CASE STUDY

Accelerate the Development of Advanced Wearable Devices

With High Performance, High Reliability, and Long-Life Batteries

Introduction

As advancements in cellular technology develops into 6G, additional capabilities like wireless sensing becomes more accessible as the networks use higher frequencies than 5G networks and provide substantially higher capacity and much lower latency. Wearable IoT devices will become an integral part of our daily lives.

Stylish next-generation smart wearable devices will become smaller in size, have higher performance and higher reliability than ever before. Along with the demand, shorter time-to-market of these new devices will be an expectation.

With the improvement in the wearable device's performance, the power consumption will increase alongside. As the device is never shutdown, it also continues to consume power in sleep mode. Therefore, the design of the wearable device needs to control power consumption and ensure it continues to be efficient throughout its operation, in any mode that it is in.

The reliability and efficiency of power consumption is especially important for the wearable devices that are used in medical or healthcare applications. These devices need to operate without any disruption, consistently and reliably for long durations, for example, to constantly monitor the patient's conditions. To ensure the reliability of the wearable device, it is necessary for the development engineer to test the device over long periods of time to ensure that there are no anomalies detected in the critical signals that could cause a glitch or malfunction as well as track the power consumption to ensure consistency throughout the long operation.

Company:

- A world-leading multinational semiconductor company

Challenges:

- Building advanced power management schemes to achieve high performance and low power consumption.
- Reliable validation and debugging to achieve high device reliability.
- Faster time-to-market to secure competitive advantage.

Solutions:

- CX3300 Device Current Waveform Analyzer.
- CX3300's powerful data analysis functions such as Current Profiler, Anomalous Waveform Analytics, and Waveform Trend Analyzer.

Results:

- Optimized power consumption quickly and easily.
- Found defects that were previously undetected.
- Introduced CX3300 more than 10 units in the R&D sites worldwide.

KEYSIGHT TECHNOLOGIES

The Challenges

A world-leading multinational semiconductor company developing System-on-a-Chip (SoC) for advanced wearable devices at their various R&D sites. They faced three main challenges that we list here.

The first challenge was in building advanced power management schemes for high performance and low power consumption. The SoC has many functions and execute many tasks that consume power. It is necessary to optimize the power consumption by reducing the peak power and shortening the execution time of each task to achieve both high performance and low power device operations. The design needs to effortlessly switch between active modes and sleep modes. This is realized with intelligent software control. To validate the complicated power management system, it is necessary to characterize the current profiles across a wide range. This includes both sleep modes (nA level) and active modes (tens to hundreds mA level). To improve the efficiency and cost of the test setup, it is important to find one instrument that can support this wide range. The alternative is to connect multiple instruments to the device under test (DUT).

The second challenge was in the validation of the reliability of the wearable device and troubleshooting the device when reliability problems occur. As all device functions reference the input power, any glitch of the power during long operation or mode changes can cause unwanted operations. This is amplified with the increase in bus speeds and data transfer speeds and with the lower voltage levels in these wearable devices. The risk of device malfunctions due to miscommunication in the signal or data busses increase during the operation or mode changes. To validate or catch these anomalies, it is necessary to monitor the power busses through long operations. Since so much data is collected during these long durations, it is also important to quickly and automatically highlight anomalies seen, so that the troubleshooting efficiency can improve, consequently improving the device reliability.

The third challenge was in reducing the duration of the device design, validation, and debug stages. The speed of new technological innovations is increasing with each decade. Manufacturers need to design in these innovations into their product before new ones emerge, thus driving the product life cycle to constantly shorten. It is necessary to shorten time-to-market of the high performance and high reliability device to maintain competitive advantage.

The Solutions

The R&D team of this world-leading multinational semiconductor company chose Keysight CX3300 Series Device Current Waveform Analyzer to address these challenges.

Keysight CX3300's wide dynamic range, up to 16-bits resolution, allows for easy capture of a device's dynamic current from sleep mode to active mode. The low noise and high sensitivity performance, from sub nano-ampere, make it possible to accurately measure the very small currents especially when the device is in deep sleep mode. Oscilloscopes that are normally used for this test, have large noise and limited resolution, cannot address this challenge.

A wide-bandwidth and high-speed current measurement is needed to accurately capture the peak current waveform or high-speed current profile. The Keysight CX3300 can capture fast signals such as inrush current or spikes that are indications of defects thanks to its wide-bandwidth of up to 200 MHz and high-sampling rate of up to 1 GSa/s. Digital multimeters (DMMs) that are normally employed for this type of test are not adequate due to their low bandwidth and low sampling rate.

