东方中科

汽车以太网总线测试方案

未来就在眼前

猜猜这是什么

东方中科

议程

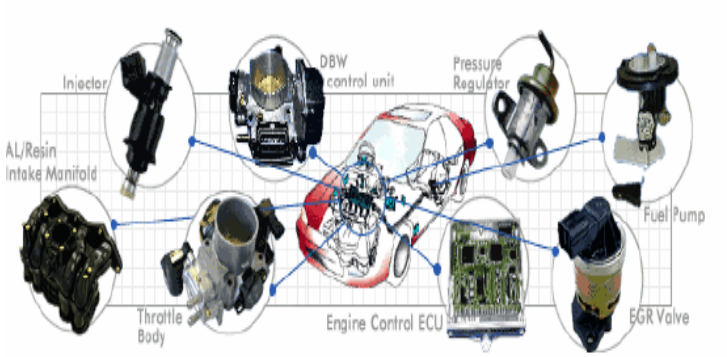
- 朝气蓬勃的汽车电子技术
- 是德科技汽车串行总线解码方案
- 汽车总线未来发展趋势和是德科技的测试方案

东方中科

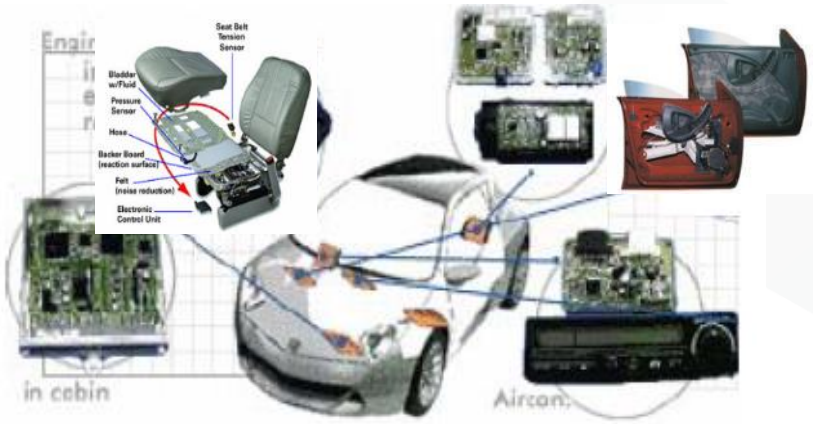
朝气蓬勃的汽车电子行业

高速发展的汽车电子总线

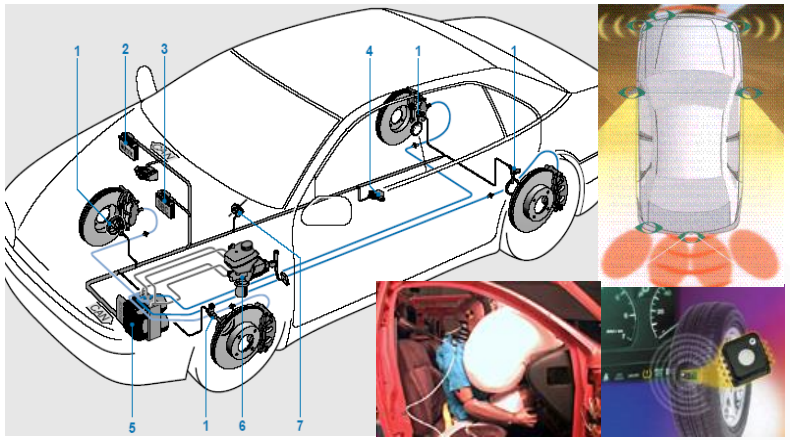
动力控制单元



车身电子



主/被动安全设备



通信和车载娱乐设备

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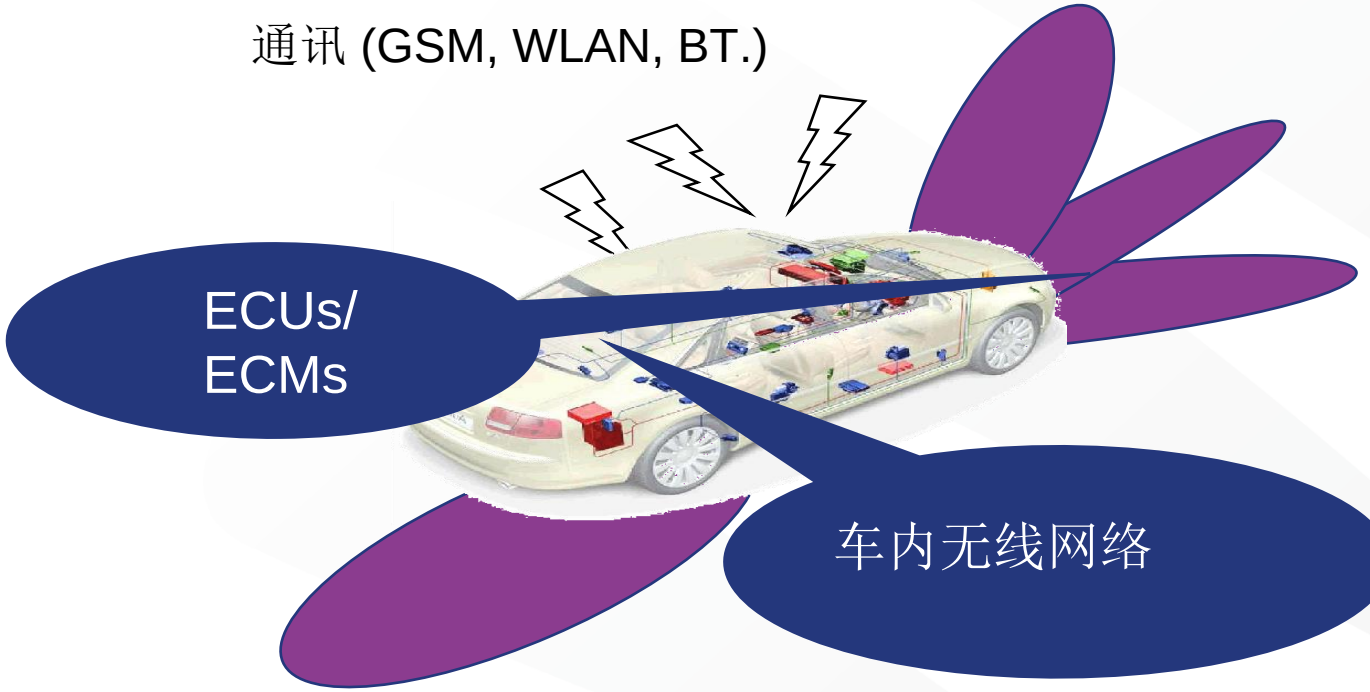
是德科技的测试领域涵盖车内和车外的部件及系统

终端可以是手机，也可以是….

娱乐
(Radio, TV)

交通信息

通讯 (GSM, WLAN, BT.)



