹ or better

测试软件界面

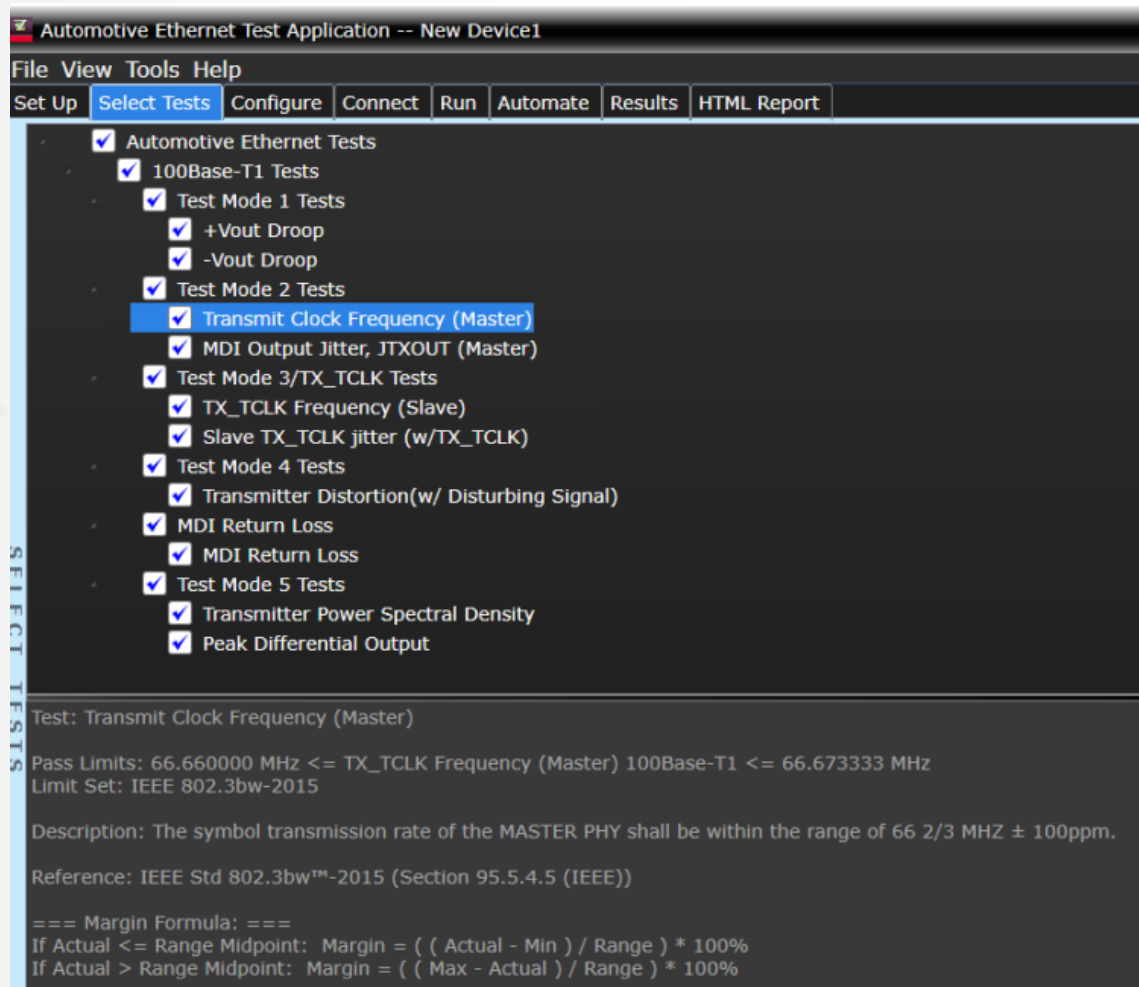


打开下拉菜单选择要测试的技术指标

