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NXP PMIC solution for TI TMS570 series MCU

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Document information

Information	Content
Keywords	Power solution, PMIC, FS26, FS45, FS65, FS85, TI TMS570, MCU, Functional safety
Abstract	NXP offers three power management solutions for use with the TI TMS570 series microcontroller, using FS26, FS45 / FS65, and FS85 PMICs. This application note outlines typical power tree, functional safety, and software initialization details for each solution.

Revision history

Rev	Date	Description
v.1	21211108	Initial version

1 Introduction

This application note presents three NXP PMIC (Power Management IC) solutions for TI TMS570 series microcontrollers (MCU). The application note explains, in detail, how to use NXP FS26, FS45 / FS65 and FS85 series PMICs to power and secure TMS570-based systems. It also provides connection details between NXP PMICs and TMS570 MCUs to facilitate user application design.

2 Power management requirements

TI TMS570 is a 16/32 bit RISC flash, ARM Cortex R4F/R5F Core MCU, designed for the performance and safety needs of transportation applications, including automotive, railway, and aerospace. TMS570 MCUs are developed in accordance with the ISO 26262 standard, with ASIL-D capability. The power management requirements of TMS570 MCU-based systems include power supply parameters and functional safety monitoring.

Table 1 shows a typical set of power supply requirements for use with a TMS570. The TMS570 needs 1.2 V VCC for the Vcore power supply and 3.3 V for IO ports and other functions. Requirements vary according to the TMS570 version. Table 1 lists maximum values. 5 V is needed for peripherals, usually, in addition to the power required by TMS570. Regarding the power-up sequence, VCC, VCCPLL, VCCIO, VCCAD/VADREFHI, and VCCP could be powered up simultaneously in the TMS570.

Table 1. TMS570 Typical power supply requirements

Domain	Name	Description	Voltage / V	Current requirement / mA (max)
TI TMS570 MCU	VCC	Digital logic supply voltage (Core)	1.2	1375
	VCCPLL	PLL supply voltage	1.2	
	VCCIO	Digital logic supply voltage (I/O)	3.3	15
	VCCAD/VADREFHI	ADC supply voltage	3.3	40
	VCCP	Flash pump supply voltage	3.3	93
Peripherals	VDD	CAN, FlexRay and other peripherals	5	System dependent

From a functional safety perspective, consider use of an independent power supply voltage monitor, an MCU fault monitor, and fail-safe state enablement. A functional safety PMIC with these safety mechanisms integrated is usually required to achieve ASIL-D capability for the system.

3 System power solution design

NXP has a rich portfolio of High-Voltage PMICs that can be connected directly to a vehicle battery. These PMICs support various levels of functional safety, from QM to ASIL-D. The portfolio allows users scalability and flexibility to optimize designs based on power supply system requirements and functional safety needs.

This section provides three typical PMIC solutions for ASIL-D systems, using NXP FS26, FS45 / FS65, and FS8500 PMICs. Table 2 lists the primary differences between these three solutions.

Table 2. NXP power solution options for TI TMS570

PMIC solution	FS26	FS45 / FS65	FS85
Battery support	12 V battery	12 V battery	12 V and 24 V battery
Vcore current capability(max)	0.8 A,1.5 A	0.5 A to 2.2 A	2.5 A
Tracker	2	1	0
CAN transceiver	0	1	0
LIN transceiver	0	1	0
Functional safety level	ASIL-B or ASIL-D	ASIL-B or ASIL-D	QM or ASIL-B or ASIL-D
Flexible OTP	YES	NO	YES

3.1 Power solution for 12 V battery system

This section presents two PMIC solutions with FS26 and FS45/65, with a 12 V battery system. FS26 and FS45 / FS65 support a wide range of battery input voltages which conform to the ISO7637 / ISO16750 standard, from 2.7 V to 40 V. These devices also support some non-ISO requirements defined by key global OEMs, such as passing the LV 124 Re-initial pulse test. Both devices have a low-power mode with a typical 32 µA draw from the battery, when all voltage regulator outputs are disabled.

