

提升物联网设备可靠性的多种调试手段

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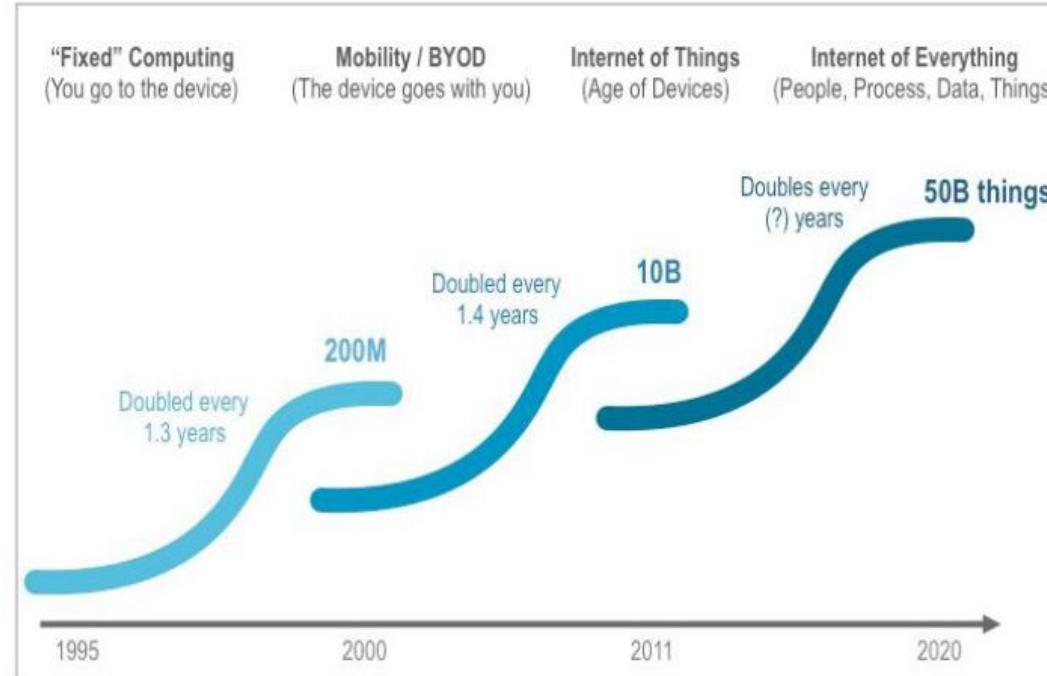
今日议题

1. 迎接万物互联的时代
2. 什么是“聪明”的设备
3. IOT 测量挑战和是德科技的应对方案
4. 你的测试够“聪明”吗

迎接万物互联的时代

我们有幸目睹的一下次“工业化革命”

互联网、移动互联网、物联网

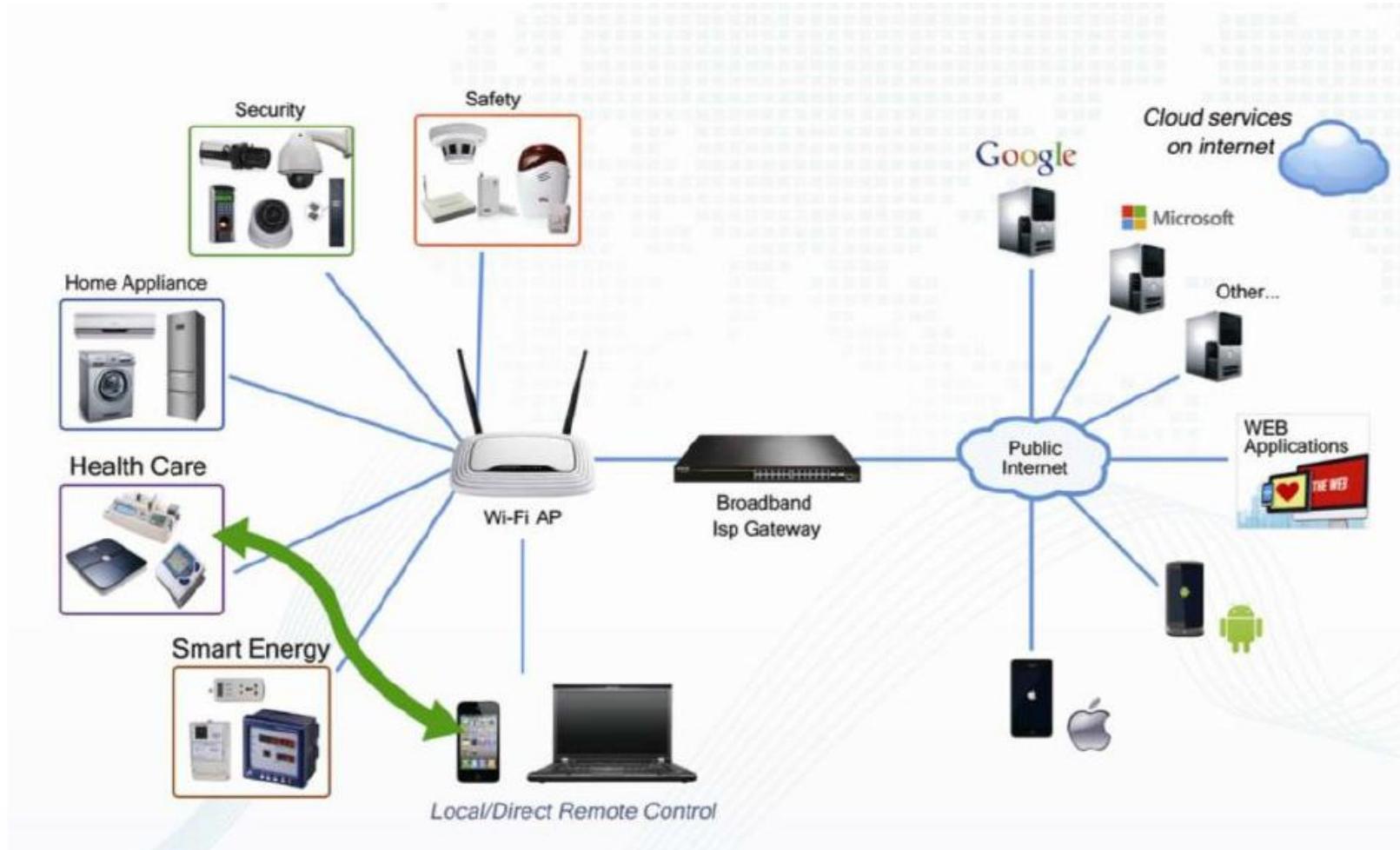


Rapid Growth of the Number of Things Connected to the Internet

Source: Cisco IBSG, 2013

迎接万物互联的时代

物联网典型应用示意图



什么是“聪明”的设备

交互 + 寿命长



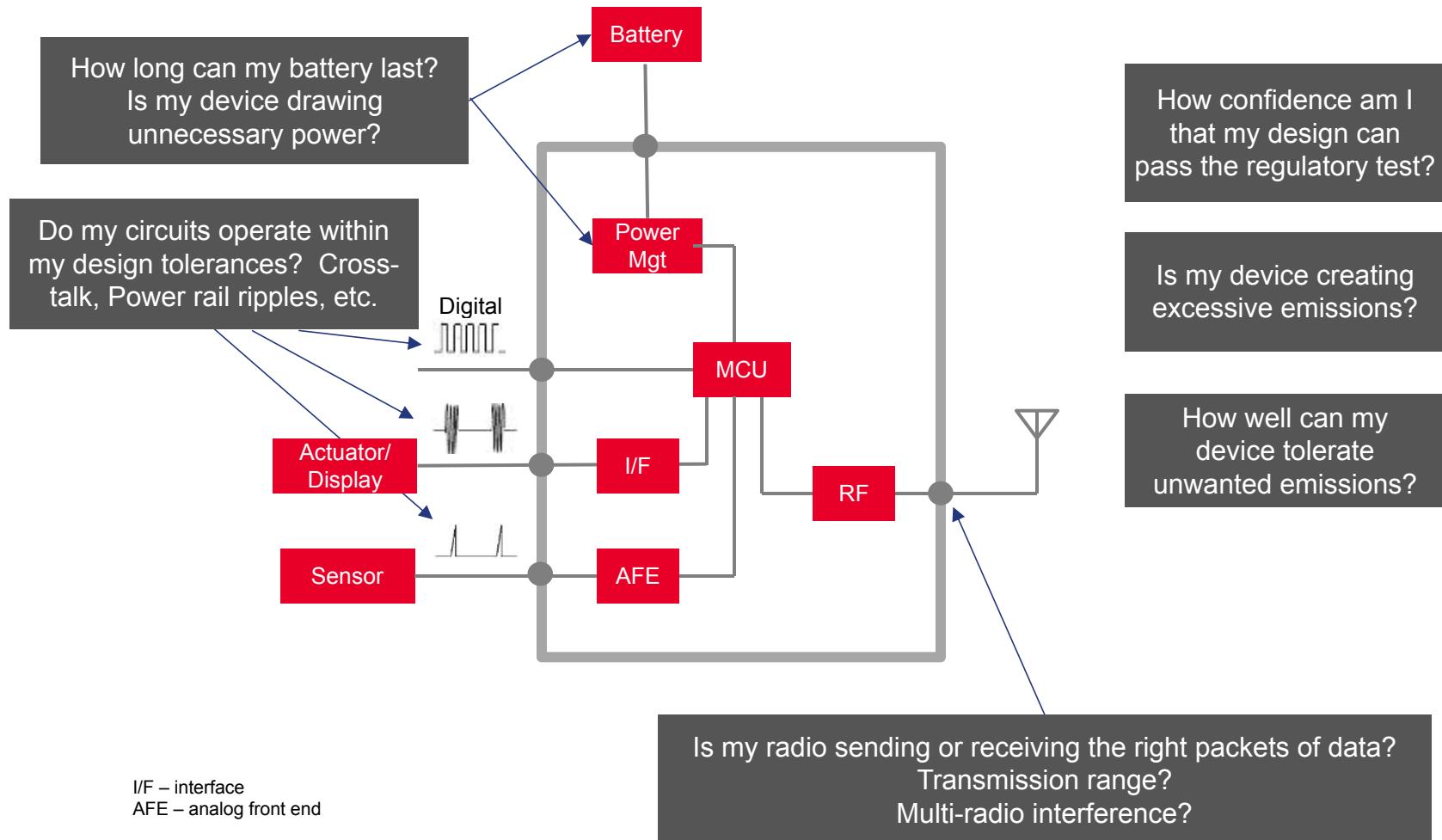
什么是“聪明”的设备

怎样才能变“聪明”