车载雷达、传感器

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汽车总线发展史

汽车总线概览

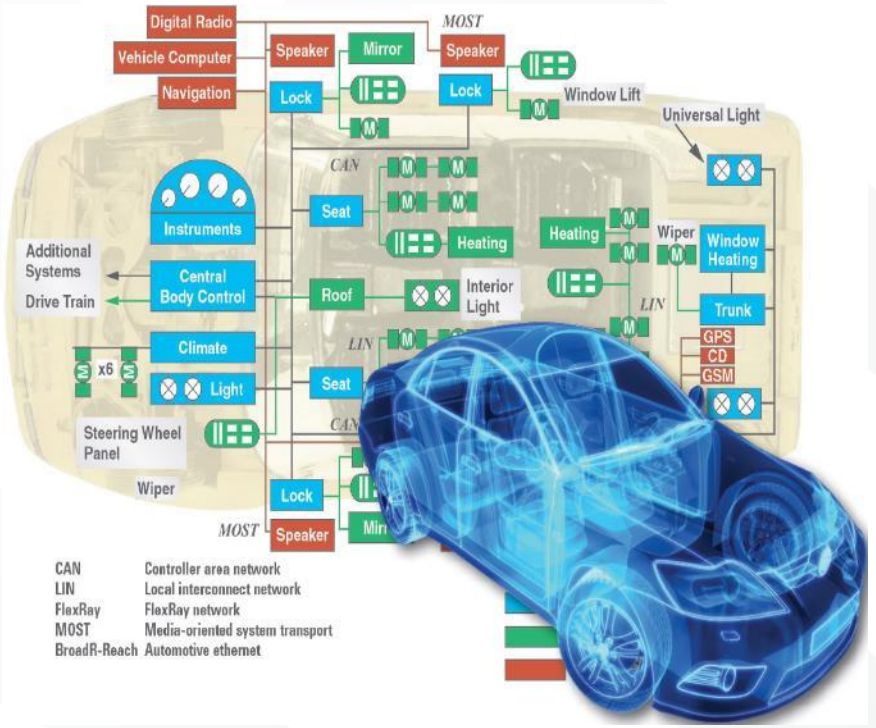
- I^2C
- SPI

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



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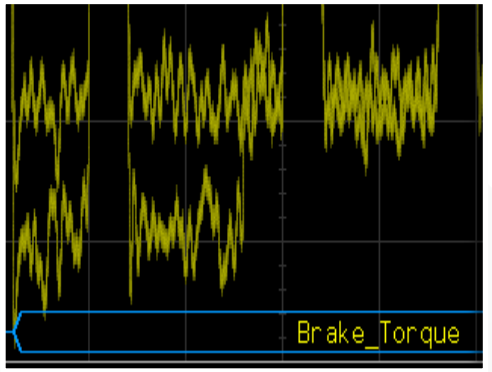
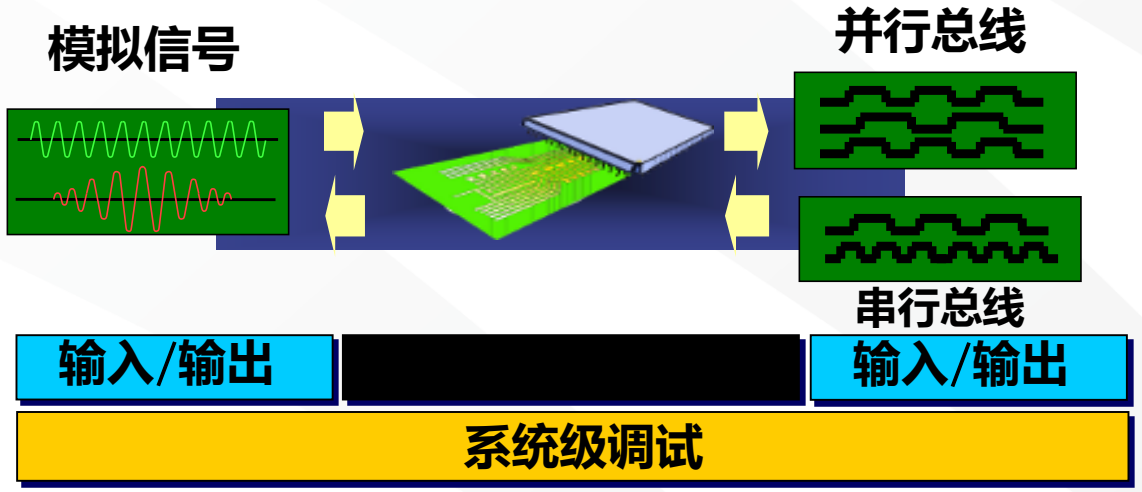
汽车串行总线解码

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





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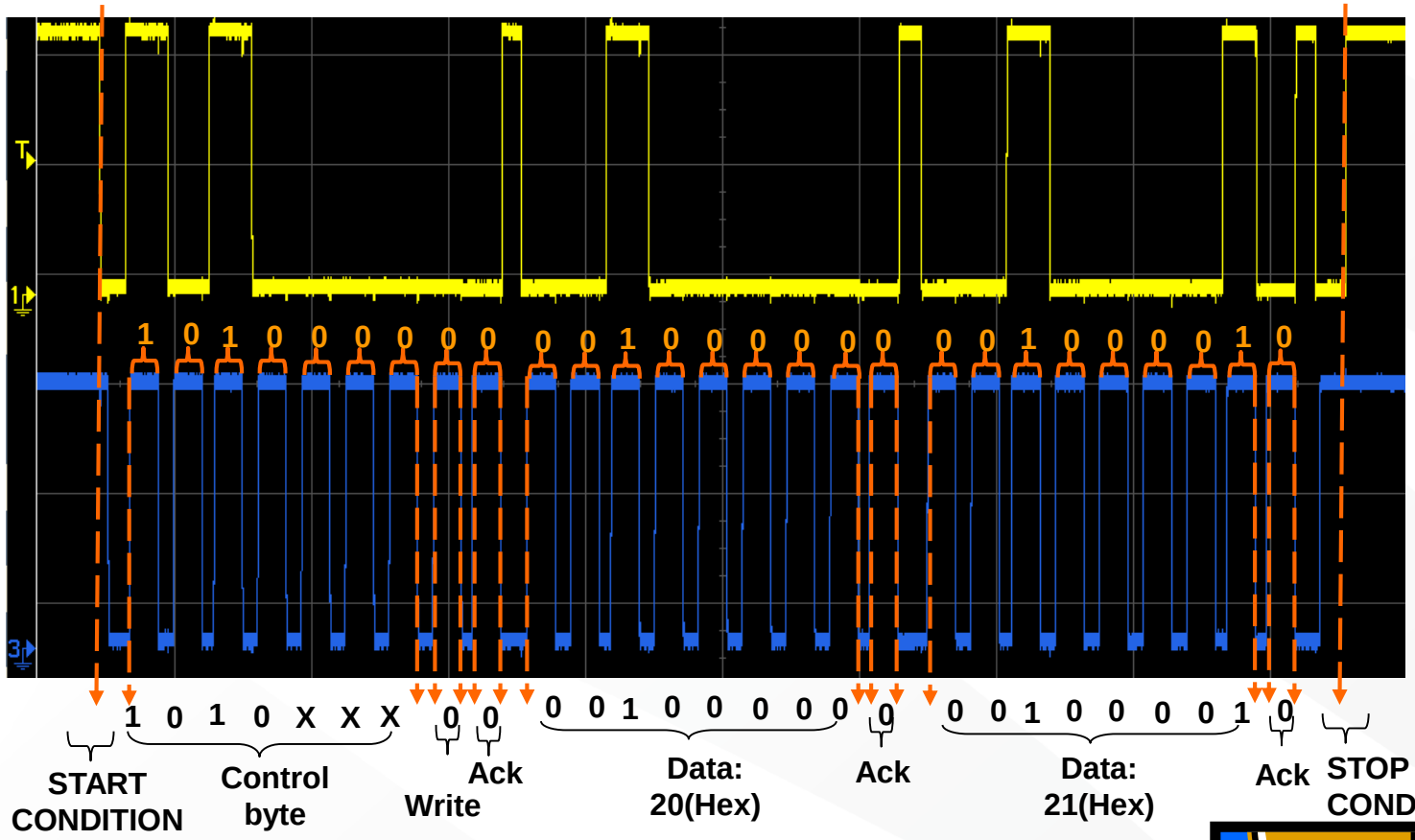
汽车串行总线解码

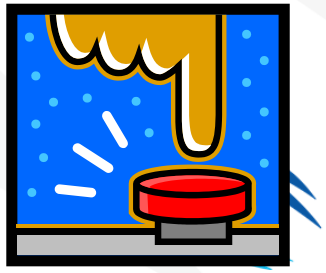
“原始”的解码方法

CH1 = **数据**

CH3 = **时钟**



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!



