



泰克移动终端核心总线MHL/MIPI解决方案

李志斌
应用工程师

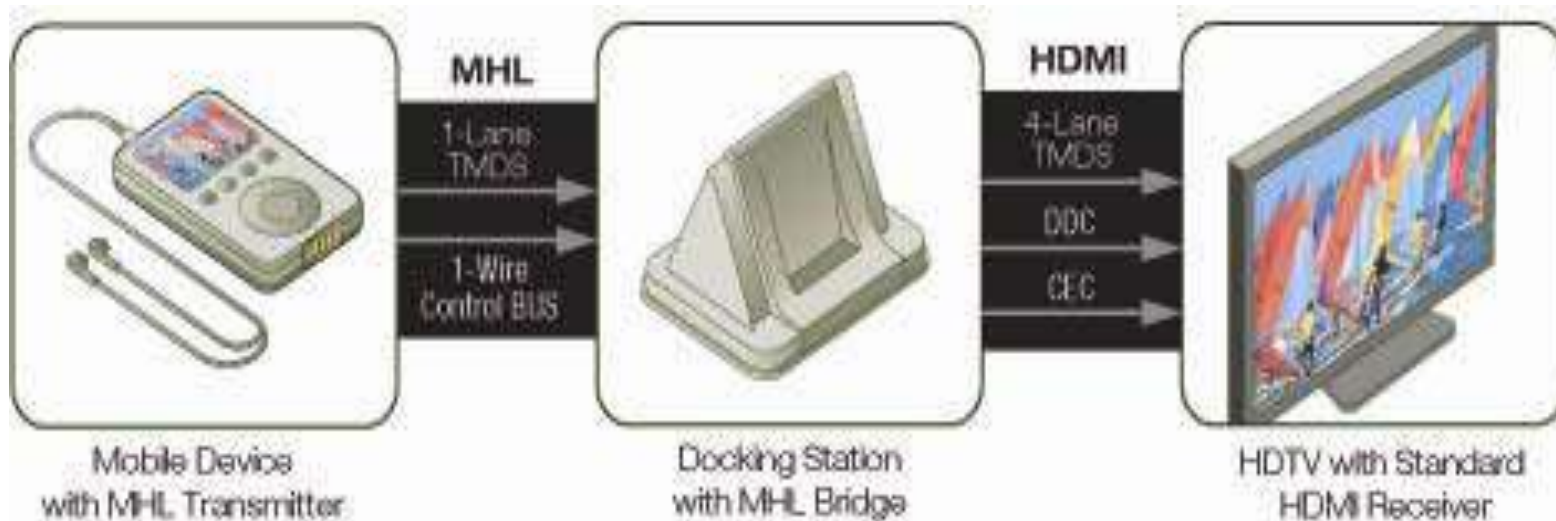


日程安排（约45分钟）

- 背景信息
- MHL
 - Tx、Rx、 protocol
- MIPI
 - D-phy: Tx、 Rx、 Protocol
 - M-phy: Tx、 Rx、 Protocol
- 总结



MHL: Mobile High-Definition Link



- **MHL:** 利用更少的走线，通过手机、相机和播放器向更大屏幕的显示终端传输高清音频、视频信号
- 该技术支持将手机设备的1080p分辨率高清视频通过现有接口直接输出
- 与MHL-HDMI桥接，带有MHL接口的手机可以变为一个完全自主的HDMI播放源，然后接入电视上的标准HDMI接口

MHL: Mobile High-Definition Link



- MHL标准功能：通过单电缆与低引脚数（5-pin）接口来实现输出高达1080p高清晰度（HD）视频和数字音频，同时为设备充电
- 现有支持MHL功能的手机如：三星i9300/S2/S3/S4/Note2、Sony Xperia系列、HTC one、小米2S、魅族MX2、华为等

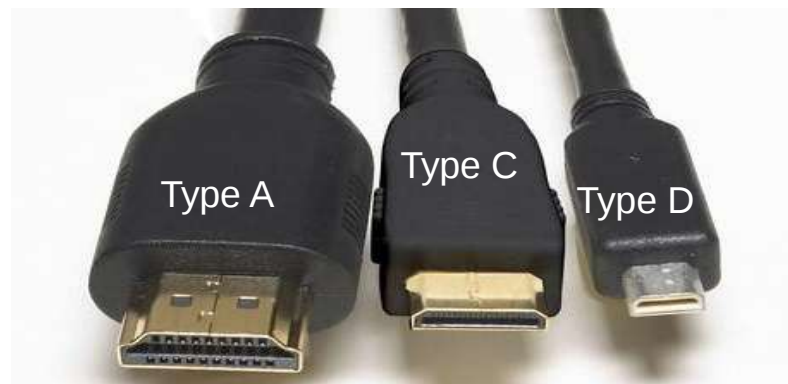


MHL: Mobile High-Definition Link



■ HDMI接口:

- Type A (标准HDMI, PC/电视)
- Type C (mini HDMI, DV/相机等)
- Type D (Micro HDMI, 部分手机)



■ 与HDMI相比:

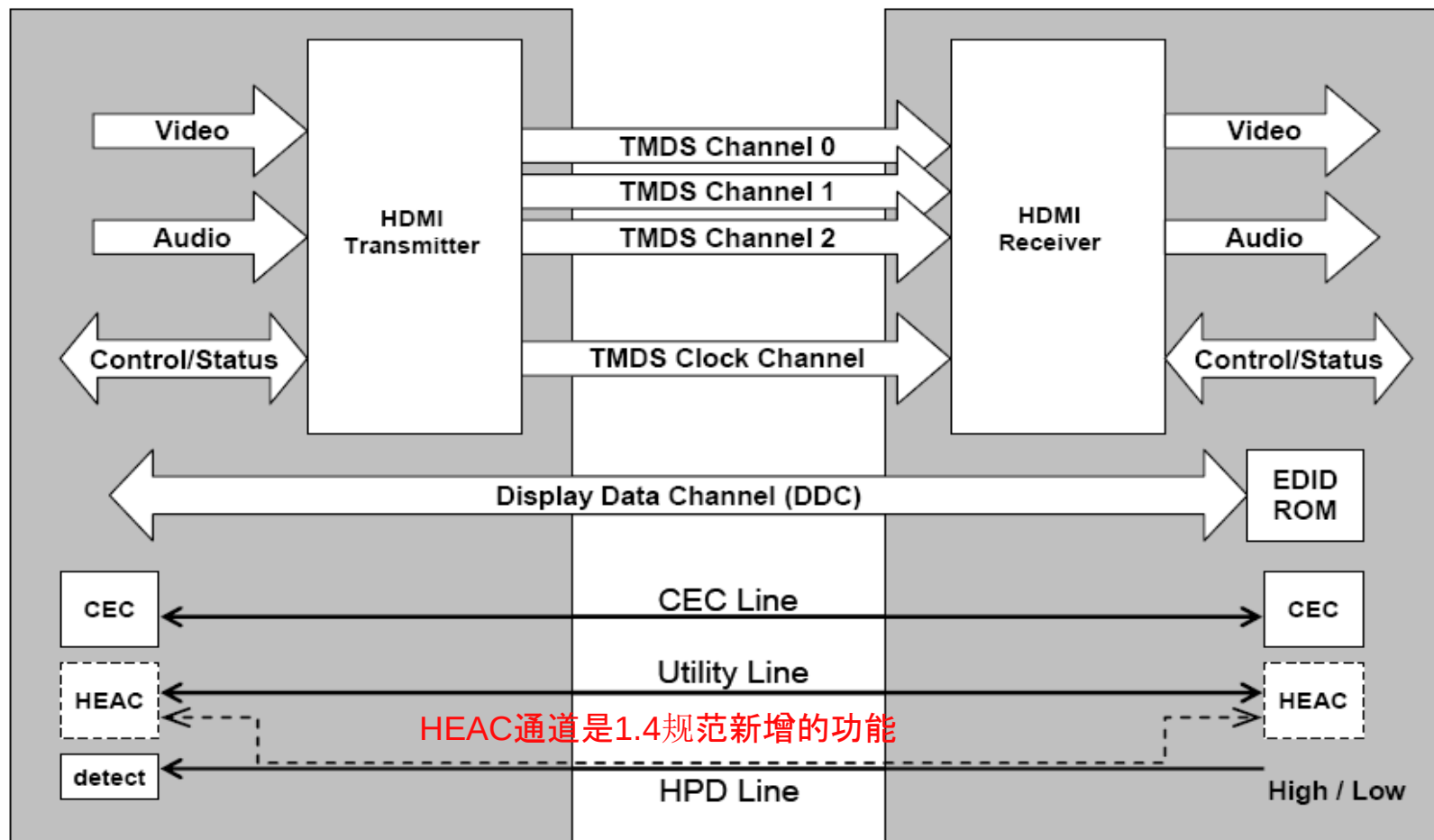
- 物理上兼容Micro USB的MHL明显可以提供更少的接线
- 同时提供相对小的尺寸和空间, **HDMI 19pin VS MHL 5pin**
- MHL可以直接充电, HDMI需要另外USB口供电

Connector type ¹	HDMI			Micro USB
	Type A	Type C	Type D	
Height (receptacle)	About 5.55mm ²	3.2mm	2.8mm	2.94mm
Width (receptacle)	About 15mm ²	11.2mm	6.4mm	7.8mm
Pin count	19	19	19	5
Pin pitch (horizontal)	0.5mm	0.4mm	0.4mm ³	0.65mm

MHL: Mobile High-Definition Link



HDMI接口走线定义



MHL: Mobile High-Definition Link



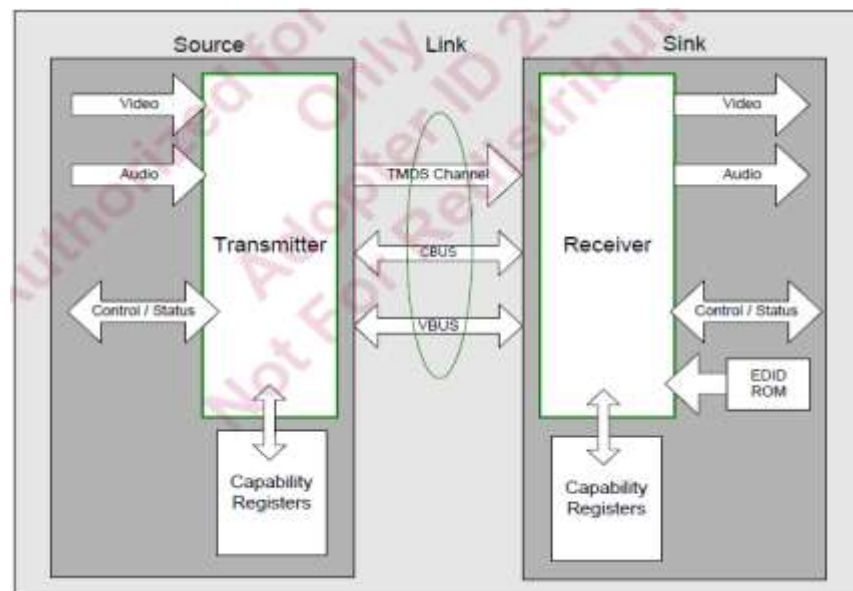
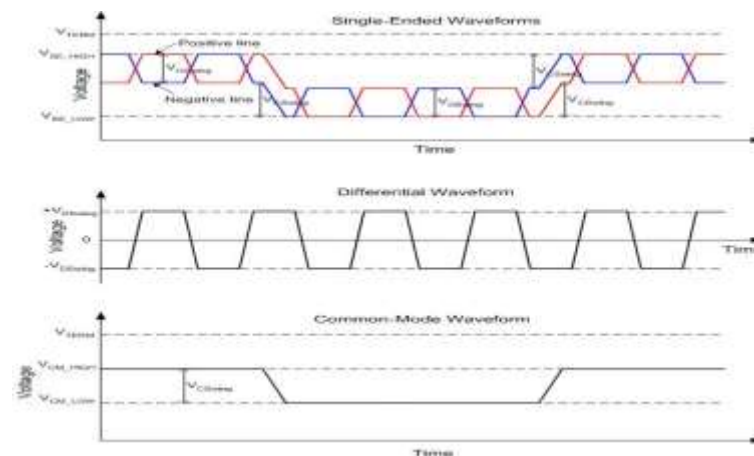
- MHL协会成立于2009年9月份, 组成员如下:

- NOKIA
- SAMSUNG
- Silicon Image
- Sony
- Toshiba

- Tektronix is a **Contributor adopter** and actively involved in defining the CTS Specs.

- 一共只用了五条线:

- VBUS: 电压供电
- CBUS: EDID/HDCP信息读取
- D+/D-
- GND接地



MHL: Mobile High-Definition Link



- Tektronix 全程参与了MHL协会关于规范的修订过程:
 - 最高数据率仍为**3Gbps**.
 - Packed Pixel实现方式没有改变, 3D功能没有改变
 - 最高**10W**充电支持, 支持**4k**超清格式
 - 对于源端的时钟抖动和数据眼图测试项目来说, 有了重新定义:
 - 这些测试将采用单端方式, 且在我们分析之前, 会在数据通道上加入最差时延滤波器来考察其影响
 - 接收端抖动容限测试 (**Jitter Tolerance**) 需要在有没有**cable emulator**的情况下都验证
 - 新的线缆电气特性引入:
 - 最小时钟摆幅测试
 - 眼图测试
 - 支持直接插拔源端和终端设备

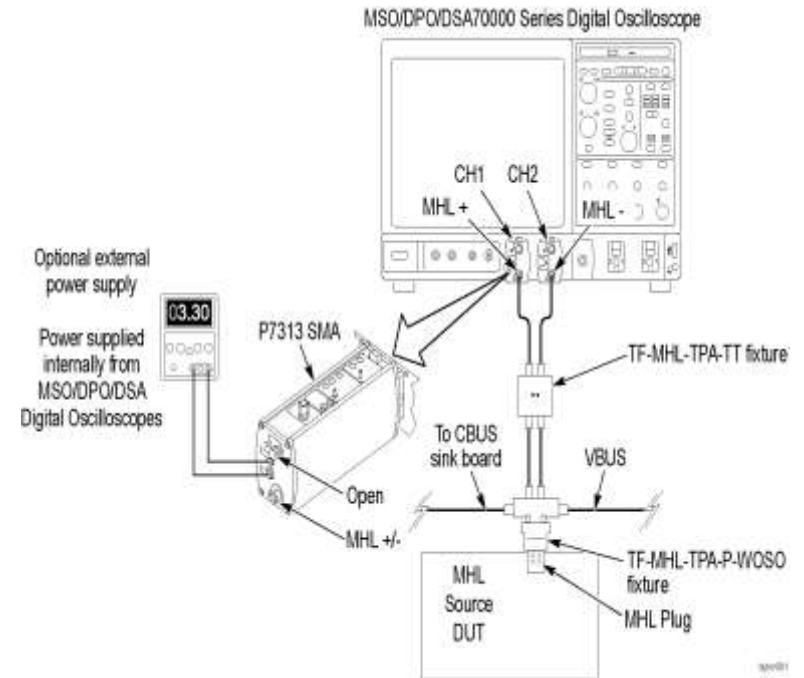
泰克MHL完整方案



■ MHL Tx Tests (Scope BW $\geq$ 8GHz)

