Application Report

Camera PMIC Spin Selection Guide

ABSTRACT

There are a wide range of core and emerging vision applications in the automotive industry. Core applications include front, rear, and surround-view cameras. Autonomous driving, mirror replacement, and driver monitoring cameras are some emerging applications as Advanced Driver Assistance Systems (ADAS) become more sophisticated. The automotive image sensor market has several key manufacturers with broad portfolios of sensors to address many of these applications. The portfolios range from low quality (1-2 megapixel image sensors) to high quality (8+ megapixel image sensors) resulting in different supply voltage, current, and power sequencing requirements.

The TPS650320-Q1 and TPS65033x-Q1 family of Power Management Integrated Circuits (PMICs) helps simplify the power design process for these cameras by optimizing solution size and enabling re-usability across many vision applications. The family of PMICs maintains strong performance against varying power requirements across existing and emerging camera applications. Each PMIC is also fully pin-compatible. Without the need for a power circuit redesign, a simple BOM change enables full power design scalability and re-usability from low-end non-functional safety cameras, to high-end functional safety cameras. This guide connects many common automotive image sensors to an appropriate PMIC part number. The part number is a Non-Volatile Memory (NVM) spin with default settings that support the sensor's power requirements.

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Trademarks

1 Camera PMIC Family Overview

TI offers a variety of camera PMICs with three buck converters and one low-noise LDO designed to support many automotive vision applications. These applications include but are not limited to:

- Rear-View
- Surround-View
- Driver Monitoring
- Cabin Monitoring
- Mirror Replacement
- Autonomous Driving
- Remote Front-View
- Digital Video Recorder (DVR)

The following sections provide a brief overview of features and capabilities. Each camera PMIC is equivalent in terms of regulator performance. The differences between variants are related to the device's feature set. This includes fault detection, fault handling flexibility, and the internal state machine. Figure 1-1 summarizes the differences between versions.

Feature	TPS650320-Q1	TPS650330-Q1	TPS650331-Q1	TPS650332-Q1	TPS650333-Q1
Severe Fault Handling	Reset State OR Wait for Power Cycle State	Reset State OR Wait for Power Cycle State	Wait for Power Cycle State	Reset State OR Wait for Power Cycle State	Reset State OR Wait for Power Cycle State
Less Severe Fault Handling	N/A	Alert State	Wait for Power Cycle State	Safe State	Safe State
I²C Communication	Only available for TPS65032001-Q1	✓	✓	✓	✓
I²C Bus CRC in Production	Optional on TPS65032001-Q1	Optional	Required	Required	Required
Option to Program NVM in Production	Only available for TPS65032001-Q1	✓			
nINT		✓	✓	✓	✓
GPIO		✓	✓	✓	✓
Thermal Warning	✓	✓	✓	✓	✓
Thermal Shutdown	✓	✓	✓	✓	✓
Under-Voltage Lock Out – VSYS	✓	✓	✓	✓	✓
Under-Voltage Lock Out – Buck 1	✓	✓	✓	✓	✓
Overvoltage Protection - VSYS	✓	✓	✓	✓	✓
Overvoltage Protection – All Outputs	✓	✓	✓	✓	✓
Over-Current Protection – All Outputs	✓	✓	✓	✓	✓
Short-circuit Monitor – All Outputs	✓	✓	✓	✓	✓
Loss of Ground Monitor	✓	✓	✓	✓	✓
Independent Voltage References	✓	✓	✓	✓	✓
Under-Voltage Monitor – All Outputs	✓	✓	✓	✓	✓
Over-Voltage Monitor – All Outputs			✓	✓	✓
Power Good Status Register			✓	✓	✓
Clock Monitor			✓	✓	✓
Analog Built-In Self Test (ABIST)			✓	✓	✓
Watchdog					✓

Figure 1-1. Camera PMIC Feature Comparison

1.1 Non-Functional Safety Camera PMICs

These devices are intended for cameras that do not require functional safety. Some examples may include rear-view camera and surround-view camera. The primary difference from the functional-safety variants lie in fault handling capabilities and state machine behavior.

1.1.1 TPS650320-Q1

The TPS650320-Q1 is a low current PMIC with a reduced feature set designed to cover image sensors with up to around 5-megapixel (MP).

1.1.2 TPS650330-Q1

The TPS650330-Q1 is a high current PMIC with a moderate feature set including GPIO and interrupt pins designed to cover low, medium, and high (8+ MP) quality vision applications.

