

AN13615

NXP PMIC solution for AG55xQ series module

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Application note

Document information

Information	Content
Keywords	Power solution, automotive, telematics, C-V2X, 5G, Quectel AG55xQ, Qualcomm SA515M
Abstract	AG55xQ is a series of automotive-grade, 5G NR Sub-6 GHz modules based on the Qualcomm SA515M chipset developed by Quectel, supporting both 5G NR NSA and SA modes.



Revision history

Revision	Date	Description
v.1	20220527	Initial version.

1 Introduction

AG55xQ is a series of automotive-grade 5G NR Sub-6 GHz modules based on Qualcomm SA515M chipset which developed by Quectel, supporting both 5G NR NSA and SA modes. Adopting 3GPP Rel-15 technology, the module supports maximum 2.4 Gbps downlink and 550 Mbps uplink data rates at 5G NSA mode, and maximum 1.6 Gbps downlink and 200 Mbps uplink data rates at LTE-A. The target application is telematics boxes (T-Box), telematics control units (TCU), advanced driver-assistance systems (ADAS), C-V2X (V2V, V2I, V2P) systems, on-board units (OBU), roadside units (RSU), and other automotive/traffic systems.

FS56 is battery-connected high voltage input PMIC(Power Management IC) in automotive application. It supports ultra low power mode which is suitable for application like Telematics\V2X that needs always-on power even vehicle is stalled. The application note demonstrate FS56 to power AG55xQ include power tree, power mode control, one completed FS56 schematic and Bill of Materials is detailed also.

2 FS56 PMIC

The FS56 is AEC-Q100 Grade1 qualified which features a battery connected DC-DC buck controller with external FET and a battery connected DC-DC buck controller with internal FET. It presents an optimized architecture for automotive with low-power modes and EMC minimizing as spread spectrum, frequency tuning and synchronization. The FS56 supports customized one time programming (OTP) definition. and customer could define FS56 default features and power-on configurations such as bucks voltage which fit for actual application.

FS56 offers Functional Safety QM, ASIL-B and Enhanced ASIL-B versions. [Figure 1](#) is a block diagram. FS56 ASIL-B version is introduced to power AG55x module in this application note. Customer could define customized QM or enhanced ASIL-B version if needed.

