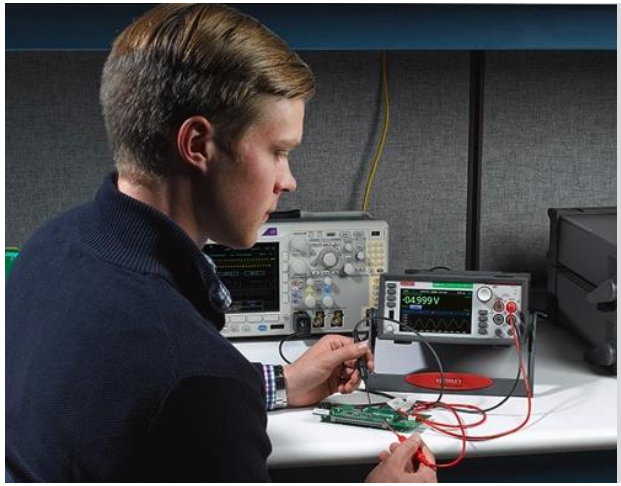
物联网设备的低功耗测试和优化

Low Power Consumption Testing Challenges and Solutions

With Keithley DMM7510 and 2280S



Touch, Test, Invent®

KEITHLEY
A Tektronix Company

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物联网设备电池优化

Low Power Consumption Testing Challenges and Solutions

市场 (Market)	IoT/Wearable
应用 (Application)	DC Power Consumption
解决方案（Solution)	DMM7510+2280S combo
竞争 (Competition)	External Competition
总结 (Conclusion)	4 Pager
演示 (Demonstration)	Smartwatch

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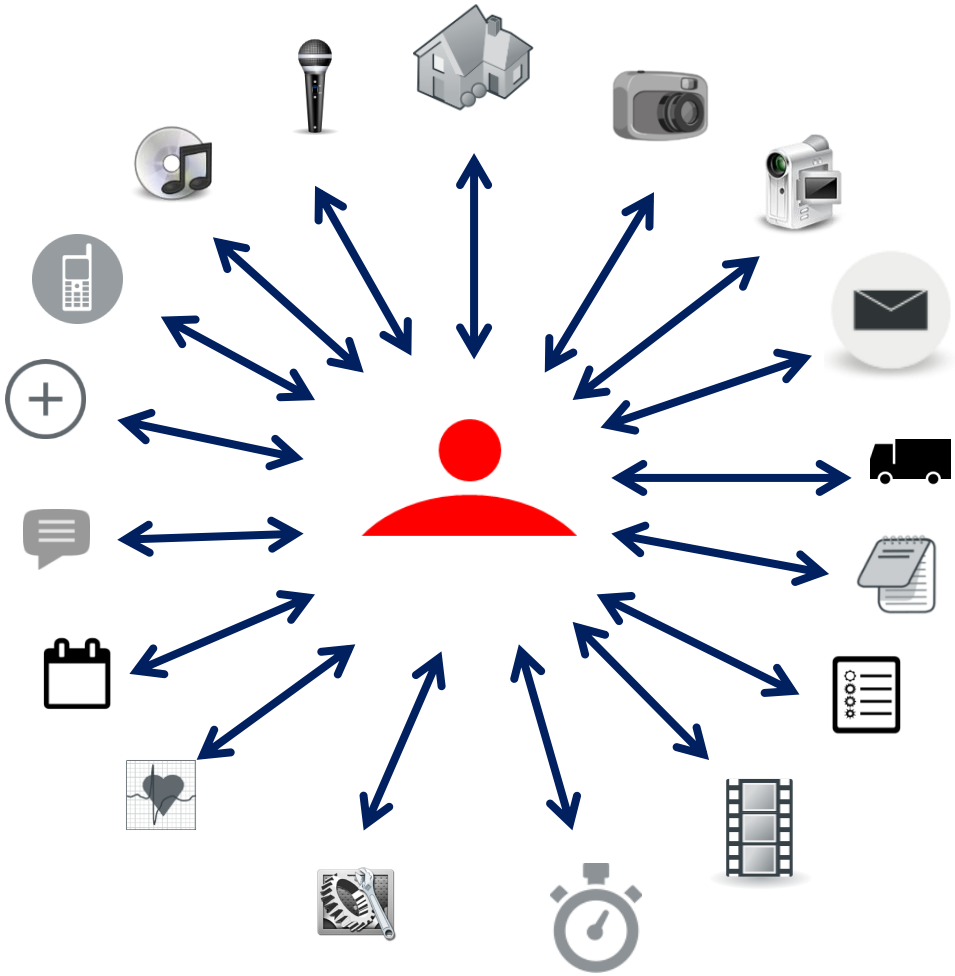
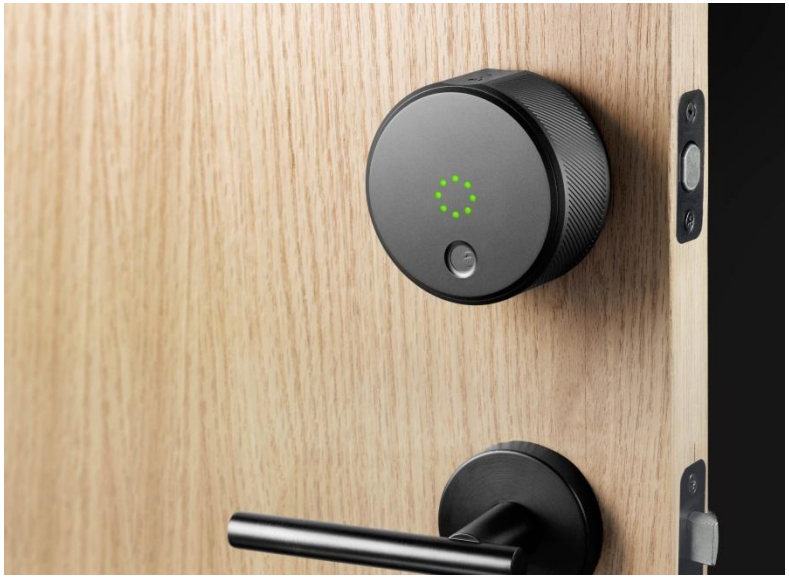
物联网（IoT)的定义



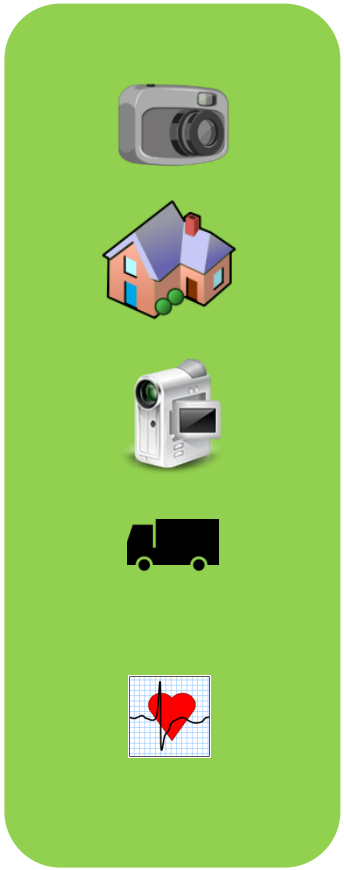
物联网：现下发展的趋势
Cisco:
250 亿的设备 2015
500 亿的设备 2020
McKinsey:
27-65亿美金的市场