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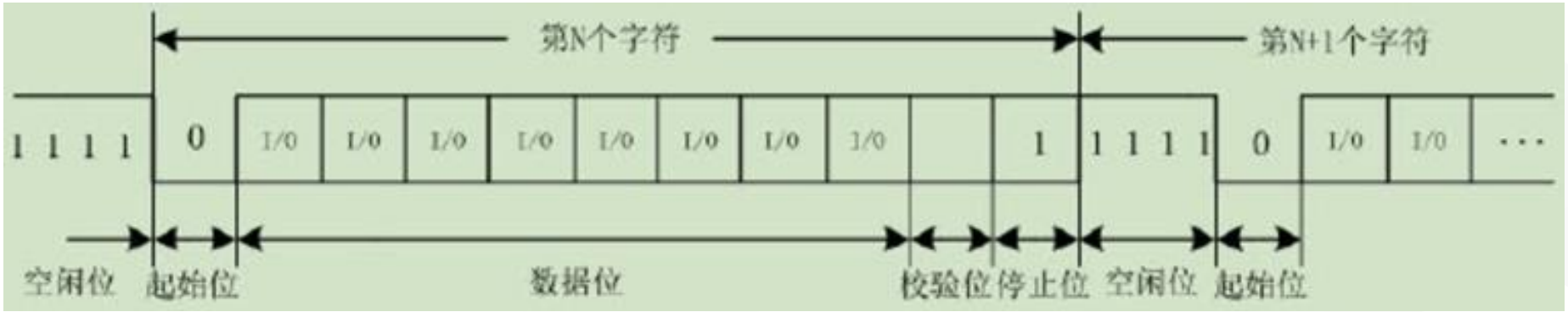
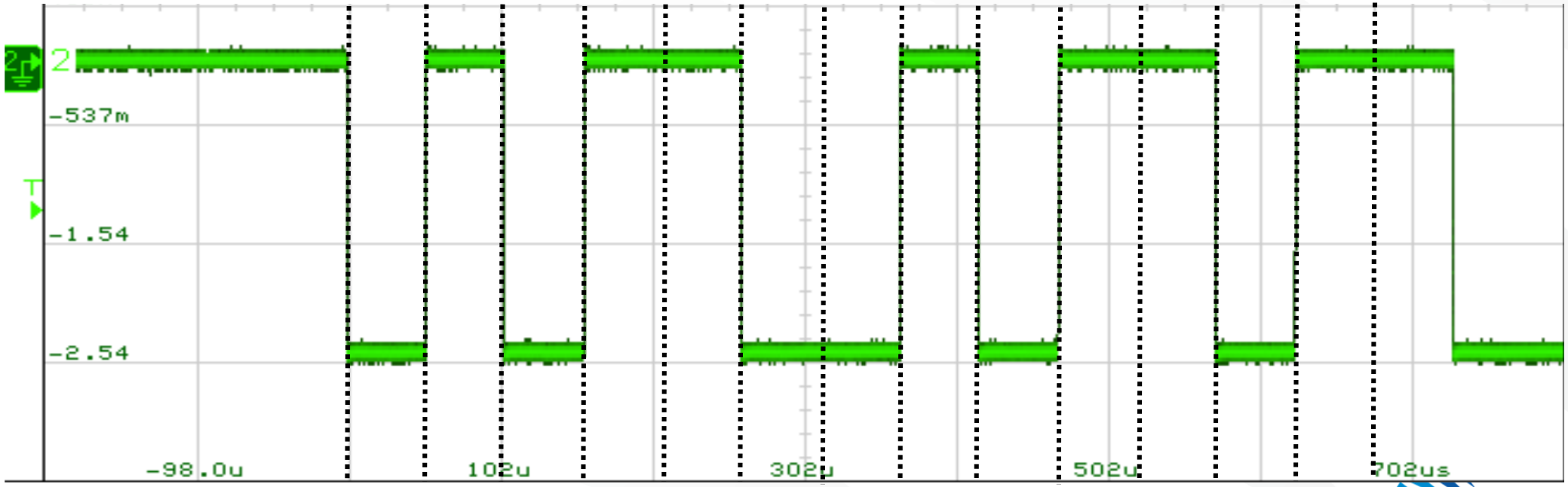
汽车串行总线解码

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



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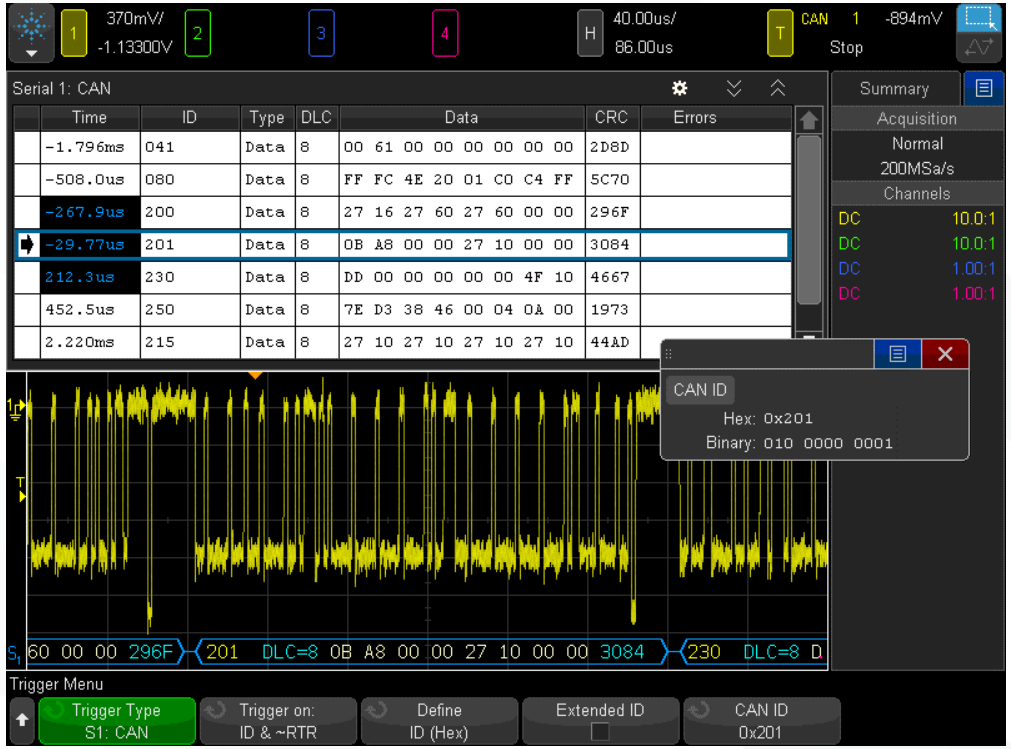
汽车串行总线解码

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?



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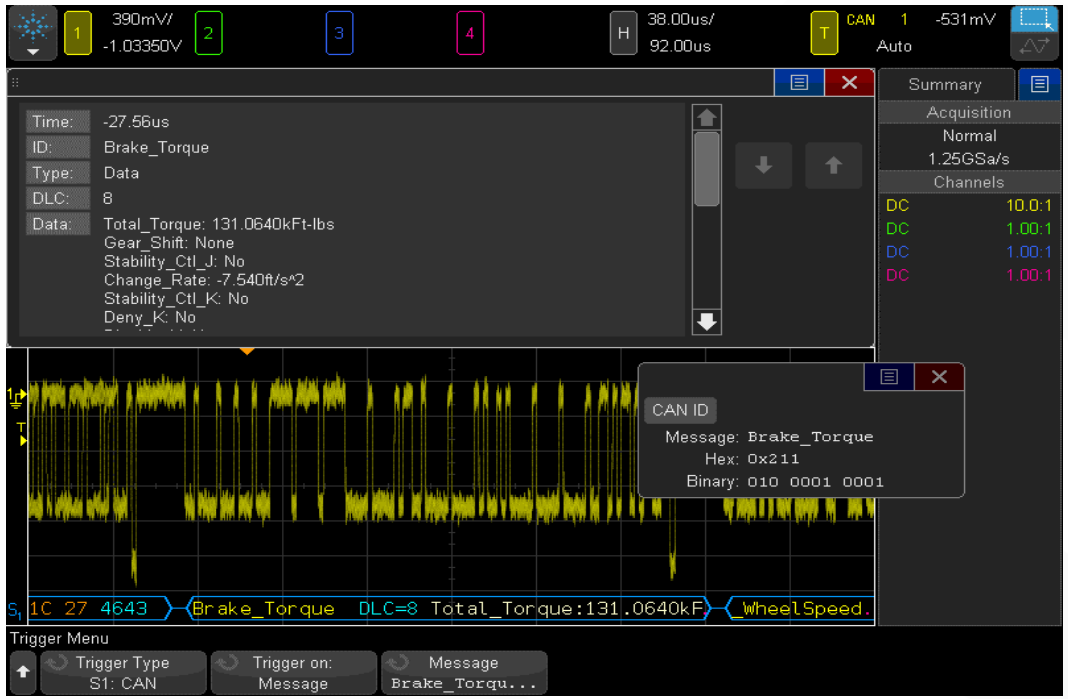
汽车串行总线解码

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/sec^2

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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