互联 高感知 强计算 续航持久 海量数据 冗余容错



IOT 测试挑战有哪些



IOT 测试挑战有哪些

互联 功耗 电源完整性 低成本测量

Maximizing battery life



Overcoming wireless, regulatory and interference challenges



Solving signal and power integrity issues



Balancing cost of test and test coverage



互联

案例一 NFC 手动和自动测试

NFC论坛

- | 由 NXP, Nokia , Sony于2004年发起成立
- | www.nfc-forum.org
- | 非盈利性组织
- | 推广NFC技术
- | 开发基于标准的NFC规范
- | NFC 品牌化
- | 制定认证程序



NFC应用 (Quelle: NFC Forum)

- | 移动式付费
- | 权限及访问控制
- | 数据传输与交换
- | 启动其他服务
- | 读取讯息
- | 购票



Connect Electronic Devices
“Touch to Connect”



Access Digital Content
“Touch to Read”



Make Contactless Transactions
“Touch to Transact”

互联

案例一 NFC 手动和自动测试 NFC传输技术总览

NFC Type		Coding	Modulation	Data rate	Frequency
NFC-A	Uplink	Modified Miller	2-ASK 100%	106 kbit/s	13.56 MHz
	Downlink	Manchester	Load modulation (ASK)	106 kbit/s	13.56 MHz \pm 848 kHz subcarrier
NFC-B	Uplink	NRZ-L	2-ASK 10%	106 kbit/s	13.56 MHz
	Downlink	NRZ-L	Load modulation (BPSK)	106 kbit/s	13.56 MHz \pm 848 kHz subcarrier
NFC-F	Uplink	Manchester	2-ASK 10%	212 / 424 kbit/s	13.56 MHz
	Downlink	Manchester	Load modulation (ASK)	212 / 424 kbit/s	13.56 MHz

Uplink = Poller to Listener

Downlink = Listener to Poller

互联

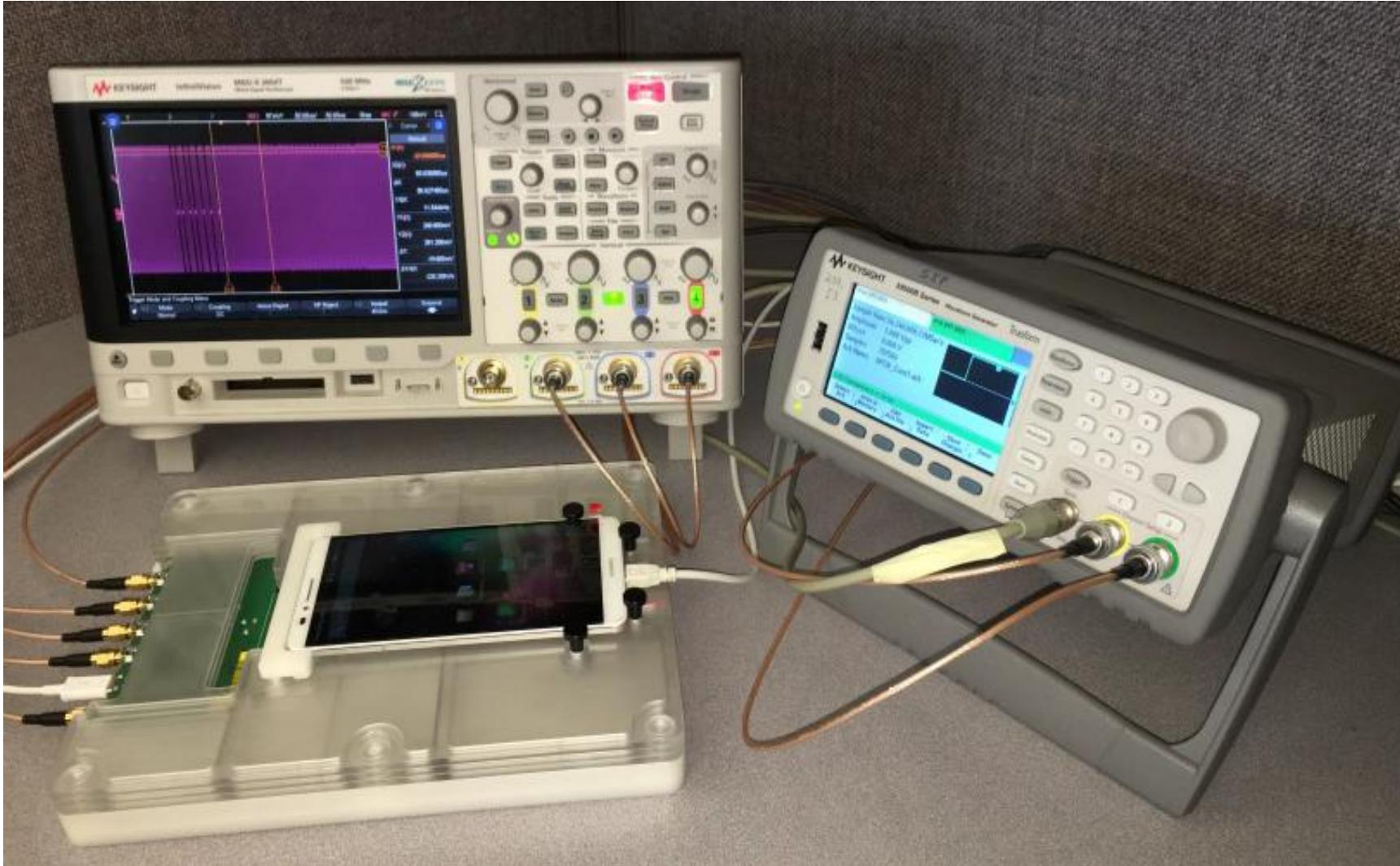
案例一 NFC 手动和自动测试

Table 1 Keysight NFC Test Coverage

Test	NFC-A	NFC-B	NFC-F (212 kbps)	NFC-F (424 kbps)
Listener Mode Tests				
Pass/Fail	√	√	√	√
Frame delay time (FTD)	√	√	√	√
Load modulation amplitude (LMA)	√	√	√	√
Response data	√	√	√	√
Poller Mode Tests				
Pass/Fail	√	√	√	√
t_1	√			
t_2	√			
t_3	√			
t_4	√			
t_5	√			
Data rate	√	√	√	√
Field strength (V_{ov})	√	√	√	√
Carrier frequency (F_c)	√	√	√	√
Modulation depth	√	√	√	√
Modulation index	√	√	√	√
Response data	√	√	√	√
Overshoot	√	√	√	√
Undershoot		√	√	√
Rise time (t_r)		√	√	√
Fall time (t_f)		√	√	√
Resonant Frequency Test (F_r)	√			

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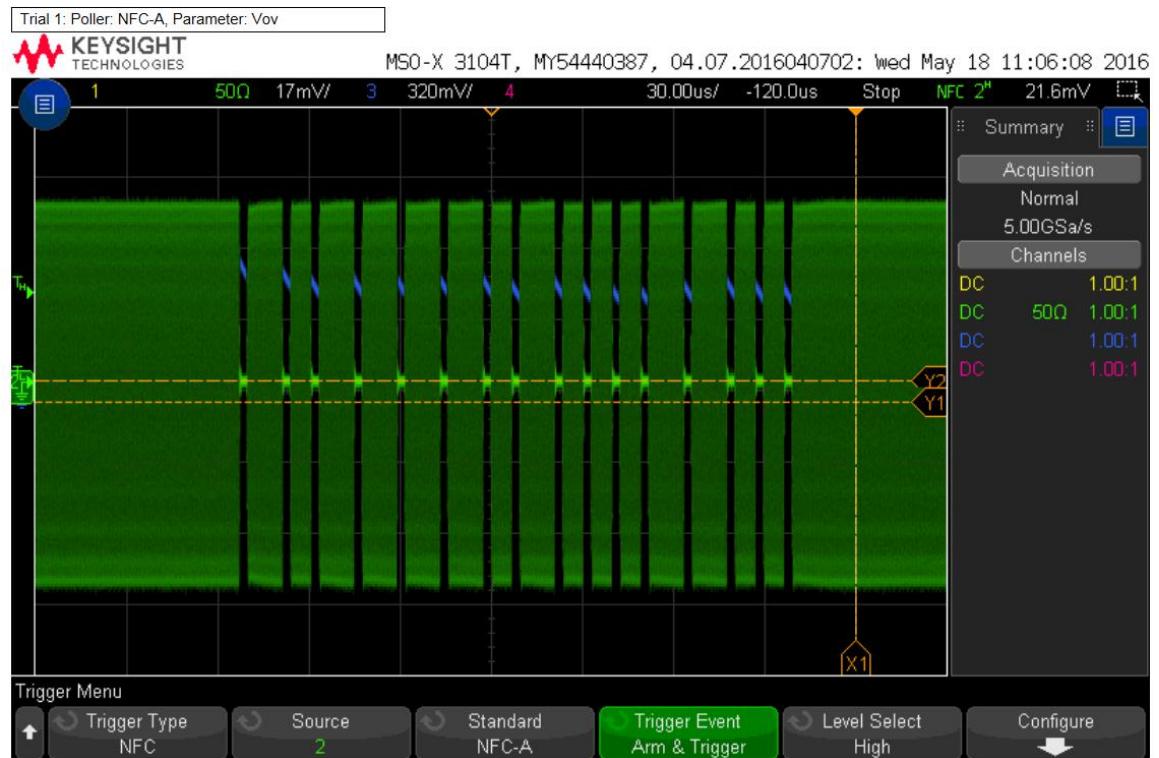
案例一 NFC 手动和自动测试



