System Design Consideration Using PMIC for Low-Power Wearable and IoT Application

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Agenda

- Power Management Requirement for i.MX RT600 Family
- Power Management IC (PMIC) Suitable for RT600
- Example: i.MXRT685 + PCA9420
- PCA9420 Introduction
- Power Management Requirement in Application System

Power Management Requirement for i.MX RT600/500 Family

(1) Power Interface

- Always-on Supply
- VDDIO
- VDDCORE
- VDD1V8

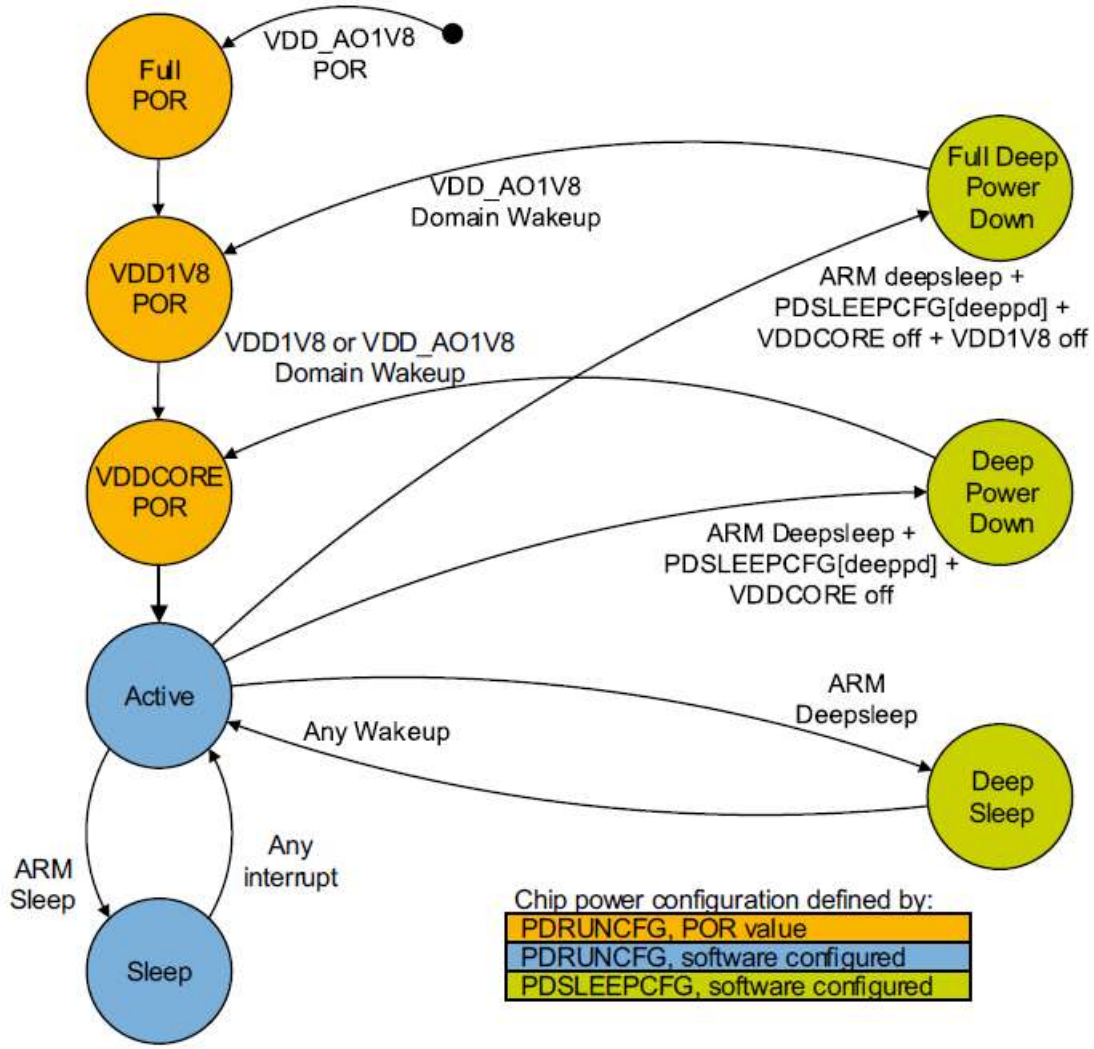
(2) PMIC Control

- LDO Enable
- PMIC_MODE0/PMIC_MODE1
- RESETN
- PMIC_IRQN
- PMIC_SCL/PMIC_SDA

Power Management Requirement for i.MX RT600/500 Family

