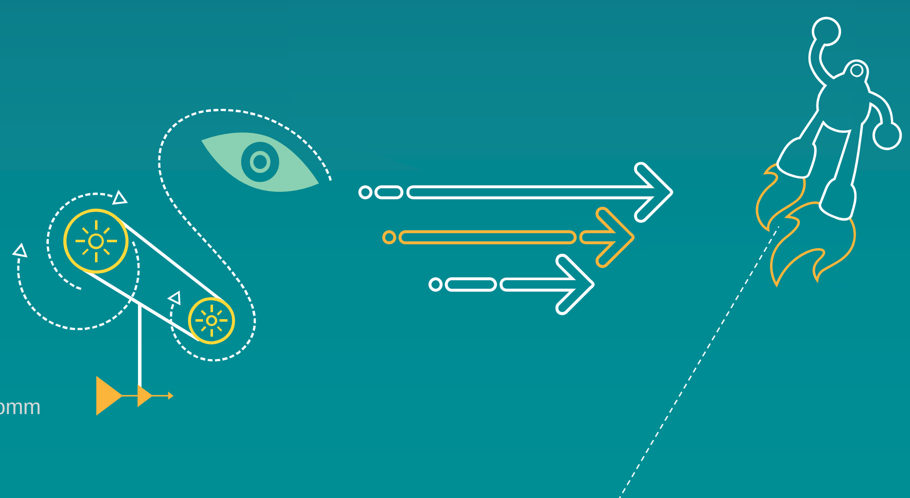
Application Note

MSM8974AB Chipset Thermal Power Projection

Qualcomm Technologies, Inc.



80-NA437-12A Rev. A

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Revision History

Revision	Date	Description
A	May 2014	Initial release; this document was previously 80-NA437-15

Thermal Power Concurrency Projection Breakout for the MSM8974AB Chipset (1 of 2)

General Information

- The thermal power projection data is intended to be used **only** for:
  - Performing system-level thermal analysis and simulation

- The data in this document is **not** intended to be used for:
  - System power consumption targets, PDN, or power budgeting purposes
  - For deriving current consumption estimates (because the data is not based on actual measurements for these chipsets)

- **Qualcomm Technologies, Inc. (QTI) provides two sets of data for performing thermal simulation:**
  - Thermal power concurrency projection (this document)
  - Chipset packages thermal models
  - The combination of thermal power projection and chipset package thermal models data that QTI provides should enable customers to perform the necessary thermal simulation on their systems.

The table on the slide 6 lists the projected concurrency thermal power dissipation data, broken out at the die-block level for each IC package in the MSM8974AB chipset.

Note: Licensed customers can access this document and other thermal related documents such as package thermal models and other thermal design supporting documents at: https://support.cdmatech.com.

Thermal Power Concurrency Projection Breakout for the MSM8974AB Chipset (2 of 2)

General Information (*cont.*)

The power values listed in this document are **general and forward-looking** information:

- These values represent thermal power projections for known, thermally challenging use cases and benchmarks to exercise various aspects of the chipset.
- Projection numbers are subject to change and data will be updated periodically as QTI acquires more detailed information.
- Customers are encouraged to review this document regularly for updates.

The thermal power values in the table on slide 6 are unmitigated and will be lowered via software (SW) thermal mitigation routines when the thermal limits are reached.

Thermal power projections are provided in **range values** to accommodate for:

- Variation in semiconductor processes and manufacturing maturity
- Any leakage associated with high power and elevated temperature environment

Non-QTI components, such as PAs, display panels, etc., are unless otherwise stated, not included in this document. Specifically, display brightness and PA transmission thermal losses are not included.

Thermal Power Projection Breakdown

Projection evaluated at indicated device junction temperature

Use cases	Projection evaluated at device junction temperature T_j	Chipset hardware configuration								Total
		MSM8974AB, 28HPM	POP -LPDDR3 3 GB (6 × 512 MB, 2 × 32 bits, 933 MHz max)	WTR1625	PA1 (ET enabled)	WCD9320	WCN3660	PM8841	PM8941	
		Units: mW								
CPU intensive (Quad-core Dhrystone, 2.5 GHz)	85°C	6800–9100	10	0	0	0	0	1000–1700	20	~7800–10800
Graphics intensive: (Egypt 2.5 HD, 60 fps)		2500–3600	1200	0	0	0	0	500–560	250	~4450–5600
4 K × 2 K camera encode at 30 fps, 1080p display	75°C	1600–2100	275	0	0	0	0	340–400	50	~2300–2850
Skype™ over LTE (SW)		1600–2000	125	300	950	8		275–350	125	~3400–3900
LTE CA (10 + 10)	65°C	900–1200	160	400	845	0	0	250–300	125	~2680–3050
WCDMA voice call (24 dBm, -90 dBm Rx)	55°C	160–215	32	180	1275	8	0	30–50	50	~1750–1800

Thermal Power Projection for the MSM8974AB Chipset

System Configuration

This table provides background information regarding system configuration and boundary condition assumptions used to generate the thermal power data in the thermal power projection table.