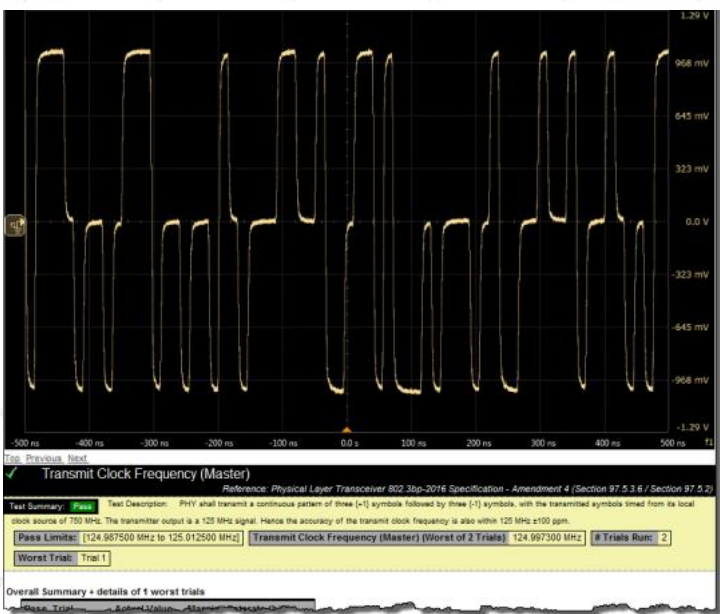
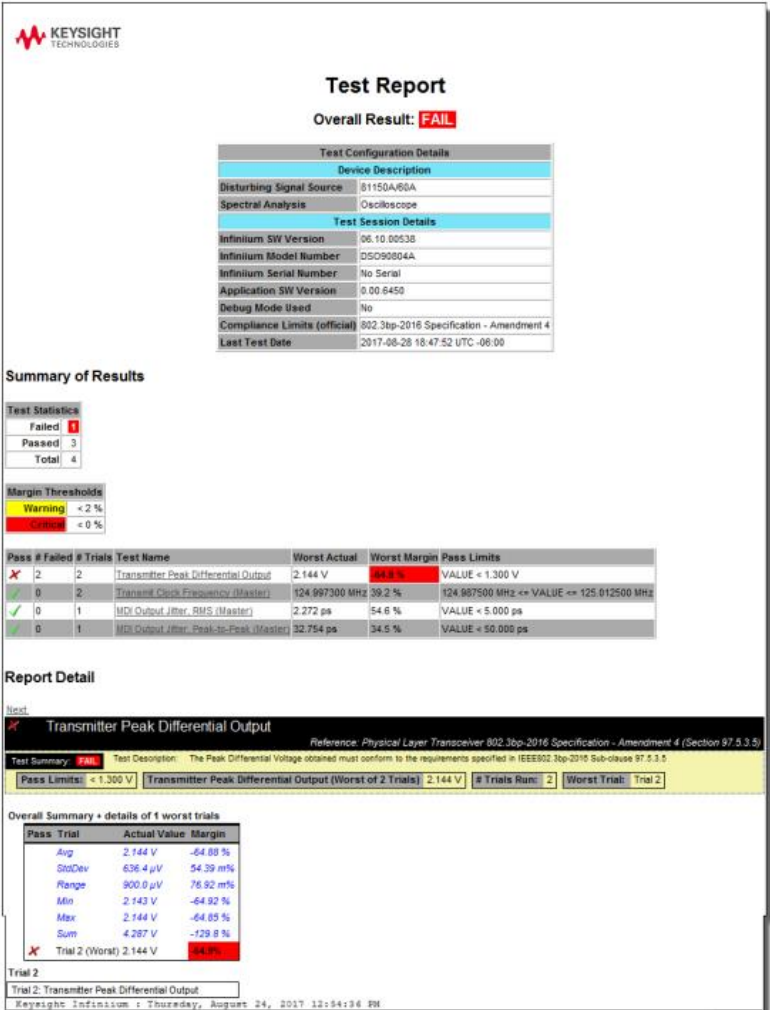