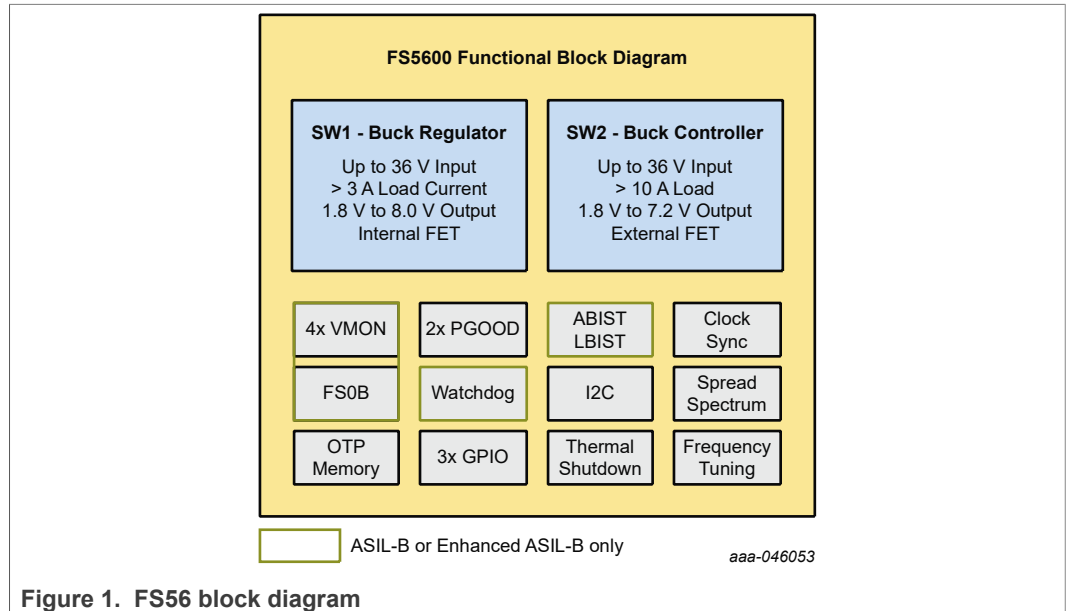


Figure 1. FS56 block diagram

3 Power solution

Figure2 shows block diagram of one typical Automotive Telematics and V2X application. One processor is needed for V2X accelerating, hardware secure and system configuration etc. FS56 have BUCK1 and BUCK2 providing power to Quectel AG55x. Processor is in charge of FS56 power on control, power mode control and detects FS56 power good signal. NXP has PF series PMIC which is low voltage input(<5V input) PMIC could power processor. The input of PF series PMIC is able to come from FS56 BUCK1 or BUCK2. [AN13130](#) details system power solution with FS56+low voltage input PMIC. [PMICs and SBCs for Multi-Vendor Processors](#) have NXP PMIC solution for multiple vendor processor.