Use-case	Description
Quad-core Dhrystone frequency	2.5 GHz, each Krait
Egypt HD (GL2.5)	GPU resolution at 1080p and 60 fps
Video recording: ultra high definition (UHD)	Single camcorder (UHD 30 fps) (rear cam: 16 MP); (UHD [rear]) → UHD camcorder and FHD preview
Skype over LTE (QVGA)	Android™ Skype, QVGA video content, LTE at 23 dBm, software video encoding/decoding
LTE CA (10 + 10)	LTE FDD CAT3 carrier aggregation 10 + 10 MHz, 22 dBm Tx (100/25 Mbps) B4 + B17, TX B17
Display resolution	FHD (1920 × 1080)

Notes:
1. All use cases assume an AC adapter as a power source (not battery power mode).
2. BL/LCD/Sensor power data is NOT included in the above estimates.

Battery Charging Thermal Power (1 of 3)

- The battery charging path includes the USB cable/connector, PWB trace, PMIC, external components (inductor, FET, and capacitor), and battery, etc.

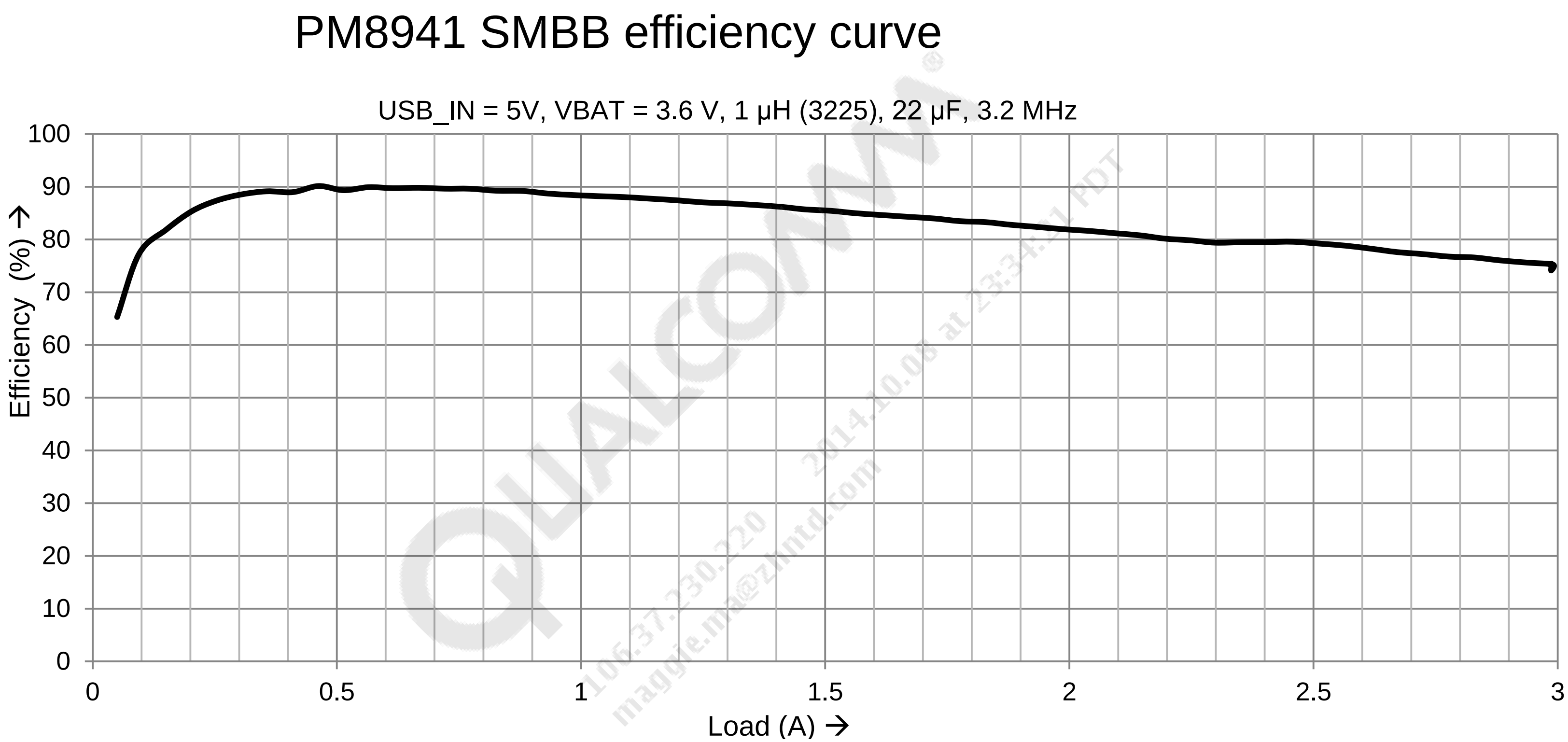
- Any resistance on the path converts the power to heat. **The consideration of all contributors at the same time is complicated; hence, the focus here is on PMIC/SMB, which is the main contributor for battery charging thermal power.**

