CASE STUDY

How to Resolve the Evaluation and Validation Challenge in Mobile Devices

Introduction

Mobile devices are an integral part of our daily lives. As a result, we have an increasing number of applications and requirements for our devices. To keep up with this demand, the market for mobile devices is growing exponentially and new product releases occur every six months.

These devices are multifunctional and loaded with new features such as high-performance cameras, fingerprint sensors, and facial recognition systems. This enables next-generation mobile devices and communications systems to accelerate the implementation of new standards such as 4G and 5G.

All of this comes at a cost.

As mobile devices get faster and sport more functions and features, they run up against battery limits. Technology developers must confront the trade-off between performance and power consumption and optimize accordingly. Also, ***developers need to evaluate and verify device reliability to prevent potential defects before product release.*** If defects are not caught early and mitigated, costs can spiral out of control. It is a massive challenge to fix problems once a product has shipped.

As new devices flood the market and compete for mindshare, technology developers must shorten time-to-market to maintain a competitive advantage.

Company:

- Mobile device/circuit design engineer

Key Issues:

- Higher speeds and lower voltages require new evaluation, validation, and debugging approaches
- Short consumer product lifecycles make time-to-market critical

Solution:

- Automated current profiles that include sleep/active mode transitions with the CX3300A

Result:

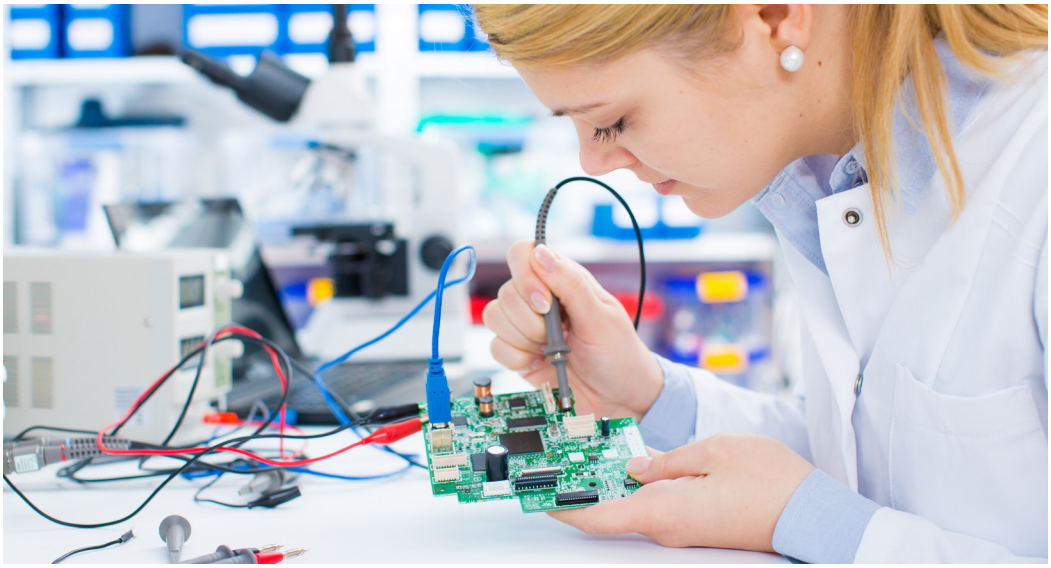
- An RFIC manufacturing engineer identified power management defects in their software

KEYSIGHT TECHNOLOGIES

R&D Engineer Challenges

R&D engineers who design mobile devices that require higher performance and lower power need to consider the following challenges.

- Realize high-speed operation at a lower voltage with the circuit design
- Build advanced power management schemes for high-performance and low-power consumption
- Execute efficient evaluation, validation, and debugging



Achieving low-voltage and high-speed operation are the critical challenges in mobile device development. The operation voltage of the processor and high-speed memory is less than 1 V, and allowable margin of voltage fluctuation is minimal. Therefore, it is important for designers to lower the impedance of the Power Delivery/Distribution Network (PDN). And, understanding the fast inrush current and the peak current of Power Management Integrated Circuit (PMIC) and DC/DC converter is a key factor to determine the allowable impedance value.

A complicated power management system is necessary for both high-performance and low-power device operations. It also needs to effortlessly switch between active modes and sleep modes. This is realized with intelligent software control. To validate a complicated power management system, it is necessary to characterize performance across a wide current range. This includes both sleep modes (less than 1 mA) and active modes (reaching several amperes).

Further efficient evaluation, validation, and debugging occurs in order to go to market in a timely and efficient manner. It is essential to measure a wide range of dynamic current patterns and to create and analyze detailed current profiles quickly.