互联

案例一 手动 NFC Poller test

- Field Strength
- Carrier Frequency
- t_1, t_2, t_3, t_4, t_5 (NFC-A)
- Modulation Index
- Overshoot /Undershoot
- Response Data
- Data Rate
- T_f / T_r (Rise/Fall time)



互联

案例一 NFC 自动测试

NFC Test Application -- NFC Device 1						
File View Tools Help						
Set Up	Select Tests	Configure	Connect	Run		
Test Name	Actual Value	Margin %	Pass Limits			
✓ Poller: NFC-A, Parameter: Vov	1.390 V	178.0	VALUE >= 500 mV			
✓ Poller: NFC-A, Parameter: Fc	13.5582 MHz	41.0	13.5500 MHz <= VALUE <= 13.5700 M			
✓ Poller: NFC-A, Parameter: t1	2.6 μ s	44.4	2.1 μ s <= VALUE <= 3.0 μ s			
✓ Poller: NFC-A, Parameter: t2	1.9 μ s	20.0	1.8 μ s <= VALUE <= 2.3 μ s			
✓ Poller: NFC-A, Parameter: t3	328 ns	2.9	LIM_MANF_PollerA_t3_MIN s <= VALUE <= LIM_MANF_PollerA_t3_MAX s			
✓ Poller: NFC-A, Parameter: t4	202 ns	54.1	VALUE <= 440 ns			
✓ Poller: NFC-A, Parameter: t5	0.000000000 s	100.0	VALUE <= 500 ns			
✓ Poller: NFC-A, Parameter: Modulation Depth	99.50 %	4.7	VALUE >= 95.00 %			
✓ Poller: NFC-A, Parameter: Modulation Index	99.00 %	10.0	VALUE >= 90.00 %			
✓ Poller: NFC-A, Parameter: Overshoot	37 m%	99.8	VALUE <= 20.000 %			
✓ Poller: NFC-A, Parameter: Response Data	01100100110000010000	100.0	VALUE = 1			
✓ Poller: NFC-A, Parameter: Data Rate	105.925 kbps	47.5	104.500 kbps <= VALUE <= 107.500 kbps			
Parameter	Value					
Poller: NFC-A, Parameter: t2	1.9 μ s					

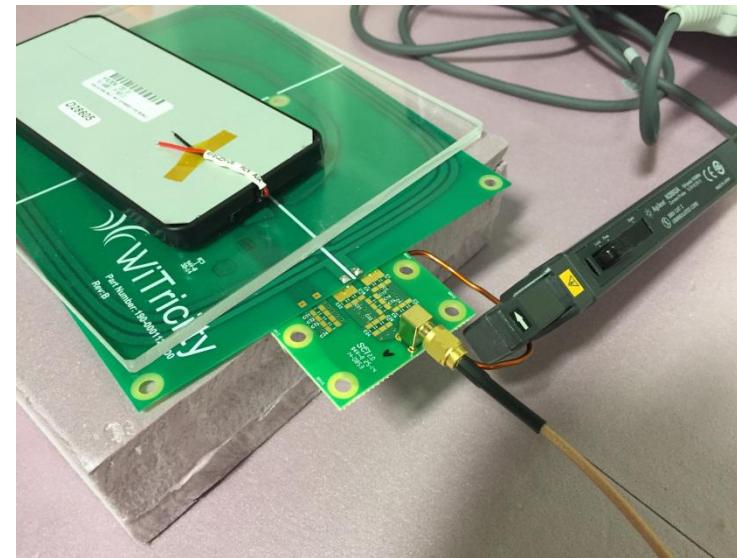
案例二：无线充电 A4WP 磁共振

Key sight Offering	Recommended Models	Qty	R A T Ref.	Remark	
VNA	● VNA Selection:				
VNA For Compliance?	Low-power	High-power			
Yes	<ul style="list-style-type: none"> ● E5072A/(245 or 285)/006 or ● E5071C/240 (require manually calculation) or ● Equivalent E5061B/3L5/005/006 or E5063A/205/006 				
No	<ul style="list-style-type: none"> ● E5072A/(245 or 285)/006 or ● E5061B/3L5/005/006 (LCR/VNA in one) or ● E5063A/205/006 (Economic) or ● E5071C/240 (require manually calculation) or ● E5080A/245 (require manually calculation) <p>If need accurate Z measurement or high Q (>100): We can further sell either E4990A/010 (or 020 to also cover NFC @13.56MHz) or 16047E fixture to use with E5061B For high-volume test, we can add 42941-60002 SMA probe head to raise the throughput</p>	E5072A/(245 or 285)/006	1	4.1.2 4.6.2	<ul style="list-style-type: none"> ● RAT Compliance: E5072A, E5071C (equivalent E5061B/E5063A) ● Opt.006 support: E5072A, E5061B, E5063A ● Require manually calculation: E5071C, E5080A
Attenuator	2x 8493A Coaxial Fixed Attenuator (to protect the VNA inputs from excessive input power) (Optional)	2	4.6.2		
Cal Kit	1x Ecal 85093C (stated in 4.1.2) or cheaper mechanical cal kit 85033E (stated in 4.6.2)	1	4.1.2 4.6.2		
Cables	<ul style="list-style-type: none"> ● 2x 11500F or Z5623A-K20 (RG316 Cables without Chokes, Maximum length: 3 meters、SMA(m)) ● 7x 11500F or Z5623A-K20 (RG36 SMA Coax Cable, slim and flexible cable should be used to wind cable around choke 5 times) 	2 7	4.1.2 4.6.2	Totally 9 SMA(m) cables	
Adaptors	2x 1250-1744, N (m) to SMA (f) adapters	2	4.1.2		
Torque Wrench	1x 8710-1761, SMA torque wrench	1	4.1.2		
Function Gen	1x 33510B (dual channel) Function Generator	1	4.3.2		
Digital Multimeter	1x U1270 Series Handheld DMM (Recommend U1273A OLED, or U1273AX, U1272A)	1	4.3.2 4.6.2		
Oscilloscopes	1x DSOX3014T (at least 100 MHz bandwidth and 2 Giga Samples/Second resolution) for all current measurement Recommended: If also need RCE measurement, then D(M)SOX4024A or above is required)	1	4.3.2 4.6.2	4.3.2 need better scope, can upselling D(M)SOX4024A or D(M)SOS054A for efficiency test and good PI performance and it's better than Tek's MSO4014B and TCP0030 probe	
AC Current Probe	2x N2893A 100MHz/15A AC/DC Current Probe (rated at least 5 Amps RMS at 6.78 MHz, bandwidth 50 MHz or more)	2	4.6.2	May need accessories using with different scopes	
HV Diff Probe	2x HV Diff Probe - N2790A, 100 MHz, 50:1/500:1, ±1,400V, HV Diff Probe	2	4.6.2		
De-skew Fixture	1x U1880A Power measurement de-skew fixture for voltage and current probes (or cheaper custom-made de-skew fixture that consists of just one 10-Ω resistor and a BNC-to-grabber adapter)	1	4.6.2		Automotive Testing China 2017

