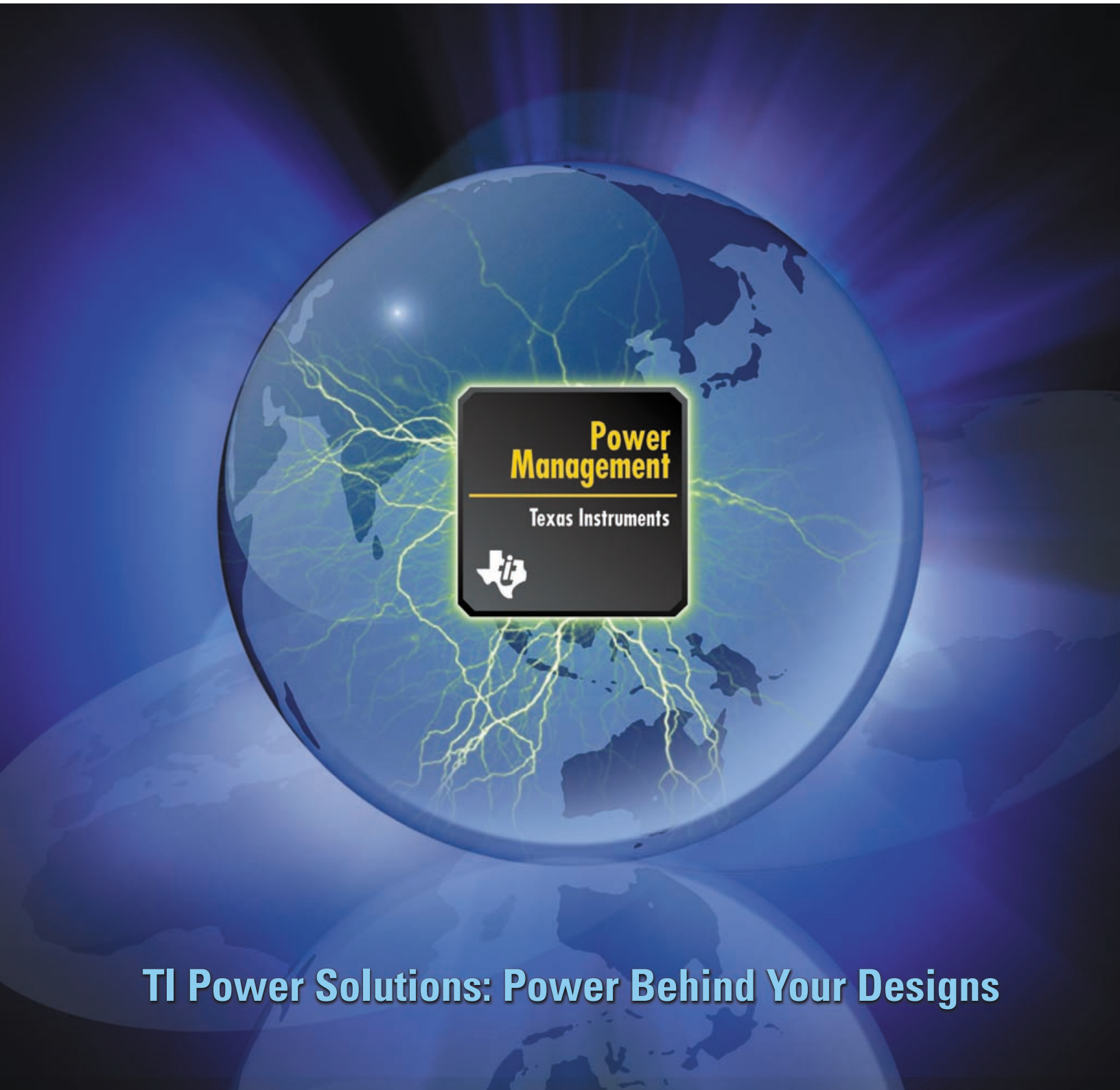
Texas Instruments

Technology for Innovators™

Power Management Selection Guide

2Q 2006



TI Power Solutions: Power Behind Your Designs

Table of Contents

Texas Instruments (TI) offers complete power solutions with a full line of high-performance products. These products, which range from standard linear ICs to plug-in and integrated power solutions, are tailored to meet your design challenges. And, TI makes designing easier by providing leading-edge support tools such as training, a broad selection of evaluation modules (EVMs), application notes, comprehensive technical documentation and more. TI also offers samples and small orders (shipped within 24 hours via TI authorized distributors) that will help you accelerate your time-to-market.

Included in this selection guide you will find design factors, featured products, graphic representations of portfolios and parametric tables. A list of application notes and evaluation modules is included in each section of the guide.

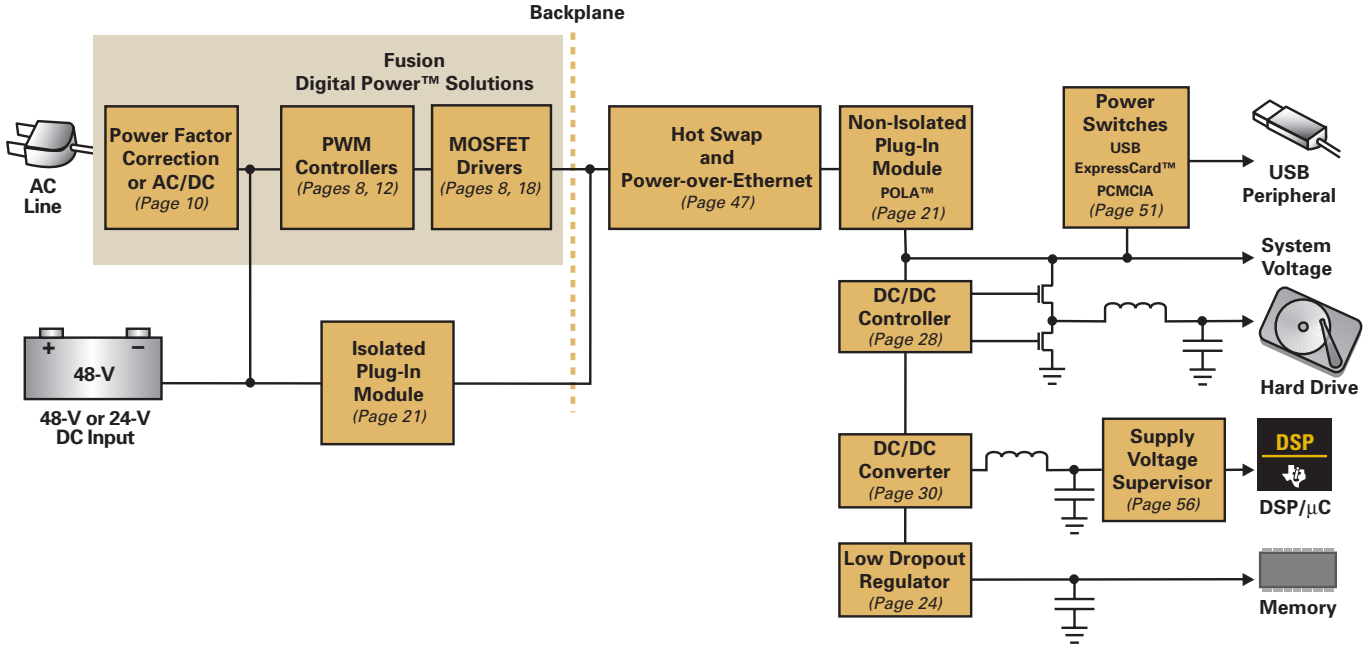
TI Power Solutions: Power Behind Your Designs

TI provides power management integration, technology and value to help you drive innovation and grow market opportunities. This is coupled with collaboration, tools, service and delivery to help you get there faster. For more information or technical assistance, please see TI Worldwide Technical Support on page 67 of this selection guide or visit TI's Power Management web site at:

power.ti.com

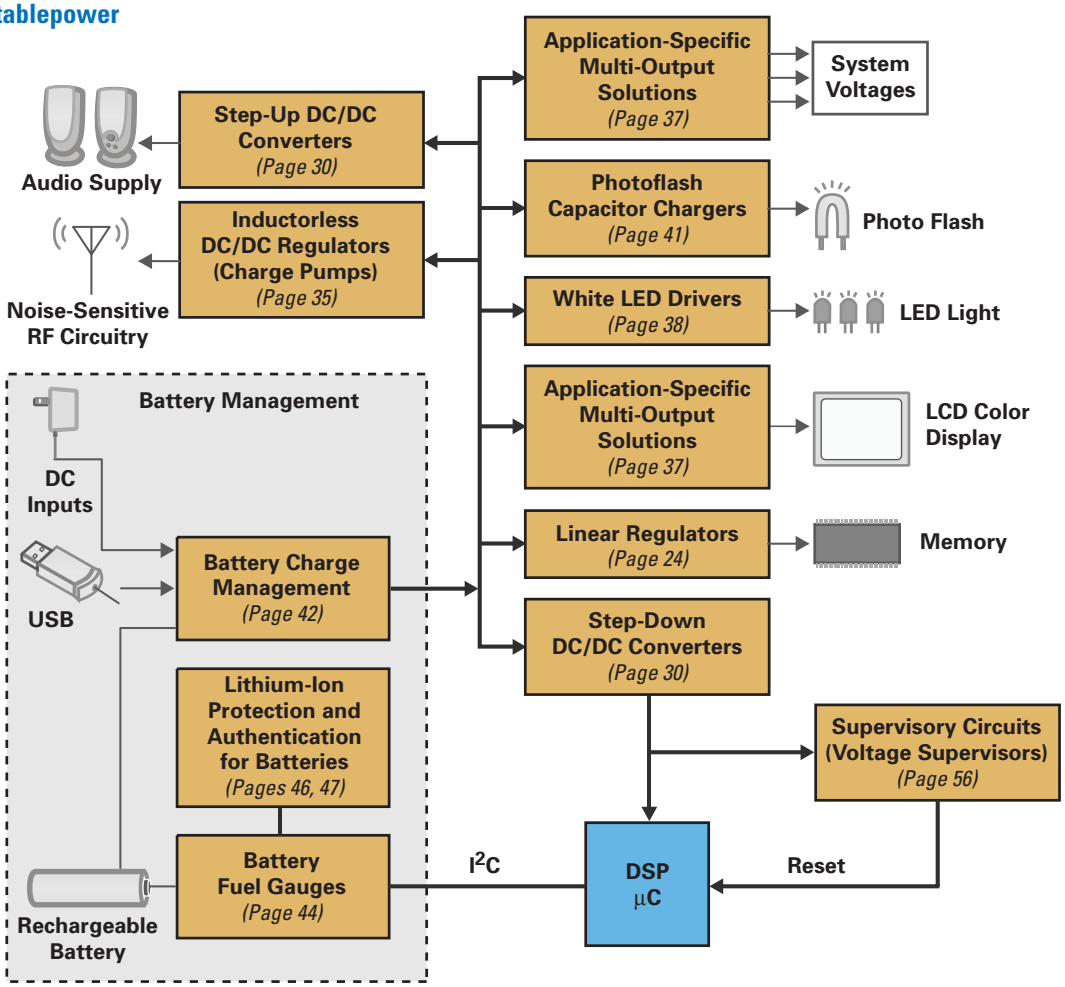
Note: Military versions of some Power Management products are available. Please visit:
power.ti.com/militaryproducts

System Power and Plug-In Solutions



Portable Power Solutions

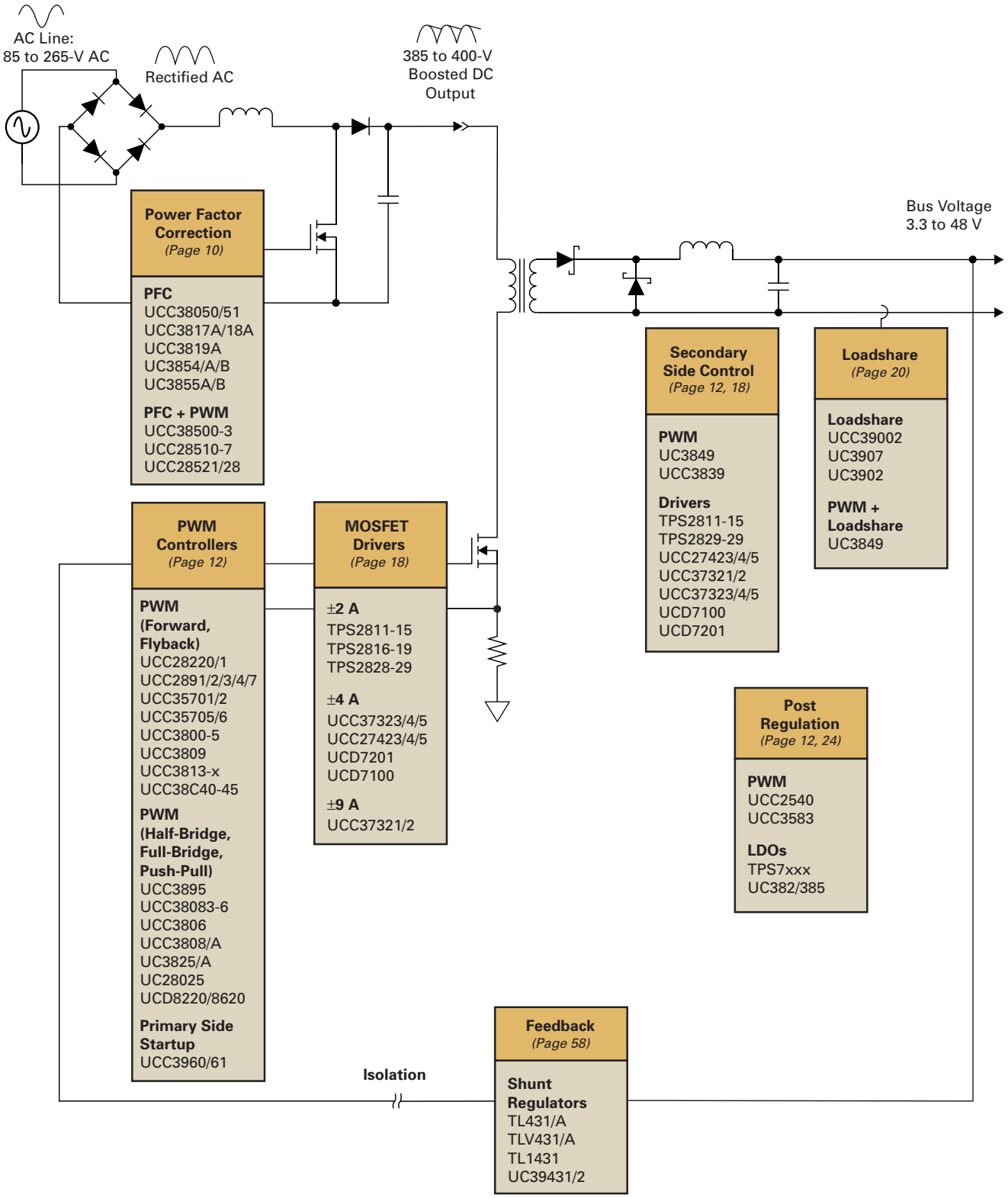
www.ti.com/portablepower



Typical Power Applications

AC/DC Solutions

Isolated DC/DC Solutions

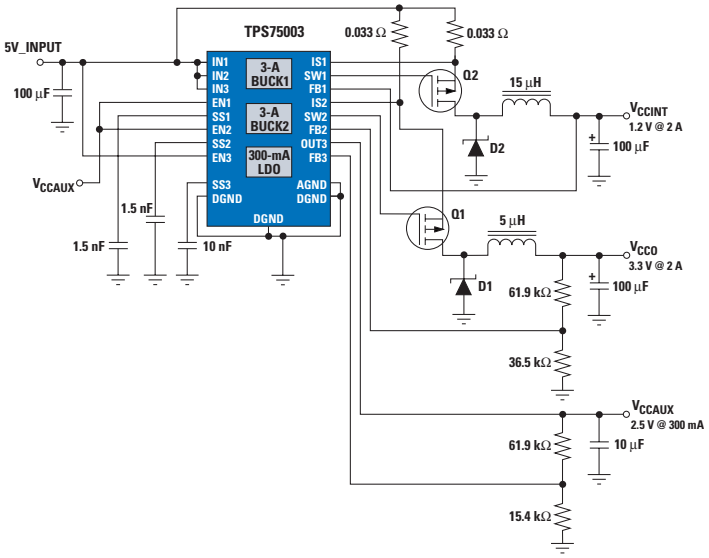


FPGA and CPLD Power Solutions

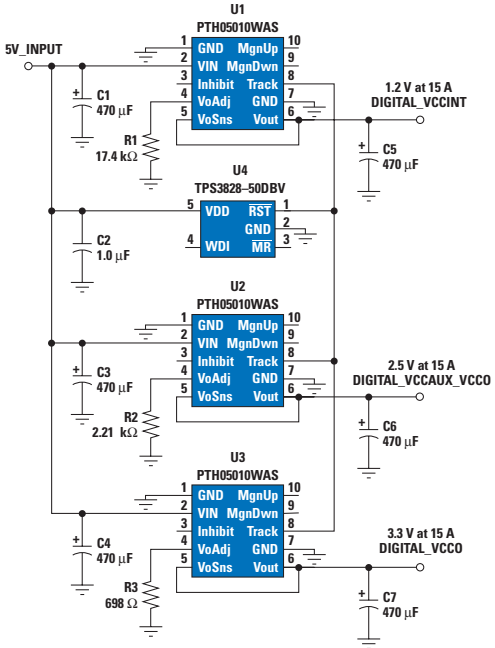
www.ti.com/xilinxfpga or **www.ti.com/alterafpga**

Access the sites for one-stop power management support for Xilinx® and Altera® FPGAs and CPLDs, including free downloads of power reference designs with complete schematics, bills-of-material and helpful implementation notes.

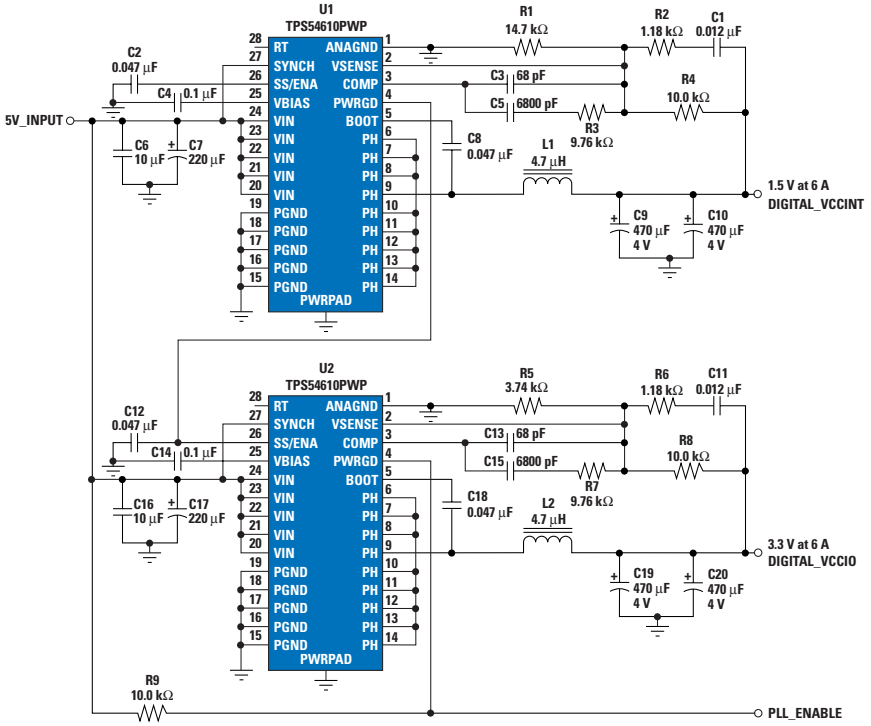
Highly Integrated TPS75003 Triple Supply Powering Spartan™-3



PTH05010 Modules Providing Fast Time-to-Market Power Solution for Virtex®-4



Two Highly Efficient TPS54610 6-A SWIFT™ DC/DC Converters Powering Stratix® II

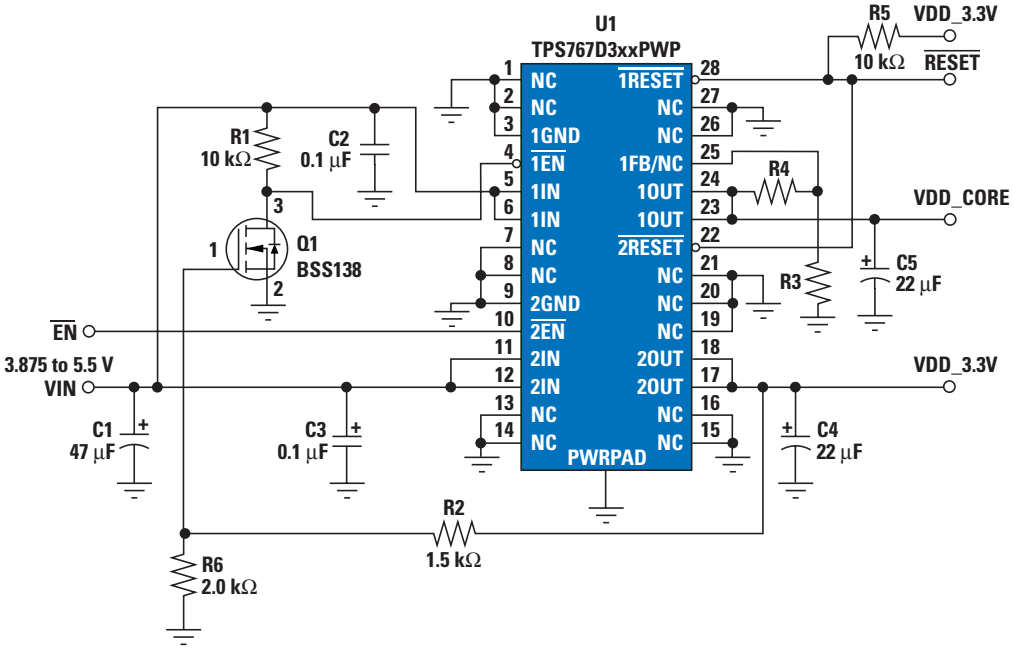


DSP Power Solutions

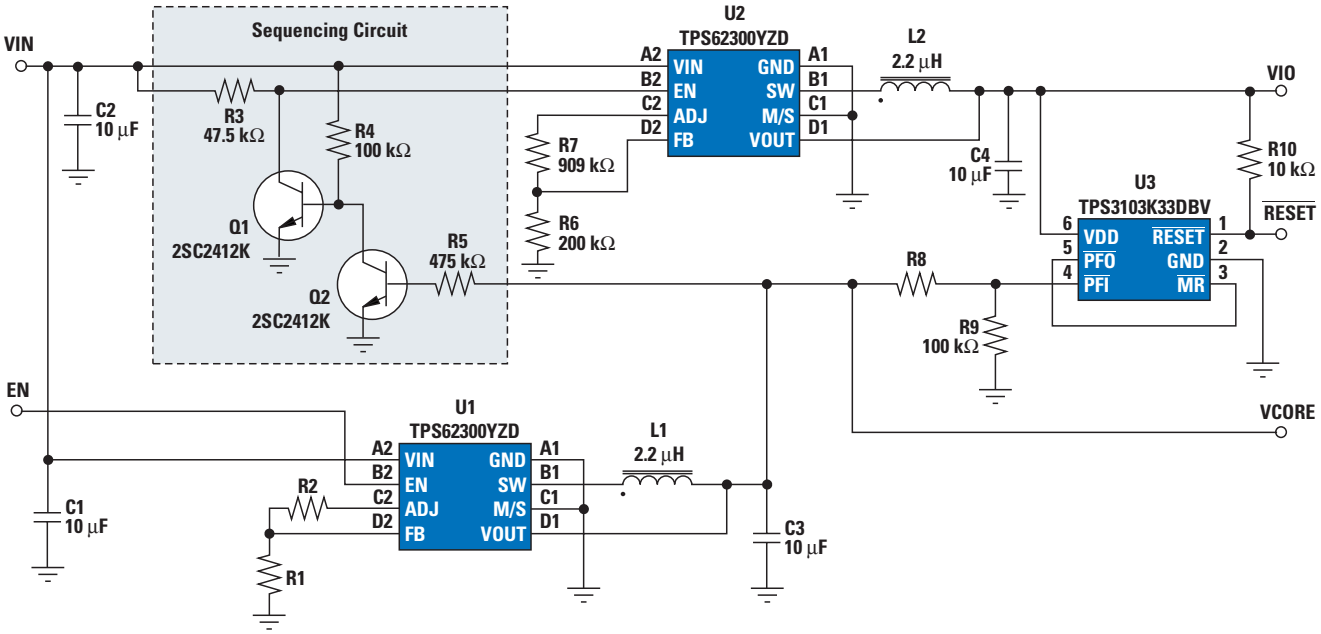
www.ti.com/dsppower

Access the site for one-stop DSP power management support, including free downloads of DSP power reference designs with complete schematics, bill-of-materials and helpful implementation notes.

Dual 1-A Linear Regulator with Integrated Supply Voltage Supervisors Powering TMS320F281x DSP



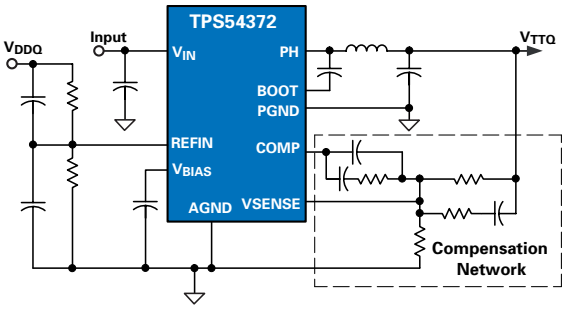
Two Highly Power- and Space-Efficient TPS62300 500-mA DC/DC Converters Powering TMS320VC5503/07/09A DSP



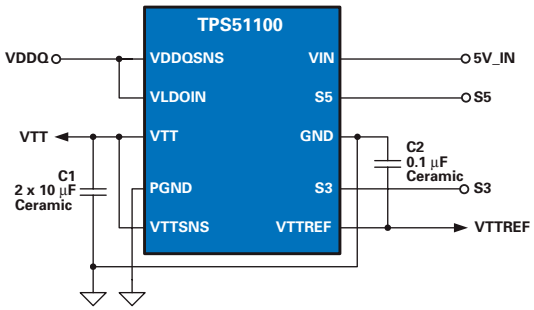
Active-Bus Termination Solutions (DDR/QDR/GTL/SSTL/HSTL)

TI offers a wide selection of active-bus termination solutions from LDOs and switching controllers to plug-in power. Typical application diagrams and product parameters are provided to aid product selection.

