Garantir l'autonomie énergetique d'un dispositif médical connecté

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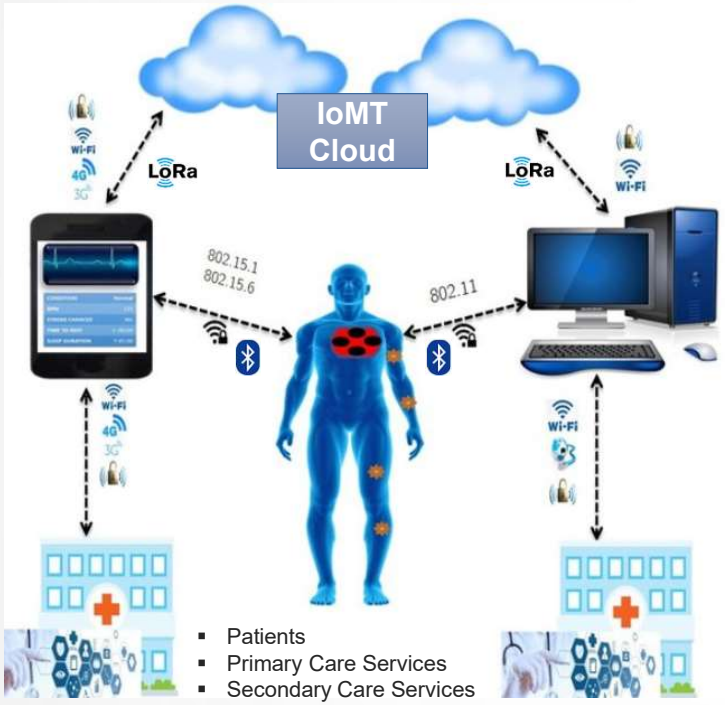
KEYSIGHT TECHNOLOGIES

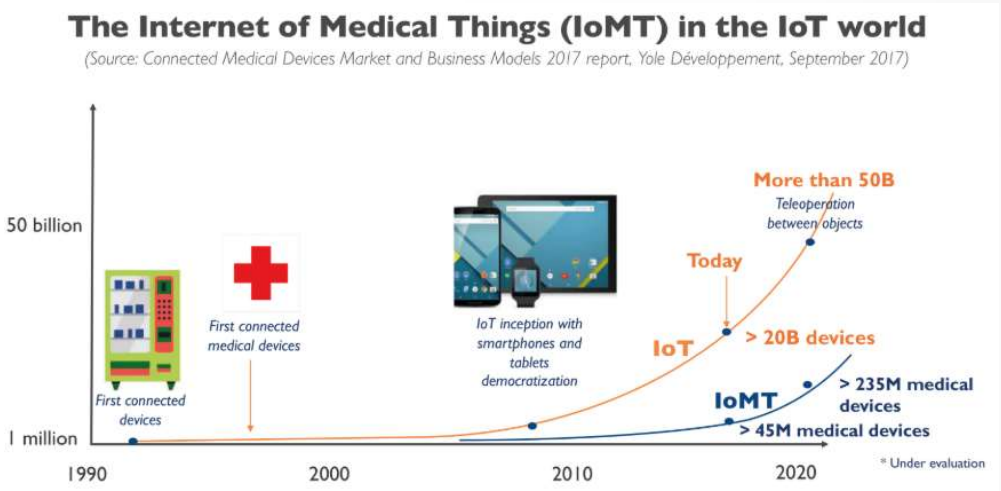
Internet of Medical Things (IoMT)

THE RISE OF CONNECTED HEALTHCARE

Connected Healthcare Environment



- Patients
- Primary Care Services
- Secondary Care Services
- Life Sciences Companies



