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NXP Power Management solution for Smart Watch & Band

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Document information

Information	Content
Keywords	Power solution, smart watch, smart band, PMIC, battery charging, fuel gauge, small size, high effiency,Flexible OTP, PCA9420, PCA9422.
Abstract	This application note introduces NXP PMIC solutions for Smart Watch and band application, demonstrate key features and typical design of PMIC which fit for long battery life, small form factor requirement. The flexible OTP functions of PMIC also ease customer design with one PMIC for various smart watch and band platform.

1 Introduction

This document introduces NXP PMIC solutions for smart watch and band applications and demonstrates key features and typical PMIC design, which fit for a long battery life and small form factor requirement. The flexible OTP functions of PMIC ease customer design with one PMIC for various smart watch and band platforms.

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2 Power management requirements of smart watch and band

There are various types of smart watch and band integrated with different functions. In general, a smart band has fewer features than a smart watch due to its smaller size. In regards of power management, these are common features between a smart watch and band:

- Need small-size design
- Need multiple power supply rails for processor, sensor, connectivity, and other peripherals
- Use Li-battery and need battery charging
- Need battery SoC measurement
- Need multiple low-power modes for Powersaving

Table 1 lists some of the typical electrical components for the power supply requirement, which are used in smart watches and bands.

Table 1. General power supply requirement in smart watch and band

Components	Power supply requirements
Processor	0,8 V~1.2 V; 1.8 V 3.3 V
RTC	0.8 V~3.0 V
EMMC	3.3 V
Display and touch	2.5 V~3.3 V
Biological sensor	4.0 V~5.0 V
Motion sensor	3.3 V
GPS	0.7 V, 0.8 V
Li-battery	50 mA~1.5 A (charging current)

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3 NXP power solutions

The NXP Power Management IC PCA942x series solutions can be applied to various smart watch and band applications. This product portfolio offers different power management functions on one PMIC like battery charging, multiple switch and LDO, load switch, fuel gauge, Power mode control. Figure 1is a block diagram of PCA9420 and PCA9421, they are Pin to Pin compatible. The difference is that PCA9421 does not have a battery charging function.

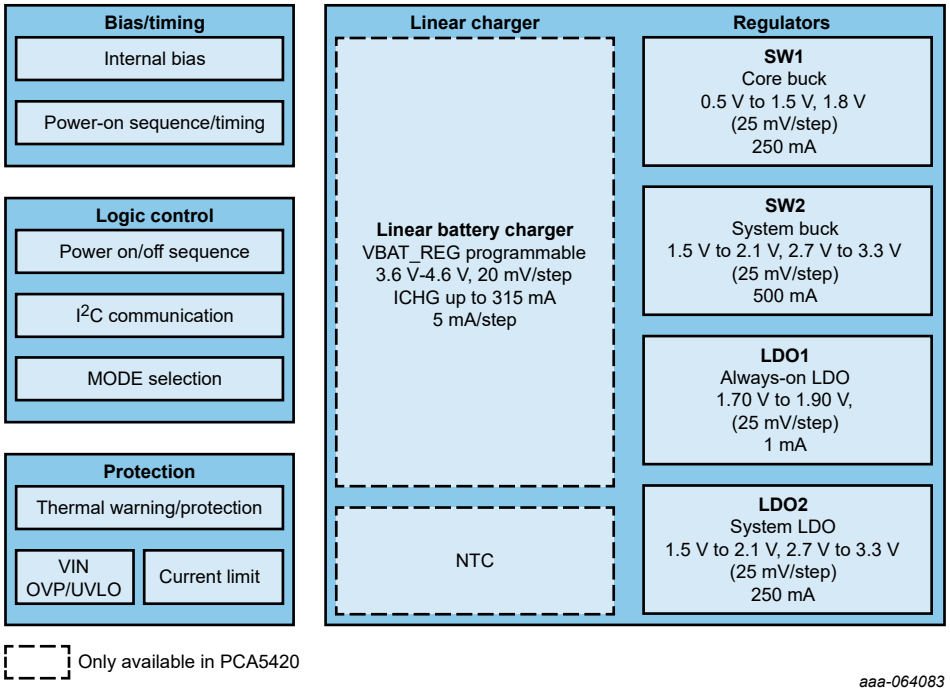

Figure 1. PCA9420 and PCA9421 block diagram

Figure 2 is the PCA9422 PMIC block diagram.

