AN13651

PMIC solution for TI AWR2243 radar transceiver

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Document information

Information	Content
Keywords	power solution, ADAS, radar, automotive, PMIC, PF502x, PF71, FS56, MMIC
Abstract	This application note illustrates the use of NXP FS56 and PF series power management ICs (PMICs) to power TI AWR2243 monolithic microwave integrated circuits (MMICs).

Revision history

Revision	Date	Description
v.1	20220929	Initial version.

1 Device introduction

The AWR2243 device is a single-chip FMCW transceiver integrated PLL, transmitter, receiver, baseband and ADC, capable of operating in the 76 to 81 GHz frequency band. It is an ideal solution for extremely small form factor, self-monitoring, low-power, ultra-accurate radar systems in the automotive field.

The AWR2243 has 76 to 81 GHz coverage with 5 GHz available bandwidth. It has four receiver channels and three transmit channels with PLL and ADC converters. The device incorporates an ultra-accurate chip engine based on Fractional-N PLLs. AWR2243 supports the SPI or I^2C interface with an external processor. Its manufacturer supplies documentation to support functional safety system design up to ASIL D and hardware integrity up to ASIL B. Its scalable sensor portfolio supports the design and development of ADAS system solutions for a wide range of performance, applications and sensor configurations in all vehicles, from comfort to safety functions.

2 NXP PMIC Overview

NXP's power management portfolio delivers scalability and flexibility for your next designs. Whether you are developing automotive, industrial or consumer applications, the NXP PMIC portfolio optimizes power and simplifies supply sequencing for various application processors. These PMICs integrate both switching and linear regulators required for a total system solution. They may also integrate battery management functions that include the battery charger, coin cell charger and power path selection. Most of NXP's PMICs can be configured via OTP and combined to provide a dedicated system solution that includes deliverables for QM and ASIL B/D functional safety requirements.

In this application note, we illustrate the use of three LV PMICs to provide different voltages and an HV PMIC to match the system from the battery.

2.1 LV PMIC: PF5020

The PF5020 device is an NXP multi-channel PMIC designed for high performance automotive and industrial applications.The device is also highly configurable, making it a perfect companion and fit for various system level power requirements. PF5020 integrates independent voltage monitoring circuits to ensure compliance with ISO26262 standard and functional safety up to ASIL B level. The PF5020 is also available as a standard non-safety device for applications that don't require ISO compliance. The PF5020 is suitable for a variety of applications, including infotainment, ADAS, vision and radar, either as a standalone power solution or as a companion to another NXP PMIC like FS5600. Figure 1 shows the PF5020 PMIC block diagram.

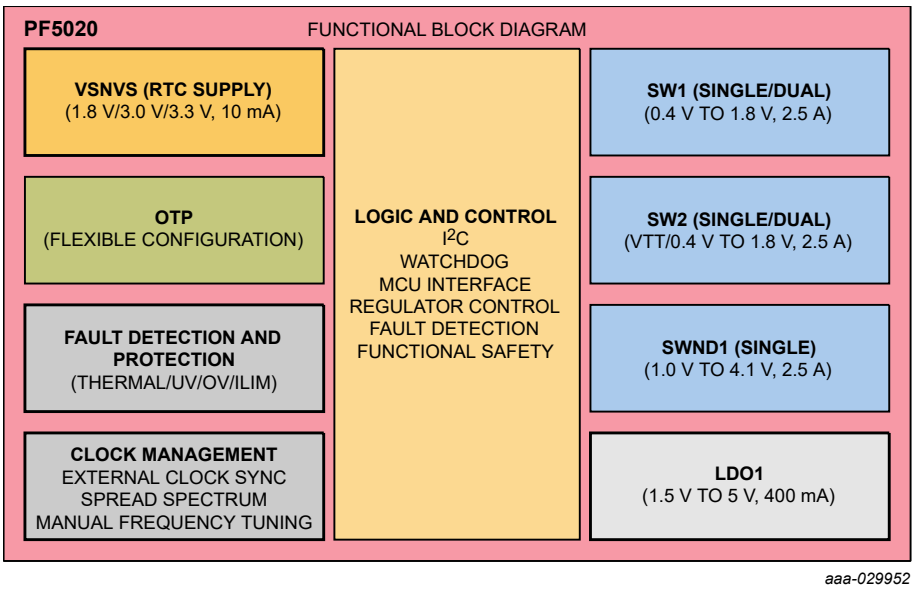

Figure 1. PF5020 PMIC block diagram

2.2 LV PMIC: PF5023

Both PF5020 and PF5023 belong to the PF502x family. This family also includes the PF5024. All the PF502x devices are integrated independent voltage monitoring circuits that ensure compliance with the ISO 26262 standard and functional safety up to ASIL B level. PF5023 has three functionally similar bucks which can supply voltage from 0.4 V to