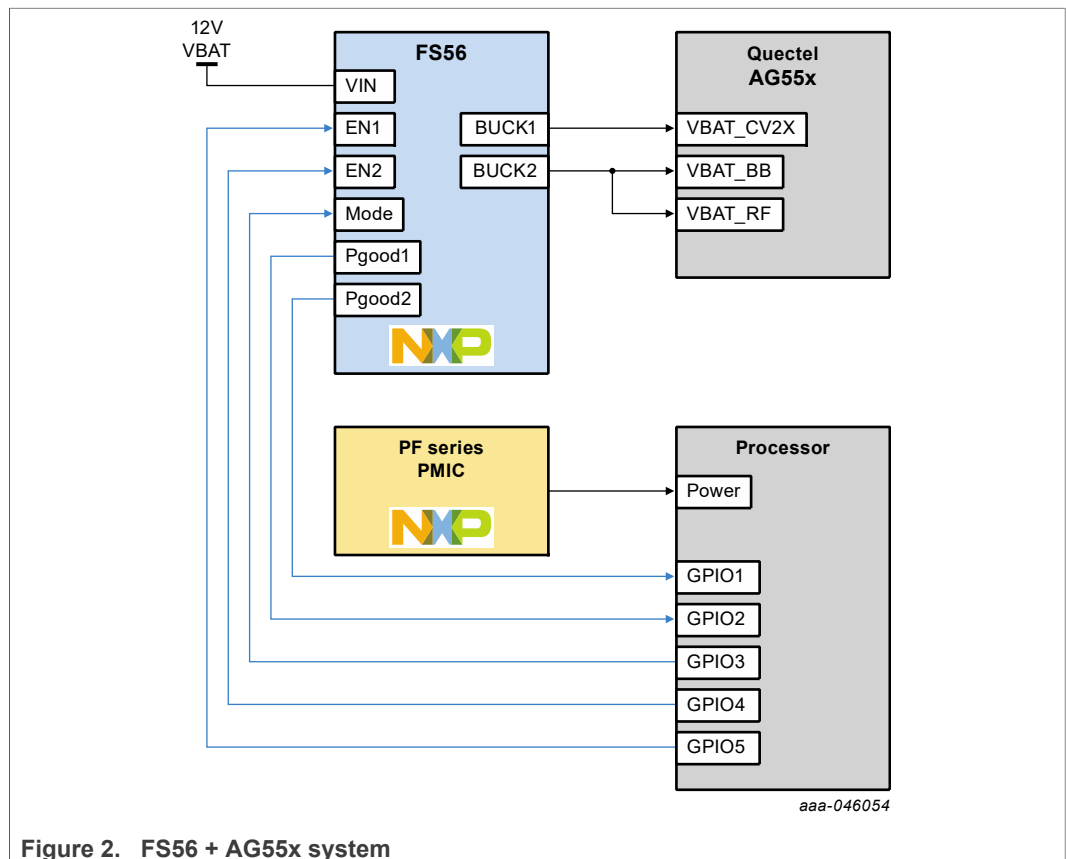


Figure 2. FS56 + AG55x system

3.1 Power tree

FS56 BUCK1 and BUCK2 is able to connect to 12 V battery directly in vehicle. BUCK1 is 3.5A current capability with internal Mosfet. Buck2 is 10A maximum current capability with external mosfet. Figure 3 is FS56 power tree with AG55x.

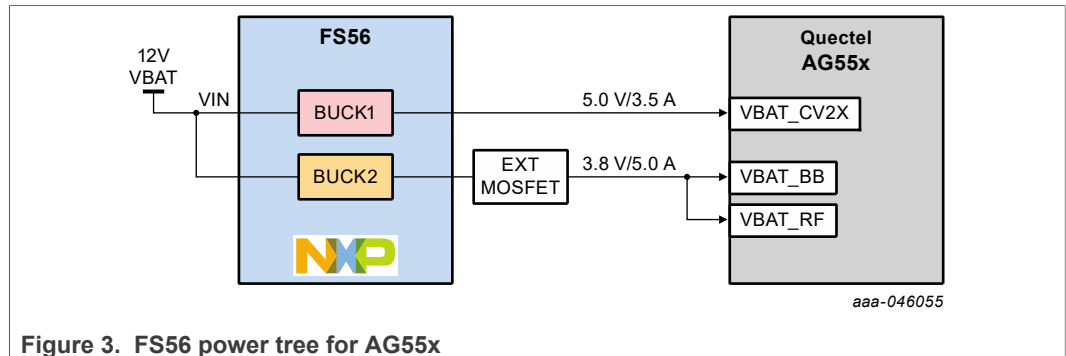


Figure 3. FS56 power tree for AG55x

BUCK1 is configured with 5 V for VBAT_CV2X, and BUCK2 is configured with 3.8 V for VBAT_BB and VABT_RF. Both BUCK1 and BUCK2 support 440 KHz and 2.2 MHz switching frequencies. The BUCK2 output current capability is decided by an external MOSFET which is 5 A in this application. Table 1 is BUCK2 external mosfet selection guidance.

