

Power Management IC (PMIC) Guide for Automotive



Power Management IC (PMIC) for Automotive

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Texas Instruments Commitment to Automotive Safety

Texas Instruments power management integrated circuits (PMICs) integrate multiple DC/DC converters in one package, simplifying power design by reducing component count while maintaining high power efficiency and performance. TI's PMIC solutions include those that integrate several inductive step-down converters with linear regulators, charge pumps or other analog circuits, such as battery chargers, and an I²C interface to save space.

Automotive-Qualified Products (Q1)

TI's automotive-qualified products are indicated by the Q1 suffix. The Q1 indicates that a product has met TI's stringent automotive standards and includes:

- 180-day product change notification from final notice
- Extended temperature qualification
- Automotive documentation service
- Target zero defects

Introduction

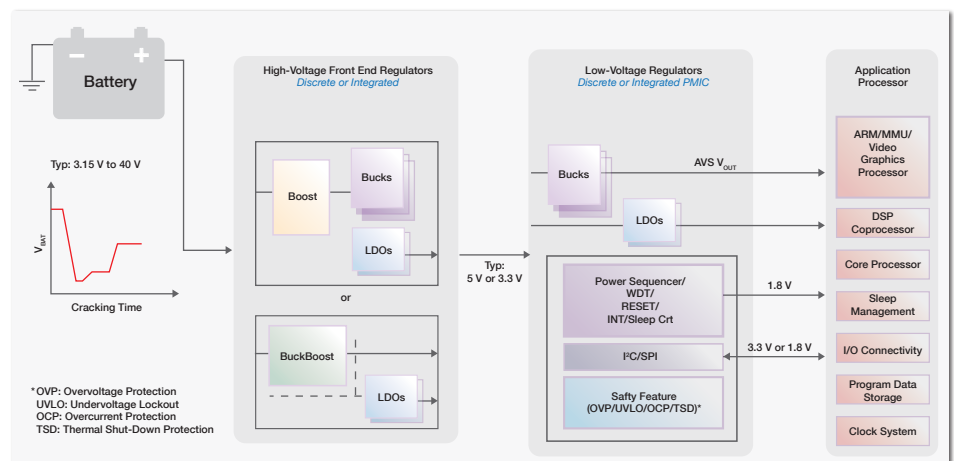
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Infotainment, Telematics and ADAS PMICs

Infotainment

Overview

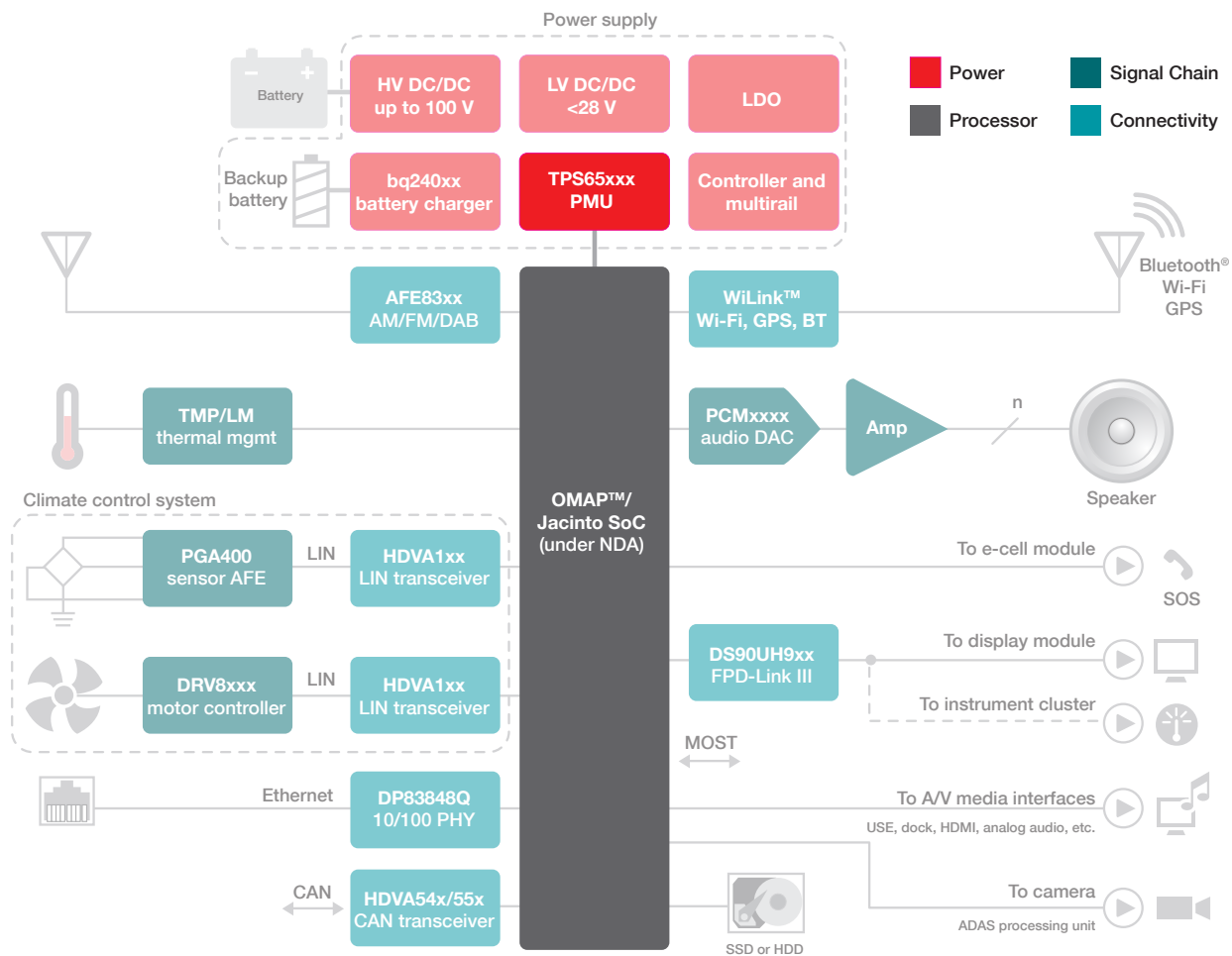
TI provides a multitude of analog and embedded processing products for rich, dedicated HMI environments complementing multimodal applications. These applications include:

- Voice, gesture and face recognition
- Consumer multimedia systems such as video games, audio, digital radio and portable electronics
- Curved high-definition cluster and center-console imaging with DLP® technology

- DLP® augmented reality and heads-up displays (HUDs)
- Telematics, emergency call (e-call) and rear-seat entertainment
- Highly efficient Class-D audio solutions
- SoCs that deliver rich multimedia, high integration and extended lifecycles
- Complete infotainment solutions augmented by software suites developed in close partnership with leading operating systems such as Android, QNX, Microsoft and Linux

TI technologies enable connectivity systems, eliminating wires within the vehicle. Systems enable comprehensive Internet access, dynamic navigation, media sharing and multizone applications for infotainment, telematics, e-call, rear-seat entertainment and other portable electronics. These include:

- Support for *Bluetooth®*, Bluetooth low energy, near field communications (NFC), GPS/GNSS, FM and Wi-Fi solutions



Infotainment Diagram

Telematics

Vehicles equipped with telematics e-call systems enable phone calls to an emergency service center in the event of an accident. Customers can accelerate the design of their e-call systems by taking advantage of a complete reference solution made up of AEC-Q100-qualified integrated circuits (ICs) from TI.

other automotive applications such as telematics, stolen vehicle tracking and HEV/EV sound generation. It also incorporates the TLV70033-Q1 voltage regulator with low quiescent current and the MSP430F2232 16-bit ultra-low-power microcontroller.

- Loud and clear audio quality: The TPA3111D1-Q1 delivers 10-W output power at 8 Ω at greater than 90 percent efficiency and has enhanced EMI suppression technology to improve noise immunity. This ensures loud and clear audio quality, which is imperative in an e-call system where outside noise can sometimes overwhelm the emergency call.

- **Emergency operation:** The TPS43330-Q1 pre-boost circuit supports automotive start/stop and boosts backup battery-supply voltage, allowing operation down to 2 V at the input. Combined with the wide supply voltage (8 V-26 V) range of the TPA311D1-Q1, the components in this reference design can be powered off a single-cell LiFePO4 battery in case the car battery connection is severed in an accident.
- **System protection:** The components offered in this system provide over-voltage and load dump protection against input transients up to 40 V. The Class-D amplifier also offers power-cycling capability and speaker open-load detection during initial powerup.



Infotainment, Telematics and ADAS PMICs

Advanced Driver Assistance Systems (ADAS)

Overview

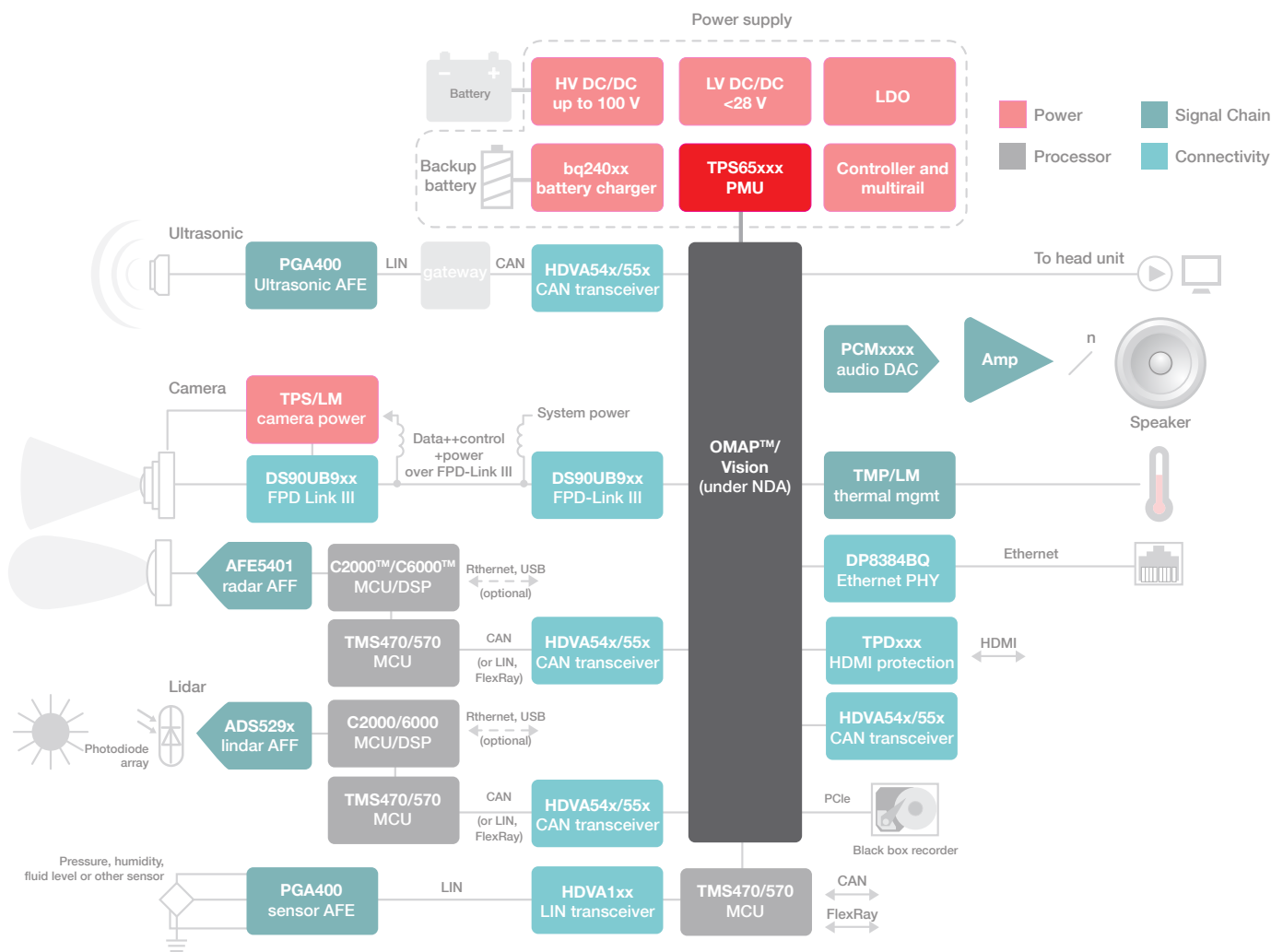
The latest technology advancements for driver awareness and safety can be found in TI's analog and embedded processing portfolio.