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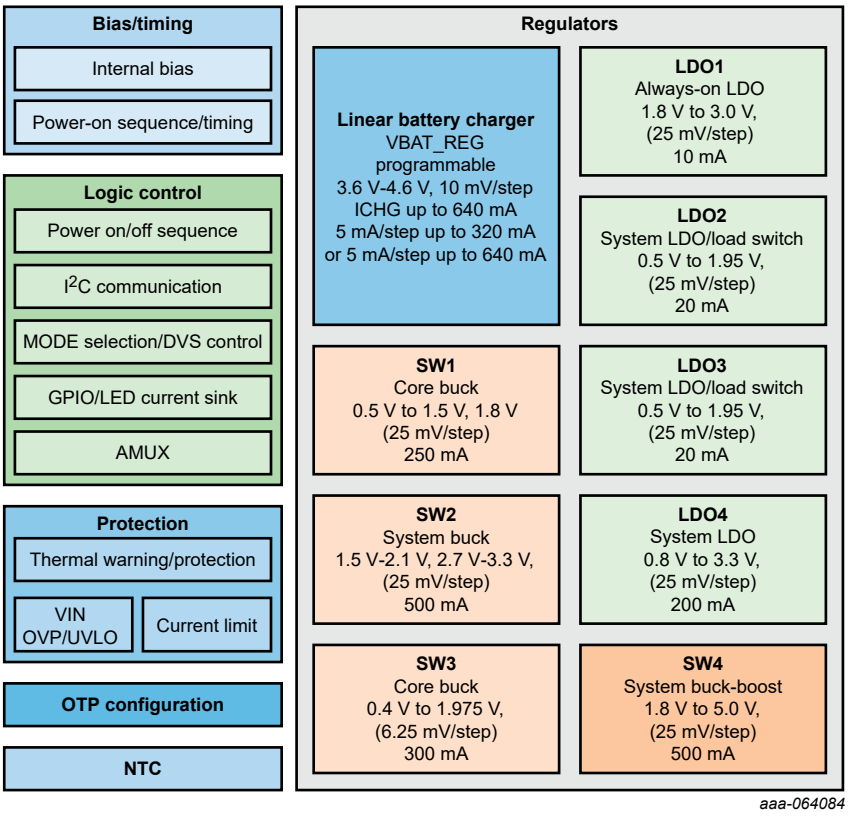

Figure 2. PCA9422 block diagram

Table 2. Key features difference of PCA942x series PMIC

Category	Items	PCA9420	PCA9421	PCA9422
Switcher	**Number of S/W**	2	2	4
	V_{OUT} resolution	25 mV	25 mV	6.25 mV
	V_{OUT}min	0.5 V	0.5 V	0.4 V
	Iq(Typ.)	700 nA	700 nA	400 nA
	L_{sw}	2.2 µH	2.2 µH	0.47 µH
	F_{sw}	1 MHz	1 MHz	2 MHz & 4 MHz
	Buck-boost	NO	NO	YES
LDO	**Number of LDO**	2	2	4
	Load switch	0	0	2
Li-battery charging	**Charger**	YES	NO	YES
	I_{MAX}	315 mA	NA	640 mA
	V_{BAT} accuracy	+/-2%	NA	+/-1%
	I_{BAT} accuracy	+/-12%	NA	+/-5%
	Ship-mode current consumption(Typ.)	10 nA	NA	10 nA
Fuel gauge		NO	NO	YES

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In Section 3.1, some key features of PCA942x are highlighted for the smart watch and band application.

3.1 Flexible OTP configuration

PCA942x series PMIC support customized OTP definition, which means the PMIC default regulators output voltage, power up sequence and system functions is configurable to fit for different system requirements. This is helpful for designers to use one PMIC as a power management solution in multiple platforms from low-end to high-end watch and band, which save design effort.

Figure 3 shows a typical power tree with PCA9420 and PCA9422 in smart watch and band application, which PMICs have different OTP configurations to meet the requirements. Contact an NXP representative if your need a more powered solution for other platforms.