Market Drivers

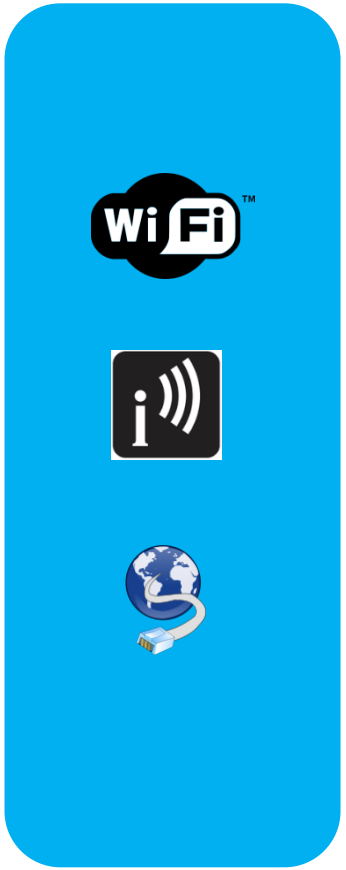


概况
系统中的关键组成

设备

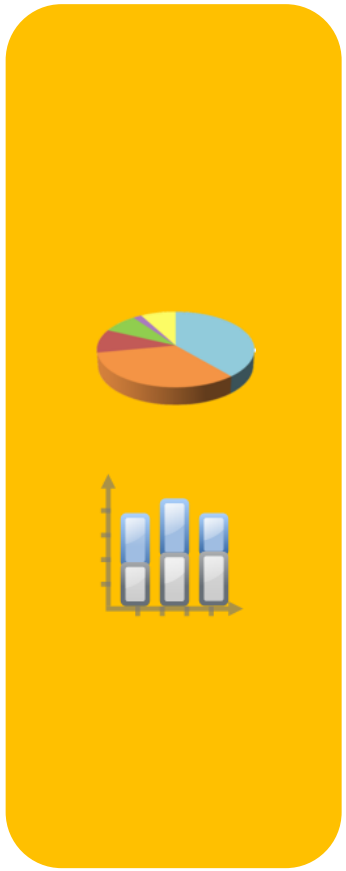


连接

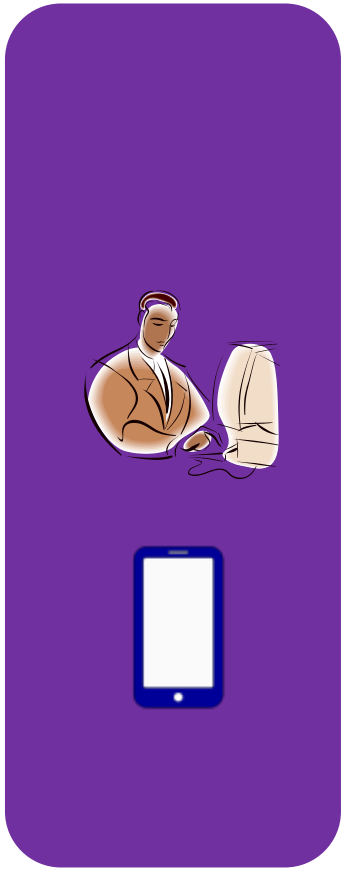


云

数据分析



控制



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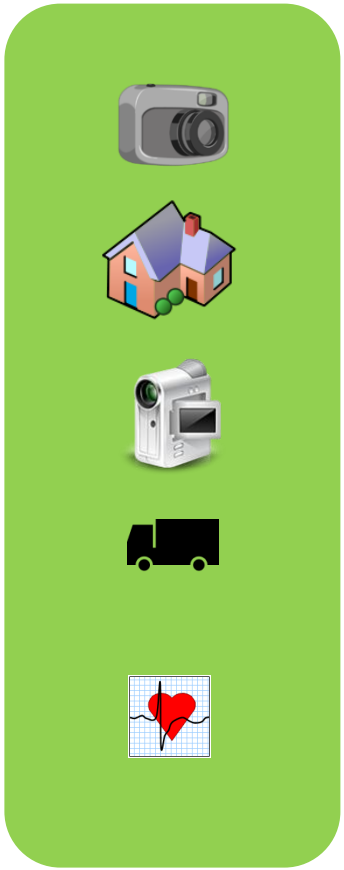
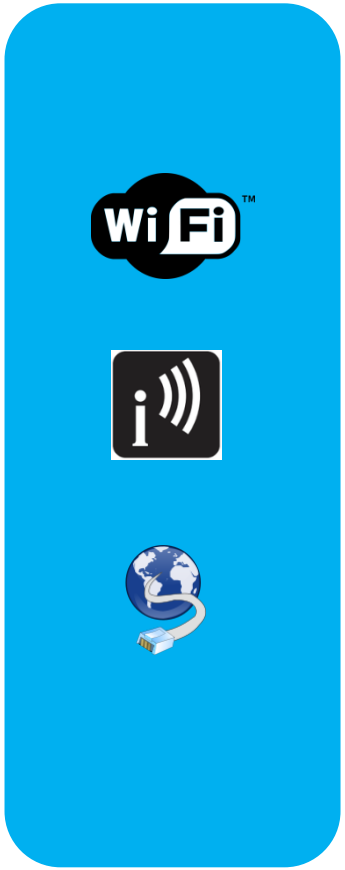


连接



- 3个重要的主题:
  - 设备的设计
  - 功耗测试
  - 连接测试

物联网设备电池优化

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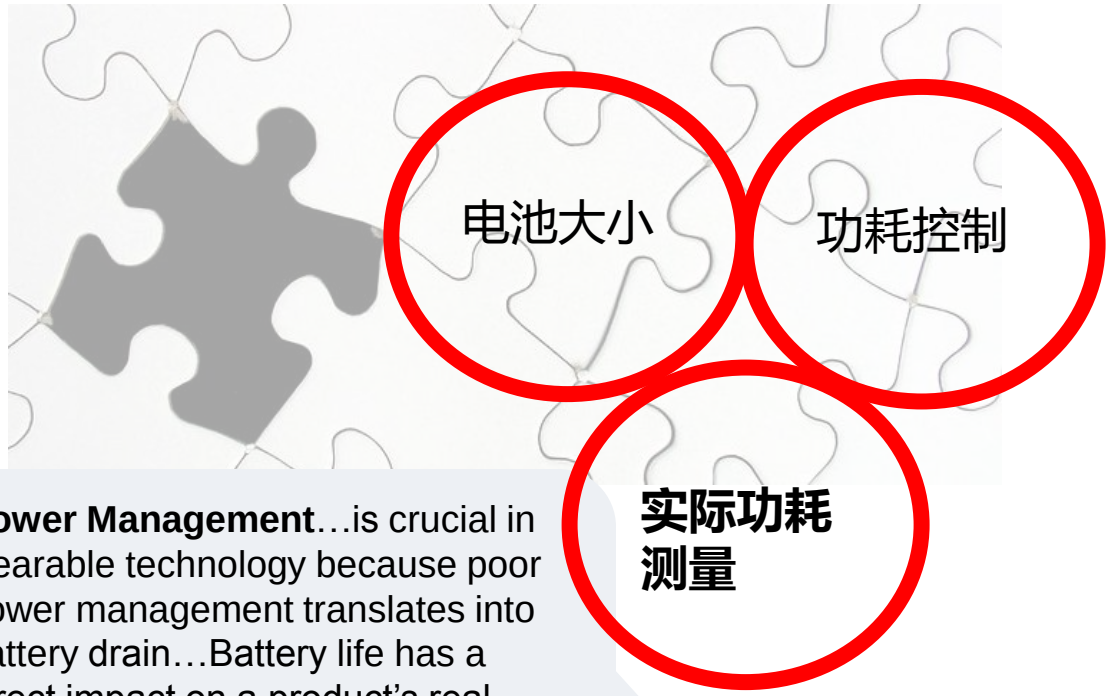
物联网设备测试中的重中之重：功耗的分析和优化