- Processors with DSP enabling multiple vision and radar systems, for applications like lane-departure

warning, rear-view and surround-view camera systems, collision warning and avoidance, as well as blind-spot detection.

- Integrated front ends for radar and LIDAR data conversion, enabling high performance and integration at lower costs.

- Fully integrated SoC for ultrasonic park assist.
- FPD-Link connecting standard cameras and megapixel cameras via thin, light and cost-optimized cables, reducing weight and complexity of the wiring harness without sacrificing performance.



ADAS Block Diagram

Infotainment, Telematics and ADAS PMICs

Integrated Power Management IC for Infotainment, Telematics and ADAS

Integrated Power Management IC for Infotainment

TPS659119-Q1

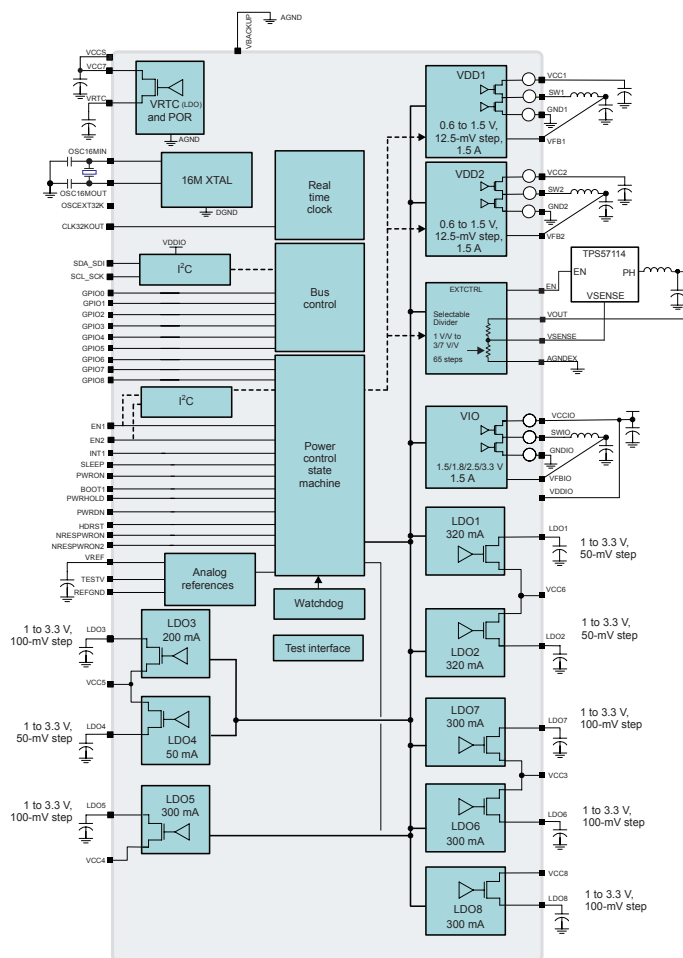
The TPS659119-Q1 is an integrated power management IC dedicated to applications powered by a 5-V input, and that require multiple output power rails. The device provides three step-down converters and an interface to control an external DC/DC buck converter, eight LDOs, and is designed to be a flexible PMIC for supporting different multicore processors and applications.

Two of the step-down converters support dynamic voltage scaling by a dedicated I²C interface for optimum power savings. The third converter provides power for the I/Os and memory in the system. The device includes general-purpose LDOs, providing a wide range of voltage and current capabilities. Five of the LDOs support 1.0 to 3.3 V with 100-mV step; three (LDO1, LDO2, LDO4) support 1.0 to 3.3 V with 50-mV step. All LDOs are fully controllable by the I²C interface. In addition to the power resources, the device contains an embedded power controller (EPC) to manage the power-sequencing requirements of systems and an RTC. Power sequencing is programmable by EEPROM.

The TPS659119-Q1 can be used for both infotainment and ADAS applications.

Key Features

- Three efficient step-down DC/DC converters
 - Two with dynamic voltage scaling
 - One for I/O
- One controller for an external DC/DC converter
- Eight LDO voltage regulators and one RTC LDO (supply for internal RTC)
- One high-speed I²C interface for general-purpose control commands
- Two independent enable signals for controlling power resources
- Two reset inputs
- Real-time clock (RTC) resource for fast startup
- Nine configurable GPIOs with multiplexed feature support
- Watchdog
- One PWM generator and two LED pulse generators
- Thermal shutdown protection and hot die detection
- Efficient hardware sleep-mode management
- Optimized design for processors from the OMAP4 and Nvidia T30 families



Functional Block Diagram

Get more information: www.ti.com/product/tps659119-Q1

Infotainment, Telematics and ADAS PMICs

Integrated Power Management IC for Infotainment, Telematics and ADAS

Integrated Power Management IC for ADAS

TPS65310A-Q1

The TPS65310A-Q1 device is a power management unit, meeting the requirements of digital signal processor (DSP)-controlled automotive systems like advanced driver assistance systems (ADAS). It is ideally suited for camera- or radar-based vision systems to support features like lane-departure warning, collision-avoidance systems, blind-spot detection, park assist and traffic-sign detection, to name a few.