Wearable Medical Devices

Implantable Medical Devices

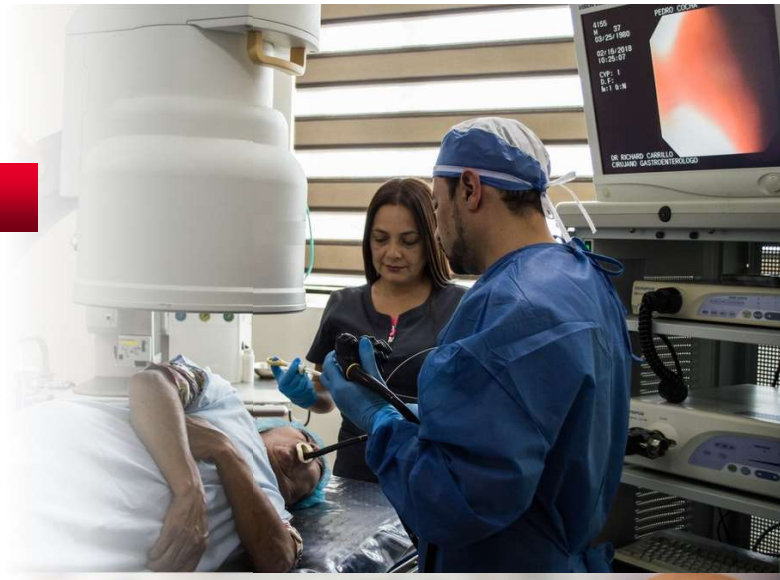
Patient Monitoring

Portable Medical Imaging

Medical Device Design is Challenging

FAILURE LEADS TO SERIOUS CONSEQUENCES

- Severe impact, especially Class III (support/sustain life).
- Possible intense suffering or death
- Pacemakers over last 20 years:
  - ~160,000 injuries
  - ~ 12,000 deaths due to device-caused harm
- What happens if your product is recalled?
- What if the device is implanted?



Battery Life is the Key Concern

WHEN DESIGNING CONNECTED MEDICAL DEVICES

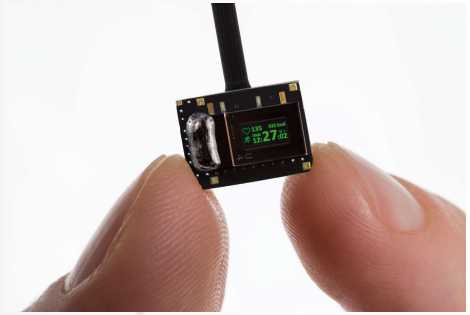
Medical Devices

Challenges:

1. How to define the battery life?
2. What are the critical events that contribute to the power consumption and how frequently do those events happen?
3. What design changes or tradeoffs should I make to optimize battery life?

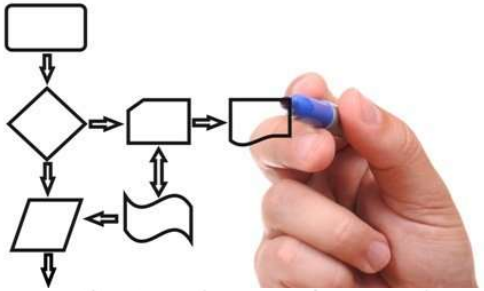
Current Drain Testing in Product Development