- The functional block responsible for battery charging in the PMIC uses switch mode battery charging (SMBC). A set of similar PMICs that includes PM8941 is used for both the MSM8974 and MSM8974AB devices.

- **To calculate the power dissipation during battery charging, use this format:**

$$P_{dissipation} = \frac{P_{out} * (1-\eta)}{\eta}$$

where $\mathbf{P_{out}}$ is the output power of SMBC, and $\boldsymbol{\eta}$ is the conversion efficiency. The curve on the next slide shows the typical SMBC efficiency of PM8941.



PM8941 SMBB efficiency:

- 80% at 100 mA I_{out}
- 90% at 500 mA I_{out}
- 88% at 1.0 A I_{out}
- 79% at 2.5 A I_{out}

Based on the above curve and choosing the efficiency of ~88% when the charging current is 1 A; hence PM8941 total loss is calculated as:

$$P_{dissipation} = (3.6\text{ V} * 1\text{ A}) * (1 - 0.88)/0.88 = 0.49\text{ W}$$

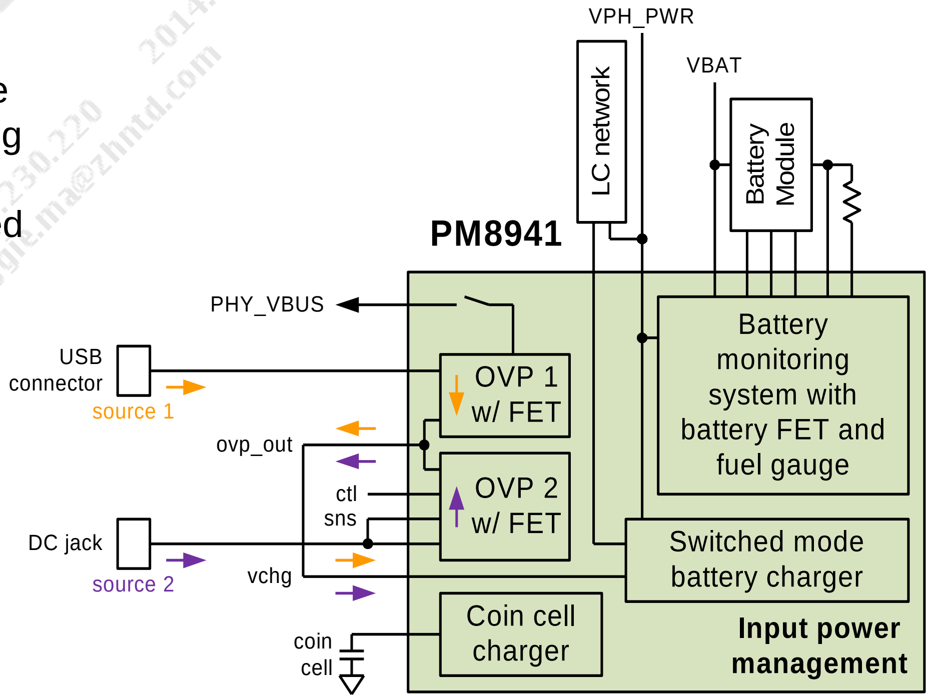
where 3.6 V is the average battery voltage for a 5 V battery during constant current charging.

Battery Charging Thermal Power (3 of 3)

However, only ~75–78% (with 1 A charging current, it is ~65% with 3 A charging current) of this power is dissipated on the die. The rest is dissipated off the chip components such as inductors (DRC and core losses) and capacitors, so the final thermal power is:

$$P_{thermal} = 0.49 * 0.78 = 0.38 \text{ W}$$

Note: A major contributor of power dissipation in the PMIC is the internal overvoltage protection "OVP" block with high Rds(on). However, this Rds(on) value and hence power dissipation can be reduced by using parallel path charging. In parallel path charging, USB_IN and DC_IN of PM8941 are externally shorted together, so that the overall internal OVP block impedance is reduced.



Questions?

You may also submit questions to:
https://support.cdmatech.com