- 如果客户想延长电池使用时间
- 要么增加电池体积
- 要么优化系统功耗
  - 所以，功耗优化是每个低功耗设备设计者的必须要步骤



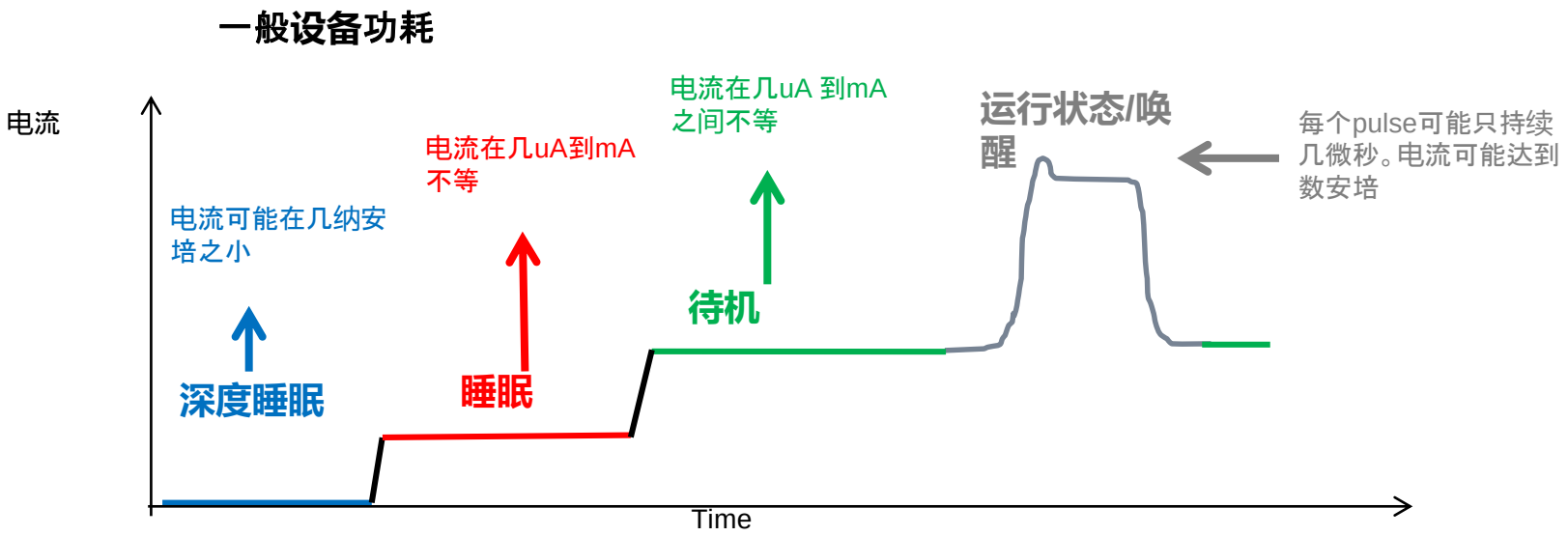
"The limitation to the number of sensors and amount of generated data is the battery life of the Wearable."

Credit Suisse

Power Management…is crucial in wearable technology because poor power management translates into battery drain…Battery life has a direct impact on a product's real usefulness... Characterizing a usage profile is a non-trivial design activity.

Mitch Maiman, president and co-founder of Intelligent Product Solutions

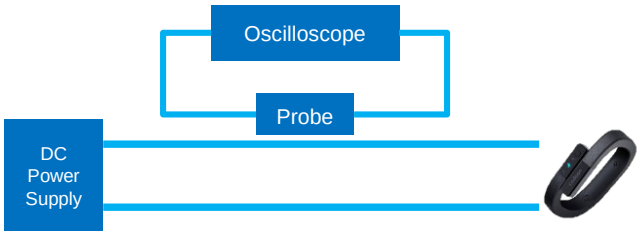
一般性的物联网设备功耗

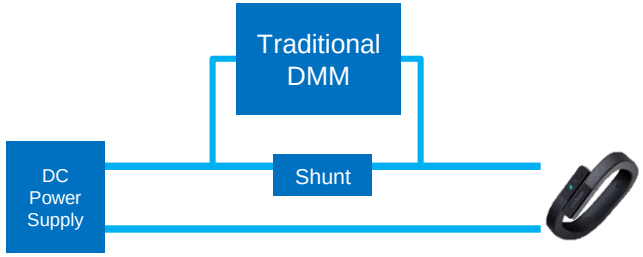


- 测试挑战
  - 在很大的量程中精确测量电流 - 从纳安到安培的
  - 唤醒/运行时间极短
  - 复杂的信号
  - 长时间监控

- **设备要求**
  - **高精确度**：在不同量程的高精确度
  - **高采样率**：抓取瞬间变化的电流波形，大储存记忆和高级触发控制
  - **高适用性**：尽快分析信号，不需要成为测量专家，抢占市场先机
  - 精确供电：保证电压的稳定，适应瞬态变化

传统的测试方案





示波器 + 电流探头 + 一般电源

- 高采样率，可以设置触发
- 低精确度 – 高噪音，抓不准信号
- 很少支持长时间测量

一般万用表+一般电源

- 高精确度
- 低采样率 – 抓不到信号
- 高Burden Voltage
- 没有高级的触发功能
- 瞬间反应慢
- 电源精确度一般

物联网设备电池优化

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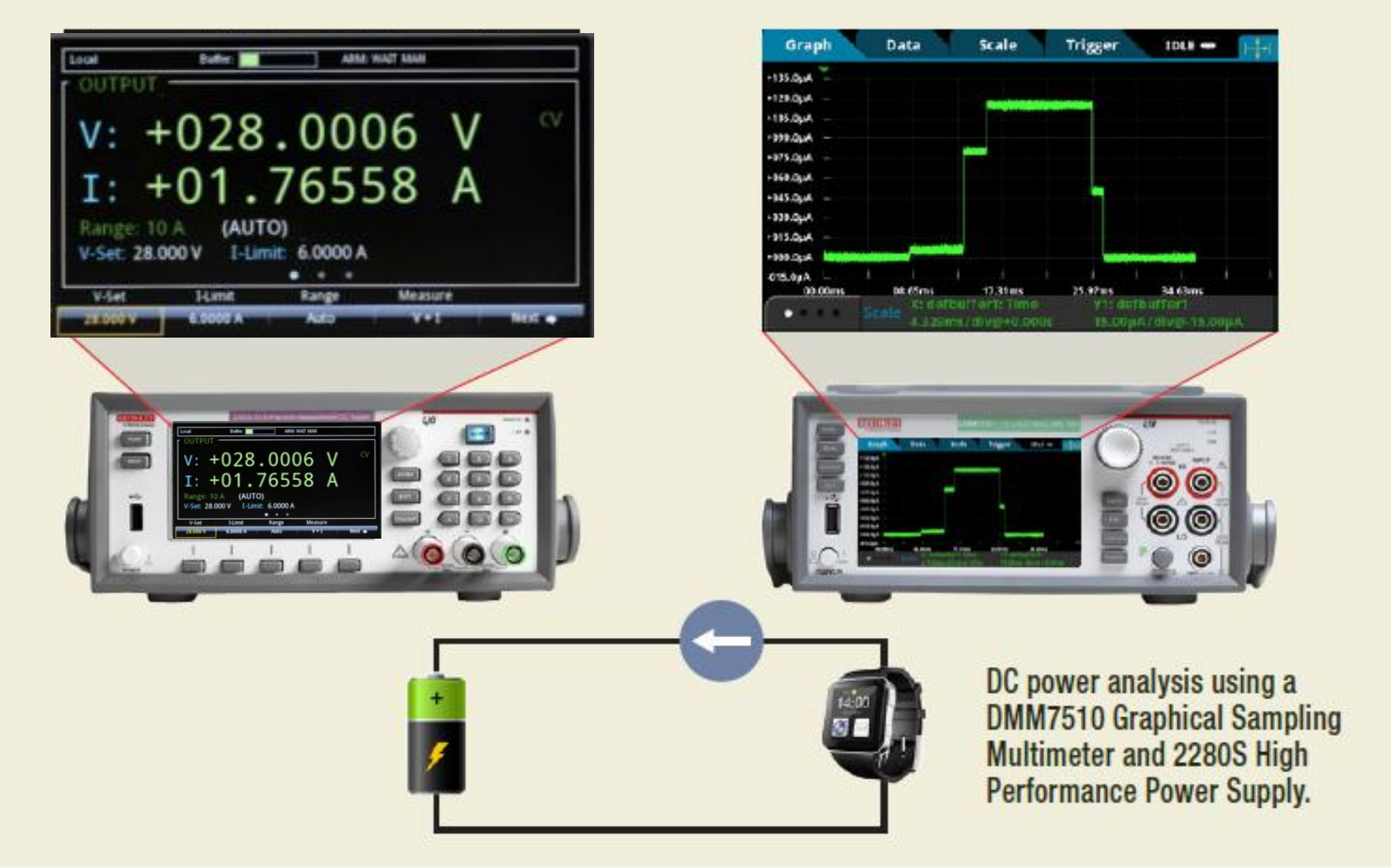
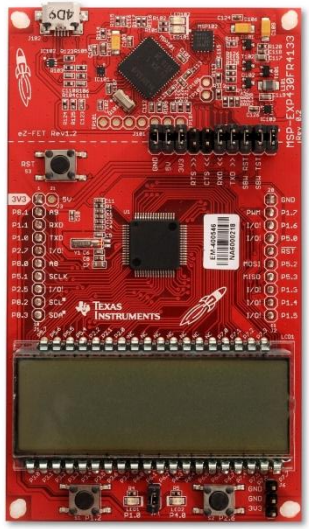
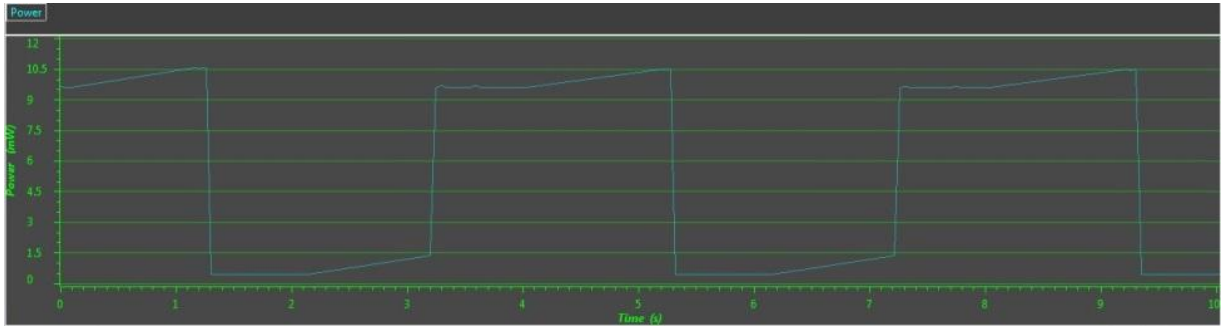
用吉时利DMM7510 + 2280S 两大金刚组合来测试物联网设备的电流



