System Power Monitoring (SPM) v3

Training Slides

Qualcomm Technologies, Inc.

80-N6594-22 Rev. B

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Revision History

Revision	Date	Description
A	February 7, 2013	Initial release
B	March 2013	• Updated the Additional Documentation slide to reflect new document names • Updated WQEPM version number to 1.2

Contents

What is System Power Monitoring (SPM)?

System Power Monitoring (SPM) is specifically designed by Qualcomm Technologies, Inc., (QTI) to support OEM power monitoring needs. SPM is a cost-effective way for OEMs to take relative current measurement for handset power tuning.

SPM is used for coarse current measurement, and it is most effective when comparing results from successive measurements, such as measuring the ***relative*** power when applying certain software changes.

Note: The QTI power team does not use SPM internally for power dashboard measurements. Instead, a sophisticated measuring system is used for finer absolute power measurement. There is no support for this system.

History of SPM

Version	Description	Supported chipset(s)
SPM v1	(Op-amp + ADC) daughter card + NRT MiniBoard, 48 current channels	MSM8960, MSM8x30
SPM v1.5	(Op-amp + ADC) daughter card + NRT ViperBoard + NRT adapter board, 48 current channels	MSM8960, MSM8x30
SPM v2 (no official release)	(Op-amp + ADC + ViperBoard pinout) daughter card + NRT ViperBoard, 48 current channels	MSM8960, MSM8x30
SPM v3	(Op-amp + ADC + 2x Cypress PSOC + USB hub) daughter card, 48 current channels + 14 voltage channels	All active chipsets