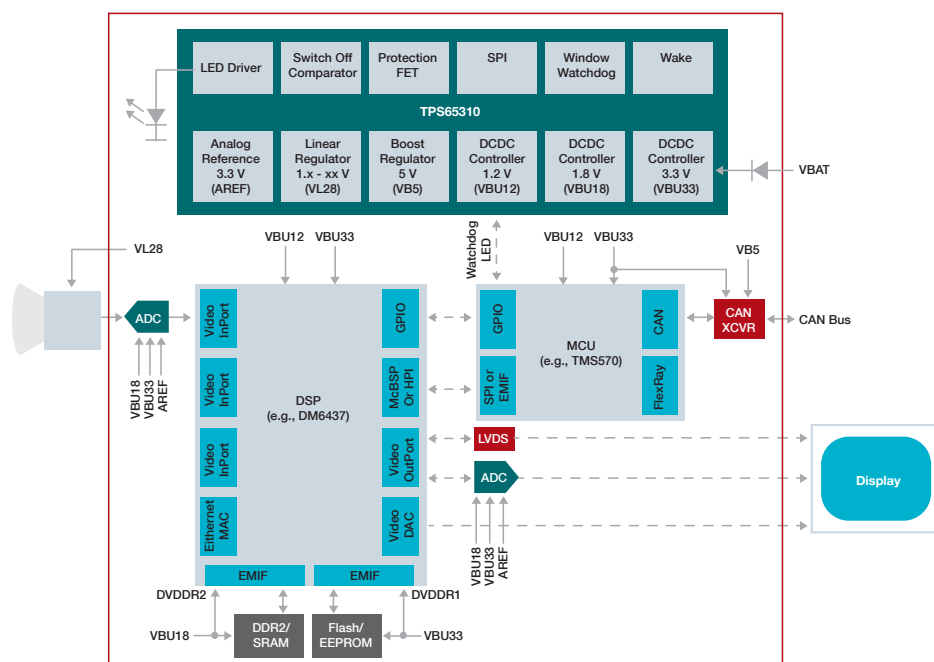
The device includes one high-voltage buck controller for pre-regulation combined with two buck and one boost converter for post-regulation. A further integrated low dropout (LDO) rounds up the power-supply concept and offers a flexible system design with five total independent voltage rails. The device offers a low power state (LPM0 with all rails off) to reduce current consumption in case the system is constantly connected to the battery line. All outputs are protected against overload and overtemperature.

The integrated window watchdog and SPI for control and diagnosis enable safety-related applications in ADAS. Safety levels up to ASIL-B can be realized using the TPS65310A-Q1.

The TPS65310A-Q1 can be used in both ADAS and safety applications.

Key Features

- Input voltage range from 4 V to 40 V with transients up to 60 V (80 V when using PMOS)
- Single-output synchronous buck controller
 - Peak-gate-drive current 0.6 A
 - 490-kHz fixed switching frequency
 - Pseudo-random frequency-hopping spread-spectrum or triangular mode
- Dual synchronous buck converter
 - Designed for output currents up to 2 A
 - Out-of-phase switching
 - Switching frequency of 0.98 MHz
- Adjustable 350-mA linear regulator
- Adjustable asynchronous boost converter
 - 1-A integrated switch
 - Switching frequency of 0.98 MHz
- Soft-start feature for all regulator outputs
- Independent voltage monitoring
- Undervoltage and overvoltage protection
- Short circuit, overcurrent and thermal protection on buck controller, gate drive, buck converters, boost converter and linear regulator outputs
- SPI for control and diagnostic
- Integrated watchdog window
- Reference voltage output
- High-side driver for use with external FET LED driver
- Input for external temperature sensor with integrated IC shutdown at $T_a < -40^\circ\text{C}$



Functional Block Diagram

Get more information: www.ti.com/product/tps65310A-Q1

Infotainment, Telematics and ADAS PMICs

Integrated Power Management IC for Infotainment, Telematics and ADAS

Integrated Power Management IC for Telematics

TPS65320-Q1

The TPS65320-Q1 power supply is a combination of a single high-voltage switch-mode asynchronous buck power supply and an LDO regulator. This is a monolithic high-voltage switching regulator with an integrated switch of 40 V, a power MOSFET and a low standby-current LDO.

The device has a voltage supervisor that monitors the outputs of the switch-mode power supply. To reduce heat, the input supply of the LDO can auto-source from the input voltage to the output of the buck. The low-voltage tracking feature can possibly eliminate the need to use a boost converter during cold-crank conditions.

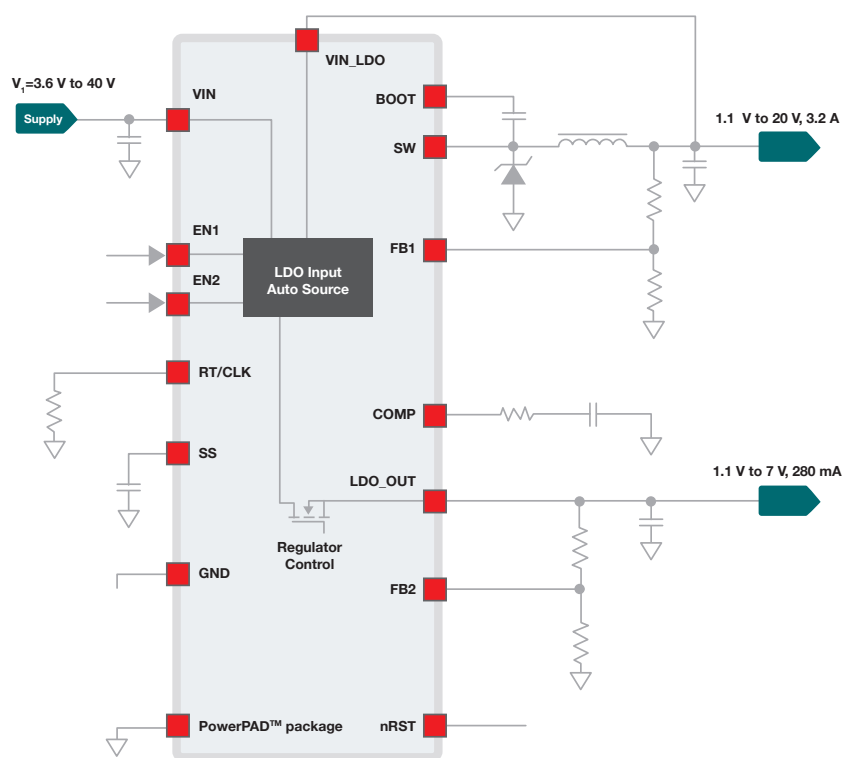
The TPS65320-Q1 has a switching frequency range from 100 KHz to 2.5 MHz, providing customers with a flexible design to fit their system needs. The external loop compensations allow users to optimize the converter response for the appropriate operating conditions. The standby current of the buck regulator is 140 μ A for low-power mode.