(3) Power Mode Control

- Active Mode
- Sleep Mode
- Deep Sleep Mode
- Deep Power Down
- Full Power Down



Power Management IC (PMIC) Suitable for RT600/500 Family

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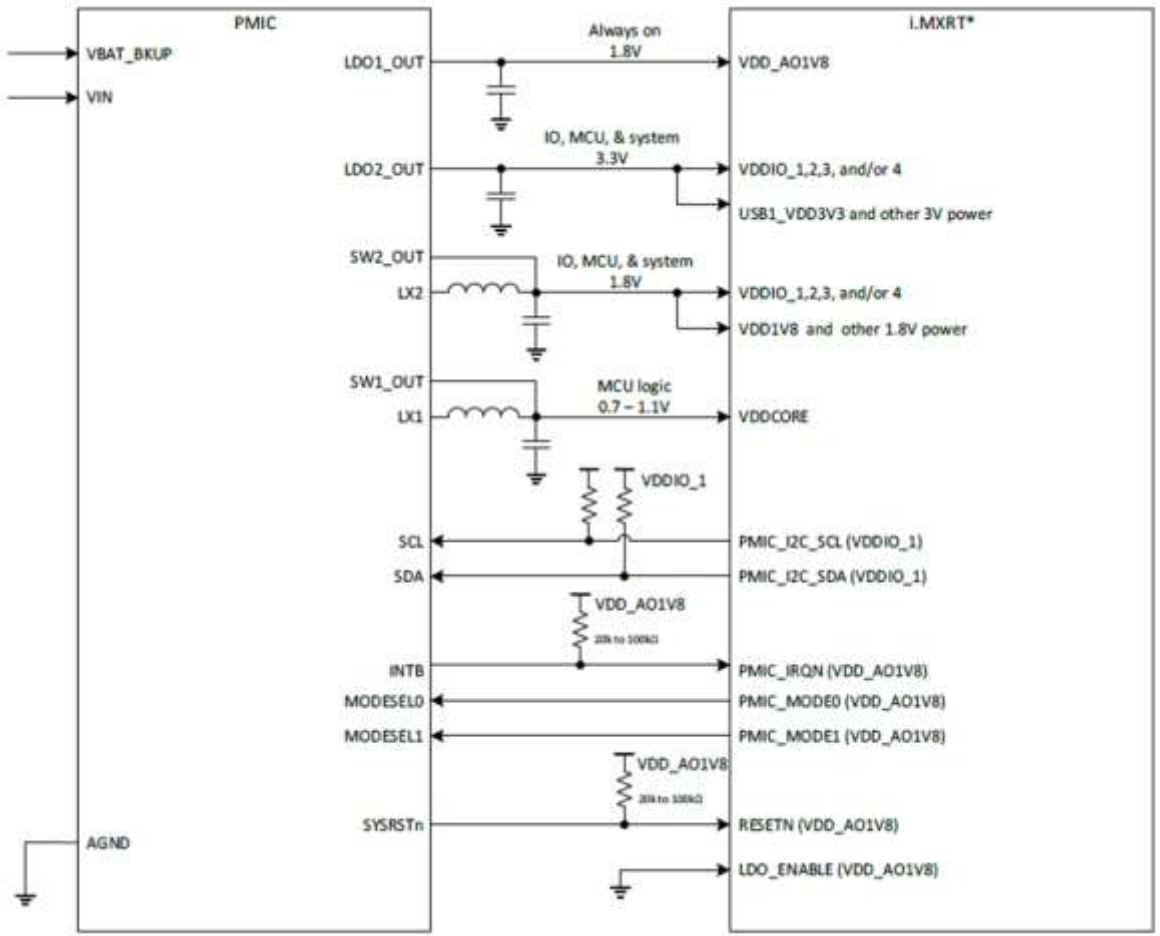
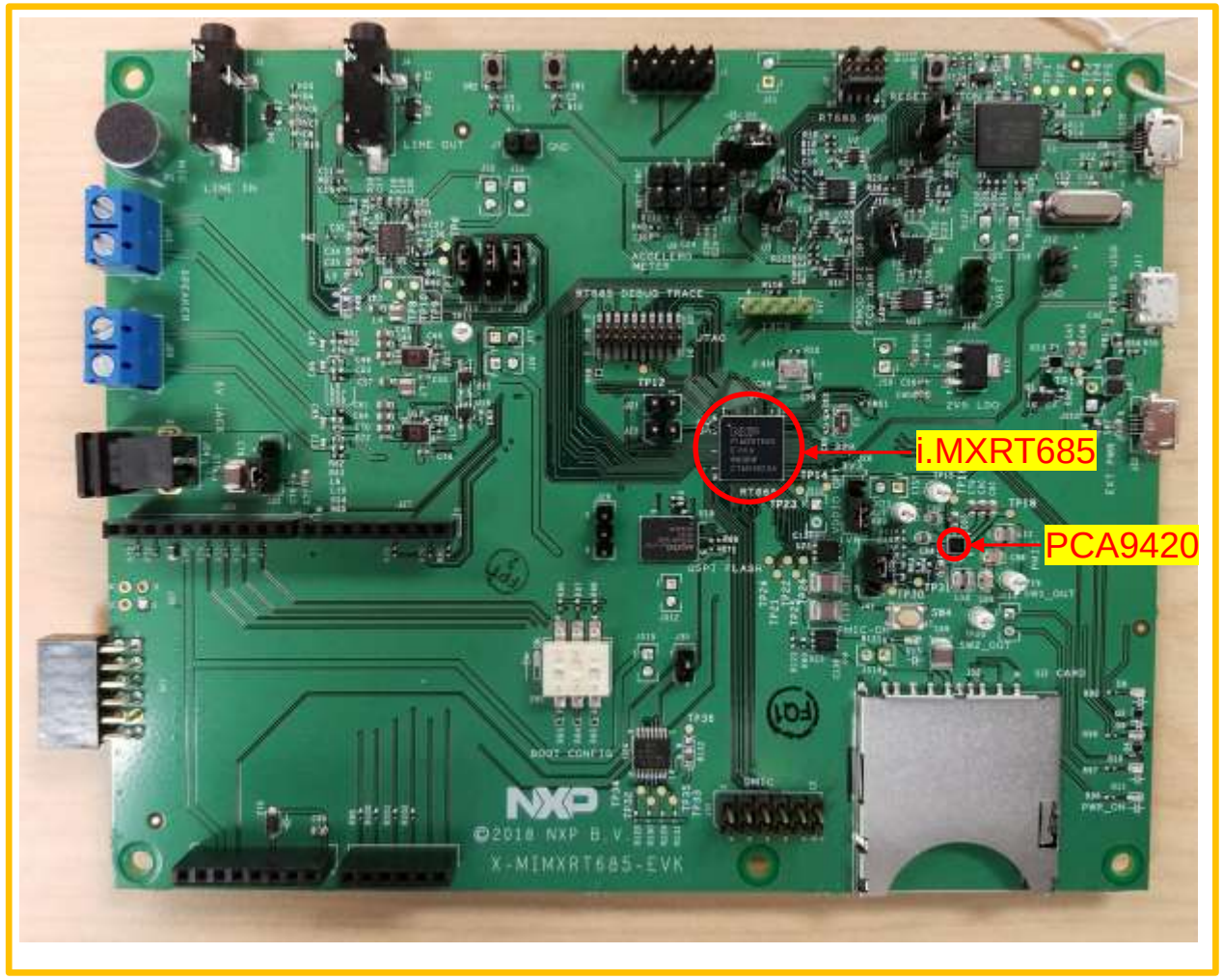