- 3.1.1.1 Standby Output Voltage VOFF
- 3.1.1.2 Single-ended High-level Voltage VSE_HIGH
- 3.1.1.3 Single-ended Low-level Voltage VSE_LOW
- 3.1.1.4 Differential Output Swing Voltage VDFSWING
- 3.1.1.5 Common Mode Output Swing Voltage VCMSWING
- 3.1.1.6 Differential Rise and Fall Times TR_DF, TF_DF
- 3.1.1.7 Common Mode Rise and Fall Times TR_CM, TF_CM
- 3.1.1.8 Differential Intra Pair Skew TSKEW_DF
- 3.1.1.10 MHL Clock Duty Cycle in Normal mode (not needed for CTS2.1)
- 3.1.1.11 MHL Clock Jitter in Normal mode (replaced by 3.1.1.17)
- 3.1.1.12 MHL Data Eye Diagram in Normal mode (replaced by 3.1.1.18)
- 3.1.1.14 MHL Clock Duty Cycle in PackedPixel mode
- 3.1.1.15 MHL Clock Jitter in PackedPixel mode (replaced by 3.1.1.19)
- 3.1.1.16 MHL Data Eye diagram in Packed Pixel mode (replaced by 3.1.1.20)
- 3.1.1.17 TP2 Clock Jitter in Normal mode (new test for CTS 1.3/2.1)
- 3.1.1.18 Data Eye Diagram in Normal mode (new test for CTS 1.3/2.1)
- 3.1.1.19 TP2 Clock Jitter in Packed Pixel mode (new test for CTS1.3/2.1)
- 3.1.1.20 Data Eye Diagram in Packed Pixel mode (new test for CTS1.3/2.1)

MHL
Mobile High-Definition Link



单端和差分对内时延测试: 6Tests

** C-Bus Sink and Source Board is needed for hand shaking and is available from Tektronix

泰克MHL完整方案



TekExpress MHL - (Untitled)* Options

1 DUT

DUT ID: DUT001

Device: MHL Physical Layer Solution

Suite: MHL Transmitter Version: CTS 1.3/2.1

☒ Acquire live waveforms ☐ Use pre-recorded waveform files

View: Compliance

Device Profile

Pixel Mode: Both ☒ Direct Attach

Termination Source: Internal

24 Bits

Low Data Rate (Gbps): 0.75

High Data Rate (Gbps): 2.22

Packed Pixel

High Data Rate (Gbps): 2.97

VTerm

Min (V): 3.135

Max (V): 3.465

Compensation Factor

MHL+: 1.2

MHL-: 1.2

Signal Threshold

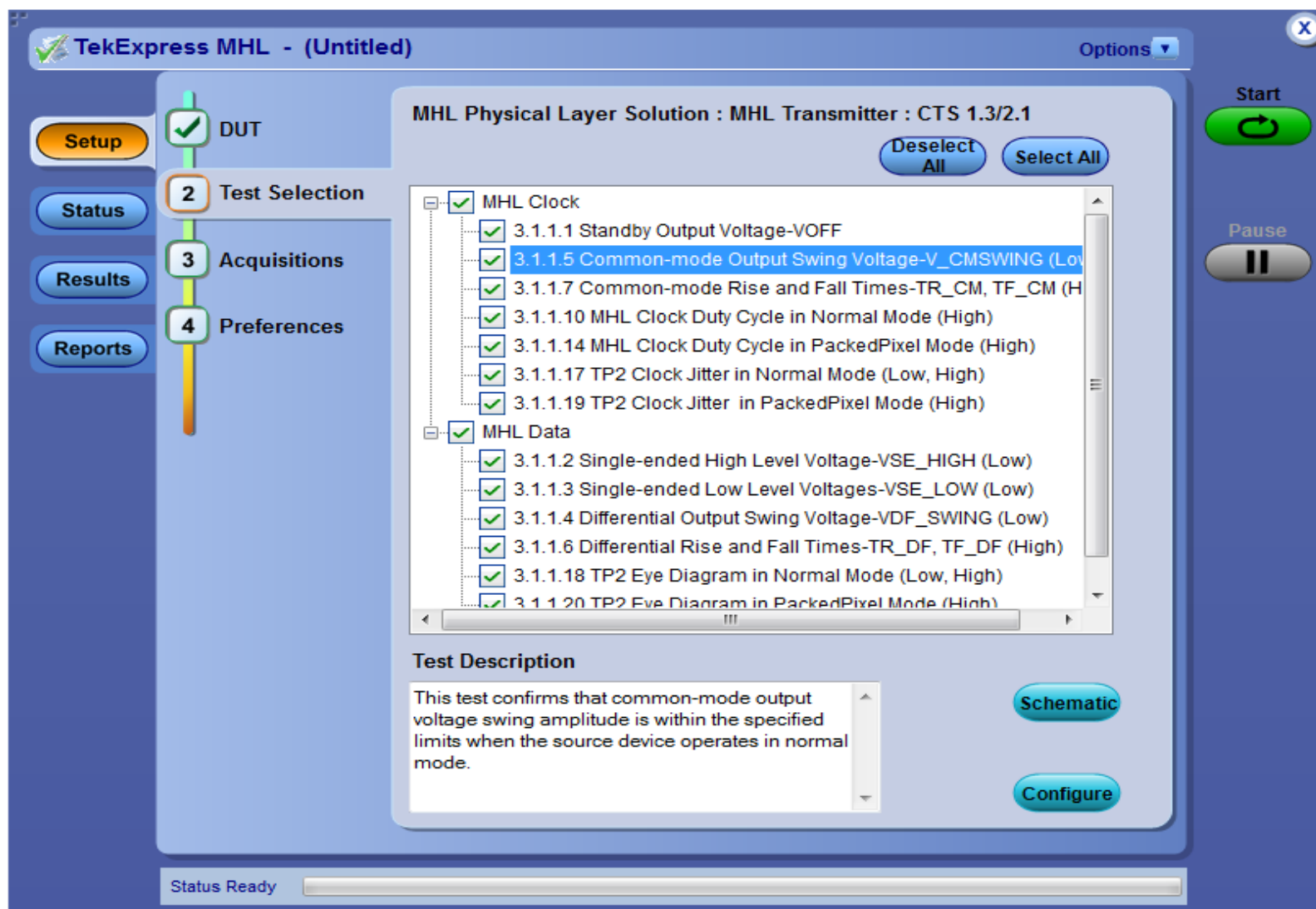
Min(mv): 250

Start

Pause

Status Ready

泰克MHL完整方案



泰克MHL完整方案



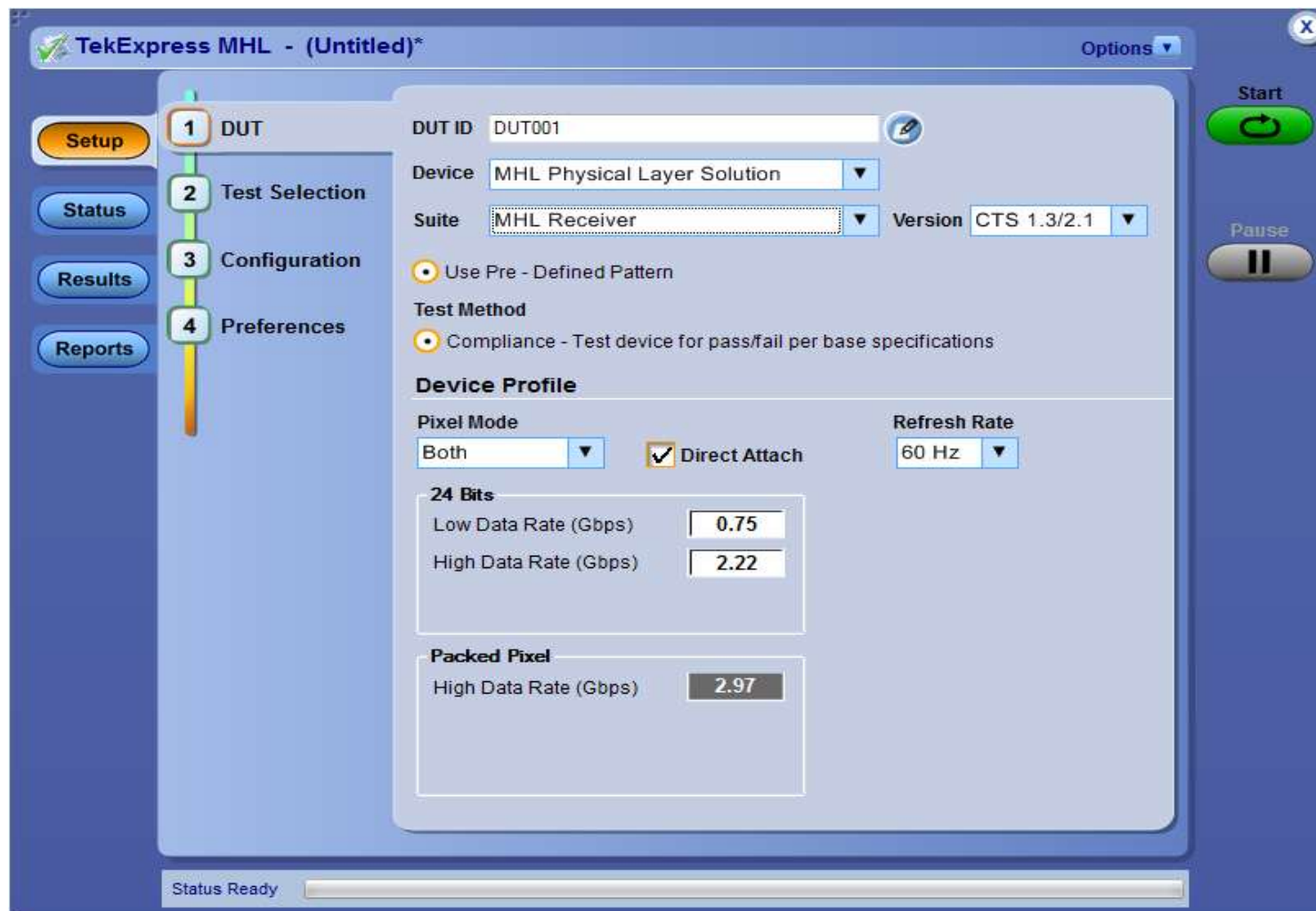
MHL Receiver Tests (supports Direct Attach Device testing)

- 4.1.1.1 Input Signal DC Voltage Level Tolerance
- 4.1.1.2 Input Signal Minimum and Maximum Swing Voltage Level Tolerance
- 4.1.1.3 Intra Pair Skew Tolerance
- 4.1.1.4 Jitter Tolerance in Normal mode
- 4.1.1.8 Jitter Tolerance in PackedPixel mode

MHL Dongle Tests

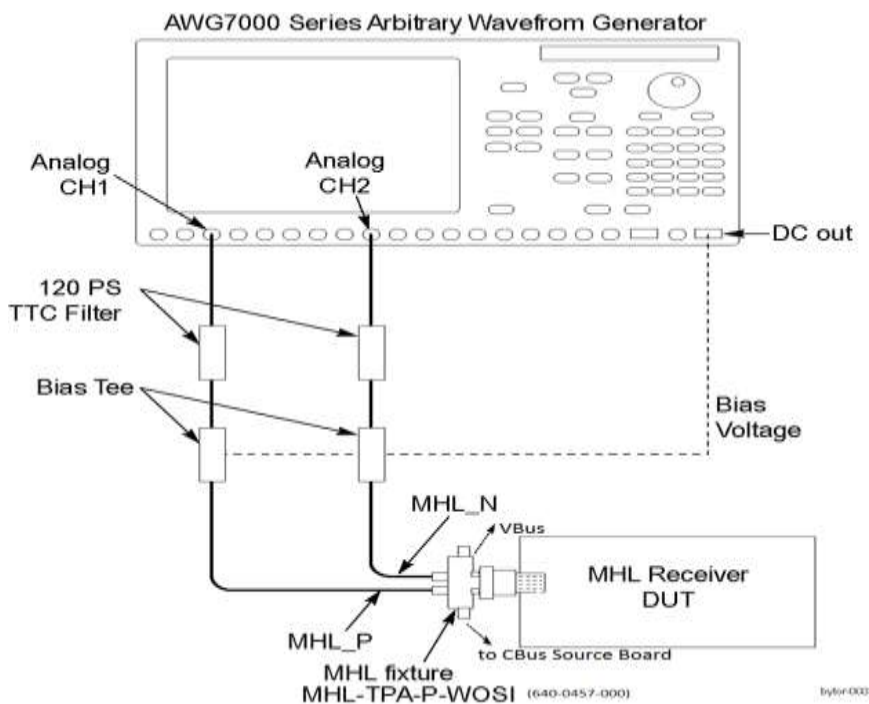
- 5.1.1.1 Input Signal Single-ended Voltage Level Tolerance
- 5.1.1.2 Input Signal Minimum and Maximum Swing Voltage Level Tolerance
- 5.1.1.3 Intra Pair Skew Tolerance
- 5.1.1.4 Jitter Tolerance in Normal mode
- 4.1.1.9 Jitter Tolerance in PackedPixel mode