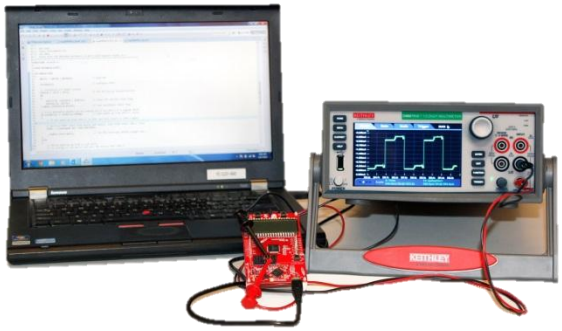
Example Application I
Using MSP430FR4133 Ultra-Low Power Microcontroller

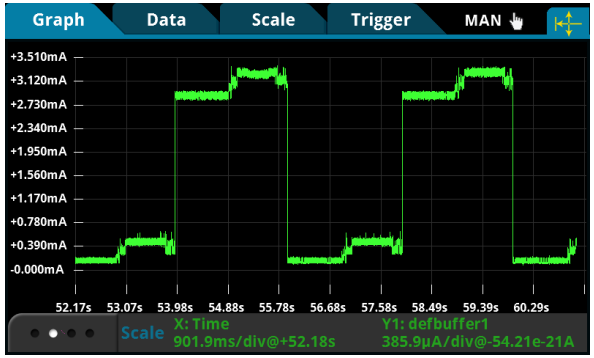


- Used for Ultra-Low Power Development
  - Active Mode：126μA/MHz
  - Standby Mode：770nA
  - Special Low Power Mode：15nA



- TI System Generated Power Consumption Profile



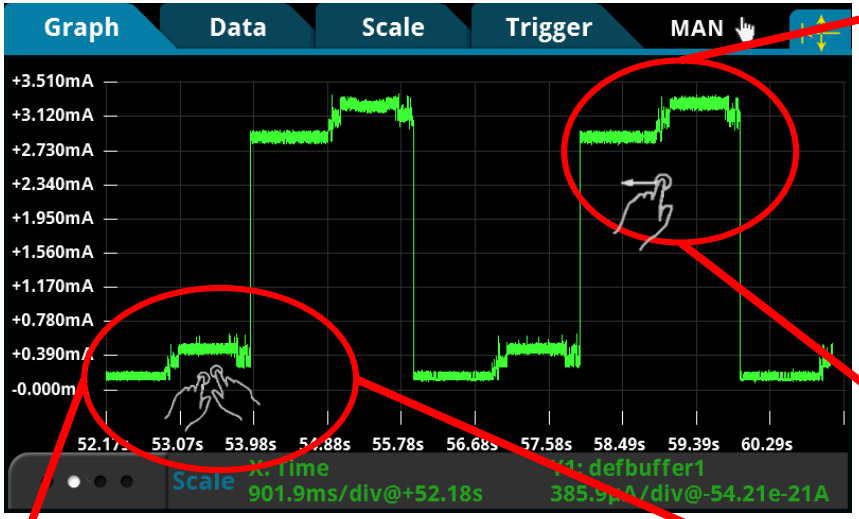


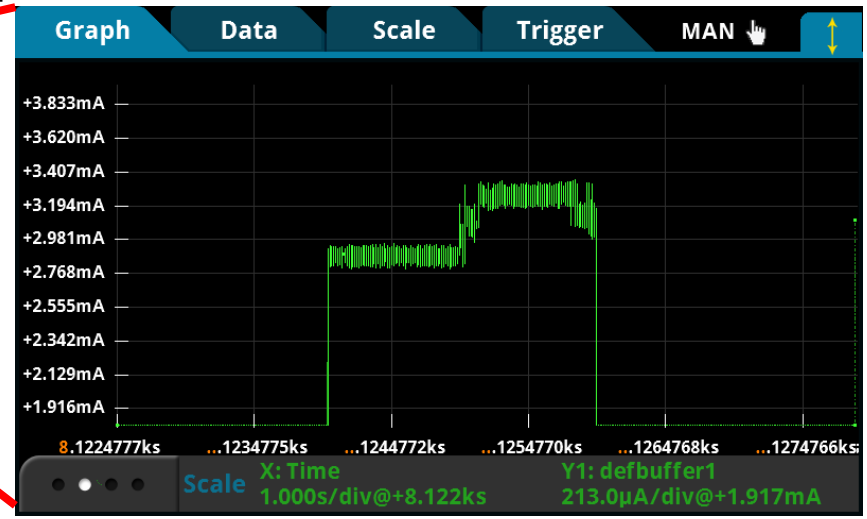
- Detailed Power Consumption Profile using DMM7510

TI MSP430FR4133 **is a product of Texas Instruments**
EnergyTrace™ is a trade mark of Texas Instruments

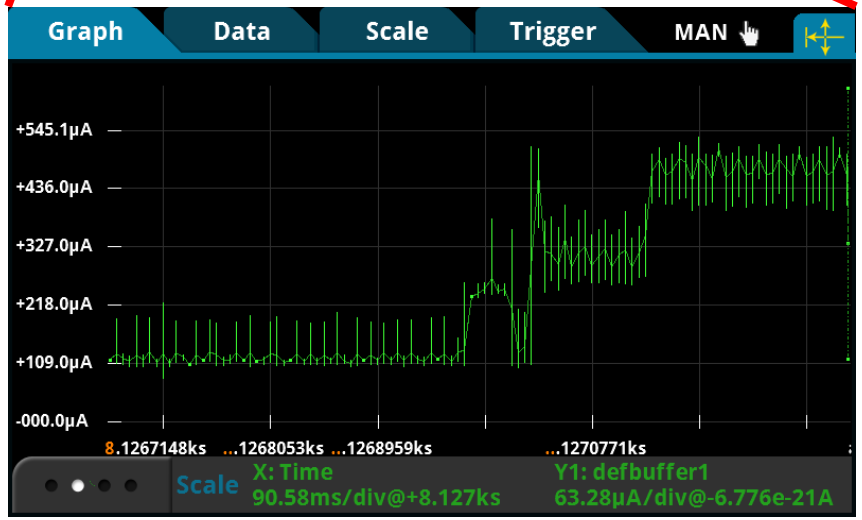
Example Application I

More Detailed Power Consumption Info with DMM7510





Active Mode

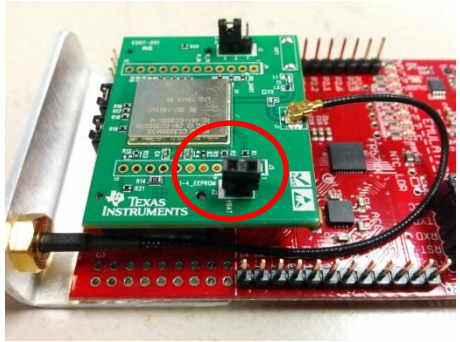


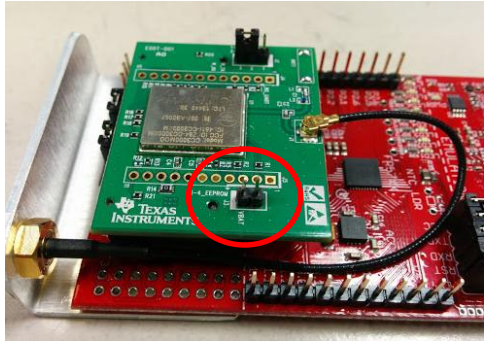
Analyzing Detailed Power Consumption in Different Modes to Ensure Better Battery Profiling

Low Power Mode

Another Demo
How to Step Up

- Unplug the jumper from Wi-Fi daughterboard. – do no lose your Jumper!!!!