通过下拉菜单可以选择测试的数据速率

测试软件界面



测试报告



A Range of Keysight Oscilloscopes



InfiniiVision Class Scopes

Infiniium Class Scopes

3000T X-Series

4000 X-Series

6000 X-Series

S-Series

EXR-Series

Channels

2, 4

2, 4

2, 4

4

4, 8

Max Bandwidth

100 MHz →
1 GHz

100 MHz →
1.5 GHz ¹

1 GHz →
6 GHz ²

500 MHz →
8 GHz ²

500 MHz →
2.5 GHz

Sample Rate ³

2.5 GSa/s

2.5 GSa/s

10 GSa/s

10 GSa/s

16 GSa/s

Max Memory ³

2 Mpts

2 Mpts

2 Mpts

400 Mpts

400 Mpts

ADC

8 bits

8 bits

8 bits

10 bits

10 bits

WaveGen

1x 20 MHz

2x 20 MHz

2x 20 MHz

N/A

1x 50 MHz

MSO

16 channels

16 channels

16 channels

16 channels

16 channels

**Operating
System**

Embedded

Embedded

Embedded

Windows 10

Windows 10

1. Max bandwidth is 1 GHz with four channels on

2. Max bandwidth is 4 GHz with four channels

3. Specified with all analog channels on

One-Click Debug - Fault Hunter

- **ALL NEW Fault Hunter** automatically finds signal anomalies
- View button to **see waveform issues**
- **Analyze glitches**, slow edges, runts

Fault Hunter

Fault Hunter automatically finds the most common types of signal faults. It begins by getting statistics on standard measurements and then runs tests to find outliers.

Setup

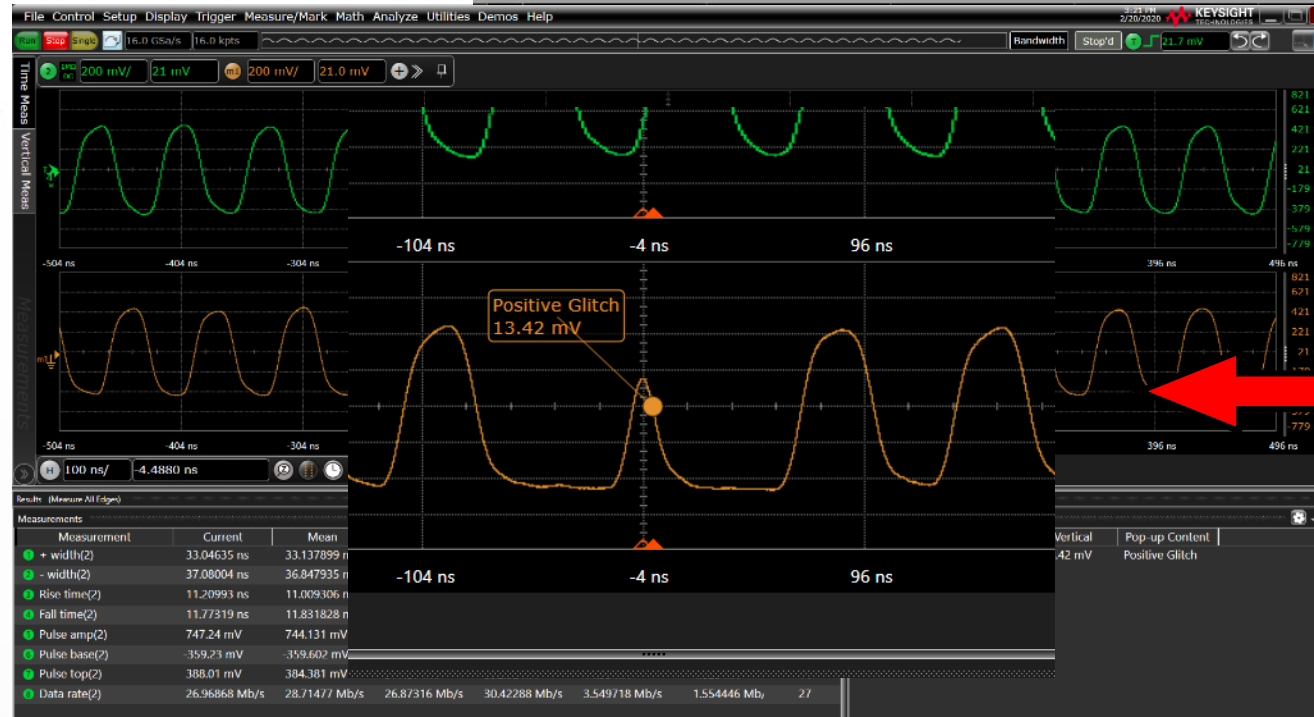
Source: **Channel 2** ☒ Triggering - Finds rare faults, restricted limits. ☐ Limit Test - May miss rare faults, unrestricted limits. Duration: **Run for a minute** Autoscale