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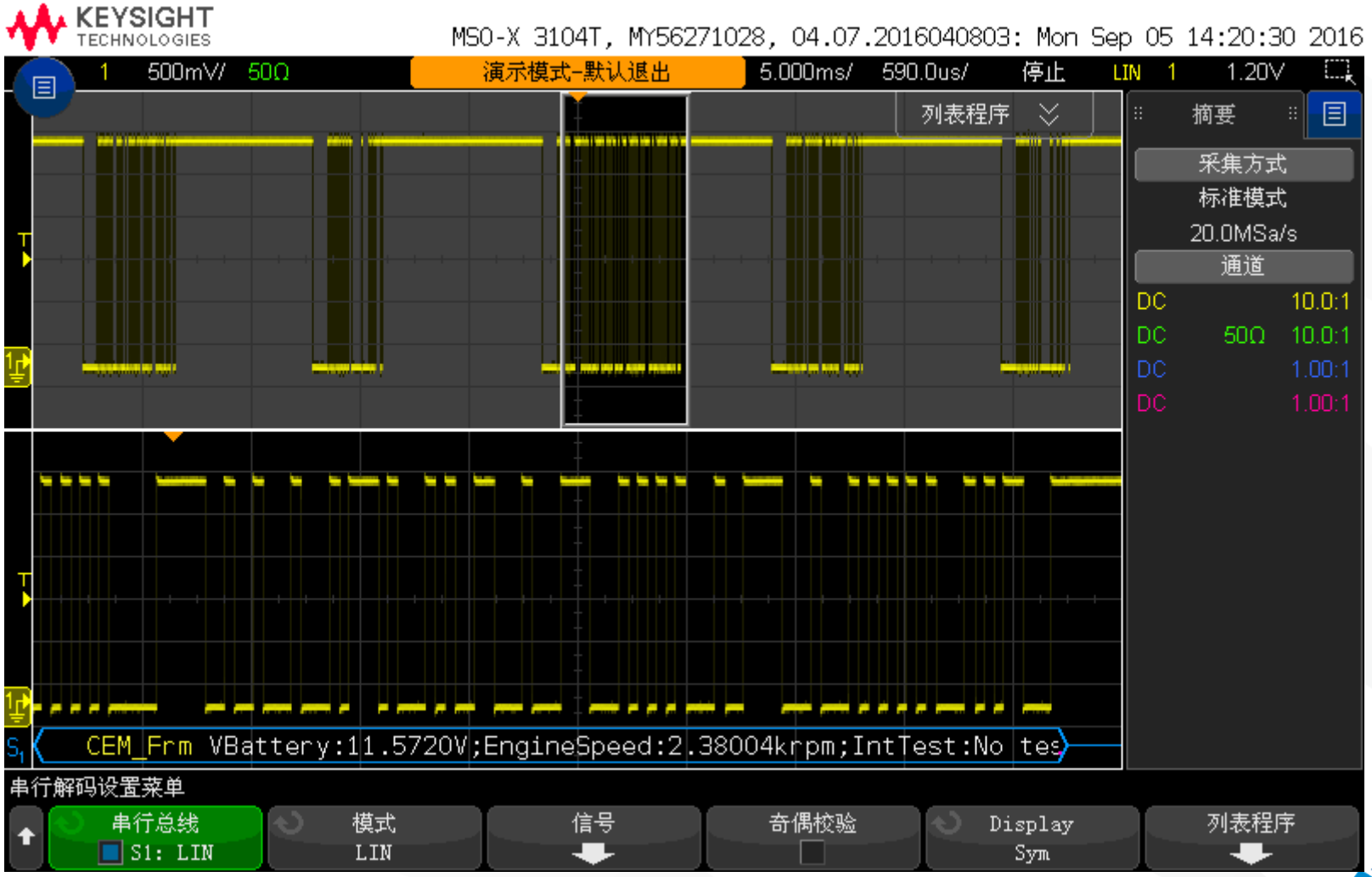
汽车串行总线解码

LIN符号解码



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汽车串行总线解码

基于符号解码的触发功能

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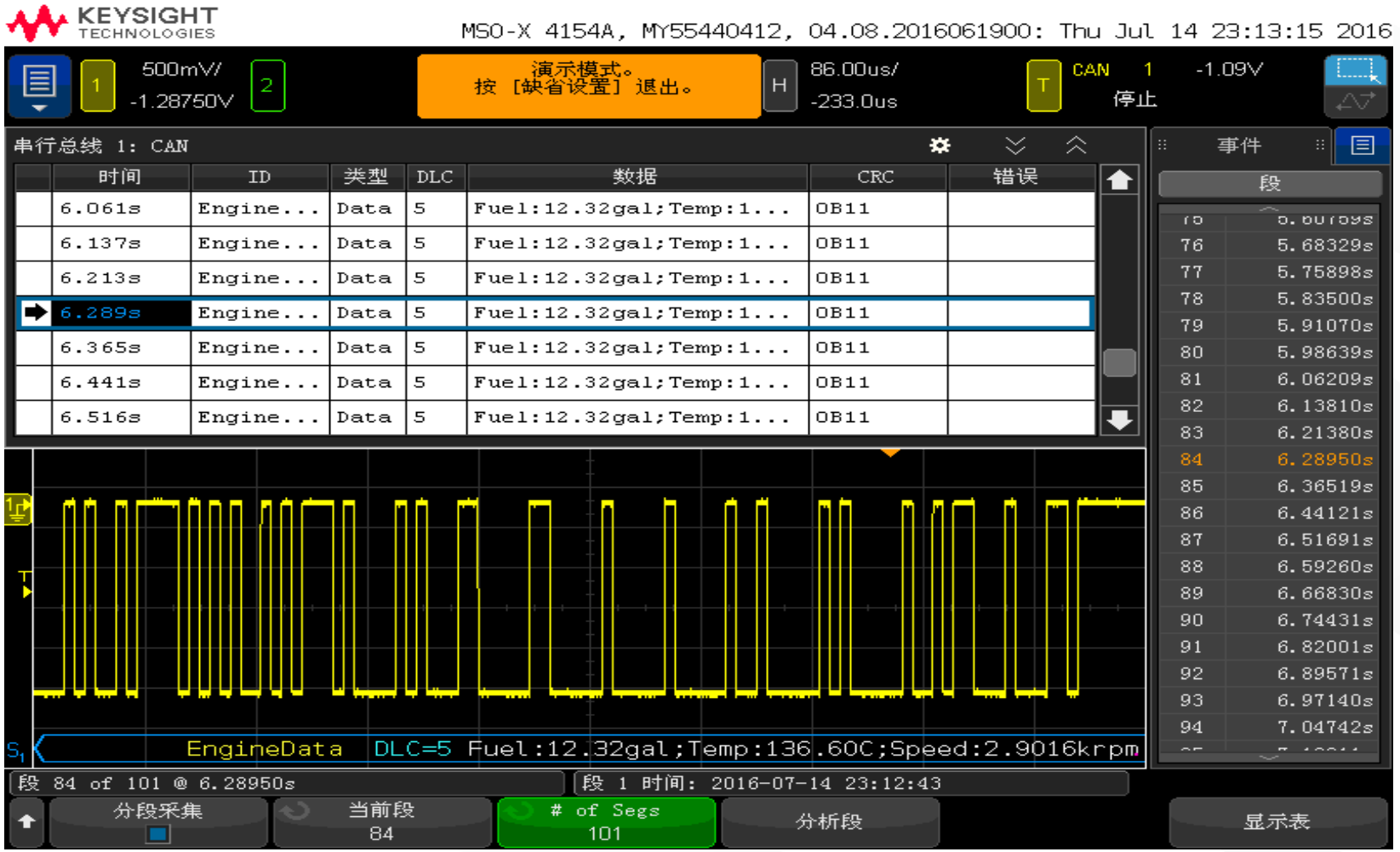
汽车串行总线解码

质量的保证：连续触发功能（分段存储）



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汽车串行总线解码

双总线解码

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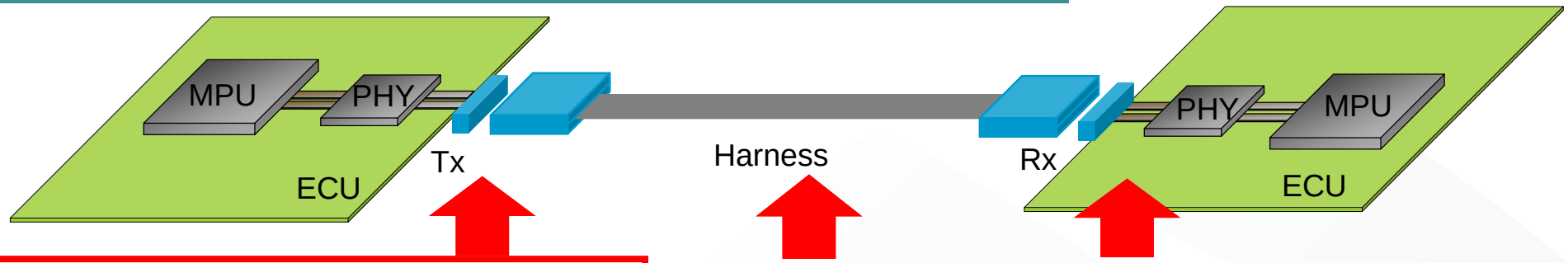
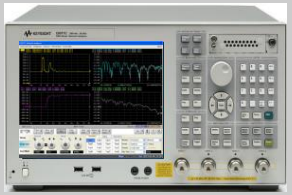
Overview of 100Base-T1 Compliance Test