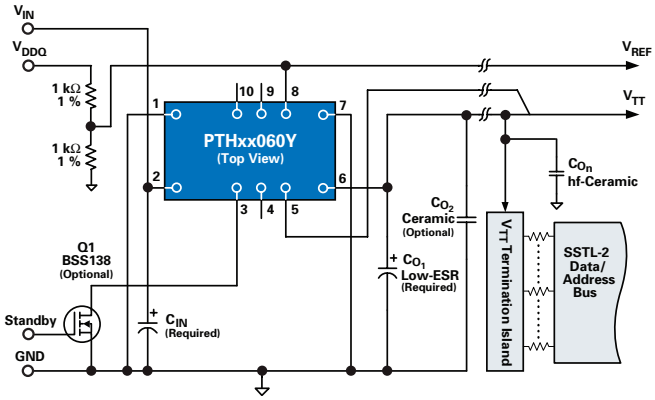
TPS54372: SWIFT™



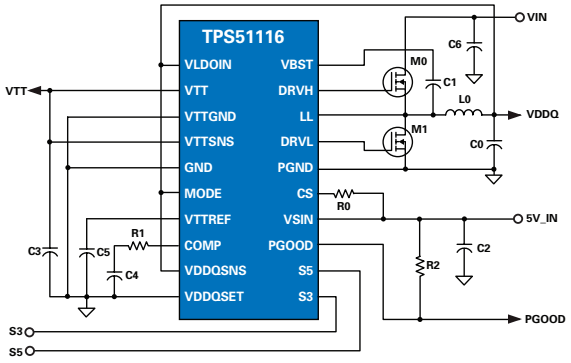
TPS51100: LDO



PTHxx060Y: Plug-In Power



TPS51116: Controller + LDO



Active-Bus Termination Solutions

Device	Input Bus Voltage (V)	I_{OUT} (A)	Isolated Outputs	V_O Range (V)	V_O Adjustable	Price*
Plug-In Power Modules						
PTH03010/50/60Y	3.3	6, 10, 15	No	0.55 to 1.8	Yes	13.95, 9.95, 11.50
PTH05010/50/60Y	5	6, 10, 15	No	0.55 to 1.8	Yes	13.95, 9.95, 11.50
PTH12010/50/60Y	12	6, 8, 12	No	0.55 to 1.8	Yes	13.95, 9.95, 11.50

Device	I_{OUT} (mA)	V_{IN} (V)	Adj. Out (V)	V_{OUT} Efficiency (%)	Switching Frequency (max) (kHz)	Package Pin Count HTSSOP	EVM	Price*
Converters (with Integrated FETs)								
TPS54372	3000	3.0 to 6.0	0.2 to 4.5	90	700	20	Yes	2.35
TPS54672	6000	3.0 to 6.0	0.2 to 4.5	90	700	28	Yes	3.35
TPS54872	8000	4.0 to 6.0	0.2 to 4.5	85	700	28	Yes	3.95
TPS54972	9000	3.0 to 4.0	0.2 to 4.5	90	700	28	Yes	4.20

Device	I_{OUT1} (V_{DDQ}) (A)	I_{OUT2} (V_{TT}) (A)	I_{OUT3} (Buf. V_{REF}) (mA)	V_{IN} (V)	V_{OUT1} (V_{DDQ}) Adj. (V)	V_{OUT2} (V_{TT}) Fixed (V)	V_{OUT3} (Buf. V_{REF}) Fixed (V)	Switching Frequency Selectable (kHz)	Light Load Eff. Mode	Control Scheme	Selectable Output Discharge	Package(s)	Price*
Controllers (with External FETs)													
TPS51020	>10 Switcher	>3 Switcher	3	4.5 to 28	2.5,1.8, Adj.	$V_{DDQ}/2$	$V_{DDQ}/2$	270, 360, 450	Yes	Voltage Mode	Yes	30 TSSOP	3.15
TPS51116	>10 Switcher	+3/–3 LDO	10	3 to 28	2.5,1.8, Adj.	$V_{DDQ}/2$	$V_{DDQ}/2$	400	Yes	D-CAP/ Current Mode	Yes	20 HTSSOP[1] 24 QFN[1]	1.20
Controller LDOs													
TPS51100	—	+3/–3 LDO	10	1.2 to 3.6[2]	—	$V_{DDQ}/2$	$V_{DDQ}/2$	—	—	—	Yes	10 MSOP[1]	0.80

[1] *PowerPAD™.* [2] *Requires separate 5-V supply.* **Suggested resale price in U.S. dollars in quantities of 1,000.*

TI's family of Fusion Digital Power™ products focuses on three areas: Digital Power Drivers (UCD7K), Digital Power PWM Controllers (UCD8K) and Full Digital Controllers (UCD9K). These products are power management specific and provide both isolated and non-isolated solutions from AC line to point-of-load, covering uninterruptible power supplies (UPS), server, telecom, datacom and VRM applications. The Fusion Digital Power ICs provide cost-effective solutions with greater levels of performance, reliability and flexibility than today's pure analog designs. For the most up-to-date information on digital power technology and product availability, go to **www.ti.com/digitalpower**

Key Benefits of Fusion Digital Power

- Greater flexibility and better time-to-market
- Enhanced performance of power supplies
- Enables system communications such as remote diagnostics
- Lowers system cost by lowering total component count

Other Benefits of Fusion Digital Power Solutions from TI

- Programmable
- Easy to use
- High precision
- Higher integration
- Common development platform
- Supports current and future topologies

Support

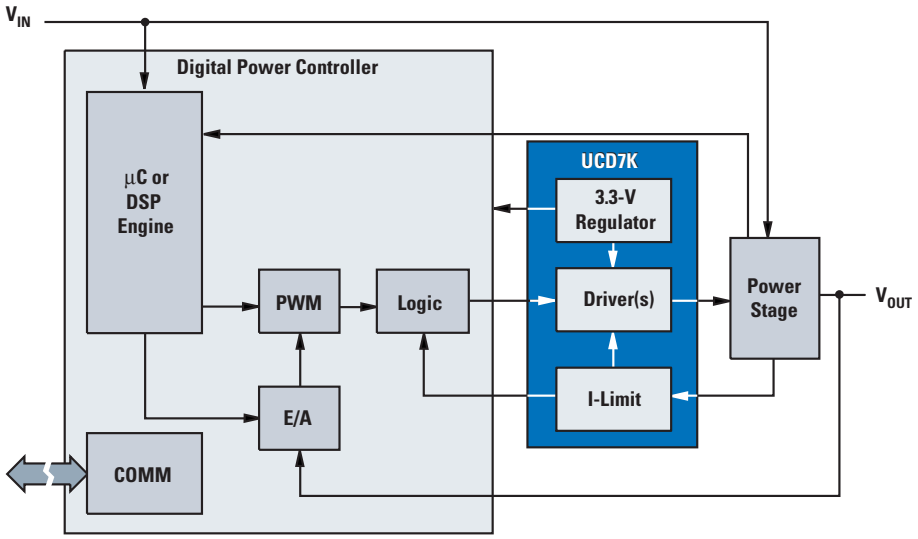
Digital control requires software support. The UCD95K and UCD91K Fusion Digital Power controllers are supported with Code Composer Studio™ IDE software. This is an integrated development environment that provides key development tools to reduce development time and effort. As part of TI's commitment to standards in the power electronics industry, PMBus™ tools are also part of our digital power customer support. Additionally, our reference designs are supported by graphical user interface (GUI) and source code examples to jump-start designs and evaluation of Fusion Digital Power products from TI.

Fusion Digital Power Control Drivers

UCD7K Family

The UCD7K drivers interface the digital controller to the power stage while providing protection for the power supply as well as bias for the digital controller.

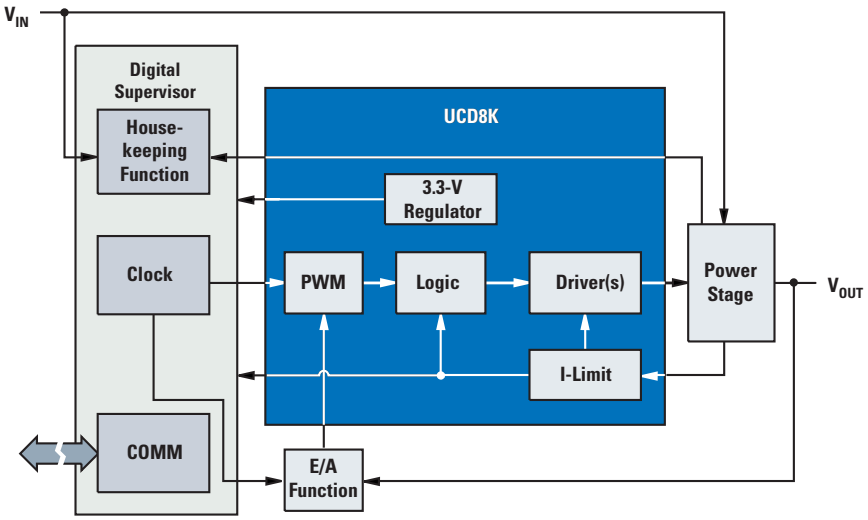
Key Features	Benefits
• High current gate drivers	• Interfaces to the power stage
• Programmable analog over-current limit with flag	• Fail-proof and flexible overload protection
• Onboard 3.3-V, 10-mA linear regulator	• Provides power to the digital controller



Fusion Digital Power PWM Controllers
UCD8K Family

The UCD8K controllers integrate PWM circuitry and a Fusion Digital Power control driver to close the feedback loop in the analog domain under digital supervision.

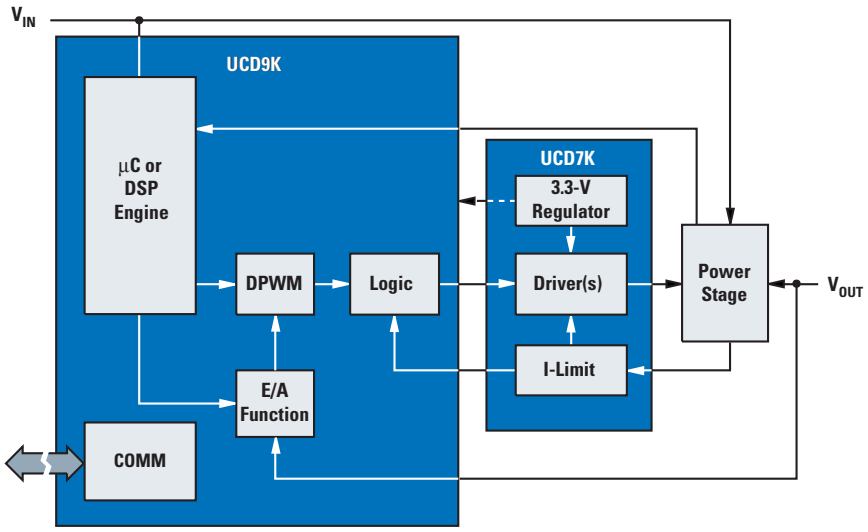
Key Features	Benefits
• Voltage mode or peak current mode control	• Provides flexibility of control methods
• Programmable over-current limit with flag	• Fail-proof and flexible overload protection
• Accepts clock input from the digital controller	• Digitally controls switching frequency and maximum duty cycle
• Onboard 3.3-V, 10-mA linear regulator	• Provides power to digital controller



Fusion Digital Power Controllers
UCD9K Family

The UCD9K devices provide full digital power management capabilities to close multiple feedback loops in the digital domain and the integrated resources for supervision, communication, configuration and monitoring.

Key Features	Benefits
• Digital PWM, up to 150-ps resolution	• No limit cycle at MHz switching frequencies
• ADC: Up to 12 bits resolution	• Accurate regulation and monitoring
• ADC: As fast as 50-ns conversion time	• Wide voltage loop bandwidth and fast transient response
• Flash memory: Up to 64 KW for program and data	• Allows for high complexity
• Multifunction I/O ports, up to 48	• Provides high flexibility
• PMBus™ compliant	• Hardware peripheral for standardized communication



Power Factor Correction (PFC)

Design Factors

Control Method

Average Current Mode (ACM) — Optimum control method to achieve PFC and low harmonic distortion.

Transition Mode — Simpler inexpensive control with high peak currents and filtering requirements.

ZVT Mode — A type of soft switching technique, which reduces EMI and allows for higher frequency operations.

Protection

- Soft-start (programmable) provides controlled start-up.
- Over-current protection (OCP) provides protection during overload conditions.
- Over-voltage protection (OVP) prevents output capacitor, switches and load from overcharge condition.

Performance

- Voltage feed-forward for linearized performance and faster transient response over wide line voltage range.
- Multiplier linearity and zero power detect functions improve light load operation.
- Onboard high output current drive capability without external MOSFET drivers.

Flexibility

- Ability to work with a wide line voltage range.
- Different levels of under-voltage lockout thresholds for self bias and auxiliary bias applications.
- Ability to synchronize controllers to eliminate noise issues.

Power Level

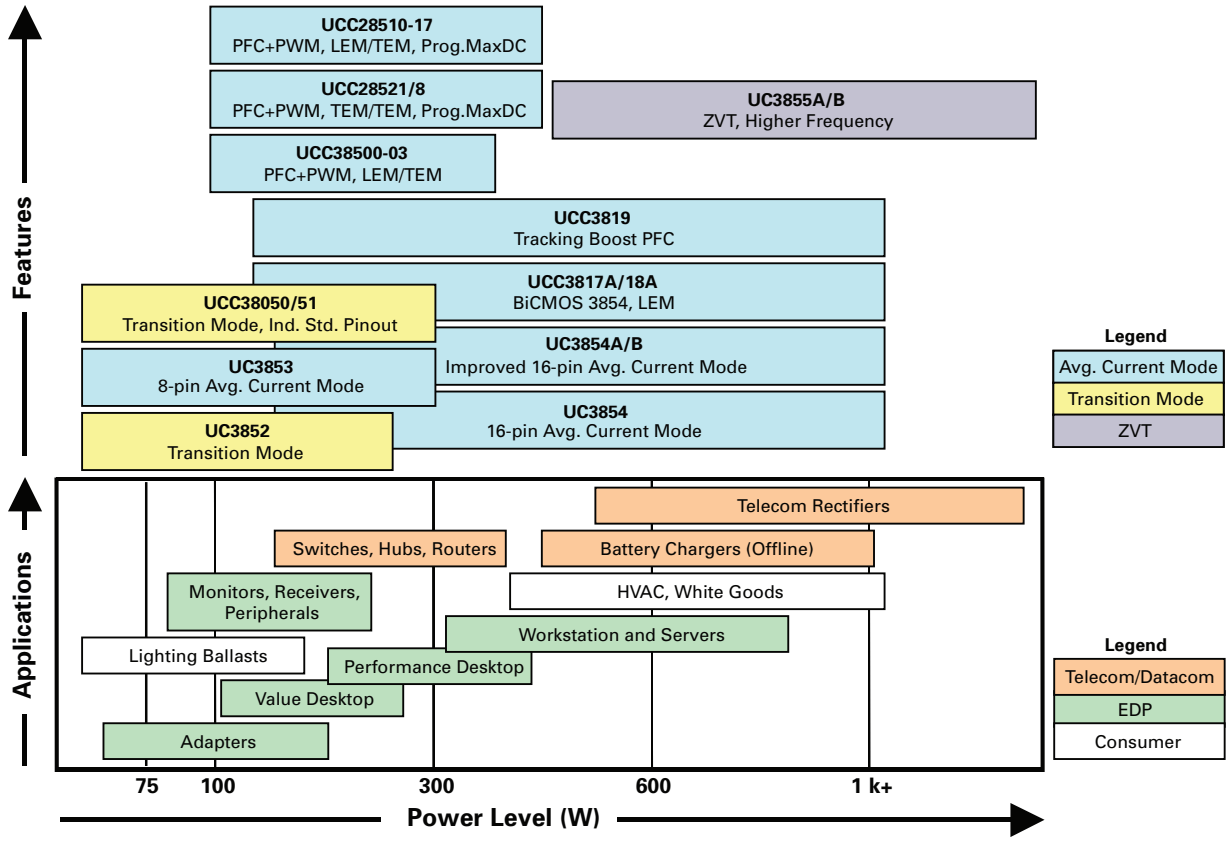
- IEC requirements are applicable to all power supplies above 150 W.
- Higher power converters may require ZCT/ZVT techniques to achieve high efficiencies.
- Some of the simpler control techniques not usable at high power levels.

Features

From 50 W to 5 kW, TI PFC controllers deliver EN61000-3-2 compliance.

- Industry standard architecture.
- Deliver PF > 0.993.
- New BiCMOS generation reduces complexity.
- Optimized PFC/PWM "combo" controllers.
- Superior applications support.

Power Factor Correction (PFC) Family of Products



Power Factor Correction (PFC)

Selection Guide

Device	Description	Control Method[1]	Typical Power Level	Soft Switching[2]	Max Frequency (kHz)	Start-Up Current (mA)	UVLO Thresholds (V)	PWM Prog. Max Duty Cycle	PWM Freq. Option	OVP	Price*
UC3852	Transition Mode PFC Controller	CRM	<150 W	—	Variable	1	16.3/11.5	—	—	—	1.70
UC3853/A	8-Pin PFC Controller	ACM	75 W to 300 W	—	125	0.25	11.5/9.5	—	—	✔	0.99
UC3854	PFC Controller	ACM	200 W to 2 kW+	—	200	1.5	16/10	—	—	—	1.15
UC3854A/B	Improved PFC Controller	ACM	200 W to 2 kW+	—	200	0.3	16/10 ('3854A) 10.5/10 ('3854B)	—	—	—	1.35
UC3855A/B	High Performance Soft Switching PFC Controller	ACM	400 W to 2 kW+	ZVT	500	0.15	16/10 ('3855A) 10.5/10 ('3855B)	—	—	✔	5.70
UCC38050/1	Transition Mode PFC Controller	CRM	50 W to 400 W	—	Variable	0.75	15.8/9.7 ('38050) 12.5/9.7 ('38051)	—	—	✔	0.70
UCC3817A/8A	BiCMOS PFC Controller	ACM	75 W to 2 kW+	—	400	0.1	16/10 ('3817A) 10.5/10 ('3818A)	—	—	✔	1.15
UCC3819A	Tracking Boost PFC Controller	ACM	75 W to 2 kW+	—	400	0.1	10.2/9.7	—	—	✔	1.15
UCC38500/1/2/3	PFC+PWM Combo Controller	ACM	75 W to 1 kW+	—	400	0.1	16/10 ('38500/2) 10.5/10 ('38501/3)	—	1x	✔	2.35
UCC28510/1/2/3	Advanced PFC+PWM Combo Controller	ACM	75 W to 1 kW+	—	600	0.1	16.6/9.3 ('28510/2) 10.2/9.7 ('28511/3)	✔[3]	1x	✔	1.80
UCC28514/5/6/7	Advanced PFC+PWM Combo Controller	ACM	75 W to 1 kW+	—	600	0.1	16.6/9.3 ('28514/6) 10.2/9.7 ('28515/7)	✔[3]	2x	✔	1.80
UCC28521/8	Advanced PWM/PFC Combo Controller with TEM/TEM Modulation	ACM	75 W to 1 kW+	—	600	0.1	10.2/9.7	✔[3] —	2x —	✔ —	1.80

[1] *CRM = critical conduction mode, ACM = average current mode.*
[2] *ZVT = zero voltage transition.*
[3] *Up to 90%.*
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
UCC28051EVM	100-W Offline AC/DC Voltage Converter with PFC	49
UCC28514EVM	100-W AC/DC Power Converter with PFC Regulating a 12-V DC Output	49
UCC28517EVM	100-W AC/DC Power Converter with PFC Regulating 2 DC Outputs	49
UCC28521EVM	350-W Two-phase Interleaved Power Factor Corrected Pre-regulator	99
UCC28528EVM	350-W Two-phase Interleaved Power Factor Corrected Pre-regulator	99
UCC38050EVM	110-W Universal Line Input PFC Boost Converter	49
UCC38500	UCC38500 Evaluation Module: 100-W, Universal Line to 12-V Regulated Output	49
UCC3817	UCC3817 Evaluation Module: 385-V, 250-W PFC Boost Converter	49

**Suggested resale price in U.S. dollars.*

Literature Number	Part Number	Description
Application Notes		
SLUA144	UC3854	UC3854 Controlled Power Factor Correction Circuit Design
SLVC018.ZIP	UCC38050	MathCAD Application Design Tool for Use with the UCC38050
SLUU138	UCC38050	100-W Critical Conduction Power Factor Corrected Preregulator
SLUA308	UCC3817	UCC3817 Current Sense Transformer Evaluation
SLUA296	UCCX8510-17	A New Synchronization Circuit for Power Converters
SLUA294	UCC3817A/18A/19A	Differences between UCC3817A/18A/19A and UCC3817/18/19
SLUA269	UCC3819	UCC3819 250-W PFC Boost Follower Preregulator Design
SLUA245	UCC3817	Synchronizing a PFC Controller from a Downstream Controller Gate Drive
SLUA196	UC3854A/B, UC3855A/B	UC3854A/B and UC3855A/B Provide Power Limiting with Sinusoidal Input Current for PFC Front Ends
SLUA177	UC3854A/B	UC3854A and UC3854B Advanced Power Factor Correction Control ICs
SEM1500	UCC28510	Designing High Power Factor Off-Line Power Supplies
SEM700	UC3854	Optimizing the Design of High Power Factor Switching Preregulator
SLYT097	UCC28517	100-W PFC Power Converter with 12-V, 8-W Bias Supply (Part 1)
SLYT092	UCC28517	100-W PFC Power Converter with 12-V, 8-W Bias Supply (Part 2)

PWM Power Supply Controllers

Single-Ended Topologies

Control Method

Voltage Mode — Simple, low-noise control method for wide input and output range requirements.

Current Mode — Fast transient response with built-in current limiting.

Level of Integration

- Integrated soft-start (programmable) provides predictable start-up.
- Internal leading edge blanking to suppress switching spike from MOSFET turn-on.

Performance

- Many voltage mode controllers have input voltage feedforward for instantaneous response to input line changes.
- Most controllers have onboard high current drive capability without external MOSFET drivers.
- Lower start-up current for offline applications (for BiCMOS products with UCC prefix).
- Low operating current (for BiCMOS products with UCC prefix) for light-load efficiency.
- Programmable minimum duty cycle clamp for light-load efficiency (UCC3581).

Features

- 10-W to 350-W offline and DC/DC power supplies.
- Single-ended topology power supplies, buck, boost, flyback and forward.

Double-Ended Topologies

Current Mode — Control technique featuring fast transient response with inherent cycle-by-cycle current limiting.

Voltage Mode — Versatile, low-noise control method for wide duty cycle ranges.

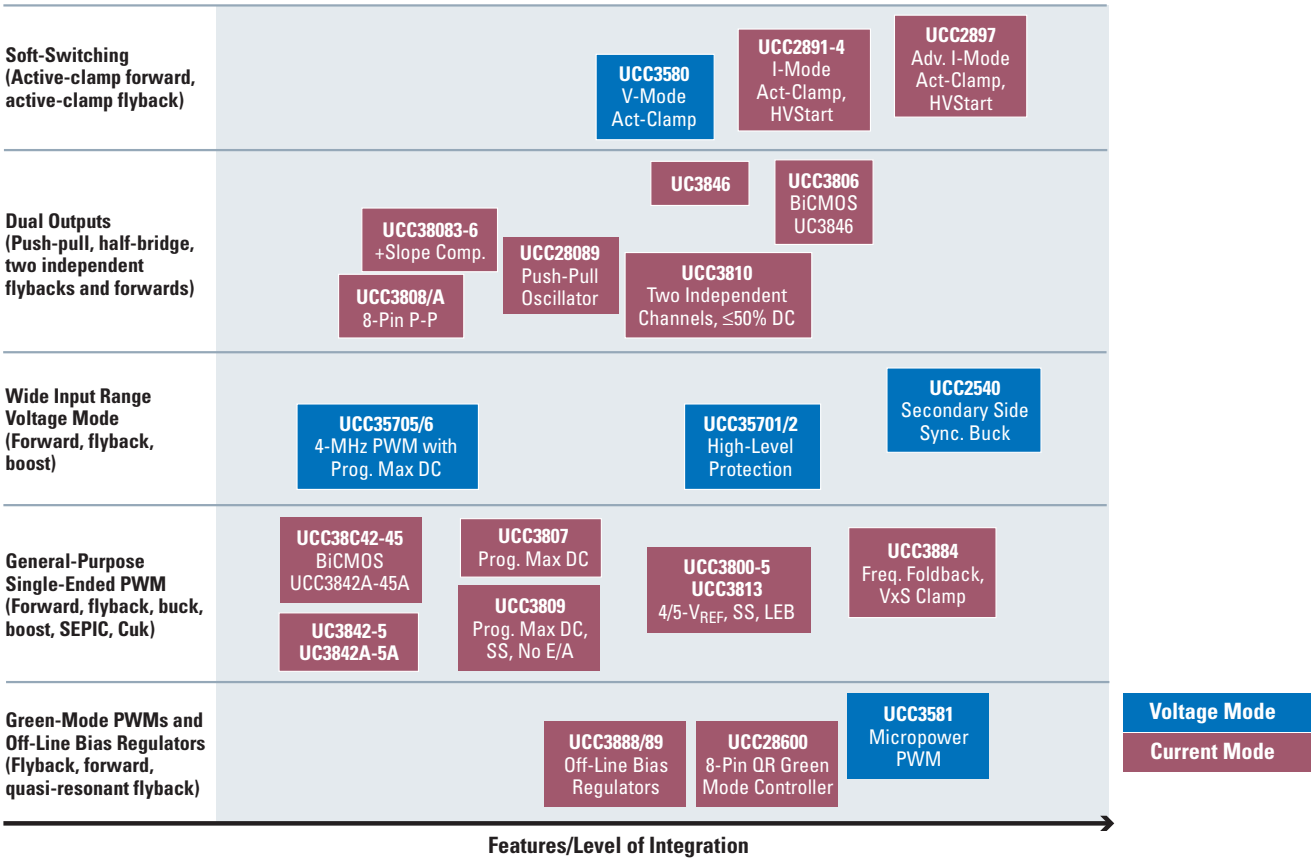
Soft Switching

- Zero Voltage Transition (ZVT) soft switching techniques minimize power loss at turn-on.
- Phase shifted, ZVT controllers maximize efficiency in full-bridge converters.

Protection

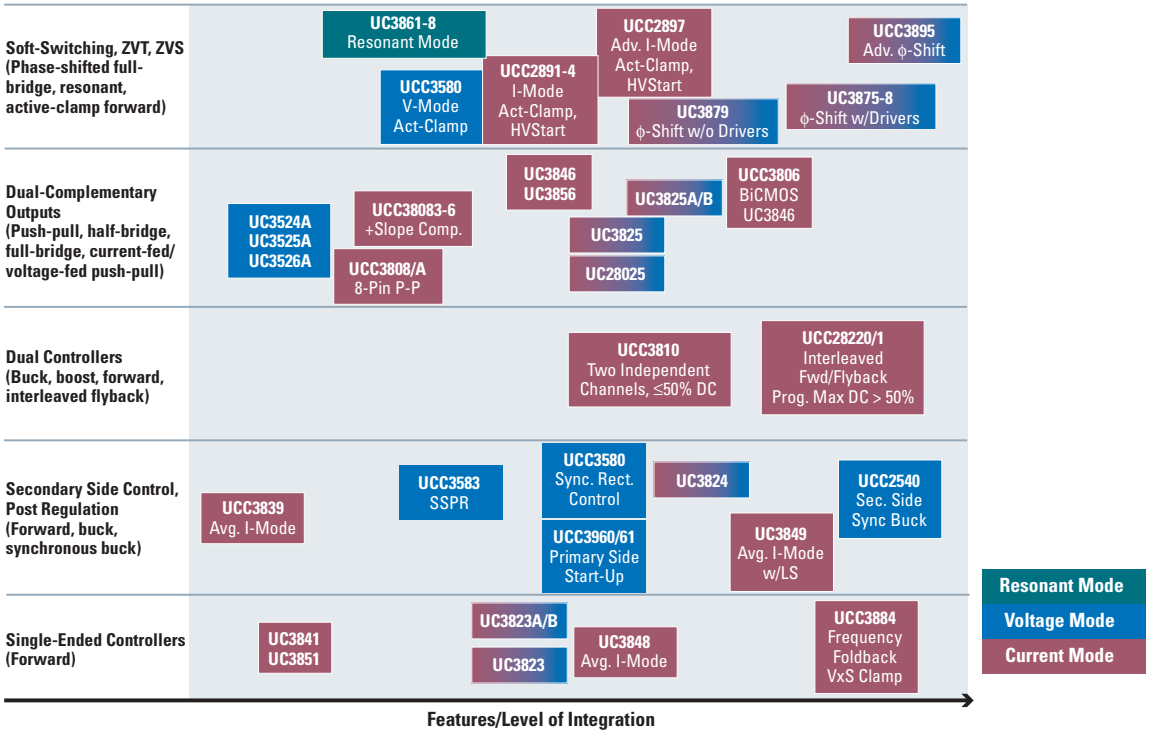
- Flexible over-current limiting circuitry provides programmable fault protection modes.
- Programmable soft-start executes predictable start-up on initialization and after faults.
- High speed, cycle-by-cycle current limiting.
- Maximum duty cycle clamp to prevent transformer saturation.
- Programmable deadtime control to prevent cross conduction of power switches.