1.2 Functional Safety Camera PMICs

These devices cover low-end to high-end cameras with an expanded feature set and fault handling capabilities to enable ASIL-B compliance as a Safety Element out of Context (SEooC). Diagnostic capabilities and protection features allow the device to be applied as a component up to ASIL-D(B), provided the system accounts for these capabilities to meet the unique safety goals. The main differences between functional safety variants are the device's fault handling and internal state machine.

1.2.1 TPS650331-Q1

The TPS650331-Q1 has full current capability along with a wide range of fault detection. Any fault detected by this device will transition to the Wait for Power Cycle state. In this state, the output rails are low, and the device will not attempt to power up until the input supply is cycled.

1.2.2 TPS650332-Q1

The TPS650332-Q1 offers more flexibility in terms of fault handling. For more severe faults, the TPS650332-Q1 can be configured to enter the Wait for Power Cycle state or the Reset state. In the reset state, the device will shut down the output rails and immediately attempt to power up again. This device also has a Safe state for less severe faults, in which the output rails remain powered and an interrupt signals the local or remote MCU or processor to decide on the appropriate response.

1.2.3 TPS650333-Q1

The TPS650333-Q1 offers all the fault handling flexibility of the TPS650332-Q1 with an added watchdog monitor. This device is suitable for functional safety applications with a local MCU or processor, including smart rear-cameras or high-end remote front-cameras with a discrete Image Sensor Processor (ISP).

2 Selection Guide

An existing spin may be appropriate based on a target image sensor or vision application. Many of the camera PMIC spins are programmed for default operation with the example image sensors specified in Table 2-1. For sensors that are not listed, an existing spin may still be compatible if it meets the voltage and sequencing requirements specified in the sensor data sheet.

The non-safety catalog spins, the TPS65032001-Q1 and TPS65033000-Q1, are re-programmable in production. This feature enables the compatibility of these spins with many standard automotive image sensors through the socketed or in-circuit programming. For more information on these devices' programming capabilities, see the BOOSTXL-TPS65033 User's Guide and the TPS650330Q1EVM User's Guide.

Table 2-1. Camera PMIC NVM Spins

Camera PMIC	Functional Safety	Configurable	Output Voltages and Sequencing	Buck 1 UVLO Thresholds	Logic IOs	Compatible Sensors
TPS65032001-Q1	×	✓	1) B1 = 3.3 V 2) B2 = 1.8 V 3) B3 = 1.2 V 4) LDO = 2.8 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull	Many
TPS65032002-Q1	×	×	1) B1 = 3.75 V 2) LDO = 3.3 V 3) B3 = 1.1 V 4) B2 = 1.8 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = open-drain	Omnivision OX01E10 Omnivision OX01F10 Sony IMX490
TPS6503200A-Q1	×	×	1) B1 = 3.8 V 2) LDO = 3.3 V 3) B2 = 1.8 V 4) B3 = 1.1 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = open-drain	Omnivision OX01E10 Omnivision OX01F10 Sony IMX490
TPS65032018-Q1	×	×	1) B1 = 3.3 V 2) B3 = 1.8 V 3) B2 = 1.1 V 4) Load Switch(1)	Rising = 5.72 V Falling = 4.5 V	nRSTOUT = open-drain	Omnivision OX01E10 Omnivision OX01F10
TPS65033000-Q1	×	✓	1) B1 = 3.3 V 2) B2 = 1.8 V 3) B3 = 1.2 V 4) LDO = 2.8 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Many
TPS65033007-Q1	×	✓	1) B1 = 3.3 V 2) B3 = 1.8 V 3) B2 = 1.2 V 4) LDO = 2.9 V	Rising = 6.24 V Falling = 5.5 V	nRSTOUT = push-pull nINT = push-pull	Sony IMX290 Sony IMX390
TPS6503300D-Q1	×	✓	1) B1 = 3.3 V 2) LDO = 2.8 V 3) B2 = 1.8 V 4) B3 = 1.2 V	Rising = 5.72 V Falling = 5.0 V	nRSTOUT = push-pull nINT = open-drain	Omnivision OV2311 Omnivision OV2312 ON Semi AR0143 ON Semi AR0233
TPS6503300E-Q1	×	✓	1) B1 = 3.85 V 2) LDO = 3.3 V 3) B2 = 1.8 V 4) B3 = 1.3 V	Rising = 5.72 V Falling = 5.0 V	nRSTOUT = push-pull nINT = open-drain	Omnivision OV2775