100BASE-T1



Transmitter

S series Scope
for Signal Quality

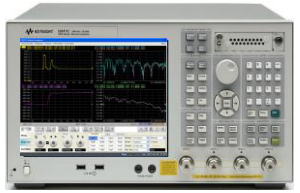


E5071C Network Analyzer
for S11

N6467B / E6961A / E6960A
Compliance Test Software

Custom Test Fixture

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

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车载以太网发射机一致性测试

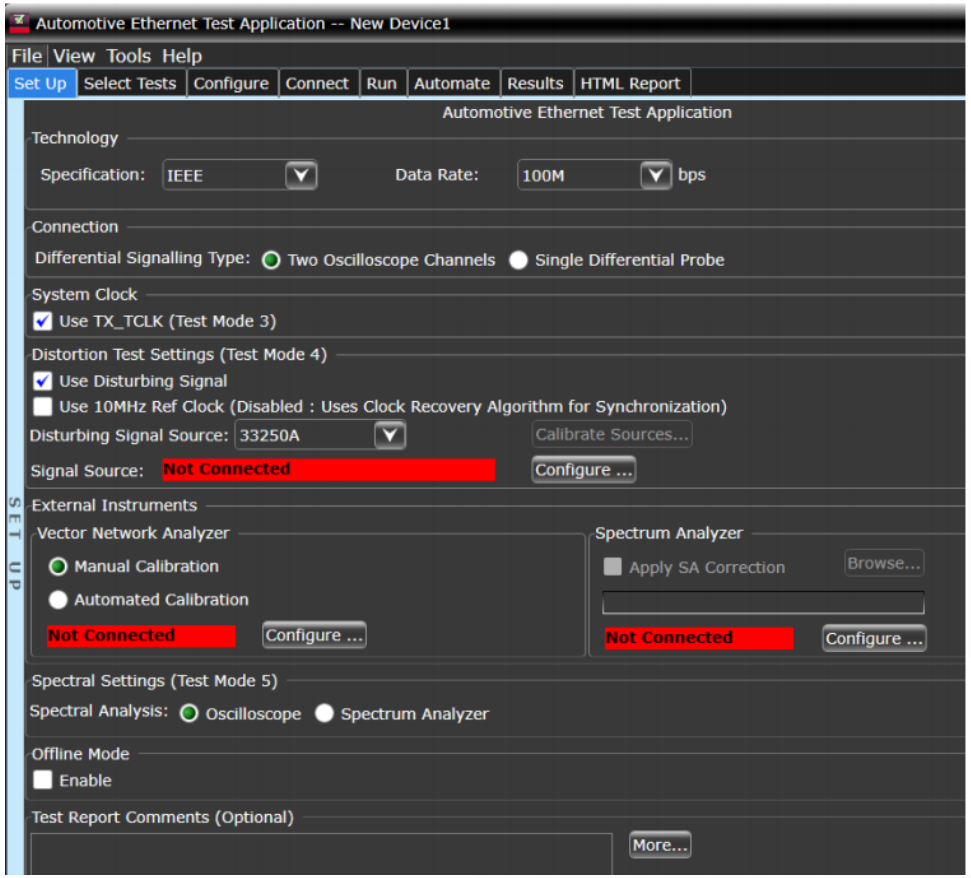
BW NEEDS FOR A 10/100/1000M TEST

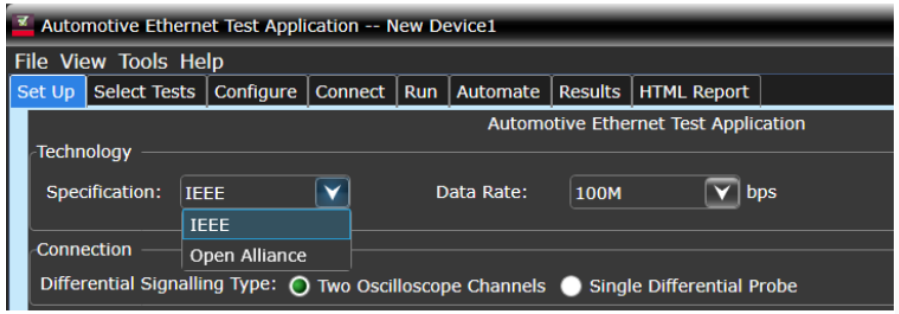
Test name	10BASE-T1S	100BASE-T1	OABR ECU	1000BASE-T1	Measurement equipment
Transmitter output droop	147.5.4.2	96.5.4.1	2.2 _01	97.5.3.1	Oscilloscope 2.5 GHz* or better
Transmitter distortion	N/A	96.5.4.2	2.2 _08	97.5.3.12	Oscilloscope + function generator†
Transmitter timing jitter (master and slave)	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	N/A	2.2 _07	N/A	Oscilloscope 2.5 GHz[1] or better

* 2.5 GHz oscilloscope will meet all specifications. If only 10 Mbps is required, a 500 MHz oscilloscope is enough bandwidth. If only 100 Mbps is required, a 1 GHz oscilloscope recommended

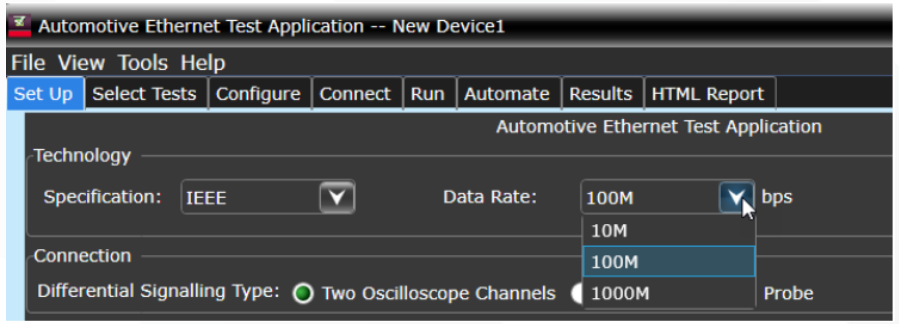
† 125 MHz signal from function generator is required for as a 1 GHz disturbing signal. for 1G. For 100Mb 12 MHz will be enough.

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

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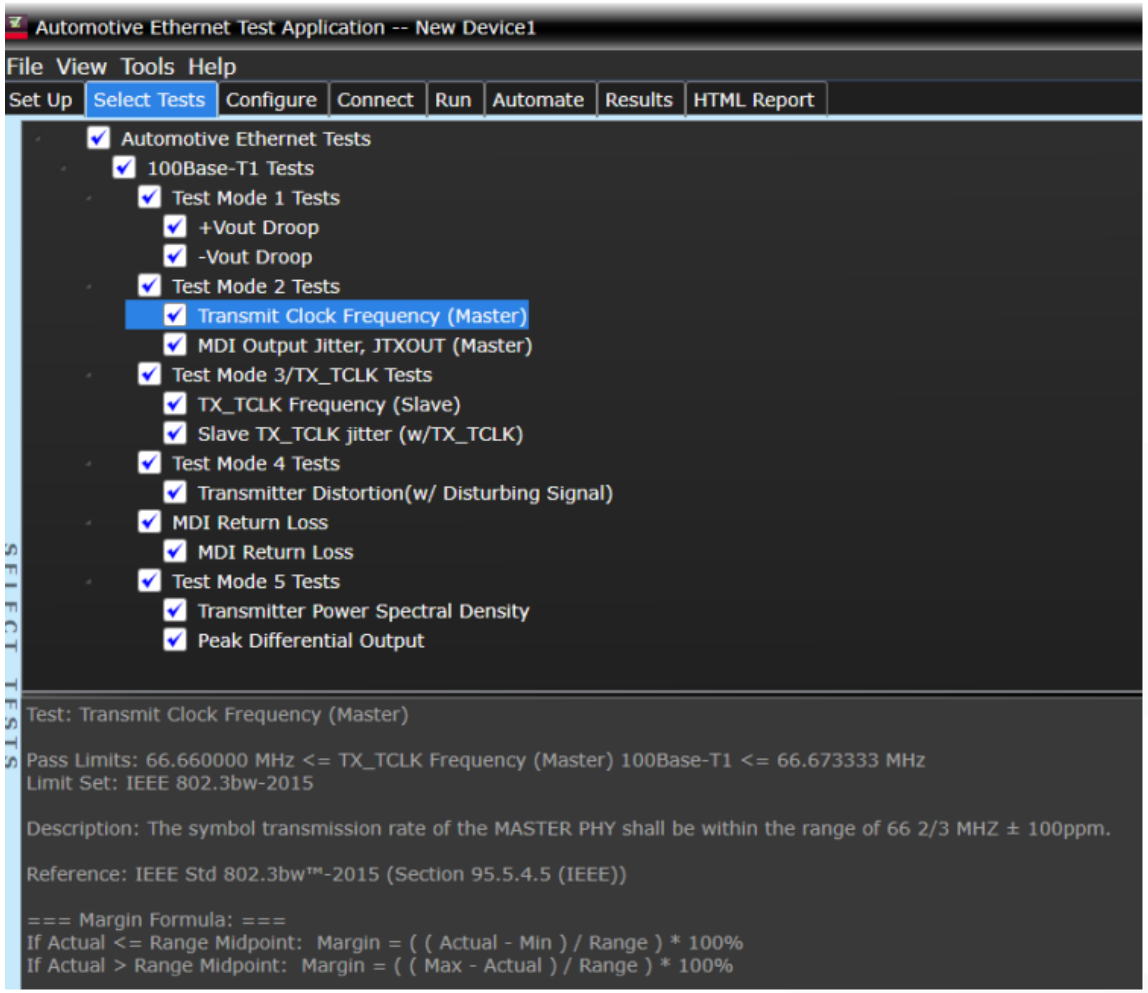
测试软件界面