1.8 V. These bucks can work in dual phase and triple phase. Figure 2 shows the PF5023 PMIC block diagram.

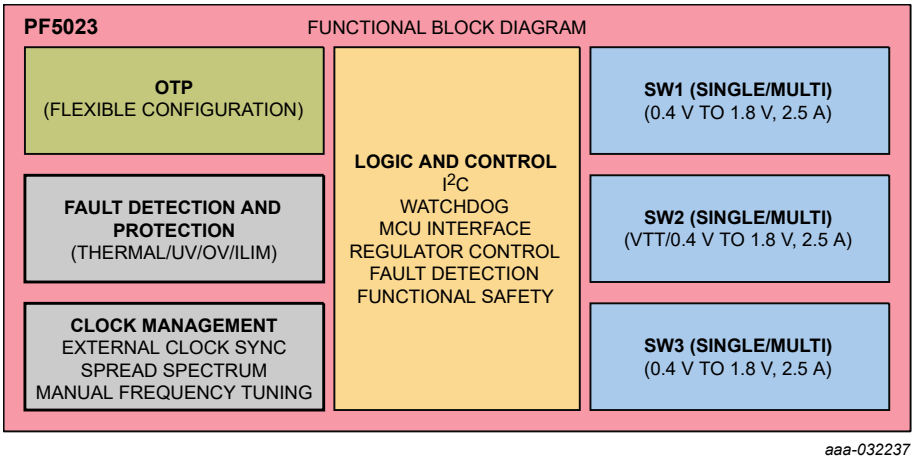

Figure 2. PF5023 PMIC block diagram

2.3 LV PMIC: PF7100

The PF7100 device features five high efficiency buck converters and two linear regulators for powering the processor, memory and miscellaneous peripherals. PF7100 is also suitable for applications requiring functional safety up to the ASIL B level. See Figure 3 for a block diagram.

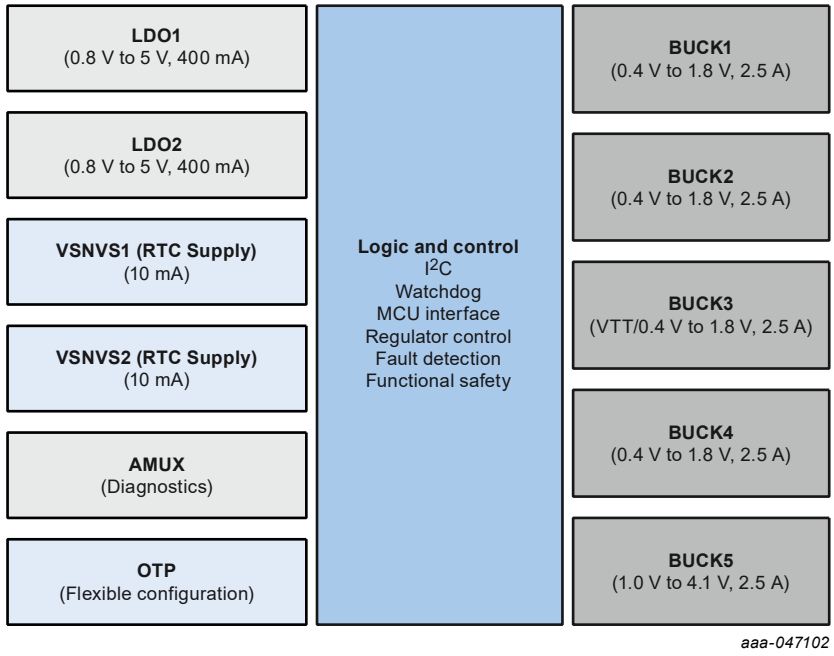

Figure 3. PF7100 PMIC block diagram

2.4 HV PMIC: FS5600

The FS56 System Basis Chip (SBC) for Automotive applications features two battery connected DC-DC buck controllers. FS56 provides functional safety features such as

independent voltage monitors, windowed watchdog timer, I/O monitoring via ERRMON and FCCU, and built-in-self test. The FS56 is offered in QM, ASIL B and enhanced ASIL B versions. We chose an FS56 with two HV bucks as the pre-buck for the radar system power solution illustrated in this application note. See Figure 4 for an FS56 block diagram.