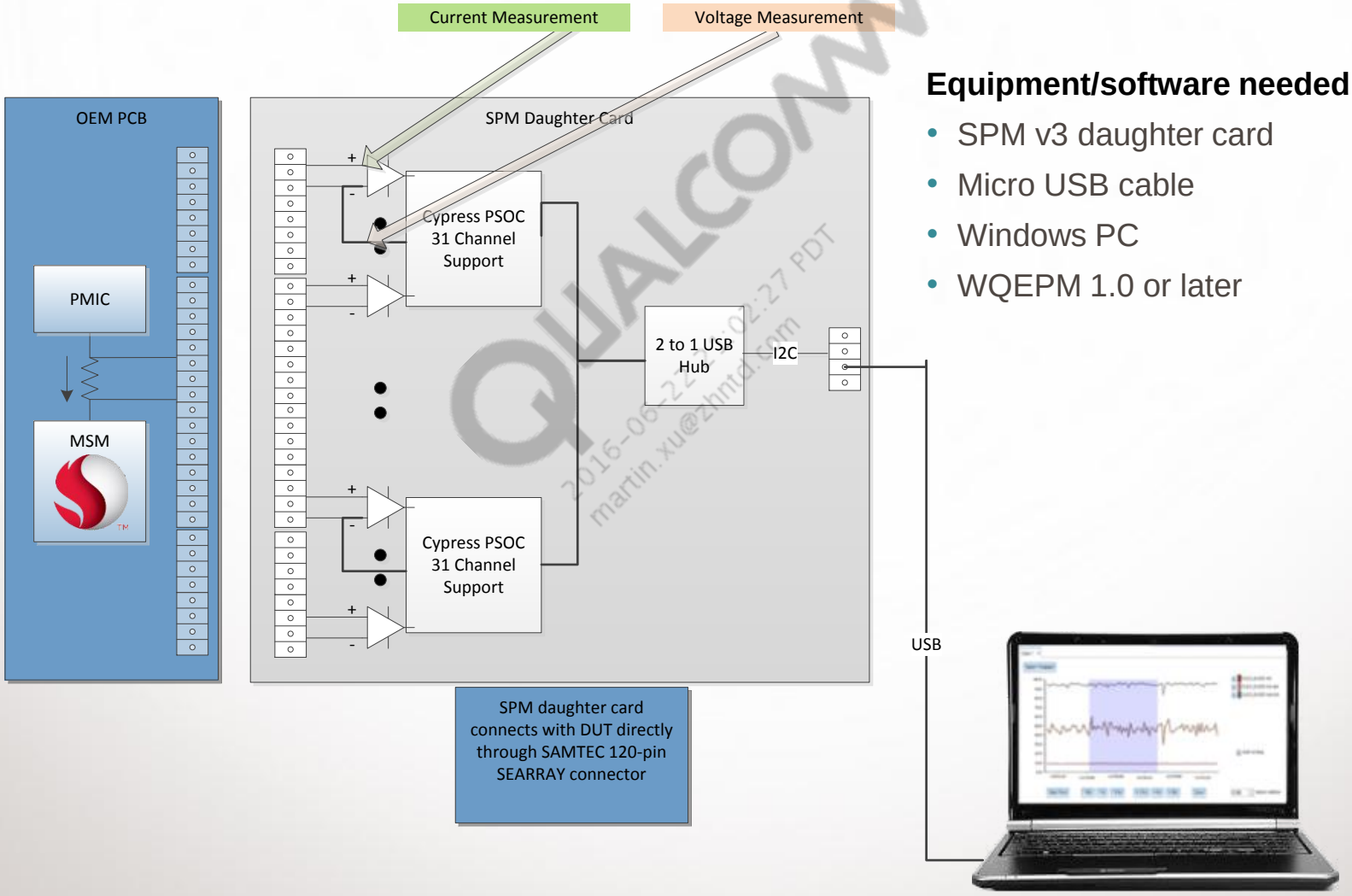
SPM v3 Features

Features	Description
Current channels	48 (2 × 24 Cypress PSOC IC)
Voltage channels	14
Sampling rate	Up to 10k samples per second shared among channels of a *single* PSOC (current and voltage separate)
Accuracy (room temperature)	Up to 3% (DMM vs. WQEPM) – Slide 13
Power supply	USB
Integrated SPI/USB converter	Yes
Operating temperature	-20°C to 80°C
Cables	1 USB

How Does SPM Work?

- The SPM intercepts the power rails from the PMIC to the MDM, MSM™, APQ, etc., device for passive power management.
- The OEM is responsible for placing a sense resistor on the power rail and routing the '+' and '-' lines to a connector on their development board.
- The op-amps on the SPM amplify the voltage drop across the sense resistor and input that voltage into one of the Cypress PSOCs.
- The PSOC IC will digitize the data and then output the data through the USB to the PC.
- WQEPM (QTI software on the PC) converts the voltage levels to current using Ohm's law (I = V/R).
  - The OEM uses a configuration file to supply WQEPM with the sense resistor value used.

SPM v3 Block Diagram



Equipment/software needed for SPM v3

- SPM v3 daughter card
- Micro USB cable
- Windows PC
- WQEPM 1.0 or later

Designing an SPM-ready Board (1 of 2)

Op-amp polarity

- It is mandatory that the PMIC side of any op-amp input is connected to the positive side of the op-amp. If it is connected in reverse, the op-amp will send a negative voltage to the SPM's ADC resulting in a 0 at the ADC's output.

Sense resistors

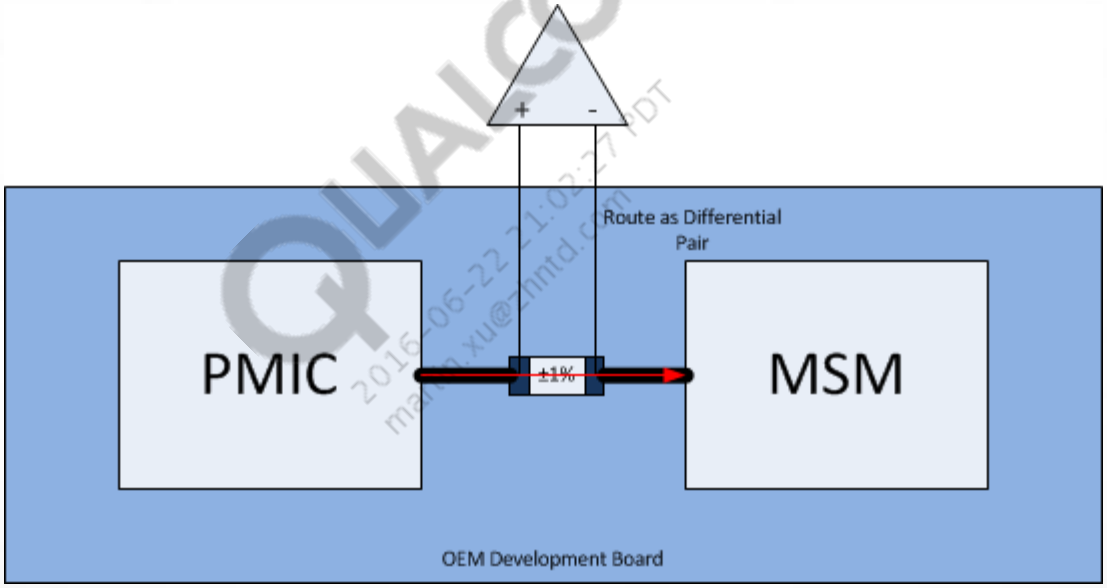
- Use resistors with ±1% (or better) tolerance: Since the WQEPM uses the optimal resistor value input into the config file, mismatched resistance will add more errors. If a resistor is 10% off from the nominal, the current reading's maximum error will increase 10%.
- Traces must be connected as close to the resistor as possible (with a Kelvin connection).
- Prevent the sense resistors from greatly affecting the PDN of the power lines: When using sense resistors, make sure to get the resistor sizing appropriate to the amount of current that goes through the resistor. Resistors on a Krait power path need to have a higher current rating. Also make sure that power lines with larger currents have an appropriate number of vias going to the sense resistors. Running 1.5 A through one micro-via will create an issue on the PDN network and potentially damage the PCB, due to thermal issues.
- For rails driven by a switching power supply, place sense resistors in series with the inductors and prior to the sense-line used for feedback.
- The voltage drop across the sense resistors must be under 0.02 V.
  - If the maximum current on a rail is 1.5 A, the recommended resistor size is ~10 mΩ
  - If the maximum current on a rail is 30 mA, the recommended resistor size is ~650 mΩ
  - Aim for a voltage drop across the sense resistors to be a maximum of 15 mV and a minimum of 0.5 mV
- The power rating of the resistor is important. It must be able to handle enough current for the rail.