Automotive Ethernet Test Application -- New Device1
File View Tools Help
Set Up
Select Tests
Configure
Connect
Run
Automate
Results
HTML Report
Automotive Ethernet Tests
100Base-T1 Tests
Test Mode 1 Tests
+Vout Droop
-Vout Droop
Test Mode 2 Tests
Transmit Clock Frequency (Master)
MDI Output Jitter, JTXOUT (Master)
Test Mode 3/TX_TCLK Tests
TX_TCLK Frequency (Slave)
Slave TX_TCLK jitter (w/TX_TCLK)
Test Mode 4 Tests
Transmitter Distortion(w/ Disturbing Signal)
MDI Return Loss
MDI Return Loss
Test Mode 5 Tests
Transmitter Power Spectral Density
Peak Differential Output
SELECT TESTS
Test: Transmit Clock Frequency (Master)
Pass Limits: 66.660000 MHz <= TX_TCLK Frequency (Master) 100Base-T1 <= 66.673333 MHz
Limit Set: IEEE 802.3bw-2015
Description: The symbol transmission rate of the MASTER PHY shall be within the range of 66 2/3 MHZ ± 100ppm.
Reference: IEEE Std 802.3bw™-2015 (Section 95.5.4.5 (IEEE))
=== Margin Formula: ===
If Actual <= Range Midpoint: Margin = ((Actual - Min) / Range) * 100%
If Actual > Range Midpoint: Margin = ((Max - Actual) / Range) * 100%

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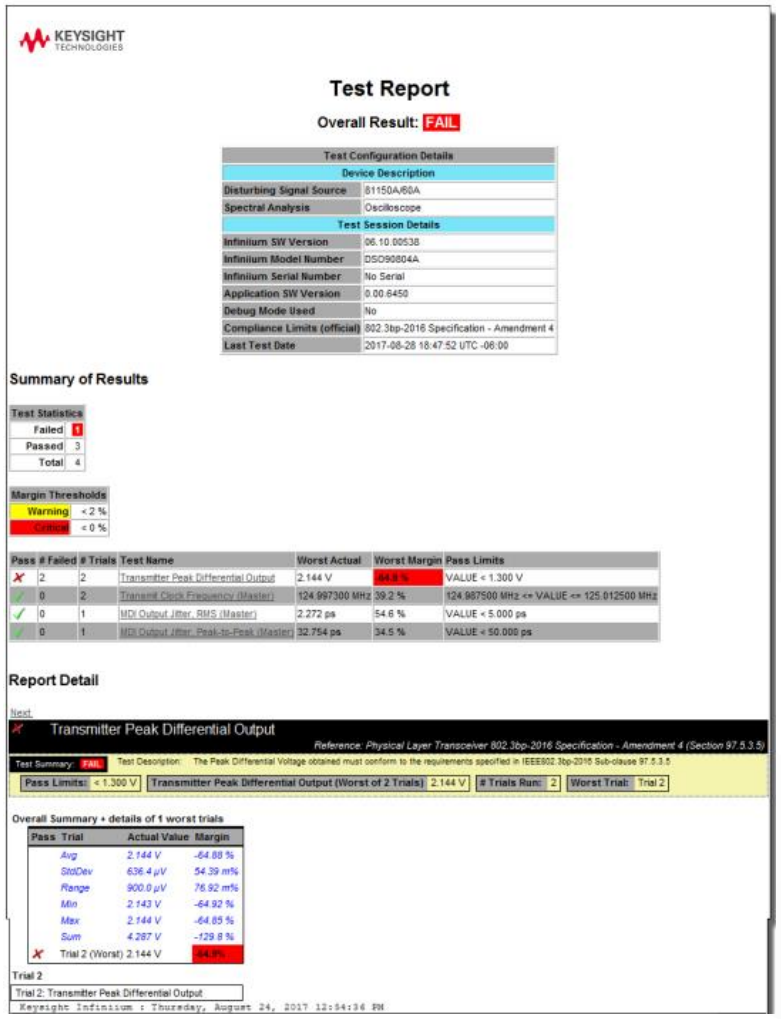
测试报告



KEYSIGHT TECHNOLOGIES

Test Report

Overall Result: FAIL

Test Configuration Details	
Device Description	
Disturbing Signal Source	81150A/60A
Spectral Analysis	Oscilloscope
Test Session Details	
Infiniium SW Version	06.10.00538
Infiniium Model Number	DSO90804A
Infiniium Serial Number	No Serial
Application SW Version	0.00.6450
Debug Mode Used	No
Compliance Limits (official)	802.3bp-2016 Specification - Amendment 4
Last Test Date	2017-08-28 18:47:52 UTC -06:00

Summary of Results

Test Statistics	
Failed	1
Passed	3
Total	4

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name	Worst Actual	Worst Margin	Pass Limits
✗	2	2	Transmitter Peak Differential Output	2.144 V	-64.8 %	VALUE < 1.300 V
✓	0	2	Transmit Clock Frequency (Master)	124.997300 MHz	39.2 %	124.987500 MHz <= VALUE <= 125.012500 MHz
✓	0	1	MDI Output Jitter, RMS (Master)	2.272 ps	54.6 %	VALUE < 5.000 ps
✓	0	1	MDI Output Jitter, Peak-to-Peak (Master)	32.754 ps	34.5 %	VALUE < 50.000 ps

Report Detail

Next

Transmitter Peak Differential Output

Reference: Physical Layer Transceiver 802.3bp-2016 Specification - Amendment 4 (Section 97.5.3.5)

Test Summary: FAIL Test Description: The Peak Differential Voltage obtained must conform to the requirements specified in IEEE802.3bp-2016 Sub-clause 97.5.3.5

Pass Limits: < 1.300 V | Transmitter Peak Differential Output (Worst of 2 Trials) 2.144 V | # Trials Run: 2 | Worst Trial: Trial 2

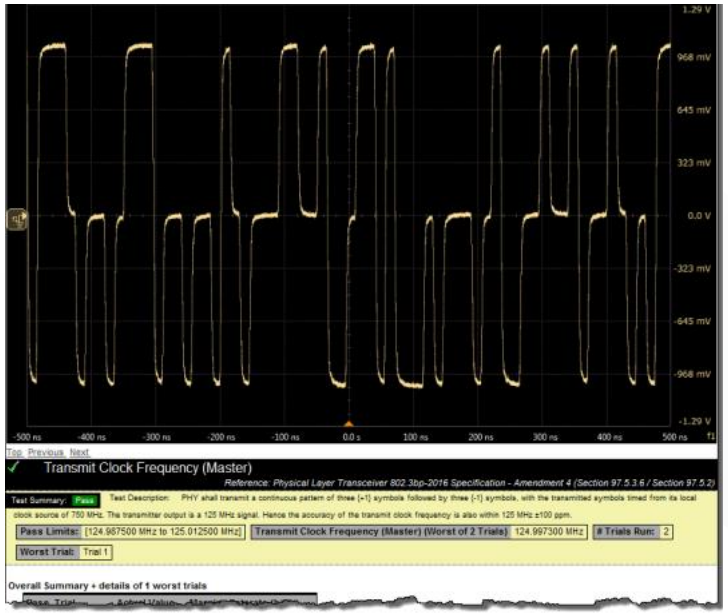
Overall Summary + details of 1 worst trials

Pass	Trial	Actual Value	Margin
	Avg	2.144 V	-64.88 %
	StdDev	636.4 µV	54.39 m%
	Range	900.0 µV	76.92 m%
	Min	2.143 V	-64.92 %
	Max	2.144 V	-64.85 %
	Sum	4.287 V	-129.8 %
✗	Trial 2 (Worst)	2.144 V	-64.8%

Trial 2

Trial 2: Transmitter Peak Differential Output

Keysight Infiniium : Thursday, August 24, 2017 12:54:36 PM



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A Range of Keysight Oscilloscopes