泰克MHL完整方案

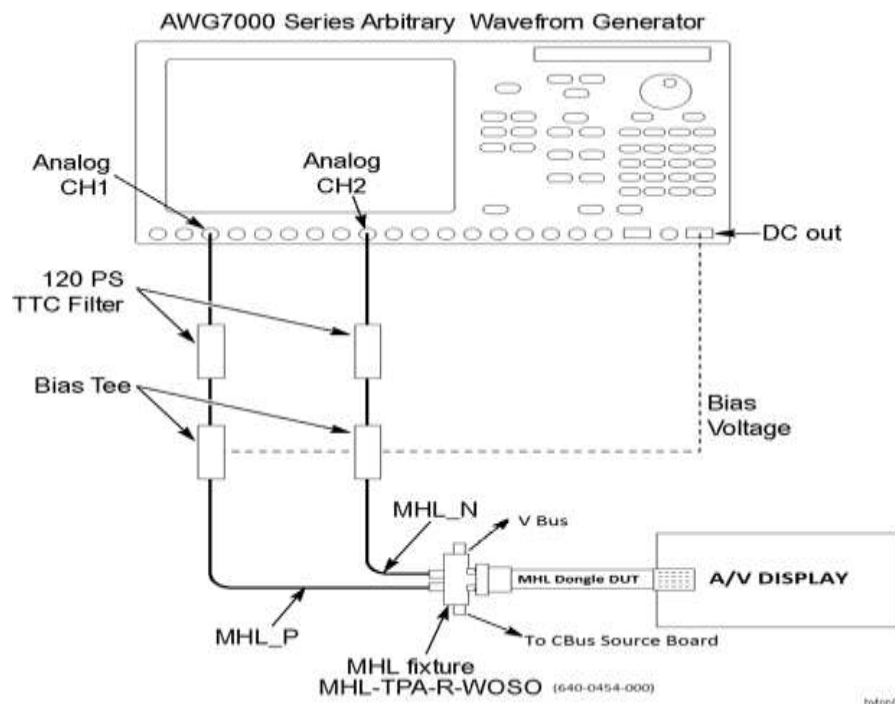


MHL接收端测试基于泰克AWG7k/70K等任意波形发生器的直接综合模拟功能

Test Setup for Sink Tests



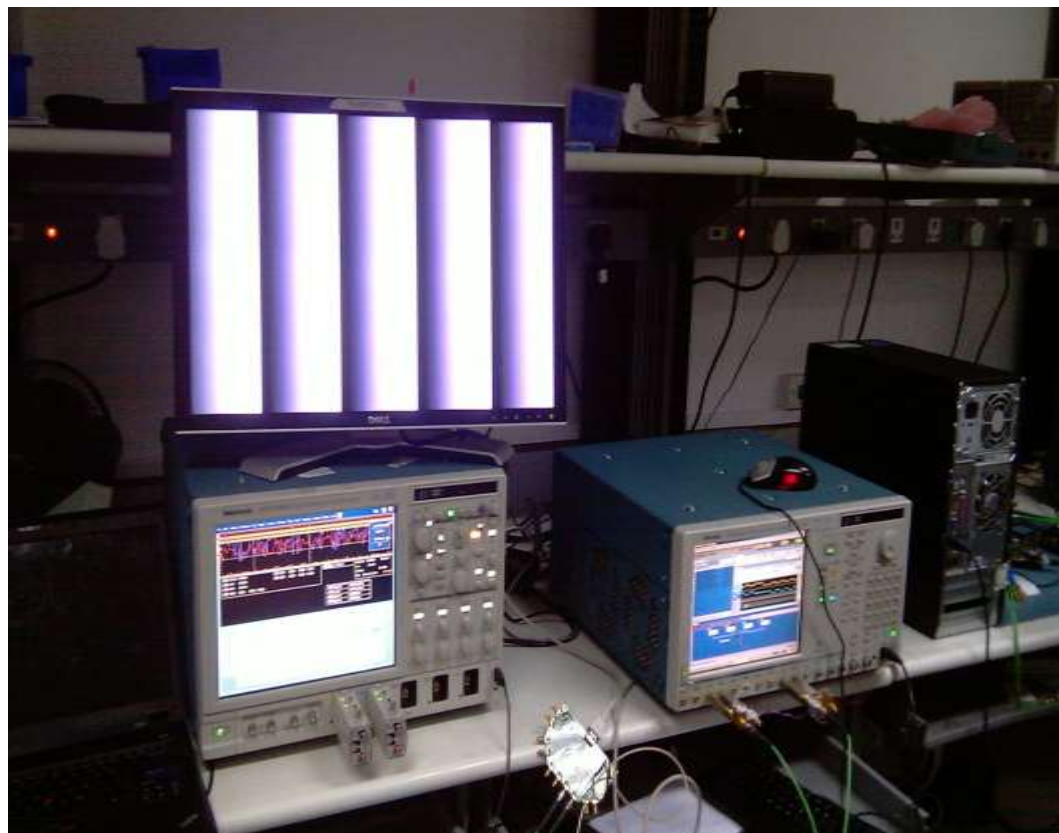
Test Setup for Dongle Tests



泰克MHL完整方案



- 基于示波器和AWG任意波形发生器的协同工作以及AWG的强大直接综合模拟能力
- 与之前HDMI sink端测试类似，通过AWG模拟加压力（抖动、噪声等损伤信号）的信号来衡量接收端对此信号的容忍能力

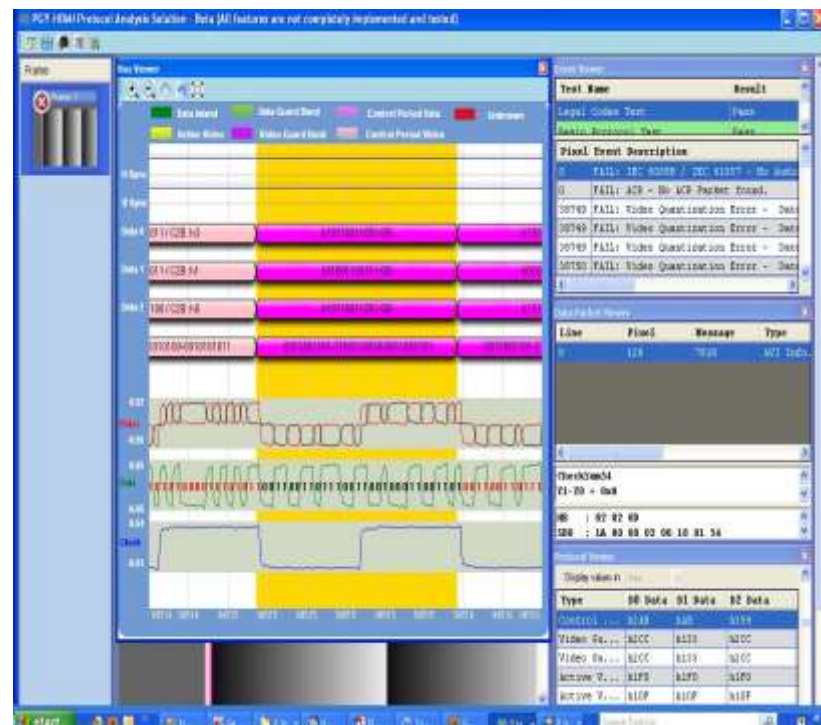


泰克MHL完整方案



- MHL 协议分析软件，基于泰克实时示波器
 - 同一台示波器同时兼顾物理层一致性测试和协议分析
 - 无缝的从物理层切换到协议层，只需加一个软件
 - 高性价比
- 协议分析特色
 - 多显示支持
 - 总线分析
 - 帧包查看
 - 事件查看
 - 协议分析
 - 协议包与时域波形同时显示
- Tektronix示波器选件：TEK-PGY-MHL-PA-SW

泰克MHL完整方案



13.8.1 Cable DC Electrical Specifications

Table 13-13 Cable Assembly MHL Characteristics

Item	Symbol	Min	Max	Unit	Notes
Ground Resistance	R_{GND}		0.16	ohms	1
Differential Intra-Pair Skew			43	psec	
Common-Mode Intra-Pair Skew			43	psec	
MHL+ and MHL- Differential Characteristic Impedance	Z_{OD}	85	115	ohms	2, 3
		90	110	ohms	2, 4
MHL Clock Common-Mode Characteristic Impedance	Z_{OC}	24	36	ohms	5, 6
		25	35	ohms	5, 7
CBUS Line Capacitance	C_{CBUS}	30	500	pF	8, 9
CBUS Cable Delay	$T_{CBUS_CBL_DLY}$		35	nsec	

泰克MHL完整方案



- MHL Cable insertion loss: S21插入损耗

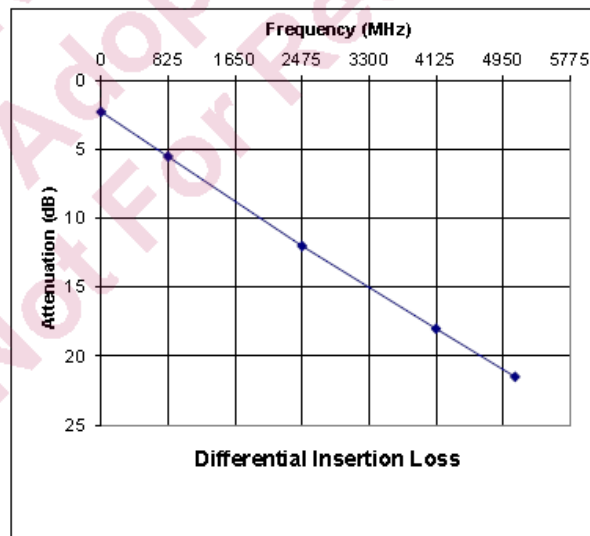
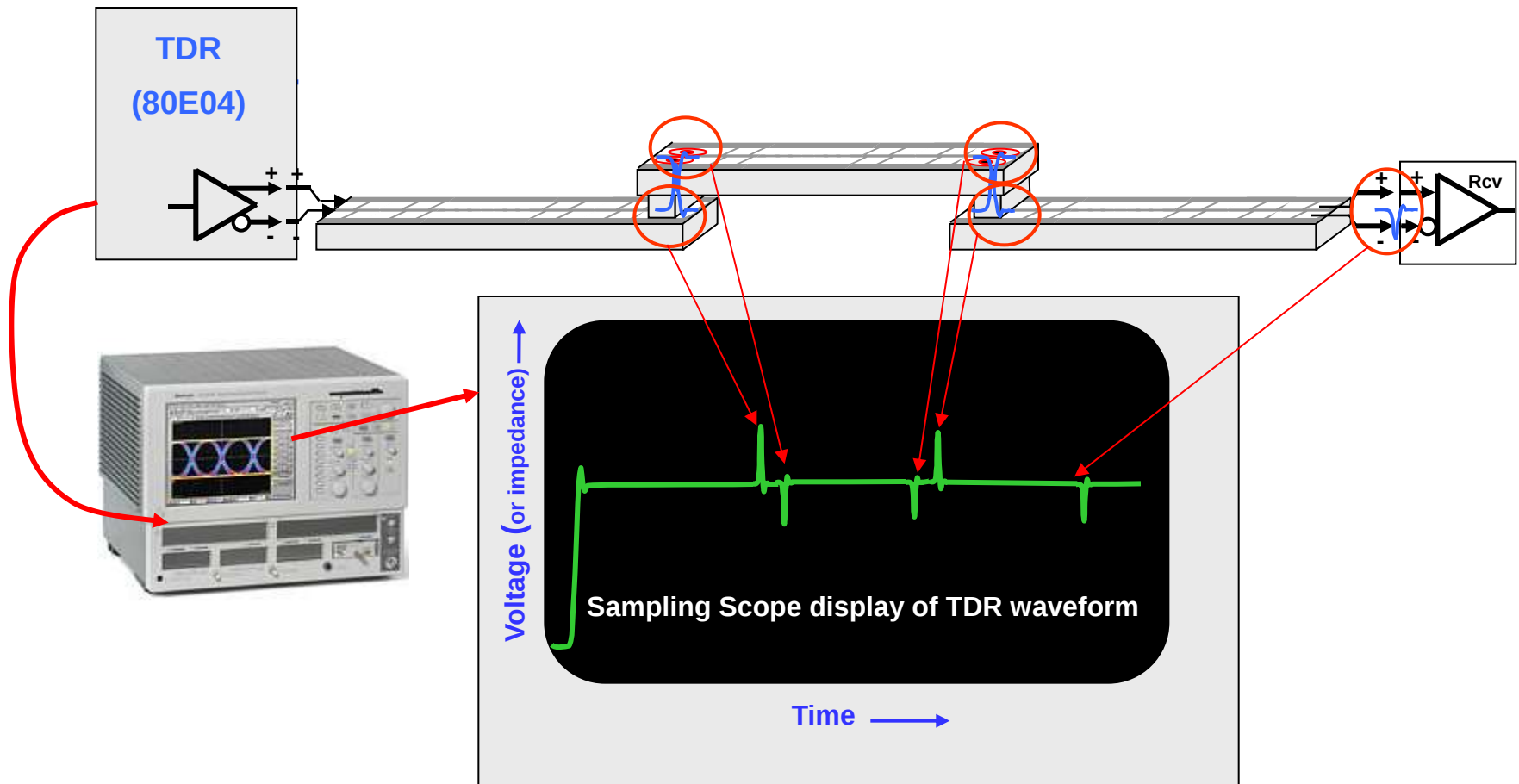


Figure 13-20 MHL Cable Differential Insertion Loss for MHL Data Signals

Table 13-14 MHL Cable Differential Insertion Loss for MHL Data Signals

Frequency (MHz)	Attenuation (dB)
0	2.25
825	5.5
2475	12.0
4125	18.0

串行链路互连验证 by Time Domain Reflectometry (TDR)

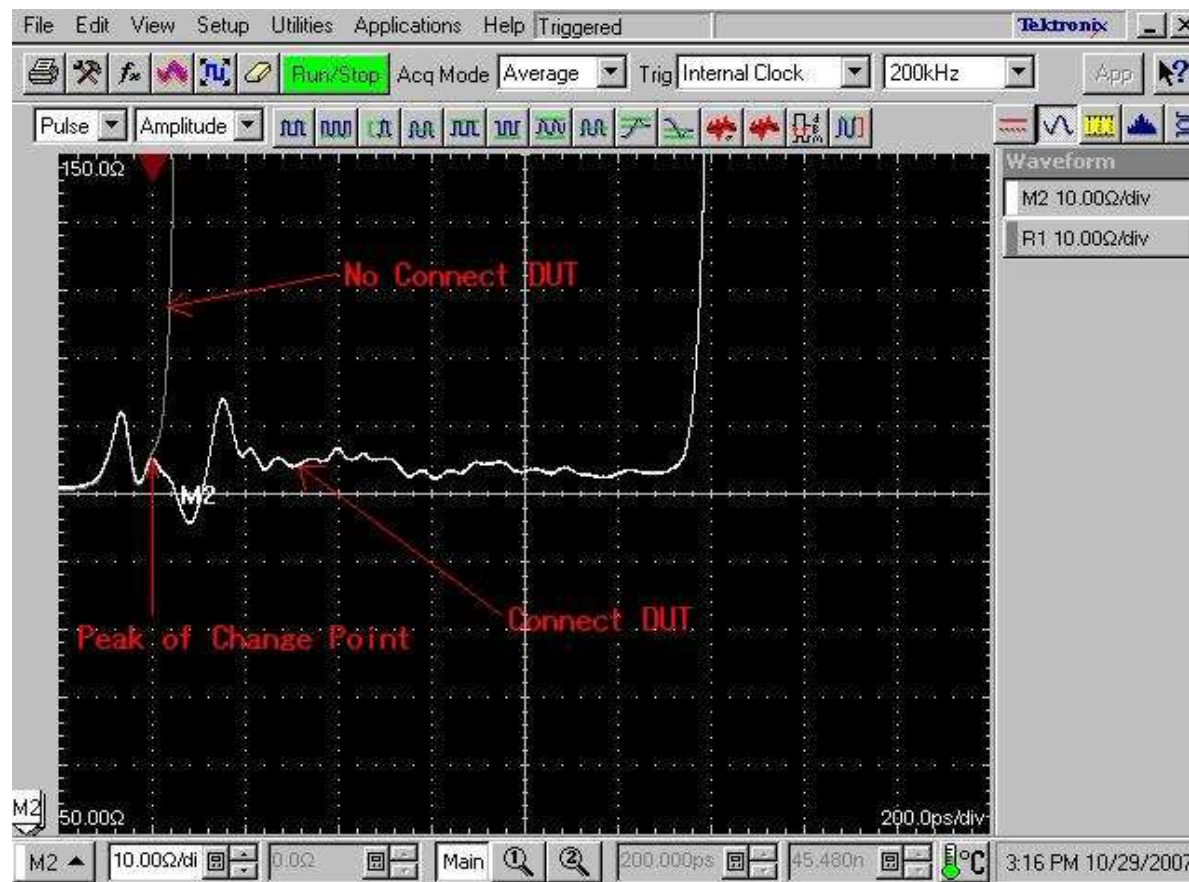


- TDR on an Equivalent Time scope is used to measure the quality of the serial data interconnect: A step is generated and returning reflections are sampled (**it's like radar for serial data cables and boards**)