- Power-up Sequence
- Mode Setting
  - Mode 0 – Run Mode
  - Mode 1 – Deep Sleep
  - Mode 2 – Deep Power Down
  - Mode 3 – Full Deep Power Down

i.MXRT600/500 (MCU) + PCA9420 (PMIC)

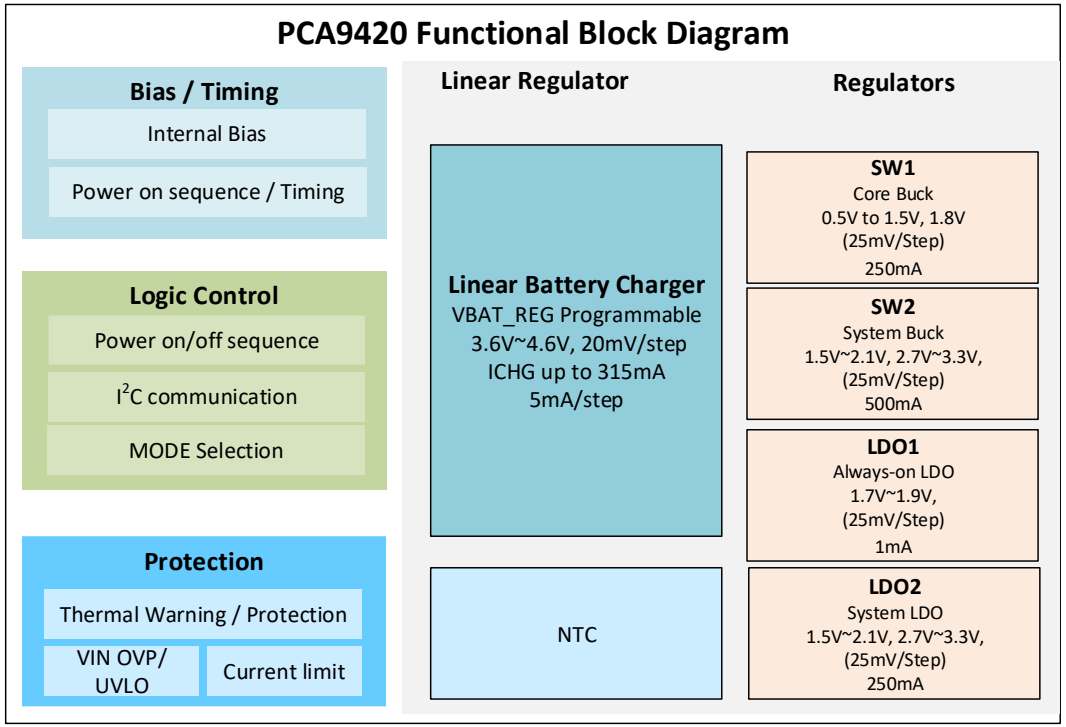
i.MXRT685 Standard EV Kit



PCA9420 Feature List

- Suitable for Low-power processors in wearable & IoT applications
- 100nA (typ) Quiescent Current Consumption During Ship-Mode
- Flexible Mode Setting Capability (via GPIO or I2C) Accommodating Fast MCU Operation Mode Switch
- Integrated Single-cell Linear Li-ion Battery Charger (up to 315mA)
- 2x DC/DC, 2x LDO
- Programmable outputs in 25 mV steps
- Output can be enabled/disabled independently
- 20V DC Tolerance on Vin with programmable OVP
- I2C interface for communications
- Packages : QFN and WLCSP
- WLCSP 25-bump, 2.09mm x 2.09mm, 0.4mm pitch
- QFN 3mmx3mm, 24 pin

