Preparation of a Nexus 5 Android Smartphone for Power Analysis

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***Abstract*—Measuring the power consumption of mobile phones needs to be performed with an external device that does not influence the power consumption of the device under test during the measurement. Additionally, a sufficiently high sampling rate is required to also capture short power consumption peaks. A solution to these problems exists in replacing the internal battery of a device with an external power supply and a power meter that measures the ingoing current over a small resistor in series to the battery connectors. In this work, we document how we modified a Nexus 5 smartphone to be able to attach external tools to the battery pads, so that results based on this setup can easily be repeated by third-party research groups.**

I. Introduction and Modification Instructions

In this work, we document how to modify a Nexus 5 smartphone for use with a power monitor that connects to the battery pads of a smartphone and acts as an external power supply. By replacing the battery, one can measure the supply voltage as well as the voltage over a small measurement resistor in series with the battery pads to derive the instantaneous current in the circuit as well as the power consumption. This allows to observe the consumed power on a very fine-grained time scale without influencing the measurement as would be the case when running power consumption measurements as an application on the device under test.

Figures 1 to 8 illustrate the modification process that connects measurement cables with banana connectors to the battery pads[1] of a Nexus 5 smartphone. The relatively large diameter of the cables' core material of 1 mm^2 leads to a low series resistance between phone and power monitor. Hence, high currents (more than 3 A) only lead to negligible voltage drops over the supply cables.

Even though the voltage of the battery is described as 3.8 volts, our measurements (see Figure 9) show that the idle voltage of the battery is more than 4.2 volts. To perform our experiments, we set the supply voltage[2] to the larger value of 4.2 volts, which reduces the supply current and, hence, the voltage drop over the supply wires. This voltage setting make the phone identify a battery charged to more than 90 percent with a voltage of 4.161 volts. The measurement setup is illustrated in Figure 10.

[1]Alternatively, one could solder the wires to the small circuit board extracted from the battery and leave the battery connector soldered to the Nexus' motherboard.

[2]To successfully power the phone with the Monsoon Power Monitor, the power-up current limit needs to be set to multiple amperes to avoid triggering the current limitation protection when connecting the phone.

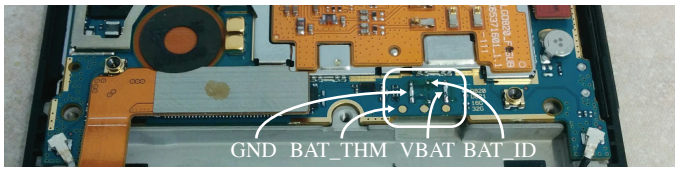

Fig. 1. View at the motherboard of a Nexus 5 after removing the motherboard securing plate and desoldering the BM22-4S-V battery connector. The GND and VBAT pads should be connected to Ground and V_{out} of the power monitor. According to the circuit board in the battery (see Figure 2), the BAT_ID pad should be connected to GND and there should be two small SMD components (extracted from the battery board) placed between BAT_THM and GND.

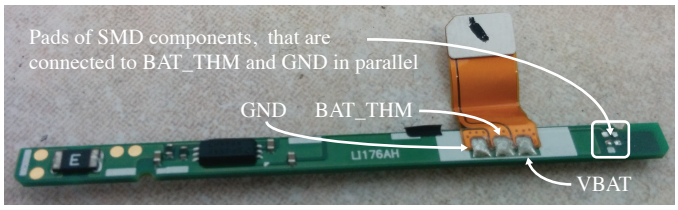

Fig. 2. This is the circuit board from the battery. It contains two SMD components that we extract and directly solder between BAT_THM and GND on Nexus's motherboard.

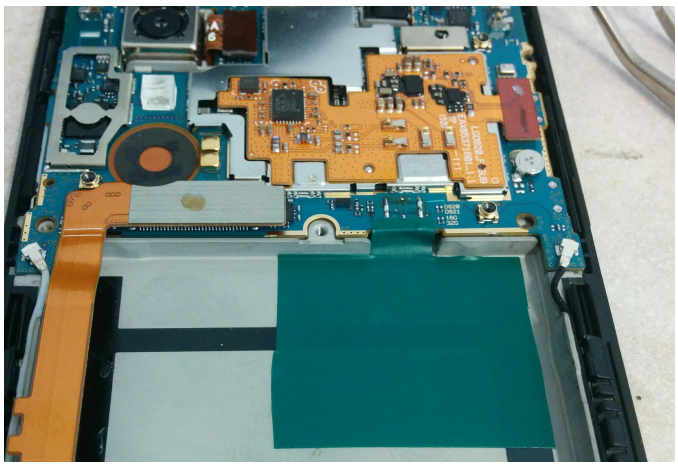

Fig. 3. To avoid short circuits in the conducting battery tray and at the test pads on the motherboard, we cover the area around the battery pads with insulating tape.