Table 2-1. Camera PMIC NVM Spins (continued)

Camera PMIC	Functional Safety	Configurable	Output Voltages and Sequencing	Buck 1 UVLO Thresholds	Logic IOs	Compatible Sensors
TPS6503300I-Q1	×	✓	1) B1 = 3.3 V 2) B2 = 1.8 V 3) B3 = 1.1 V 4) LDO = 2.9 V	Rising = 7.28 V Falling = 5.0 V	nRSTOUT = push-pull nINT = push-pull	Sony IMX324 Sony IMX424 Sony ISX019
TPS65033201-Q1	✓	×	1) B1 = 3.3 V 2) B3 = 1.8 V 3) LDO = 2.8 V 4) B2 = 1.2 V	Rising = 6.76 V Falling = 6.0 V	nRSTOUT = open-drain nINT = open-drain	ON Semi AR0220 ON Semi AR0820
TPS65033205-Q1	✓	×	1) B1 = 3.3 V 2) B2 = 1.8 V 3) Load Switch(2) 4) B3 = 1.1 V	Rising = 5.20 V Falling = 4.5 V	nRSTOUT = push-pull nINT = push-pull	Omnivision OX01E10 Omnivision OX01F10
TPS65033206-Q1	✓	×	1) B1 = 3.3 V 2) LDO = 2.8 V 3) B2 = 1.8 V 4) B3 = 1.2 V	Rising = 5.20 V Falling = 4.5 V	nRSTOUT = push-pull nINT = push-pull	Omnivision OV2311 Omnivision OV2312 ON Semi AR0143 ON Semi AR0233
TPS65033207-Q1	✓	×	1) B1 = 3.3 V 2) B2 = 1.8 V 3) LDO = 2.8 V 4) B3 = 1.2 V	Rising = 9.36 V Falling = 8.5 V	nRSTOUT = push-pull nINT = push-pull	ON Semi AR0220 ON Semi AR0820
TPS65033208-Q1	✓	×	1) B1 = 3.8 V 2) LDO = 3.3 V 3) B2 = 1.8 V 4) B3 = 1.1 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Omnivision OX01E10 Omnivision OX01F10 Sony IMX490
TPS65033209-Q1	✓	×	1) B1 = 3.3 V 2) B3 = 1.1 V 3) B2 = 1.8 V 4) LDO = 2.8 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Omnivision OV2311(3) Omnivision OV2312(4)
TPS6503320D-Q1	✓	×	1) B1 = 3.3 V 2) B3 = 1.8 V 3) LDO = 2.8 V 4) B2 = 1.2 V	Rising = 6.76 V Falling = 6.0 V	nRSTOUT = open-drain nINT = open-drain	ON Semi AR0220 ON Semi AR0820
TPS6503320F-Q1	✓	×	1) B1 = 3.3 V 2) LDO = 2.9 V 3) B2 = 1.8 V 4) B3 = 1.1 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Omnivision OX03C10 Omnivision OX08A4Y Omnivision OX08B40 Omnivision OX08B4C Sony IMX324 Sony IMX424 Sony ISX019
TPS6503320G-Q1	✓	×	1) B1 = 3.3 V 2) LDO = 2.9 V 3) B2 = 1.8 V 4) B3 = 1.2 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Sony IMX290 Sony IMX390

Table 2-1. Camera PMIC NVM Spins (continued)

Camera PMIC	Functional Safety	Configurable	Output Voltages and Sequencing	Buck 1 UVLO Thresholds	Logic IOs	Compatible Sensors
TPS65033303-Q1	✓	×	1) B1 = 3.3 V 2) B2 = 1.8 V 3) B3 = 1.2 V 4) LDO = 2.9 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Sony IMX290 Sony IMX390
TPS65033304-Q1	✓	×	1) B1 = 3.3 V 2) B2 = 1.8 V 3) B3 = 1.1 V 4) LDO = 2.9 V	Rising = 4.68 V Falling = 4.0 V	nRSTOUT = push-pull nINT = push-pull	Sony IMX324 Sony IMX424 Sony ISX019

(1) External filtering may be needed for imager analog rail.
(2) External filtering may be needed for imager analog rail.
(3) Power solution requires additional 1.2 V regulator.
(4) Power solution requires additional 1.2 V regulator.

3 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (October 2021) to Revision A (June 2021)	Page
• Updated *Camera PMIC NVM Spins* table in the *Selection Guide* section	4

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