Low- to Medium-Power PWM Controllers (25 W – 350 W)



PWM Power Supply Controllers

Medium- to High-Power PWM Controllers (>300 W)



Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
UCC2540EVM-054	Secondary Side Post Regulator Evaluation Module with the UCC38083	49
UCC28221EVM	A 200-W Power Converter Using Two-Channel Interleaved Forward Converter Topology	49
UCC2891EVM	48-V to 3.3-V Forward Converter with Active Clamp Reset Using the UCC2891	49
UCC35705EVM	48-V to 3.3-V RCD Forward with the UCC35705	49
UCC3895EVM-001	UCC3895EVM Configuring for Direct Control Driven Synchronous Rectifier Applications	99
UCC3809EVM	10-W Flyback Converter Utilizing the UCC3809	49
UCC3889EVM	A Dual-Output, Non-Isolated Off-Line Power Supply Highlighting the UCC3889 and TPS77401	49

**Suggested resale price in U.S. dollars.*

Literature Number	Description
Application Notes	
SLUA149	UCC3800/1/2/3/4/5 BiCMOS Current Mode Control ICs
SLUA303	Designing for High Efficiency with the Active Clamp UCC2891 PWM Controller
SLUA276	25-W Forward Converter Design Review
SLUA213	Comparing the UC3842, UCC3802, and UCC3809 Primary Side PWM Controllers
SLUA246	A Comparison Between the BiCMOS UCC3895 Phase Shift Controller and the UC3875
SLUA257	The UCC38C42 Family of High-Speed, BiCMOS Current-Mode PWM Controllers
SLUA286	Low Voltage Feedback in PWM Applications
SLUA287	Control Driven Synchronous Rectifiers in Phase Shifted Full Bridge Converters
SLUA322	Active Clamp Transformer Reset: High Side or Low Side?
Reference Designs	
SLUU135A	UCC38083 50-W Push-Pull Converter
SLUA276	UCC38C42 25-W Forward Converter
SLUA274	UCC38C44 12-V Isolated Bias Supply
SLUA275	UCC3895 OUTC/OUTD Asymmetric Duty Cycle Operation
SLUU192A	48-V to 3.3-V Forward Converter with Active Clamp Reset Using the UCC2897 PWM Controller
SLUA303	Designing with the UCC2891 Active Clamp Controller
SLUU178	Using the UCC2891 Active Clamp and Reset PWM

PWM Power Supply Controllers

Selection Guide

(Device parameters continued on next page)

Device	Typical Power Level (W)	Control Method: Voltage Mode	Control Method: Current Mode	Control Method: Avg. Current Mode	Topologies: Buck	Boost	Flyback (SEPIC, Cuk)	Fwd (Including 2-Switch Fwd)	Forward (D > 50%)	Interleaved Fwd/Flyback/Boost	Act-Clamp Fwd/Flyback	Push-Pull	I-Fed/V-Fed Push-Pull	Half-Bridge	Full-Bridge	Φ-Shifted FB	Maximum Practical Frequency	Start-Up Current	Operating Current	Supply Voltage (V)	110-V Start-Up Circuit	UVLO: On/Off (V)
Green Mode Controllers and Offline Bias Regulators																						
UCC3581	10 to 200	✔			✔	✔	✔		✔								100 kHz	85 µA	300 µA	6.8 to 15	—	7.3/6.8
UCC28600	50 to 150		✔				✔							✔		✔	130 kHz	25 µA	50 mA	30	—	13/8
UCC3888/89	<10	✔					✔										250 kHz	150 µA	1.2 mA	9	—	8.4/6.3
General-Purpose Single-Ended Controllers																						
TL3842	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.5 mA	11 mA	10 to 30	—	16/10
TL3843	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.5 mA	11 mA	7.6 to 30	—	8.4/7.6
TL3844	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.5 mA	11 mA	10 to 30	—	16/10
TL3845	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.5 mA	11 mA	7.6 to 30	—	8.4/7.6
UC28023	50 to 750	✔	✔		✔	✔	✔		✔								1 MHz	1.1 mA	22 mA	9 to 30	—	9.2/8.4
UC3823	50 to 750	✔	✔		✔	✔	✔		✔								1 MHz	1.1 mA	22 mA	9 to 30	—	9.2/8.4
UC3823A/B	50 to 750	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	28 mA	9 to 22	—	9.2/8.416/10
UC3842	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.5 mA	11 mA	10 to 30	—	16.0/10.0
UC3842A	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.3 mA	11 mA	10 to 30	—	16.0/10.0
UC3843	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.5 mA	11 mA	7.6 to 30	—	8.4/7.6
UC3843A	30 to 350	✔	✔		✔	✔	✔		✔								500 kHz	0.3 mA	11 mA	7.9 to 30	—	8.5/7.9
UC3844	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.5 mA	11 mA	10 to 30	—	16.0/10.0
UC3844A	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.3 mA	11 mA	10 to 30	—	16.0/10.0
UC3845	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.5 mA	11 mA	7.6 to 30	—	8.4/7.6
UC3845A	30 to 350	✔	✔		✔	✔	✔	✔									500 kHz	0.3 mA	11 mA	7.9 to 30	—	8.5/7.9
UC3849	50 to 250			✔				✔	✔								1 MHz	—	21 mA	8.4 to 20	—	8.4/8
UCC35705	25 to 250	✔				✔	✔		✔								4 MHz	50 µA	2.5 mA	8.2 to 15	—	8.8/8.2
UCC35706	25 to 250	✔				✔	✔	✔									4 MHz	50 µA	2.5 mA	8.0 to 15	—	12/8
UCC3800	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	7.2 to 15	—	7.2/6.9
UCC3801	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	9.4 to 15	—	9.4/7.4
UCC3802	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	12.5 to 15	—	12.5/8.3
UCC3803	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	4.1 to 15	—	4.1/3.6
UCC3804	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	12.5 to 15	—	12.5/8.3
UCC3805	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	4.1 to 15	—	4.1/3.6
UCC3807-1	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	1.3 mA	6.9 to 15	—	7.2/6.9
UCC3807-2	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	1.3 mA	8.3 to 15	—	12.5/8.3
UCC3807-3	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	1.3 mA	4.1 to 15	—	4.3/4.1
UCC3809-1	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	50 µA	500 µA	8 to 19	—	10.0/8.0
UCC3809-2	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	50 µA	500 µA	8 to 19	—	15.0/8.0
UCC3813-0	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	7.2 to 15	—	7.2/6.9
UCC3813-1	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	9.4 to 15	—	9.4/7.4
UCC3813-2	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	12.5 to 15	—	12.5/8.3
UCC3813-3	10 to 200	✔	✔		✔	✔	✔		✔								1 MHz	100 µA	500 µA	4.1 to 15	—	4.1/3.6
UCC3813-4	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	12.5 to 15	—	12.5/8.3
UCC3813-5	10 to 200	✔	✔		✔	✔	✔	✔									1 MHz	100 µA	500 µA	4.1 to 15	—	4.1/3.6
UCC3884	50 to 250	✔	✔		✔	✔	✔		✔								1 MHz	200 µA	5 mA	8.9 to 15	—	8.9/8.3
UCC38C40	10 to 250	✔	✔		✔	✔	✔		✔								1 MHz	50 µA	2.3 mA	6.6 to 20	—	7.0/6.6
UCC38C41	10 to 250	✔	✔		✔	✔	✔	✔									1 MHz	50 µA	2.3 mA	6.6 to 20	—	7.0/6.6
UCC38C42	10 to 250	✔	✔		✔	✔	✔		✔								1 MHz	50 µA	2.3 mA	9 to 20	—	14.5/9
UCC38C43	10 to 250	✔	✔		✔	✔	✔		✔								1 MHz	50 µA	2.3 mA	7.6 to 20	—	8.4/7.6

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

*Preview devices are listed in **bold blue**.*

PWM Power Supply Controllers

(Device parameters continued from previous page)

Device	V_{REF} (V)	V_{REF} Tol. (%)	Max Duty Cycle (%)	Soft Start	E/A	Shut-down Pin	Voltage Feed-forward	Output Drive (Sink/Source) (A)	Slope Comp	Sync Pin	Leading Edge Blanking	Available Packages									Price*
												MSOP	SSOP	TSSOP	HTSSOP-PowerPAD™	SOIC	SOIC-W (300 mil)	SOIC-W Power	PLCC	DIL (PDIP)	
Green Mode Controllers and Offline Bias Regulators																					
UCC3581	4	1.5	Prog.	✔	—	✔	—	1/1	—	✔	—					14				14	1.00
UCC28600	—	—	—	✔	—	—	—	1/–0.75	—	—	—					8					0.49
UCC3888/89	2.5	3	5.5	✔	—	—	✔	0.2/0.15	—	—	—						8			8	0.59
General-Purpose Single-Ended Controllers																					
TL3842	5	2	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.40
TL3843	5	2	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.40
TL3844	5	2	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.40
TL3845	5	2	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.40
UC28023	5.1	1	Prog.	✔	✔	—	—	1.5/1.5	—	✔	—						16			16	1.35
UC3823	5.1	1	Prog.	✔	✔	—	✔	1.5/1.5	—	✔	—						16		20	16	1.60
UC3823A/B	5.1	1	Prog.	✔	✔	—	✔	2/2	—	✔	—						16		20	16	4.90
UC3842	5	1.5	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3842A	5	1.5	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3843	5	1.5	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3843A	5	1.5	100	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3844	5	1.5	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3844A	5	1.5	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3845	5	1.5	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3845A	5	1.5	50	—	✔	—	—	1/1	—	—	—					8/14				8	0.80
UC3849	5	2	Prog	✔	✔	—	—	0.3/0.3	—	—	✔						24		28	24	3.05
UCC35705	—	—	93	—	—	—	✔	0.1/0.1	N/A	—	—	8				8				8	0.75
UCC35706	—	—	93	—	—	—	✔	0.1/0.1	N/A	—	—	8				8				8	0.75
UCC3800	5	1.5	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3801	5	1.5	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3802	5	1.5	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3803	4	1.5	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3804	5	1.5	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3805	4	1.5	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	1.35
UCC3807-1	2 (Int)	—	Prog.	✔	✔	—	—	1/1	—	—	100 ns					8				8	1.50
UCC3807-2	2 (Int)	—	Prog.	✔	✔	—	—	1/1	—	—	100 ns					8				8	1.50
UCC3807-3	2 (Int)	—	Prog.	✔	✔	—	—	1/1	—	—	100 ns					8				8	1.50
UCC3809-1	5	5	90	✔	—	✔	—	0.8/0.4	—	—	—	8		8		8				8	0.85
UCC3809-2	5	5	90	✔	—	✔	—	0.8/0.4	—	—	—	8		8		8				8	0.85
UCC3813-0	5	2	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3813-1	5	2	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3813-2	5	2	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3813-3	4	2	100	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3813-4	5	2	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3813-5	4	2	50	✔	✔	—	—	1/1	—	—	100 ns			8		8				8	0.80
UCC3884	5	2.5	100	✔	✔	—	✔	1/0.5	—	—	—					16				16	1.60
UCC38C40	5	2	100	—	✔	—	—	1/1	—	—	—	8				8				8	0.95
UCC38C41	5	2	50	—	✔	—	—	1/1	—	—	—	8				8				8	0.95
UCC38C42	5	2	100	—	✔	—	—	1/1	—	—	—	8				8				8	0.95
UCC38C43	5	2	100	—	✔	—	—	1/1	—	—	—	8				8				8	0.95

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

*Preview devices are listed in **bold blue**.*

PWM Power Supply Controllers

Selection Guide (Continued)

(Device parameters continued on next page)

Device	Typical Power Level (W)	Control Method			Topologies												Maximum Practical Frequency	Start-Up Current	Operating Current	Supply Voltage (V)	110-V Start-Up Circuit	UVLO: On/Off (V)
		Voltage Mode	Current Mode	Avg. Current Mode	Buck	Boost	Flyback (SEPIC, Cuk)	Fwd (Including 2-Switch Fwd)	Forward (D > 50%)	Interleaved Fwd/Flyback/Boost	Act-Clamp Fwd/Flyback	Push-Pull	I-Fed/V-Fed Push-Pull	Half-Bridge	Full-Bridge	Φ-Shifted FB						
General-Purpose Single-Ended Controllers (Continued)																						
UCC38C44	10 to 250	✔	✔		✔	✔	✔	✔									1 MHz	50 µA	2.3 mA	9 to 20	—	14.5/9
UCC38C45	10 to 250	✔	✔		✔	✔	✔	✔									1 MHz	50 µA	2.3 mA	7.6 to 20	—	8.4/7.6
Wide-Input Range Voltage Mode Controllers																						
UCC3570	25 to 250	✔					✔	✔	✔								500 kHz	85 µA	1 mA	9.0 to 15	—	13.0/9
UCC35701	25 to 250	✔					✔	✔	✔								700 kHz	130 µA	750 µA	9.0 to 15	—	13.0/9
UCC35702	25 to 250	✔					✔	✔	✔								700 kHz	130 µA	750 µA	8.8 to 15	—	9.6/8.8
UCC35705	25 to 250	✔				✔	✔	✔	✔								4 MHz	50 µA	2.5 mA	8.2 to 15	—	8.8/8.2
UCC35706	25 to 250	✔				✔	✔	✔	✔								4 MHz	50 µA	2.5 mA	8.0 to 15	—	12/8
Dual Output Controllers																						
TL494	50 to 500	✔			✔	✔	✔	✔	✔	✔		✔		✔	✔		300 kHz	—	7.5 mA	7 to 40	—	—
TL594	50 to 500	✔			✔	✔	✔	✔	✔	✔		✔		✔	✔		300 kHz	—	12.4 mA	7 to 40	—	6.1/6
TL598	50 to 500	✔			✔	✔	✔	✔	✔	✔		✔		✔	✔		300 kHz	—	15 mA	7 to 40	—	6.1/6
SG3524	50 to 500	✔										✔		✔	✔		450 kHz	—	—	8 to 40	—	—
UC28025	50 to 750	✔	✔									✔		✔	✔		1 MHz	1.1 mA	22 mA	9 to 30	—	9.2/8.4
UC3524	50 to 500	✔										✔		✔	✔		250 kHz	—	—	8 to 40	—	—
UC3524A	50 to 500	✔										✔		✔	✔		250 kHz	4 mA	5 mA	8 to 40	—	7.5/7
UC3525A/B	50 to 500	✔										✔		✔	✔		250 kHz	—	14 mA	8 to 40	—	7.0/7.0
UC3526A	50 to 500	✔										✔		✔	✔		250 kHz	—	14 mA	8 to 35	—	—
UC3825	50 to 750	✔	✔									✔		✔	✔		1 MHz	1.1 mA	22 mA	9 to 30	—	9.2/8.4
UC3825A/B	50 to 750	✔	✔									✔		✔	✔		1 MHz	100 µA	28 mA	9 to 22	—	16/109.2/8.4
UC3827-1/-2	50 to 500		✔										✔				450 kHz	1000 µA	32 mA	8.4 to 20	—	9/8.4
UC3846	50 to 750	✔	✔									✔		✔	✔		500 kHz	1.5 mA	17 mA	8 to 40	—	7.7/7
UC3856	50 to 750	✔	✔									✔		✔	✔		1 MHz	1.5 mA	17 mA	8 to 40	—	7.7/7
UCC28089	25 to 250									✔		✔		✔	✔		500 kHz	130 µA	1.4 mA	8 to 15	—	10.5/8.0
UCC28220	50 to 800		✔							✔							1 MHz/ch.	200 µA	3 mA	8 to 14.5	—	10/8
UCC28221	50 to 800		✔							✔							1 MHz/ch.	500 µA	3 mA	8 to 14.5	✔	13/8
UCC3806	50 to 750	✔	✔									✔		✔	✔		350 kHz	100 µA	1.4 mA	7 to 15	—	7.5/6.7
UCC3808-1/-2/A-1/A-2	50 to 500		✔									✔		✔	✔		1 MHz	130 µA	1 mA	4.3 to 15	—	12.5/8.34.3/4.1
UCC38083/4/5/6	50 to 500		✔									✔		✔	✔		1 MHz	130 µA	20 mA	8.3 to 15	—	12.5/8.3
UCC3810	50 to 500	✔	✔		✔	✔	✔	✔		✔							1 MHz	150 µA	2 mA	8.3 to 11	—	11.3/8.3
Soft-Switching, ZVT and ZVS Controllers																						
UC3875-8	200 W to 2 kW	✔	✔	✔							✔					✔	1+ MHz	150 µA	45 mA	10.7 to 20	—	10.7/9.315/9
UC3879	200 W to 2 kW	✔	✔													✔	500 kHz	150 µA	27 mA	11 to 20	—	15.2/910.7/9
UCC2891/2/3/4	75 to 600		✔						✔		✔						1 MHz	300 µA	2 mA	8.5 to 14.5	✔[1]	13/8.0
UCC2897	75 to 600		✔						✔		✔						1 MHz	300 µA	2 mA	8.5 to 14.5	✔	13/8.0
UCC3580-1/-2/-3/-4	50 to 500	✔							✔		✔						500 kHz	100 µA	1.5 mA	7 to 15	—	15/8.5,9.8/5
UCC3895	200 W to 2 kW	✔	✔	✔												✔	1 MHz	150 µA	5 mA	11 to 17	—	11/ 9
Secondary-Side, Post Regulation																						
UC3824	50 to 250	✔	✔														1 MHz	1.1 mA	22 mA	9 to 30	—	9.2/8.4
UCC2540	50 to 500	✔			✔												1000 kHz	—	12 mA	2.8 to 36	—	—
UCC3580-1/-2/-3/-4	50 to 500	✔									✔						500 kHz	100 µA	1.5 mA	7 to 15	—	15/8.5,9.8/5
UCC3583	50 to 500																500 kHz	100 µA	3 mA	8.5 to 15	—	9/8.4
UCC3960	25 to 250	✔			✔	✔	✔	✔									400 kHz	150 µA	2.3 mA	8.0 to 19	—	9.5/10.5
UCC3961	25 to 250	✔			✔	✔	✔	✔									400 kHz	150 µA	2.3 mA	8.0 to 19	—	9.5/10.5

[1] *UCC2891 and UCC2893.*

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

PWM Power Supply Controllers

(Device parameters continued from previous page)

Device	V_{REF} (V)	V_{REF} Tol. (%)	Max Duty Cycle (%)	Soft Start	E/A	Shut-down Pin	Voltage Feed-forward	Output Drive (Sink/Source) (A)	Slope Comp	Sync Pin	Leading Edge Blanking	Available Packages									Price*
												MSOP	SSOP	TSSOP	HTSSOP-PowerPAD™	SOIC	SOIC-W (300 mil)	SOIC-W Power	PLCC	DIL (PDIP)	
General-Purpose Single-Ended Controllers (Continued)																					
UCC38C44	5	2	50	—	✔	—	—	1/1	—	—	—	8				8				8	0.95
UCC38C45	5	2	50	—	✔	—	—	1/1	—	—	—	8				8				8	0.95
Wide-Input Range Voltage Mode Controllers																					
UCC3570	5	2	Prog.	✔	—	✔	✔	1.2/1.2	N/A	—	N/A					14				14	3.45
UCC35701	5	1.5	VS Clamp	✔	—	✔	✔	1.2/1.2	N/A	✔	N/A			14		14				14	2.95
UCC35702	5	1.5	VS Clamp	✔	—	✔	✔	1.2/1.2	N/A	✔	N/A			14		14				14	2.95
UCC35705	—	—	93	—	—	—	✔	0.1/0.1	N/A	—	N/A	8				8				8	0.75
UCC35706	—	—	93	—	—	—	✔	0.1/0.1	N/A	—	N/A	8				8				8	0.75
Dual Output Controllers																					
TL494	5	5	45	—	✔	—	—	0.2/0.2	N/A	✔	—			16		16				16	0.23
TL594	5	1	45	—	✔	—	—	0.2/0.2	N/A	✔	—			16		16				16	0.38
TL598	5	1	45	—	✔	—	—	0.2/0.2	N/A	✔	—					16				16	0.81
SG3524	5	4	45	—	✔	✔	—	0.1/0.1	N/A	✔	—					16				16	0.50
UC28025	5.1	1	Prog.	✔	✔	—	—	1.5/1.5	—	✔	—						16			16	1.35
UC3524	5	4	45	—	✔	✔	—	0.1/0.1	N/A	✔	—					16				16	0.85
UC3524A	5	2	Prog.	✔	✔	✔	—	0.2/0.2	—	✔	—					16				16	1.70
UC3525A/B	5	2	Prog.	✔	✔	✔	—	0.2/0.2	—	✔	—					16			20	16	1.05
UC3526A	5.1	1.3	Prog.	✔	✔	✔	—	0.2/0.2	—	✔	—					16			20	16	1.05
UC3825	5.1	1	Prog.	✔	✔	—	—	1.5/1.5	—	✔	—						16		20	16	1.60
UC3825A/B	5.1	1.5	Prog.	✔	✔	—	—	2/2	—	✔	—						16		20	16	2.65
UC3827-1/-2	5	4	—	✔	✔	—	—	1/0.8	—	✔	—						24		28	24	3.50
UC3846	5	2	Prog.	✔	✔	—	—	0.5/0.5	—	✔	—						16		20	16	1.60
UC3856	5	2	Prog.	✔	✔	—	—	0.5/0.5	—	✔	—						16		20	16	1.70
UCC28089	—	—	50	✔	—	—	—	0.5/1.0	—	✔	—					8					0.65
UCC28220	3.3	4.5	Prog.	✔	—	—	—	0.01/0.01	Prog.	—	—			16		16					1.60
UCC28221	3.3	4.5	Prog.	✔	—	—	—	0.01/0.01	Prog.	—	—			20		16					1.65
UCC3806	5.1	3	Prog.	✔	✔	✔	—	0.5/0.5	—	✔	—		16	16		16	16		20	16	4.10
UCC3808-1/-2/A-1/A-2	—	—	Prog.	✔	✔	—	—	1.0/0.5	—	✔	—			8		8				8	1.30
UCC38083/4/5/6	5	2	50	✔	—	—	—	1.0/0.5	Prog.	—	—			8		8				8	1.10
UCC3810	5	2	50	—	✔	✔	—	1/1	—	✔	—					16				16	1.85
Soft-Switching, ZVT and ZVS Controllers																					
UC3875-8	5	2	Prog.	✔	✔	—	—	Four @ 2/2	—	✔	—							20	28	20	4.85
UC3879	5	2.5	Prog.	✔	✔	—	—	Four @ 0.1/0.1	—	✔	—						20		28	20	3.70
UCC2891/2/3/4	5	1	Prog.	✔	—	✔	—	2/2, 2/2	Prog.	✔	—			16		16					1.50
UCC2897	5	1	Prog.	✔	—	✔	—	2/2, 2/2	Prog.	✔	—			20		16					1.50
UCC3580-1/-2/-3/-4	5	1	Prog.	✔	✔	✔	✔	0.5/1, 0.3/0.3	—	—	—					16				16	2.40
UCC3895	5	3	Prog.	✔	✔	✔	—	Four @ 0.1/0.1	—	✔	—						20		20	20	4.35
Secondary-Side, Post Regulation																					
UC3824	5.1	1	Prog.	✔	✔	—	—	1.5/1.5	—	✔	—						16			16	4.55
UCC2540	3.3	0.6	100	✔	✔	—	—	3/3	—	✔	—				20						1.85
UCC3580-1/-2/-3/-4	5	1	Prog.	✔	✔	✔	✔	0.5/1, 0.3/0.3	—	—	—					16				16	1.90
UCC3583	5	1.5	9.5	✔	✔	—	—	0.5/1.5	—	✔	—					14			20	14	1.75
UCC3960	—	—	72	✔	—	—	—	0.75/1.5	—	—	—					8				8	0.95
UCC3961	—	—	72	✔	—	—	—	0.75/1.5	—	—	—					14				14	1.05

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

MOSFET Drivers

Design Factors

Supply Voltage Range — With internal voltage regulators, MOSFET drivers can operate over a wide input voltage range, making them flexible for many applications.

Number of Outputs — Single and dual drivers are available to complement DC/DC switching and motor control applications.

Output Configuration — Inverting, non-inverting, AND and NAND configurations are available.

TrueDrive™ Output Stage —- Used in TI high-current gate drivers and controllers, the TrueDrive output architecture is constructed of bipolar and CMOS transistors in parallel. TrueDrive technology delivers high current where it is needed most—at the MOSFET Miller plateau region thresholds—and provides switching efficiency gains.

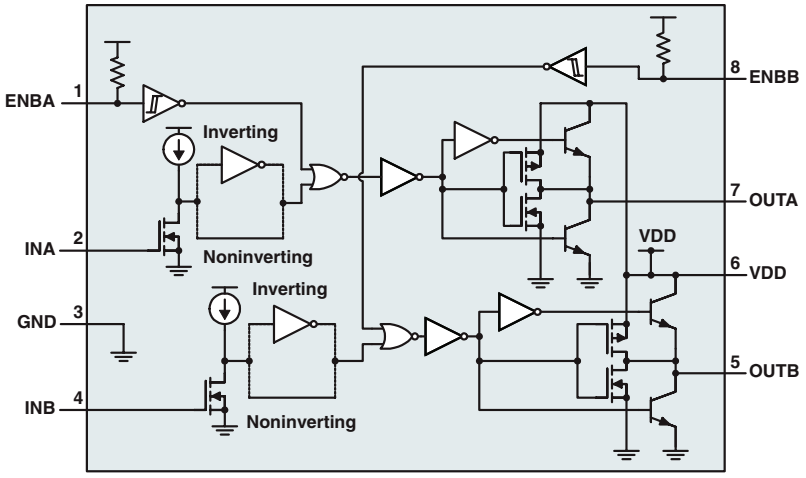
Predictive Gate Drive™ Technology — This patented TI technology is a digital control technique to control delay times in high-efficiency, low-output-voltage synchronous buck converters. See our application notes (SLUA281 and SLUA285) on Predictive Gate Drive for a complete description.