The Keysight CX3300 includes a data logger mode with high sampling rate of up to 10 MSa/s. This enables the CX3300 to record a continuous current waveform for a long duration of up to 100 hours without a trigger event, and capture any anomalous signals even if they are fast or rare. Oscilloscopes, DMMs and data loggers are not able to meet this challenge because of their limitations in memory depth, bandwidth, or sampling rate.

The Keysight CX3300 also includes powerful data analysis functions that automate and accelerate characterization, validation, and debugging.

A current profile analysis is essential to optimize the device performance and power consumption. This analysis is a time-consuming task as it is currently done manually using an external PC with software such as Excel. The Keysight CX3300's Automatic Current Profiler automatically analyze the current profiles in a fraction of the time and optimize both the design and reliability of the wearable devices.

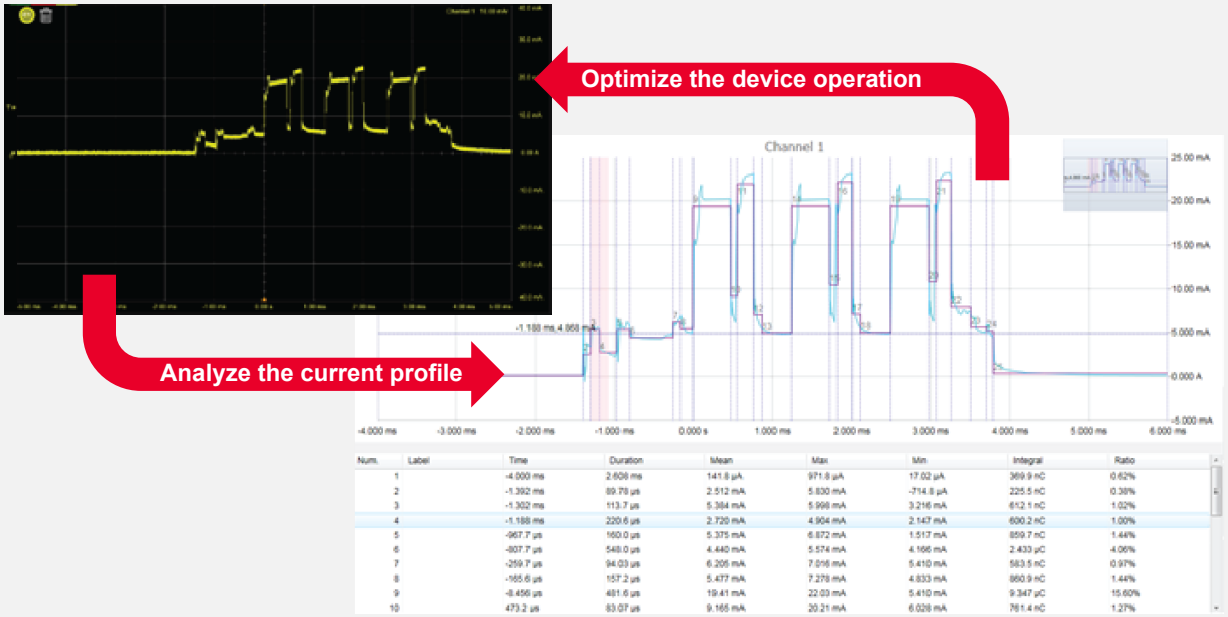

Figure 1. Automatic Current Profiler automatically adjust the time scale by the vertical level difference, instantly calculate key parameters such as average current, max/min current, accumulated charge.

It is also challenging to detect the rare anomalies in the current waveforms throughout the DUT's operation. With a long duration measurement, there could be up to 100 hours of data and the resultant waveform data size could be over a terabyte. The validation engineer can miss out critical but rare anomalies, if he/she scans the waveform segments manually using just his/her eyes. The Keysight CX3300 automates this analysis in two innovative ways.

The first innovation is in the Anomalous Waveform Analytics which is an AI driven patented feature. In a nutshell, this feature scans the whole waveform, through the large volume of waveform data, and filters out any anomalous signals instantly. What took hours or days using the manual process, is now compressed into seconds or minutes by the patented AI algorithms. Furthermore, there are chances that human errors could allow anomalies to be missed out in the manual process. Whereas, the AI algorithm allows for consistent and accurate anomaly detection, consequently, enhances the product reliability assessment significantly.