PCA9420 PMIC For Low Power Applications



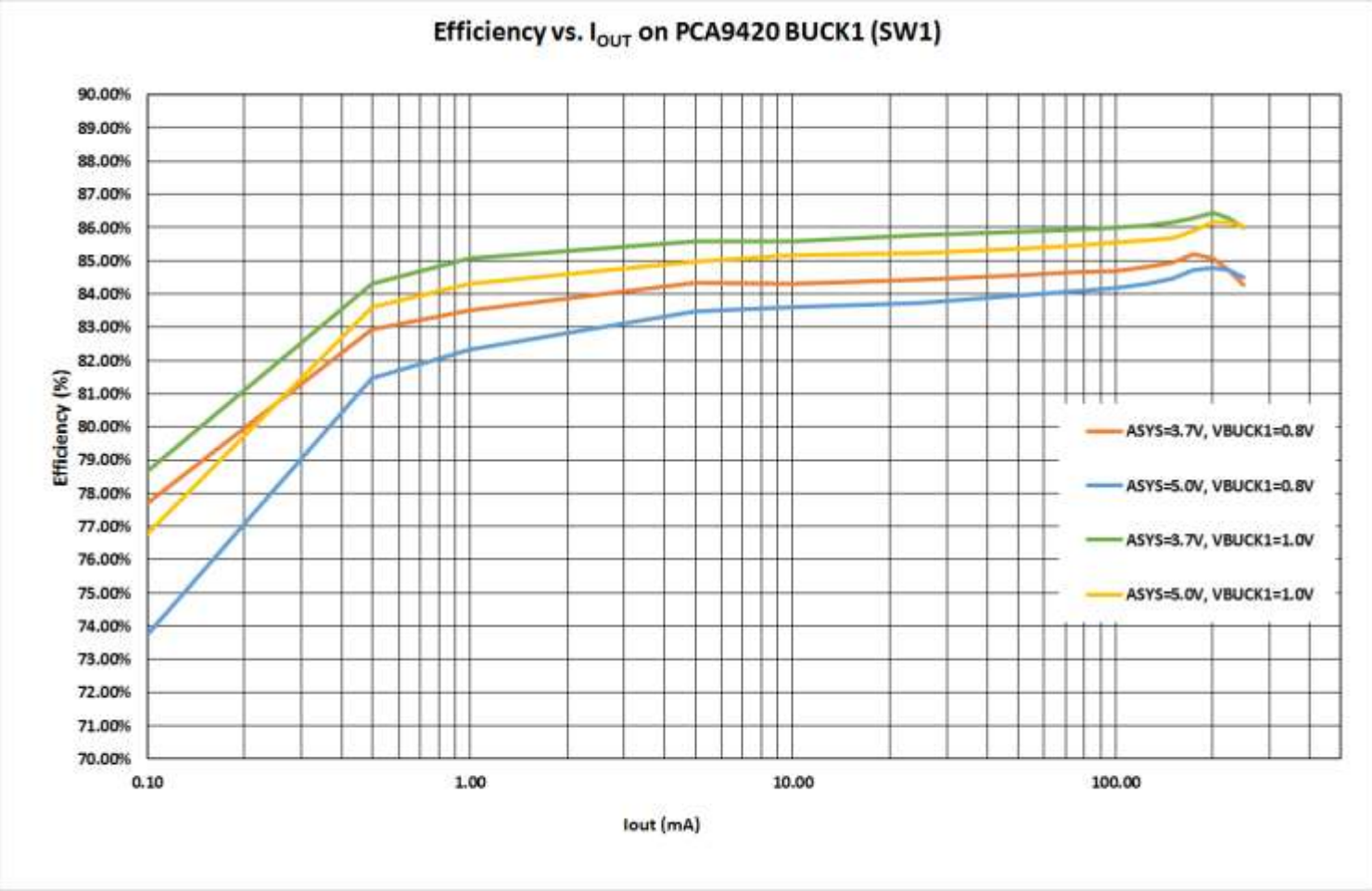
Target Applications

- Wearable devices – watch, band, fitness accessories, etc.
- Hearable device – earbud, headset, etc.
- Other low-power applications powered by li-ion battery