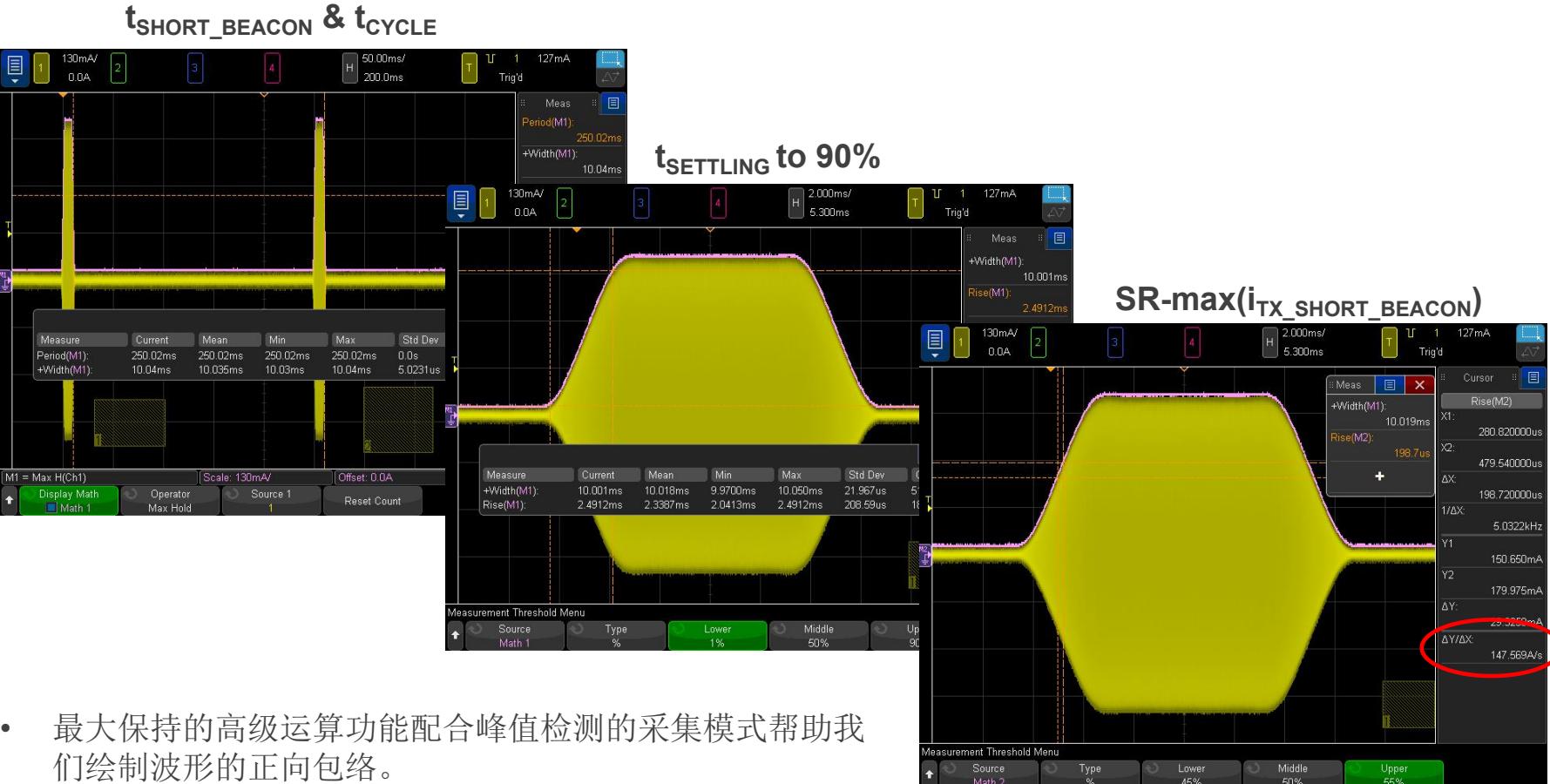
互联

案例二： 无线充电

- 谐振电流(I_{TX_COIL})
 - 功率传输状态 (Min, Max, Absolute max, Nominal, etc.)
 - 省电模式 ($I_{TX_SHORT_BEACON_MIN}$ & $I_{TX_LONG_BEACON_MIN}$)
 - 谐振器频率测量 (6.78 MHz ±15 kHz)
 - 斜率 (mArms/ms) & 建立时间
- 信标时序
 - t_{SHORT_BEACON}
 - t_{LONG_BEACON}
 - t_{CYCLE}
 - $t_{LONG_BEACON_PERIOD}$
- 功率和效率测量 (非一致性)
 - 功率传输单元真实功率 (P_{TX_IN})
 - 功率接收单元真实功率 (P_{RX_OUT})
 - 谐振耦合效率(RCE)
 - 系统效率 ($\eta = P_{RX_OUT}/P_{IN(DC)}$)



案例二： 无线充电 短信标参数测量

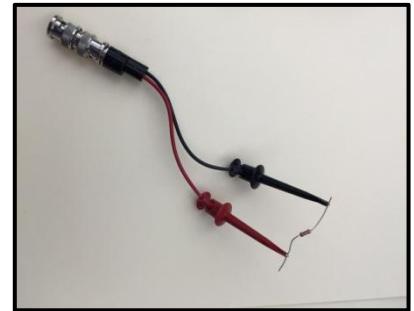
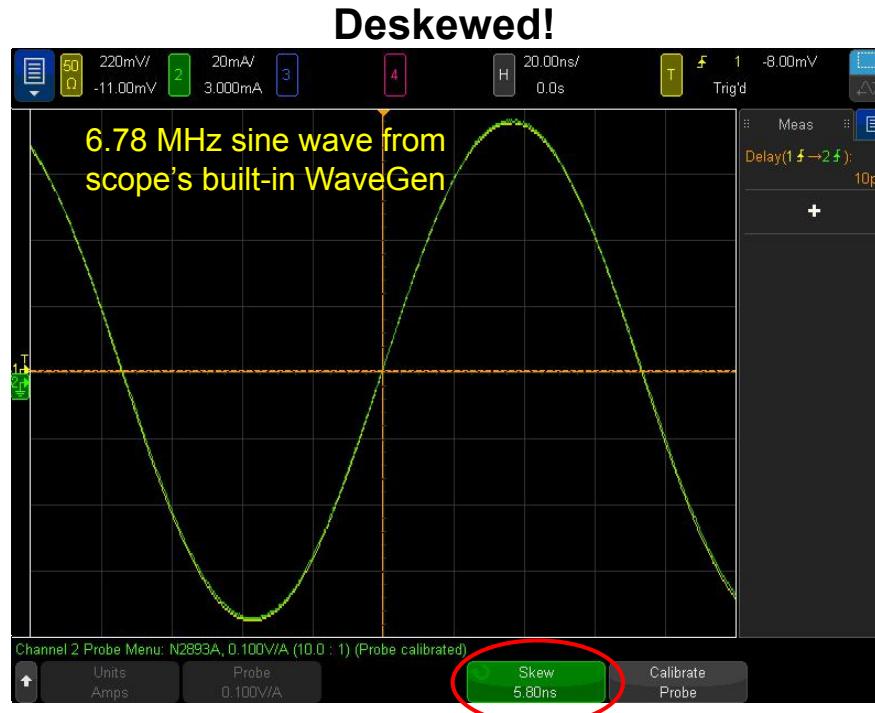
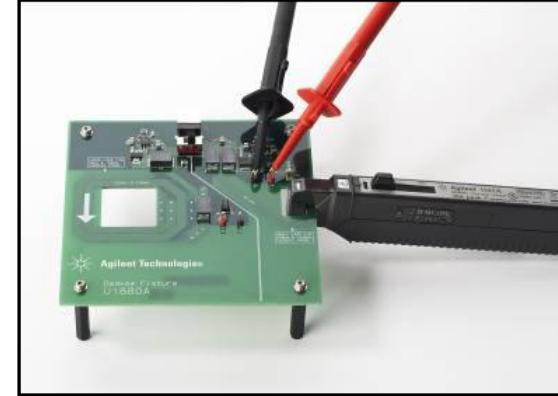


- 最大保持的高级运算功能配合峰值检测的采集模式帮助我们绘制波形的正向包络。
- 我们可以在包络波形上进行脉宽，周期以及上升时间的测量。
- 用户自定义阈值电平来测量建立时间和上升斜率。

互联

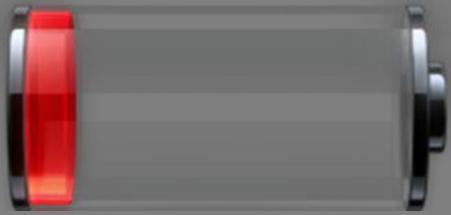
案例二： 无线充电

- 时间延迟校准对于准确的功率测量 power ($V \times I$) 非常重要。
- 校准夹具(or a 10- Ω resistor) 配合功率分析软件可以自动对电压探头以及电流探头的时间进行校准确保我们进行准确的功率测量.。



电池和功耗

案例三：低功耗测试

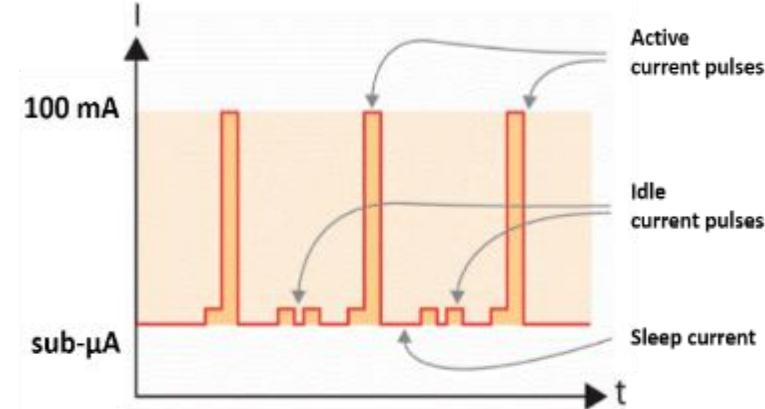


Battery Low...
Shutting Down

电池和功耗

案例三：低功耗测试

1. Extremely low levels during sleep mode
2. Large amplitude shifts in active mode
3. Narrow pulses require high bandwidth
4. Connections to DUT can impact results