- In hardware development



- Optimize energy efficiency

- In software development validate new code builds



- Run application code regression test suites, assess impact on battery drain

- In integration and validation run suites of benchmark tests

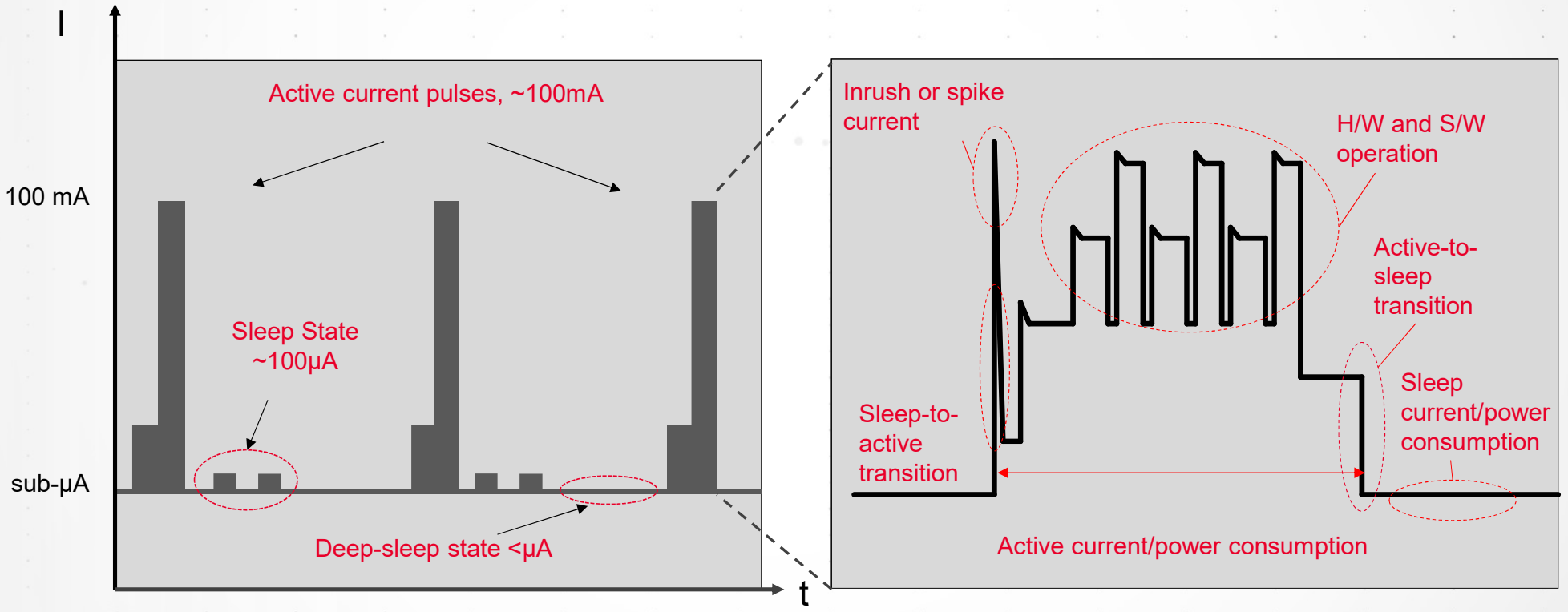
- run suites of benchmark tests
  - Validate battery drain for all required operational modes
  - Validate operating time with product's battery (battery run-down test)

Benefits:

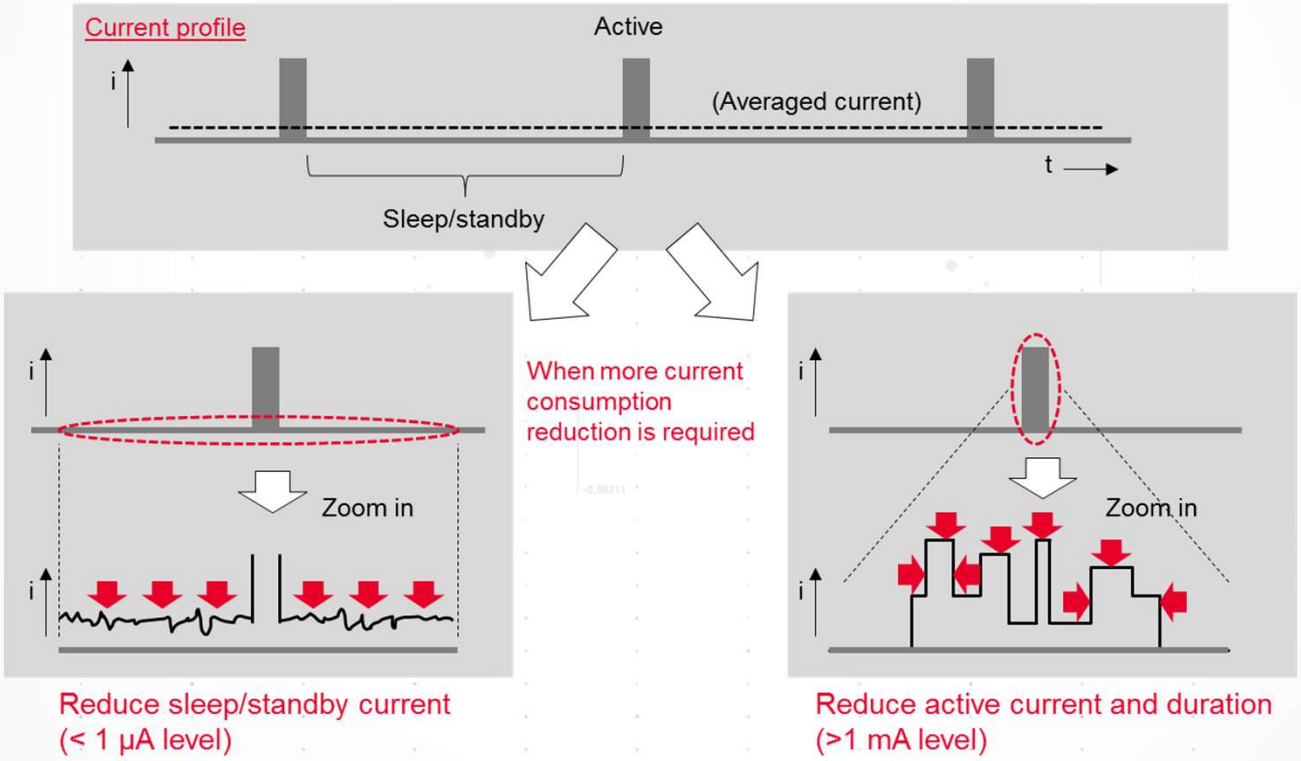
- Bring smaller, longer running, more competitive products to market
- Faster time-to-market and at lower expense by reducing development time

Typical Connected Device Operation

INTERMITTENT TRANSITIONS BETWEEN ACTIVE AND SLEEP STATES



Current Drain Optimization

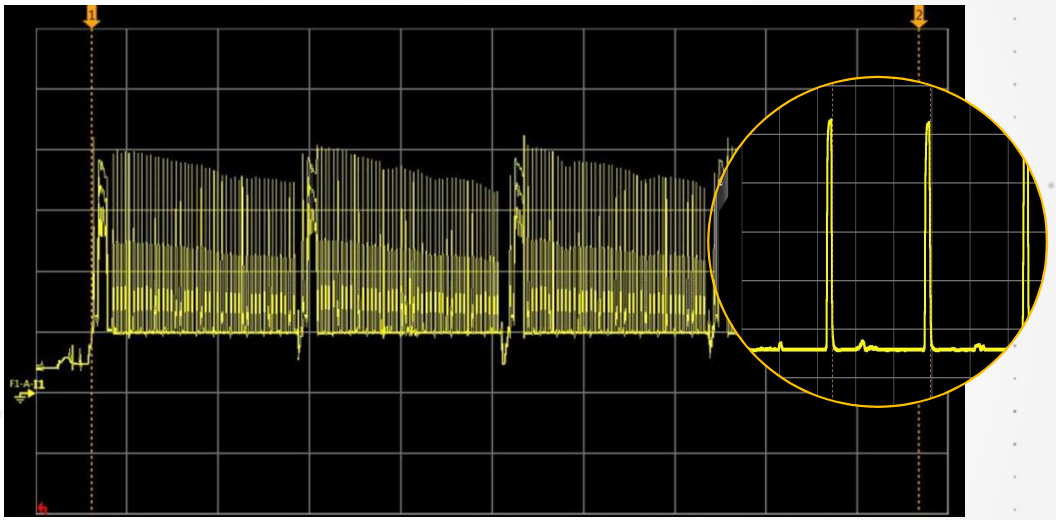


Optimizing Battery Life is Hard

DIFFICULT MEASUREMENTS, LOTS OF DECISIONS TO MAKE

We see below on the current profile of a wireless blood pressure monitor transmitting data :