The device has built-in protection features such as soft start, pulse-by-pulse current limit, thermal sensing and shutdown due to excessive power dissipation.

The TPS65320-Q1 is a general-purpose PMIC and can be used in infotainment, telematics and ADAS applications.

Key Features

- One high-Vin buck converter
 - Input range of 3.6 V to 40 V
 - Supports direct battery connection and start/stop
 - Asynchronous buck converter (internal FET)
 - Max load current: 3.2 A
 - Output adjustable from 1.1 V to 20 V
 - High duty-cycle operation supported
 - Adjustable switch-mode frequency from 100 KHz to 2.5 MHz
 - Less than 140- μ A standby current in low-power mode
 - Input switching frequency synchronization pin to reduce radiated noise
- One low-dropout voltage (LDO) regulator
 - 280-mA current capability with 40- μ A standby current in low-load condition
 - Input supply auto-source to balance efficiency and low standby current
 - Power-good output (push-pull)
 - Low-dropout voltage of 300 mV at $I_{out} = 200$ mA
- Overcurrent protection for all regulators
- Overtemperature protection



Functional Block Diagram

Get more information: www.ti.com/product/tps65320-Q1

Infotainment, Telematics and ADAS PMICs

Integrated Power Management IC for Infotainment, Telematics and ADAS

Integrated Power Management IC for ADAS

TPS659039-Q1

The TPS659039-Q1 provides seven configurable step-down converters with up to 6 A of output current for memory, processor core, input/output (I/O) or preregulation of LDOs. One of these configurable step-down converters can be combined with another 3-A regulator to allow up to 9 A of output current.

The TPS659039-Q1 contains six LDO regulators for external use. These LDO regulators can be supplied from either a system supply or a preregulated supply. The power-up and power-down controller is configurable and can support any power-up and power-down sequences (OTP based).

The device includes a 32-kHz RC oscillator to sequence all resources during power-up and power-down. In cases where a fast startup is needed, a 16-MHz crystal oscillator is also included to quickly generate a stable 32 kHz for the system.

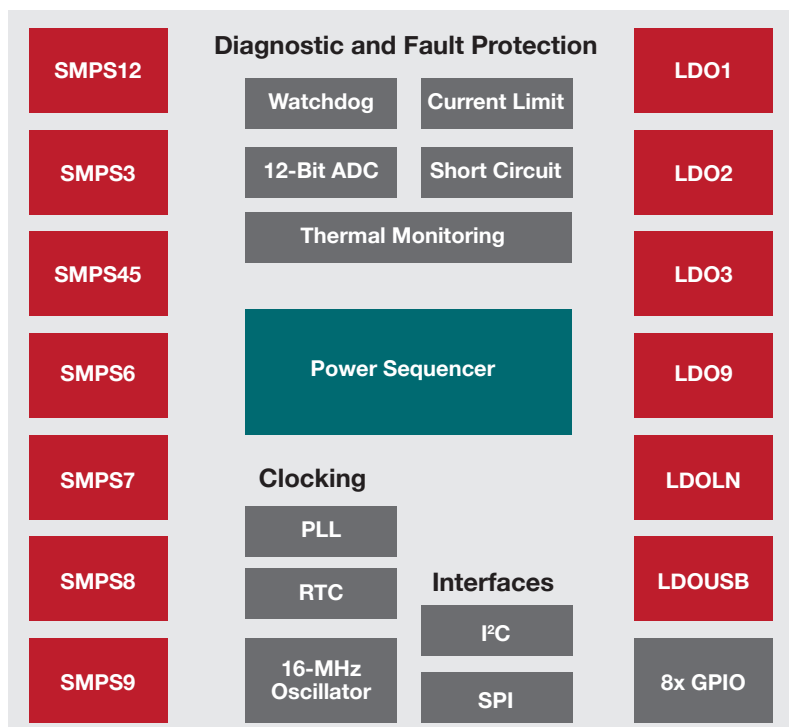
All LDOs and SMPS converters can be controlled by the SPI or I²C interface, or by power request signals. In addition, voltage scaling registers allow transitioning the SMPS to differential voltage by SPI, I²C, or roof and floor control. One dedicated pin in each package can be configured as part of the power-up sequence to control external resources.

GPIO functionality is available and two GPIOs can be configured as part of the power-up sequence to control external resources. Power request signals enable power-mode control for power optimization. The device includes a general-purpose sigma-delta analog-to-digital converter (ADC) with three external input channels.

The TPS659039-Q1 can be used in both infotainment and ADAS applications.

Key Features

- Seven step-down switched-mode power-supply regulators from 0.7 V to 3.3 V
 - Output current measurement in all except 1-A SMPS regulators
 - Differential remote sensing (output and ground) in dual-phase and triple-phase regulators
 - Hardware- and software-controlled ECO mode up to 5 mA with 15-μA I_q
- Six general-purpose low drop-out with 50-mV steps
 - Five from 0.9 V to 3.3 V
 - One 100-mA USB LDO
- Clock management up to 16 MHz with crystal oscillator and 32-kHz RC oscillator
- Real-time clock (RTC) with alarm wake-up mechanism
- 12-bit sigma-delta general-purpose analog-to-digital converter (GPADC) with three external input channels for self monitoring
- High-temperature warning and thermal shutdown
- One-time programmable configurable sequences for power-up, power-down, and between sleep and active states
- Selectable control interface
- Undervoltage lockout
- System voltage range from 3.15 V to 5.25 V