Dual 4-A MOSFET Drivers with Enable
UCC27423, UCC27424, UCC27425

Get samples and datasheets at: **www.ti.com/sc/device/PARTnumber**
(Replace **PARTnumber** with **UCC27423**, **UCC27424** or **UCC27425**)

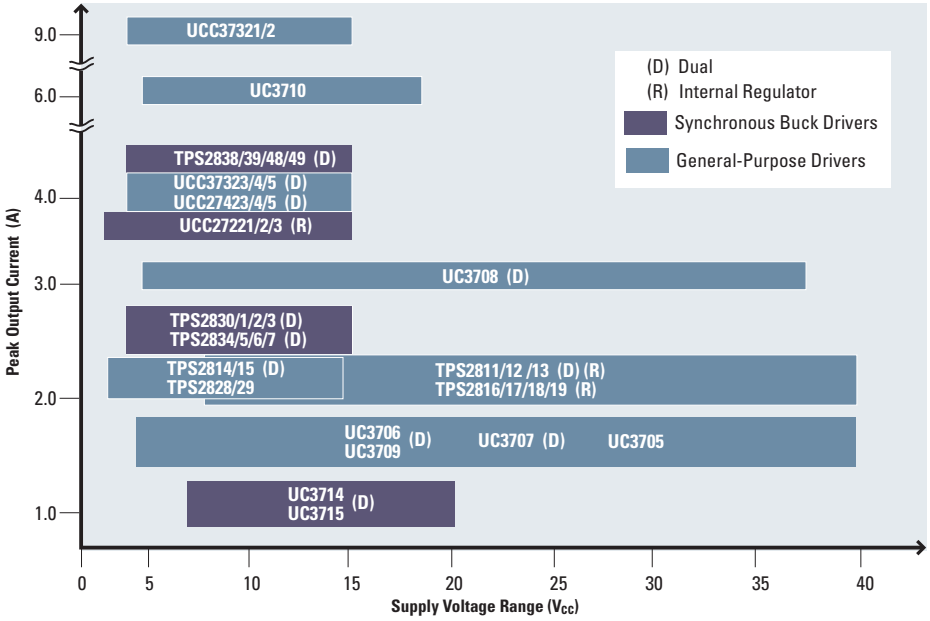
Key Features

- Independent enable functions for each driver
- Industry-standard pinout
- High-current drive capability of ±4 A
- Unique bipolar and CMOS TrueDrive™ output stage provides high current at MOSFET Miller thresholds



UCC27423/24/25 block diagram.

MOSFET Drivers Family of Products



Selection Guide

Device	No. of Outputs	Output Configuration	Output Type[1]	Peak I_{OUT} Source/Sink (A)	Rise/Fall Time (ns)	V_{CC} Range (V)	Prop Delay (ns)	Input Threshold	Enable	Dead Time Control	Protection Features[2]	Internal Regulator	Price*
General-Purpose Low-Side Drivers													
TPS2811	2	Inverting	TrueDrive™	2.0/2.0	25/25	4 to 40	40	CMOS	—	—	—	✔	0.90
TPS2812	2	Non-inverting	TrueDrive	2.0/2.0	25/25	4 to 40	40	CMOS	—	—	—	✔	0.90
TPS2813	2	See Note 3	TrueDrive	2.0/2.0	25/25	4 to 14	40	CMOS	—	—	—	✔	0.90
TPS2814	2	Dual 2-input AND; one inverting	TrueDrive	2.0/2.0	25/25	4 to 14	40	CMOS	—	—	—	—	0.90
TPS2815	2	2-input NAND	TrueDrive	2.0/2.0	25/25	4 to 14	40	CMOS	✔	N/A	—	—	0.90
TPS2816	1	Inverting	TrueDrive	2.0/2.0	25/25	4 to 40	40	CMOS	—	N/A	—	✔	0.65
TPS2817	1	Non-inverting	TrueDrive	2.0/2.0	25/25	4 to 40	40	CMOS	—	N/A	—	✔	0.65
TPS2818	1	Inverting	TrueDrive	2.0/2.0	25/25	4 to 40	40	CMOS	—	N/A	—	✔	0.65
TPS2819	1	Non-inverting	TrueDrive	2.0/2.0	25/25	4 to 40	40	CMOS	—	N/A	—	✔	0.65
TPS2828	1	Inverting	TrueDrive	2.0/2.0	25/25	4 to 14	40	CMOS	—	N/A	—	—	0.60
TPS2829	1	Non-inverting	TrueDrive	2.0/2.0	25/25	4 to 14	40	CMOS	—	N/A	—	—	0.60
UC3714	2	Non-inverting	Bipolar	0.5/1.0	30/25	7 to 20	50	TTL/PWM	✔	Adj.	—	—	0.95
UC3715	2	See Note 3	Bipolar	1.0/2.0	30/25	7 to 20	50	TTL/PWM	✔	Adj.	—	—	0.90
UCC27323	2	Inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.80
UCC27324	2	Non-inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.80
UCC27325	2	See Note 3	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.80
UCC27423	2	Inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	✔	—	—	—	0.85
UCC27424	2	Non-inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	✔	—	—	—	0.85
UCC27425	2	See Note 3	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	✔	—	—	—	0.85
UCC28089	2	N/A	Bipolar	0.5/1.0	28/13	8 to 15	45	N/A	—	Adj.	OCP	—	0.65
UCC37321	1	Inverting	TrueDrive	9/9	20/20	4 to 15	30	TTL/CMOS	✔	—	—	—	0.99
UCC37322	1	Non-inverting	TrueDrive	9/9	20/20	4 to 15	30	TTL/CMOS	✔	—	—	—	0.99
UCC37323	2	Inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.75
UCC37324	2	Non-inverting	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.75
UCC37325	2	See Note 3	TrueDrive	4.0/4.0	25/25	4 to 15	35	TTL/CMOS	—	—	—	—	0.75
Synchronous Buck Drivers													
TPS2830	2	Non-inverting	TrueDrive	2.4/2.4	50/50	4.5 to 15	75	CMOS	✔	Adaptive	OVPC	—	1.05
TPS2831	2	Inverting	TrueDrive	2.4/2.4	50/50	4.5 to 15	75	CMOS	✔	Adaptive	OVPC	—	1.05
TPS2832	2	Non-inverting	TrueDrive	2.4/2.4	50/50	4.5 to 15	75	CMOS	—	Adaptive	—	—	1.00
TPS2833	2	Inverting	TrueDrive	2.4/2.4	50/50	4.5 to 15	75	CMOS	—	Adaptive	—	—	1.00
TPS2834	2	Non-inverting	TrueDrive	2.4/2.4	30/30	4.5 to 15	70	TTL	✔	Adaptive	OVPC	—	1.05
TPS2835	2	Inverting	TrueDrive	2.4/2.4	30/30	4.5 to 15	70	TTL	✔	Adaptive	OVPC	—	1.05
TPS2836	2	Non-inverting	TrueDrive	2.4/2.4	30/30	4.5 to 15	70	TTL	—	Adaptive	—	—	1.25
TPS2837	2	Inverting	TrueDrive	2.4/2.4	30/30	4.5 to 15	70	TTL	—	Adaptive	—	—	1.25
TPS2838	2	Non-inverting	TrueDrive	4/4	120	10 to 15	40	TTL	✔	Adaptive	—	✔	1.30
TPS2839	2	Inverting	TrueDrive	4/4	120	10 to 15	40	TTL	✔	Adaptive	—	✔	1.30
TPS2848	2	Non-inverting	TrueDrive	4/4	120	10 to 15	20	TTL	✔	Adaptive	—	✔	1.25
TPS2849	2	Inverting	TrueDrive	4/4	120	10 to 15	20	TTL	✔	Adaptive	—	✔	1.25
UCC27221	2	Inverting	TrueDrive	3.3/3.3	20/20	3.7 to 20	82/103	TTL	—	PGD[4]	—	✔	1.35
UCC27222	2	Non-Inverting	TrueDrive	3.3/3.3	20/20	3.7 to 20	82/103	TTL	—	PGD[4]	—	✔	1.35
UCC27223	2	Non-Inverting	TrueDrive	3.3/3.3	25/35	4.15 to 20	82/103	TTL	✔	PGD[4]	—	✔	1.35
UCD7100PWP	1	Uncommitted/ Non-Inverting	TrueDrive	4/4	10/10	4.5 to 16	20	CMOS/TTL	—	Adaptive	Adjustable	—	0.99
UCD7201PWP	2	Uncommitted/ Non-Inverting	TrueDrive	4/4	10/10	4.5 to 16	20	CMOS/TTL	—	Adaptive	Adjustable	—	1.20

[1]Output type: TrueDrive is the hybrid bipolar/CMOS output architecture for improved current drive capability at low voltages (at Miller threshold).
[2]OCP = over-current protection, OVPC = over-voltage protection crowbar.
[3]One inverting, one non-inverting.
[4]Predictive Gate Drive™.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Loadshare Controllers

Design Factors

Current Sensing — The power supply output current can be sensed in either the high or low side of the output being loadshared. Two controllers (UC3907, UCC39002) can be used in either arrangement; however, the UC3902 is for dedicated low-side (ground referenced) current sensing.

Single or Differential Current Sensing — Optimal results can be obtained using a differential current-sense technique in both high- and low-side applications. The single-ended configuration reduces pin count for dedicated, ground-referenced applications.

Single or Differential Share Bus — Depending on the amount of noise in any specific application, designers can choose to use either a single-ended or differential type common loadshare bus command among the modules being shared. True differential mode offers the most noise immunity, but the single-ended variety can also yield excellent results when designed with a high amplitude loadshare signal.

Master/Slave Status — One loadshare controller (the UC3907) features a master/slave output signal for interfacing with other power supplies and end-system diagnostic circuits.

Hot-Swap/Hot-Plug — The new UCC39002 features the ability to hot-swap or hot-plug modular power supplies without disturbing the loadshare bus "share" command.

Current Loop Compensation — Each of these loadshare controllers offers designers the ability to compensate the current share loop as required by the system or individual power supplies.

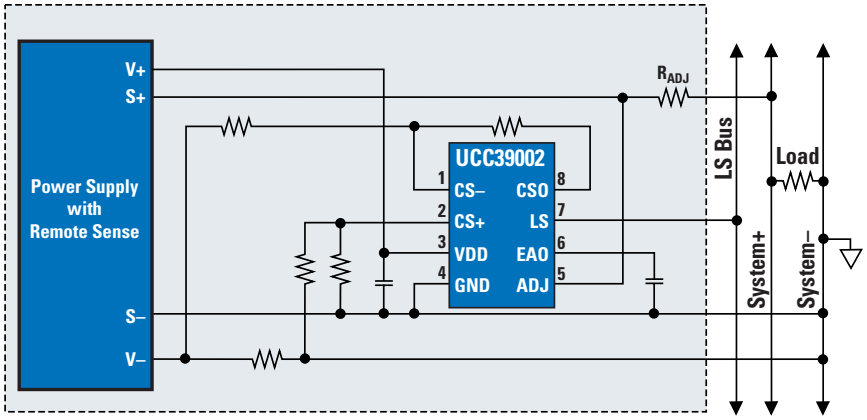
Intel SSI Compliance — The UCC39002 meets the Intel SSI spec requirements of 1) single connection between parallel modules and 2) scalable loadshare voltage independent of the CS resistor.

Advanced 8-Pin Loadshare Controller
UCC39002

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/UCC39002**

Key Features

- High accuracy, better than 1% current share error at full load
- High-side or low-side (GND reference) current-sense capability
- Ultra-low offset current-sense amplifier using post package trimming



Selection Guide

Device	V_{IN} (min)	V_{IN} (max)	Reference Accuracy (%)	Share Bus	Pin Count	Supply Current (mA)	Price*
UC3902	2.7	20	—	Differential	8	6	1.85
UC3907	4.5	35	1.25	Single Ended	16	6	2.10
UCC39002	4	15	—	Single Ended	8	2.5	0.95

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

*New devices are listed in **bold red**.*

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Module (EVM)		
UCC39002EVM	Advanced Loadshare Controller User's Guide, HPA027A	49

**Suggested resale price in U.S. dollars.*

Literature Number	Description
Application Notes	
SLUA270A	48-V_{IN}, 12-V_{OUT} Loadshare System Using the UCC39002 with 3 DC/DC Modules
SLUA128	The UC3902 Loadshare Controller and its Performance in Distributed Power
SLUA147	UC3907 Loadshare IC Simplifies Parallel Power Supply Design

Design Factors

Plug-in power solutions are board-mounted, completely integrated, DC/DC converters requiring only one or two external components.

Input Voltage (V_{IN}) — Plug-in power solutions are designed to work from industry-standard DC bus voltages.

Output Current (I_{OUT}) — The I_{OUT} of the converter should match the maximum current need of your application.

Output Voltage (V_{OUT}) — Choose an adjustable or fixed V_{OUT} that meets your requirements.

Isolation — Converters with electrical input to output isolation are usually more complex and more expensive.

Features — *TurboTrans*™, SmartSync, adjustable V_{OUT}, remote sense, over-temperature, over-current and output inhibit are some of the many features.

Airflow Requirements — The max current of converters often depends on airflow. SOA curves determine the airflow needs of converters at specific currents.

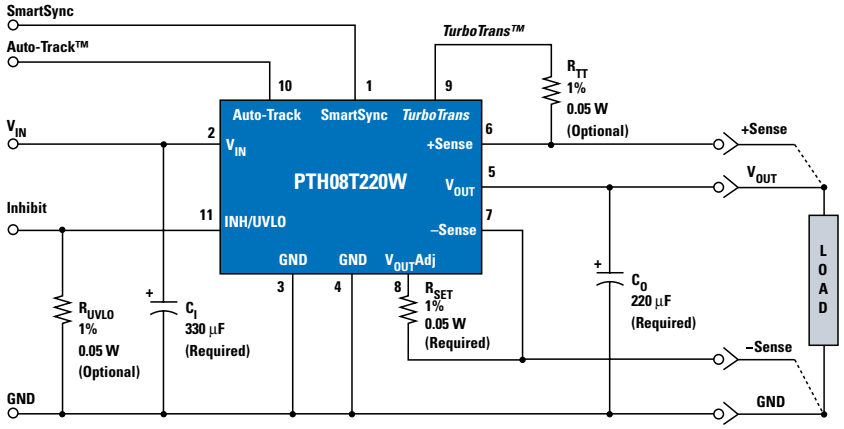
Protection — Fault protection can include short circuit, over-temperature, over-current and over-voltage protection.

Package — Vertical mounting uses the smallest footprint. Surface mount and horizontal through-hole are available in most product series.

16-A, 4.5-V to 14-V Input, POL Module with *TurboTrans*™ Technology PTH08T220W

Get samples and datasheets at: **www.ti.com/sc/device/PTH08T220W**

The PTH08T220W is a high-performance, 16-A-rated, T2 point-of-load (POL) power module. Operating from an input voltage range of 4.5 V to 14 V, the PTH08T220W requires a single resistor to set the output voltage to any value over the range of 0.7 V to 5.5 V. The PTH08T220W incorporates *TurboTrans* technology, SmartSync and Auto-Track™ sequencing.



Plug-In Power Modules (POLA™ and Others) Family of Products

V_{IN}	1 A	2 A	3 A	5 A	8 A	15 A	20 A	30 A	60 A
48 V	PT4210 PT4310 #	PTMA PTB48540	PTMA PTB48540	PT4120 PTB48500 #	PTB48560	PTB48501 # PTB48502 #	PTB48520	PTQA	
24 V	DCP01/02 # DCR01/02 DCV01 # PTN78000	PT4240 PTN78060	PT4240 PTN78060	PT4140 PTN78020	PTB78560	PTB78520	PTB78520		
12 V	DCP02 # DCR01/02 DCV01 # PTN78000	PTN78060 PTH08000 PTH08080 PT5070	PTN78060	PTN78020 PT6640 ♣	PTH08T230 PTH12000 PTH12050 PTV12010	PTH08T240 PTH12060 PTH12010 PT6980 #	PTH08T220 PTH12020 PTV12020	PTH08T210 PTH12030	PTV08T250 PTV08040 PTH12040
5 V	DCP01/02 # DCR01 DCV01 # PTN04050	PTH04000 PTH04070	PTH04000 PTH04070	PTH05000 PT6670 ◆	PTH05050 PTV05010 PT6910 ♣ PT6940 #	PTH05060 PTH05010	PTH05020 PTV05020	PTH05T210 PTH05030	PTH04040
3.3 V		PTH04000 PTH04070	PTH04000 PTH04070 PT6670	PTH03000 PT6670 ◆ PT6910 ♣ PT6940 #	PTH03050 PTV03010 PT6910 ♣	PTH03060 PTH03010	PTH03020 PTV03020	PTH03030	PTH04040

I_{OUT}

Multiple output voltages ◆ Special function; boost ♣ Special function; negative output

Isolated | Non-Isolated

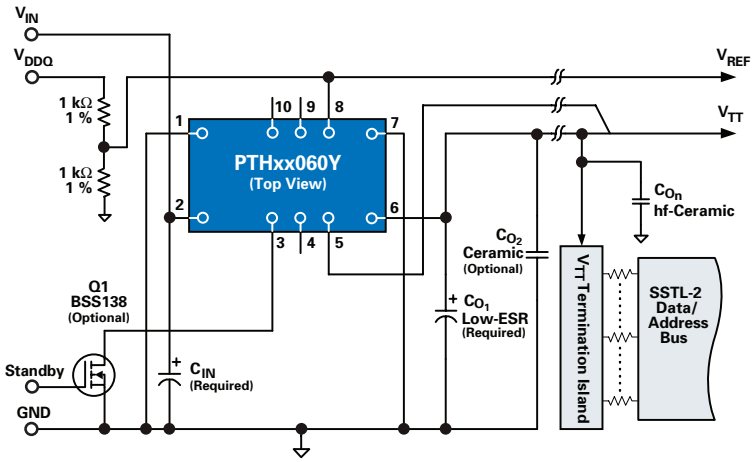
PTH QDR/DDR Series Power Modules

PTHxx060Y

Get samples and datasheets at: **www.ti.com/sc/device/PARTnumber**
(Replace **PARTnumber** with **PTH03060Y**, **PTH05060Y** or **PTH12060Y**)

Key Features

- Non-isolated DC/DC modules for double data rate (DDR) and quad data rate (QDR) 1 and 2 memory bus terminations
- Generates termination voltage (V_{TT}) that will source or sink current to track an external reference voltage (V_{REF})
- V_{TT} tracks V_{DDQ} voltage with tolerance of ±40 mV under transient conditions
- Supports V_{TT} range from 0.55 to 1.8 V
- 3.3-, 5- and 12-V input models
- Output currents up to 15 A
- POLA™ compatible



Standard application.

Selection Guide

Device[1]	Input Bus Voltage	Description	P_{OUT} or I_{OUT}	V_O Range (V)	V_O Adjustable	Auto-Track™ Sequencing	POLA™	DDR-QDR	Price*
Non-Isolated Single Positive Output									
PTH03000W	3.3 V	3.3-V Input 6-A POL	6 A	0.8 to 2.5	✔				6.90
PTH03010W	3.3 V	3.3-V Input 15-A POL with Auto-Track™ Sequencing	15 A	0.8 to 2.5	✔	✔	✔		11.60
PTH03020W	3.3 V	3.3-V Input 22-A POL with Auto-Track Sequencing	22 A	0.8 to 2.5	✔	✔	✔		18.15
PTH03030W	3.3 V	3.3-V Input 30-A POL with Auto-Track Sequencing	30 A	0.8 to 2.5	✔	✔	✔		25.00
PTH03050W	3.3 V	3.3-V Input 6-A POL with Auto-Track Sequencing	6 A	0.8 to 2.5	✔	✔	✔		6.90
PTH03060W	3.3 V	3.3-V Input 10-A POL with Auto-Track Sequencing	10 A	0.7 to 2.5	✔	✔	✔		9.80
PTH04000W	3.3 V/5 V	3-V to 5.5-V Input 3-A POL with Auto-Track Sequencing	3 A	0.9 to 3.6	✔	✔	✔		4.50
PTH04070W	3.3 V/5 V	3-V to 5.5-V Input 3-A POL	3 A	0.9 to 3.6	✔				4.28
PTH04040W	3.3 V/5 V	3-V to 5.5-V Input 60-A POL with Auto-Track Sequencing	60 A	0.8 to 3.6	✔	✔	✔		35.00
PTH05000W	5 V	5-V Input 6-A POL	6 A	0.8 to 3.6	✔				6.90
PTH05010W	5 V	5-V Input 15-A POL with Auto-Track Sequencing	15 A	0.8 to 3.6	✔	✔	✔		11.60
PTH05020W	5 V	5-V Input 22-A POL with Auto-Track Sequencing	22 A	0.8 to 3.6	✔	✔	✔		18.15
PTH05030W	5 V	5-V Input 30-A POL with Auto-Track Sequencing	30 A	0.8 to 3.6	✔	✔	✔		25.00
PTH05050W	5 V	5-V Input 6-A POL with Auto-Track Sequencing	6 A	0.8 to 3.6	✔	✔	✔		6.90
PTH05060W	5 V	5-V Input 10-A POL with Auto-Track Sequencing	10 A	0.8 to 3.6	✔	✔	✔		9.80
PTH05T210W	5 V	5-V Input, 30-A T2 2nd Gen PTH POL with *TurboTrans*™	30 A	0.7 to 3.6	✔	✔	✔		18.00
PTH08000W	12 V	8-V to 14-V Input, 3-A POL	3 A	0.9 to 5.5	✔	✔	✔		4.50
PTH08080W	5 V/12 V	5-V to 18-V Input, 2.25-A POL	2.25 A	0.9 to 5.5	✔				4.28
PTH08T210W	12 V	5.5- to 14-V Input, 30-A T2 2nd Gen PTH POL with *TurboTrans*	30 A	0.7 to 3.6	✔	✔	✔		18.00
PTH08T220W	5 V/12 V	4.5- to 14-V Input, 16-A T2 2nd Gen PTH POL with *TurboTrans*	16 A	0.7 to 5.5	✔	✔	✔		12.60
PTH08T230W	5 V/12 V	4.5- to 14-V Input, 6-A T2 2nd Gen PTH POL with *TurboTrans*	6 A	0.7 to 5.5	✔	✔	✔		7.90
PTH08T240W	5 V/12 V	4.5- to 14-V Input, 10-A T2 2nd Gen PTH POL with *TurboTrans*	10 A	0.7 to 5.5	✔	✔	✔		10.80
PTH12000L/W	12 V	12-V Input 6-A POL	6 A	0.8 to 1.8/1.2 to 5.5	✔				6.90
PTH12010L/W	12 V	12-V Input 12-A POL with Auto-Track Sequencing	12 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		11.60
PTH12020L/W	12 V	12-V Input 18-A POL with Auto-Track Sequencing	18 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		18.15
PTH12030L/W	12 V	12-V Input 26-A POL with Auto-Track Sequencing	26 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		25.00
PTH12040W	12 V	12-V Input 50-A POL with Auto-Track Sequencing	50 A	0.8 to 5.5	✔	✔	✔		35.00
PTH12050L/W	12 V	12-V Input 6-A POL with Auto-Track Sequencing	6 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		6.90
PTH12060L/W	12 V	12-V Input 10-A POL with Auto-Track Sequencing	10 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		9.80
PTH03010Y	3.3 V	3.3-V Input 15-A DDR Terminating Module	15 A	Follows V_{REF}	✔		✔	✔	11.60
PTH03050Y	3.3 V	3.3-V Input 6-A DDR Terminating Module	6 A	Follows V_{REF}	✔		✔	✔	6.90

[1] *See* **power.ti.com** *for a complete product offering.*

New devices are listed in ***bold red****.*

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

Selection Guide (Continued)

Device[1]	Input Bus Voltage	Description	P_{OUT} or I_{OUT}	V_O Range (V)	V_O Adjustable	Auto-Track™ Sequencing	POLA™	DDR-QDR	Price*
Non-Isolated Single Positive Output (Continued)									
PTH03060Y	3.3 V	3.3-V Input 10-A DDR Terminating Module	10 A	Follows V_{REF}	✔		✔	✔	9.80
PTH05010Y	5 V	5-V Input 15-A DDR Terminating Module	15 A	Follows V_{REF}	✔		✔	✔	11.60
PTH05050Y	5 V	5-V Input 6-A DDR Terminating Module	6 A	Follows V_{REF}	✔		✔	✔	6.90
PTH05060Y	5 V	5-V Input 10-A DDR Terminating Module	10 A	Follows V_{REF}	✔		✔	✔	9.80
PTH12010Y	12 V	12-V Input 12-A DDR Terminating Module	12 A	Follows V_{REF}	✔		✔	✔	11.60
PTH12050Y	12 V	12-V Input 6-A DDR Terminating Module	6 A	Follows V_{REF}	✔		✔	✔	6.90
PTH12060Y	12 V	12-V Input 8-A DDR Terminating Module	8 A	Follows V_{REF}	✔		✔	✔	9.80
PTN04050C	3.3 V/5 V	3-V/5-V Input, 12-W Output Step-Up (Boost) ISR	12 W	5 to 15	✔				8.00
PTN78000W/H	V_O + 2 to 36 V	Wide-Input, Wide-Output 1.5-A Positive Step-Down ISR	1.5 A	2.5 to 12/12 to 22	✔				8.00
PTN78060W/H	V_O + 2 to 36 V	Wide-Input, Wide-Output 3-A Positive Step-Down ISR	3 A	2.5 to 12/12 to 22	✔				11.00
PTN78020W/H	V_O + 2 to 36 V	Wide-Input, Wide-Output 6-A Positive Step-Down ISR	6 A	2.5 to 12/12 to 22	✔				15.00
PTV03010W	3.3 V	5-V Input 8-A Vertical SIP with Auto-Track™ Sequencing	8 A	0.8 to 2.5	✔	✔	✔		6.90
PTV03020W	3.3 V	5-V Input 18-A Vertical SIP with Auto-Track Sequencing	8 A	0.8 to 2.5	✔	✔	✔		11.60
PTV05010W	5 V	5-V Input 8-A Vertical SIP with Auto-Track Sequencing	8 A	0.8 to 3.6	✔	✔	✔		6.90
PTV05020W	5 V	5-V Input 18-A Vertical SIP with Auto-Track Sequencing	8 A	0.8 to 3.6	✔	✔	✔		11.60
PTV08040W	12 V	8-V to 14-V Input, 50-A Vertical SIP with Auto-Track Sequencing	50 A	0.8 to 3.6	✔	✔			35.00
PTV08T250W	12 V	8-V to 14-V Input, 50-A T2 2nd Gen PTH POL with *TurboTrans*™	50 A	0.8 to 3.6	✔	✔	✔		36.00
PTV12010L/W	12 V	12-V Input 8-A Vertical SIP with Auto-Track Sequencing	18 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		6.90
PTV12020L/W	12 V	12-V Input 18-A Vertical SIP with Auto-Track Sequencing	18 A	0.8 to 1.8/1.2 to 5.5	✔	✔	✔		11.60
Non-Isolated Single Negative Output									
PT6910	3.3 V/5 V	3.3-V/5-V Input 12-W Adjustable Plus to Minus Voltage Converter	12 W	–1.2 to –6.5	✔				26.25
PTN04050A	3.3 V/5 V	3-V to 5-V Input, 6-W Positive to Negative (Buck-Boost) ISR	6 W	–3.3 to –15	✔				8.00
PTN78000A	7 to 29 V	Wide-Input, Wide-Output 1.5-A Positive to Negative (Buck-Boost) ISR	1.5 A	–3 to –15	✔				8.00
PTN78060A	9 to 29 V	Wide-Input, Wide-Output 15-W Positive to Negative (Buck-Boost) ISR	15 W	–3 to –15	✔				11.00
PTN78020A	9 to 29 V	Wide-Input, Wide-Output 25-W Positive to Negative (Buck-Boost) ISR	25 W	–3 to –15	✔				15.00
Non-Isolated Multiple Output									
PT5060	5 V	5- to ±12/15-V_{OUT} 9-W Dual Output Adjustable ISR	9 W	±8 to ±20	✔				10.80
PT6940	3.3 V/5 V	6-A 3.3-V/5-V Input Adjustable Dual Output ISR	Dual 6 A	1.2 to 3.3	✔				32.40
PT6980	12 V	10-A 12-V Input Adjustable Dual Output ISR	10 A	1.3 to 3.6	✔				27.40
Isolated Single Output									
DCP01_B	5, 24	1-W Unregulated Isolated DC/DC Converter with Synchronization	1 W	5, 12, 15					5.35
DCP02	5, 12, 24	2-W Unregulated Isolated DC/DC Converter with Synchronization	2 W	3.3, 5, 7, 9, 12, 15					6.95
DCR01	5, 12, 24	1-W Regulated Isolated DC/DC Converter with Synchronization	1 W	3.3, 5					5.95
PT4210	48 V	3- to 7-W 48-V Input Isolated DC/DC Converter	3 to 7 W	3.3 to 12					18.75
PTB48520W	48 V	25-A 48-V Input Isolated POL Converter with Auto-Track I/O	75 W	1.8 to 3.6	✔	✔			62.00
PTB48540A/B/C	48 V	10-W 48-V Input Isolated PoE Module	10 W	3.3, 5, 12	✔				26.00
PTB48560A/B/C	48 V	30-W 48-V Input Isolated POL Converter with Auto-Track I/O	30 W	3.3, 5, 12	✔	✔			25.00
PTB78520W	18 V to 60 V	20-A 18-V to 60-V Input Isolated POL Converter with Track I/O	65 W	1.8 to 3.6	✔	✔			62.00
PTB78560A/B/C	18 V to 60 V	30-W 18-V to 60-V Input Isolated POL Converter with Track I/O	30 W	3.3, 5, 12	✔	✔			25.00
PTMA	48 V	10-W 48-V Input Isolated DC/DC Converter — Industry Std Footprint	10 W	3.3, 5, 12	✔				20.00
PTQA	48 V	100-W 48-V Input Isolated DC/DC Converter — Industry Std Footprint	100 W	2.5, 3.3	✔				44.00
Isolated Multiple Output									
DCP01_DB	5, 15, 24	1-W Unregulated Dual Isolated DC/DC Converter with Synchronization	1 W	±5, ±12, ±15					5.90
DCP02_D	5, 12, 24	2-W Unregulated Dual Isolated DC/DC Converter with Synchronization	2 W	±5, ±12, ±15					6.95
PTB48500A	48 V	30-W 48-V Input Isolated Dual DC/DC Converter	30 W	3.3/1.2	✔				43.00
PTB48501A/B	48 V	35-W 48-V Input Isolated Dual DC/DC Converter	35 W	3.3/1.2 or 1.5	✔				45.00
PTB48502A/B	48 V	40-W 48-V Input Isolated Dual DC/DC Converter	40 W	3.3/1.2 or 1.5	✔				49.00

[1] *See* **power.ti.com** *for a complete product offering.*

New devices are listed in ***bold red****.*

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

Linear and Low Dropout (LDO) Regulators

TI offers an extremely broad LDO portfolio covering applications from microampere keep-alive circuits to 7.5-A telecom loads. Key products are highlighted in the diagram on this page and the table on page 25. For a more comprehensive selection, please review pages 26–27 or visit **power.ti.com** for our complete portfolio.