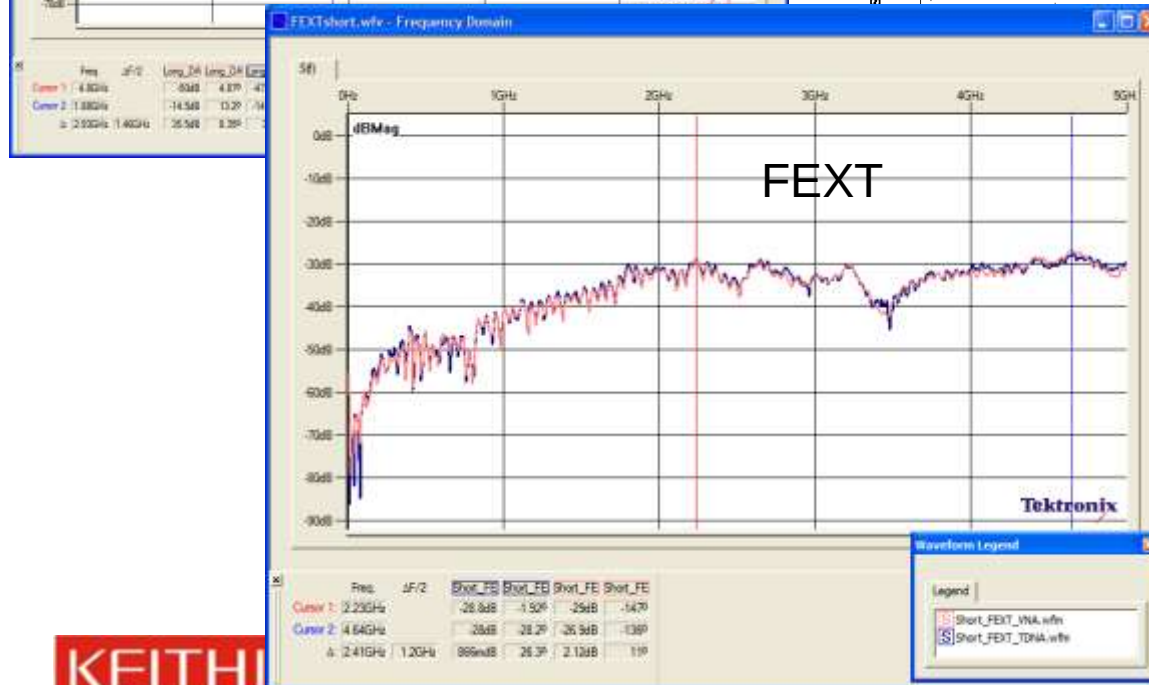
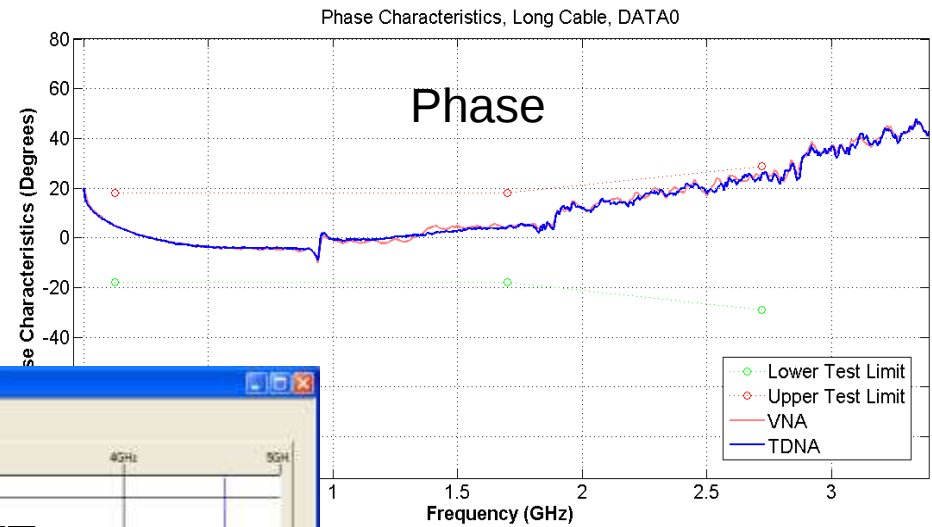
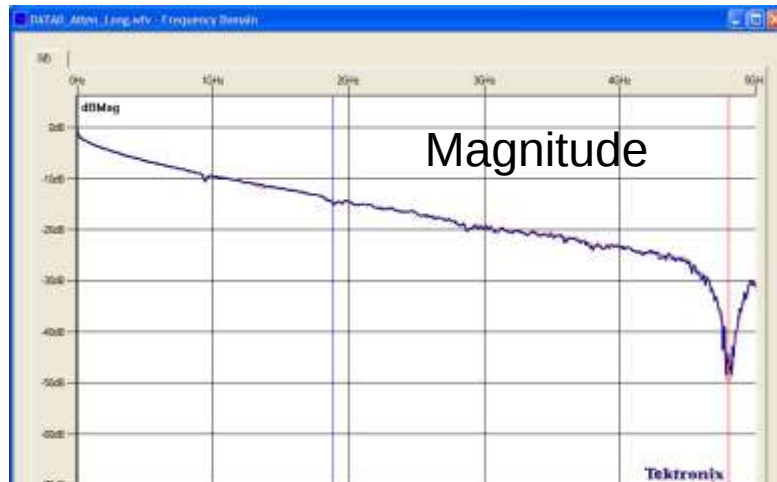
泰克MHL完整方案



■ 阻抗验证



MHL 线缆示例



Tektronix MHL完整解决方案

- DPO/MSO70K C/DX系列示波器, 带宽 $\geq 8\text{GHz}$
- MHL物理层一致性测试软件
- MHL协议分析软件TEK-PGY-MHL-PA-SW
- 相关探头和MHL夹具
- AWG7122C配合相应软件测试 MHL Rx/Dongle
- DSA8300/80E04 配合I-Connect测试MHL线缆



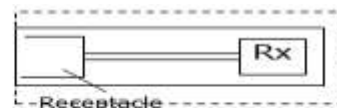
Mobile Devices, STBs



发送端物理层和协议层



Dongles, Cables



TVs, Monitors, .



接收端物理层和协议层

日程安排

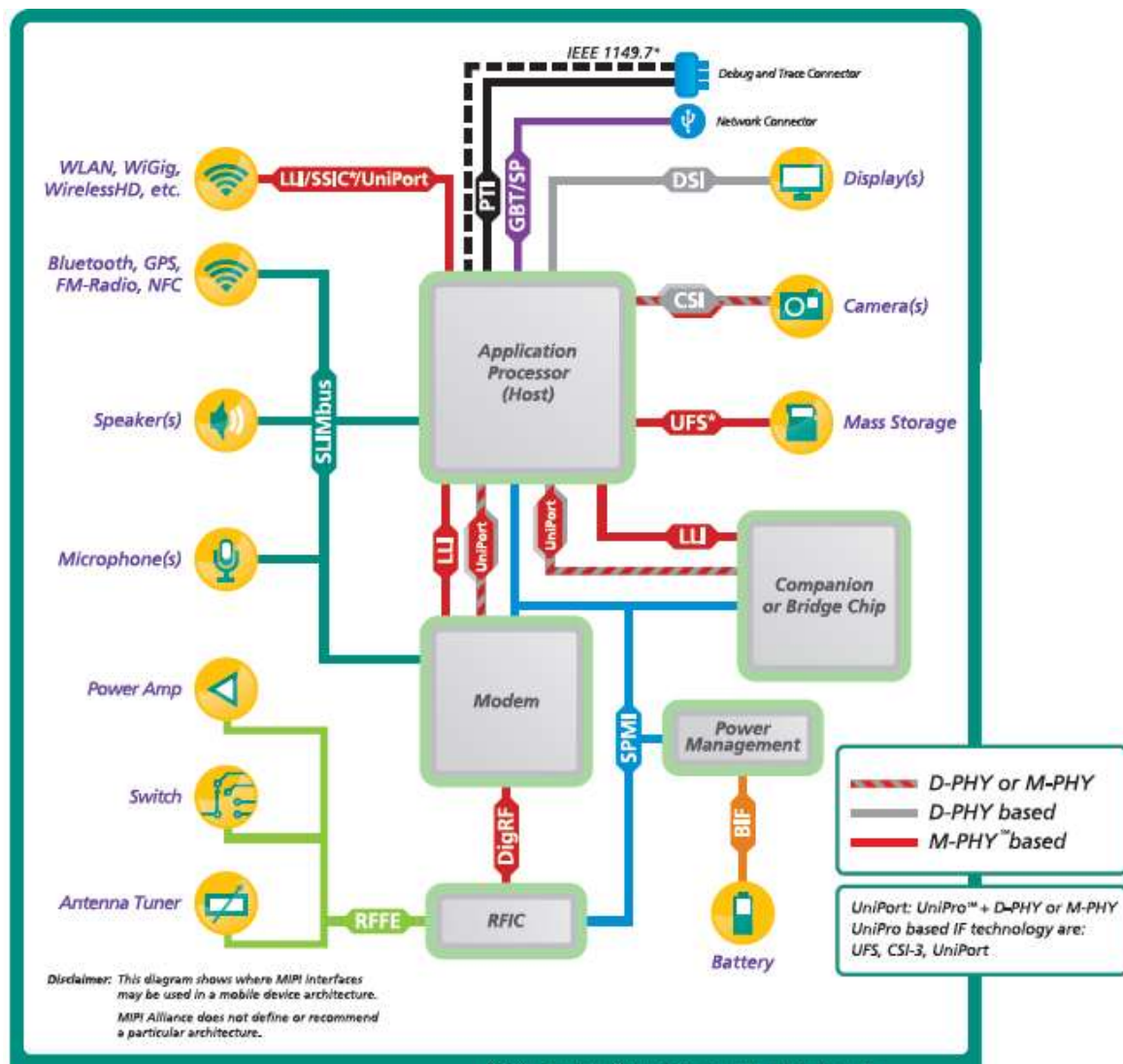
- 背景信息
- MHL
 - Tx、Rx、protocol
- MIPI
 - D-phy: Tx、Rx、Protocol
 - M-phy: Tx、Rx、Protocol
- 总结



泰克MIPI完整方案



- 高速串行接口
 - 宽带宽
 - 相对较少pin
 - 多个功率节省模式
 - 多种传输模式
 - Clocking灵活多变
 - 多种符号编码方式
- 一种标准用于多个应用场景

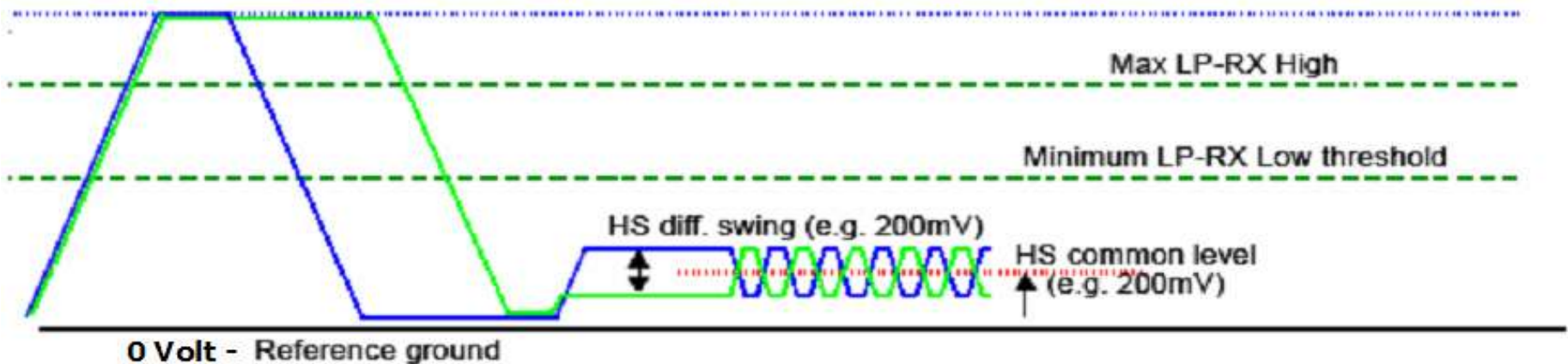


Source: MIPI Alliance

泰克MIPI完整方案: D-phy

- 物理层标准: Camera CSI接口和显示屏DSI接口的规范
- 两种传输模式: 高速(HS) and 低功耗 (LP)
- 传输模式在实际应用中混合交替
 - 信号不断在LP和HS之间切换
- 最高数据率
 - High Speed mode: 80 Mbps – 1.5 Gbps, 典型值~500 Mbps.
 - Low Power mode: Up to 10 Mbps
- 总线端接
 - 50 ohm, 高速HS模式
 - Hi-Z 高阻, LP模式

Low-Power signaling level (e.g. 1.2V)