Op-amp traces

- Treat the traces to the op-amp pins as a differential pair: Because the drop across the sense resistors can sometimes be smaller than 1 mV, noise can play a major role on the outcome if the noise couples onto one of the traces (+1 mV induced onto the positive-only side would create 100% error). To minimize this, these two traces should run as close together as possible all the way from the sense resistor up to the Samtech connector. Noise coupled onto one line will be the same on the second line and will effectively be ignored.
- Traces should start as close to the resistor as possible.

Designing an SPM-ready Board (2 of 2)

A diagram of the points listed in the previous slide.



Pros and Cons of SPM

Pros

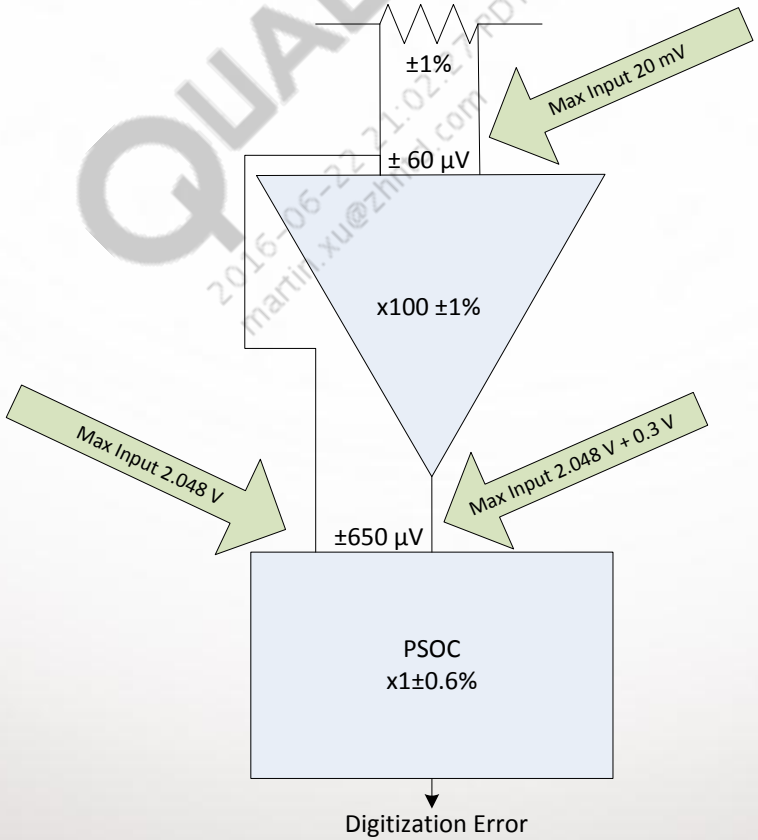
- Easy setup and use
- Cost-effective solution
- Supported on all active chipsets
- Offers quick rail-to-rail measurements for power optimization and debugging
- Designed to measure deltas from one software build to another
- Offers accuracy of up to 3% with proper calibration

Cons

- Not as accurate as QTI internal measurement tools and is not a reliable source to try and match QTI dashboard numbers
- It is an open board, therefore, misuse can cause damage to the board
- Temperature variations affect the board since SPM is connected directly to the board
  - Early tests show typical error at -20/85 degrees ~1.5%, worst case has been 5%
- ADCs become saturated at 2.048 V

Error Calculation Explained

- Data measured using SPM should not be compared to QTI's dashboard numbers
- The number of errors is in reference to absolute current through the sense resistor
- Error calculations were done at room temperature
- Calculation assumes a purely DC signal
  - Maximum sample rate per channel is only 10 ksps (did not affect these error calculations)
- The larger the current through the resistor, or the same current through a larger resistor, increases the accuracy



Additional Documentation

Document	Description
80-N1622-16 (Rev. F or later)	*Application Note: System Power Monitor Tool*
80-N6594-41	*System Power Monitor (SPM) v1 Daughter Card Reference Schematic*
80-N6594-43	*SPM v3 Daughter Card Reference Schematic*

Ordering SPM v3 (Preliminary)

- Customers can purchase the boards through https://cp.qti.qualcomm.com. The CCA is 20-ND959-H1.
- Requests for WQEPM currently go through Salesforce (https//support.cdmatech.com).
  - Initial problem type = Hardware
  - Problem area 1 = Digital baseband
  - Problem area 2 = Power consumption
  - Make sure to specify the latest version of WQEPM in the subject line and QTI will try to make the program available within two business days.
    - *WQEPM Ver. 1.2* (HK11-N6521-2)
    - *Web-based Qualcomm Embedded Power Monitor Version 1.2 User Guide* (80-N4235-3)

Questions?

https://support.cdmatech.com