3.1.1 FS26 PMIC solution

FS26 features multiple switch mode regulators as well as LDO voltage regulators to supply the microcontroller, sensors, peripheral ICs, and communication interface. FS26 offers a high precision voltage reference to the system, as well as reference voltage for two independent voltage tracking regulators. It also integrates various functionalities for system control and diagnostics, such as selectable wake-up events from I/O, long duration timer, and configurable GPIO or SPI communication. Figure1 shows a typical power tree and interconnections between FS26 and TMS570. Vcore, LDO1, and LDO2 are configured to 1.20 V, 1.2 V, and 3.3 V respectively, as TMS570 requires.

FS26 VREF is a high precision reference voltage available to the TMS570 ADC reference. Tracker1 and Tracker2 are configured with a tracker function for sensor power supply from an external board.

The FS26 secured SPI register allows the TMS570 to initialize and configure the FS26 using the SPI protocol. The FS26 also integrates the following functional safety features to monitor and secure the TMS570 and the system: Watchdog, Fault Collection Control Unit (FCCU), Reset MCU and Safety output FSxB.

Because the FS26 series PMIC power supply voltage and functional safety features can be flexibly configured through OTP (one time programming), customers can set up these configurations according to actual application requirements.

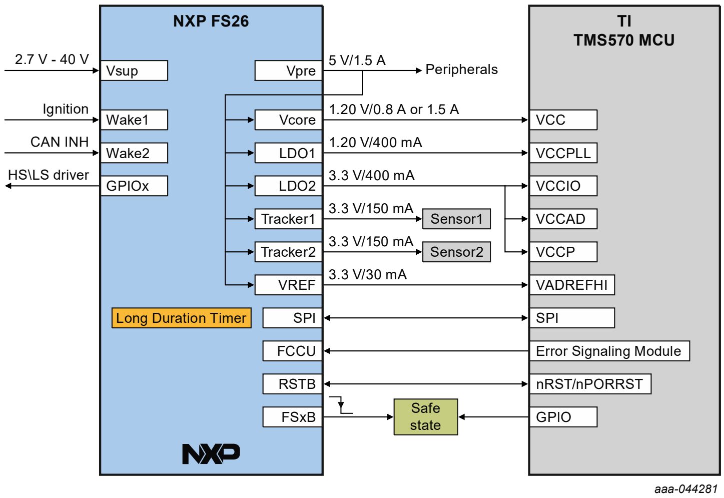

Figure 1. FS26 design for TMS570 in 12 V battery system

3.1.2 FS45 / FS65 PMIC solution

The FS45 / FS65 PMIC devices are multi-output power supply integrated circuits with 12 V battery inputs, including CAN/LIN transceivers, dedicated to automotive applications. Figure 2 shows one typical FS45 / FS65 power solution for a TMS570-based system.

FS45 / FS65 Vcore, Vcca, and Vaux are configured to 1.2 V, 3.3 V, and 5.0 V respectively, for power supply to the system. The FS65 also has a Vpre output available to power other peripherals or regulators as needed. A CAN-FD transceiver and a LIN transceiver are included in FS45 / FS65 for communication between the TMS570 and electronic control units (ECUs) or sensors.

There are more than 40 part number options for FS45 / FS65 series PMICs with scalable functions. This allows customers to choose the appropriate parts for their system requirements.

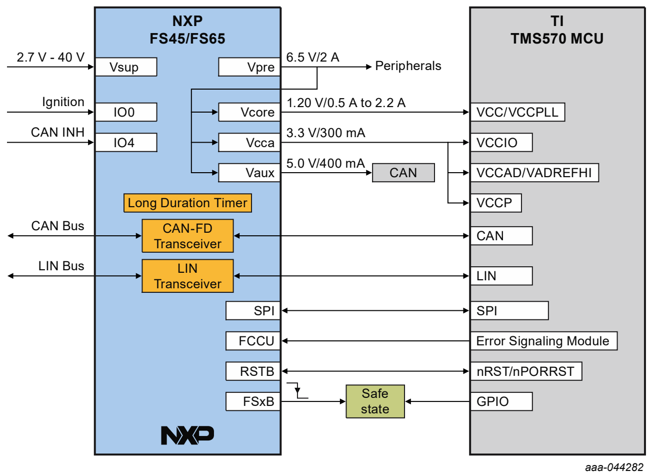

Figure 2. FS45 / FS65 design for TMS570 in 12 V battery system

Vcca and Vaux can output 3.3 V or 5 V, depending on the resistor value on the SELECT pin. The Vcca output current capability is 300 mA, with 3% accuracy, with external PNP, and 100 mA, with 1% accuracy, with internal PNP (leave VCCA_B open and tie VCCA_E and Vpre together). The current capability of Vaux is 400 mA. Refer to Figure 3 for Vcca/ Vaux configuration for Vcca 3.3 V and Vaux 5 V. For customers who need Tracker, Vaux could also be configured to track Vcca for a sensor power supply.