- Complex current waveforms
- Fast sleep to active transitions
- Large dynamic range



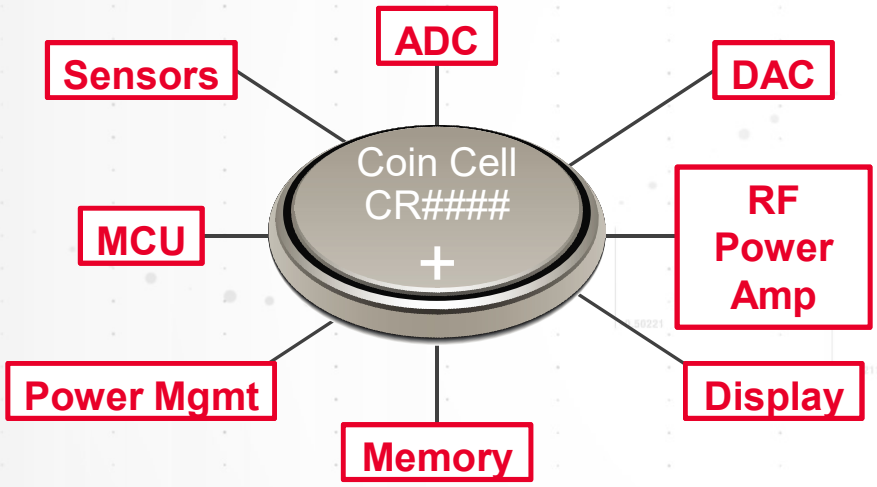
Fast transients require high measurement bandwidth

High crest factor require high measurement dynamic range

Optimizing Battery Life is Hard

DIFFICULT MEASUREMENTS, LOTS OF DECISIONS TO MAKE

Once I have measurements, I can estimate the battery runtime (operation time on one charge) for my device. What is next ?



Where are my coulombs going?

… then re-perform the measurements

Maximize battery runtime with design trade-offs:

- ✓ battery type & capacity
- ✓ processing power
- ✓ component size & quality
- ✓ cost
- ✓ Firmware optimization : sleep mode frequency, pre-process to reduce data transmission, display refresh rate, …

Keysight X8712A - Battery life optimization solution

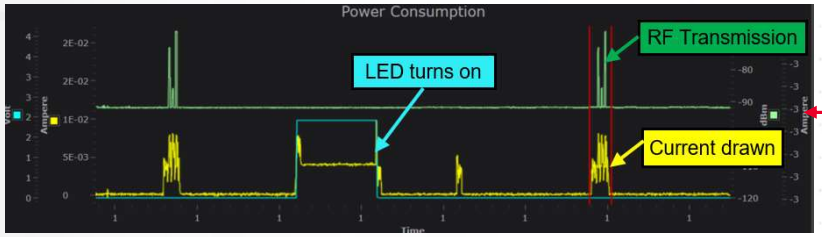
Measurement processing Software

Shield box

DC Power Analyzer with Source/Measure Units

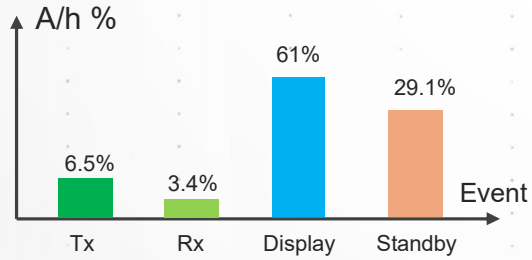
RF Event Detector

Detect design weakness with quick and effortless event-based power consumption analysis