泰克MIPI完整方案: D-phy

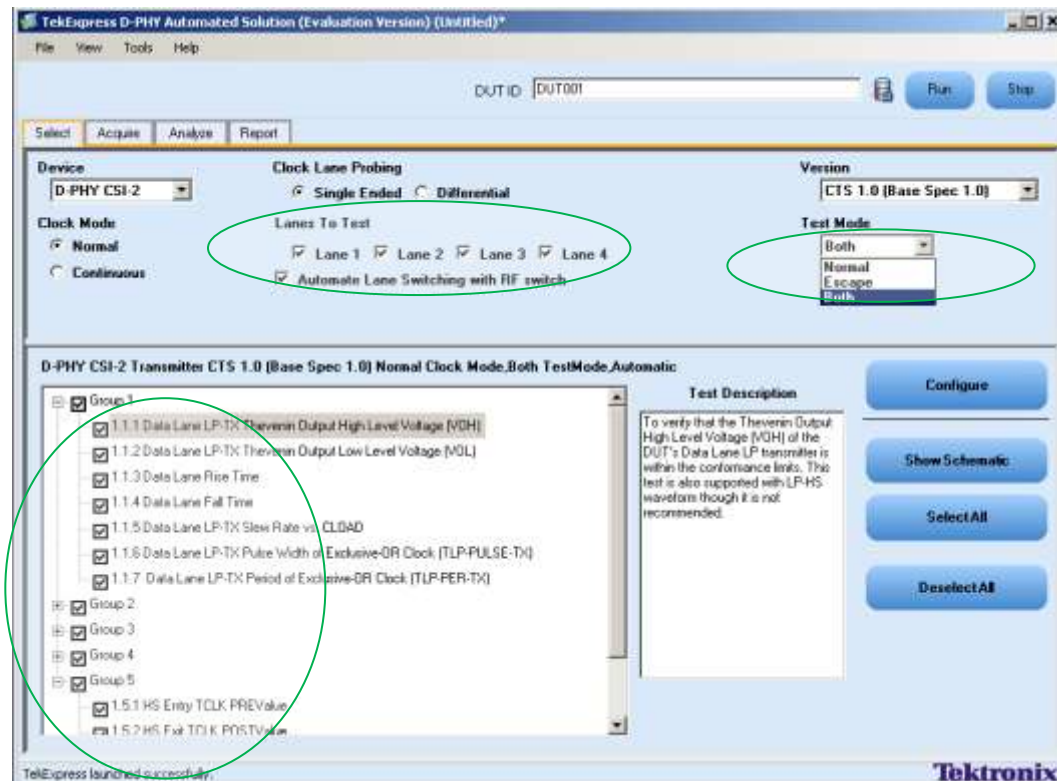


- Logo认证测试不是必须的，可选
 - MIPI是芯片到芯片间或者芯片到外围接口的总线，类似DDR信号
 - 手机不需要一致性log标识，不像PC/TV等包含USB/HDMI接口的设备
- 没有两个包含MIPI总线的设备是完全一样的
 - 可变的数据率（从80Mbps到1.5Gbps不定）
 - 同时最高多达4条总线
- 多种测试项目要求，共计 56项
 - Clock Lane
 - Data Lane
 - Clock data Timing

泰克MIPI完整方案



- TEKEXP DPHY: 业内最全面的MIPI Dphy Tx 自动化测试软件
- 多达56个测试项目精密验证
- 支持多达四条lane同时测试
- 100%满足D-phy关于DSI 和 CSI 的最新规格
- 支持温箱测试
- HTML网页格式完整报告
- 最低2.5G以上示波器



泰克MIPI完整方案： Dphy解码



Missing Sync



Checksum Error



ECC error

Errors and Warnings indicated in event table

MSO70000 高性能混合信号示波器

业内领先的配有高性能数字通道的实时示波器

高性能

■33G 模拟通道
4个通道

■16 数字通道
连同4个模拟通道
组成的采集系统

■事件触发能力
隔离定位偶发的故障

■新数字逻辑探头
提供高信号保证度
以及最小的负载

■80ps 数字定时分辨率
■10 ps模拟定时分辨率

■深存储
■模拟通道1G存储

iCapture™ 同时进行模
拟数字时间相关调试

集成了MIPI多路、
I2C、SPI解码功能

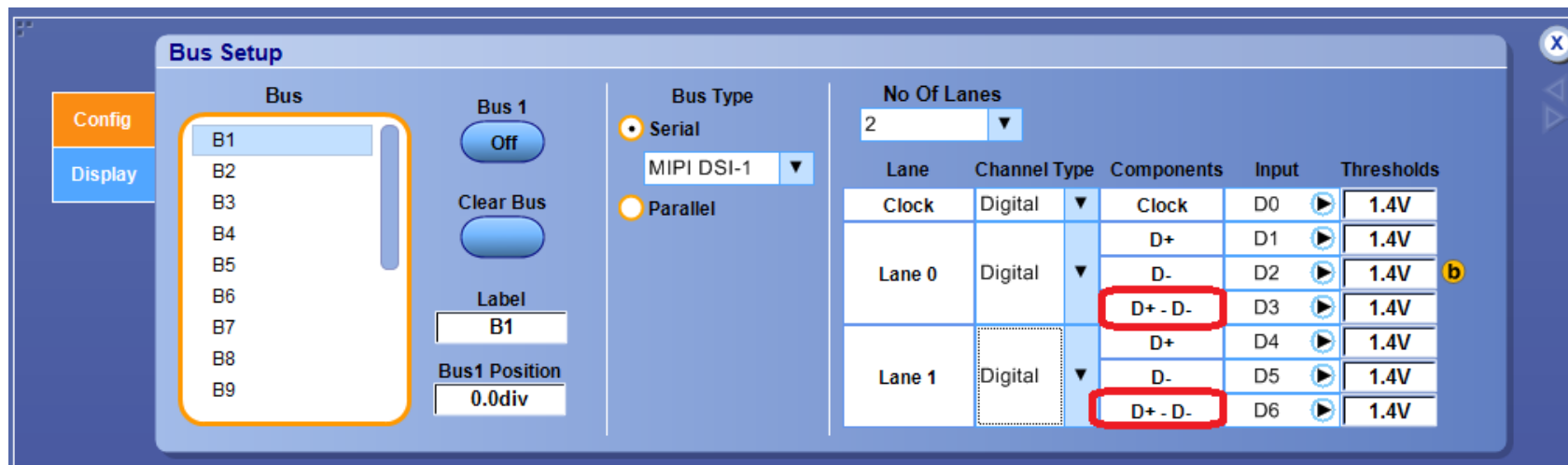


泰克MIPI完整方案



■ MSO70000C/DX系列:

- MSO功能和Dphy解码软件可以完美配合
- 同时decode Dphy所有的四条lane
- 丰富的编码信息显示
- 16个通道阈值单独设定满足多样化需要
- 数字与模拟通道可以同时使用
- 数字探头经济实惠



泰克MIPI完整方案

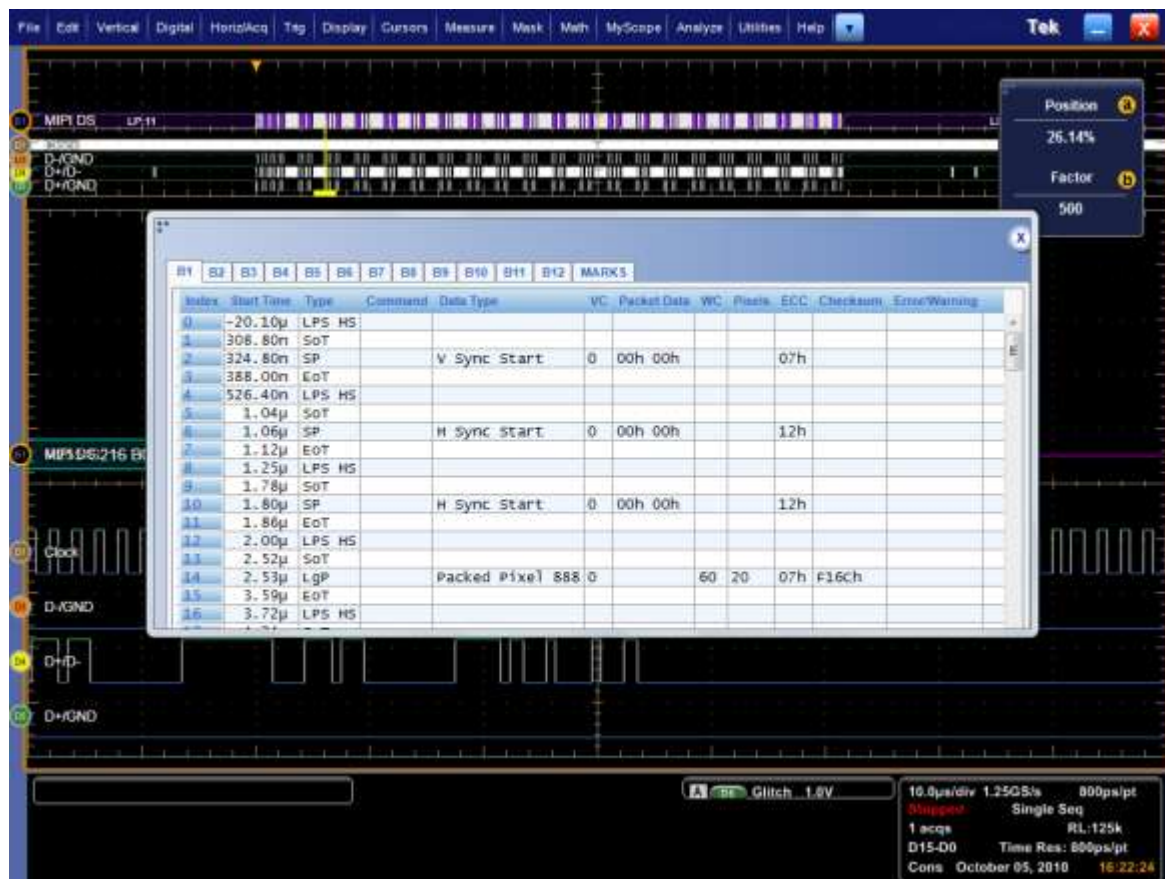
- 利用MSO数字探头可以看到如下解码的信息：

- Start of Transmission (SoT)
- Data Type - Packed Pixel 888
- Virtual Channel – 0
- Word Count – 60
- ECC – 07h
- 1st Pixel Value
- Red – 255
- Green – 216
- Blue - 000



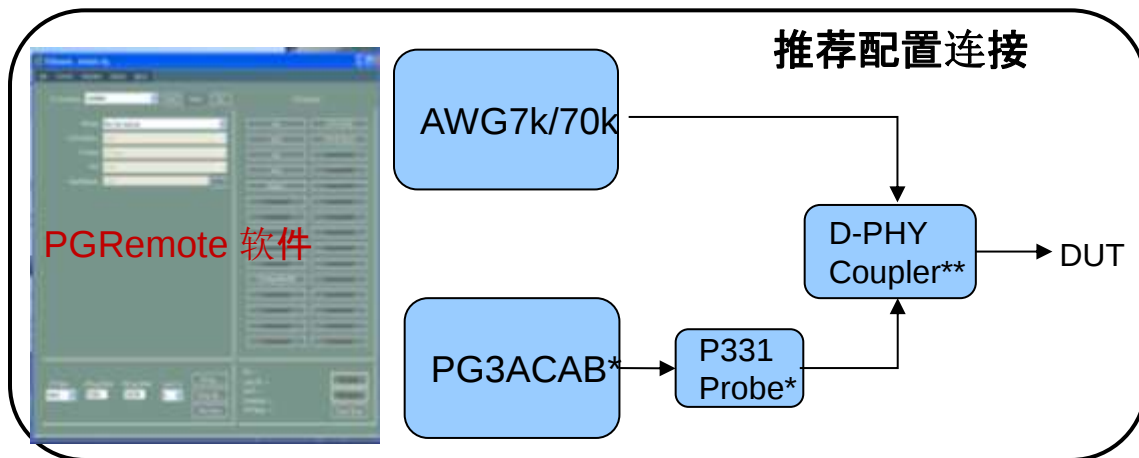
泰克MIPI完整方案

- 利用MSO数字探头可以看到如下：
 - Timestamps for each event
 - Short / Long packet indication
 - Data Type, Virtual Channel, Packet Data, Word Count, ECC and Checksum all decoded
 - Number of pixels
 - Error/Warning column indicates problems



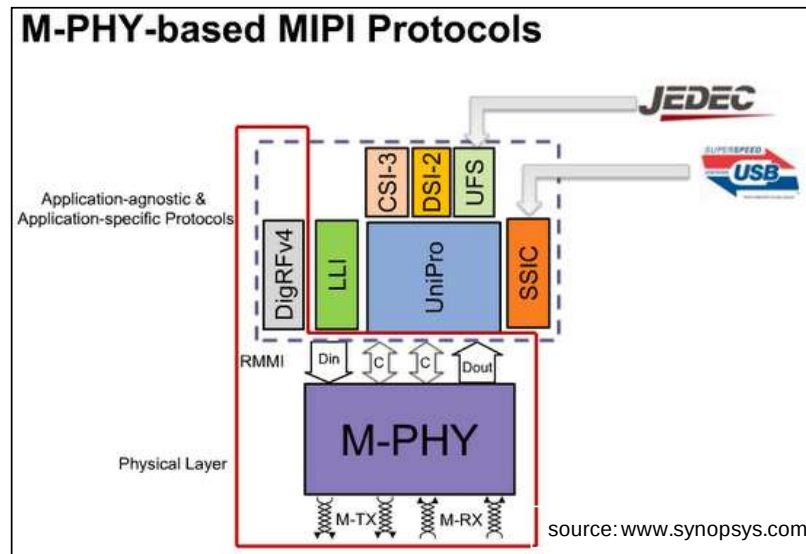
泰克MIPI完整方案: Dphy Rx

- 100%满足Rx CTS规范要求
 - 满足UNH-IOL认证中心CTS规范
- 快捷方便的设置
 - 无需繁琐的VXI架构, 单一的独立机器加一根探头
- 超高的性价比方案
 - 比同类功能产品价位低近60%
- 物理层Rx测试之外还兼顾协议层测试
 - PG3A唯一的可以同时支持4条lane CSI/DSI测试的方案
- PG3A码型发生器
 - 控制时钟和数据来建立与DUT之间的联系
 - 调整信号电压幅度、数据包类型等来强化接收端测试
- AWG7k/70k
 - 往D-phy信号里面添加抖动、干扰等损伤信号来检测Rx端抗压能力



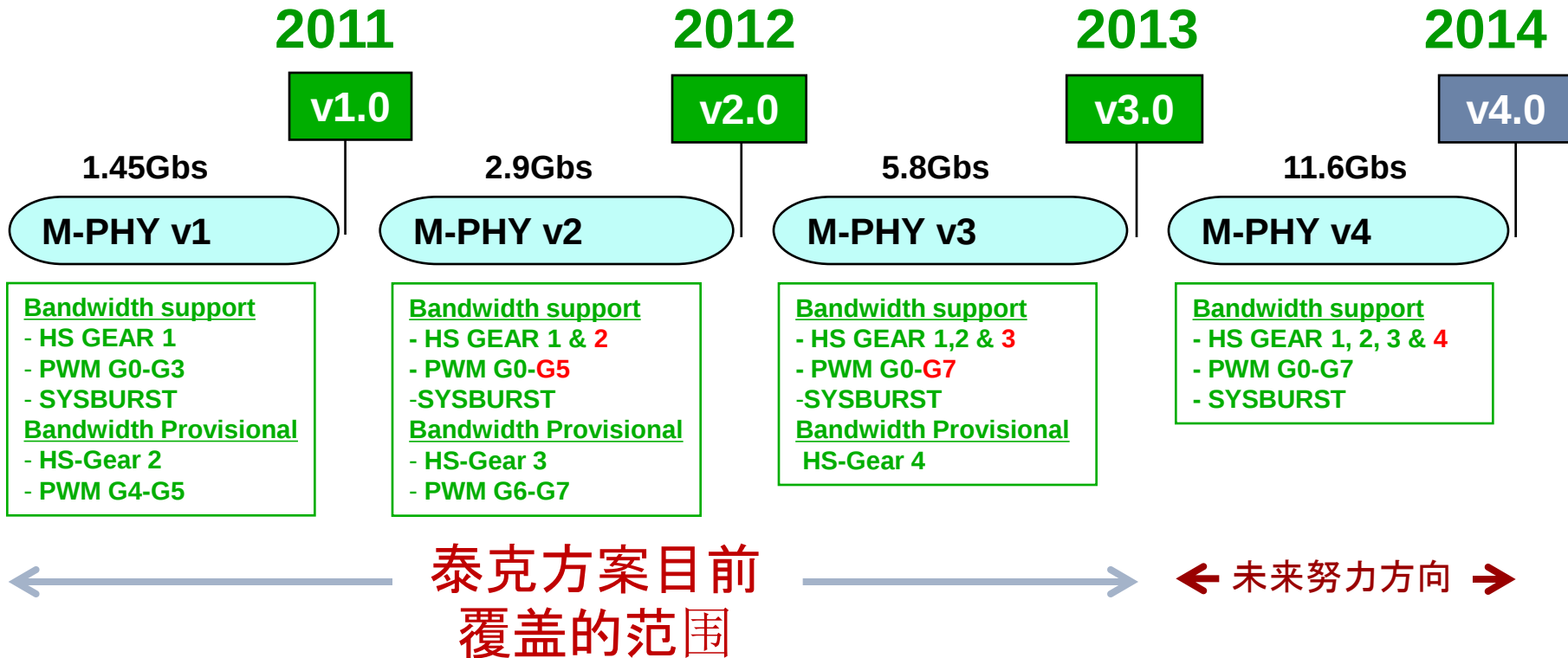
什么是M-PHY ?