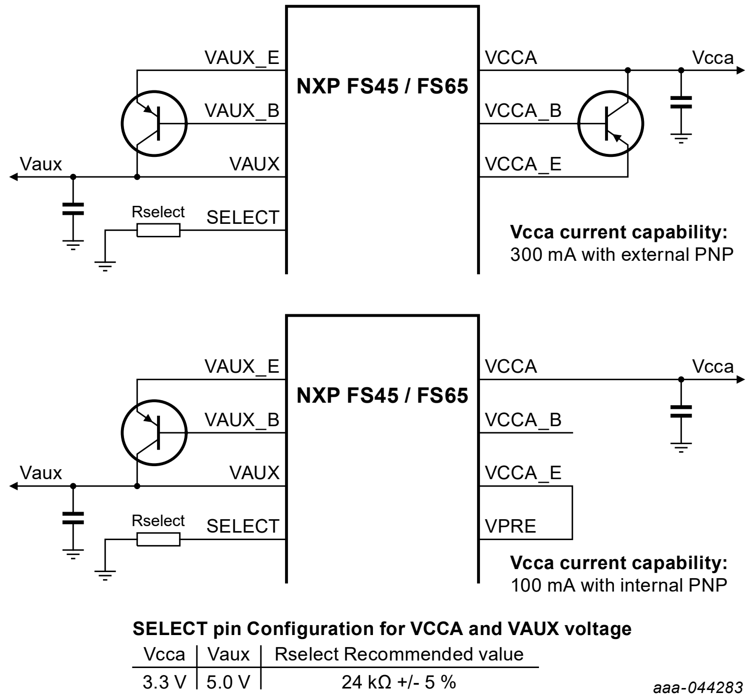

Figure 3. FS45 / FS65 Vcca and Vaux configuration

3.2 Power solution for 12 V and 24 V battery compatible designs

FS85 series PMICs have a wide voltage input range to support 12 V battery and 24 V battery systems. Figure 4 shows the FS8500 power solution for a TMS570 based system.

FS85 meets ISO7637 and ISO16750 standard requirements, and can pass non-ISO pulse simulations defined by key global OEMs. It supports low-power mode, and current consumption is typically 15 µA. The functional safety features of FS8500 are similar to those of FS26 and FS45 / FS65.

FS85 series PMICs also support flexible OTP configurations, allowing customers to set up FS85 systems with actual use cases.

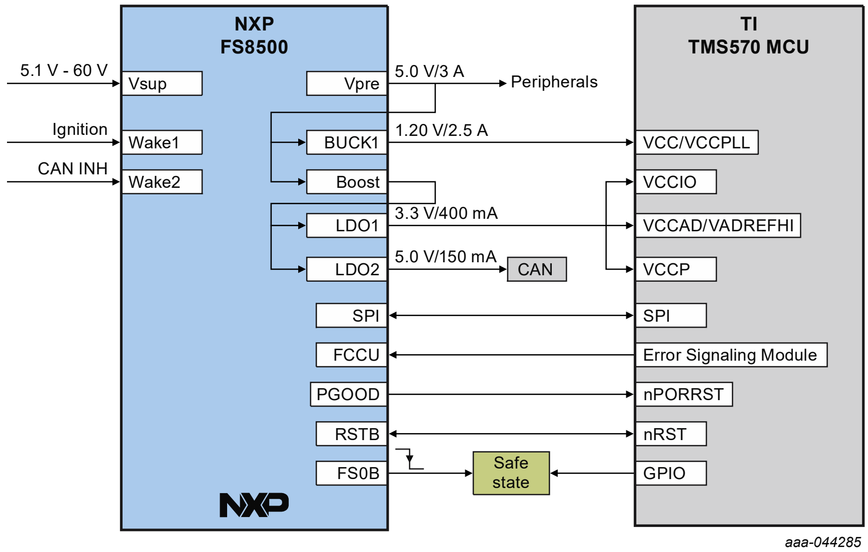

Figure 4. FS8500 design for TMS570 in 12 V and 24 V battery compatible design systems

4 Functional safety

FS26, FS45 / FS65 and FS85 series PMIC development rules, processes, and tools are certified as compliant with the ISO26262 standard. They have the same functional safety architecture and safety mechanisms for single point fault and latent fault diagnosis and reaction.