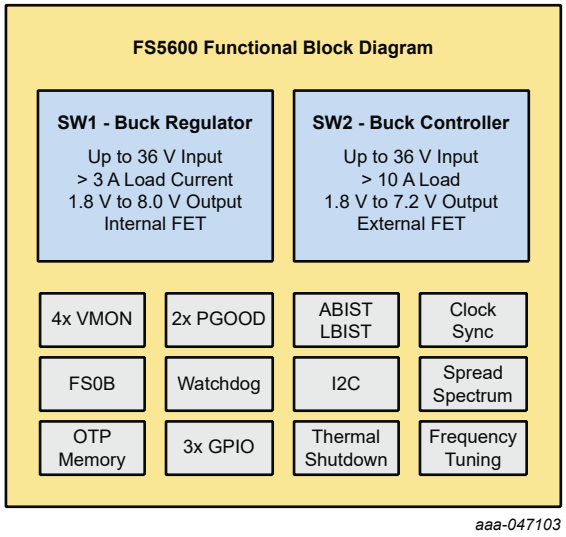

Figure 4. FS56 Functional Block Diagram

3 Introduction to AWR2243 power solution

As the automotive industry continues to develop towards high automatic performance and high reliability, radar is used more and more in automotive systems. Standards are emerging for 4D millimeter-wave imaging radar, and this technology is expected to support one of the core sensors in automotive driver assistance (ADAS) systems.

Using NXP's HV PMIC FS56 and LV PMIC PF series solutions to implement the NXP power solution for the AWR2243 monolithic microwave IC (MMIC) enables a total system for automotive radar. For MCU/CPU power solutions, refer to NXP PMICs and SBCs for Multi-Vendor Processors.

The FS56 can connect to the 12 V battery and produce an intermediate voltage from battery voltage. This device is aimed at replacing discrete battery connected regulators in the system while providing value in functional safety and integration. The PF series PMICS provide matched voltages for various processors and DDRs.

This application note illustrates how the FS56 can be used to produce 5 V for LV PMICs and 3.3 V for an MCU that controls and communicates with the controller MMIC and target MMICs.

Clock synchronization is required in radar applications to facilitate the removal of random noise from various devices. FS56, PF71, and PF502x all support a clock synchronization input using their configurable SYNCIN pin. PF71 also supports a clock synchronization output with its SYNCOUT pin.

Figure 5 shows a block diagram for single, dual, and quad AWR2243 power solutions.