Design Factors

Input Voltage — The minimum V_{IN} must be larger than $V_{OUT} + V_{DO}$, independent from the minimum value given in the selection table.

Efficiency — By neglecting the quiescent current (I_q) of the LDO, efficiency can be calculated as V_{OUT}/V_{IN}.

Power Dissipation — $P_D = (V_{IN} – V_{OUT}) \times I_{OUT}$; P_D is limited by package, T_A and T_{JMAX}. Refer to application note SLVA118, "Digital Designer's Guide to Linear Voltage Regulators and Thermal Management," for support. For higher power dissipation or requirements for higher efficiency, TI recommends step-down (buck) DC/DC converters/controllers (refer to pages 28–34 for products).

Capacitor Requirements — The output capacitor and especially its ESR are critical for stability. Therefore, some LDOs require tantalum output capacitors, which have high ESR. If an LDO is stable with no output capacitor or with low-ESR ceramic output capacitors, it is usually stable with all types of capacitors.

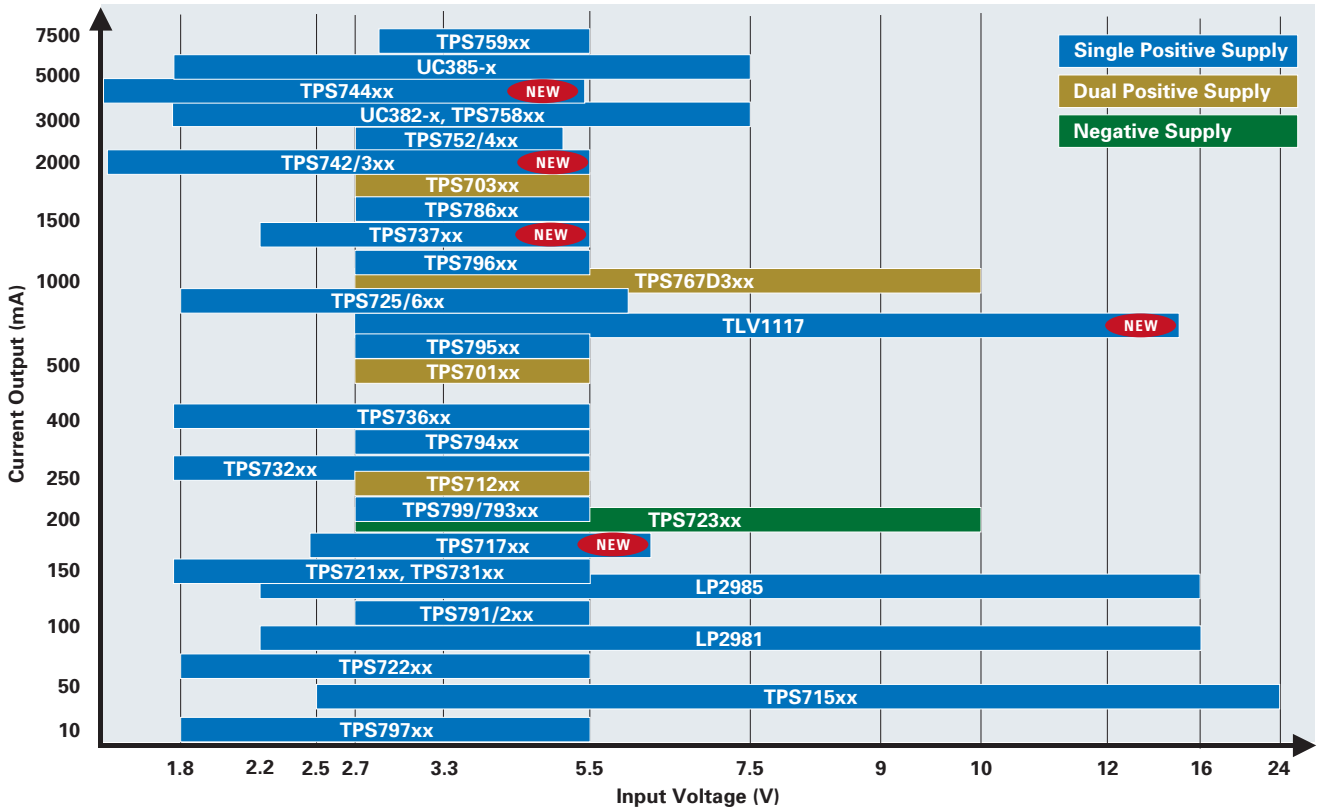
RF, Audio and Other Noise-Sensitive Applications — Select an LDO with high power supply ripple rejection (PSRR) for noise immunity from the input supply, and low output noise (< 50 µVrms). Some LDOs have a bypass (BP) pin for adding capacitance to lower the output noise.

PG/SVS — Devices such as microprocessors, DSPs and FPGAs require a minimum voltage for proper operation. The supply voltage supervisor (SVS) function monitors the system voltages and outputs a signal when the voltages drop below a certain value, so the system can reset and prevent malfunction. An SVS asserts the reset signal after a specified delay, while a power-good (PG) function does not have a delay.

Reverse Leakage Protection — In special applications where the voltage on the output of the LDO is higher than at the input, the reverse leakage protection feature prevents current from flowing from the LDO output to the input, which can be damaging to the input supply, especially if it is a battery.

Application-Specific Multi-Output Solutions — See page 37.

Linear and Low Dropout (LDO) Regulators Family of Products (selected models shown)

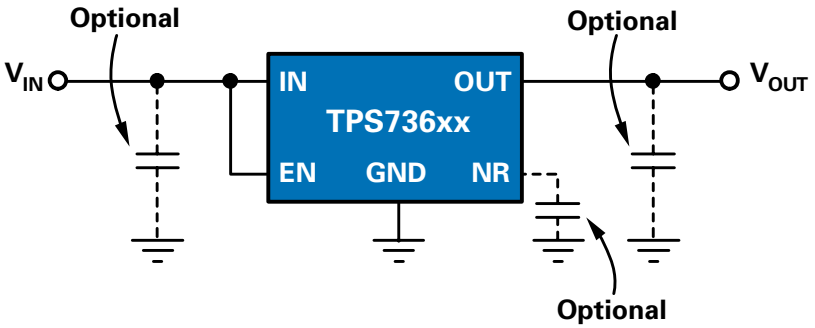


Linear and Low Dropout (LDO) Regulators

Product Applications

Device	I_{OUT} (mA)	Highlights	Target Applications: Handset	WLAN	RF (High PSRR + Low Noise)	Portables/PDA/DSC	Reverse Leakage Protection	MSP430 Processor	OMAP™ Processor	DSP and FPGA	DDR Termination	High Voltage	Low Profile (≤12 mm)	Low Cost	Price*
TPS797xx	10	1.2-µA I_q, Power Good for brown-out protection, ceramic cap, SC70	✔			✔		✔					✔		0.34
REF30xx	25	0.2% accuracy, 50-µA max I_Q, SOT-23				✔		✔							0.59
REF29xx	25	2% accuracy, 50-µA max I_Q, SOT-23				✔		✔							0.49
TPS715xx	50	3.4-µA I_q, 24-V_{IN} max, ceramic cap, SC70	✔			✔		✔				✔	✔		0.34
TPS715Axx	80	Higher power version of TPS715xx, in thermally enhanced QFN	✔			✔		✔				✔	✔		0.44
TPS769xx	100	17-µA I_q, low-cost option for <100-mA apps, SOT23				✔								✔	0.29
LP2981	100	16-V_{IN} max, fast transient response, SOT23										✔		✔	0.36
TPS731xx	150	Cap-free, 1% acc, 1.7- to 5.5-V V_{IN}, custom V_{OUT} available, SOT23				✔	✔			✔					0.45
LP2985	150	Low-cost option for 150-mA apps, SOT23												✔	0.36
TPS730xx	200	Low-cost alternative to TPS793xx, SOT23/WCSP												✔	0.20
TPS793xx	200	LP2985 cross, RF, ceramic cap, SOT23/WCSP	✔	✔	✔	✔			✔	✔			✔		0.23
TPS799xx	200	LP3985 cross with 40-µA I_q in TSOT23/WCSP/SON	✔	✔	✔	✔			✔	✔			✔		0.30
TPS794xx	250	RF, ceramic cap, thermally enhanced PowerPAD™ MSOP8			✔	✔			✔	✔			✔		0.65
TPS732xx	250	Cap-free, 1% acc, 1.7- to 5.5-V V_{IN}, custom V_{OUT} available, SOT23/QFN				✔			✔	✔			✔		0.65
TPS766xx	250	35-µA I_q, Power Good, low-cost option for 250-mA apps, SOIC8				✔			✔	✔				✔	0.40
TPS712xx	250/250	Dual RF LDO in QFN package, ceramic cap	✔	✔	✔	✔			✔	✔			✔		0.80
TPS736xx	400	Cap-free, 1% acc, 1.7- to 5.5-V V_{IN}, custom V_{OUT} avail., SOT23/QFN/SOT223				✔	✔			✔			✔		0.95
TPS776xx	500	Low-cost option for 500-mA apps, SOIC and PowerPAD TSSOP (PWP) package								✔			✔	✔	0.70
TPS795xx	500	RF performance, ceramic cap, SOT223			✔					✔					1.05
TPS726126	1000	1.26-V core and integrated reset for C5501/02 and C6711/12/13								✔					1.10
TPS725xx	1000	Low input voltage (down to 1.8 V), any cap LDO, SOT223/TO263/SOIC								✔					1.10
TPS796xx	1000	RF performance, ceramic cap, SOT223/TO263/QFN			✔					✔					1.10
TPS768xx	1000	Low-cost option for 1-A apps, SOIC and PowerPAD TSSOP (PWP)								✔				✔	0.90
TPS786xx	1500	RF performance, ceramic cap, SOT223/TO263			✔					✔					1.35
UC382-x	3000	Separate V_{bias} allows regulation from as low as 1.7 V_{IN}, TO220/TO263								✔					2.70
TPS51100	3000	Source/sink LDO; see page 7 for details									✔				0.80
UC385-x	5000	Separate V_{bias} allows regulation from as low as 1.7 V_{IN}, TO220/TO263								✔					3.15

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



Typical application circuit for TPS736xx 400-mA cap-free LDO.

Linear and Low Dropout (LDO) Regulators

Low Dropout (LDO) Regulators Selection Guide

Device[1]	I_O (mA)	V_{DO} @ I_O (mV)	I_q (µA)	Output Options: Fixed Voltage (V)	Output Options: Adj. (V)	Min V_{IN}	Max V_{IN}	Accuracy (%)	Packages: WCSP	SC70	SOT23	MSOP	QFN	SO8	SOT223	PWP	TO220	PW	TO263	Features[2]	C_O[3]	Comments	Price*
Positive Voltage, Single Output Devices																							
TPS797xx	10	105	1.2	1.8, 3.0, 3.3	—	1.8	5.5	4		✔										PG	0.47 µF C	MSP430; Lowest I_q	0.34
TPS715xx	50	415	3.2	2.5, 3.0, 3.3, 5.0	1.2 to 15	2.5	24	4		✔										—	0.47 µF C	Ultra-Low I_q	0.34
TPS770xx	50	35	17	1.2, 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0	1.2 to 5.5	2.7	10	3			✔									/EN	4.7 µF T	Low I_q	0.34
TPS790xx	50	57	18	1.5, 1.8, 2.5, 2.8, 3.0	—	2.7	10	3			✔									/EN	4.7 µF T	Low I_q and High V_{IN}	0.36
TPS715Axx	80	670	3.2	3.3	1.2 to 15	2.5	24	4					✔							—	0.47 µF C	Thermally Enhanced Pkg	0.44
TPS789xx	100	115	18	1.5, 1.8, 2.5, 2.8, 3.0	—	2.7	13.5	3			✔									/EN	4.7 µF T	Low I_q and High V_{IN}	0.30
TPS792xx	100	38	185	2.5, 2.8, 3	1.2 to 5.5	2.7	5.5	2			✔									EN, BP	1 µF C	RF Low Noise; High PSRR	0.40
TPS791xx	100	38	185	1.8, 3.3, 4.7	1.2 to 5.5	2.7	5.5	2			✔									/EN, BP	1 µF C	RF Low Noise; High PSRR	0.40
TPS769xx	100	70	18	1.2, 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0	1.2 to 5.5	2.7	10	3			✔									/EN	4.7 µF T	Low Cost	0.29
LP2981	100	200	600	1.8, 2.5, 2.8, 3.0, 3.3, 5	1.3 to 9	2.2	16	1			✔									EN	3.3 µF C	Fast Transient Response	0.36
TPS76201	100	100	22	—	0.7 to 5.5	2.7	10	3			✔									/EN	4.7 µF T	Lowest V_{OUT} LDO	0.37
TPS717xx	150	170	50	1.8, 2.6, 2.8, 2.85, 3.0, 3.3, EEPROM[4]	0.9 to 6.2	2.5	6.5	1.5		✔										EN, BP	1 µF C	Ultra-High PSRR	0.45
TPS731xx	150	30	400	1.5, 1.8, 2.5, 3.0, 3.3, 5.0, EEPROM[4]	1.20 to 5.5	1.7	5.5	1			✔									EN, BP	No Cap	Reverse Leakage Protection	0.45
LP2985	150	280	850	1.25, 1.5, 1.8, 2.5, 2.7–3.3, 5.0	—	2.2	16	1	✔		✔									EN	3.3 µF C	Fast Transient Response	0.36
TPS763xx	150	180	85	1.6, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 3.8, 5.0	1.5 to 6.5	2.7	10	3			✔									EN	4.7 µF T	Low Cost	0.25
TPS721xx	150	150	90	1.5, 1.6, 1.8	1.2 to 2.5	1.8	5.5	3			✔									EN	0.1 µF C	Low Noise and Low V_{IN}	0.41
TPS771xx	150	75	90	1.5, 1.8, 2.7, 2.8, 3.3, 5.0	1.5 to 5.5	2.7	10	2				✔								/EN, SVS	10 µF T	Low Noise	0.60
TPS730xx	200	120	180	1.8, 2.5, 2.8, 2.85, 3.0, 3.3	1.2 to 5.5	2.7	5.5	2			✔									EN, BP	2.2 µF C	Low Cost vs. TPS793xx	0.23
TPS793xx	200	77	180	1.8, 2.5, 2.8, 2.85, 3.0, 3.3, 4.75	1.2 to 5.5	2.7	5.5	2	✔		✔									EN, BP	2.2 µF C	RF Low Noise, High PSRR	0.28
TPS799xx	200	100	40	1.2, 1.5, 1.8, 1.9, 2.5, 2.6, 2.7, 2.8, 2.85, 3.0, 3.2, 3.3, EEPROM[4]	1.2 to 5.5	2.7	6.5	2	✔		✔		✔							EN, BP	2.2 µF C	Low Power vs. TPS793xx	0.35
TPS794xx	250	145	172	1.8, 2.5, 2.8, 3.0, 3.3	1.2 to 5.5	2.7	5.5	3				✔			✔					EN, BP	2.2 µF C	RF Low Noise, High PSRR	0.65
TPS732xx	250	40	400	1.5, 1.8, 2.5, 3.0, 3.3, 5.0, EEPROM[4]	1.20 to 5.5	1.7	5.5	1			✔		✔		✔					EN, BP	No Cap	Reverse Leakage Protection	0.65
TPS766xx	250	140	35	1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0	1.25 to 5.5	2.7	10	3						✔						/EN, PG	4.7 µF T	Low Cost	0.40
TPS773xx	250	125	90	1.5, 1.6, 1.8, 2.7, 2.8, 3.3, 5.0	1.5 to 5.5	2.7	10	2				✔								/EN, SVS	10 µF T	Low Noise	0.70
TPS779xx	250	250	90	1.8, 2.5, 3.0	1.5 to 5.5	2.7	10	2				✔								EN, SVS	10 µF T	Low Noise	0.70
TPS736xx	400	75	300	1.25, 1.5, 1.8, 2.5, 3.0, 3.3, EEPROM[4]	1.20 to 5.5	1.7	5.5	1			✔		✔		✔					EN, BP	No Cap	Reverse Leakage Protection	0.95
TPS795xx	500	105	265	1.6, 1.8, 2.5, 3.0, 3.3	1.2 to 5.5	2.7	5.5	2							✔					EN, BP	1 µF C	RF Low Noise, High PSRR	1.05
TPS775xx	500	169	87	1.5, 1.6, 1.8, 2.5, 3.3	1.5 to 5.5	2.7	10	2						✔		✔				/EN, SVS	10 µF T	Fast Transient Response	0.95
TPS776xx	500	169	87	1.5, 1.8, 2.5, 2.8, 3.3	1.20 to 5.5	2.7	10	2						✔		✔				/EN, PG	10 µF T	Fast Transient Response	0.70
TPS777xx	750	260	85	1.5, 1.8, 2.5, 3.3	1.5 to 5.5	2.7	10	2						✔		✔				/EN,SVS	10 µF T	Fast Transient Response	1.05
TLV1117	800	1200	5 mA	1.2, 1.5, 1.8, 2.5, 3.3, 5.0	1.4 to 13	2.7	15	3					✔		✔				✔	—	10 µF T	Low Cost	0.41
TPS737xx	1000	200	300	EEPROM[4]	1.2 to 5.5	2.0	5.5	2							✔					EN	1 µF C	Low Cost	0.60
TPS725xx	1000	170	75	1.5, 1.6, 1.8, 2.5	1.2 to 5.5	1.8	6	2						✔	✔				✔	EN, SVS	No Cap	Low Noise; SVS Delay 50 ms	1.10
TPS726xx	1000	170	75	1.26, 1.5, 1.6, 1.8, 2.5	—	1.8	6	2							✔				✔	EN, SVS	No Cap	Low Noise; SVS Delay 200 ms	1.10
TPS796xx	1000	200	310	1.8, 2.5, 2.8, 3.0, 3.3	1.2 to 5.5	2.7	5.5	2						✔		✔			✔	EN, BP	1 µF C	RF Low Noise, High PSRR	1.10
TPS767xx	1000	230	85	1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0	1.5 to 5.5	2.7	10	2							✔		✔			/EN, SVS	10 µF T	Fast Transient Response	1.10
TPS768xx	1000	230	80	1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5.0	1.2 to 5.5	2.7	10	2							✔		✔			/EN, PG	10 µF T	Fast Transient Response	0.90
TPS742xx	1500	60	2 mA	EEPROM[4]	0.8 to 3.3	0.9	5.25	1						✔			✔			EN, SS, PG	No Cap	Low V_{OUT}, High Accuracy	2.25
TPS743xx	1500	125	2 mA	EEPROM[4]	0.8 to 3.3	0.9	5.25	1						✔			✔			EN, TR, PG	No Cap	Low V_{OUT}, High Accuracy	2.25
TPS786xx	1500	390	310	1.8, 2.5, 2.8, 3.0, 3.3	1.2 to 5.5	2.7	5.5	2							✔				✔	EN, BP	1 µF C	RF Low Noise, High PSRR	1.35
TPS751xx	1500	160	75	1.5, 1.8, 2.5, 3.3	1.5 to 5.0	2.7	5	2									✔			/EN, PG	47 µF T	Fast Transient Response	1.60
TPS753xx	1500	160	75	1.5, 1.8, 2.5, 3.3	1.5 to 5.0	2.7	5	2									✔			/EN, SVS	47 µF T	Fast Transient Response	1.70
TPS752xx	2000	210	75	1.5, 1.8, 2.5, 3.3	1.5 to 5.0	2.7	5	2									✔			/EN, SVS	47 µF T	Fast Transient Response	1.80
TPS754xx	2000	210	75	1.5, 1.8, 2.5, 3.3	1.5 to 5.0	2.7	5	2									✔			/EN, PG	47 µF T	Fast Transient Response	1.75
TPS744xx	3000	125	2 mA	EEPROM[4]	0.8 to 3.3	0.9	5.25	1						✔			✔			EN, SS, PG	No Cap	Low V_{OUT}, High Accuracy	2.95
UC382-x	3000	350	6 mA	1.5, 2.1, 2.5	1.20 to 6.0	1.7	7.5	1										✔	✔	—	100 µF T	Fast LDO with Reverse Leak.	2.70
UCC383-x	3000	400	400	3.3, 5.0	1.2 to 8.5	1.8	9	2.5										✔	✔	/EN	22 µF T	Reverse Leakage Protection	2.70
TPS51100	3000	1250	3	½ VDDQSNS	—	4.75	5.25	1.6				✔								EN	20 µF C	DDR/DDR2 V_H Power	0.80
TPS758xx	3000	150	110	1.5, 1.8, 2.5, 3.3	1.2 to 5.0	2.8	5.5	3										✔	✔	EN	47 µF T	Fast Transient Response	2.70
UC385-x	5000	350	8 mA	1.5, 2.1, 2.5	1.20 to 6.0	1.7	7.5	1										✔	✔	—	100 µF T	Fast LDO with Reverse Leak.	3.15
TPS756xx	5000	250	110	1.5, 1.8, 2.5, 3.3	1.2 to 5.0	2.8	5.5	3										✔	✔	EN	47 µF T	Fast Transient Response	3.00
TPS759xx	7500	400	110	1.5, 1.8, 2.5, 3.3	1.2 to 5.0	2.8	5.5	3										✔	✔	/EN, PG	47 µF T	Fast Transient Response	3.20
Negative Voltage, Single Output Devices																							
TPS723xx	200	280	130	–2.5	–1.2 to –9	–10	–2.7	2			✔									EN, BP	2.2 µF C	Low Noise, High PSRR	1.05
UCC384-x	500	150	200	–12.0, –5.0	–1.25 to –15	–15	–3.5	3						✔						/EN	4.7 µF T	Duty Cycled Short	1.86

[1] *xx represents the voltage option. For example, 33 represents the 3.3-V option. The adjustable output voltage option is represented by 01.*

[2] *BP = bypass pin for noise reduction capacitor, EN = active high enable, /EN = active low enable, PG = Power Good, SS = soft-start pin, SVS = supply voltage supervisor, TR = tracking.*

[3] *C = ceramic, T = tantalum, No Cap = capacitor-free LDO.*

[4] *EEPROM programmable at the factory, allowing production of custom fixed voltages. Minimum quantities apply. Please contact TI.*

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

*New devices are listed in **bold red**.*

Dual Output LDOs Selection Guide

Device	I_{O1} (mA)	I_{O2} (mA)	V_{DO1} @ I_{O1} (mV)	V_{DO2} @ I_{O2} (mV)	I_q (µA)	Output Options: Fixed Voltage (V)	Output Options: Adj.	Accuracy (%)	Package	V_O (min) (V)	V_O (max) (V)	Features: Enable	PG	SVS	Seq	Low Noise	V_{IN} (min) (V)	V_{IN} (max) (V)	C_O[1]	Comments	Price*
TPS712xx	250	250	145	145	400	See Note 2	✔	2	QFN	1.2	5.5	EN				✔	2.7	5.5	2.2 µF C		0.80
TPS713xx	250	250	145	145	400	3.3/1.8	✔	2	QFN	1.2	5.5	EN		✔		✔	2.7	5.5	2.2 µF C	Integrated SVS	0.90
TPS707xx	250	150	83	125	187	See Note 3	✔	2	PWP	1.2	5	$\overline{EN}$	✔	✔	✔	✔	2.7	5.5	10 µF T	See TPS708xx[4]	1.20
TPS701xx	500	250	170	220	187	See Note 3	✔	2	PWP	1.2	5	$\overline{EN}$	✔	✔	✔	✔	2.7	5.5	10 µF T	See TPS702xx[4]	1.50
TPS767D3xx	1000	1000	350	350	85	3.3/2.5, 3.3/1.8	✔	2	PWP	1.5	5.5	$\overline{EN}$		✔			2.7	10	10 µF T	Dual Output Fast LDO with Integrated SVS	2.00
TPS703xx	1000	2000	160	190	185	See Note 3	✔	2	PWP	1.2	5.5	$\overline{EN}$	✔	✔	✔	✔	2.7	5.5	22 µF T	See TPS704xx[4]	2.35
TPPM0110	1500	300	1000	2500	1000	3.3/1.8		2	—	1.8	3.3	—					4.7	5.3	100 µF T	See TPPM0111 for 3.3-V/1.5-V Output	1.60

[1] C = ceramic, T = tantalum.
[2] 1.8/2.85, 1.8/Adj., 2.8/2.8, 2.8/Adj., 2.85/2.85.
[3] 3.3/2.5, 3.3/1.8, 3.3/1.5, 3.3/1.2.
[4] For independent enables instead of integrated sequencing.