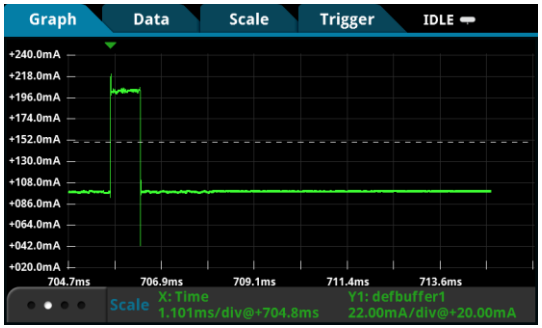


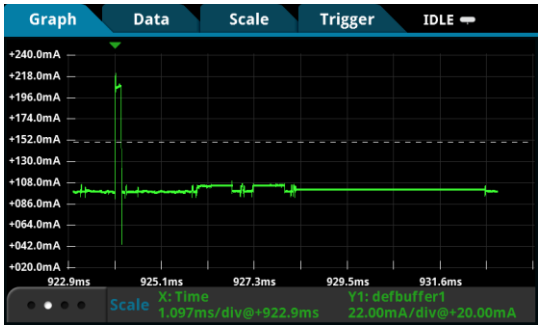


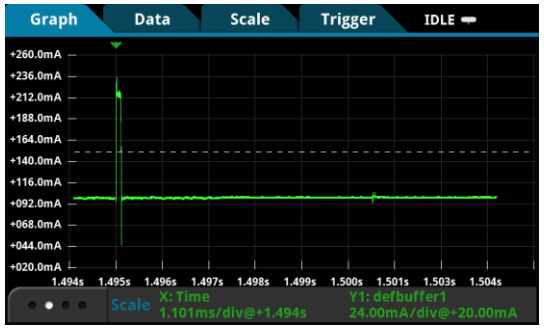
- Connect DMM7510 to the board as shown below. Now your set up is complete

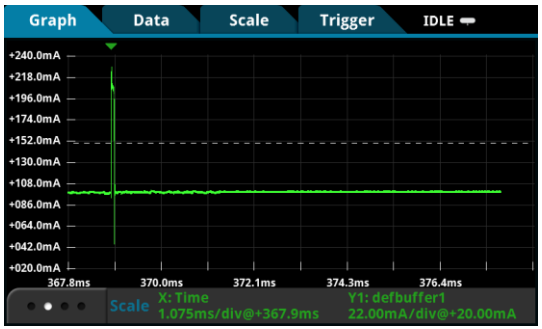
Results

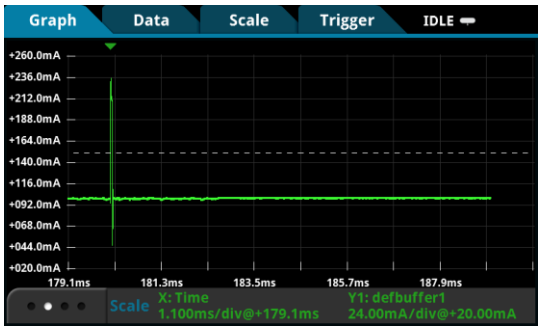
- You will see different power consumption in different modes. Below are screenshots of current draw in different modes –





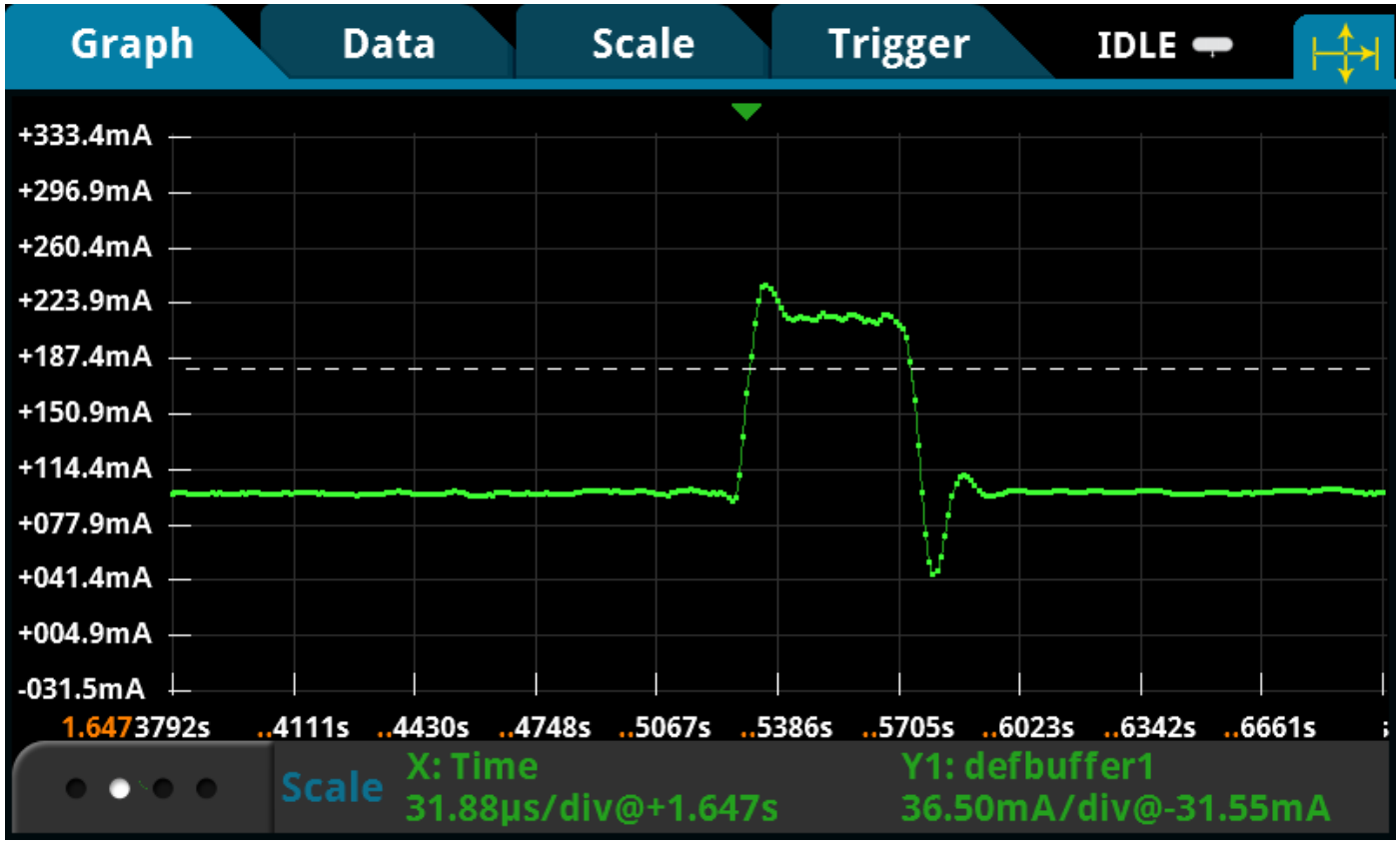






Results

- Because DMM's high accuracy perspective, you can zoom in on the data to read overshoot etc.