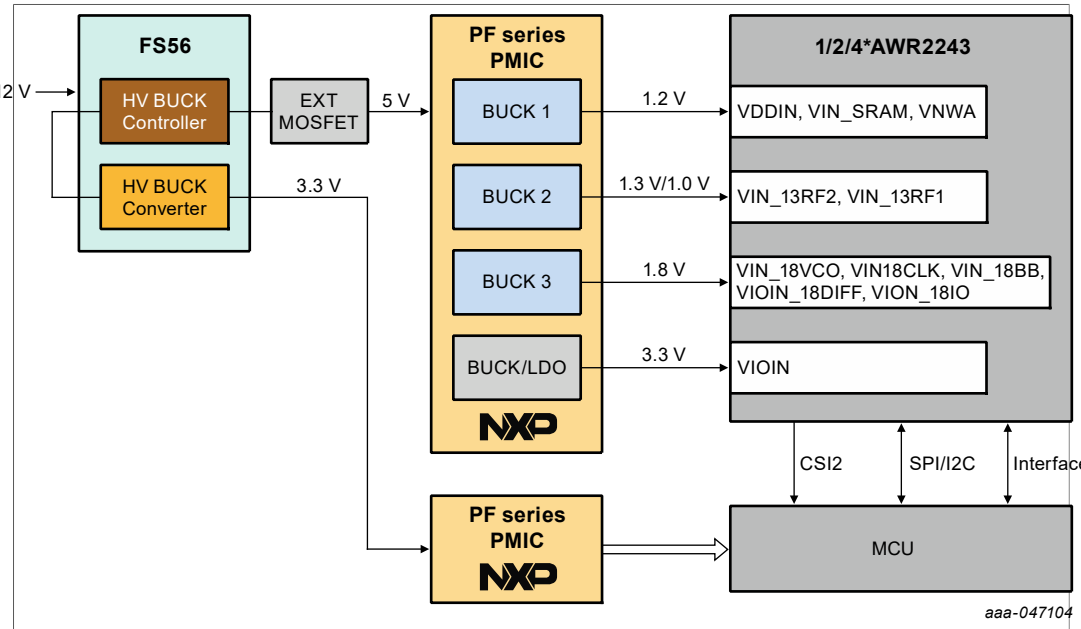

Figure 5. NXP FS56 + PF Series PMICs power solution for single/dual/quad AWR2243

3.1 Power tree

Figure 6, Figure 7, and Figure 8 show use of NXP LV PMICs for AWR22443. For a single AWR2243, the PF5020 is the best solution, because it fulfills all the AWR2243 requirements. For dual parts, the PF7100 is the best solution, and for quad parts, the PF5023 + PF7100 is the best solution.

NXP PMICs feature one-time programming (OTP). The PMIC OTP memory can store key startup configurations, greatly reducing the number of external components used to set the output voltages and sequence of external regulators. Because of this function, both the dual part and quad part configurations can use the PF7100 PMIC with the same part number.