Functional Block Diagram

Get more information:
www.ti.com/product/TPS659039-Q1

Safety PMICs

Overview

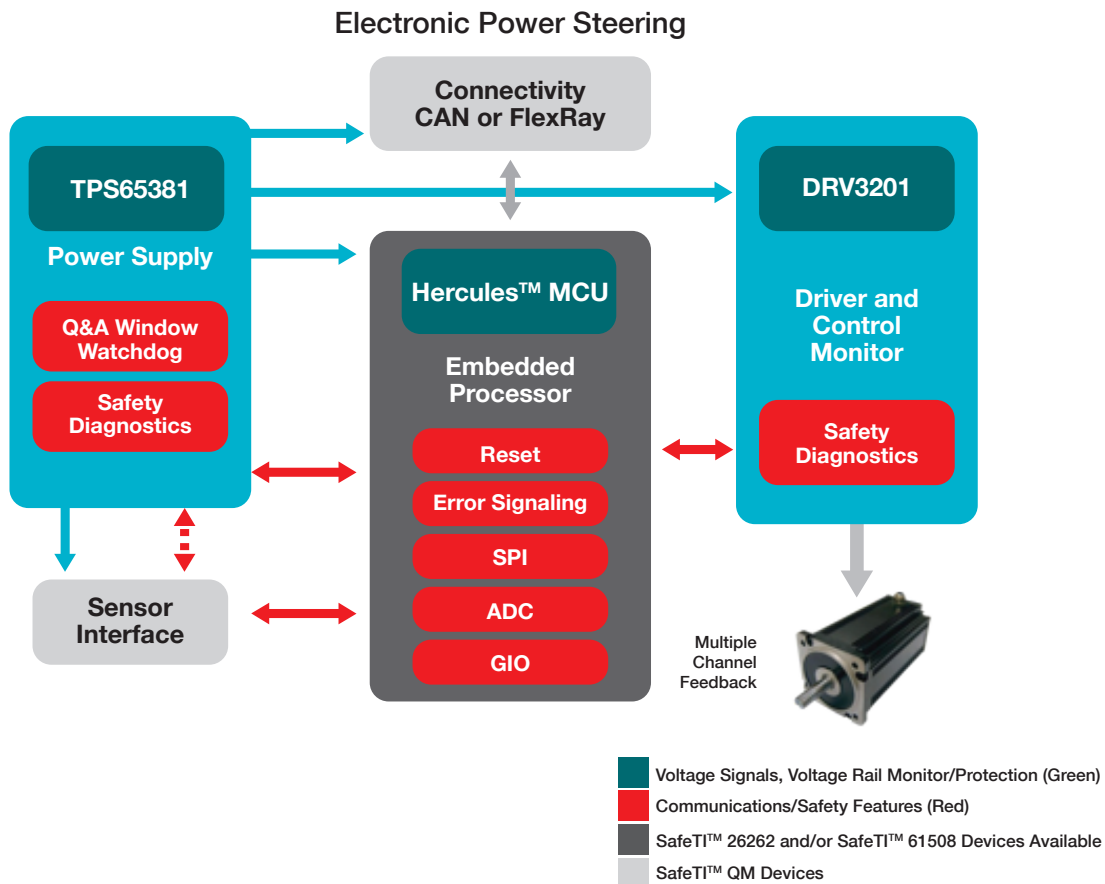
Overview

SafeTI™ designated products offer fast safety certification for critical systems requiring compliance with standards including ISO 26262, IEC60730 and

IEC61508. The types of applications where these standards can be applied are:

- Stability control and anti-lock braking systems

- Electric power steering systems
- Airbag, occupant detection and alarm systems
- Advanced driver assistance systems



Safety PMICs

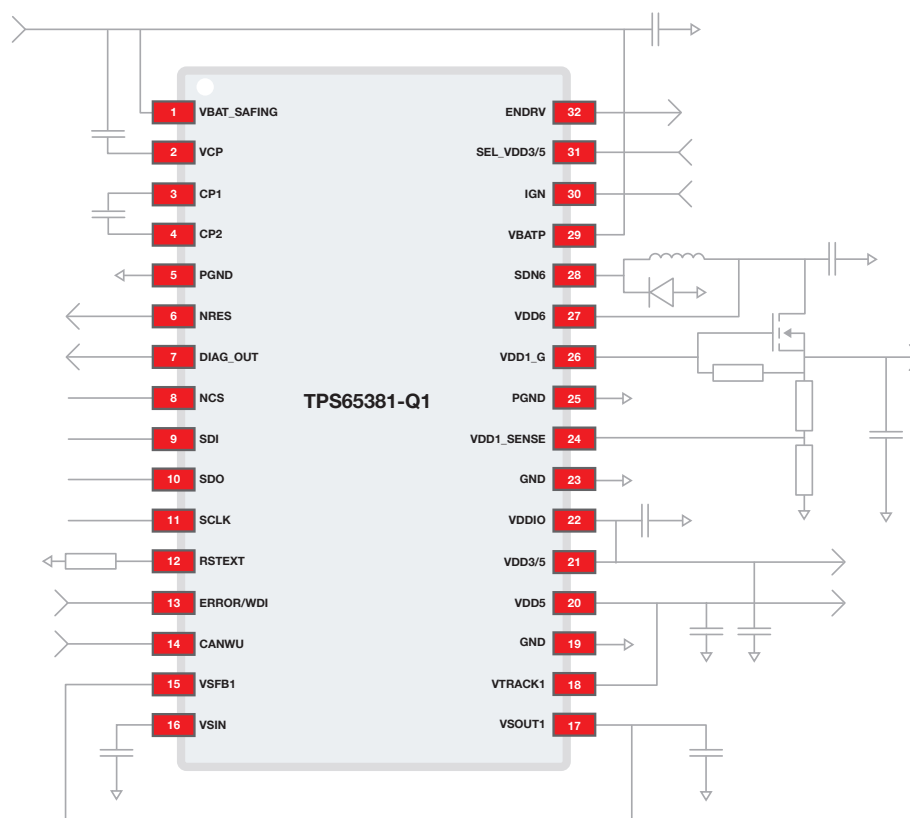
Integrated Power Management

Integrated Power Management IC for Safety

TPS65381-Q1

The TPS65381-Q1 is a multirail power supply designed to supply microcontrollers in safety-critical applications, such as those found in automotive. The devices support Texas Instruments' TMS570LS series 16-/32-bit RISC flash MCU and other microcontrollers with dual-core lockstep (LS) or loosely coupled (LC) architectures.