Control

Auto Setup ☒ Run All after Auto Setup Run All Tests

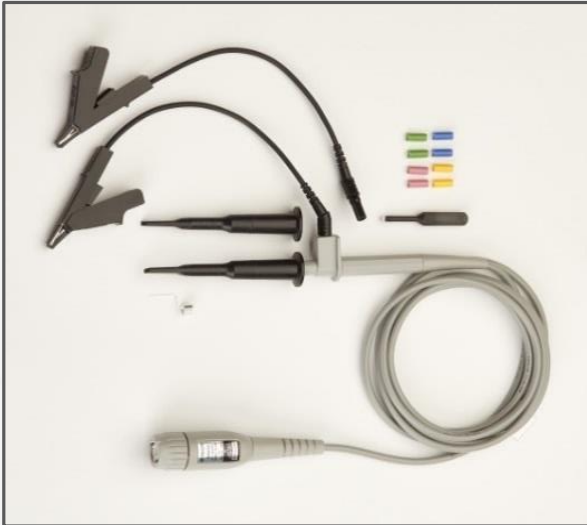
Results

Test	Result	Mean	Std Dev	Acceptable Range	
Positive Glitch	Failed	34.8 ns	184 ps	> 17.3951 ns	Run View Copy to Trig
Negative Glitch	Passed	34.8 ns	9.32 ns	> 17.3951 ns	Run View Copy to Trig
Slow Rising Edge	Passed	11.1 ns	356 ps	< 12.2036 ns	Run View Copy to Trig
Slow Falling Edge	Passed	11.5 ns	378 ps	< 12.6759 ns	Run View Copy to Trig
Positive Runt	Failed	Low -359 mV : Hi 385 mV	9.19 mV	> -209.8 mV and < 237.0 mV	Run View Copy to Trig
Negative Runt	Passed	Low -359 mV : Hi 385 mV	9.19 mV	> -209.8 mV and < 237.0 mV	Run View Copy to Trig



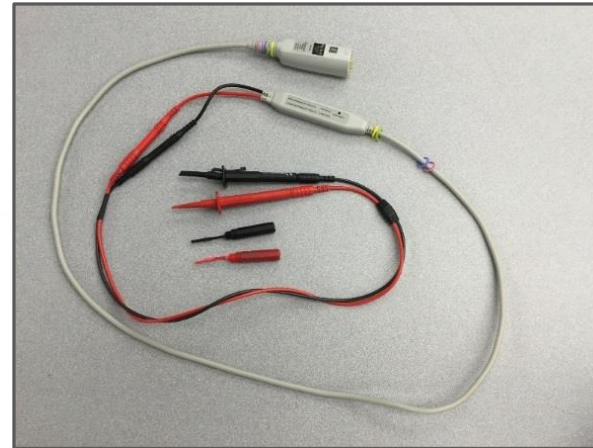
Extreme Temperature Probing Solutions

FOR TESTING IN TEMPERATURES RANGING FROM -40° TO +85° C



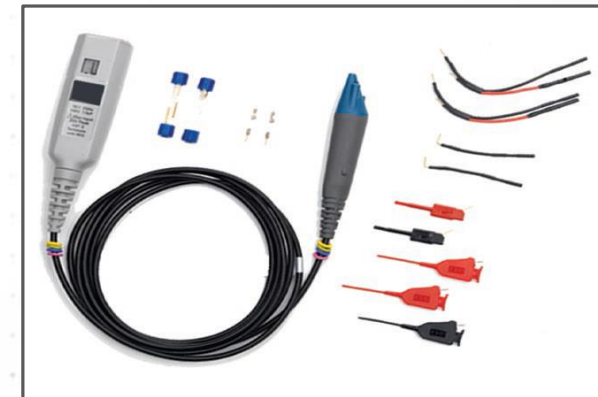
N7007A

400 MHz passive probe (2 meters)



N7013A

Differential probe extension cables
(>2 meters w/ N2818A)