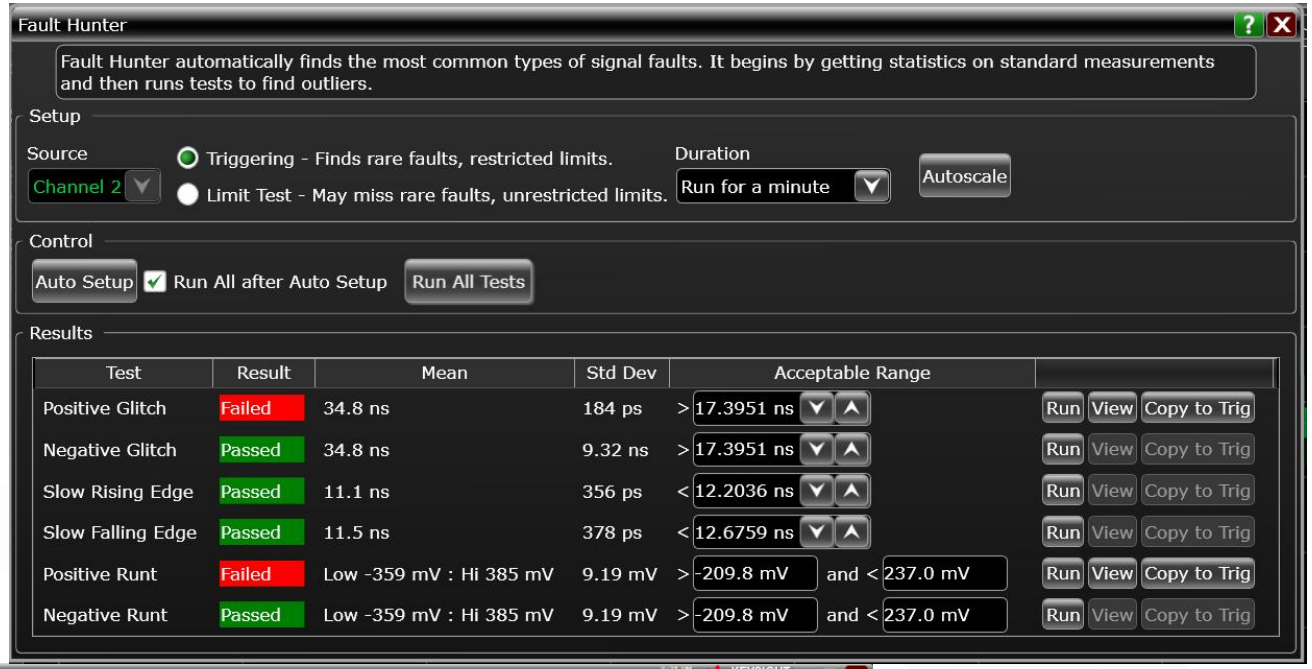


	InfiniiVision Class Scopes			Infiniium Class Scopes	
	3000T X-Series	4000 X-Series	6000 X-Series	S-Series	EXR-Series
Channels	2, 4	2, 4	2, 4	4	4, 8
Max Bandwidth	100 MHz → 1 GHz	100 MHz → 1.5 GHz [1]	1 GHz → 6 GHz [2]	500 MHz → 8 GHz [2]	500 MHz → 2.5 GHz
Sample Rate [3]	2.5 GSa/s	2.5 GSa/s	10 GSa/s	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



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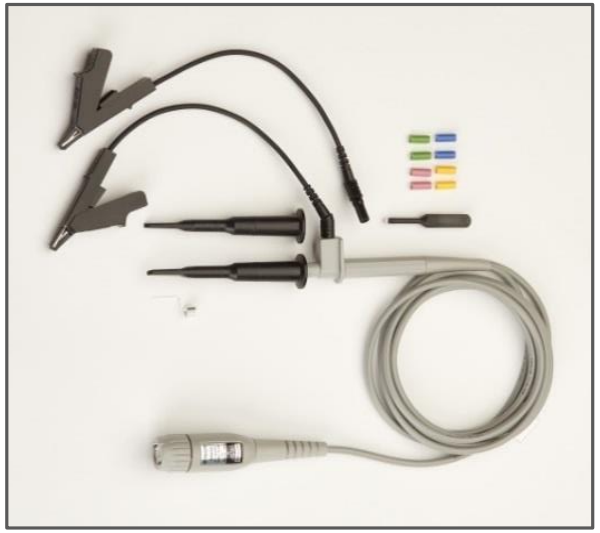
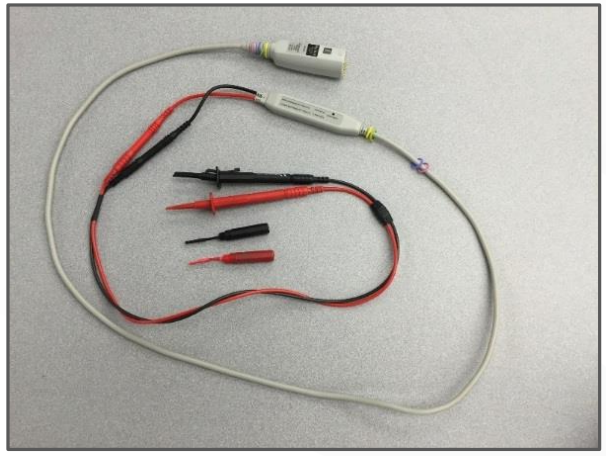
Extreme Temperature Probing Solutions

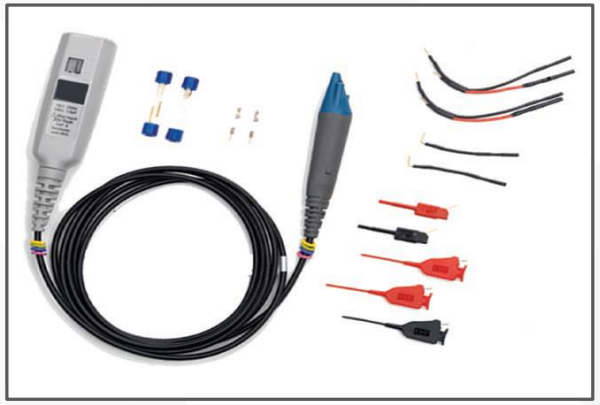
FOR TESTING IN TEMPERATURES RANGING FROM -40° TO +85° C



N7007A
400 MHz passive probe (2 meters)



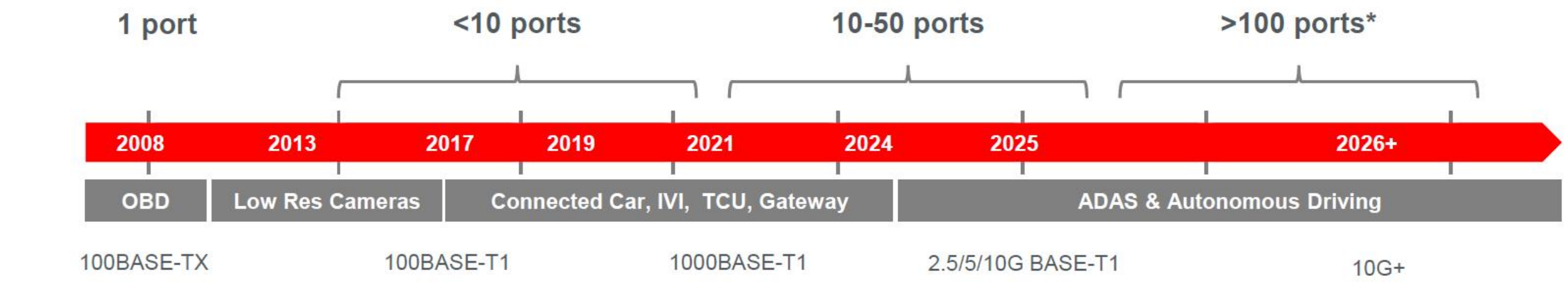
N7013A
Differential probe extension cables
(>2 meters w/ N2818A)

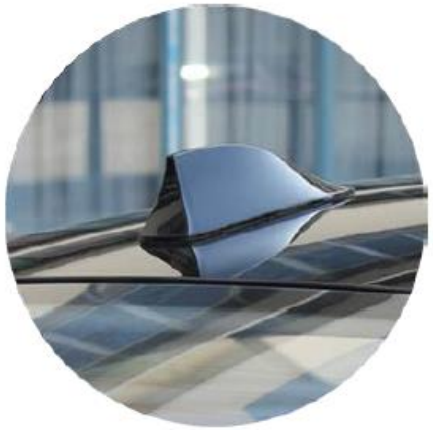


N2797A
1.5 GHz SE active probe (2 meters)