低功耗测试要 I: 各种量程的精确测量

DMM7510's Significant Advancement in DC performance

- 1pA resolution, 0.006% 基本一年电流
- 0.1nA digitize current resolution
- 15mV burden voltage

Digitize Current		
Basic One Year Accuracy	Range	Accuracy ±(% of Reading + % of Range)
	10µA	0.016% + 0.0075%
	1mA	0.016% + 0.0075%
	10mA	0.016% + 0.0075%
	1A	0.050% + 0.0110%
	10A	0.150% + 0.0350%

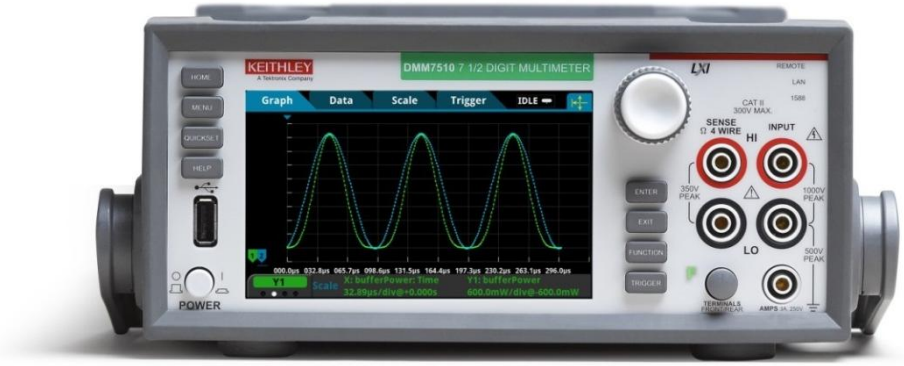
DC Current		
Basic One Year Accuracy	Range	Accuracy ±(% of Reading + % of Range)
	10µA	0.0075% + 0.0030%
	1mA	0.0060% + 0.0009%
	10mA	0.0060% + 0.0009%
	1A	0.0400% + 0.0050%
	10A	0.0800% + 0.0275%

Digitize Voltage		
Basic One Year Accuracy	Range	Accuracy ±(% of Reading + % of Range)
	100mV	0.0220% + 0.0100%
	1V	0.0120% + 0.0075%
	10V	0.0120% + 0.0075%
	100V	0.0120% + 0.0075%
	1000V	0.0120% + 0.0075%

	高精确度	高采样率	高使用性	精确供电	

低功耗测试要求II: 高采样率和长时间测量

DMM7510's Built-in Digitizer



- Precisely analyze current and voltage waveforms and transients with 1MS/sec, 18-bit digitizer
- Capture signal with advanced analog triggering including edge, pulse, and window that traditional DMM cannot offer
- Large reading memory (27.5 million compact and 11 million standard) to capture more of your signal
- Plot multiple waveforms on the same scale for easy analysis

Digitizer Characteristics			
MAXIMUM RESOLUTION	18 bits	**TIMESTAMP RESOLUTION**	1ns with standard or full buffer style. 1μs with compact buffer style
MEASUREMENT INPUT COUPLING	DC or AC (voltage only)	**TIMESTAMP ACCURACY**	With standard or full buffer style, 20ns between adjacent readings, with total buffer time <2s
SAMPLING RATE	Programmable 1k through 1 million		With compact buffer style, 2μs adjacent readings, with total buffer time <2s
MINIMUM RECORD TIME	1μs		
VOLATILE SAMPLE MEMORY WITH TIMESTAMP	27.5 million	**MAXIMUM RECORD LENGTH**	8 million

	高精确度	高采样率	高使用性	精确供电	

低功耗测量要求III: 用户友好的界面和使用性

Touch Test Invent ®

- DMM7510
  - Display more with five-inch, high resolution touchscreen interface
  - Readings and screen images can be saved quickly via the front panel USB memory port
- 2280S
  - Built-in graphing simplifies analyzing trends or displaying voltage or current waveforms
  - High resolution TFT display and soft-key/icon-based user interface simplify power supply operation

DMM7510

2280S

	高精确度	高采样率	高使用性	精确供电	

KEITHLEY
A Tektronix Company

Tektronix®

低功耗测量要求IV: 精确提供所需电压

2280S High Performance Power Supply

- Voltage setting and measurement accuracy of 0.02% of reading +3mV - superior to most power supplies
- Low noise; it is a linear supply: < 1mVrms output ripple and noise
- 4-wire remote sensing to ensure that the programmed load is accurately delivered to the load

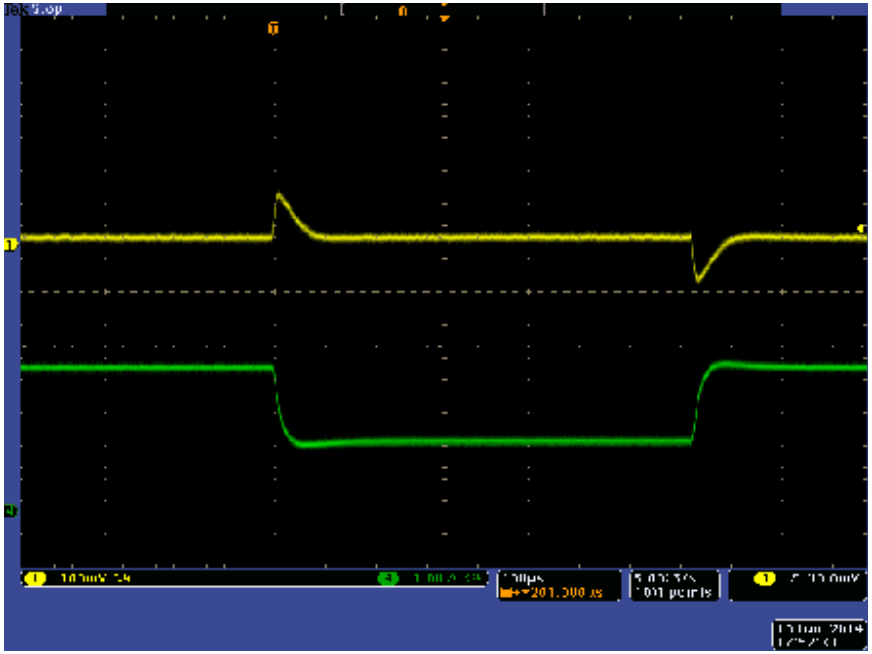
Voltage		
Source Setting	2280S-32-6	2280S-60-3
DC Voltage Output Ratings	0 to 32 V	0 to 60 V
Accuracy	± (0.02% + 3 mV)	± (0.02% + 6 mV)
Resolution	1 mV	1 mV

Current		
Source Setting	2280S-32-6	2280S-60-3
DC Current Output Ratings	0 to 6 A	0 to 3.2 A
Accuracy	±(0.05% + 5 mA)	±(0.05% + 5 mA)
Resolution	0.1 mA	0.1 mA

	高精确度	高采样率	高使用性	精确供电	

Using fast response power supply to power IoT device

- 2280S power supply offer clean and stable output to your DUT
  - Low ripple and noise, Vpp less than 5mV
  - Fast transient response time, voltage recover with in 50uS under



Output voltage recovered within 38uS

Load current pulse from 3A to 1.5A

Fast transient response time make the output voltage stable, not interrupting your DUT with voltage drop or overshoot

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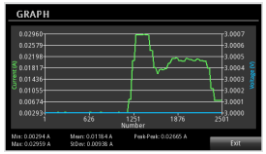
2280S Precision Measurement Power Supply

Precision Measurement, Low Noise, Programmable DC Power Supply

2280S Precision Measurement DC Power Supply

High Precision DC Power Supply

6½ Digit Multimeter



Graphical Interface

物联网设备电池优化

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物联网设备功耗分析
测试挑战和设备要求

- 功耗分析
  - 对于物联网产品设计至关重要
  - 直接与设备的成败关系
  - 物联网设备功耗分析不是一项简单的程序
- 测试挑战
  - 在很大的量程中精确测量电流 - 从纳安到安培的
  - 唤醒/运行时间极短
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  - 长时间监控