N2797A

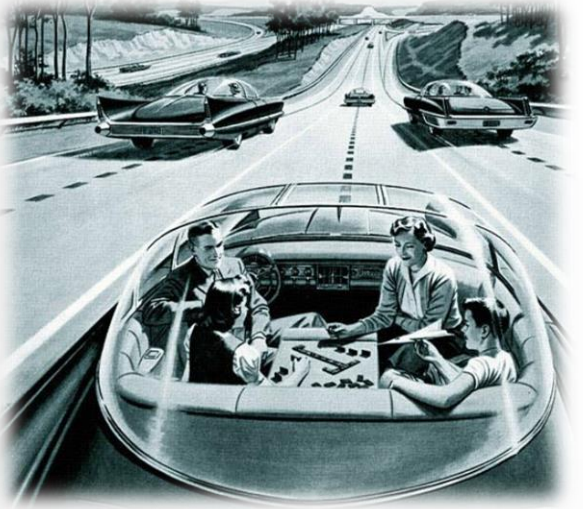
1.5 GHz SE active probe (2 meters)

Trends in Automotive Ethernet



What drives the multigigabit speed in IVN?

SECURE ADAS AND AV NETWORKS ENABLED BY MULTIGIGABIT ETHERNET



Higher Bandwidth

- To process larger amount of data collected by sensors and cameras

Safety

- To allow the vehicle to make function-critical decision to enable utmost safety

Simplification

- Moving from multiple networks into an industry proven secure network with scalability

Why Ethernet

Cable weight

- 100BASE-T1 is a physical full-duplex standard
- Only a single unshielded-twisted pair cable is needed