3.1.1 PMICs for single AWR2243

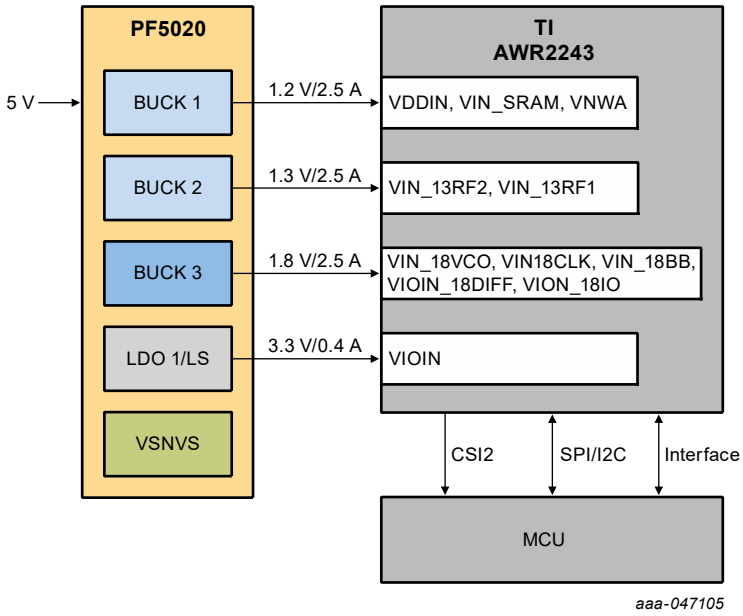

Figure 6. LV PMIC PF5020 power solution for single AWR2243

3.1.2 PMICs for dual AWR2243

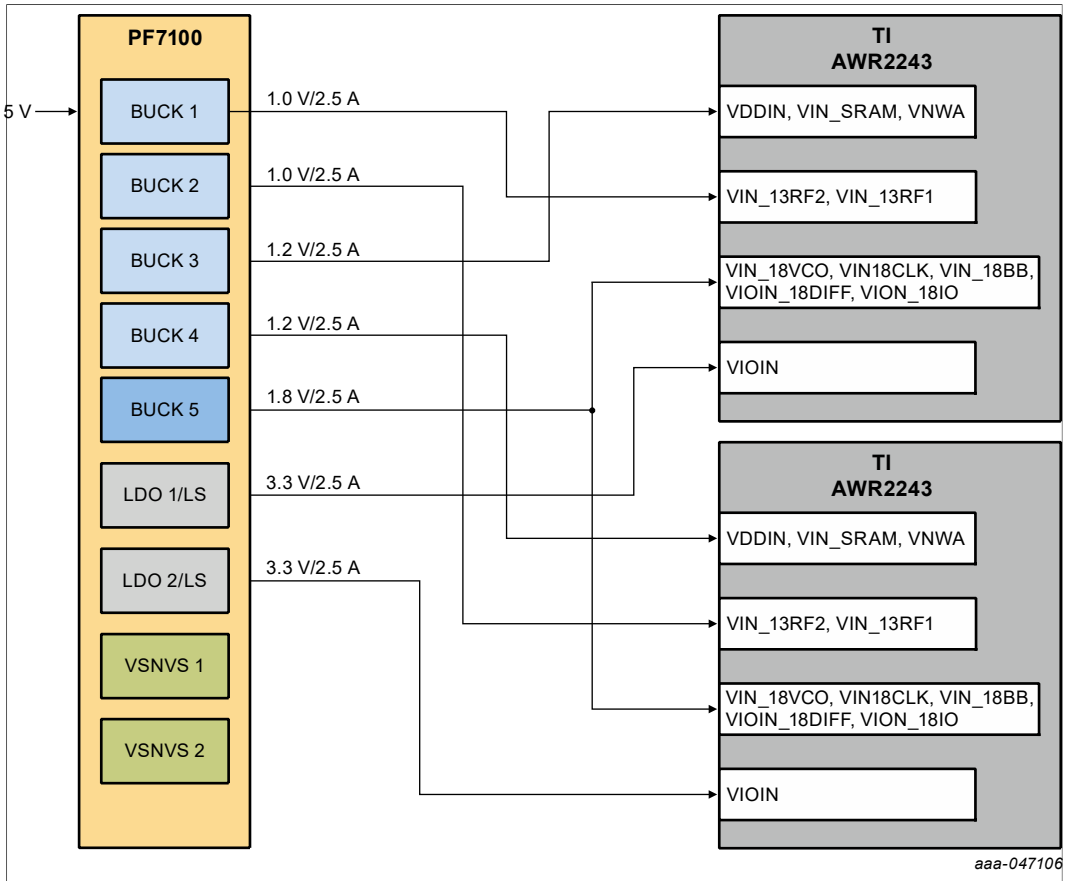

Figure 7. LV PMIC PF7100 power solution for dual AWR2243

3.1.3 PMICs for quad AWR2243

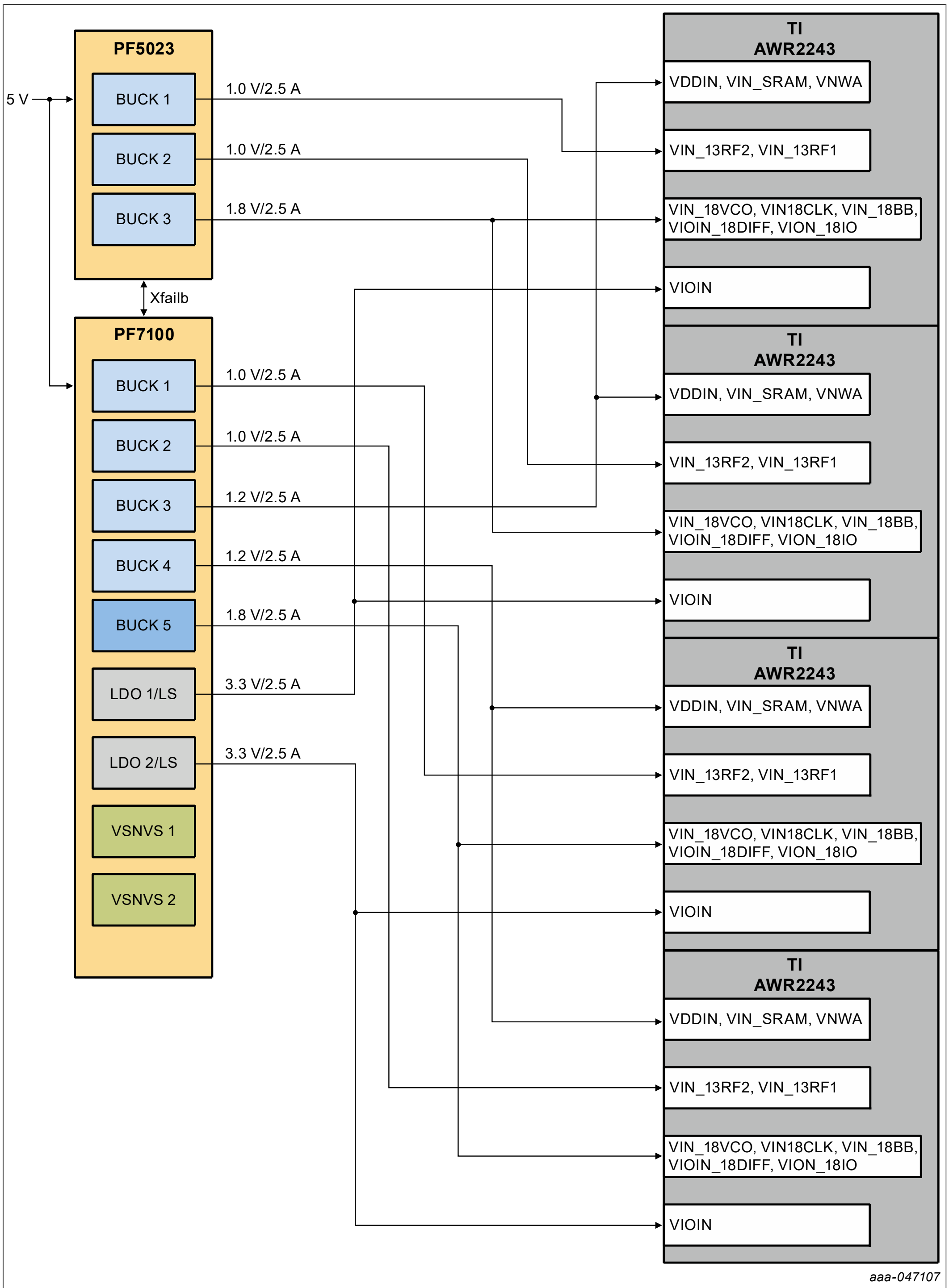

Figure 8. LV PMIC PF5023 + PF7100 power solution for quad AWR2243

3.2 Power up and power down sequence

In the solution for quad AWR2243s, the customer should connect the XFAILB pins of PF5023 and PF7100 together. NXP multiple PMICs effectively synchronize accurate

power-up and power-down sequencing for all power rails through the PMIC itself, without the need for MCU control. This combination of devices acts as “one PMIC” for power up/down sequences through the NXP PMIC internal power-up sequencer PWRON and XFAILB functions.

Table 1. PMIC configuration for single/dual/quad AWR2243