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

Standard Linear Voltage Regulators Selection Guide

Device	V_{OUT} (nom) (V)	V_{OUT}/V_{REF} Tol. Over Temp. (%)	I_{OUT} (max) (mA)	Min I_{OUT} for Regulation (mA)	I_q (max) (mA)	V_{DO} (typ) (V)	V_{DO} (max) (V)	V_{IN} (max) (V)	$V_{IN} - V_{OUT}$ (max) (V)	Price*
LM237, LM337	Adj. (–1.2 to –37)	4	1500	1.2, 1.5	—	—	3	—	–40	0.29
LM317, LM317M	Adj. (1.2 to 37)	4	1500, 500	3.5	—	—	3	—	40	0.27
MC79Lxx/A	–5, –12, –15	5, 10	100	—	6 to 6.5	1.7	2 to 2.5	–20, –27, –30	—	0.13
TL317	Adj. (1.2 to 35)	4	100	1.5	—	—	2.5	—	35	0.13
TL780-xx	5, 12, 15	2	1500	—	8	2	2 to 2.5	25, 30, 30	—	0.32
TL783	Adj. (1.25 to 125)	6	700	15	—	—	20	—	125	1.15
UA723	Adj. (2 to 37)	5 (25°C)	150	—	4	—	3	—	38	0.29
UA78Lxx/A	2.6, 5, 6.2, 8, 9, 10, 12, 15	5, 10	100	—	6 to 6.5	1.7	2 to 2.5	20 to 30	—	0.11
UA78Mxx	3.3, 5, 6, 8, 9, 12	5	500	—	6	2	2 to 2.5	25 to 30	—	0.25
UA78xx	5, 8, 10, 12, 15, 24	5	1500	—	8	2	2 to 3	25 to 38	—	0.23
UA79xx	–5, –8, –12, –15	5	1500	—	2	1.1	2 to 2.5	–25 to 30	—	0.25
UA79Mxx	–5, –8	5	500	—	2	1.1	2 to 2.5	–25	—	0.25

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

LDO Controllers Selection Guide

Device	I_q (mA)	I_{drive} (max) (mA)	V_{IN} (max) (V)	V_{OUT} (min) (V)	Tolerance (%)	Shutdown	Short Circuit Limit Type	Comments	Price*
UC3832/3	3.3	100	40	2	2	Yes	Duty Cycle	Precise	2.50
UC3834	5.5	200	40	1.5	4	Yes	Foldback	High Efficiency	5.33
UC3835/6	3.75	250	40	5.0/2.5	2	Yes	Foldback	High Efficiency	3.05
UCC3837	1.2	500	12	1.5	1	No	Duty Cycle	8-Pin	1.95
LFC789D25	2	10	18	2.5	2	No	—	Dual	0.36

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

Automotive Qualified LDOs

Device	I_O (typ) (mA)
TPS769xx-Q1	100
TPS791xx-Q1	100
TPS792xx-Q1	100
TPS793xx-Q1	200
TPS766xx-Q1	250
TPS775xx-Q1	500
TPS776xx-Q1	500
TPS725xx-Q1	1000

Device	I_O (typ) (mA)
TPS767xx-Q1	1000
TPS768xx-Q1	1000
TPS751xx-Q1	1500
TPS753xx-Q1	1500
TPS752xx-Q1	2000
TPPM0110-Q1	1500/300
TPPM0111-Q1	1500/300

Above parts are screened in accordance to AEC-Q100 and are suited for automotive applications. Additional devices can be released for automotive by contacting TI. Please see electrical specifics on previous page.

Resources *For a complete list of Resources, visit power.ti.com*

Literature Number	Description
Free Development Boards	
DEM-SOT23LDO	Compatible with most positive-output LDOs in the SOT23 (DBV) package
DEM-SOT223LDO	Compatible with most positive-output LDOs in the SOT223 (DCQ) package
Application Notes	
SLVA118	Digital Designer's Guide to Linear Regs and Thermal Management
SLVA072	Technical Review of LDO Operation and Performance
SLVA115	ESR, Stability and the LDO Regulator
SLVA119	Extending the Input Voltage Range of an LDO Regulator
SLUA256	Adjusting High Current LDOs down to 0.5-V Output Voltage
SLMA002	PowerPAD Thermally Enhanced Package Application Report
SLVA076	Supply Voltage Drop on Fast Current Demand
SLVA207	Understanding LDO Dropout

DC/DC Controllers (External Switch)

Design Factors

Input Voltage — More than one voltage may be available on the circuit board. One voltage can operate the controller IC, while another voltage can be used in the power conversion section. Choose the most suitable voltage that can handle the current needed by the system.

Output Voltage — The output voltage can be adjusted down to the controller reference voltage by using a voltage divider.

Output Current — Output current is often set by external power MOSFETs. Paralleling multiple power MOSFETs can control higher currents, as long as the MOSFET drivers can adequately drive the external FETs.

Efficiency — Higher efficiency will help with thermal issues, since wasted power is converted into heat. Higher currents quickly generate more heat, so airflow and board space must be considered.

Accuracy — Today's advanced processors need better accuracy to support lower core voltages. There is a cost tradeoff when a more accurate controller is needed.

Protection Features — Applications that use many expensive processors and peripheral ICs on a single board can benefit from the long-term reliability ensured by implementing the controller's protection features.

TPS40K™ Series — Designer software available at: **power.ti.com/40kswifttool**

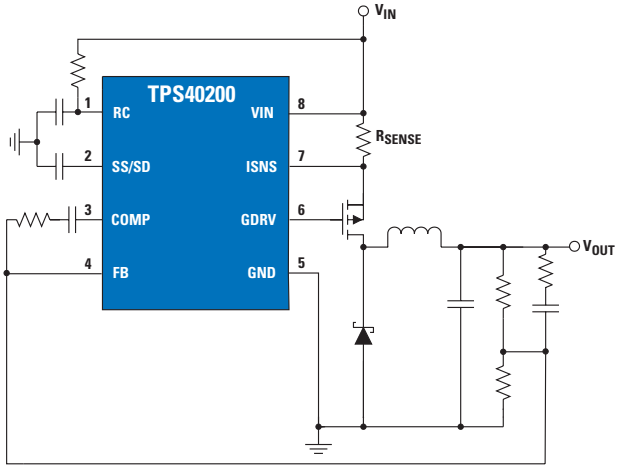
Software Tool Available

Wide Input Range (4.5-V to 52-V) Flexible Non-Synchronous Buck Controller

TPS40200

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/TPS40200**

The TPS40200 is a flexible non-synchronous controller with a built-in 200-mA driver for P-channel FETs. The circuit operates up to 52 V with a power-saving feature that turns off driver current once the external FET has been fully turned on. The circuit operates with voltage mode feedback and has feed-forward input voltage compensation that responds instantly to input voltage change. The controller's 0.700-V reference is trimmed to 1%, providing the means to control low voltages with good accuracy. The TPS40200 comes in an 8-pin SOIC and supports many of the features of more complex controllers.



Typical application.

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
TPS40009EVM-001	TPS40009-Based 5-A Converter in Less Than One Square Inch	49
TPS40021EVM-001	Highly Efficient Sync. Buck Converter with PWM Controller. Input Range 2.5 to 5.0 V, at 3.3 V_{IN} Steps Down to 1.5 V at 20 A	49
TPS40055EVM-001	TPS40055-Based Design Converts Bus from 12 to 1.8 V at 15 A	49
TPS40055EVM-002	Wide Range Input TPS40055 Converter Delivers 5 V at 2 A	49
TPS40071EVM-001	Step-Down Converter Delivers 10 A from 5- to 12-V Bus Voltages	49
TPS40074EVM-001	A 12-V Input, 1.5-V Output, 15-A Synchronous Buck Converter	49
TPS40090EVM-001	Multiphase Buck Converter Steps Down from 12 to 1.5 V at 100 A with UCC27222 Driver	49
TPS40090EVM-002	Multiphase 12 V to 1.5 V at 100 A	49
TPS40100EVM-001	A 12-V Input, 3.3-V Output, 10-A Synchronous Buck Converter	49
TPS40130EVM-001	Multi-Phase 12-V_{IN}, 1.5-V_{OUT}, 40-A Two-Phase Synchronous Buck Converter	49
TPS40190EVM-001	A 12-V Input, 1.5-V Output, 10-A Synchronous Buck Converter	49
TPS40200EVM-001	A 12-V Input, 3.3-V Output, 2.5-A Nonsynchronous Buck Converter	49
TPS51020EVM-001	Highly Efficient Dual DDR Selectable EVM	49
TPS5124EVM-001	Accepts V_{IN} (6.5- to 15-V) 12-V Step-Down to Dual 2.0-V Outputs at 6 A	49

**Suggested resale price in U.S. dollars.*

Literature Number	Description
Application Notes	
SLUA285	Predictive Gate Drive™—Frequently Asked Questions
SLUA281	Predictive Gate Drive Boosts Converter Efficiency

DC/DC Controllers (External Switch)

Selection Guide

Device	V_{IN} (V)	V_O (max) (V)	V_O (min) (V)	V_{REF} Tol (%)	Driver Current (A)	Output Current (A)[1]	Multiple Outputs	Frequency (kHz)	Protection[2] SCP	OVP	UVLO	Application[3] PG	Non-Sync	Source/ Sink	Prebias Operation	Sync	PGD	DDR	Remote Sense	Price*
General-Purpose DC/DC Controllers																				
TPS40007	2.25 to 5.5	4	0.7	1.5	1	15	No	300	✔		✔			✔			✔			0.99
TPS40009	2.25 to 5.5	4	0.7	1.5	1	15	No	600	✔		✔				✔		✔			0.99
TPS40021	2.25 to 5.5	4	0.7	1	2	25	No	See Note 4	✔		✔	✔		✔		✔	✔			1.15
TPS40040	2.25 to 5.5	4.95	0.60	1	1	15	No	300	✔		✔			✔	✔					0.65
TPS40041	2.25 to 5.5	4.95	0.60	1	1	15	No	600	✔		✔			✔	✔					0.65
TPS40052	10 to 40	35	0.7	1	1	20	No	See Note 4	✔		✔							✔		1.35
TPS40055	8 to 40	35	0.7	1	1	20	No	See Note 4	✔		✔			✔						1.35
TPS40057	8 to 40	35	0.7	1	1	20	No	See Note 4	✔		✔				✔	✔				1.35
TPS40061	10 to 55	40	0.7	1	1	10	No	See Note 4	✔		✔			✔						1.40
TPS40071	4.5 to 28	23	0.7	1	1	20	No	See Note 4	✔		✔	✔		✔			✔			1.35
TPS40074	4.5 to 28	23	0.7	1	1	20	No	See Note 4	✔		✔	✔			✔	✔	✔		✔	1.35
TPS40100 (Sequencing)	4.5 to 18	6	0.7	0.6	1.3	20	No	Program 100 to 600	✔		✔	✔			✔	✔				1.45
TPS40190	4.5 to 15	12.75	0.59	1	1.2	20	No	300			✔			✔	✔					0.99
TPS40200	4.5 to 52	46	0.7	2	0.2	3	No	Program from 35 to 500 kHz	✔		✔		✔			✔				0.55
TPS51020	4.5 to 28	24	0.85	1	2	20	2	450	✔	✔	✔	✔						✔		2.40
TPS5124	4.5 to 15	12	0.85	1	2	20	2	500	✔	✔	✔									2.15
UCC2541	2.7 to 35	30	0.7	—	3	40	No	1 MHz	✔						✔	✔	✔			1.45
Multiphase DC/DC Controllers																				
TPS40090 (Up to 4 phase)	4.5 to 15	3.3	0.7	1	—	30 per phase	No	See Note 4	✔		✔	✔				✔				1.90
TPS40091 (w/Tristate) (Up to 4 phase)	4.5 to 15	3.3	0.7	1	—	30 per phase	No	See Note 4	✔		✔	✔			✔	✔				1.90
TPS40120 (VID DAC)	4.5 to 5.5	1.6	0.8375	0.3	—	—	—	—												0.49
TPS40130 (2 phase)	3.0 to 40	4	0.7	1	1.2	30 per phase	No	See Note 4	✔	✔	✔	✔		✔		✔		✔	✔	1.15
DC/DC Controllers with Light Load Efficiency													**Comments**							
TPS51020	4.5 to 28	5.5	0.85	1	2	20	2 + 1	270, 360, 450	✔	✔	✔	✔	Dual, DDR selectable w/skip mode					✔		2.40
TPS5110	4.5 to 28	3.5	0.9	1	1.5	1.2/1.5	1 + 1	Up to 500	✔	✔	✔	✔	Single buck w/NMOS LDO controller							2.35
TPS51116	3 to 28	3.0	1.5	1	0.8	10	1 + 1	Up to 400	✔	✔	✔	✔	Sync switcher w/3-A tracking LDO					✔		1.20
TPS51117	4.5 to 28	5.5	0.75	1	3	10	1	Up to 550	✔	✔	✔	✔	Single buck							0.80
TPS51120	4.5 to 28	5.5	2	1	3	20	2 + 1 + 1	270, 330, 430, 580	✔	✔	✔	✔	Dual buck with 5-V/3.3-V LDOs							2.50
TPS51124	3 to 28	5.5	0.76	1	3	10	2	300, 360, 420	✔	✔	✔	✔	Dual buck							2.25
TPS5130	4.5 to 28	5.5	0.9	1.5	1.5	1.2/1.5	3 + 1	Up to 500	✔	✔	✔	✔	Triple buck w/NMOS LDO controller							3.65
DC/DC Controllers (Without Drivers)													**Comments**							
TL1451A	3.6 to 50	50	2.5	4	0.02	—	2	500			✔		Dual PWM buck/boost							0.95
TL5001	3.6 to 40	50	1	5	0.02	—	No	400			✔		PWM buck boost, typ. ref. voltage tolerance ±5%							0.45
TL5001A	3.6 to 40	50	1	3	0.02	—	No	400			✔		PWM buck boost, typ. ref. voltage tolerance ±3%							0.55
Other Topology DC/DC Controllers													**Comments**							
TPS43000	1.8 to 9	8	0.8	2	1.25	7	No	2 MHz	✔	✔	✔	✔	High-frequency, buck, boost, or sepic controller							2.10
TPS64200	1.8 to 6.5	6.5	1.2	—	—	3	No	—	✔		✔		Simple, hysteretic high-efficiency controller in SOT-23							0.55
UC3572	4.75 to 30	0	–48	2	0.5	5	No	300	✔		✔		Simple inverting PWM controller							1.05

[1]Current levels of this magnitude can be supported.

*New devices are listed in **bold red**.*

[2]SCP = short-circuit protection, OVP = over-voltage protection, UVLO = under-voltage lockout.

[3]The controller of choice for most applications will be the source/sink version, which has two-quadrant operation and will source or sink output current. PG = Power Good; PGD = Predictive Gate Drive™ technology included; DDR = supports DDR memory.

[4]Programmable up to 1 MHz.

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

DC/DC Converters (Integrated Switch)

Design Software Available at power.ti.com

Design Factors

Efficiency and Solution Size — Use of inductive switching converters with integrated switches is recommended when highest conversion efficiency and smallest solution size are desired.

TI's family of low-power DC/DC converters (TPS6xxxx) and SWIFT™ (TPS54xxx) point-of-load step-down DC/DC converters achieve 97% peak efficiencies. Synchronous rectification not only replaces the cost of an external Schottky rectifier diode but also increases the converter efficiency by up to 10%. Higher efficiency will directly translate into additional operating time in battery-powered applications and smaller power dissipation in high-current applications, easing thermal design.

Integrating the high- and low-side switching FETs reduces board space, as only resistors and capacitors along with one inductor are required externally for operation. Depending on the output current, DC/DC converters come in packages such as CSP (800 mA), SOT-23 (400 mA), QFN-10 (1.2 A) and TSSOP-28 (13 A), further reducing solution size.

Output Current — Output current is typically limited by the size of the integrated FETs and is rated for the minimum input voltage (end-of-discharge voltage in battery systems) for the TPS6xxxx series. The TPS54xxx output current denotes the continuously available output current; higher peak-currents are achievable to ensure proper supply at start-up of high-performance DSP, FPGA and ASIC systems. For Boost converters, the datasheet specifies the current limit of the built-in switches. A rough estimate of the output current can be obtained using the formula:

$$I_{OUT} = 0.65 \times I_{Switch(min)} \times (V_{IN}/V_{OUT})$$

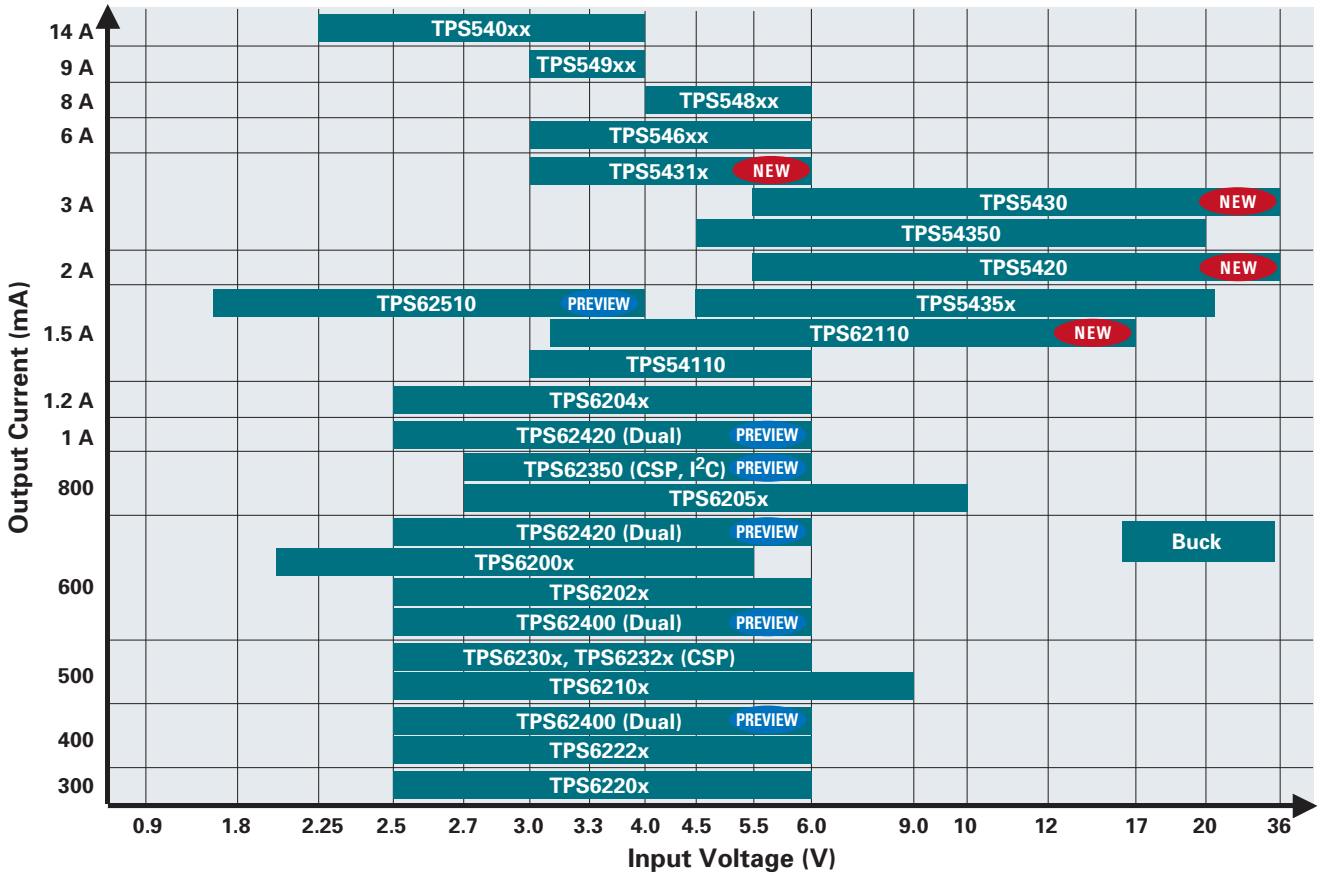
For output currents below 300 mA and efficiencies under 90%, inductorless charge-pump DC/DC regulators can be a cost and space-efficient alternative (see pages 35–36).

Input Voltage — DC/DC converters can operate from a wide range of input sources: power modules, wall supplies or batteries. The TPS6xxxx series with its small packaging and quiescent current is optimized for low-power, battery-operated applications. For battery-powered systems the input voltage changes over a wide range while the battery is being discharged. For this reason converter selection depends on the given battery technology and number of cells.

The TPS54xxx SWIFT™ series can operate from preregulated 24-, 12-, 5- or 3.3-V bus voltages.

Output Voltage — Lower voltages are required for today's advanced DSPs, FPGAs and ASICs. To allow maximum flexibility, both fixed and adjustable output voltages down to 0.7 V are available. The TPS61xxx allows input voltage step-up to as high as 28 V.

DC/DC Step-Down Converters (Integrated Switch) Family of Products



5.5-V to 36-V Input, 3-A Step-Down DC/DC Converter

TPS5430 NEW

Get samples and datasheet at: **www.ti.com/sc/device/TPS5430**

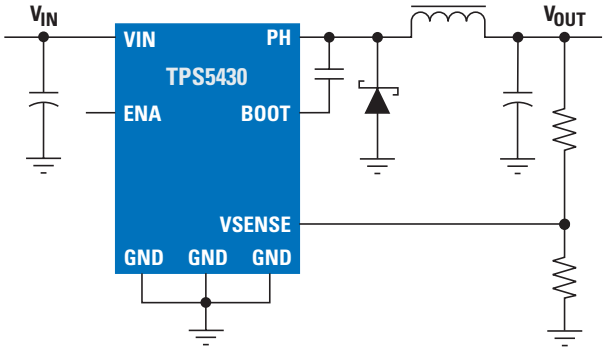
The TPS5430 3-A DC/DC converter is ideal for a wide range of applications using a popular 12- or 24-V rail. Using the SWIFT™ software tool greatly reduces development time.

Key Features

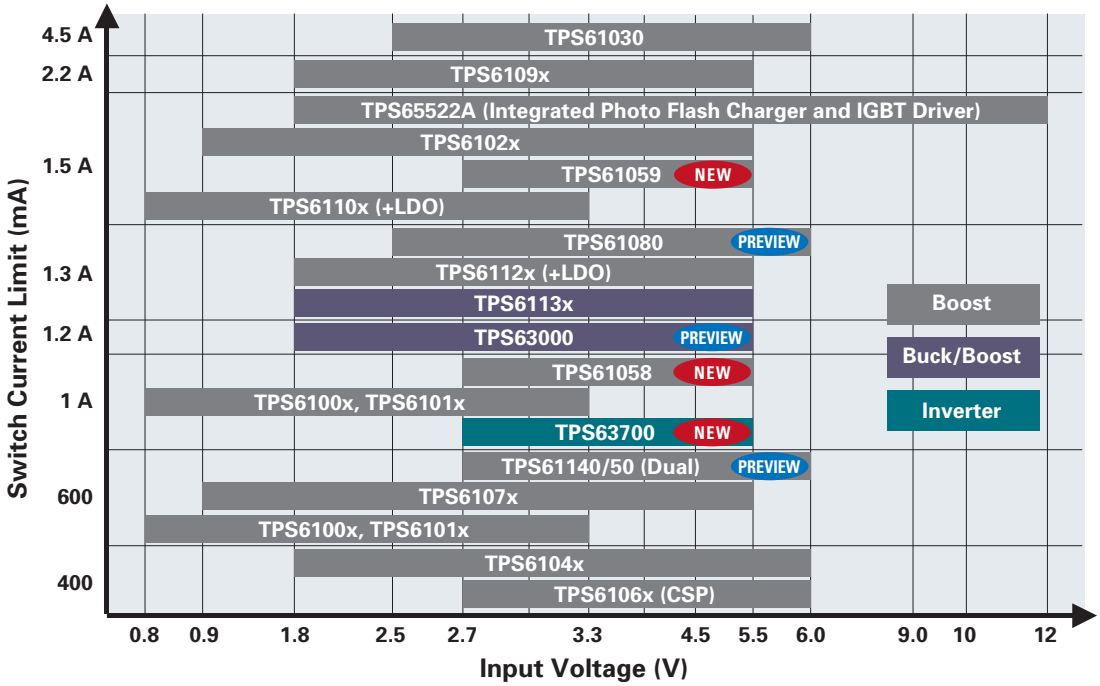
- Integrated 110-mΩ N-channel MOSFET
- Fixed 500-kHz switching frequency
- Adjustable output voltage down to 1.23 V
- Internal compensation
- Internal slow start
- Internal bootstrap diode
- Voltage feed-forward
- Built-in over-current protection and thermal shutdown
- Only 18-µA shutdown quiescent current
- –40°C to ~125°C operating junction temperature range
- Packaging: Small thermally enhanced 8-pin SOIC PowerPAD™

Applications

- Consumer: Set-top box, DVD, LCD displays
- Industrial and car audio power supplies
- Battery chargers, high-power LED supply
- 12/24-V distributed power systems



DC/DC Step-Up Converters (Integrated Switch) Family of Products



DC/DC Converters (Integrated Switch)

Resources *For a complete list of Resources, visit power.ti.com*

Literature Number	Description
Application Notes	
SLVA107	Designing for Small-Size, High-Frequency Applications with SWIFT™ Regulators
SLVA126	SWIFT Regulators w/Ceramic Output Caps Worst Case Analysis and Measurement
SLVA109	Designing with the TPS54310 Synchronous Buck Regulator
SLVA111	Designing with the TPS54311 Through TPS54316 Synchronous Buck Regulators
SLVA104A	Designing with the TPS54610 Synchronous Buck Regulator
SLVA105A	Designing with the TPS54611 Through TPS54616 Synchronous Buck Regulators
SLVA113A	Optimizing the Layout of the TPS5461x for Thermal Performance
SLUA273	Using the TPS54372 Tracking/Termination Synchronous PWM Switcher
SLVA112	Using the TPS54672 Tracking/Termination Synchronous PWM Switcher
SLVA121	Using the TPS54872 Tracking/Termination Synchronous PWM Switcher
SLVA120	Using the TPS54972 Tracking/Termination Synchronous PWM Switcher
SLVA007	Sequencing with TPS54x80 and TPS54x73 SWIFT DC/DC Converters
SLVA117	Dual Output Power Supply Sequencing for High Performance Processors
SLPB008B	TI Power Solutions for Xilinx® FPGAs
SLVA123	DVS For OMAP1510 Using TPS62200
SLVA006	Maximum Output Current of TPS62050
SLUA272	High Voltage Power Supply Using the TPS61040
SLEA004	Extending Battery Life with the TPS61040 White Light LED Driver
SLVA125	TPS61042 White Light LED Driver Boost Converter
SLVA131	TPS61042 Dual Li-Ion and Higher Input Voltages
SLVA122	White Light LED Driver With Gradual Dimming
SLUA271	QFN/SON PCB Attachment Application Note
SLVA134	Adjusting the Output Voltage of Fixed-Voltage SWIFT Devices
SLUP100	Snubber Circuits Theory, Design and Application
SLVA201	Thermal Performance of SWIFT DC/DC Converters in 28-Pin HTSSOP Package
SLVA202	Low Voltage SWIFT DC/DC Converters Pin Compatibility
SLVA159A	Using 3.3-V Signals for Spartan™-3 Configuration and JTAG Ports
SLVA203	Using TPS54x80 Tracking SWIFT DC/DC Converters for Simultaneous Tracking of Input Supply
SLVA212	Limitations of Slew Rate on the REFIN Pin of the TPS54x72 Family