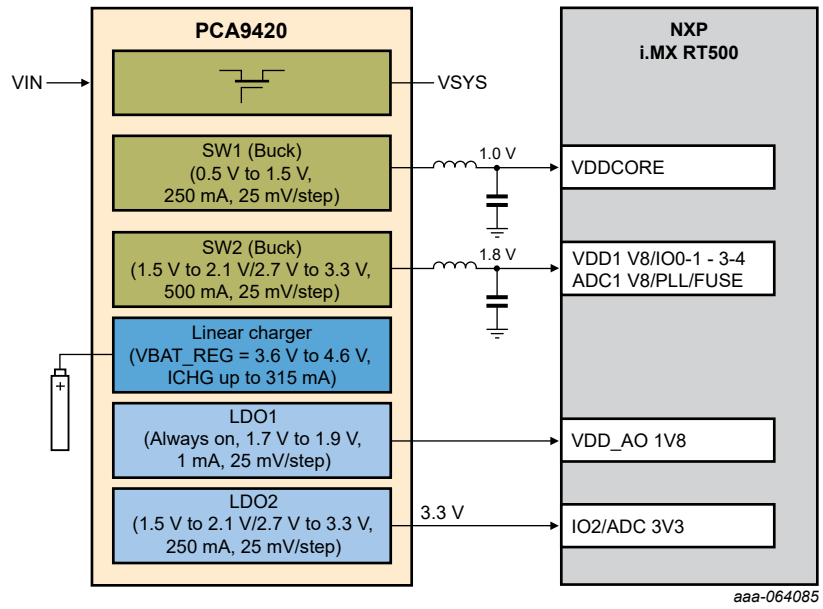

Figure 3. PCA9420 and NXP IMX RT500 series

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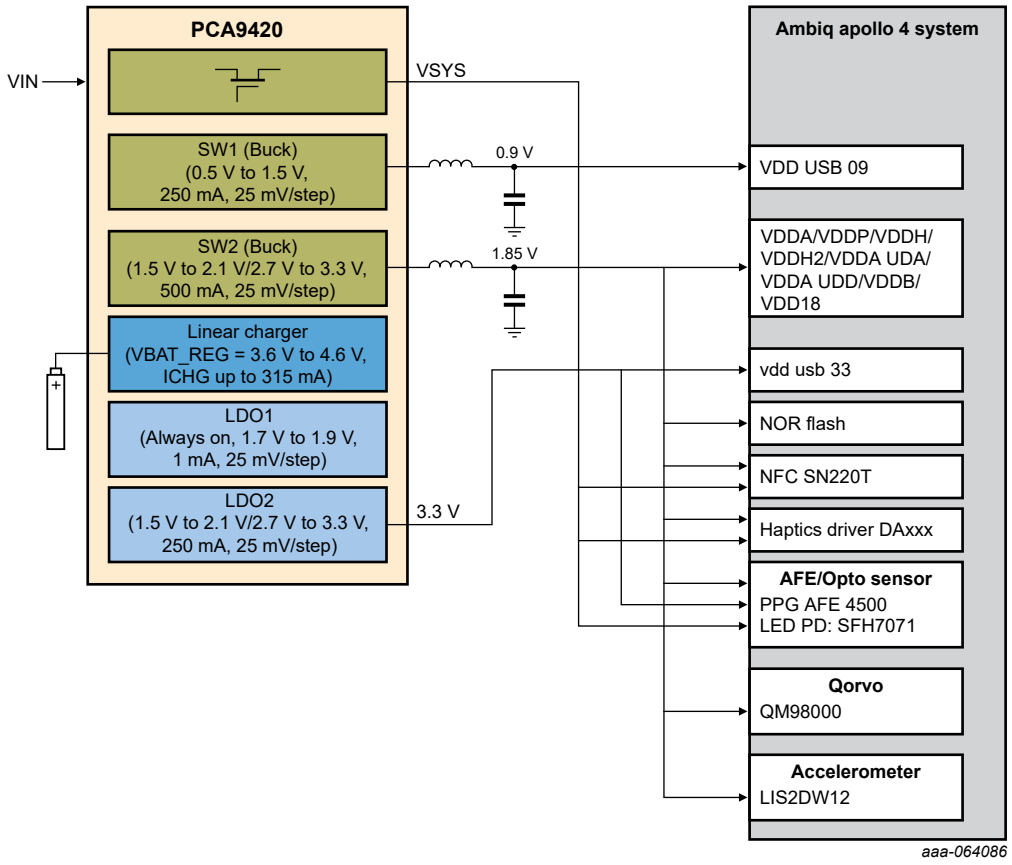