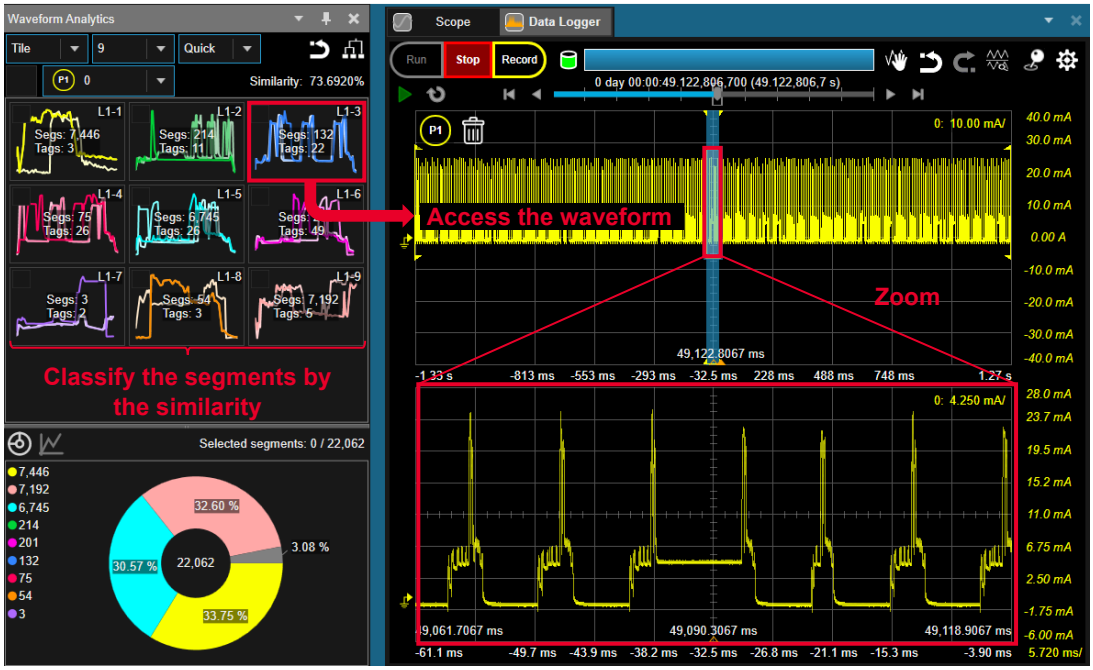

Figure 2. Anomalous Waveform Analytics detects and classifies anomalous signals quickly

The second innovation is in the Waveform Trend Analyzer. This feature compresses the volume of waveform data losslessly and quickly decompresses the data for user visualization. The innovation is that the response and refresh are so fast that the user would not know that all these are done in the background. The high-resolution screen built on the Keysight CX3300, visualizes the statistical trend (minimum, maximum, average, and charge) of the entire waveform or its segments. Users can quickly find the anomaly or inflection point detected during the device operation, and quickly zoom to the display of that specific segment in the waveform, to analyze the measured data in detail.