Table 1. BUCK2 external MOSFET selection

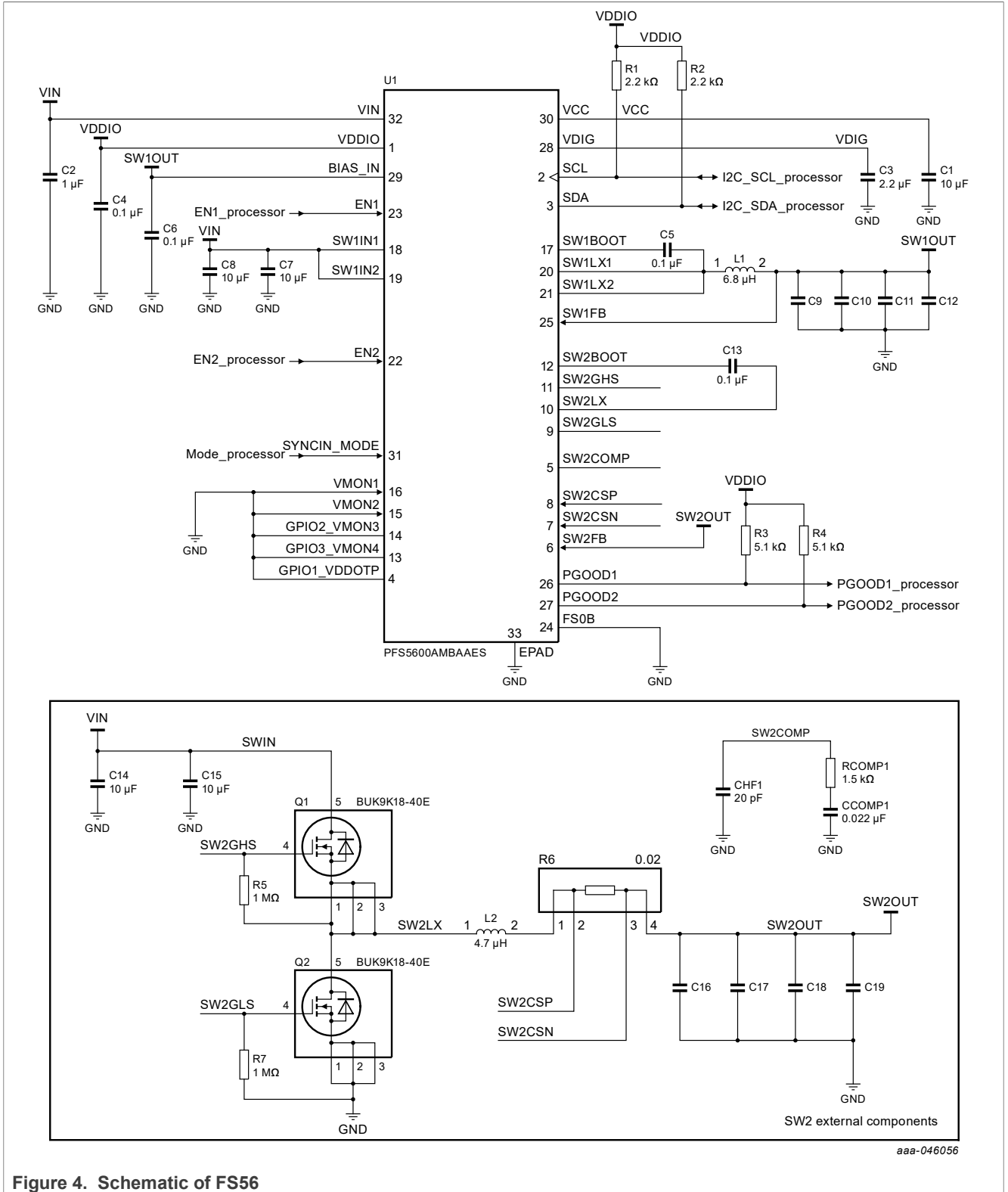
Switching frequency	Load current	High-side MOSFET	Low-side MOSFET
440 KHz	<5 A	Qg < 10 nC Rds(on) < 40 mΩ Example: BUK9K18-40E	Qg < 20 nC Rds(on) < 20 mΩ Example: BUK9K18-40E
	< 8 A	Qg < 10 nC Rds(on) < 25 mΩ Example: NVTFS5C471NL	Qg < 20 nC Rds(on) < 15 mΩ Example: NVTFS5C471NL
	> 8 A	Qg < 10 nC Rds(on) < 10 mΩ Example: BUK9M9R5-40H	Qg < 20 nC Rds(on) < 4 mΩ Example: BUK9M3R3-40H
2.2 MHz	< 5 A	Qg < 10 nC Rds(on) < 30 mΩ Example: BUK9M20-40H	Qg < 20 nC Rds(on) < 20 mΩ Example: BUK9M20-40H

3.2 Power mode

FS56 BUCK1 and BUCK2 power on is controlled by EN1 pin and EN2 pin separately. When EN1 and EN2 is high, BUCK1 and BUCK2 have voltage output. BUCK1&BUCK2 supports PWM, PFM and pulse skipping mode for different power operation. When AG55x is in standby mode/sleep mode which still need BUCK1&BUCK2 working, processor could change BUCK1&BUCK2 mode with Mode pin. If FS56 Mode pin is high, it will enter ultra low power mode which working in PFM mode and several internal circuits are turned off to save current consumption. FS56 quiescent current on battery line in ULP mode is 138uA typical with BUCK1&BUCK2 enable.