Acknowledgment

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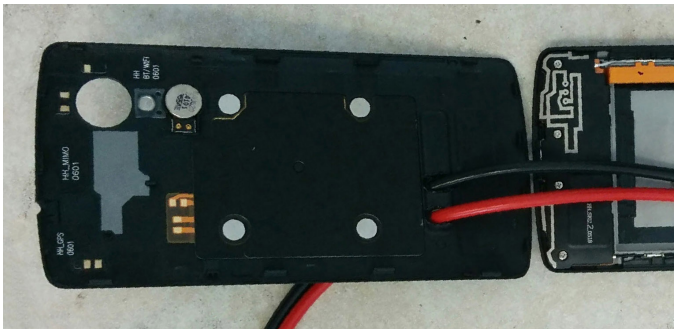

Fig. 4. To be able to close the rear panel during experiments, we make two holes below the wireless charging antenna in the rear panel and insert two measurement cables (1 mm^2).

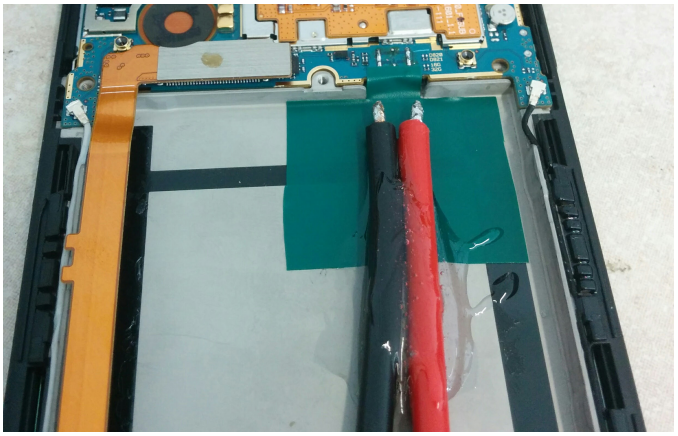

Fig. 5. To connect the battery pads to the power meter, we use measurement cables and glue them to the battery tray using two-component glue.

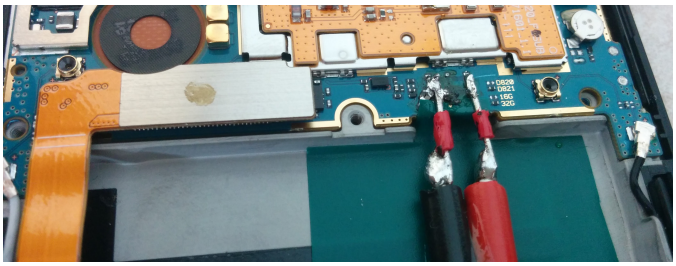

Fig. 6. As the measurement cables are to thick for the battery pads, we use solid 22 AWG wires to create a connection between pads and measurement wires.

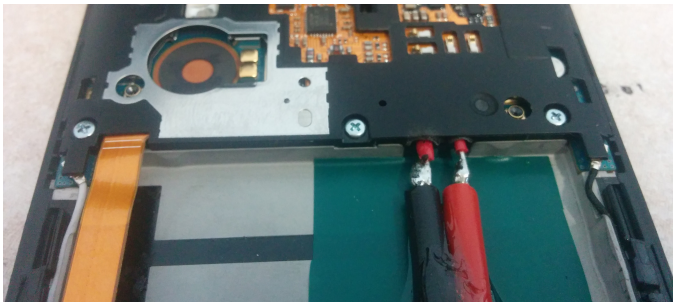

Fig. 7. To reinstall the motherboard securing plate, we create two small recesses at the position of the wires.

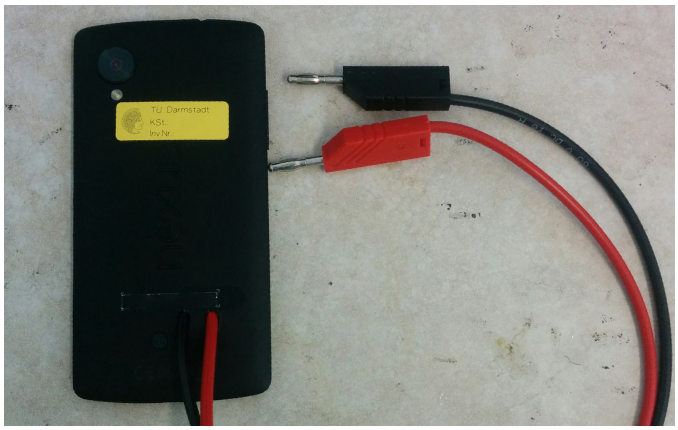

Fig. 8. The modified phone with closed rear panel and outgoing measurement cables with banana connectors.

Fig. 9. Measuring the idle voltage of a fully loaded Nexus 5 battery.

Fig. 10. Nexus 5 connected to the Monsoon Power Monitor.