东方中科

Trends in Automotive Ethernet

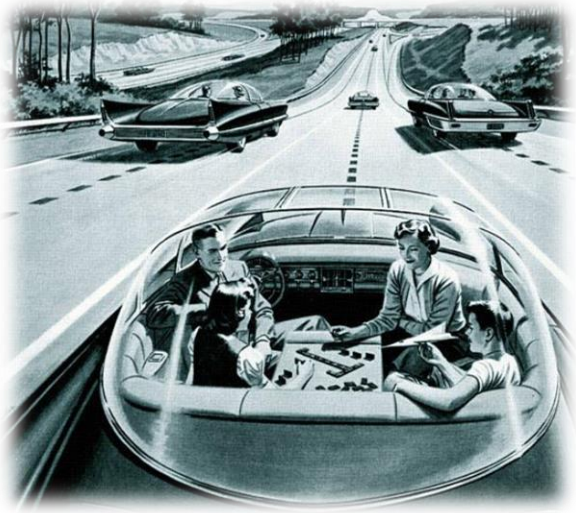




东方中科

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
- 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

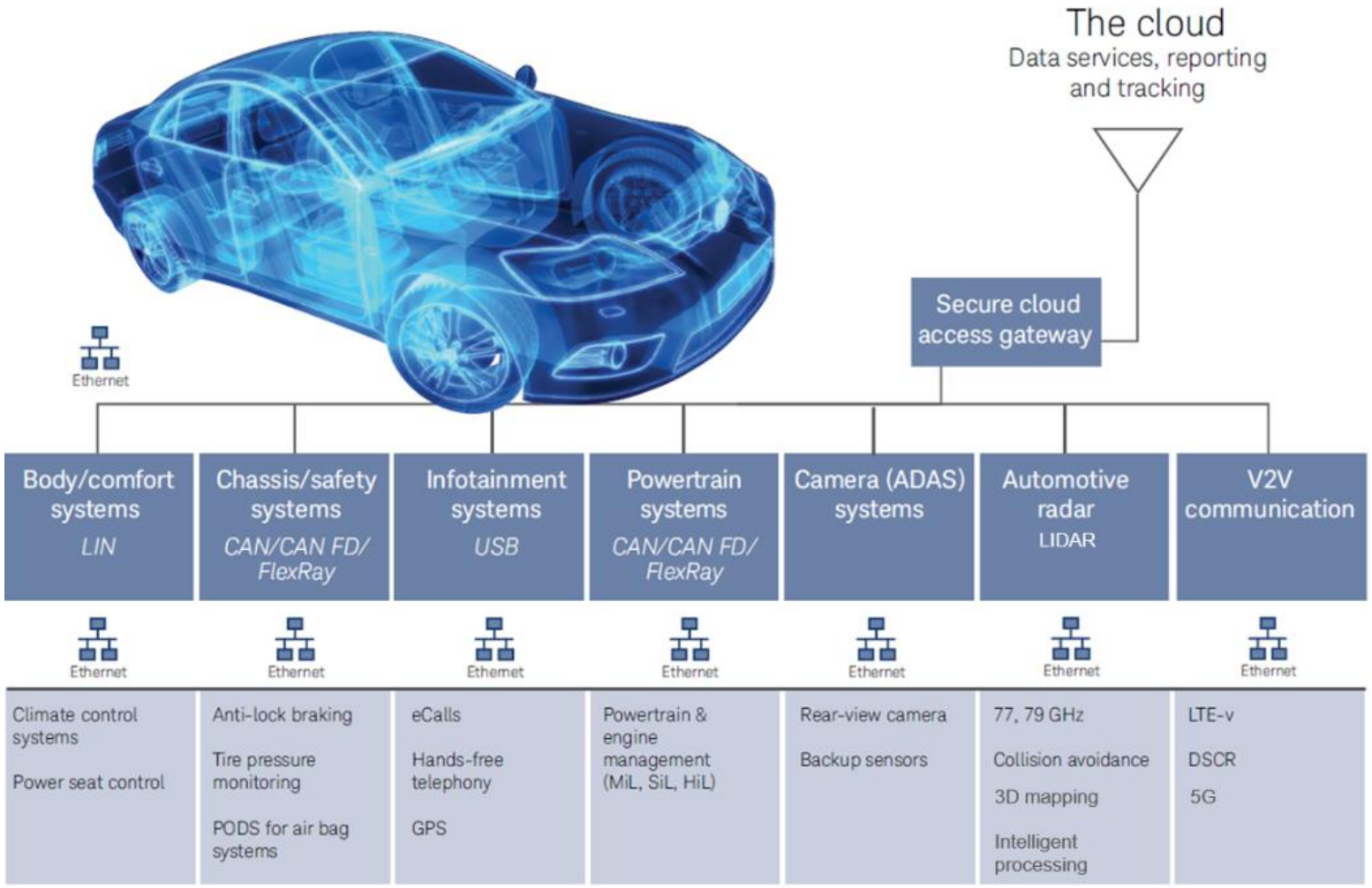
- CISPR25 Class 5
- PAM3 for noise immunity

Proven technology

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

Automotive Ethernet link everywhere

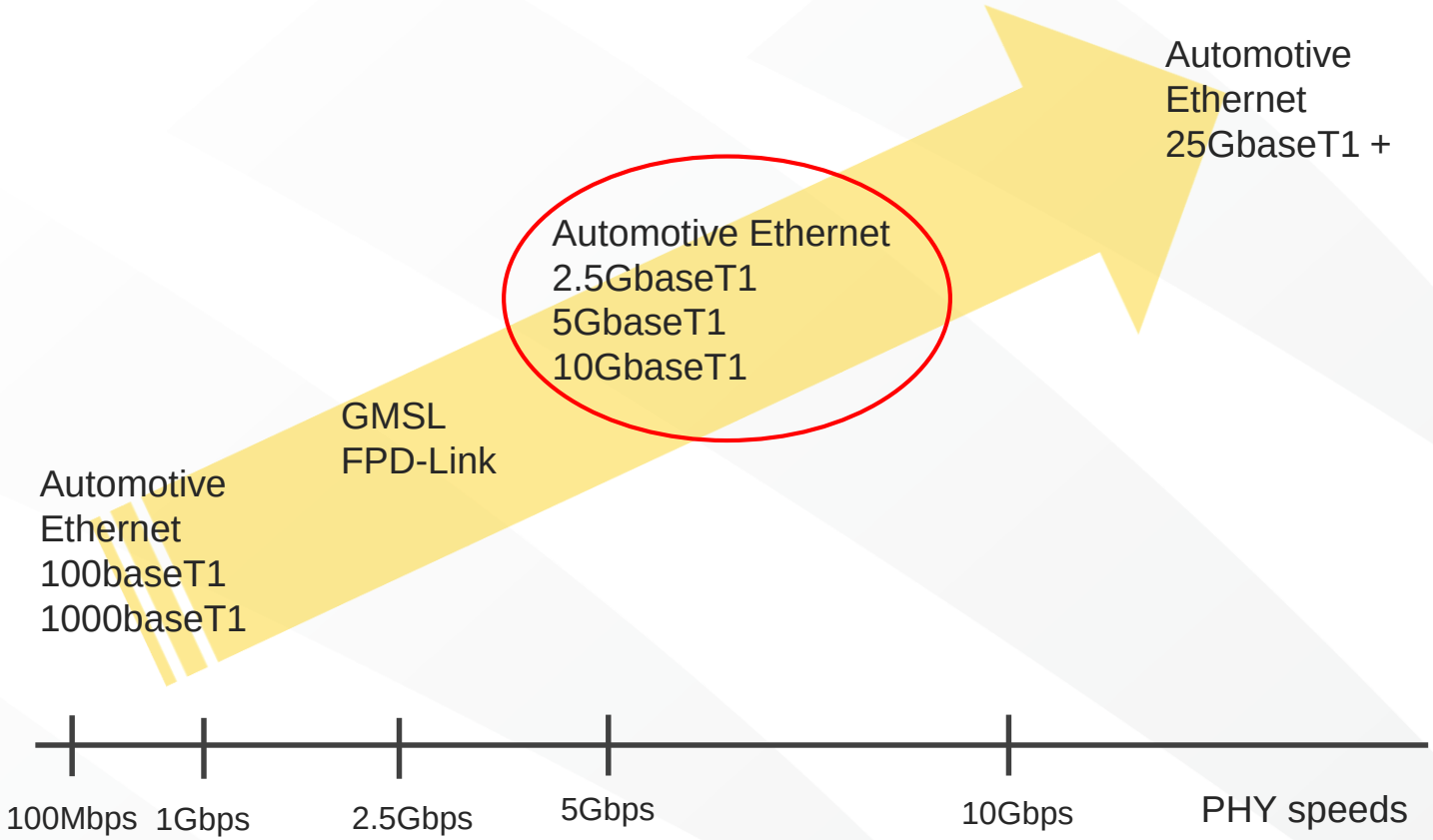
TYPICAL NODE



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

Receiver (Rx)
- release 2.0, TBD

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

* Coming soon

东方中科

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

NEW