- M-PHY: 下一代MIPI互联标准, D-phy的更高级趋势.
- M-PHY总线应用于:
 - DigRFv4, LLI, UniPro, CSI-3 and DSI-2 等MIPI标准



M-PHY信号特性			
信号类型	数据率		
High Speed (HS)	Gears	A (Gbps)	B (Gbps)
	G1	1.25	1.45
	G2	2.5	2.91
	G3	5	5.83
PWM (ie. TYPE-I)	Gears	Min (Mb/s)	Max (Mb/s)
	G0	0.01	3
	G1	3	9
	G2	6	18
	G3	12	36
	G4	24	72
	G5	48	144
	G6	96	288
SYS (ie. TYPE-II)	G7	192	576
			576 (Mb/s)

MIPI M-PHY 规范发展路线图



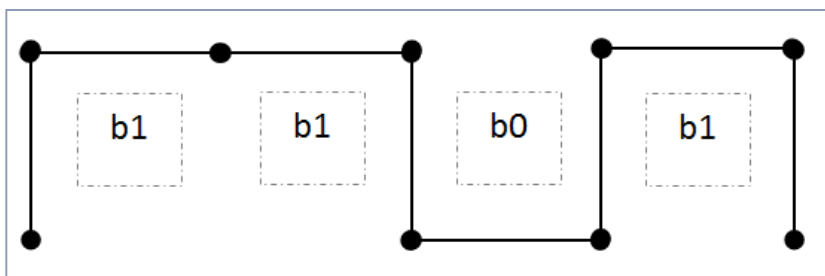
Source: Previous MIPI Alliance Face to Face Presentations

M-PHY – 数据传输方式

Non-Return-to-Zero (NRZ)

不归零码

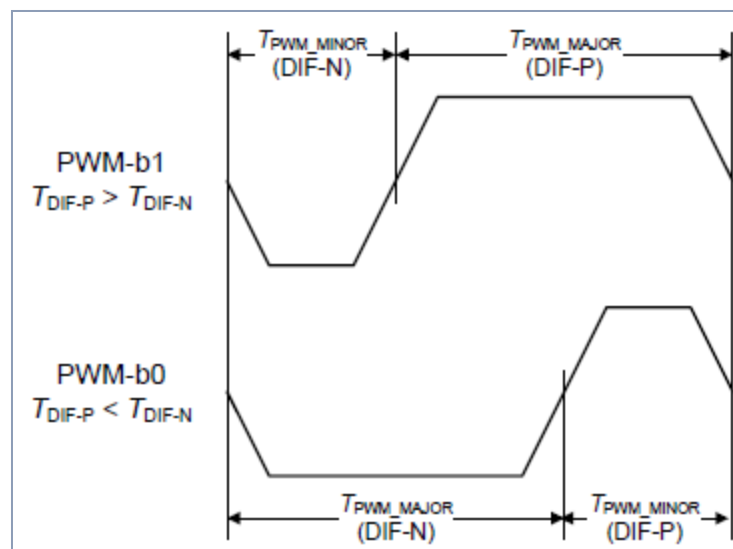
- 一定间隔的高低电平代表一个bit



Pulse Width Modulation (PWM)

脉冲宽度调制

- 两个子相位传输一个bit信息



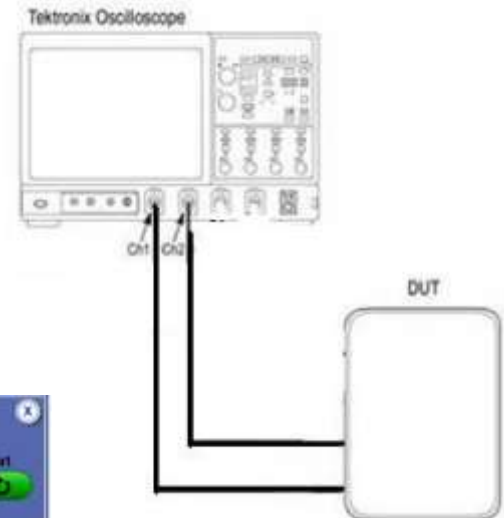
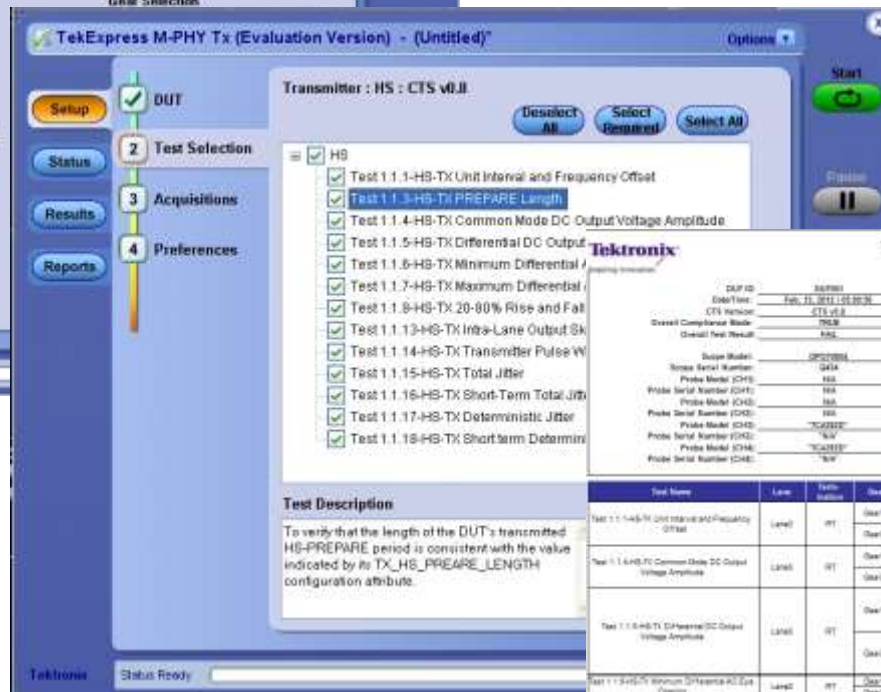
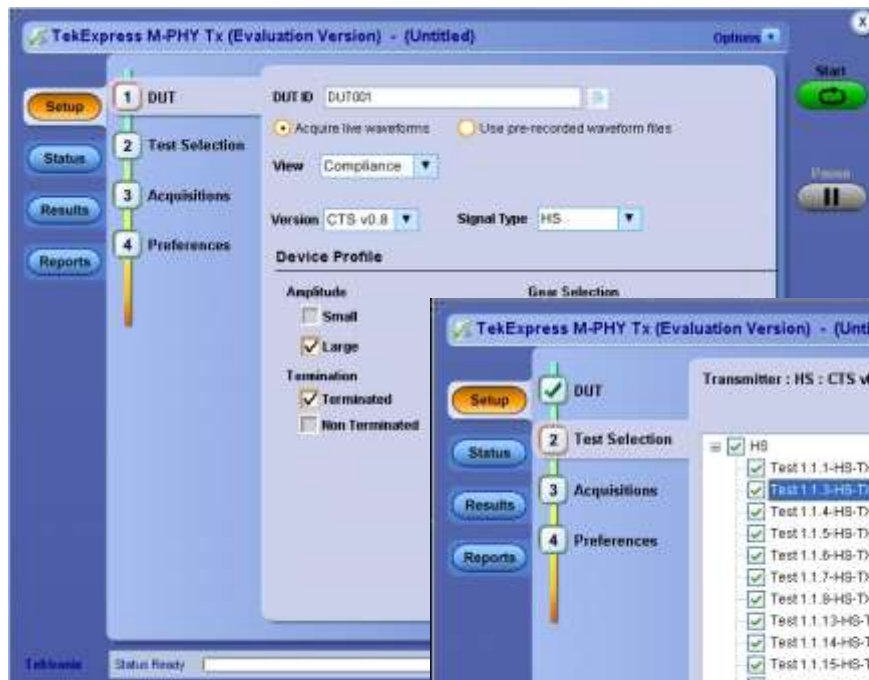
M-PHY Tx 测试软件: M-PHYTX

- M-PHY 高速HS模式测试项目:
 - 1.1.1 HS-TX Unit Interval and Frequency Offset
 - 1.1.2 HS-TX Common Mode AC Power Spectral Magnitude Limit
 - 1.1.3 HS-TX Prepare Length
 - 1.1.4 HS-TX Common Mode DC Output Voltage Amplitude
 - 1.1.5 HS-TX Differential DC Output Voltage Amplitude
 - 1.1.6 HS-TX Minimum Differential AC Eye Opening
 - 1.1.7 HS-TX Maximum Differential AC Output Voltage Amplitude
 - 1.1.8 HS-TX 20/80% Rise and Fall Times
 - 1.1.10 HS-TX Slew Rate
 - 1.1.11 HS-TX Slew Rate State Monotonicity
 - 1.1.12 HS-TX Slew Rate State Resolution
 - 1.1.13 HS-TX Intra-lane Output Skew
 - 1.1.14 HS-TX Transmitter Pulse Width
 - 1.1.15 HS-TX Total Jitter
 - 1.1.16 HS-TX Short-term Total Jitter
 - 1.1.17 HS-TX Deterministic Jitter
 - 1.1.18 HS-TX Short-term Deterministic Jitter

M-PHY Tx 测试软件: M-PHYTX

- M-PHY PWM模式测试项目:
 - 1.2.1 PWM-TX Transmit Bit Duration
 - 1.2.2 PWM-TX Transmit Ratio
 - 1.2.3 PWM-TX Prepare Length
 - 1.2.4 PWM-TX Common Mode DC Output Voltage Amplitude
 - 1.2.5 PWM-TX Differential DC Output Voltage Amplitude
 - 1.2.8 PWM-TX 20/80% Rise and Fall Times
 - 1.2.10 PWM-TX G1 Transmit Bit Duration Tolerance
 - 1.2.11 PWM-TX G0 Minor Duration

M-PHY Tx 测试软件: M-PHYTX



Tektronix

TekExpress HS-TX Report

DUT ID: DU001
Date/Time: Fri, 11/01/2013 09:30:34
CTS Version: CTS v0.8
Overall Compliance Mode: PASS
Overall Test Result: PASS

Device Type: Transmitter
Execution Time: 47 Sec

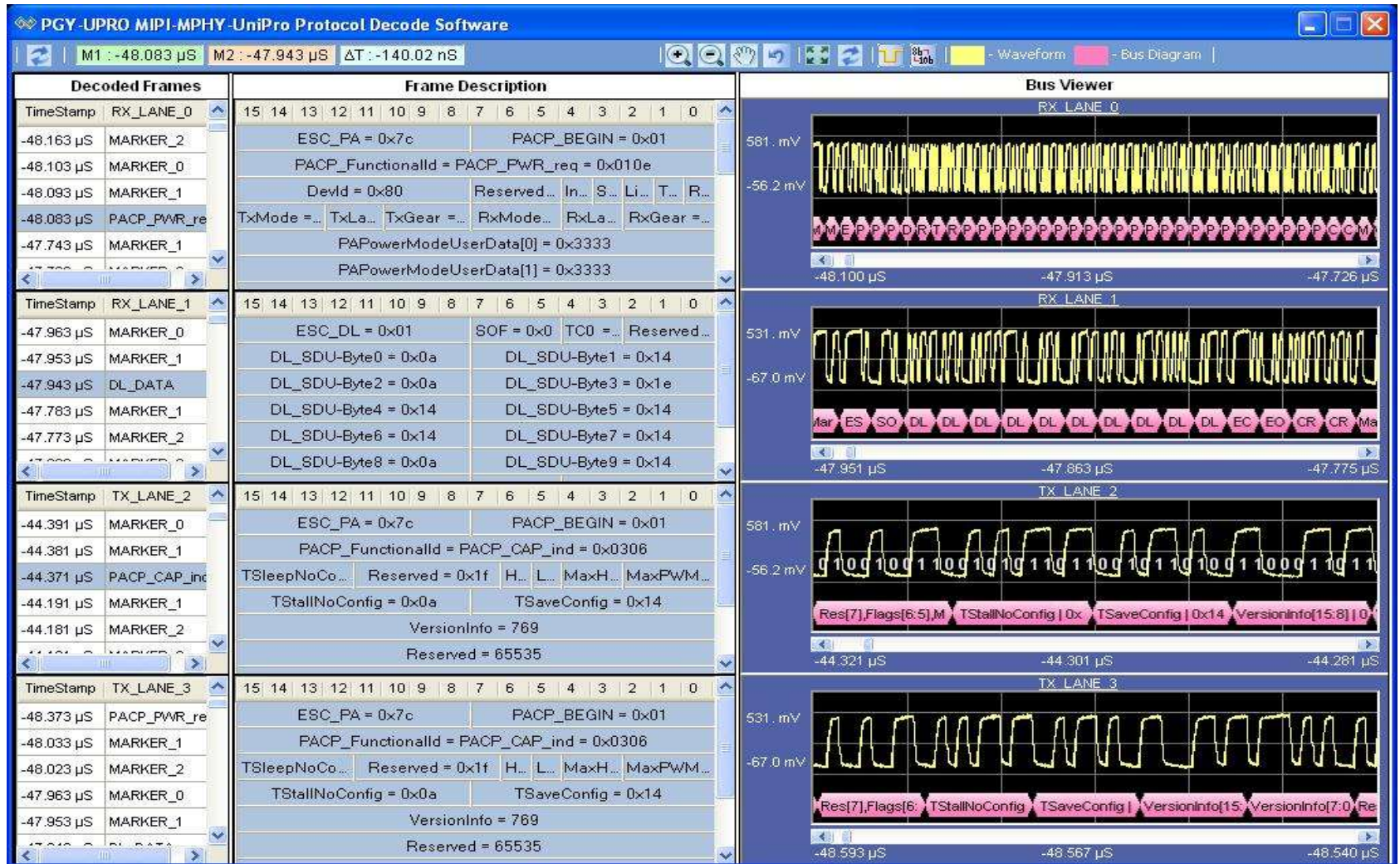
Scope P100 Version: 5.2.1 BUILD 05
IPC Factory Calibration: 7.0.0-086.1.0.0.04
TelExpress Version (PWR App): 5.5.7 Build 17