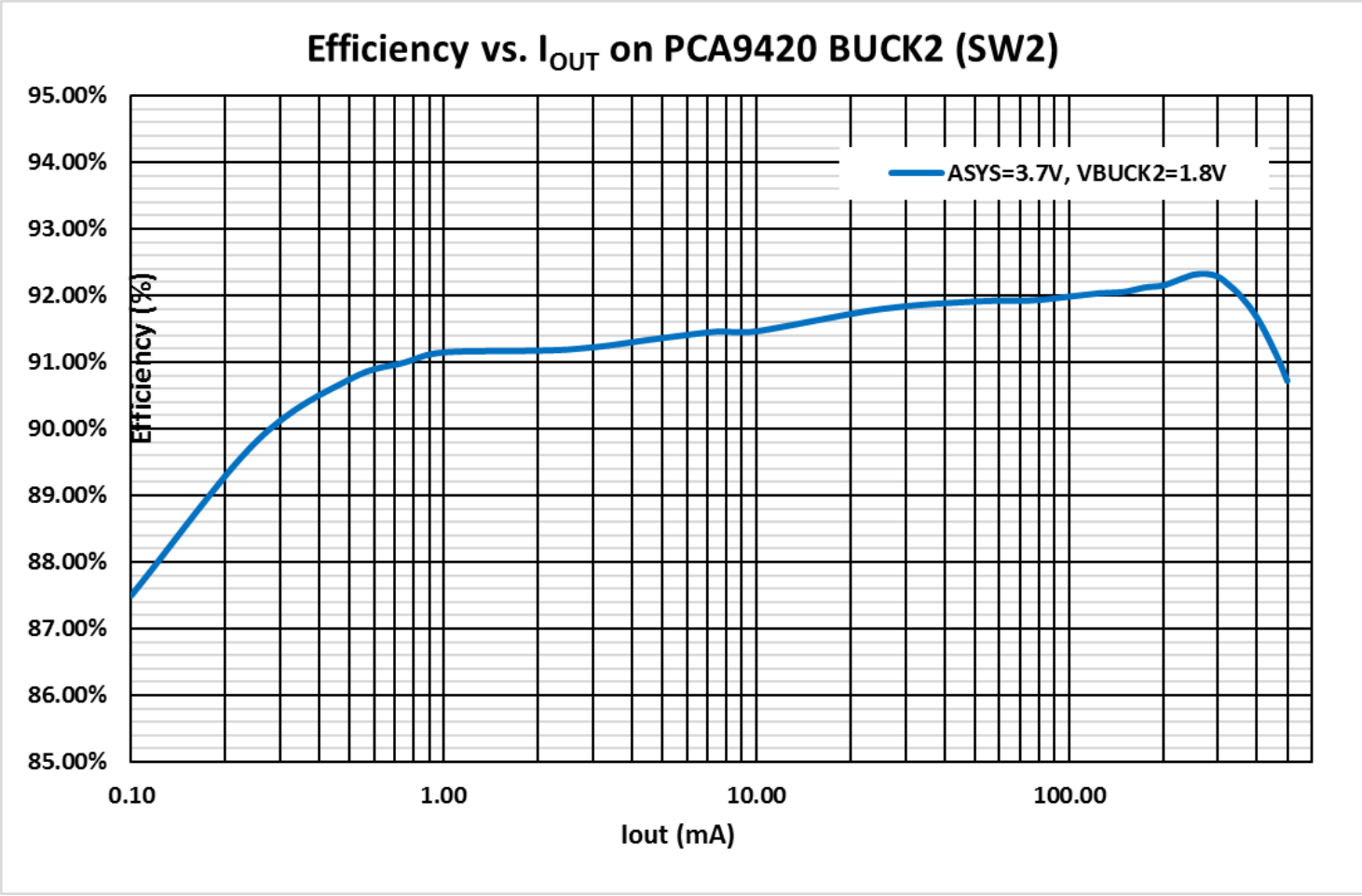
Features and Benefits

- Ultra-compact Low-Iq PMIC for Low Power Applications
- Very low Iq, high light load efficiency, longer system standby time
  - Very Low Quiescent Current in Ship mode (< 150nA)
- Highly integrated solution, flexible programmability, small solution size
  - 1x Linear Battery Charger (up to 315mA)
  - 2x Buck Regulators (500mA, 250mA)
  - 2x LDO (250mA, 1mA)
  - Built-in “Mode” Configuration to Accommodate Fast Mode Switch Supporting Different MCU Operation Modes
  - 20V DC Tolerance on Vin Pin with Programmable OVP
  - Fm+ 1MHz I^2C Interface
  - Package:
    - WLCSP 25-bump, 2.09mm x 2.09mm, 0.4mm pitch
    - QFN 24-pin 3mm x 3mm

Buck1 (Core Buck) Efficiency vs. Load Current



Buck2 (SYS Buck) Efficiency vs. Load Current



Test Condition: VASYS=3.7V, VBUCK2=1.8V, IBUCK2=0mA to 500mA

PCA9420 Functional Block Summary

	Linear Battery Charger	SW1	SW2	LDO1	LDO2
V_{OUT} Range	3.6V ~ 4.6V (CV regulation range) Accuracy 0.5% @25C	0.5V ~ 1.5V, and 1.8V	1.5V~2.1V 2.7V-3.3V	1.7V~1.9V	1.5V~2.1V 2.7V-3.3V
V_{OUT} Adjustable resolution	20mV/step	25mV/step (DVFS)	25mV/step	25mV/step	25mV/step
Output Current Range	Up to 315mA	Up to 250mA	Up to 500mA	Up to 1mA	Up to 250mA
Input Voltage DC Rating	Up to 20V	Built-in	Built-in	Built-in	Built-in

Comparison

	PCA9420	Bx2512xA
Key Function Summary	1x Linear Battery Charger 2x DC/DC: 500mA/ 250mA 2x LDO: 250mA/ 1mA	1x Linear Battery Charger 1x DC/DC: 300mA 1x LDO(Load Switch): 100mA