The Fail-Safe state machine is a dedicated functional safety state machine integrated into NXP PMICs. It controls all applicable safety aspects.

Refer to Figure 5 for functional safety interconnections between the PMIC and the TMS570 MCU. The Voltage Monitor provides independent supervision for undervoltage and overvoltage detection of FS26, FS45 / FS65 and FS85 regulators. Analog Built-in Self Test and Logic Built-in Self Test (ASIL-D only) are implemented within the PMIC for latent fault diagnosis. These features remove any need for the TMS570 to take part in PMIC fault diagnosis. This can save TMS570 MCU resources and reduce system complexity.

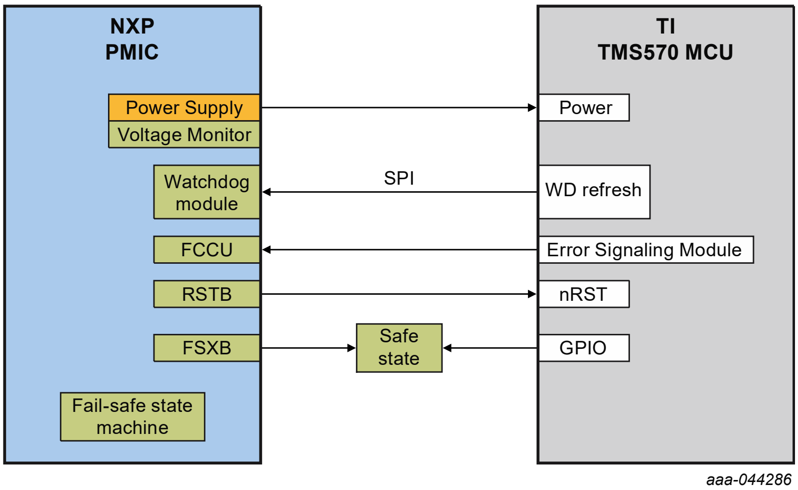

Figure 5. Functional safety block diagram

FS26, FS45 / FS65 and FS85 integrate Challenge WD, allowing monitoring of the TMS570 through the serial-parallel interface (SPI).

PMIC FCCU pins can be connected to the error signaling output from the TMS570 MCU. Refer to Figure 6 for recommended FCCU connections. When the PMIC detects a TMS570 Watchdog failure or error signal, it can reset the MCU with the RSTB pin and/or set the system into the Safe State through the FSxB pin.

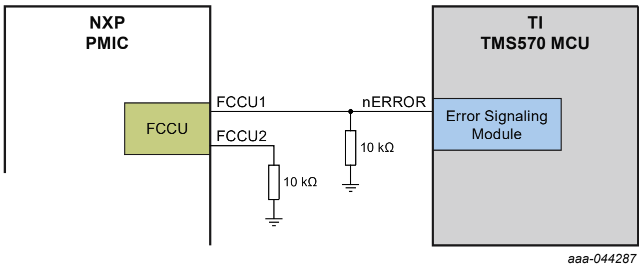

Figure 6. FCCU connection

The FS26, FS45 / FS65 series PMICs have two functional safety outputs, FS0B and FS1B, used to place the system into the safe state when the MCU cannot respond to a fault. FS0B and FS1B have two modes configurable by the MCU: Tdelay mode and Tduration mode. Figure 7 shows an example usage of FS0B and FS1B. FS8500 has only one functional safety output, FS0B, which can place the system into a safe state.