Single AWR2243	Dual AWR2243	Quad AWR2243	Voltage	Power up delay	Power down delay	Power rail
SW1/PF5020	SW1 and SW2/PF71	SW1 and SW2/ PF5023 + SW1 and SW2/ PF71	1.2 V	0.5 ms-slot1	1.5 ms-Group4	VDDIN, VIN_ SRAM VNWA
SW2/PF5020	SW3 and SW4/PF71	SW3 and SW4/PF71	1 V or 1.3 V	1 ms-slot2	1.5 ms-Group4	VIN_13RF1 VIN_13RF2
SW3/PF5020	SW5/PF71	SW3/PF5023 + SW5/PF71	1.8 V	1 ms-slot2	1.5 ms-Group4	VIOIN_18 VIN18_CLK VIOIN_18DIFF VIN18_BB
LDO/PF5020	LDO1 and LDO2/ PF71	LDO1 and LDO2/ PF71	3.3 V	1.5 ms-slot3	1.5 ms-Group4	VIOIN
RESETBMCU				2.0 ms-slot4	—	nRESET

The AWR2243 device expects all external voltage rails and sense of power (SOP) lines to be stable before reset is de-asserted. See Figure 9 for the PMIC power-up and power-down sequence for AWR2243.

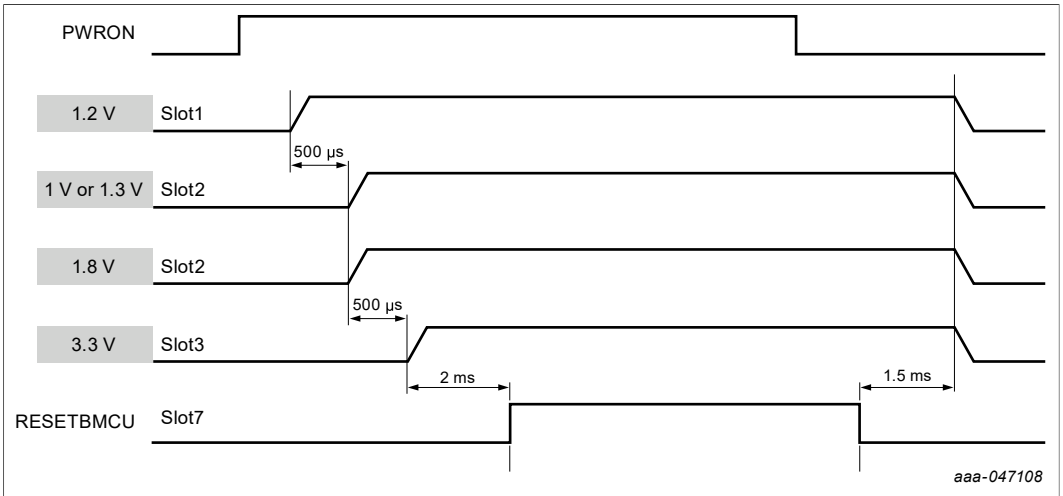

Figure 9. PMIC Power-up and Power-down Sequence for AWR2243

4 Schematics

See Figure 10 and Figure 11 for schematics of AWR2243 power solutions based on NXP PMICs.