The TPS65381-Q1 integrates multiple supply rails to power the MCU, CAN or FlexRay, and an external sensor. An asynchronous buck switch-mode power-supply converter with internal FET converts the input battery voltage to a 6-V pre-regulator output. This 6-V output is used to supply the other regulators. A fixed 5-V linear regulator with an internal FET is integrated to be used as, for example, a CAN supply.



Functional Block Diagram

Key Features

Multirail power supply:

- Supports TMS570LS series
- 16-/32-bit RISC flash microcontroller

Supply rails:

- Input voltage range:
 - 5.8 V to 36 V (CAN, I/O, MCU core and sensor supply regulators functional)
 - 4.5 V to 5.8 V (3.3-V I/O and MCU core voltage functional)
- 6-V asynchronous switch-mode pre-regulator with internal FET, 1.5-A current limit and temperature protection
- 5-V (CAN) supply voltage, linear regulator with internal FET and temperature protection
- 3.3-V or 5-V MCU I/O voltage, linear regulator with internal FET and temperature protection
- 0.8-V to 3.3-V adjustable MCU core voltage, linear regulator controller with external FET
- Sensor supply: linear tracking regulator with tracking input, 300-mA current limit, temperature protection and protection against short-to-battery and short-to-ground
- Reverse battery protection with external FET allowing for low voltage

Power supply/system monitoring:

- Under- and overvoltage monitoring on all regulator outputs, battery voltage and internal supplies
- Self-check on all voltage monitoring (during powerup and after powerup initiated by external MCU)
- Independent voltage references for regulator references and voltage-monitoring circuitry with separate battery voltage input
- Wakeup through deglitched ignition signal
- Wakeup through CAN wakeup pin
- Enable circuit for peripheral device wake-up circuitry or power stages

Get more information: www.ti.com/product/tps65381-Q1

Safety PMICs

Integrated Power Management

Integrated Power Management IC for Safety

TPS65311-Q1

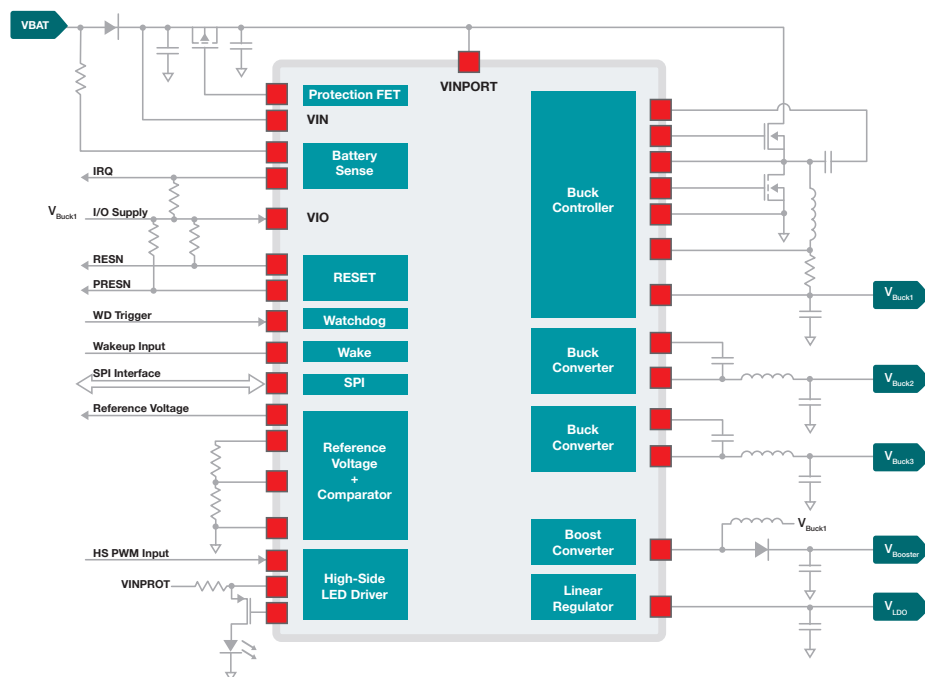
The TPS65311-Q1 device is a power management unit, meeting the requirements of digital signal processor (DSP)-controlled automotive systems like advanced driver assistance systems (ADAS). It is ideally suited for camera- or radar-based vision systems to support features like lane-departure warning, collision-avoidance systems, blind-spot detection, park assist and traffic-sign detection, to name a few.

The device includes one high-voltage buck controller for pre-regulation combined with two buck and one boost converter for post-regulation. A further integrated low dropout (LDO) rounds up the power-supply concept and offers a flexible system design with five total independent voltage rails. The device offers a low power state (LPM0 with all rails off) to reduce current consumption in case the system is constantly connected to the battery line. All outputs are protected against overload and overtemperature.

The integrated window watchdog and SPI for control and diagnosis enables safety-related applications in ADAS. Safety levels up to ASIL-B can be realized using the TPS65311-Q1.