Test Name	Line	Test Direction	Start	Stop	Start Value	Measurement Details	Measured Value	Units	Test Result	Margin
Test 1.1.3-HS-TX PREPARE Length	Line0	RT	Start/RA	LA	207.211	207.211	ns	207.211	PASS	100.000
Test 1.1.4-HS-TX Common Mode DC Output Voltage Amplitude	Line0	RT	Start/RA	LA	332.449	332.449	mV	332.449	PASS	100.000
Test 1.1.5-HS-TX Differential DC Output Voltage Amplitude	Line0	RT	Start/RA	LA	234.262	234.262	mV	234.262	PASS	100.000
Test 1.1.6-HS-TX Minimum Differential Eye Opening	Line0	RT	Start/RA	LA	218.86	218.86	mV	218.86	PASS	100.000
Test 1.1.7-HS-TX Maximum Differential Eye Opening	Line0	RT	Start/RA	LA	225.803	225.803	mV	225.803	PASS	100.000
Test 1.1.8-HS-TX 20-80% Rise and Fall Time	Line0	RT	Start/RA	LA	190.000	190.000	ns	190.000	PASS	100.000
Test 1.1.13-HS-TX Intra-Lane Output Skew	Line0	RT	Start/RA	LA	-214.341	-214.341	ps	-214.341	PASS	100.000
Test 1.1.14-HS-TX Transmitter Pulse Width	Line0	RT	Start/RA	LA	190.121	190.121	ns	190.121	PASS	100.000
Test 1.1.15-HS-TX Total Jitter	Line0	RT	Start/RA	LA	-194.895	-194.895	ps	-194.895	PASS	100.000
Test 1.1.16-HS-TX Short-Term Total Jitter	Line0	RT	Start/RA	LA	0.117	0.117	ps	0.117	PASS	100.000
Test 1.1.17-HS-TX Deterministic Jitter	Line0	RT	Start/RA	LA	0.220	0.220	ps	0.220	PASS	100.000
Test 1.1.18-HS-TX Short-term Deterministic Jitter	Line0	RT	Start/RA	LA	0.240	0.240	ps	0.240	PASS	100.000

M-PHY 解码:

- UniPro 与 LLI 协议解码软件提供了快速的协议层debug测试能力
- 完全满足最新的UniPro和LLI相关协议规范
- 完整的界面显示，同时提供协议层信息和与之相应的时域波形，且可以联动
- 自动的CRC（循环冗余码校验）计算，模拟协议包或者帧序列中的CRC错误
- 与示波器的触发功能结合，可以方便的去定位UniPro和LLI特定的事件所在位置
- 生成完善详细的测试网页报告，可以将协议包信息输出至txt或者csv文件

M-PHY 解码:



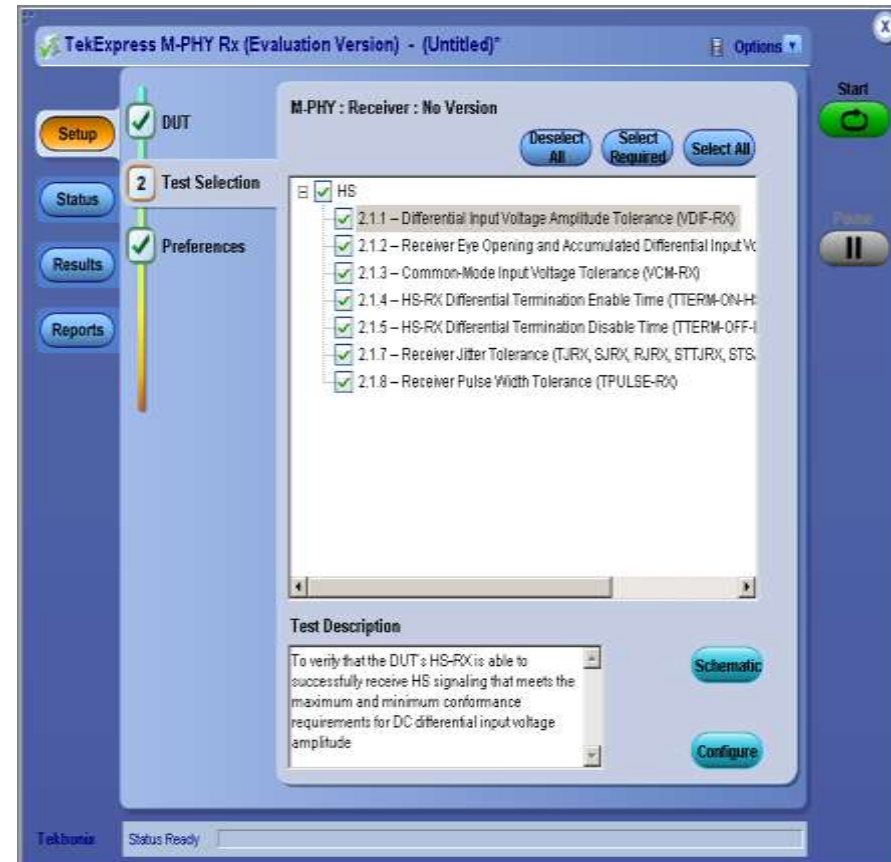
M-PHY Rx接收机测试

- 多种信号仿真生成
 - **PWM**, NRZ编码信号
 - 多种时钟方式
 - 8b/10b 编码
 - 差分、共模分量
- 信号要求加压, CTS要求
 - 周期性抖动Pj、随机抖动Rj
 - **ISI** 码间干扰
 - S参数模拟
- 误码测试 **BER (Bit Error Rate)**
 - 不需要单独购买误码检测设备
 - 基于泰克示波器误码检测的方案性价比极高

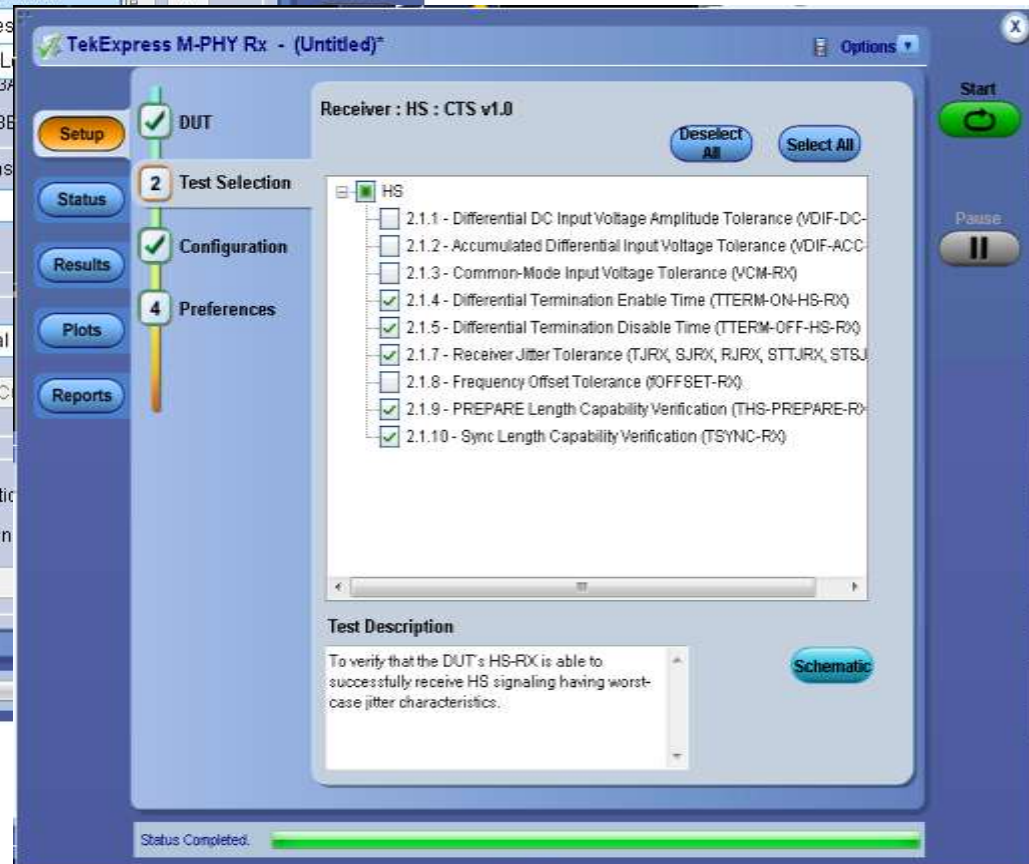
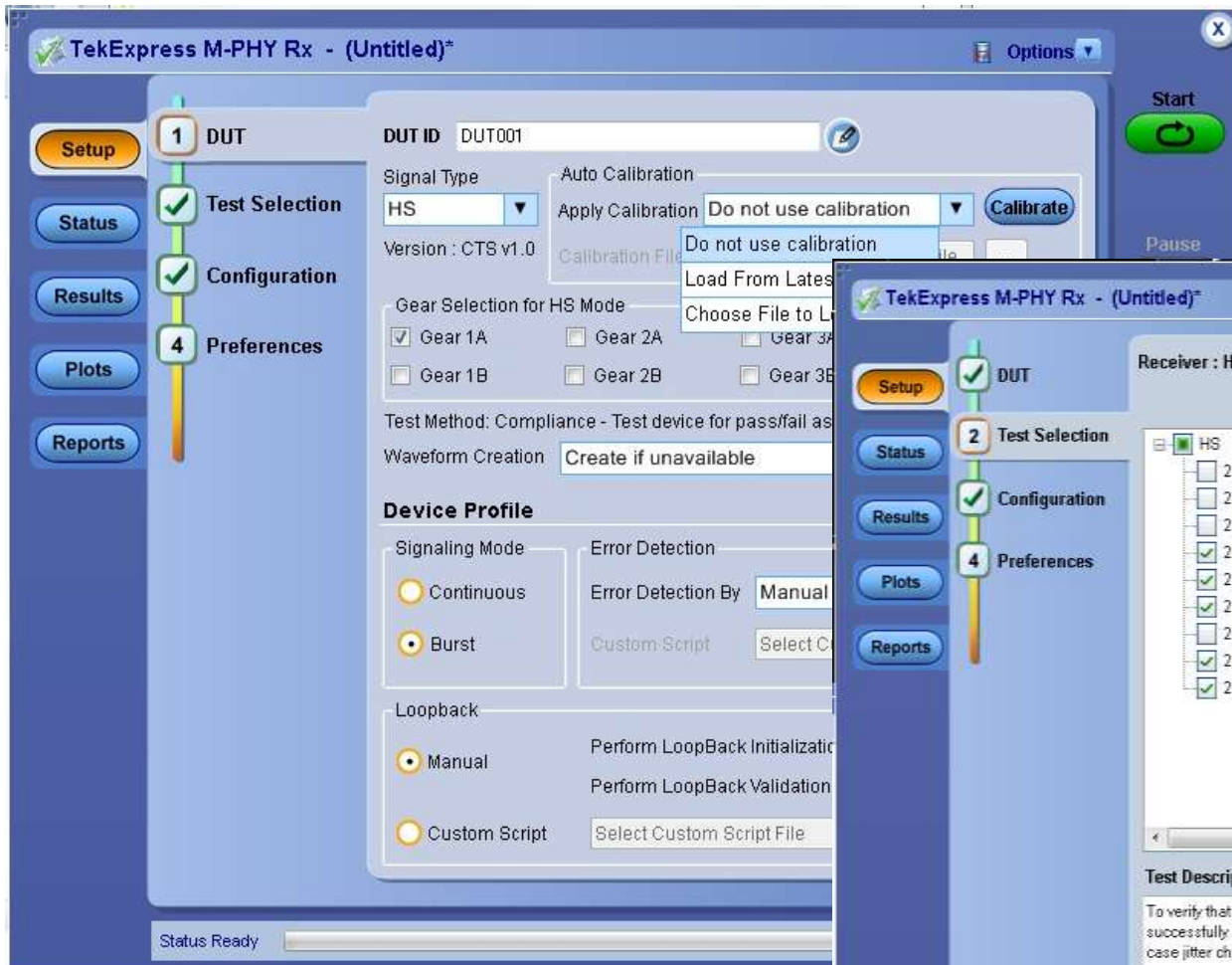
DPO70KC/DX示波器 + AWG7K 提供了完整的信号发生与损伤注入