Current draw by a wireless Blood Pressure Monitor

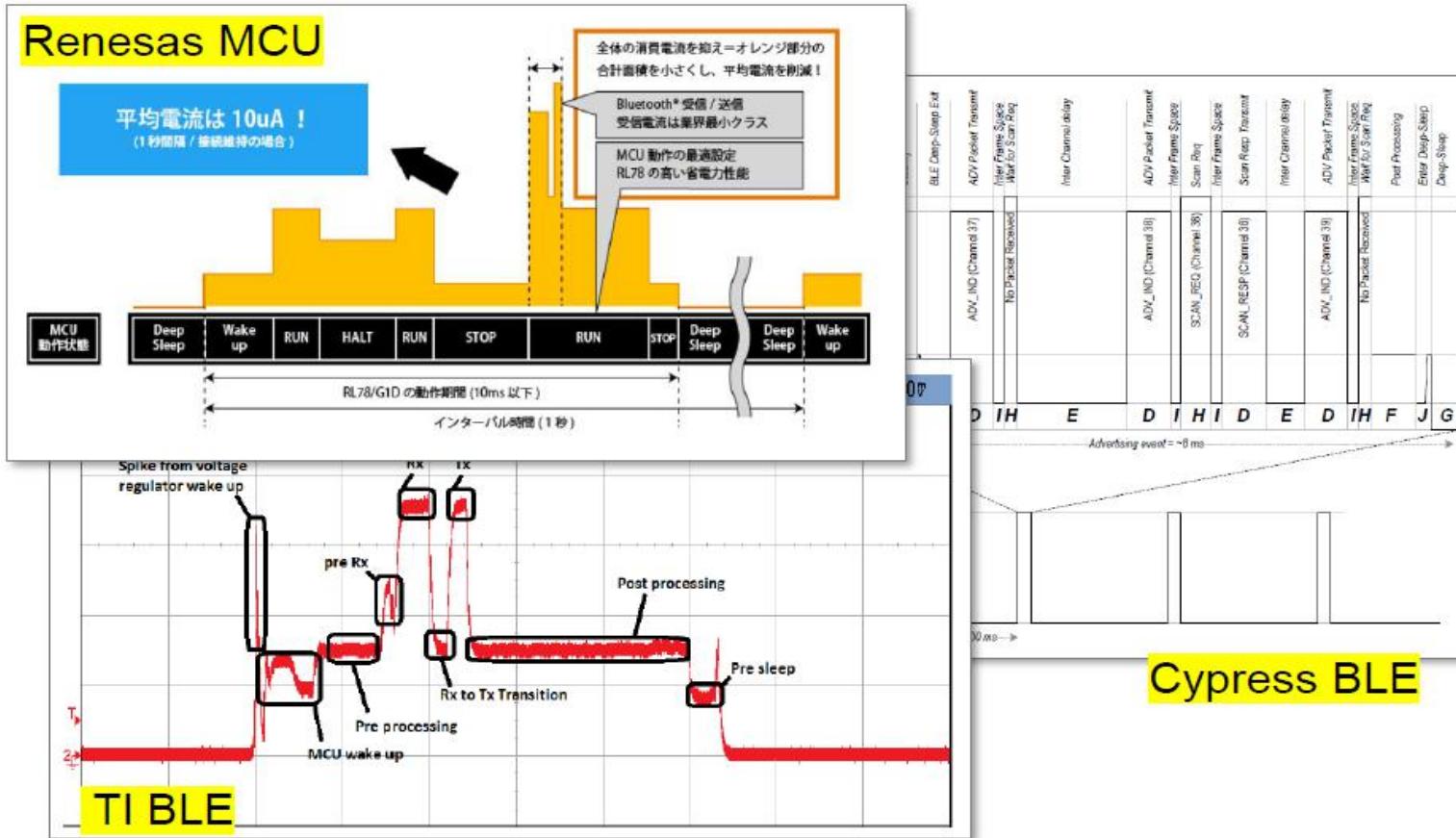


Current draw by a wearable fitness band

电池和功耗

案例四： 蓝牙收发模块和MCU功耗分析的终极武器

- 功耗测试通常需要多次测试，并进行功耗调试和优化
- 可以依照已知的电流变化特征，或时间特征来调整功耗特性列表



电池和功耗

IOT 电池和功耗测量方案对比

	34470 DMM	N2820A scope probe	N6705C + N6781A	B2900 SMU	CX3300 DCWA
Display size	4.3"	Scope dependent	5.9"	4.3"	14.1"
BW, sample rate	17 kHz, 50 kSA/s	500 kHz, 5 Gsa/s	29 kHz, 200 kSa/s	10 kHz, 100 kSa/s	140 MHz, 1 GSa/s
Meas. Res	14 bits	14 bits	18 bits	20 bits	14 bits
Min measurable static current	10 pA	500 nA	800 nA	1 pA	150 pA
Min measurable dynamic current	10 nA	500 nA	1.4 uA	10 fA	150 pA
Max meas current	10 A	5 A	3 A	3 A	10 A
Min/Max source current	None	None	3 A	3 A	None
Burden voltage	27 mV	1 mV	0 mV	0 mV	4 mV
Price	+	++	++	++	++++
Typical use	R&D / Mfg	R&D	R&D / Mfg	R&D	R&D