Figure 4. PCA9420 and Apollo4 series

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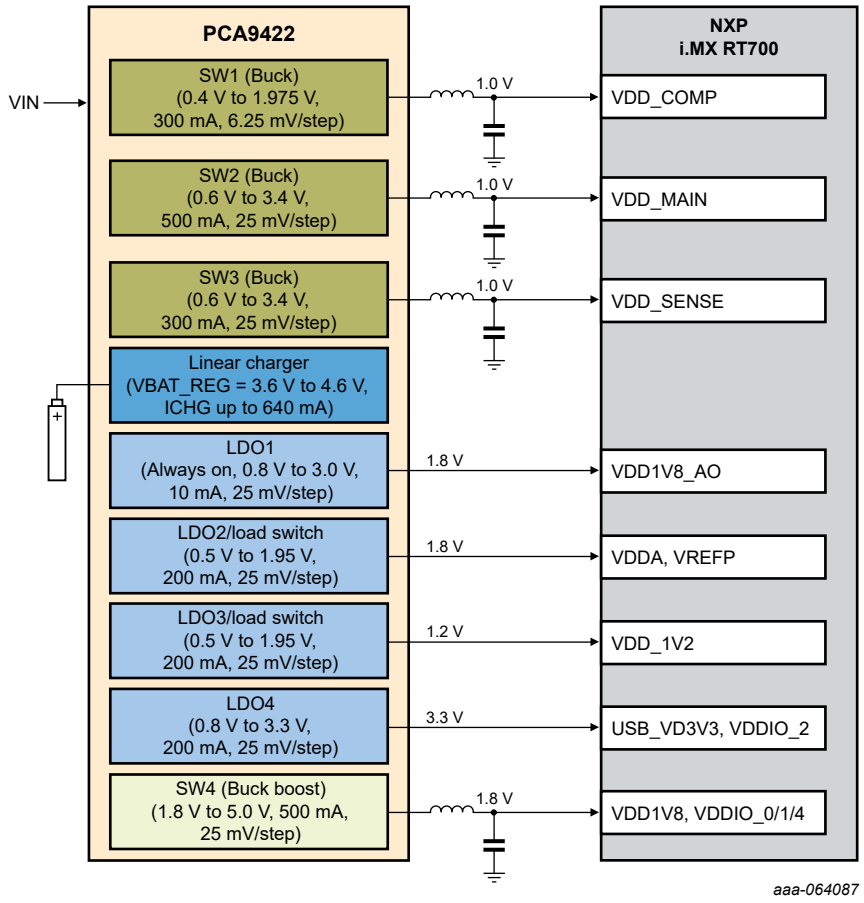

Figure 5. PCA9422 and i.MX RT700 series

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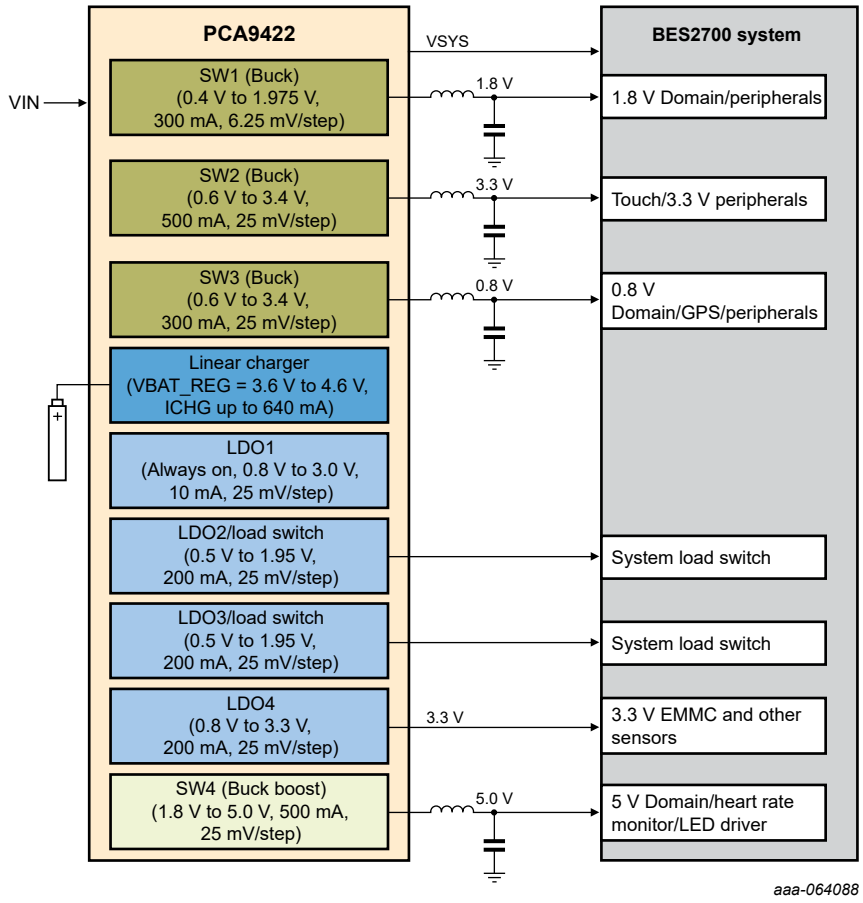