Measurement Challenge: Dynamic Current of Mobile Devices

It helps to characterize detailed current waveforms across these varying current ranges. However, existing instruments do not have sufficient bandwidth, dynamic range, or noise floor.

A common solution for low-voltage, high-speed measurements is an oscilloscope, differential probe, and shunt resistor. With this method, a very small shut resistor (mΩ range) is used to avoid a brownout of the circuit caused by the voltage drop across the shunt resistor. However, since the voltage fluctuation generated by these shunt resistors is small, it is difficult to measure the voltage waveform accurately. The oscilloscope is often limited by dynamic range and measurement noise constraints. It is also necessary to separate the measurements by different instruments to characterize a current profile from sleep to active. This process is time-consuming for R&D engineers.

A common advanced power technique is control multiple sleep modes based on the active mode current level. It is very difficult to verify operation and detect defects in these modes because the instrument noise is too high.

Instruments must have high bandwidth and sample rates to accurately identify current spikes, inrush current, and the fast peak current of switching power circuits (PMICs, DC/DC converters). If the bandwidth or sampling rate is too low there is a risk of overlooking a fast spike current or underestimating the peak current.

Validation also requires creating a current profile from the current waveform. This profile is then compared to the expected/simulated operation. Doing this, however, is quite time-consuming.

Solution: CX3300 Series Device Current Waveform Analyzer

The CX3300 Series is a solution that obtains detailed current profile measurements and performs analysis efficiently with one unit. It can capture the dynamic current of mobile devices from sleep mode to active mode in one measurement. Its five dedicated current/differential sensors yeild a wide dynamic range, up to 16-bits resolution, and cover 150 pA to 100 A of current range. Also, because of its low measurement noise, an engineer can find small signals that would be hidden by the measurement noise of other instruments. In the past, these small signals were not visible.

The CX3300's wide bandwidth current measurement, up to 200 MHz, accurately captures the peak current of high-speed switching power circuits (PMICs, DC/DC converters), or fast spikes that may cause circuit failure or brownout. Its extensive memory, up to 256 Mpts/ch, allows an engineer to capture errors that happen less frequently; such as sleep mode transition problems.

In addition to the functions of a standard oscilloscope, the CX3300 supports statistical analysis capabilities such as Complimentary Cumulative Distribution Function (CCDF) measurements for amplitude, Fourier transform (FFT) for power integrity analysis, and automatic current profile generation. The CX3300 can accelerate the characterization, validation, and debugging of PDN in mobile devices.

Since it can also capture the voltage waveform with a up to 16-bits of resolution, the CX3300 can also be used as a low noise/high-resolution oscilloscope for precise voltage measurements of a PDN.