M-PHY Rx接收机测试: TEKEXP M-phy Rx

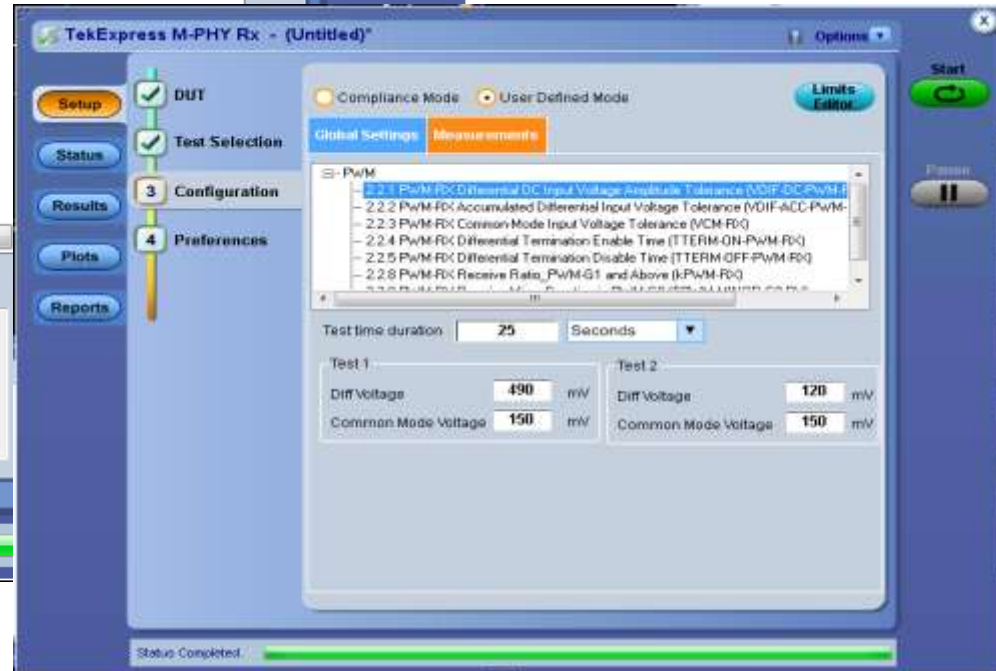
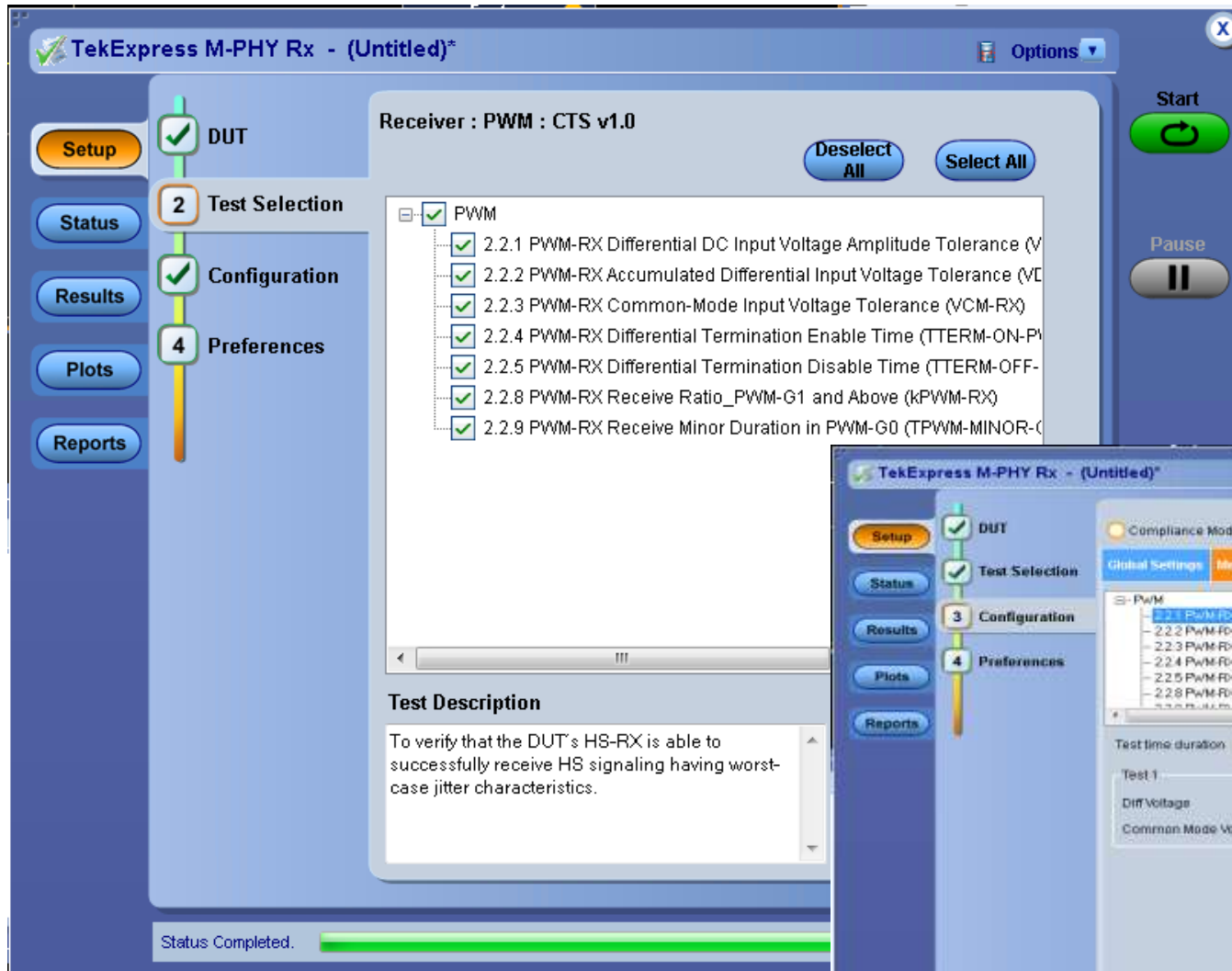
- 自动化测试软件Opt.M-PHYRX
 - 自动化接收机符合性测试
 - 运行于泰克DPO70K系列示波器上
- 特点Differentiation
 - 两台机器即可完成Rx测试
 - BER: 基于示波器的误码率测试
 - 广泛的M-phy测试项目支持HS/PWM



M-PHY Rx接收机测试： 同时支持Gear1、2、3



M-PHY Rx接收机测试： 同时支持PWM G0-G7



M-PHY Rx接收机测试： 报告示例



Jitter Margin Test					
Measurement Details	Frequency (Hz)	Amplitude (UI)	Bit Error	Margin (UI)	Results
Waveform for F:1000000.0, A:0.1) - HS Gear 1A	1000000.0	0.1	0	N.A.	Pass
Waveform for F:1000000.0, A:0.5) - HS Gear 1A	1000000.0	0.5	0	N.A.	Pass
Waveform for F:1000000.0, A:0.9) - HS Gear 1A	1000000.0	0.9	0	N.A.	Pass
Waveform for F:1000000.0, A:1.3) - HS Gear 1A	1000000.0	1.3	0	N.A.	Pass
Waveform for F:1000000.0, A:1.7) - HS Gear 1A	1000000.0	1.7	0	N.A.	Pass
Waveform for F:21000000.0, A:0.1) - HS Gear 1A	21000000.0	0.1	0	N.A.	Pass
Waveform for F:21000000.0, A:0.5) - HS Gear 1A	21000000.0	0.5	0	N.A.	Pass
Waveform for F:21000000.0, A:0.9) - HS Gear 1A	21000000.0	0.9	2886663634	0.646630090385	Fail
Waveform for F:21000000.0, A:0.1) - HS Gear 1A	21000000.0	0.1	0	N.A.	Pass
Waveform for F:21000000.0, A:0.5) - HS Gear 1A	21000000.0	0.5	0	N.A.	Pass
Waveform for F:21000000.0, A:0.9) - HS Gear 1A	21000000.0	0.9	2952706555	0.648383170805	Fail
Waveform for F:41000000.0, A:0.1) - HS Gear 1A	41000000.0	0.1	0	N.A.	Pass
Waveform for F:41000000.0, A:0.5) - HS Gear 1A	41000000.0	0.5	0	N.A.	Pass
Waveform for F:41000000.0, A:0.9) - HS Gear 1A	41000000.0	0.9	Not Valid	0.627309696447	Fail
Waveform for F:61000000.0, A:0.1) - HS Gear 1A	61000000.0	0.1	0	N.A.	Pass
Waveform for F:61000000.0, A:0.5) - HS Gear 1A	61000000.0	0.5	0	N.A.	Pass
Waveform for F:61000000.0, A:0.9) - HS Gear 1A	61000000.0	0.9	Not Valid	0.643660600212	Fail

M-PHY Rx接收机测试： 自动化校准参数

Encoding

- ☒ PWM: T_Minor: 0.33 UI
- Scheme: None (NRZ)
- ☒ 8B10B Disparity: RD+

Periodic Jitter (Pk-Pk)

- ☒ Sine1: Magnitude: 2.000, Frequency (Hz): 10.000000 M
- ☒ Sine2: Magnitude: 1.000, Frequency (Hz): 10.000000 M

S-Parameter Filter:

- Select the Mode: Cascading
- Bandwidth Limit - embed/de-embed: 2.400000000 G Hz
- None Auto Custom

Cascading

File 1 (On) → File 2 (On) → File 3 (Off) → File 4 (Off) → File 5 (Off) → File 6 (Off)

S-Parameter Settings: File 1

Read from File: alXpress\Samples\Touchstone\40inlSITrace.s4p

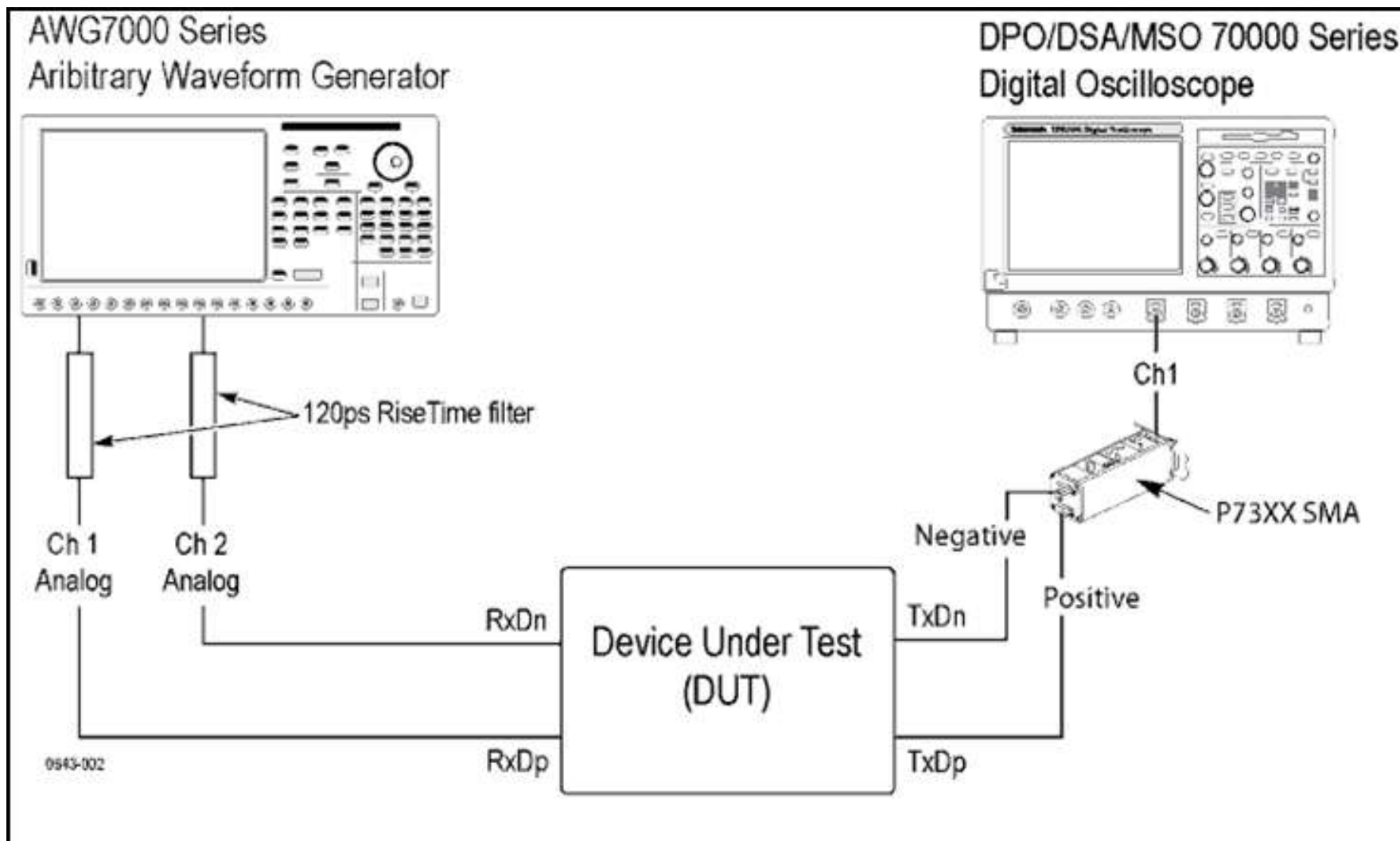
M-PHY Rx接收机测试： HS测试项目

- 2.1.1 – HS-RX Differential DC Input Voltage Amplitude Tolerance
- 2.1.2 – HS-RX Accumulated Differential Input Voltage Tolerance
- 2.1.3 – HS-RX Common Mode Input Voltage Tolerance
- 2.1.4 – HS-RX Differential Termination Enable Time
- 2.1.5 – HS-RX Differential Termination Disable Time
- 2.1.7 – HS-RX Receiver Jitter Tolerance
- 2.1.8 – HS-RX Frequency Offset Tolerance
- 2.1.9 – HS-RX PREPARE Length Capability Verification
- 2.1.10 – HS-RX Sync Length Capability Verification

M-PHY Rx接收机测试： PWM测试项目

- 2.2.1 – PWM-RX Differential DC Input Voltage Amplitude Tolerance
- 2.2.2 – PWM-RX Accumulated Differential Input Voltage Tolerance
- 2.2.3 – PWM-RX Common Mode Input Voltage Tolerance
- 2.2.4 – PWM-RX Differential Termination Enable Time
- 2.2.5 – PWM-RX Differential Termination Disable Time
- 2.2.8 – PWM-RX Receive Ratio, PWM-G1 and Above
- 2.2.9 – PWM-RX Receive Minor Duration in PWM-G0

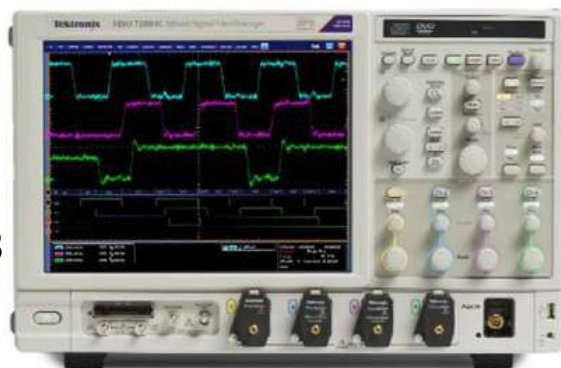
M-PHY Rx接收机测试连接示意



MIPI M-PHY G1/G2/G3 TX Setups

■ 泰克MIPI Mphy方案

- 推荐DPO72304DX 23 G带宽实时示波器
 - 最低要求16GHz带宽（覆盖M-phy Gear1、2、3
- MIPI M-PHY探头夹具套件
 - 包含连接P7500探头和DUT的线缆、附件等
- HS gears测试
 - 16GHz以上有源探头
 - 探头数量
 - ❑ 差分测试一根
 - ❑ 单端、共模测试项目需要两根
- LS/PWM gears测试
 - 8GHz以上有源探头
 - P7380A、P7508或者以上





接下来是：

大数据时代的能源管理