Correlate current waveform with other RF/DC events

Typical current consumption breakdown by subsystem events



Simplify battery life estimation

Battery (Ah)	0.2

Battery capacity

Max Current	11.04 mA
Cycle Time	6.02 ms
Charge Energy	5.24 nAh
Battery Life	63.84 h

Max current

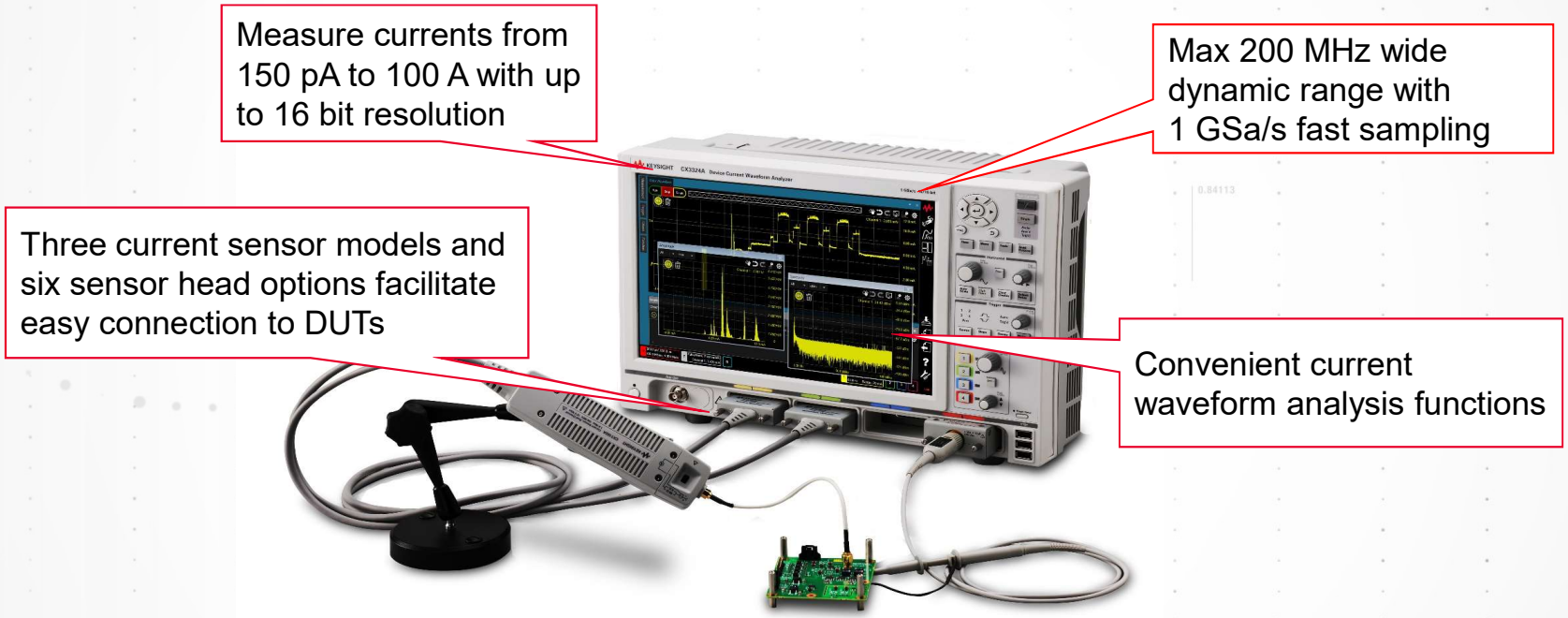
Charge consumed

Battery life

KEYSIGHT TECHNOLOGIES

CX3300 Device Current Waveform Analyzer

EXTEND YOUR ADVANTAGE IN LOW POWER



- Convenient current waveform analysis capabilities: automatic current profiler, cumulative current distribution function (CCDF) and fast Fourier transform (FFT)

Success Healthcare Application

AUTOMATED BLOOD PRESSURE MONITOR

Automated blood pressure monitor measures blood pressure at the upper arm and provide a more accurate picture of users' blood pressure over time (avoid one-off reading "white coat effect"). Information is sent via Bluetooth to external unit.