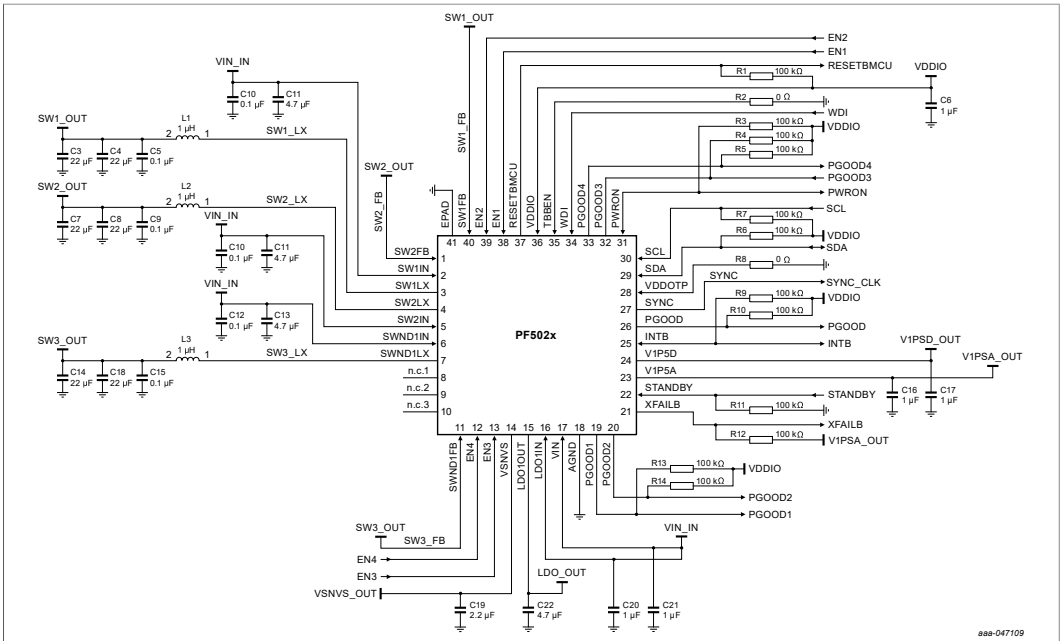

Figure 10. PF502x schematic for single/quad AWR2243 power rails

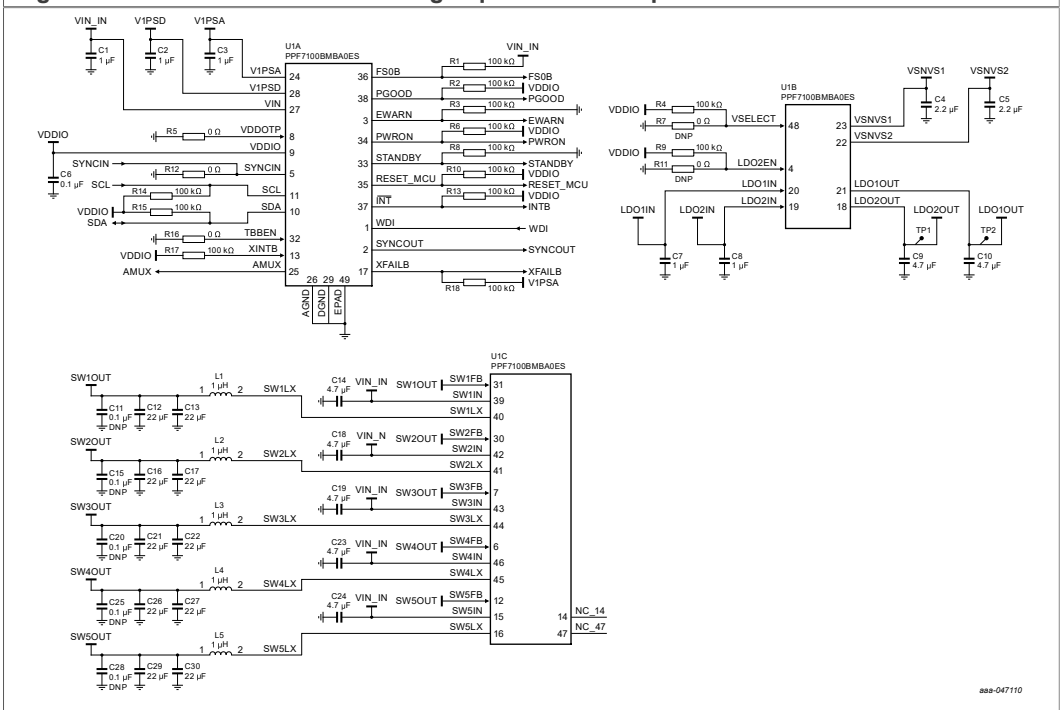

Figure 11. PF7100 schematic for dual/quad AWR2243 power rails

5 Bill of materials

Table 2. BOM for PF502x

Value	Quantity	Description	Part Number	Vendor
0.1 µF	6	CAP CER 0.1 µF 16 V 10% X7R AEC-Q200 0402	GCM155R71C104KA55D	MURATA
4.7 µF	4	CAP CER 4.7 µF 16 V 10% X7R AEC-Q200 0805	CGA4J3X7R1C475K125AB	TDK
22 µF	6	CAP CER 22 µF 10 V 10% X7R AEC-Q200 1206	LMJ316BB7226KLHT	TAIYO YUDEN
1 µF	5	CAP CER 1 µF 10 V 10% X7S AEC-Q200 0402	GCM155C71A105KE38D	MURATA
2.2 µF	1	CAP CER 2.2 µF 10 V 10% X7S AEC-Q200 0402	GRT155C71A225KE13	MURATA
1 µH	3	IND PWR 1.0 µH@1 MHZ 4.7 A 20% AEC-Q200 SMD	TFM252012ALMA1R0MTAA	TDK
100K	12	RES MF 100K OHM 1% 1/10 W AEC-Q200 0402	ERJ-2RKF1003X	PANASONIC
0	2	RES MF ZERO 1/8 W AEC-Q200 0805	MCR10EZPJ000	ROHM
PF502x	1	IC POWER MANAGEMENT 5.5 V AEC-Q100 QFN40	PF502x[1]	NXP SEMICONDUCTORS

[1] For a single AWR2243, it is PF5020; for quad AWR2243s, it is PF5023.

Table 3. BOM for PF7100

Value	Quantity	Description	Part Number	Vendor
1 µF	5	CAP CER 1 µF 10 V 10% X7S AEC-Q200 0402	GCM155C71A105KE38D	MURATA
2.2 µF	2	CAP CER 2.2 µF 10 V 10% X7S AEC-Q200 0402	GRT155C71A225KE13	MURATA
0.1 µF	6	CAP CER 0.1 µF 16 V 10% X7R AEC-Q200 0402	GCM155R71C104KA55D	MURATA
4.7 µF	7	CAP CER 4.7 µF 16 V 10% X7S 0603	GRM188C71C475KE21	MURATA