- **设备要求**
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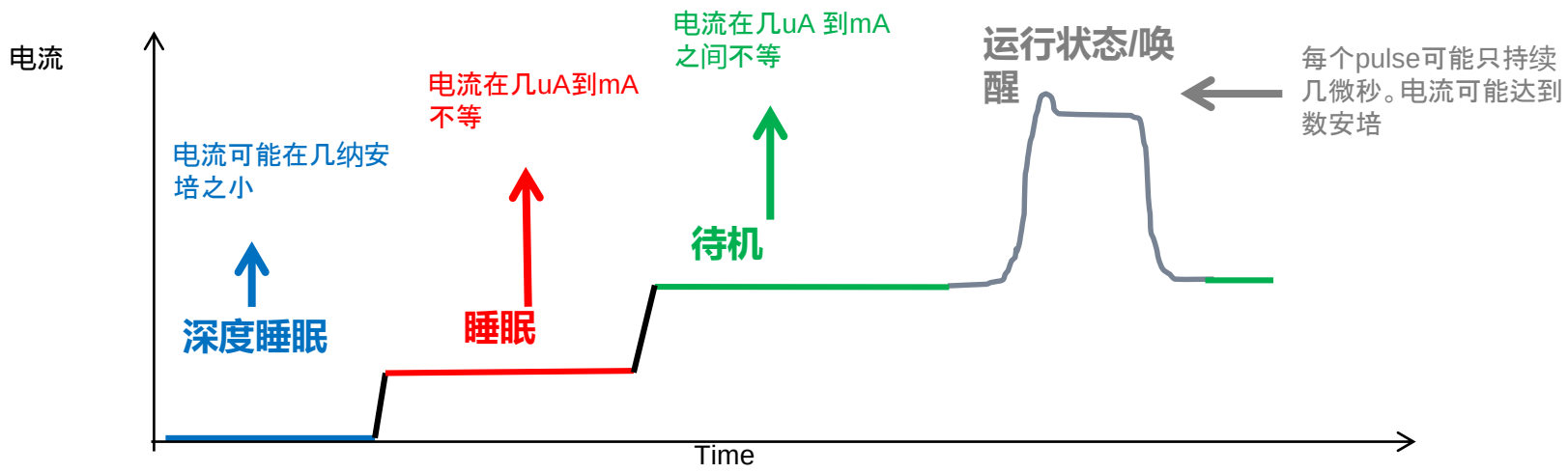
一般设备功耗



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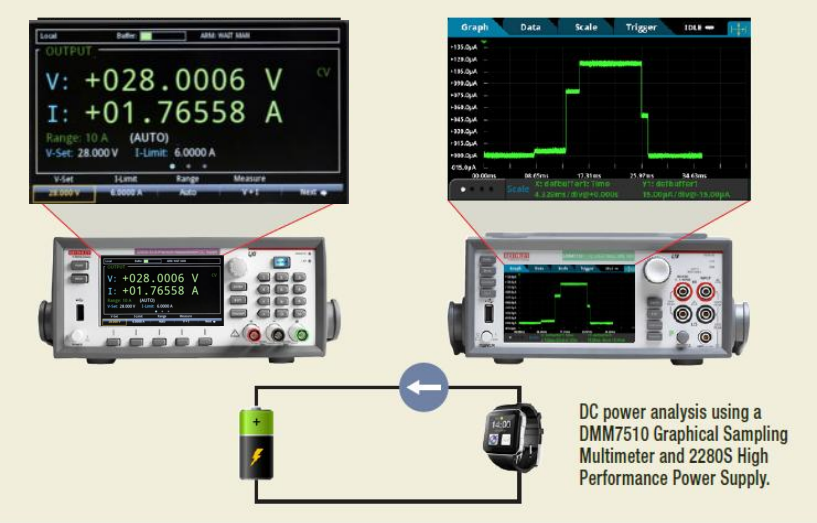
解决方案 – 高规格，低价格



高精确度

- Gain measurement confidence for today's ultra-low power measurement needs

高采样率

- Capture and visualize waveforms and transient signals

高适用性

- Significantly work efficiency improvement, minimize learning curve

精确供电

- Eliminating errors caused by power source, get more accurate power measurements

DMM7510 7½-Digit Graphical Sampling Multimeter

- 1pA 精确度, 0.006% 基本一年直流电流测量
- 15mV burden voltage
- 1MS/sec, 18-位数字化仪
- 高级的触发功能
- 2750万记忆储存
- 5英寸大尺寸触摸屏

2280S Precision Measurement DC Power Supply

- 精准直流电源，确保设置电压干净稳定地传送到设备中
- 瞬态反应速度低于50微秒，减少电源对测量的干扰

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A Tektronix Company

Tektronix®

物联网设备电池优化

Low Power Consumption Testing Challenges and Solutions

市场 (Market)	IoT/Wearable
应用 (Application)	DC Power Consumption
解决方案 （Solution)	DMM7510+2280S combo
竞争 (Competition)	External Competition
总结 (Conclusion)	4 Pager
演示 (Demonstration)	Smartwatch

IoT Device Test Demo

https://danahertm.app.box.com/s/a4msoiadjez123rxfj0584oqi0v5xxcq

Example Application II

Analyzing Smart Watch Overall Power Consumption

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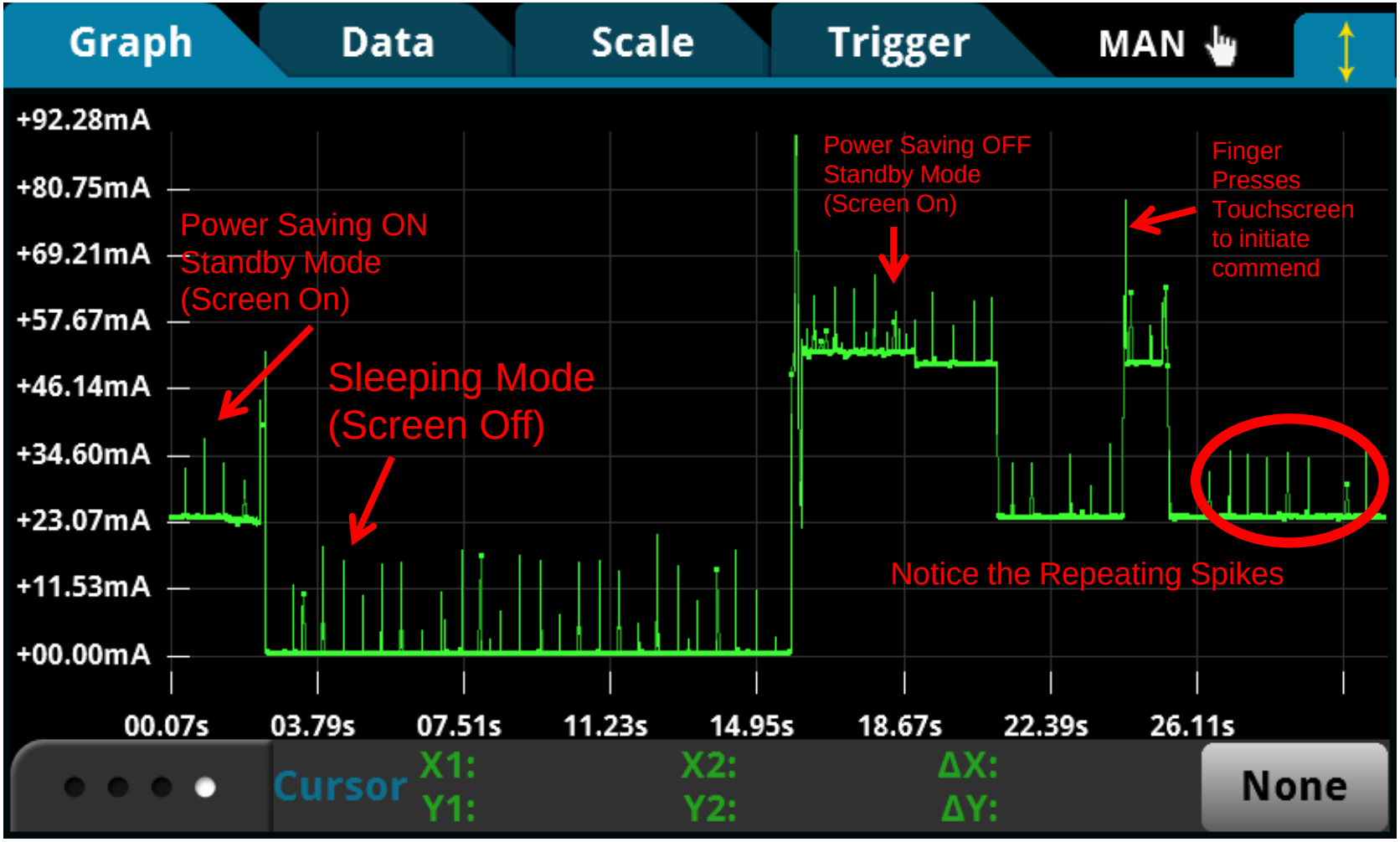
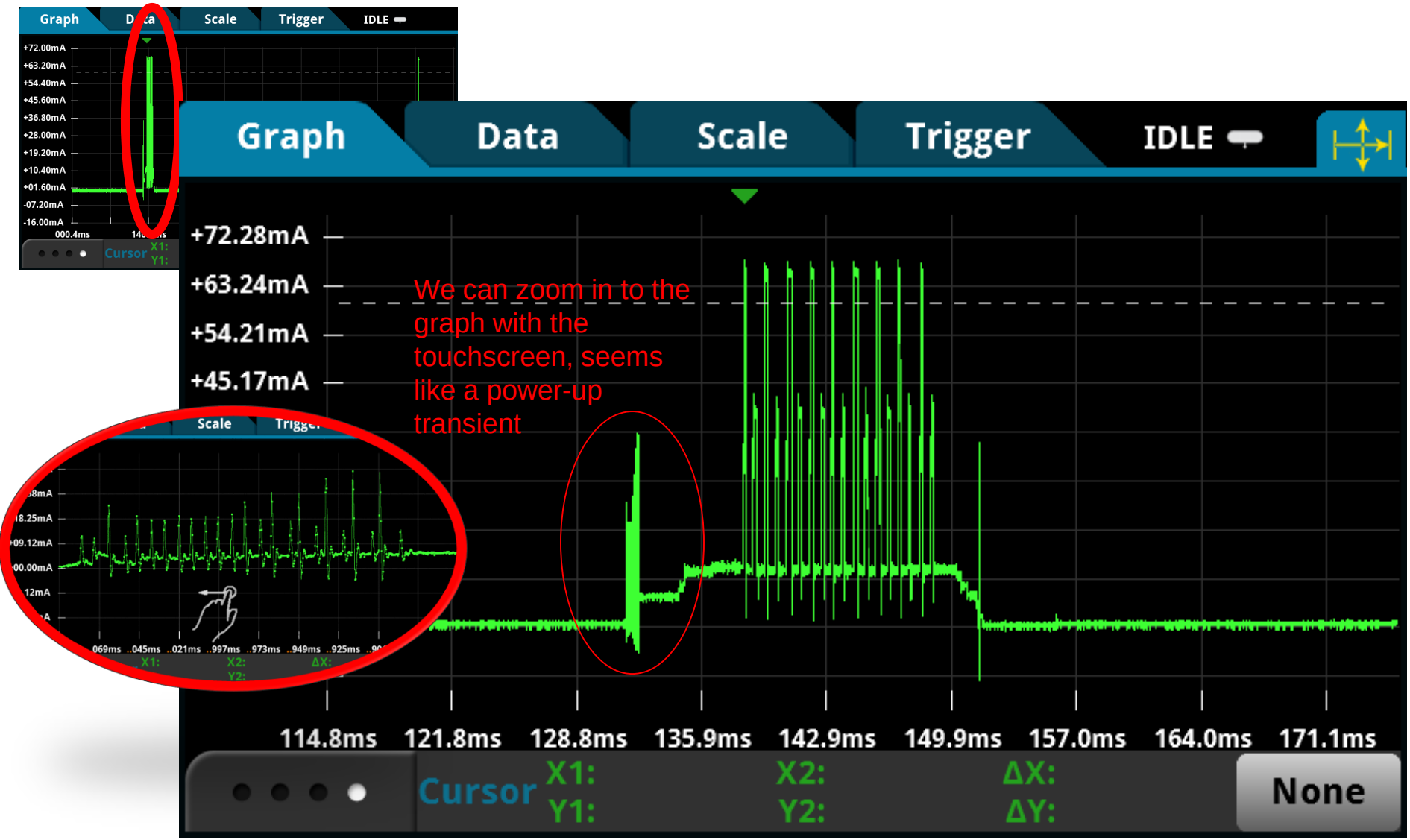
Analyzing Smart Watch Overall Power Consumption