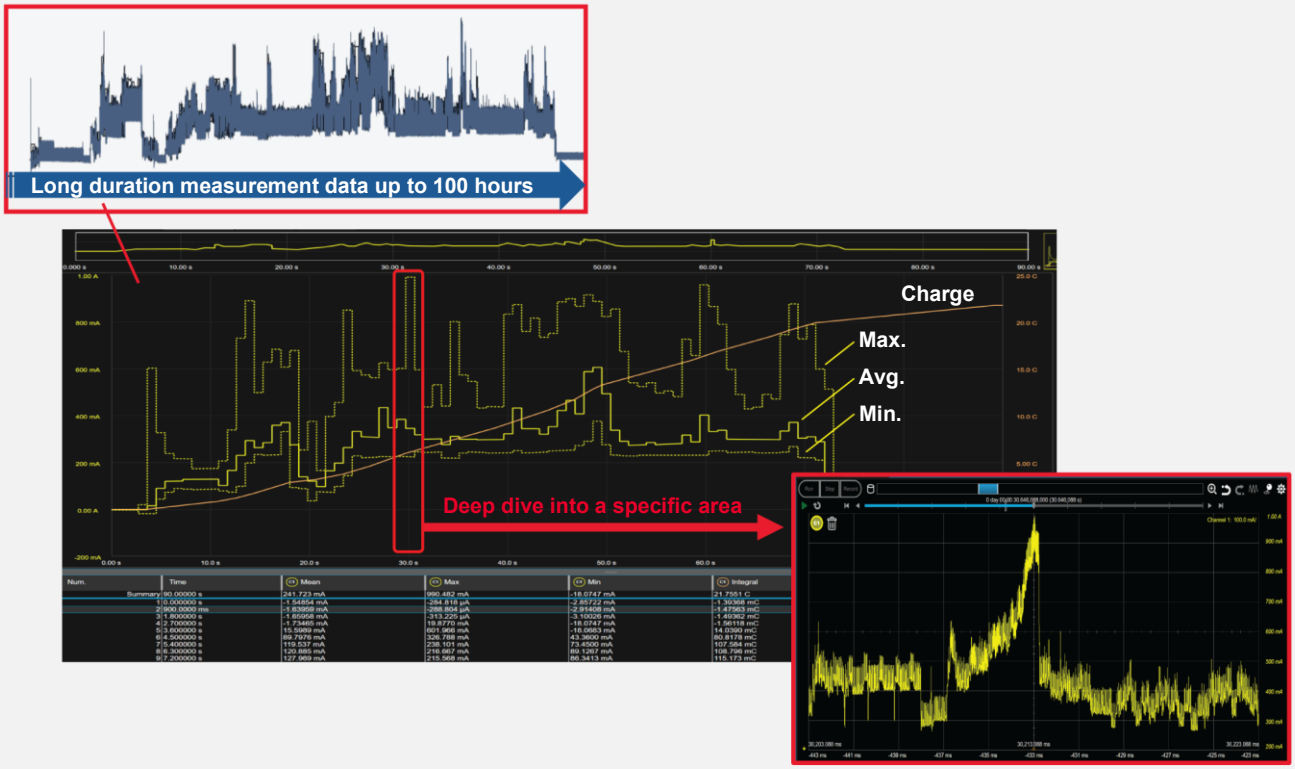

Figure 3. Waveform Trend Analyzer quickly creates the statistical trend to perform in-depth analysis

The Results

The R&D team of this world-leading multinational semiconductor company easily captured necessary current profiles in detail faster than before by analyzing these data using the Automatic Current Profiler. This allowed them to identify and resolve a firmware defect and optimize the power consumption quickly and easily.

They also captured the current consumption waveform for long durations with as much detail as possible using the data logger mode and quickly analyzed the data using the Anomalous Waveform Analytics and the Waveform Trend Analyzer. As a result, they were able to find defects that were previously undetected and improve the device's reliability by resolving the root cause.

The R&D team acknowledged that the Keysight CX3300 is a breakthrough for them. As a result, they further purchased more than 10 units of the Keysight CX3300. This enables their other R&D sites, including sister companies, to benefit from the efficiency and accuracy of Keysight CX3300's capability for current waveform validation and troubleshooting, thus accelerating the next-generation SoC development for future wearable devices and their lead in this industry.

Going Forward

As there is an increasing need for shorter time-to-market, Keysight determined that the measurement and the post-measurement analysis could be performed in parallel to improve the efficiency.

The Keysight CX3300APPC Current Waveform Analytics Software provides all the Keysight CX3300 capabilities, except for executing measurements. The post-measurement analysis, such as Current Profiling, Anomalous Waveform Analysis or Waveform Trend Analysis, can be executed on a PC, without the instrument. The measured waveform data is saved into an external storage drive and attached to the PC. The Keysight CX3300APPC software installed on the PC, will load the waveform data from the external storage drive for analysis. This allows the analysis of the current profile and the anomalies to be executed in parallel and by multiple validation engineers, if needed. In this way, if the validation engineers are in multiple time zones, the analysis can proceed round the clock. This accelerates the entire validation process in the R&D group.

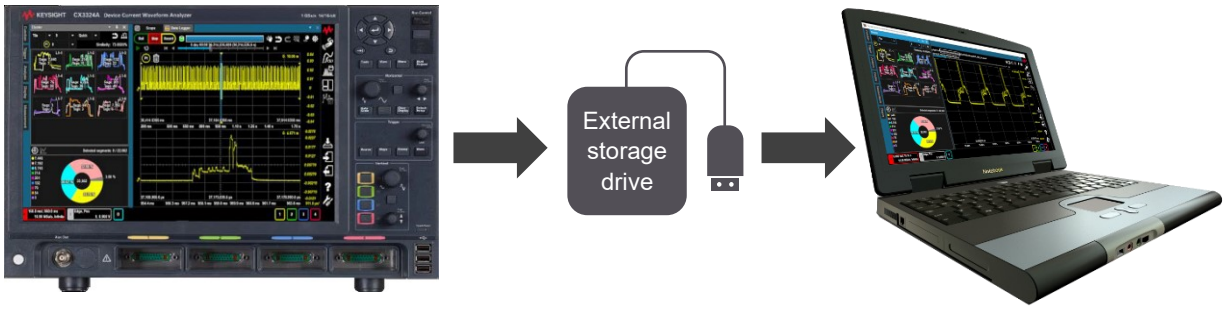

Figure 4. CX3300APPC performs waveform analysis on the external PC

Related Information

- CX3300 Series Device Current Waveform Analyzers
- Keysight University - Using Anomalous Waveform Analytics for IoT Device Analysis
- Keysight University - Use IoT Design Anomalous Waveform Analytics for Innovative Failure Analysis
- YouTube - CX3300 All-In-One Measurement and Analysis Solution

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

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