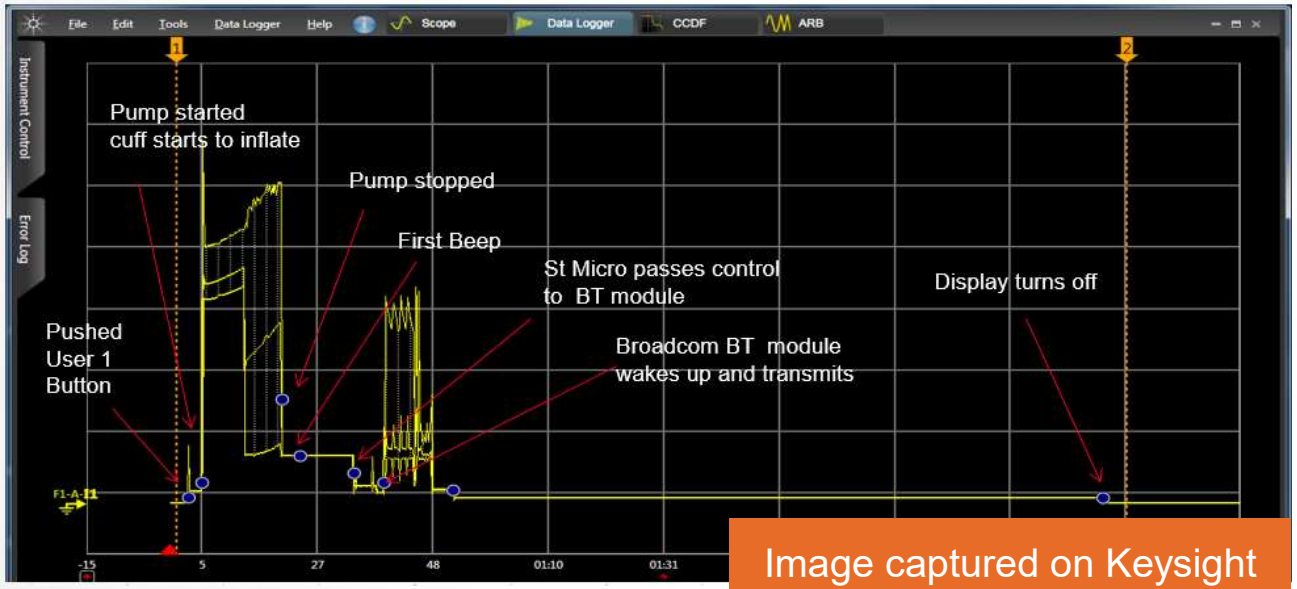


Image captured on Keysight N6705C DC Power Analyzer

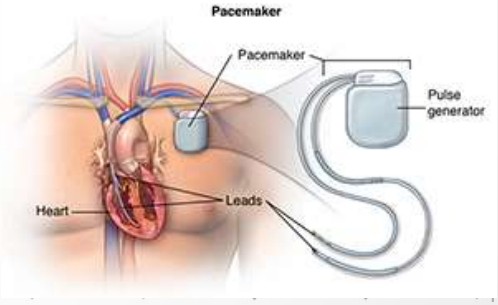
Success Healthcare Application

IMPLANTABLE PACEMAKER

A pacemaker helps control abnormal heart rhythms. It uses electrical pulses to prompt the heart to beat at a normal rate. It can speed up a slow heart rhythm, control a fast heart rhythm, and coordinate the chambers of the heart.
Latest models wirelessly transfers important information to the patient's clinic.