Selection Guide

Device	I_{OUT} (mA)	V_{IN} (V)	V_{OUT} (V)	Max Frequency (kHz)	Power Good	Enable	Current Limit	Thermal Shutdown	Sync Pin	Adj. Soft Start	EVM	Package	Comments	Price*
SWIFT™ Synchronous Step-Down (Buck) Regulators — Up to 14 A														
TPS54110	1500	3.0 to 6.0	Adj. to 0.9	700	✔	✔	✔	✔	✔	✔	✔	20 HTSSOP	Adjustable Output Only	2.00
TPS40222	1600	4.5 to 5.5	Adj. to 0.8	1250			✔	✔			✔	6 SON	Non-synchronous Buck	0.70
TPS5420	2000	5.5 to 36	Adj. to 1.23	500		✔	✔	✔			✔	8 SOIC	Non-synchronous Buck	1.70
TPS5430	3000	5.5 to 36	Adj. to 1.23	500		✔	✔	✔			✔	8 HSOIC	Non-synchronous Buck	1.85
TPS54350/2/3/4/5/6/7	3000	4.5 to 20	Adj. and fixed	700	✔	✔	✔	✔	✔		✔	16 HTSSOP	Sync. or Non-sync. Buck	2.05
TPS54310/1/2/3/4/5/6	3000	3.0 to 6.0	Adj. and fixed	700	✔	✔	✔	✔	✔	✔	✔	20 HTSSOP	Adj., 0.9, 1.2, 1.5, 1.8, 2.5, 3.3 V	2.35
TPS54317	3000	3.0 to 6.0	Adj. to 0.9	1600	✔	✔	✔	✔	✔	✔	✔	24 QFN	Output Voltage (0.9 to 0.9 x V_{IN})	2.50
TPS54372	3000	3.0 to 6.0	Adj. to 0.2	700	✔	✔	✔	✔			✔	20 HTSSOP	Active Bus Termination/DDR	2.35
TPS54380	3000	3.0 to 6.0	Adj. to 0.9	700	✔	✔	✔	✔			✔	20 HTSSOP	Sequencing (TRACKIN pin)	2.35
TPS54550	5000	4.5 to 20	Adj. and fixed	700	✔	✔	✔	✔	✔	✔	✔	16 HTSSOP	Sync. or Non-sync. Buck	2.95
TPS54610/1/2/3/4/5/6	6000	3.0 to 6.0	Adj. and fixed	700	✔	✔	✔	✔	✔	✔	✔	28 HTSSOP	Adj., 0.9, 1.2, 1.5, 1.8, 2.5, 3.3 V	3.35
TPS54672	6000	3.0 to 6.0	Adj. to 0.2	700	✔	✔	✔	✔			✔	28 HTSSOP	Active Bus Termination/DDR	3.35
TPS54680	6000	3.0 to 6.0	Adj. to 0.9	700	✔	✔	✔	✔			✔	28 HTSSOP	Sequencing (TRACKIN pin)	3.35
TPS54810	8000	4.0 to 6.0	Adj. to 0.9	700	✔	✔	✔	✔	✔	✔	✔	28 HTSSOP	Adjustable Output Only	3.95
TPS54872	8000	4.0 to 6.0	Adj. to 0.2	700	✔	✔	✔	✔			✔	28 HTSSOP	Active Bus Termination/DDR	3.95
TPS54880	8000	4.0 to 6.0	Adj. to 0.9	700	✔	✔	✔	✔			✔	28 HTSSOP	Sequencing (TRACKIN pin)	3.95
TPS54910	9000	3.0 to 4.0	Adj. to 0.9	700	✔	✔	✔	✔	✔	✔	✔	28 HTSSOP	Adjustable Output Only	4.20
TPS54972	9000	3.0 to 4.0	Adj. to 0.2	700	✔	✔	✔	✔			✔	28 HTSSOP	Active Bus Termination/DDR	4.20
TPS54980	9000	3.0 to 4.0	Adj. to 0.9	700	✔	✔	✔	✔			✔	28 HTSSOP	Sequencing (TRACKIN pin)	4.20
TPS54010	14000	2.25 to 4.0	Adj. to 0.9	700	✔	✔	✔	✔	✔	✔	✔	28 HTSSOP	Dual Input Bus (2.5, 3.3 V)	5.30

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

*New devices are listed in **bold red**. Preview devices are listed in **bold blue**.*

DC/DC Converters (Integrated Switch)

Selection Guide (Continued)

Device	I_{OUT} (mA)	Switch Current Limit (typ) (mA)	V_{IN} (V)	V_{OUT} Adj. (V)	V_{OUT} Fixed (V)	Peak Efficiency (%)	Switching Frequency (typ) (kHz)	Recommended Inductor Size (µH)	Quiescent Current (typ) (mA)	Shutdown Current (typ) (µA)	Low Battery	Power Good	Undervoltage Lockout	Thermal and/or Short-Circuit Protection	Package: Chipscale (WCSP)	Package: SOT-23	Package: MSOP	Package: QFN	Package: SOIC	EVM	Price*
Low-Power Step-Down (Buck) Regulators — Small, Efficient, Low I_q																					
TPS62200	300	670	2.5 to 6.0	0.7 to 6.0	—	97	1000	10	0.015	0.1			✔	✔		6				✔	1.20
TPS62201/2/3/4	300	670	2.5 to 6.0	—	1.5, 1.6, 1.8, 3.3	97	1000	10	0.015	0.1			✔	✔		6				✔	1.35
TPS62205/6/7/8	300	670	2.5 to 6.0	—	1.2, 1.6, 1.875, 2.5. 2.6	97	1000	10	0.015	0.1			✔	✔		6					1.35
TPS62220	400	880	2.5 to 6.0	0.7 to 6.0	—	95	1250	4.7	0.015	0.1			✔	✔		6				✔	1.40
TPS62221/2/3/4	400	880	2.5 to 6.0	—	1.5, 1.6, 1.8, 2.3	95	1250	4.7	0.015	0.1				✔		6				✔	1.50
TPS62228/9	400	880	2.5 to 6.0	—	1.7, 1.875	95	1250	4.7	0.015	0.1				✔		6				✔	1.50
TPS62400	400/600	800/1000	2.6 to 6.0	0.6 to 6.0	1.1/1.6	95	2250	2 x 3.3	0.030	0.1								10			2.70
TPS62100/1/2/3	500	—	2.5 to 9.0	0.8 to 8.0	—	92	2000	10	0.625	1				✔					8	✔	1.90
TPS62300	500	740	2.5 to 6.0	0.6 to 5.4	—	90	3000	1	0.086	0.1			✔	✔	8			10		✔	1.85
TPS62301/2/3/5	500	740	2.5 to 6.0	—	1.5, 1.6, 1.8, 1.875	93	3000	1	0.086	0.1			✔	✔	8			10		✔	1.95
TPS62320	500	740	2.5 to 6.0	0.6 to 5.4	—	90	3000	1	0.086	0.1			✔	✔	8			10		✔	1.95
TPS62321	500	740	2.5 to 6.0	—	1.5	93	3000	1	0.086	0.1			✔	✔	8			10		✔	1.95
TPS62000	600	1600	2.0 to 5.5	0.8 to 5.0	—	95	750	10	0.05	0.1	✔	✔	✔	✔	8		10			✔	1.30
TPS62001/2/3/4	600	1600	2.0 to 5.5	—	0.9, 1, 1.2, 1.5	95	750	10	0.05	0.1	✔	✔	✔	✔			10				1.40
TPS62005/6/7/8	600	1600	2.0 to 5.5	—	1.5, 1.8, 1.9, 2.5, 3.3	95	750	10	0.05	0.1	✔	✔	✔	✔			10			✔	1.40
TPS62020/1	600	1100	2.5 to 6.0	0.7 to 6.0	—	95	1250	6.2	0.018	0.1			✔	✔			10	10		✔	1.60
TPS62026	600	1100	2.5 to 6.0	—	3.3	95	1250	6.2	0.018	0.1			✔	✔			10	10		✔	1.60
TPS62420	600/800	1000/1400	2.6 to 6.0	0.6 to 6.0	1.1/1.6	95	2250	2 x 3.3	0.030	0.1								10		✔	2.95
MC34063A	750	1500	3 to 40	1.25 to 33	—	—	100	—	2.7	—								8	8	✔	0.39
TPS62050	800	1400	2.7 to 10.0	0.7 to 6.0	—	95	850	10	0.012	1.5	✔	✔	✔	✔			10			✔	1.85
TPS62051	800	1400	2.7 to 10.0	0.7 to 6.0	—	95	850	10	0.012	1.5	✔	✔	✔	✔			10				1.85
TPS62052/4/6	800	1400	2.7 to 10.0	—	1.5, 1.8, 3.3	95	850	10	0.012	1.5	✔	✔	✔	✔			10			✔	1.85
TPS62350	800	1300	2.7 to 6.0	0.75 to 1.5375	—	95	3000	1.0	0.030	0.1			✔	✔	12			10		✔	2.15
TL2575/HV	1000	3200	4.75 to 40/60	1.25 to 38/58	3.3, 5, 12, 15	88	52	330	5	50										✔	0.96/2.45
TPS62040	1200	2000	2.5 to 6.0	0.7 to 6.0	—	95	1250	6.2	0.018	0.1			✔	✔			10	10		✔	1.90
TPS62042/3/4/6	1200	2000	2.5 to 6.0	—	1.5, 1.6, 1.8, 3.3	95	1250	6.2	0.018	0.1			✔	✔			10	10		✔	1.90
TPS62110	1500	2400	3.1 to 17	1.2 to 16	—	95	1000	6.8	0.018	1.5	✔	✔	✔	✔				16		✔	2.50
TPS62111/2	1500	2400	3.1 to 17	—	3.3, 5	95	1000	6.8	0.018	1.5	✔	✔	✔	✔				16		✔	2.50
TPS62510	1500	2000	1.6 to 3.8	0.6 to 3.8	—	97	1500	2.2	0.018	0.1								10		✔	2.50

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

*New devices are listed in **bold red**.*
*Preview devices are listed in **bold blue**.*

DC/DC Converters (Integrated Switch)

Selection Guide (Continued)

Device	I_{OUT} (mA)[1]	Switch Current Limit (typ) (mA)	V_{IN} (V)	V_{OUT} Adj. (V)	V_{OUT} Fixed (V)	Peak Efficiency (%)	Switching Frequency (typ) (kHz)	Recommended Inductor Size (µH)	Quiescent Current (typ) (mA)	Shutdown Current (typ) (µA)	Integrated LDO I_{OUT} (mA)/ V_{OUT} (V)	Low Battery	Power Good	Undervoltage Lockout	Thermal and/or Short-Circuit Protection	Package: SOT-23	Package: MSOP	Package: QFN	Package: TSSOP	Package: SOIC	EVM	Price*
Step-Up Regulators — Up to 4.5-A Switch Limit																						
TPS6734	120	—	2.7 to 12	—	12	86	170	18	1.2	3	—				✔					8	✔	1.25
TPS61041	50	250	1.8 to 6.0	V_{IN} to 28	—	87	1000	10	0.028	0.1	—			✔	✔	6					✔	0.75
TPS61040	90	400	1.8 to 6.0	V_{IN} to 28	—	87	1000	10	0.028	0.1	—			✔	✔	6					✔	0.95
TPS61045	100	450	1.8 to 6.0	V_{IN} to 28	—	85	1000	4.7	0.035	1	—			✔	✔			8			✔	1.35
TPS61011/2/3	100	480/560/930	0.8 to 3.3	—	1.5/1.8/2.5	95	500	10	0.036	1	—	✔		✔	✔		10					1.10
TL497A	—	500	4.5 to 12	(V_{IN} + 2) to 30	—	85	—	—	11	6000	—								14	14		0.86
TPS61001/2/3	100	500/650/900	0.8 to 3.3	—	1.5/1.8/2.5	85	500	33	0.05	0.2	—	✔		✔			10					0.95
TPS61080/1	—	500/1200	2.5 to 6.0	V_{IN} to 27	—	85	1200	4.7	—	—	—				✔			10			✔	1.90
TPS61070/71	150	600	0.9 to 5.5	1.8 to 5.5	—	90	1200[2]	4.7	0.019	0.1	—			✔	✔	6						0.95
TPS65130	700	800	2.7 to 5.5	15/–15	—	89	1380	4.7	0.5	0.2	—			✔	✔			24			✔	2.95
TPS61004/5/6	200	950/1000/1100	0.8 to 3.3	—	2.8/3/3.3	85	500	33	0.05	0.2	—	✔		✔			10					0.95
TPS61014/5/6	200	1010/1060/1130	0.8 to 3.3	—	2.8/3/3.3	95	500	10	0.036	1	—	✔		✔	✔		10					1.10
TPS61000	200	1100	0.8 to 3.3	1.5 to 3.3	—	85	500	33	0.05	0.2	—	✔		✔			10				✔	0.95
TPS61007	200	1100	0.8 to 3.3	1.5 to 3.3	—	85	500	33	0.05	0.2	—	✔		✔			10					0.95
TPS61010	200	1130	0.8 to 3.3	1.5 to 3.3	—	95	500	10	0.036	1	—	✔		✔	✔		10				✔	1.10
MC34063A	750	1500	3 to 40	3 to 39.5	—	—	100	—	2.7	—	—				✔			8		8	✔	0.39
TPS61020	500	1500	0.9 to 5.5	1.8 to 5.5	—	96	720	6.8	0.025	0.1	—	✔		✔	✔			10			✔	1.40
TPS61024/5/7	500	1500	0.9 to 5.5	1.8 to 5.5	3/3.3/5	96	720	6.8	0.025	0.1	—	✔		✔	✔			10				1.40
TPS65131	700	2000	2.7 to 5.5	15/–15	—	88	1380	4.7	0.5	0.2	—			✔	✔			24			✔	2.95
TPS61090	700	2200	1.8 to 5.5	1.8 to 5.5	—	96	600	6.8	0.02	0.1	—	✔		✔	✔			16			✔	1.70
TPS61091/2	700	2200	1.8 to 5.5	—	3.3/5	96	600	6.8	0.02	0.1	—	✔		✔	✔			16				1.70
TPS61030	1000	4500	1.8 to 5.5	1.8 to 5.5	—	96	600	6.8	0.02	0.1	—	✔		✔	✔			16	16		✔	2.10
TPS61031/2	1000	4500	1.8 to 5.5	—	3.3/5	96	600	6.8	0.02	0.1	—	✔		✔	✔			16	16		✔	2.10
Step-Up (Boost) Regulators with Integrated LDO																						
TL499A	100	—	1.1 to 10	2.9 to 30	—	85	—	—	—	15	100/Adj.											0.90
TPS61080/1	—	500/1200	2.5 to 6.0	V_{IN} to 27	—	85	600	10	—	—	—				✔			10			✔	1.90
TPS61120	500	1300	1.8 to 5.5	2.5 to 5.5	—	95	500	10	0.04	0.2	200/Adj.	✔	✔	✔	✔			16	16		✔	1.95
TPS61121/2	500	1300	1.8 to 5.5	—	3.3/3.6	95	500	10	0.04	0.2	200/1.5, 3.3	✔	✔	✔	✔			16	16		✔	1.95
TPS61100	200	1500	0.8 to 3.3	1.5 to 5.5	—	95	500	10	0.065	0.5	120/Adj.	✔	✔	✔	✔			24	20		✔	1.85
TPS61103/6/7	200	1500	0.8 to 3.3	—	3.3/3.3/3.3	95	500	10	0.065	0.5	120/Adj., 1.5, 1.8	✔	✔	✔	✔			24	20		✔	1.85
Buck-Boost Regulators																						
TL497A	—	500	4.5 to 12	1.2 to (V_{IN}–1)	—	85	—	—	11	6000	—								14	14		0.86
TPS61130	300	1300	1.8 to 5.5	2.5 to 5.5	—	90	500	10	0.04	0.2	200/Adj.	✔	✔		✔			16	16		✔	2.05
TPS61131/2	300	1300	1.8 to 5.5	—	3.3/3.3	90	500	10	0.04	0.2	200/1.5, 3.3	✔	✔		✔			16	16			2.05
MC34063A	750	1500	3 to 40	3 to 39.5	—	—	100	—	2.7	—	—				✔			8		8	✔	0.39
TPS63000	1200	1700	1.8 to 5.5	1.2 to 5.5	3.3/5.0	90	1800	2.2	0.030	0.1	—				✔			10			✔	3.35
Inverting Regulators																						
TPS6735	200	—	4 to 6.2	—	–5.0	78	160	10	1.9	1	—			✔						8		1.25
TPS6755	200	—	2.7 to 9	Yes	—	78	160	10	1.9	1	—				✔					8		1.25
TL497A	—	500	4.5 to 12	–1.2 to –25	—	85	—	—	11	6000	—								14	14		0.86
TPS65130	700	800/2000	2.7 to 5.5	15/–15	—	89	1380	4.7	0.5	0.2	—			✔	✔			24			✔	2.95
TPS65131	700	800/2000	2.7 to 5.5	15/–15	—	81	1380	4.7	0.5	0.2	—			✔	✔			24			✔	2.95
TPS63700	360	1000	2.7 to 5.5	–2 to –15	—	84	1400	4.7	—	0.014	—							10			✔	2.35
MC34063A	750	1500	3 to 38	–1.25 to –36.3	—	—	100	—	2.7	—	—				✔			8		8	✔	0.39
TL2575/HV	350	3200	4.75 to 25/45	–1.25 to –35/55	–5/–12/–15	88	52	330	5	50	—				✔							0.96/2.45

[1] *For boost converters, max. I_{OUT} can be estimated with 0.65 x switch limit x (V_{IN}/V_{OUT}).*
[2] *PWM/PFM (TPS61070); PWM only (TPS61071).*
**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New devices are listed in **bold red**.*
*Preview devices are listed in **bold blue**.*

Inductorless DC/DC Regulators (Charge Pumps)

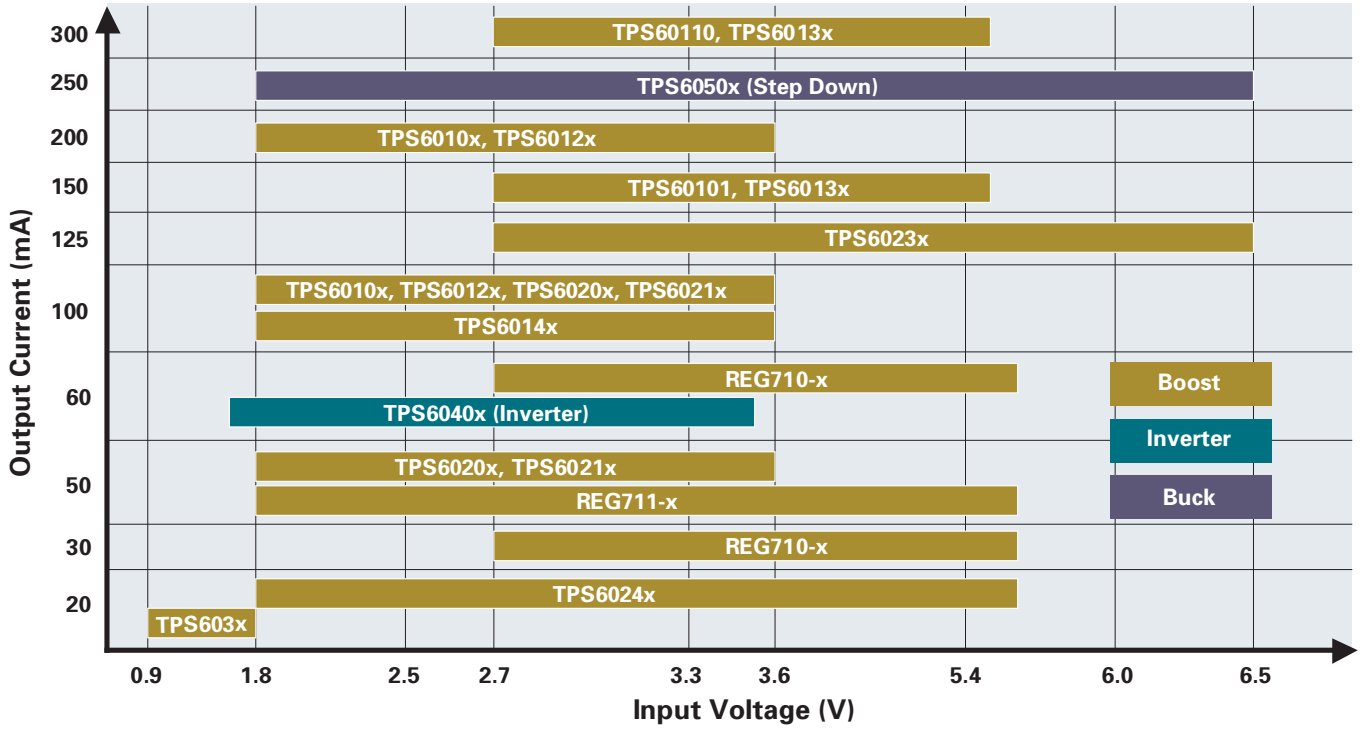
Design Factors

Efficiency and Solution Size — Use of charge pumps is recommended when a trade-off between efficiency and solution size needs to be made. Higher efficiency will directly translate into additional operating time in battery-powered applications. Charge pumps achieve peak efficiencies of 90% and typically require only a few capacitors for operation. No inductors, diodes or FETs are needed. Charge pumps come in small packages such as SOT-23 and MSOP-8, which further reduce solution size.

Output Current — Charge pump converters allow for small, power-efficient and cost-effective DC/DC solutions with output currents less than 300 mA and output voltage less than 6 V. If larger output currents, higher output voltages or greater efficiency are required, use of an inductive switching converter is more cost- and space-efficient (pages 28–34).

Output Ripple and Noise – TI charge pumps reduce output voltage ripple to a minimum by operating a pair of integrated charge pump loops with a phase shift of 180 degrees. This helps to avoid the cost of additional filtering at the output. Charge pumps also tend to generate less noise than an equivalent inductive switching converter of equal output current rating. This may be important in RF-sensitive or low-noise applications.

Inductorless DC/DC Regulators (Charge Pumps) Family of Products



Resources *For a complete list of Resources, visit power.ti.com*

Literature Number	Description
Application Notes	
SLVA082	Powering the TMS320VC5402 DSP Using the TPS60100, TPS76918, and the TPS3305-18
SLVA070A	TPS6010x/TPS6011x Charge Pump
SLVA098	Additional Negative Output with TPS601xx
SLVA099	Improved Start-up Performance for Charge Pumps TPS6030x
SLVA128	Optimizing Output Voltage Ripple for the REG710
SLVA133	TPS6031x Evaluation Using the TPS6030xEVM

Inductorless DC/DC Regulators (Charge Pumps)

Selection Guide

Device	I_{OUT} (mA)	V_{IN} (V)	V_{OUT} Adj. (V)	V_{OUT} Fixed (V)	Efficiency (%)	Switching Frequency (max) (kHz)	Quiescent Current (typ) (µA)	Shutdown Current (typ) (µA)	Features						Packaging				EVM	Price*
									Shutdown	Low Battery	Power Good	Undervoltage Lockout	Current Limit	Thermal Limit	SOT-23	QFN	MSOP	TSSOP		
Step-Down (Buck) Regulators																				
TPS60500	250	1.8 to 6.5	0.8 to 3.3	—	90	1200	40	0.05	✔		✔	✔	✔	✔			10		✔	0.80
TPS60501	250	1.8 to 6.5	—	3.3	90	1200	40	0.05	✔		✔	✔	✔	✔			10			0.80
TPS60502	250	1.8 to 6.5	—	1.8	90	1200	40	0.05	✔		✔	✔	✔	✔			10			0.80
TPS60503	250	1.8 to 6.5	—	1.5	90	1200	40	0.05	✔		✔	✔	✔	✔			10			0.80
Boost Regulators																				
TPS60100	200	1.8 to 3.6	—	3.3	90	300	50	0.05	✔			✔	✔					20	✔	1.25
TPS60101	100	1.8 to 3.6	—	3.3	90	300	50	0.05	✔			✔	✔					20		1.05
TPS60110	300	2.7 to 5.4	—	5.0	90	300	60	0.05	✔			✔	✔					20	✔	1.30
TPS60111	150	2.7 to 5.4	—	5.0	90	300	60	0.05	✔			✔	✔					20		1.15
TPS60120/1	200	1.8 to 3.6	—	3.3	85	450	55	0.05	✔	✔[1]	✔[1]	✔	✔					20	✔	1.25
TPS60122/3	100	1.8 to 3.6	—	3.3	85	450	55	0.05	✔	✔[1]	✔[1]	✔	✔					20		1.05
TPS60124/5	200	1.8 to 3.6	—	3.0	85	450	55	0.05	✔	✔[1]	✔[1]	✔	✔					20		1.25
TPS60130/1	300	2.7 to 5.4	—	5.0	90	450	60	0.05	✔	✔[1]	✔[1]	✔						20	✔	1.30
TPS60132/3	150	2.7 to 5.4	—	5.0	90	450	60	0.05	✔	✔[1]	✔[1]	✔						20		1.15
TPS60140/1	100	1.8 to 3.6	—	5.0	70	450	65	0.05	✔	✔[1]	✔[1]	✔	✔					20	✔	1.05
TPS60200/1	100	1.8 to 3.6	—	3.3	90	400	40	0.05	✔	✔[1]	✔[1]	✔					10		✔	1.05
TPS60202/3	50	1.8 to 3.6	—	3.3	90	400	40	0.05	✔	✔[1]	✔[1]	✔					10			0.95
TPS60204/5	100	1.8 to 3.6	—	3.3	90	400	35	0.05	✔	✔[1]	✔[1]	✔					10			1.05
TPS60210/1	100	1.8 to 3.6	—	3.3	90	400	35	2	Snooze	✔[1]	✔[1]	✔					10		✔	1.05
TPS60212/3	50	1.8 to 3.6	—	3.3	90	400	35	2	Snooze	✔[1]	✔[1]	✔					10			0.95
TPS60230/1	125	2.7 to 6.5	—	5.5[2]	85	1250	160	0.1	✔			✔	✔	✔		16			✔	1.55
TPS60240	12	1.8 to 5.5	—	3.3	90	160	250	0.1					✔	✔			8			1.15
TPS60241	12	2.7 to 5.5	—	5.0	90	160	250	0.1					✔	✔			8		✔	1.15
TPS60242	12	1.8 to 5.5	—	3.0	90	160	250	0.1					✔	✔			8			1.15
TPS60243	12	1.8 to 5.5	—	2.7	90	160	250	0.1					✔	✔			8			1.15
TPS60300/2	20	0.9 to 1.8	—	3.3	90	900	35	1	✔		✔[3]	✔					10		✔	0.95
TPS60301/3	20	0.9 to 1.8	—	3.0	90	900	35	1	✔		✔[3]	✔					10			0.95
TPS60310/2	20	0.9 to 1.8	—	3.3	90	900	35	2	Snooze		✔[3]	✔					10			1.05
TPS60311/3	20	0.9 to 1.8	—	3.0	90	900	35	2	Snooze		✔[3]	✔					10			1.05
ICL7660/A/S	20	1.5 to 12	—	< 2 V_{IN}	99	10, 35	80	—									✔			0.38
Buck-Boost Regulators																				
REG710-2.5	30	1.8 to 5.5	—	2.5	90	1000	65	0.01	✔				✔	✔	6					0.65
REG710-2.7	30	1.8 to 5.5	—	2.7	90	1000	65	0.01	✔				✔	✔	6					0.65
REG710-3	30	1.8 to 5.5	—	3.0	90	1000	65	0.01	✔				✔	✔	6					0.65
REG710-3.3	30	1.8 to 5.5	—	3.3	90	1000	65	0.01	✔				✔	✔	6				✔	0.65
REG71050	60	2.7 to 5.5	—	5.0[2]	90	1000	65	0.01	✔				✔	✔	6				✔	0.65
REG710-5	60	2.7 to 5.5	—	5.0[2]	90	1000	65	0.01	✔				✔	✔	6				✔	0.65
REG71055	60	3.0 to 5.5	—	5.5[2]	90	1000	65	0.01	✔				✔	✔	6					0.65
REG711-2.5	50	1.8 to 5.5	—	2.5	90	1000	60	0.01	✔				✔	✔			8			0.90
REG711-2.7	50	1.8 to 5.5	—	2.7	90	1000	60	0.01	✔				✔	✔			8			0.90
REG711-3	50	1.8 to 5.5	—	3.0	90	1000	60	0.01	✔				✔	✔			8			0.90
REG711-3.3	50	1.8 to 5.5	—	3.3	90	1000	60	0.01	✔				✔	✔			8			0.90
REG711-5	50	2.7 to 5.5	—	5.0	90	1000	60	0.01	✔				✔	✔			8			0.90
Inverting Regulators																				
LT1054	100	3.5 to 15	—	–5.0	—	25	2500	100	✔											1.44
TPS60400	60	1.6 to 5.5	–(1.6 to 5.5)	—	99	50 to 250	125	—							5				✔	0.33
TPS60401	60	1.6 to 5.5	–(1.6 to 5.5)	—	99	28	65	—							5					0.33
TPS60402	60	1.6 to 5.5	–(1.6 to 5.5)	—	99	70	120	—							5					0.33
TPS60403	60	1.6 to 5.5	–(1.6 to 5.5)	—	99	300	425	—							5					0.33

[1]Features apply respectively to device numbers shown. For example, only the TPS60120 has the Low Battery feature and only the TPS60121 has the Power Good feature.