电池和功耗

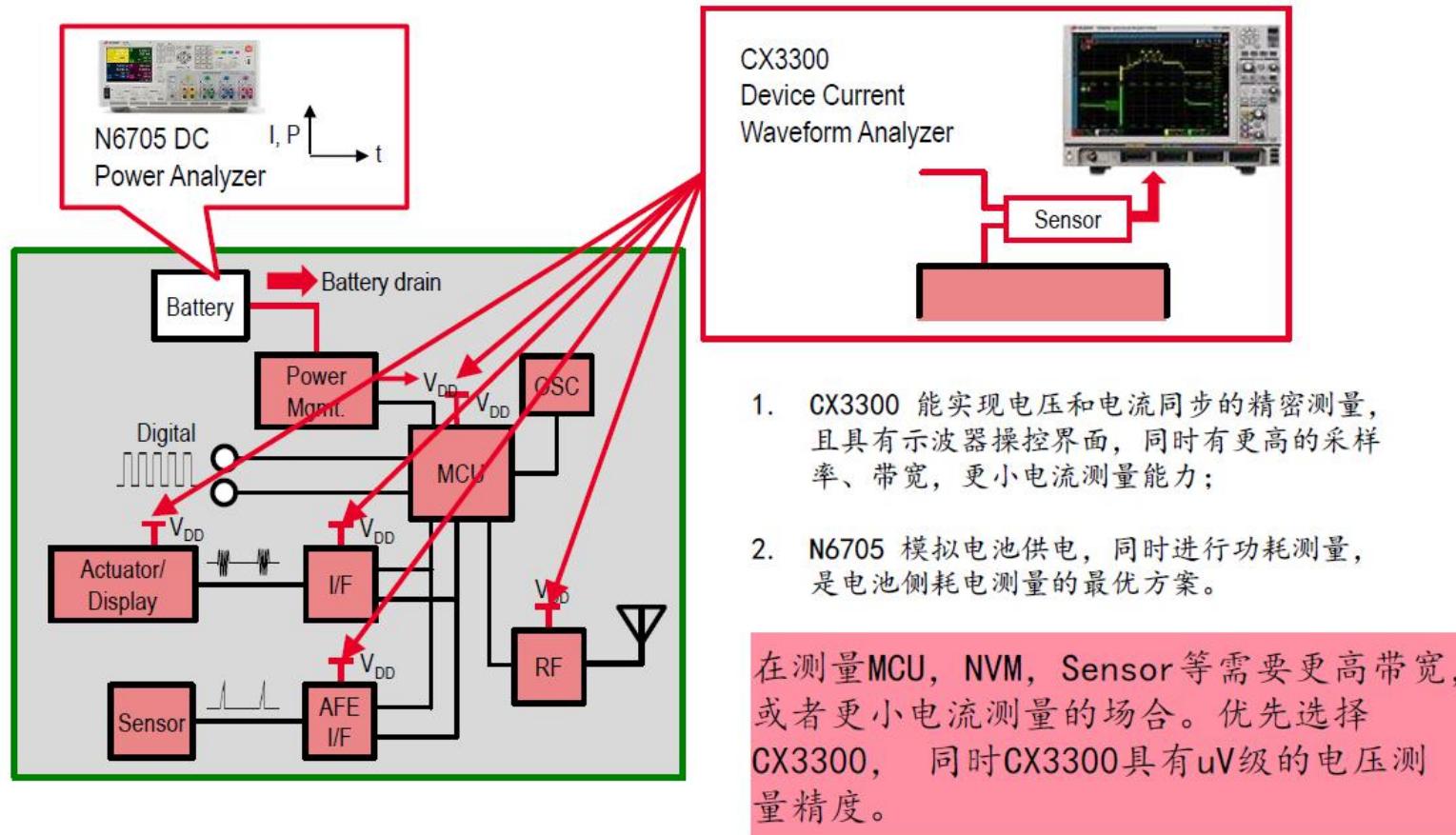
案例三：低功耗测试



电池和功耗

案例四：功耗分析工具的对比

CX3300 与 N6705 两者的异同

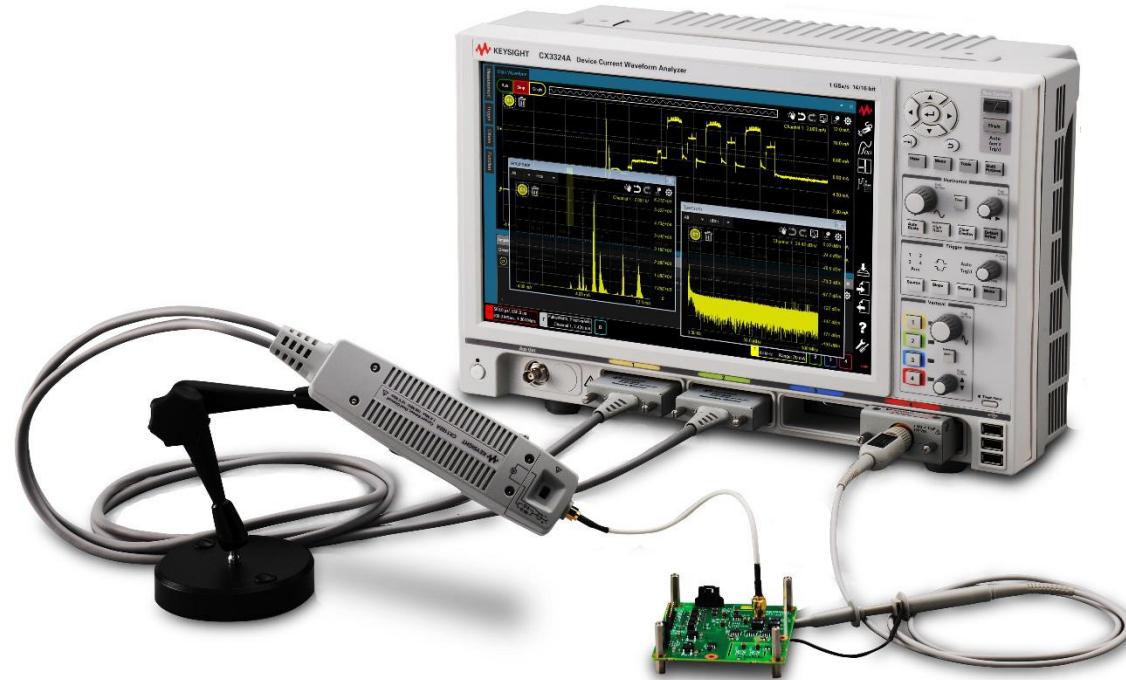


电池和功耗

案例四：难以望其项背的性能

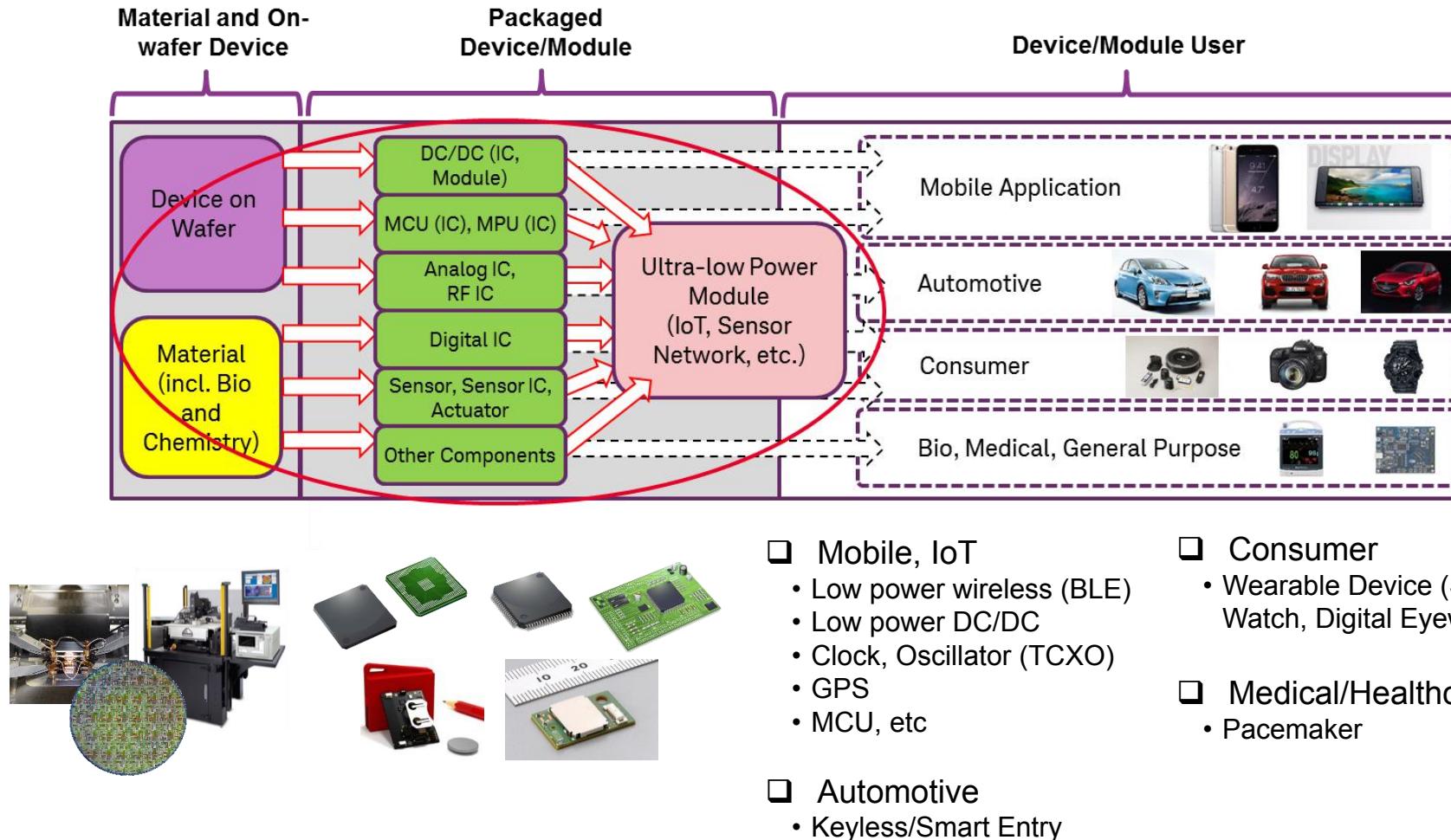
主要指标

- 测试电流范围：10A 至150pA
- 采样速率：1GSa/s
- 测量带宽：200MHz
- 测量动态：14比特（高速模式）
16比特（高分辨率模式）
- 存储深度： 256M pts/通道
- 通道数：2或4通道
- 电压测量： 噪声(RMS) < 90uV



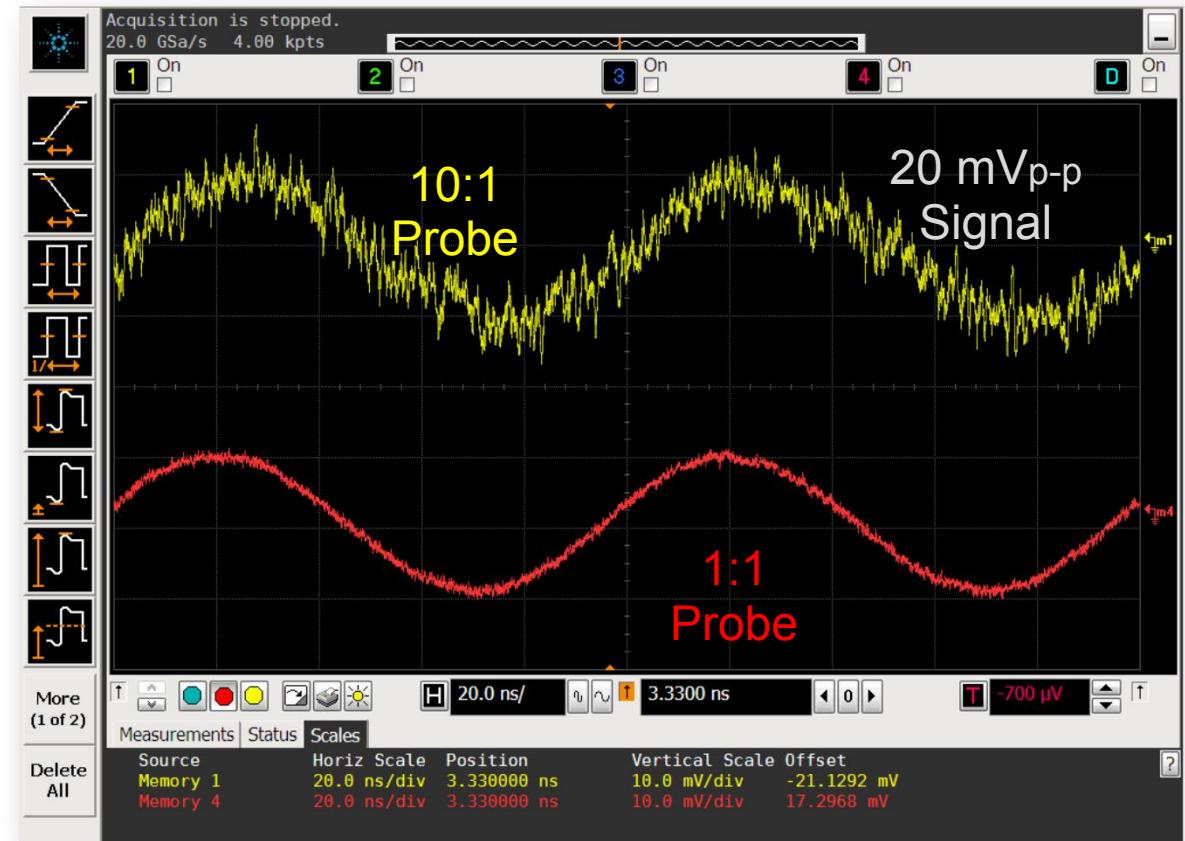
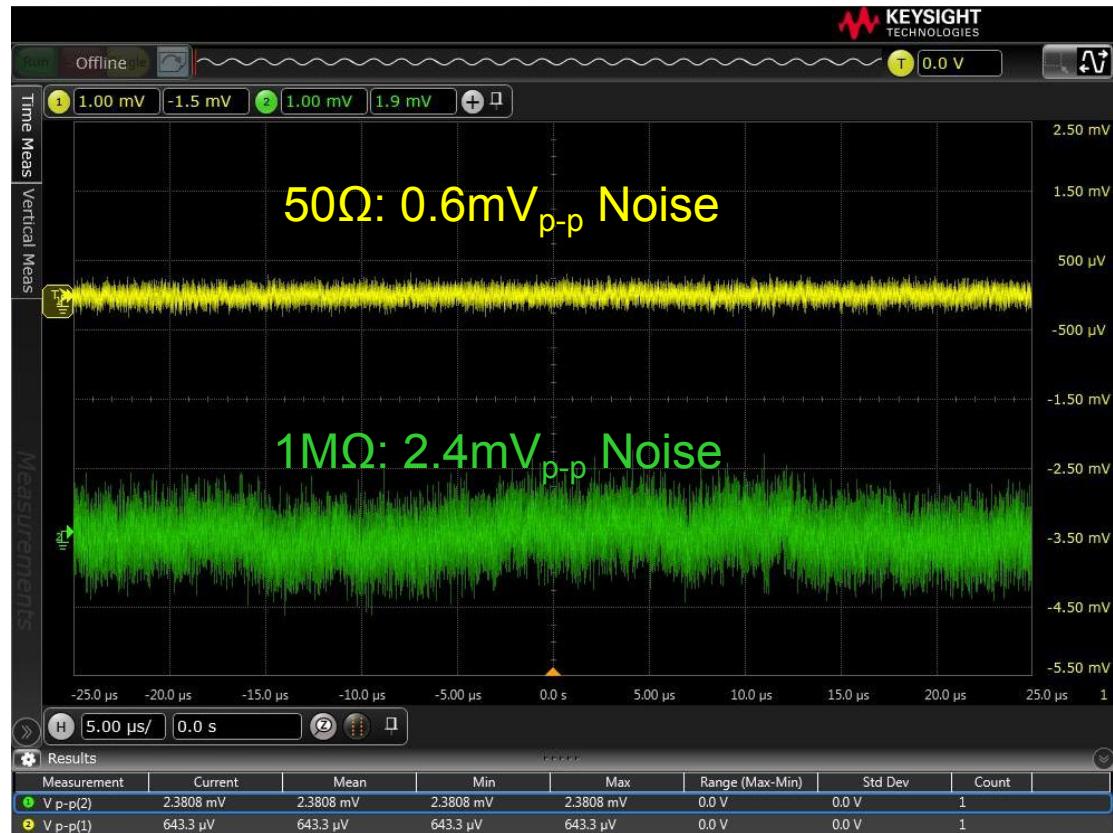
精密动态电流分析系统目标用户