Key Features

- Input voltage range from 4 V to 40 V with transients up to 60 V (80 V when using PMOS)
- Single-output synchronous buck controller
 - Peak gate-drive current 0.6 A
 - 490-kHz fixed switching frequency
 - Pseudo-random frequency-hopping spread-spectrum or triangular mode
- Dual synchronous buck converter
 - Designed for output currents up to 2 A
 - Out-of-phase switching
 - Switching frequency of 2.45 MHz
- Adjustable 350-mA linear regulator
- Adjustable asynchronous boost converter
 - 1-A integrated switch
 - Switching frequency of 2.45 MHz
- Soft-start feature for all regulator outputs
- Independent voltage monitoring
- Undervoltage and overvoltage protection
- Short circuit, overcurrent and thermal protection on buck controller, gate drive, buck converters, boost converter and linear regulator outputs
- SPI for control and diagnostic
- Integrated watchdog window
- Reference voltage output
- High-side driver for use with external FET LED driver
- Input for external temperature sensor with integrated IC shutdown at $T_a < -40^{\circ}\text{C}$



Functional Block Diagram

Get more information: www.ti.com/product/tps65311-Q1

Power Management IC (PMIC)

Component Recommendations

Device	Processor Name	Vin (min) (V)	Vin (max) (V)	Reg. Outputs (#)	LDO	Battery Input	Start/ Stop Support	Special Features	End Equipment App.	Package	Price
LP3907-Q1	Advanced Apps Processors, FPGA, Generic	2.8	5.5	4	2	—	—	Dynamic Voltage Scaling, Enable, I ² C Control, Low Iq Current, Over Current Protection, Power Good, Synchronous Rectification, Thermal Shutdown, PFM/PWM, UVLO, Flexible POR/Power good with delay, SYNC pin, Thermal warning flags		24WQFN 25DSBGA	1.10
LP8728-Q1	Advanced Apps Processors, FPGA, Generic	2.7	5.5	4		—	—	Enable, Over Current Protection, Power Good, Thermal Shutdown		28WQFN	1.60
LP8731-Q1	Advanced Apps Processors, FPGA, Generic	2.8	5.5	4	2	—	—	Dynamic Voltage Scaling, Enable, I ² C Control, Low Iq Current, Over Current Protection, Power Good, Synchronous Rectification, Thermal Shutdown, PFM/ PWM, UVLO, Flexible POR/Power good with delay, SYNC pin, Thermal warning flags		24WQFN 25DSBGA	1.10
TPS43330-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43330A-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43331-Q1	Generic	5	40	4	2	Yes	Yes	Power Good	General Purpose PMIC	38HTSSOP	4.00
TPS43332-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43333-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43335-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43336-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS43337-Q1	Generic	4	40	3	0	Yes	Yes	Power Good, Synchronous Rectification	General Purpose PMIC	38HTSSOP	2.20
TPS65000-Q1		2	6	3	2	Yes	Yes	Adjustable, Enable, Low Iq Current, Power Good	General Purpose PMIC	16WQFN	1.64
TPS65023-Q1	TI-DM357x, TI DM644x TI OMAP3503/15/25/30, TI AM3505/17, TI OMAP-L1xx	2.5	6	6	3	-	-	-	General Purpose PMIC	40VQFN 40WQFN	3.45
TPS650241-Q1	Samsung-S3C2443-533MHz	2.5	6	6	3	-	-		General Purpose PMIC	32VQFN	3.04
TPS650243-Q1	Samsung-S3C6410	2.5	6	6	3	-	-		General Purpose PMIC	32VQFN	3.04
TPS650244-Q1	Freescale-IMX31	2.5	6	6	3	-	-		General Purpose PMIC	32VQFN	3.04
TPS650250-Q1	Freescale-IMX35	2.5	6	6	3	-	-	-	Front Camera, Radar	32VQFN	2.57
TPS65051-Q1	Freescale-IMX25	2.5	6	6	4	-	-		General Purpose PMIC	32VQFN	2.05
TPS65053-Q1	TI-DM355, Freescale IMX27	2.5	6	5	3	-	-		General Purpose PMIC	24VQFN	1.95
TPS650732-Q1	TI-AM3505/17	2.8	6.3	5	2	-	-		Infotainment	48VQFN	4.25
TPS65300-Q1	TI-TMS570, TI-C28xxx	5.6	40	4	3	Yes	-		Multi Rail Power Solution for Multi-Rail MCUs & DSPs	24HTSSOP 24VQFN	1.98
TPS65301-Q1	TI-TMS570 TI-C28xx	5.6	40	4	3	Yes	-		Multi Rail Power Solution for Multi-Rail MCUs & DSPs	24HTSSOP	2.15

*Suggested resale price in U.S. dollars in quantities of 1,000.

Preview products are listed in **bold teal**.

Power Management IC (PMIC)

Component Recommendations cont.

Device	Processor Name	Vin (min) (V)	Vin (max) (V)	Reg. Outputs (#)	LDO	Battery Input	Start/ Stop Support	Special Features	End Equipment App.	Package	Price
TPS65310A-Q1	Generic	4.8	40	5	1	Yes	-			56VQFN	4.99
TPS65311-Q1	Generic	4.8	40	5	1	Yes	-			56VQFN	4.99
TPS65320-Q1	Generic	3.6	40	2	1	Yes	-	Eco-mode	General Purpose PMIC	14HTSSOP	1.45
TPS65381-Q1	TI-TMS570	5.8	40	5	4	Yes	-	Adjustable, Low Iq Current, Power Good, Thermal Shutdown, Ext Adjustable, UVLO		32HTSSOP	2.57
TPS658629-Q1	Nvidia-Tegra T20	2.9	5.5	14	11	-	-		Infotainment	169NFBGA	7.00
TPS659038-Q1	TI-OMAP54xx	3.135	5.25	18	11	-	-		Infotainment	169NFBGA	
TPS659039-Q1	TI-DRA74x, TI-DRA75x, TI-TDA2x, TI-AM572x	3.135	5.25	13	6	-	-		Infotainment, Fusion	169NFBGA	
TPS659119-Q1	TI-DM81xx, TI-AM387x, TI-AM389x, Nvidia-Tegra T30, TI-DRA6x	2.7	5.5	11	8	-	-	I ² C Control	Infotainment	80HTQFP	4.49

*Suggested resale price in U.S. dollars in quantities of 1,000.

Preview products are listed in **bold teal**.



Behind the Wheel Blog

Drive in to see how TI is engineering the future of automotive.

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Notes

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Internet

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TI E2E Community Home Page

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Product Information Centers

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Domestic www.tij.co.jp/pic

Asia

Phone

International +91-80-41381665
Domestic Toll-Free Number

Note: Toll-free numbers do not support mobile and IP phones.

Australia 1-800-999-084
China 800-820-8682
Hong Kong 800-96-5941
India 1-800-425-7888
Indonesia 001-803-8861-1006
Korea 080-551-2804
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