Package	WLCSP (5x5 bump array): 2.09mm x 2.09mm = 4.37sqmm QFN (24-pin): 3mm x 3mm = 9sqmm	DSBGA 2.5mm x 2.5mm = 6.25sqmm 6 X 6 Bump Array
Battery Charger	Linear	Linear
Charger CC Current Range	5mA~315mA, 5mA/step (I2C programmable)	5mA~300mA (set by external resistor)
Charger CV Voltage Range	3.6V~4.6V, 20mV/step (I2C programmable)	3.6V~4.65V, 10mV/step (I2C programmable)
Number of Buck Conveter	2	1
Buck Converter	Buck #1: 500mA output 1.5~2.1V/2.7~3.3V, 25mV/step Buck #2: 250mA output 0.5~1.5V/1.8V, 25mV/step	Buck#1: 300mA output 1.1~3.3V, 100mV/step
Number of LDO	2	1
LDO	LDO #1: 1mA output 1.7~1.9V, 25mV/step LDO #2: 250mA output 1.5~2.1V/2.7~3.3V, 25mV/step	LDO#1: 100mA output 0.8~3.3V, 100mV/step
NTC Sensing	Yes	Yes

Power Management Requirement in Applications

Mini-Questionnaire

1. Try to understand the power tree of the existing system on customer side, and if possible, get the parts used for each power management block

2. Is there requirement for a single cell Li-Ion battery charger? If so, what's the requirement for Constant Current (CC) and Constant Voltage (CV).

3. How many output voltage rails will be needed, and input/output voltage/current range for each rail. (When possible, also check if there is any voltage rail which may be noise sensitive? And if so, LDO supply should be considered for the rail).

4. Any other function blocks in the system? Watchdog, NTC, GPIO, ADC, etc….

Q&A

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