4 Schematic

[Figure 4](#) is an FS56 schematic with BUCK1 and BUCK2 configured for a 440 KHz switching frequency.



aaa-046056

Figure 4. Schematic of FS56

5 Bill of materials

[Table 2](#) is an FS56 bill of materials, with BUCK1 and BUCK2 configured for a 440 KHz switching frequency.

Table 2. BOM for FS56

Value	Quantity	Part number	Description	Vendor	Part Reference
0.022 μ F	1	C0603C223J5RACTU	CAP CER 0.022 μ F 50 V 5% X7R 0603	KEMET	CCOMP1
20 pF	1	C0603C200F5GACTU	CAP CER 20 pF 50 V C0G 1% 0603	KEMET	CHF1
10 μ F	5	GCM32EC71H106KA03	CAP CER 10 μ F 50 V 10% X7S AEC-Q200 1210	MURATA	C1,C7,C8,C14,C15
1 μ F	1	GCM155C71A105KE38D	CAP CER 1 μ F 10 V 10% X7S AEC-Q200 0402	MURATA	C2
2.2 μ F	1	GRT155C71A225KE13	CAP CER 2.2 μ F 10 V 10% X7S AEC-Q200 0402	MURATA	C3
0.1 μ F	4	GCM155R71H104KE02D	CAP CER 0.1 μ F 50 V 10% X7R AEC-Q200 0402	MURATA	C4,C5,C6,C13
22 μ F	8	CGA6P1X7R1C226M250AC	CAP CER 22 μ F 16 V 20% X7R AEC-Q200 1210	TDK	C9,C10,C11,C12,C16,C17,C18,C19
6.8 μ H	1	SPM10065VT-6R8M-D	IND PWR 6.8 μ H@100 KHz 10.2 A 20% AEC-Q200 SMT	TDK	L1
4.7 μ H	1	SPM12565VT-4R7M-D	IND PWR 4.7 μ H@100 KHz 14.0 A 20% AEC-Q200 SMT	TDK	L2
BUK9K18-40E	1	BUK9K18-40E	Dual logic level N-channel MOSFET in an LFPAK56D	Nexperia	Q1
BUK9K18-40E	1	BUK9K18-40E			Q2
1.5 K	1	CR0603-JW-152ELF	RES MF 1.5K 1/10 W 5% 0603	BOURNS	RCOMP1
2.2 K	2	RK73H1ETTP2201F	RES MF 2.2K 1/10 W 1% AEC-Q200 0402	KOA SPEER	R1,R2
5.1 K	2	ERA2AEB512X	RES MF 5.1K 1/16 W 0.1% 0402	PANASONIC	R3,R4
1 M	2	CRCW04021M00FKED	RES MF 1.0M 1/16 W 1% AEC-Q200 0402	VISHAY	R5,R7
0.02 ohm	1	WSK2512R0200FEA	RES MF 0.02 OHM 1 W 1% AEC-Q200 2512	VISHAY	R6
FS56	1	PFS5600AMBAAES	IC VREG DCDC BUCK DUAL 3-5.5V 3A/10A 2.7-40V AEC-Q100 QFN32	NXP	U1

6 References

- [1] [FS56 main page](#)
- [2] [PMICs and SBCs for Multi-Vendor Processors](#)
- [3] [NXP V2X solutions](#)
- [3] [Power management community](#)

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Tables

Tab. 1. BUCK2 external MOSFET selection 6 Tab. 2. BOM for FS56 10

Figures

Fig. 1.	FS56 block diagram	4	Fig. 3.	FS56 power tree for AG55x	6
Fig. 2.	FS56 + AG55x system	5	Fig. 4.	Schematic of FS56	8

Contents

1	Introduction	3
2	FS56 PMIC	4
3	Power solution	5
3.1	Power tree	5
3.2	Power mode	6
4	Schematic	7
5	Bill of materials	9
6	References	12
7	Definitions	13
8	Legal information	14

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