Customer Previous Solution	Keysight CX3300 Current Analyzer
DMM for low current – too slow	Faster – 200 MHz measurement engine
Scope with differential probe for active and shock level current – noisy	Lower noise
Measurement time – hours / days	Minutes to measure all modes
Data processing – hours / days	Automatic current profiler, CCDF, FFT in minutes

Result: dramatically reduced evaluation time for device certification



Success Healthcare Application

RECHARGEABLE HEARING AIDS

Before 2016, hearing aids were powered by batteries or accumulators that needed replacement at least once a year.

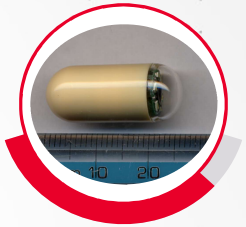
Rechargeable Lithium-Ion batteries allow several years of use. However it was needed to ensure a battery runtime of one full day, which was challenging given the extended use of wireless connectivity.

18 - 19.5 hours	16 - 17 hours	15 - 16 hours
No streaming	90 minutes of iPhone® streaming	4 hours of TV and 1 hour of iPhone streaming

Daily hours of usage depend on level of hearing loss and lifestyle.

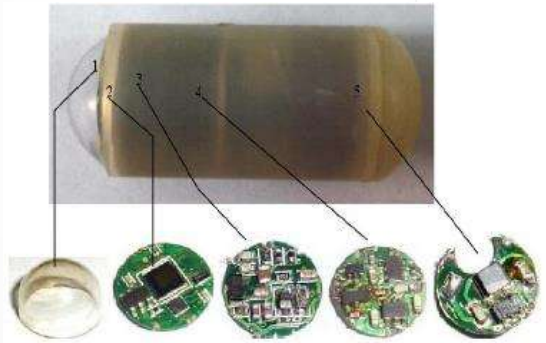
Success Healthcare Application

CAPSULE ENDOSCOPY



Capsule endoscopy is a procedure used to record internal images of the gastrointestinal tract for use in medical diagnosis. The miniature capsule (~25x10 mm) contains a tiny camera and an array of LEDs powered by a battery.

- Very small camera for small intestine.
- Must work for a day, taking and sending pictures to external monitor system
- Very small battery
- Similar to mission-critical IoT application

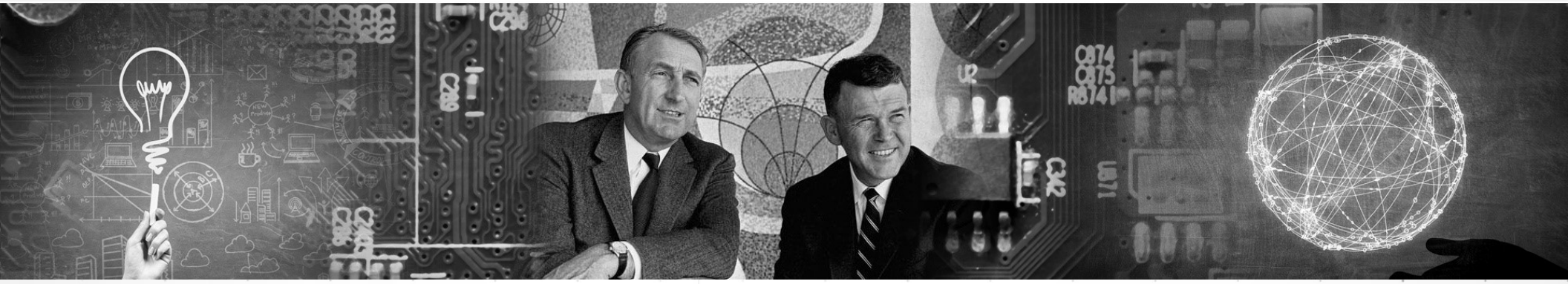


Inside a Capsule Camera

1. Optical Dome
2. Lens & Holder
3. Illuminating LED
4. CMOS Image Sensor
5. Button Battery
6. ASIC Transmitter
7. Antenna

Keysight Helps You Get to Market Faster

WE HELP YOU CREATE. INNOVATE. AND DELIVER WHAT'S NEXT.



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KEYSIGHT
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