Example Application II

Analyzing Smart Watch Overall Power Consumption



Example Application II

Analyzing Smart Watch Overall Power Consumption

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挑战	产品需求	解决方案
多量程	高精确度	0.1nA 精确度, 0.016% 基本1年采样电流
短脉冲	高采样率	1MS/sec, 18bit 内置 Digitizer
长时间监视	大储存数据	2750万数据储存
传统电表的shunt问题	对电路小影响	15mV burden voltage
高电流引起的电压变化	供电精准	Transient Capture Accurate Voltage Setting

- 提问：
  - 1. 用什么样的电池来供电 – 判断是否是低功耗设备
  - 2. 最低电流及最高电流范围？
  - 3. 需要多高的采样率？
  - 4. 一般需要多长的监视时间？
- 关键词：
  - 低功耗， 高速-低电流测试
  - 示波器+ Current Probe， 示波器+ Amplifier
- 成功案例
  - RF 模块
  - Microcontroller/Microprocessor
  - 传感器
  - 电路
  - 设备– 医疗，工业，智能家居等等

问：仪器价格：为什么DMM7510与以往吉时利的7.5位DMM相比价格贵？

答：DMM7510是世界上首款触屏数字化采样万用表，而不是普通的DMM。强调其高解析度，高采样率和高易用性和性价比。

问：与N6705有什么区别？

答：在功耗测量这一个方向当中，DMM7510+2280S组合有比N6705相同或者更好的设置，不到一半的价格。N6705是一个很多功能的模块式的仪器。并不是针对这个应用而设计的。

问：但是N6705有无缝隙量程？

答：记住无缝隙只针对高量程，低量程不能使用

问：但是34470A有个1uA量程？

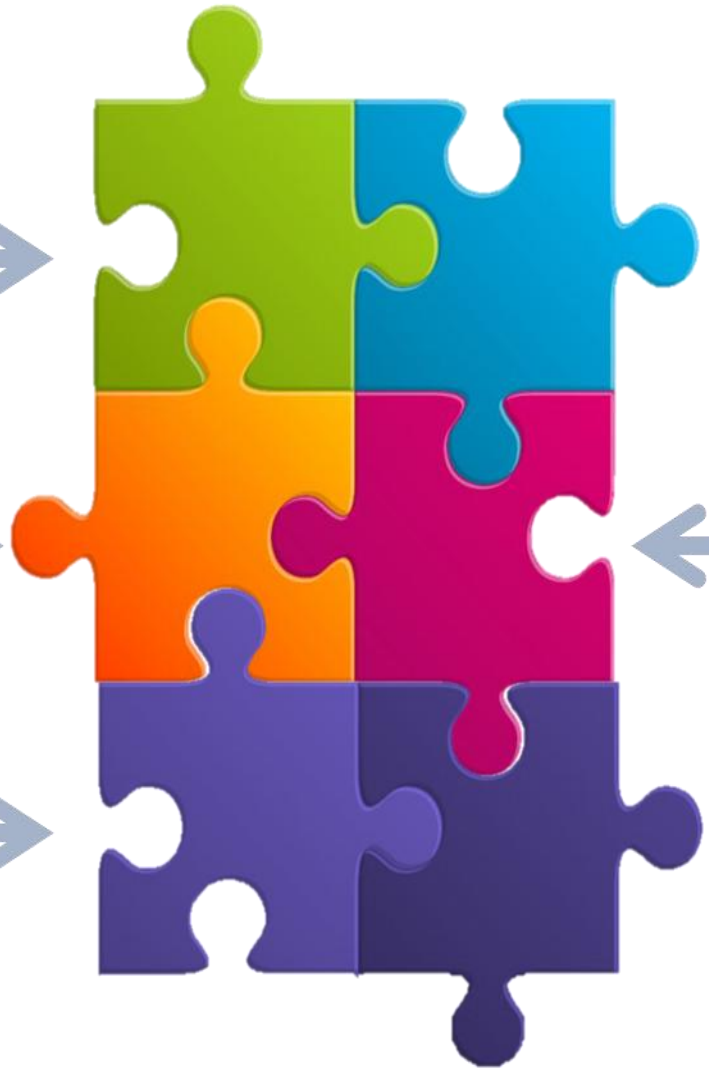
答：DMM7510最低量程到10uA,但是10uA量程的清晰度比对手1uA的清晰度更高。

T&M - IoT is More than Just Power Management

元件
Design/Verification
2400/2600/4200 Source Measure® Source Meter SMU instrument

链接技术
SAPL – RSA306

充电效率
PA1000 Power Analyzer



设备设计
MDO3000 6 in 1

功耗管理
Power Supplies/Digital Multimeter

服务
Calibration
Contracts

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