22 µF	10	CAP CER 22 µF 10 V 20% X6S AEC-Q200 0805	GRT21BC81A226ME13	MURATA
1 µH	5	IND PWR 1.0 µH@1 MHZ 4.7 A 20% AEC-Q200 SMD	TFM252012ALMA1R0MTAA	TDK
100K	13	RES MF 100K OHM 1% 1/10 W AEC-Q200 0402	ERJ-2RKF1003X	PANASONIC
0	5	RES MF ZERO 1/8 W AEC-Q200 0805	MCR10EZPJ000	ROHM
PPF7100	1	IC POWER MANAGEMENT 7-CH 2.7-5.5V AEC-Q100 HVQFN48	PPF7100BMBA0ES	NXP SEMICONDUCTORS

6 Reference Resources

PF5020 information and tools can be found at this link: https://www.nxp.com/products/power-management/pmics-and-sbcs/pmics/multi-channel-5-pmic-for-automotive-applications-4-high-power-and-1-low-power-fit-for-asil-b-safety-level:PF5020

PF5023 information and tools can be found at this link: https://www.nxp.com/products/power-management/pmics-and-sbcs/pmics/multi-channel-3-pmic-for-automotive-applications-3-high-power-fit-for-asil-b-safety-level:PF5023

PF7100 information and tools can be found at this link: https://www.nxp.com/products/power-management/pmics-and-sbcs/pmics/7-channel-power-management-integrated-circuit-for-high-performance-applications-fit-for-asil-b-safety-level:PF7100

FS56 information can be found at this link: https://www.nxp.com/products/power-management/pmics-and-sbcs/safety-sbcs/automotive-dual-buck-regulator-and-controller-with-voltage-monitors-and-watchdog-timer:FS5600

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