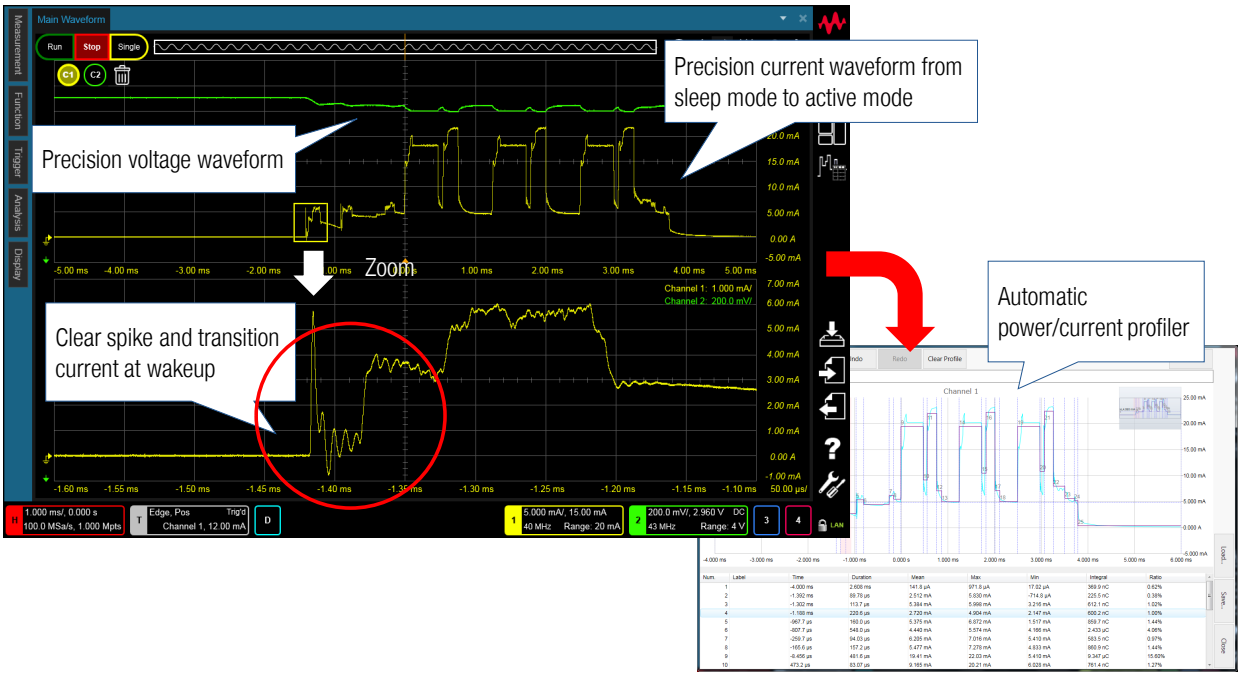


Figure 1: CX3300 characterizes sleep current, active current and fast inrush current with a single shot

Result: CX3300 Device Current Waveform Analyzer

In real-world testing, the CX3300 captured a very clear current waveform of a mobile device moving from sleep mode to active mode. The R&D engineer had not seen this clear current waveform in the past. Because of the CX3300, this engineer quickly identified a defect in the power management software at the evaluation phase. Also, the analysis functions such as automatic current profiler designed for current waveform analysis helped the engineer immediately find the source of the problem. Using conventional tools, this process would have taken a long time. (Testimony from a customer in a major IC manufacture for mobile device).

The CX3300 with CX1105 ultra-low noise differential sensor easily captures the DC/DC converter current waveform supplied to the LPDDR memory – a waveform not detectable with conventional methods. This accurate current profile helped the engineer verify the circuit operation and contributed to improvements in product reliability. (Testimony from a customer in a DRAM manufacturer).

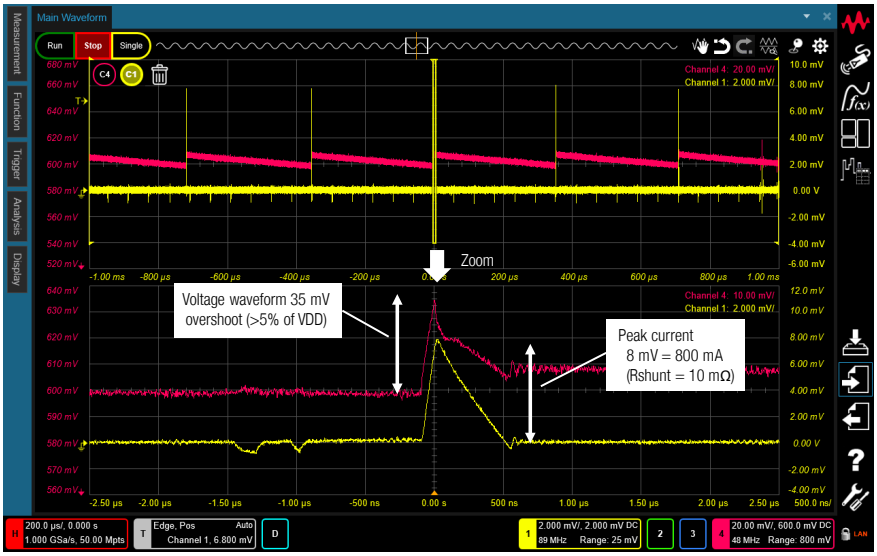


Figure 2: DC/DC converter current and voltage waveform outputted to LPDDR4 memory. Through a 10m shunt, only 8mV voltage fluctuation (=800 mA) is clearly monitored.

Going Forward

Mobile devices continue to gain higher speeds and more functions. Therefore, it is imperative that engineers evaluate the dynamic current of the PDN for advanced mobile devices to strike the right balance of higher performance and lower power.

The CX3300 Series Device Current Waveform Analyzer successfully accelerates characterization, validation, and debugging for the PDN in mobile devices with detailed current waveform measurement.

Related Information

- Product Webpage: *Device Current Waveform Analyzer*
- Technical Datasheet: *CX3300 Series Device Current Waveform Analyzer*
- Application Note: *Characterize, Validate, and Debug Advanced Devices with Precision Dynamic Current Measurements*
- Application Note: *CX3300 Series Device Current Waveform Analyzer, 7 Hints for Precise Current Measurements*

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