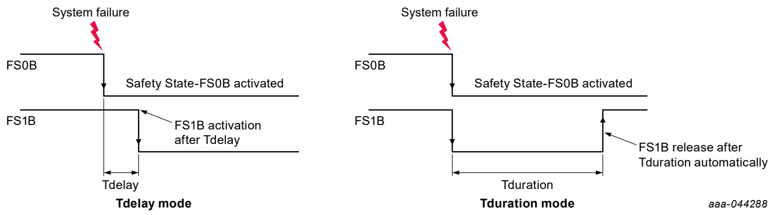

Figure 7. FS0B and FS1B mode (FS26, FS45 / FS65)

5 PMIC initialization

Refer to Figure 8 for the PMIC initialization process. During initialization, the TMS570 MCU can write to registers in FS26, FS45 / FS65, or FS85, or read their configurations through SPI or I2C (FS8500 only).

From a functional safety point ot view, FS26, FS45 / FS65 and FS85 have integrated hardware-ready safety mechanisms. The MCU need not participate in fault diagnosis, but needs only to check the PMIC diagnosis from a PMIC register and report the fault.

NXP provides free generic software and Autosar drivers for FS26 and FS45 / FS65. Vector also provides qualified FS45 / FS65 and FS85 Autosar drivers. Contact your NXP representative for details.

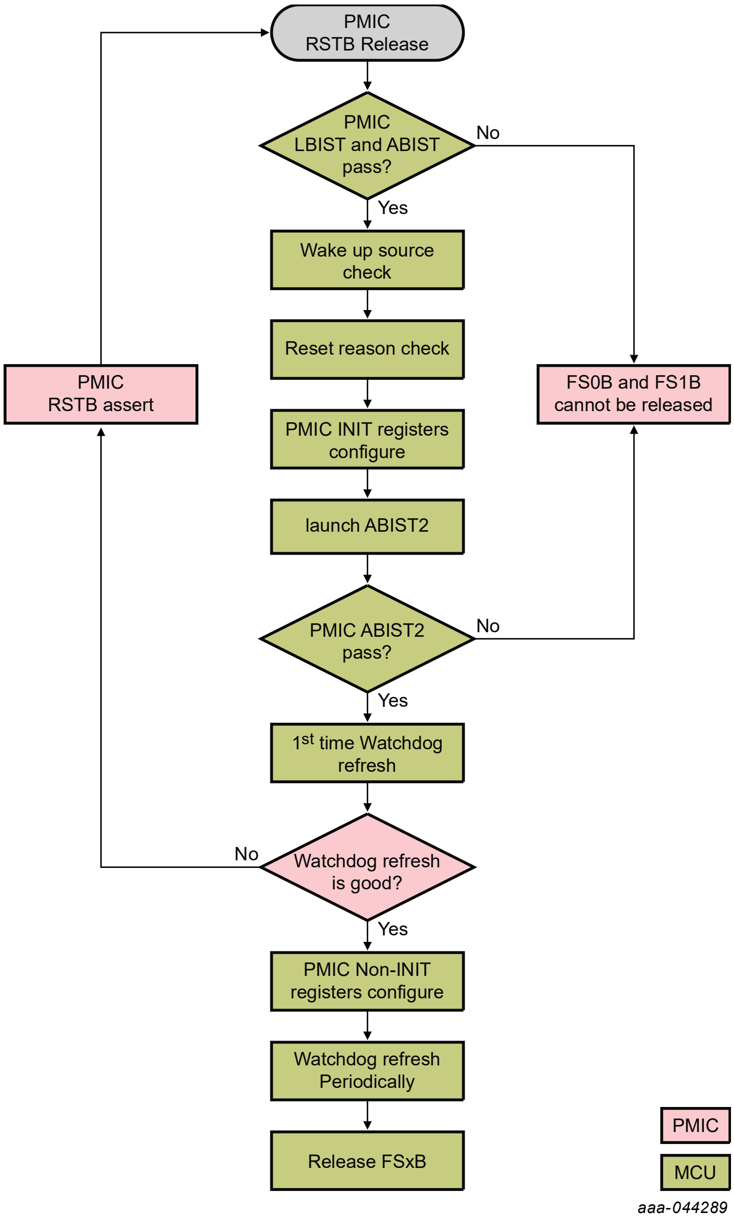

Figure 8. PMIC initialization process

6 Reference Resources

[1] **FS26 overview**

[2] **FS45 webpage including documentation and tools (Datasheet, Safety Manual, FMEDA, SW driver)**

[3] **FS85 webpage including documentation and tools (Datasheet, Safety Manual, FMEDA, SW driver)**

[4] **Power Management Community**

[5]**BYLink System Power Platform**

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