Immunity and Emissions requirements

- CISPR25 Class 5
- PAM3 for noise immunity

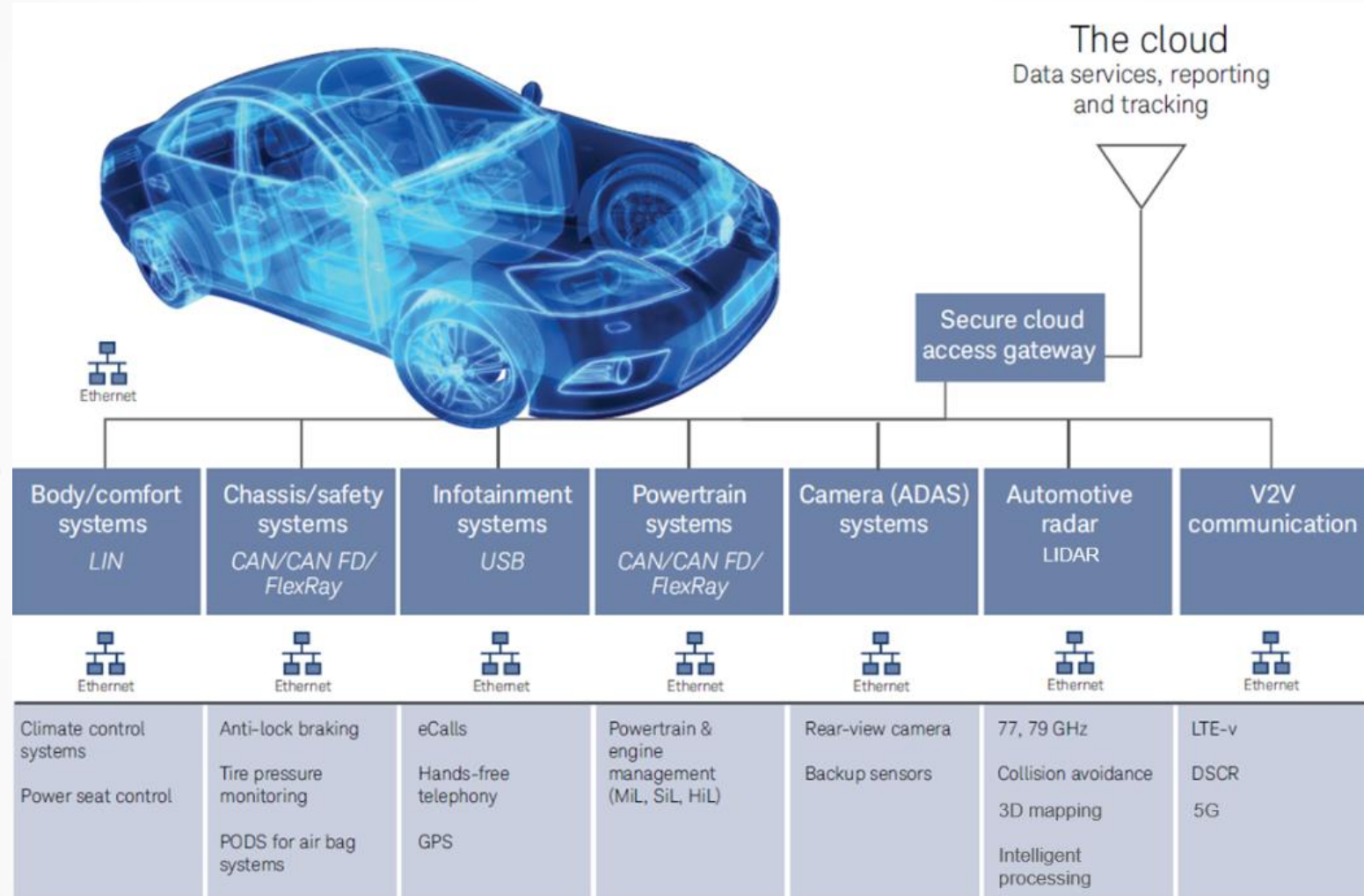
Proven technology

- Decades of development
- Standardized interface
- MAC can remain the same
 - Transparent to CPU/MCU/FPGA