Low Power ICs (Battery Powered Device)

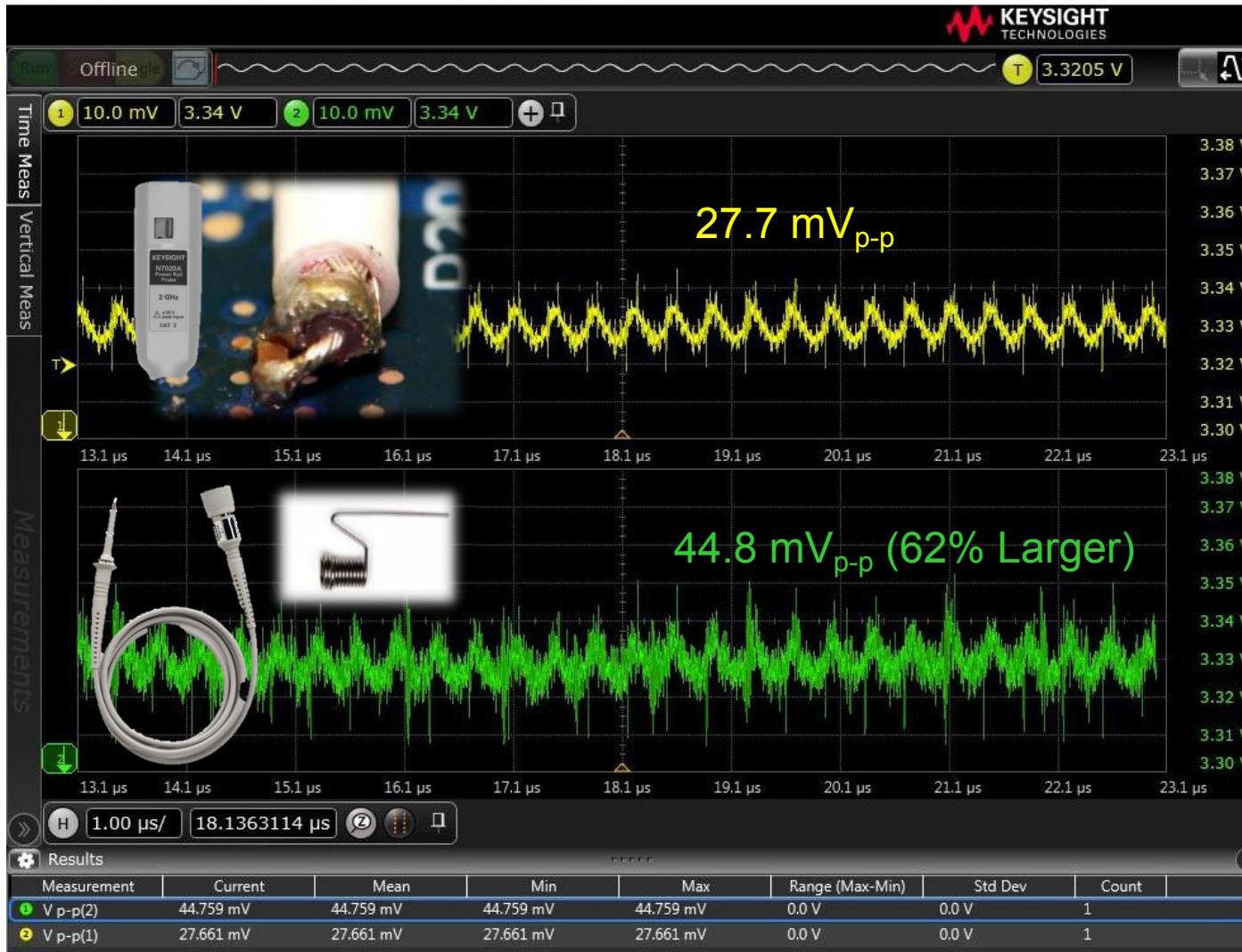


电源完整性

示波器端接与探头

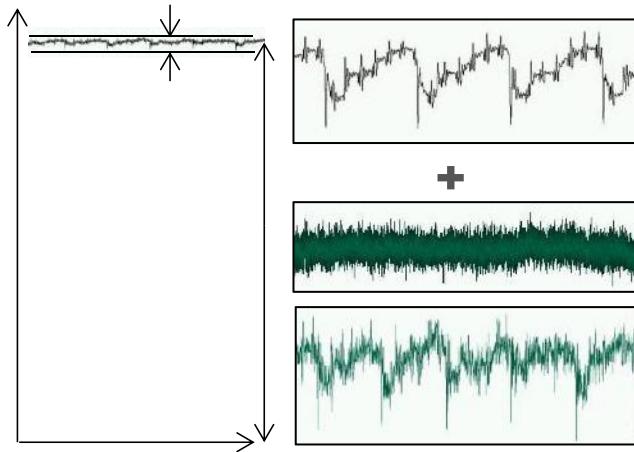


电源完整性 接地线的处理



电源完整性

专用电源完整性探头



1. Measurement system noise
2. Large signal offset
3. Adequate bandwidth
4. Low Loading

1. 50Ω Termination
2. 1:1 Attenuation ratio
3. Minimal ground loop area
4. DC offset
5. High bandwidth
6. Large DC input Impedance

Characteristics and Specifications: N7020A Power Rail Probe

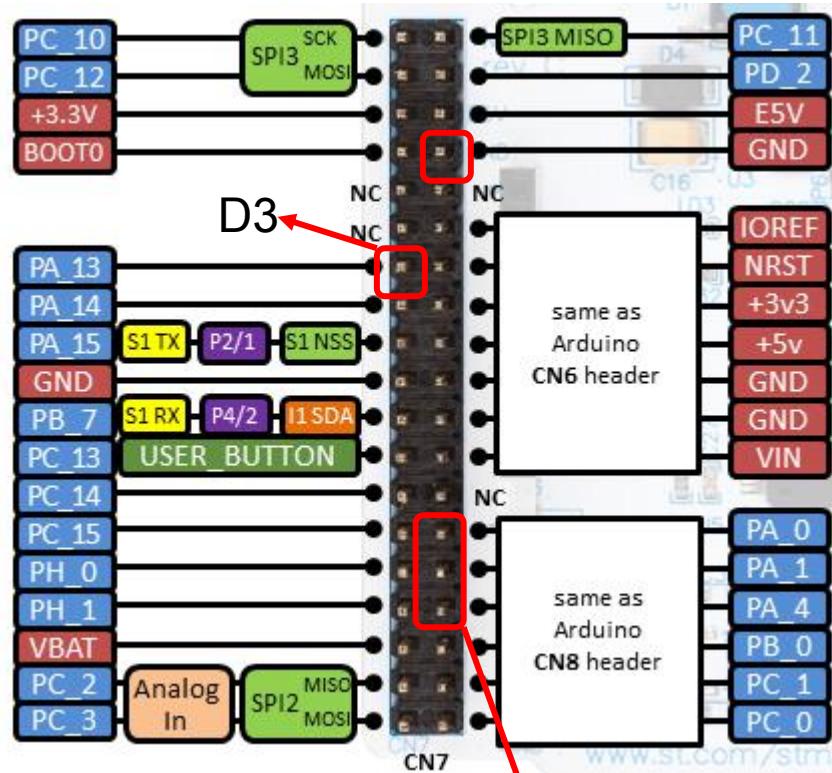
Termination	50Ω
Attenuation Ratio	1:1
Connection Accessories	N7021A—Coaxial Pigtail Probe Head N7023A—350MHz Browser
Offset Range	± 24V
Probe Bandwidth (-3dB)	2GHz
* Input Impedance @ DC	50kΩ +/-2%



电源完整性

案例五：IOT 开发板测试体验

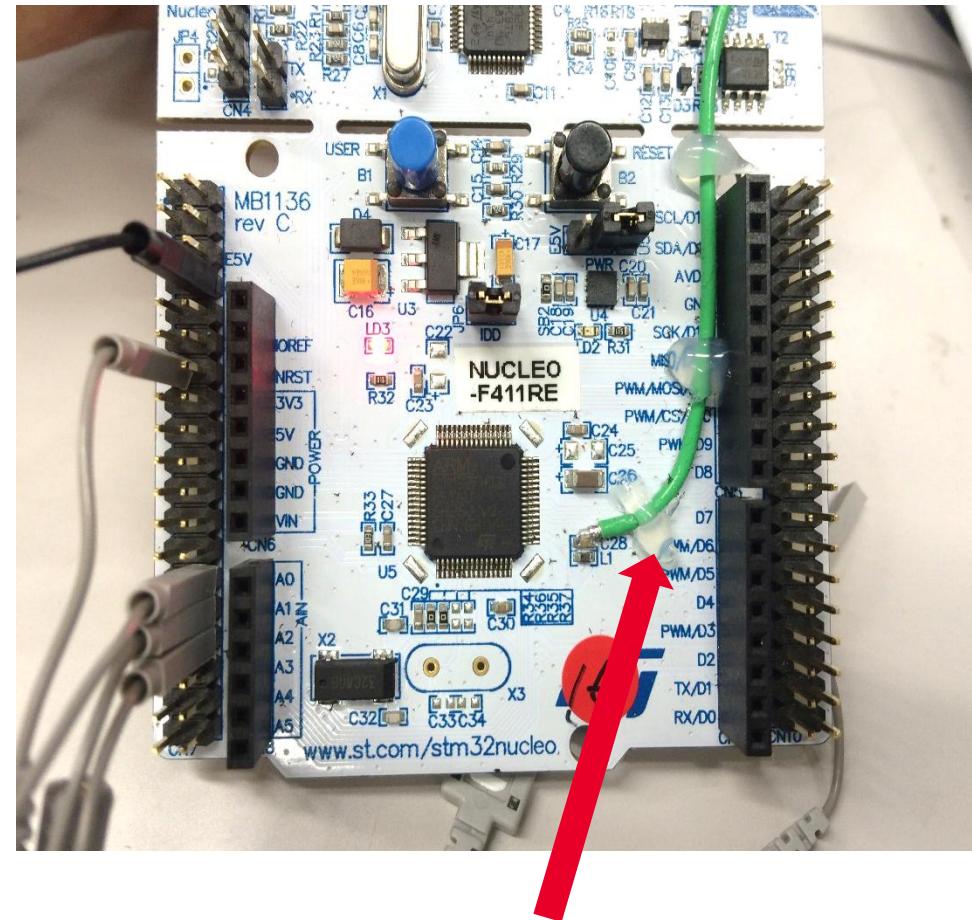
MSO digital channel



D2

D1

D0



N7021A Pigtail, 2X soldered to C28 (only one shown so connection is easier to see)