Figure 6. PCA9422 and BES27xx series

3.2 Small form factor

PCA9420\1 has WLCSP25 package, which is 2.09 mm * 2.09 mm * 0.525 mm and PCA9422 WLCSP49 is 2.90 mm x 3.00 mm x 0.57 mm. Their small footprint has an advantage compared with discrete solutions in a space saving point of view.

Figure 7 is one example of comparison with using discrete power solution (switcher, LDO and charging IC) and PCA942x. The total components are reduced as a lot and the PCB size save ~40% with using PCA942x.

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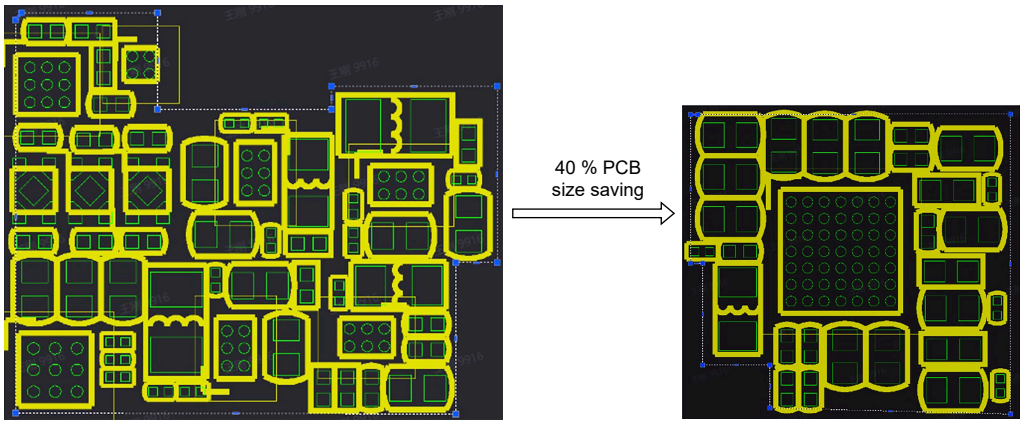

Figure 7. Comparison of PCB size with discrete solution and PCA942x

3.3 Extended battery life

The PCA942x series PMICs provide several switchers and LDOs. The switcher has a 94 % efficiency maximum, which targets for a high current load and it has PFM mode for light load to optimize efficiency. LDO is used for low current and noise-sensitive load condition. The LDO also has a load switch mode, which could cut off load when needed to reduce power consumption.

NXP PMIC enables battery life extension not only from its own integrated features, but also from system-level interaction with processors. The regulators voltage in PMIC is adjustable to I^2C on the fly. The switcher supports dynamic voltage scaling, which enables the processor to run in a different frequency to save power. To ease the system Power mode adjustment, the PMICs has IO pins to change Power mode with different preconfigured voltage regulators.

3.4 Safe battery management

The PCA9420 and PCA9422 integrate single Li-battery charging with 5 V typical input. The charging current and voltage are configurable through I^2C. They are linear chargers that PCA9420 maximum charging current is 315 mA and PCA9422 is 640 mA. If a customer has a higher battery charging current requirement, they could select a discrete charging IC plus PCA9421 or PCA9422 without charging function.

Multiple safe protection features are embedded in PMICs:

- Input overvoltage protection
- Battery over current protection
- Thermal protection
- Jeita compliant for charging

The PCA9422 has a voltage-based fuel gauge with 3 % accuracy for SoC measurement. This technology applies the information of battery voltage, load current estimation, temperature for accuracy.

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4 References

PCA9420 and PCA9421 information and tools can be found here: https://www.nxp.com/products/PCA9420-PCA9421

PCA9422 information and tools can be found here: https://www.nxp.com/products/PCA9422

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5 Revision history

Table 3. Revision history

Document ID	Release date	Description
AN14981 v.1.1	05 August 2026	Updates: • Keywords.
AN14981 v.1.0	01 July 2026	• Initial version

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