Automotive Ethernet link everywhere

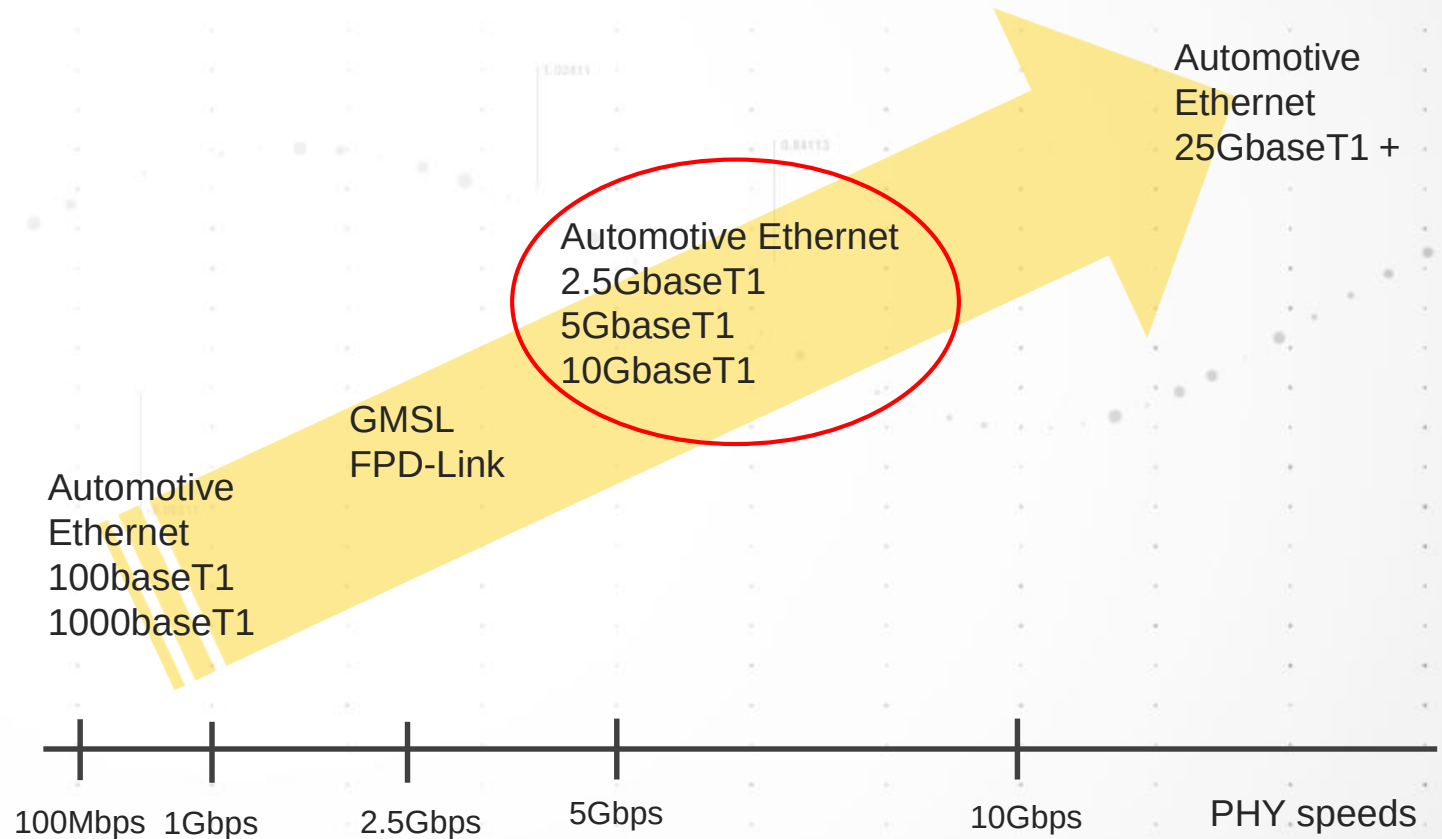
TYPICAL NODE



Three new automotive ethernet PHY specs

AUTOMOTIVE ETHERNET MULTIGIG

- **2.5GBASE-T1:** 2.5 Gb/s Automotive Ethernet (full duplex) over a single balanced pair of conductors, with reach up to at least 15 m
- **5GBASE-T1:** 5 Gb/s Automotive Ethernet (full duplex) over a single balanced pair of conductors, with reach up to at least 15 m
- **10GBASE-T1:** 10 Gb/s Automotive Ethernet (full duplex) over a single balanced pair of conductors, with reach up to at least 15 m



Keysight Automotive Ethernet Solutions

PHYSICAL LAYER TEST COVERAGE



Transmit (Tx)

- Complete 10S/100/1G/2.5G/5G/10G (one installer)
- Protocol trigger & decode 100/1000*BASE-T1
- Fixtures/Adapters/Connectors



Link Segment (Lx)

- 100% test coverage for harness, connectors, cables
- Different platforms of VNA



*Receiver (Rx)
- release 2.0, TBD*

Supported PMA Tx Test Items in Comparison

AUTOMOTIVE ETHERNET TX

100BaseT1	1000BaseT1 802.3bp/TC12	2.5G/5G/10GBaseT1 802.3ch/TC15
Transmitter output droop (149.5.2.1)		
Transmitter output distortion		Transmitter output linearity (149.5.2.2)
Transmitter timing jitter (149.5.2.3)		
Transmitter power spectral density (PSD) and power level (149.5.2.4)		
Transmitter peak differential output (149.5.2.5)		
Transmitter clock frequency (149.5.2.6)		
Transmitter MDI return loss (149.8.2.1)		
		MDI random jitter in master mode (149.5.2.3.1)
		MDI deterministic jitter in master mode (149.5.2.3.2)
		MDI even-odd jitter in master mode (149.5.2.3.2)

Note: the clause numbers are based on IEEE 802.3ch

Automotive Ethernet Multi-gig support

ONE INSTALLER

Data Rate	Standards body	
10BaseT1S	IEEE 802.3cg	
100BaseT1	IEEE 802.3bw	OA TC1 & TC8
1000BaseT1	IEEE 802.3bp	OA TC12 & TC8
2.5G/5G/10G BaseT1	IEEE 802.3ch	OA TC15

Data Rate	Scope min BW	Other required
10BaseT1S	500 MHz	
100BaseT1	1 GHz	VNA, AWG
1000BaseT1	2.5 GHz	VNA, AWG
2.5GBaseT1	4 GHz*	VNA
5GBaseT1	8 GHz*	VNA
10GBastT1	16 GHz*	VNA

These are conservative estimates and not in our datasheet yet

TWO DIFFERENT PRICE POINTS – ONE FOR MXR ONE FOR UXR

Available adapter boards



AE6942A

- SMA to Mini-50
- Designed for 100M/1Gbps automotive ethernet (802.3bw/bp)
- Molex



AE6943A

- SMA to MateNet
- Designed for 100M/1Gbps automotive ethernet (802.3bw/bp)
- TE



AE6960A

- SMA to H-MTD
- Designed for multi-gig 10Gbps (802.3ch)
- Rosenberger

NEW