电源完整性

案例五：IOT 开发板测试体验



电源完整性

如何选择正确的探头测量小信号

N2820A特性

- 量程和动态范围由所使用的前端附件决定
 - 最小可测电流: 500nA
 - 最大可测电流: 5 A
 - 动态范围最大超过 20,000:1
- 带宽
 - 3 MHz 全局通道
 - 500 kHz 局部细节放大通道
- 前端连接部分可更换阻值: 20 mΩ, 100 mΩ 以及 用户自定义模组
- 新的自动测量项目 – 特定时间范围内的电流消耗 (AmpH)
- 相容 InfiniiVision 3kX, 4kX, 6kX 以及 Infiniium S, 9k, 9kX/Q/Z (with N5449A)

N2820A 双通道



- 500 mW
- 50 μA - 2.2 A
- ± 1% tolerance
- For higher sensitivity, bandwidth and lower noise
- Order N2824A for replacement head

100 mΩ



是德科技电流测试方案



300A ~~3000Aac



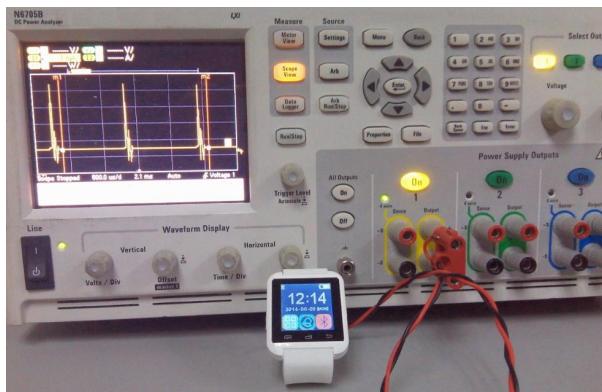
5mA ~~700A



1mA ~~30A



500nA ~~5A

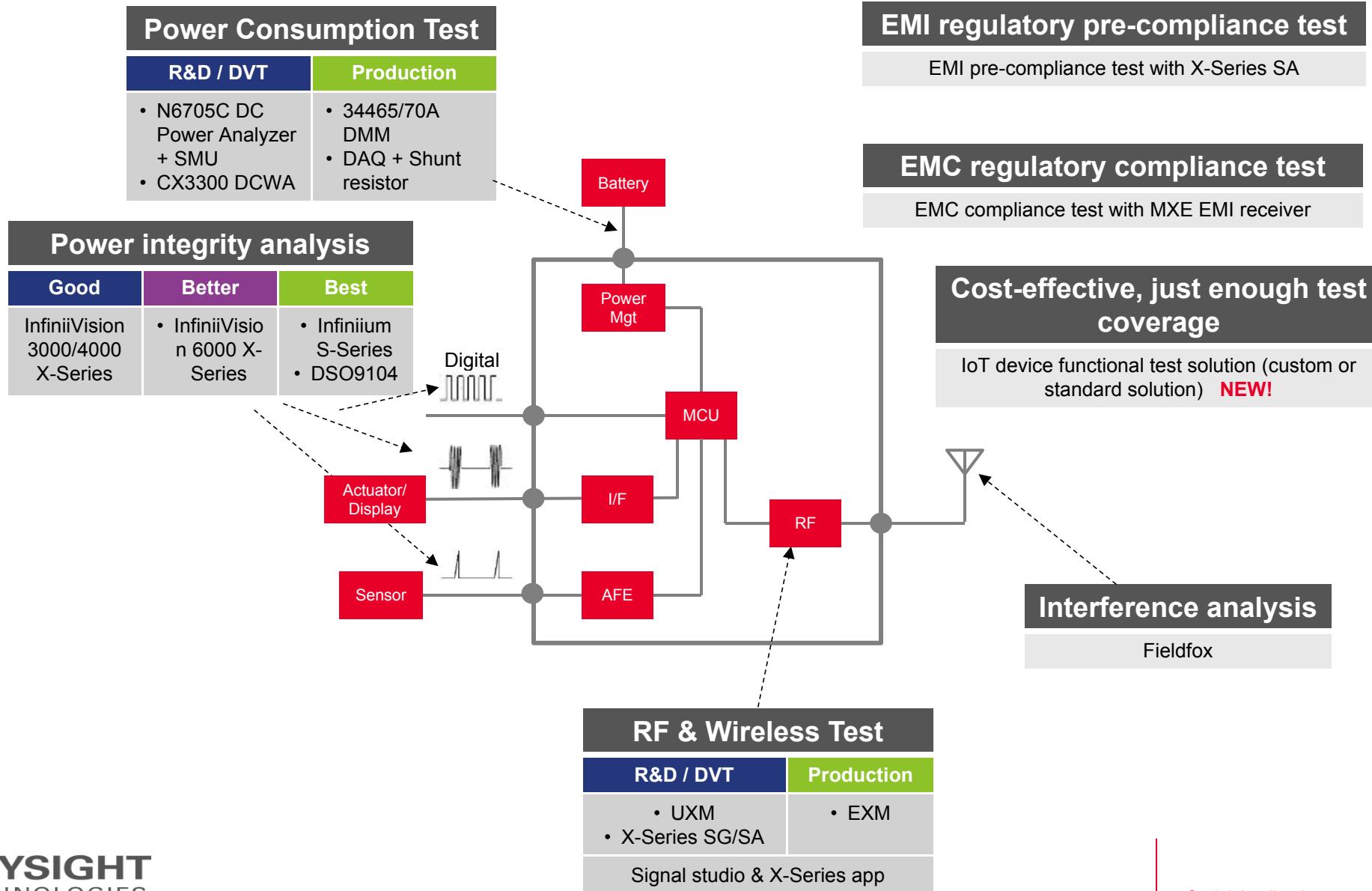


80nA ~~3A



150pA ~~10A

应对IOT 测试挑战有哪些



BenchVue & TestFlow 你的测试够聪明吗？

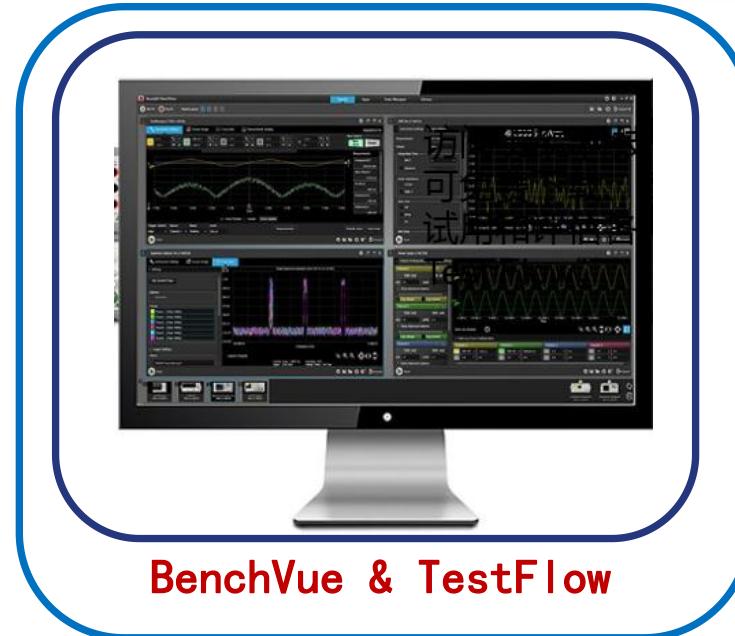
磁材，变压器、
线圈测试



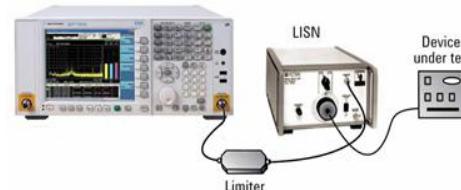
开关器件、纹波、
频响分测试析



交流，直流电源
稳态和瞬态供电



精确功率、谐波测试



传导、辐射、EMI测试

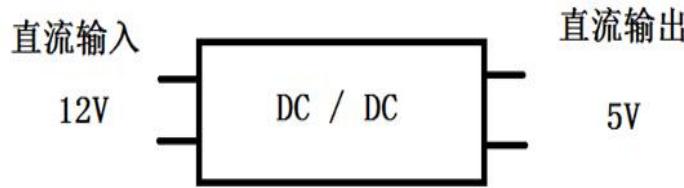


电子负载



温度特性测试

你还在做效率和纹波测量？



输入电压: 标称12V, 范围5-18V
输出电压: 5V
输出电流: < 2A
输出效率? 纹波噪声? 输出电压波动范围?

Vin	Iload	lin	Vout	Pin	Pout	Eff	Vpk-pk
5Vdc	0.5A						
5Vdc	1A						
5Vdc	1.5A						
5Vdc	2A						
12Vdc	0.5A						
12Vdc	1A						
12Vdc	1.5A						
12Vdc	2A						
18Vdc	0.5A						
18Vdc	1A						
18Vdc	1.5A						
18Vdc	2A						



- 请问这组参数测试共有多少组数据？
- 请问你用多长时间完成这组参数的测量？



$$3 \text{ (V)} \times 4 \text{ (I)} \times 6 \text{ (S)} = 72$$

老化测试？



TestFlow 测试程序流APP



详细的测试数据文件



Questions?

Page

Thank you!
谢谢