[2]White LED driver.

[3]Feature applies only to second device shown. For example, only the TPS60302 has the Power Good feature.

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

*Preview devices are listed in **bold blue**.*

Design Factors

Integration Level — Application-specific power management devices offer different levels of integration and address specific power needs of the end equipment. They may feature building blocks such as chargers, linear regulators, DC/DC controllers or DC/DC converters. Some devices also integrate specific communication interfaces such as I^2C to control voltages and other functions.

Package — Due to the integration level, power dissipation capability needs to be taken into consideration. Most packages for highly integrated devices have a thermal pad at the bottom for optimal thermal performance.

Efficiency and External Component Count — Integrated power conversion devices typically feature a combination of different power converters ranging from LDOs to charge pumps and inductive DC/DC regulators. Multiple LDO devices may offer the most channels and least external components per given package size but are least efficient. Devices with several inductive DC/DC converters require a larger package and external inductors, but they typically provide the best conversion efficiency and longest battery life for portable applications.

Integrated 6-Channel Power Solution for Handheld Equipment TPS65020/1

Get samples and datasheets at: **www.ti.com/sc/device/TPS65021**

The TPS65021 is a small, integrated 6-channel power management device featuring three DC/DC and three LDO outputs to power several subsystems such as processor core, memory and RF in handheld applications. An I^2C interface allows full programmability of the device.

Selection Guide

Device	V_{IN} (V)	Charger	A/D Converter	No. of Regulator Outputs	DC/DC Converter	DC/DC Controller	Charge Pump	LDO	LDO Controller	Communication Interface	Quiescent Current (mA)	Shutdown Current (µA)	Description	Package	Price*
Integrated Power Management for Smartphone, PDA, Media Players															
TPS65800	3.0 to 4.7	Li-Ion	Yes	10	3	—	—	7	—	I^2C	—	—	Complete 1-cell Li-Ion battery, lighting and power management for handheld applications	QFN-56	6.50
TPS65010/1/2/3/4	2.5 to 6.0	Li-Ion	—	4	2	—	—	2	—	I^2C	0.07	0.015	Power management for Texas Instruments OMAP™ processors	QFN-48	3.95
TPS65020/1	2.5 to 6.0	—	—	6	3	—	—	3	—	I^2C	0.07	—	Power management for Intel XScale,® OMAP™ and other processors with dynamic voltage scaling	QFN-40	3.75
Integrated Power Management for DSP, FPGA, ASIC															
TPS75003	2.2 to 6.5	—	—	3	—	2	—	1	—	—	0.075	0.05	Power management for Xilinx® Spartan™-3 and other FPGA, DSP and ASIC	QFN-20	1.90
TPS62400/20	2.5 to 6.0	—	—	2	2	—	—	—	—	Serial	0.03	2	Dual, synchronous DC/DC converter in 3x3 QFN with EasyScale™ interface	QFN-10	2.70
TPS71202	2.7 to 5.5	—	—	2	—	—	—	2	—	—	—	—	Dual 250-mA, high PSRR, low noise LDO in 3x3 QFN	QFN-10	0.80
Integrated Power Management for Digital Still Camera															
TPS65520	1.5 to 5	—	—	13	7	1	—	5	—	—	—	—	Complete 13-channel (7 DC/DC + 5 LDO) power management for DSC	BGA-121	3.95
Integrated Power Management for TFT/TFD LCD and OLED Displays															
TPS61045	1.8 to 6.0	—	—	1	1	—	—	—	—	—	0.035	1	Digitally adjustable, small form factor LCD and passive-matrix OLED bias supply	QFN-8	1.35
TPS61080/1	2.5 to 6.0	—	—	1	1	—	—	—	—	—	1	1	Adjustable, 27-V output, 0.7/1.6-A switch, OLED bias supply	QFN-10	1.90
TPS63700	2.7 to 5.5	—	—	1	1	—	—	—	—	—	1	0.2	Adjustable, –15-V output, 1-A switch, inverting DC/DC converter for bias applications	QFN-10	2.35
TPS65110/1	2.4 to 5.5	—	—	3	—	—	3	—	—	—	0.05	1	High-accuracy, small form factor, inductorless LTPS LCD bias supply with low ripple	QFN-24	1.70
TPS65120/1/3/4	2.5 to 5.5	—	—	4	1	—	2	1	—	—	—	0.1	High-accuracy, small form factor, LTPS and a-Si LCD bias supply, sequencing	QFN-16	1.75
TPS65130/1	2.7 to 5.5	—	—	2	2	—	—	—	—	—	0.5	0.2	Positive/negative small form factor OLED, TFT and CCD bias supply, dual rail	QFN-24	2.95
TPS65100/5	2.7 to 5.8	—	—	4	1	—	1	—	1	—	3.5	1	High-accuracy, large form factor TFT LCD bias supply w/vcom buffer, sequencing	QFN/TSSOP-24	2.30
TPS65140/5	2.7 to 5.8	—	—	4	1	—	1	—	1	—	3.5	1	High-accuracy, large form factor TFT LCD bias supply w/Power Good, sequencing	QFN/TSSOP-24	2.00
TPS65150	1.8 to 6	—	—	3	1	—	2	—	—	—	—	—	High-accuracy, large form factor TFT LCD bias supply w/flicker compensation, sequencing	QFN/TSSOP-24	2.40
TPS65160/60A/65	8 to 14	—	—	4	2	—	2	—	—	—	—	—	LCD TV/monitor TFT display bias supply w/protection, softstart, sequencing	TSSOP-28	2.60

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

*New devices are listed in **bold red**. Preview devices are listed in **bold blue**.*

White LED Drivers

Design Factors

Series or Parallel LED Configuration — Drives the driver topology. Inductive boost converters provide the necessary high voltage to a series LED string. This requires only one current regulation loop and two connection points for the LED string.

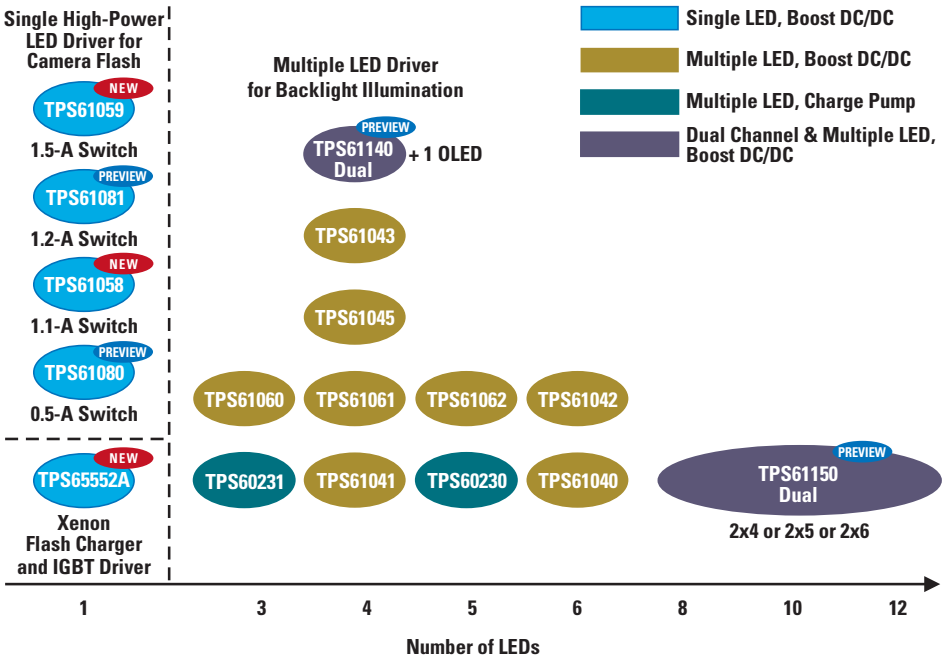
Charge pumps typically drive parallel LEDs; but unless each LED is current-regulated, each leg requires a current-set resistor. Often the choice is driven by the already existing LED configuration in a pre-assembled color LCD display module.

Current Regulation — Avoids brightness variations in LED strings or legs that consist of LEDs with different forward voltages (V_f).

Over-Voltage Protection (OVP) — Protects the inductive driver from destruction in case faulty LEDs open the LED string.

Dimming — LED drivers typically feature analog and/or digital mechanisms to adjust the LED brightness.

Load-Disconnect During Shutdown — Eliminates leakage from the battery through the LED string to ground when the driver is disabled, thus saving battery energy.



Selection Guide

Device	V_{IN} (V)	Type	Number of LEDs[1]	LED Configuration	Switch Current Limit (typ) (mA)	Current Regulation	Over-Voltage Protection (min) (V)	Synchronous	Output Capacitor	Load-Disconnect During Shutdown	Dimming[2]	Peak Efficiency[3] (%)	Quiescent Current (typ) (mA)	Shutdown Current (typ) (µA)	Package	Price*
TPS61041	1.8 to 6.0	Inductive	4	Series	250	No	No	No	1 µF	No	Yes	85	0.028	0.1	SOT-23	0.75
TPS61040	1.8 to 6.0	Inductive	6	Series	400	No	No	No	1 µF	No	Yes	86	0.028	0.1	SOT-23	0.95
TPS61043	1.8 to 6.0	Inductive	4	Series	400	Yes	17	No	100 nF	Yes	Yes	85	0.038	0.1	QFN-8	0.99
TPS61042	1.8 to 6.0	Inductive	6	Series	500	Yes	28	No	100 nF	Yes	Yes	85	0.038	0.1	QFN-8	1.20
TPS61140	2.5 to 6.0	Inductive	See Note 4	2 Series	700	—	—	Yes	—	—	—	85	—	—	QFN-10	1.85
TPS61150	2.5 to 6.0	Inductive	See Note 5	2 Series	700	—	—	Yes	—	—	—	85	—	—	QFN-10	1.65
TPS61058	2.7 to 5.5	Inductive	1	Series	1100	No	No	Yes	3 x 22 µF	Yes	—	5.5	—	0.1	QFN-10	0.85
TPS61059	2.7 to 5.5	Inductive	1	Series	1500	No	No	Yes	3 x 22 µF	Yes	—	5.5	—	0.1	QFN-10	0.55
TPS61060	2.7 to 6.0	Inductive	3	Series	400	Yes	14	Yes	220 pF	Yes	Yes	83	—	1	QFN-8/WCSP-8	1.35
TPS61061	2.7 to 6.0	Inductive	4	Series	400	Yes	18	Yes	220 pF	Yes	Yes	82	—	1	QFN-8/WCSP-8	1.35
TPS61062	2.7 to 6.0	Inductive	5	Series	400	Yes	22	Yes	220 pF	Yes	Yes	81	—	1	QFN-8/WCSP-8	1.35
TPS61020	0.9 to 5.5	Inductive	1	Series	1500	Yes	Optional	Yes	2.2 µF	Yes	Flash	90	0.025	0.1	QFN-10	1.40
REG71050	3.2 to 5.5	Charge pump	3	Parallel	—	No	—	—	2.2 µF	—	Yes	70	0.065	0.01	SOT-23	0.65
TPS60231	2.7 to 6.5	Charge pump	3	Parallel	—	Yes	—	—	1 µF	—	Yes	85	0.200	0.1	QFN-16	0.95
TPS60230	2.7 to 6.5	Charge pump	5	Parallel	—	Yes	—	—	1 µF	—	Yes	85	0.200	0.1	QFN-16	1.30
TPS61080/1	2.5 to 6.0	Inductive	7	Series	1.3 A/0.7 A	No	27	No	4.7 µF	Yes	No	94	1	1	QFN-10	1.90

[1]More LEDs can be driven in parallel string configuration.
[2]May be via ENABLE pin, CONTROL pin or analog feedback network.
[3]Depends on LED current, input voltage, number of LEDs, ILED pin.
[4]1 OLED + 4 LED.
[5]2 outputs with a maximum of 6 LEDs on each.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New devices are listed in **bold red**.*
*Preview devices are listed in **bold blue**.*

Design Factors

Dot Correction — Creates uniform LED brightness. Gives the ability to dynamically control the output current.

Grayscaling — Provides an enhanced color spectrum per LED equivalent with the number of grayscale steps available.

Output Voltage Monitor — Monitors voltages at constant current output terminals to detect LED failure and short circuit.

LED Open Detection — Indicates a broken or disconnected LED at an output terminal.

Thermal Error Flag — Indicates an overtemperature condition.

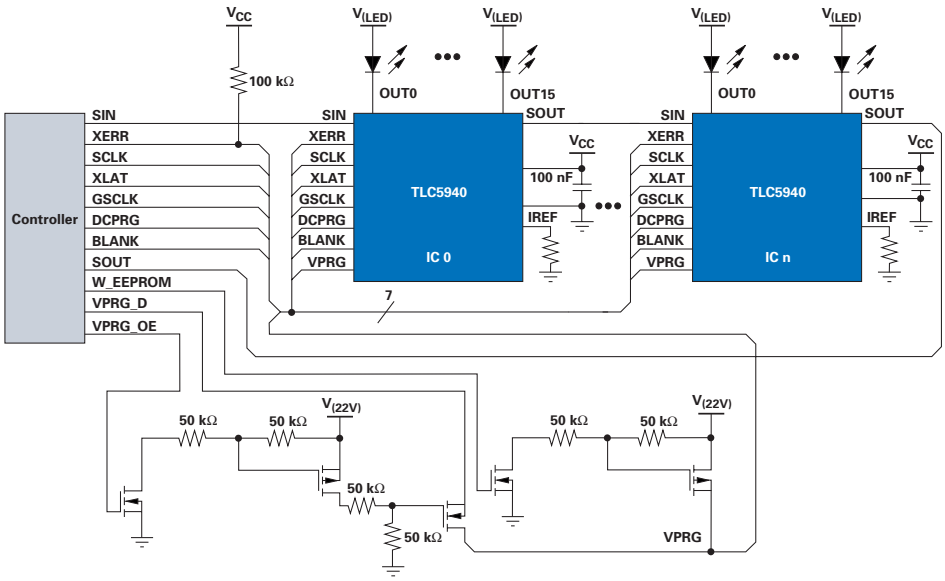
Watchdog Timer — Turns output off when scan signal is stopped.

Thermal Shutdown — Turns output off when junction temperature exceeds its limit.

16-Channel LED Driver with Dot Correction and PWM Grayscale
TLC5940

Get samples and datasheets at: **www.ti.com/sc/device/TLC5940**

The TLC5940 is an LED driver for high-end video displays. The device features 64-step dot correction and 4096-step PWM grayscaling, with 120 mA of peak current per channel. EEPROM is integrated into the IC, and the device is offered in HTSSOP, PDIP and QFN packages.



Selection Guide

Device	Data Input (Bits)	Output Count (Bits)	Input Voltage Range (V)	Output Current Drive (mA)	Channel-to-Channel Accuracy (typ) (%)	Data Transfer Rate (MHz)	Brightness Adjustment (Steps)	Dot Correction (Steps)	PWM Grayscale (Steps)	EEPROM	OVM[1]	LOD[2]	TEF[3]	WDT[4]	TSD[5]	Price*
TLC5904	8-bit parallel	8, 16	4.5 to 5.5	120	±4	15	32	—	256	—	Yes	Yes	No	Yes	Yes	3.70
TLC5905	1	8, 16	4.5 to 5.5	120	±4	15	32	—	256	—	Yes	Yes	No	Yes	Yes	2.85
TLC5911	7, 10	16	4.5 to 5.5	80	±4	20	64	128	1024	—	No	Yes	No	Yes	Yes	4.50
TLC5930	1	12	3.0 to 3.6	40	±1	20	64	256	1024	—	Yes	Yes	Yes	No	No	2.50
TLC5920	1	16	4.5 to 5.5	30	±6	10	—	—	—	—	No	No	No	No	No	1.10
TLC5921	1	16	4.5 to 5.5	80	±1	20	—	—	—	—	No	Yes	No	No	Yes	1.25
TLC5922	1	16	3.0 to 5.5	80	±1	30	—	128	—	—	No	No	Yes	No	No	1.85
TLC5923	1	16	3.0 to 5.5	80	±1	30	—	128	—	—	No	Yes	Yes	No	No	1.90
TLC5940	1	16	3.0 to 5.5	120	±1	30	—	64	4096	Yes	No	Yes	Yes	No	No	1.90
TLC5941	1	16	3.0 to 5.5	80	±1	30	—	64	4096	—	No	Yes	Yes	No	No	1.65

[1]Output voltage monitoring.
[2]LED open detection.
[3]Thermal error flag.
[4]Watchdog timer.
[5]Thermal shutdown.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

CCFL Backlight Controllers

Design Factors

Input Voltage — Backlight power supplies run from the battery or a regulated supply. It is important to know the input voltage available for the backlight supply to select the best IC and power conversion topology to generate the output power required to light the lamp.

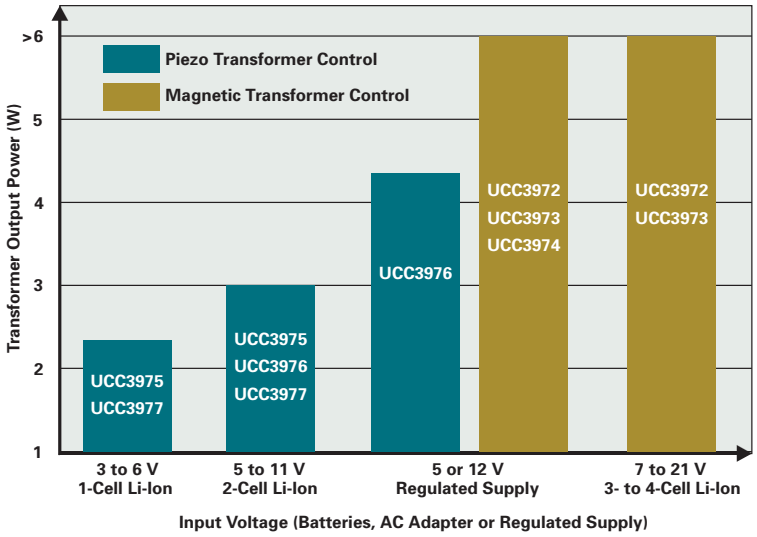
Lamp Characteristics (Output Power) — Common CCFL lamps require 250- to 1000-VAC (2 to 10 mA) for operation. The relationship between the input voltage and output voltage dictates the best IC and power topology.

Power Topology — The parts control the transformer in different ways. Sometimes the input/output relationship dictates a certain topology. Different topologies also have different power conversion efficiencies.

Transformer Type — Piezo for smaller size and higher efficiency in some applications.

Control Options — Single or dual lamp control and dimming control.

CCFL Backlight Controllers Family of Products



Features

- Complete power-supply control for CCFL.
- Magnetic or piezo transformer control.
- Open lamp and transformer protection.
- Burst-dimming control for efficient, wide dimming range.
- Four different power topologies:
  - Half-bridge
  - Flyback
  - Royer
  - Push-pull

Selection Guide

Device	Input Voltage (V)	Power Control Topology	Transformer Type	Dimming and Protection Control	Industrial Temp Version	Packages	Price*
Input Voltage = 5 to 11 V (2-Cell Li-Ion Application)							
UCC3975	3 to 13.5	Flyback	Piezo	Yes	UCC2975	8-pin TSSOP	1.70
UCC3976	3 to 13.5	Half-bridge	Piezo	Yes	UCC2976	8-pin TSSOP	1.00
UCC3977	3 to 13.5	Push-pull	Piezo	Yes	UCC2977	8-pin TSSOP	1.00
TPS68000	8 to 30	Full Bridge	Magnetic	Yes	TPS68000	30-pin TSSOP	2.50
Input Voltage = 5 or 12 V (Regulated Supply)							
UCC3973	4.5 to 25	Royer	Magnetic	Yes	UCC2973	8-pin TSSOP or SOIC	3.00
UCC3976	3 to 13.5	Half-bridge	Piezo	Yes	UCC2976	8-pin TSSOP	1.00
TPS68000	8 to 30	Full Bridge	Magnetic	Yes	TPS68000	30-pin TSSOP	2.50
Input Voltage = 7 to 21 V (3- or 4-Cell Li-Ion Application)							
UCC3973	4.5 to 25	Royer	Magnetic	Yes	UCC2973	8-pin TSSOP or SOIC	3.00
TPS68000	8 to 30	Full Bridge	Magnetic	Yes	TPS68000	30-pin TSSOP	2.50

**Suggested resale price in U.S. dollars in quantities of 1,000.*
The selection guide is a general reference tool. External components dictate most of the circuit parameters in the circuit; therefore, designs outside of the input voltage/device boundaries in the selection guide can be achieved.

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
UCC3973EVM	UCC3973 Evaluation Module	50
UCC3976-77EVM	UCC3976 and UCC3977 Evaluation Module	50
TPS68000EVM-161	TPS68000 Single-Lamp Evaluation Module	49
TPS68000EVM-166	TPS68000 Multi-Lamp Evaluation Module	49

**Suggested resale price in U.S. dollars.*

Design Factors

Transformer — The output voltage of the converter is set by the turns ratio of the flyback transformer. The switching frequency is determined by the primary inductance of the flyback transformer. These two factors, along with the necessary voltage rating of the secondary, are key requirements for selecting the transformer.

Flash Capacitor — The flash capacitor must be rated for photoflash applications. The flash capacitor usually has low inductance in order to handle the surge currents during a flash. Capacitors not rated for photoflash applications will have a short lifespan in this application.

IGBT — Look for a photoflash rating when selecting an IGBT used to trigger the flash tube. There are several IGBTs that can withstand the voltage and surge currents associated with the flash; however, they usually come in a very large package since these ratings are for continuous duty. The photoflash-rated IGBT has the same ratings but comes in a small package since the loads are all surge and not continuous.

Flash Tube — Selection of a flash tube is based on several system level considerations such as desired light spectrum, physical size, mounting method, trigger method, required light power, flash frequency, flash voltage, encapsulation material and tube coatings. Customers should determine which lamp to select for their specific applications.

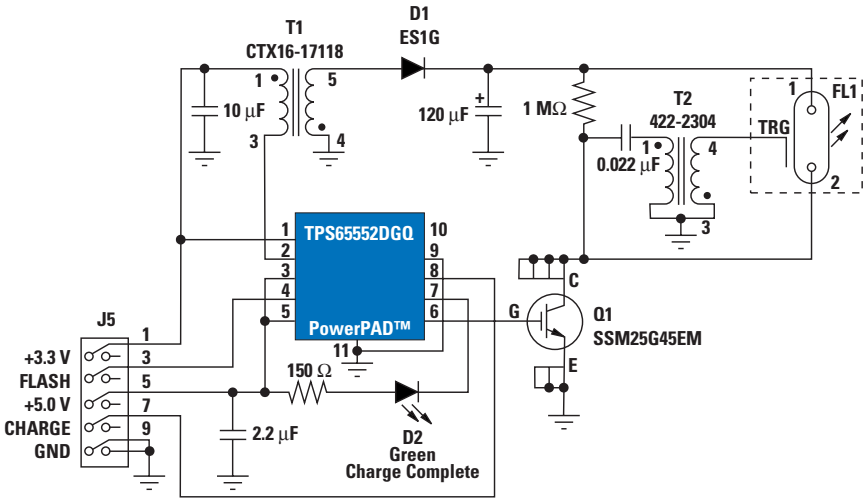
Trigger Transformer — Selection of the trigger transformer should be performed once a lamp has been selected. Each lamp has a specific trigger energy needed to initiate a flash.

Efficiency — The efficiency of the converter is greatly impacted by the recovery time of the high-voltage diode. The faster the diode, the better the efficiency.

Integrated Photoflash Charger and IGBT Driver TPS65552A

Get datasheets at: **www.ti.com/sc/device/TPS65552A**

The TPS65552A offers a complete solution for charging a photoflash capacitor from a battery input, and subsequently discharging the capacitor to the xenon tube. The device includes an integrated power switch, IGBT driver, and control logic blocks for charge applications.



TPS65552A application circuit.

Selection Guide

Device	Input Voltage (V)	V_{CC} (V)	Programmable Peak Current (A)	Power Switch (V)	IGBT Driver	Protection: Max On Time	Protection: Over-Voltage Shutdown	Protection: Thermal Monitor	Packaging	Price*
TPS65552A	1.8 to 12	5	0.95 to 1.8	50	Yes	Yes	Yes	Yes	10-pin MSOP, 16-pin QFN	1.00
TPS65560	1.6 to 12	2 to 4	0.9 to 1.8	50	Yes	Yes	Yes	Yes	16-pin QFN	0.85

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

*New devices are listed in **bold red**.*

Battery Charge Management

Design Factors

Battery Chemistry — Each battery chemistry has unique requirements for its charge algorithm, which is critical for maximizing its capacity, cycle life and safety.

Control Topology — A simple linear topology works well in applications with low-power (e.g., one- or two-cell Li-Ion) battery packs that are charged at less than 1 A.

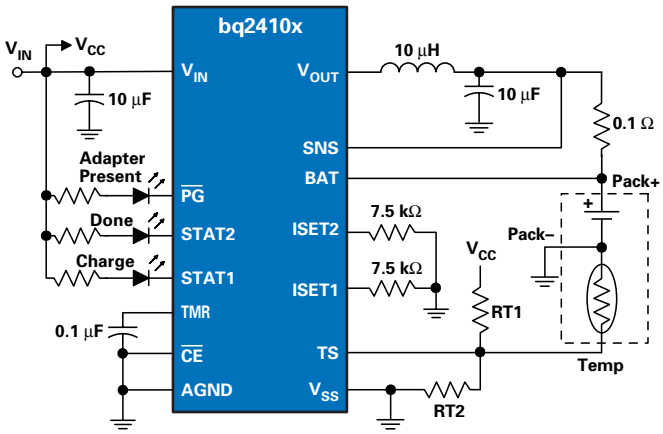
A switchmode topology is ideally suited for large (e.g., 3 or 4 series Li-Ion or multiple NiCd/NiMH) battery packs that require charge rates >1 A. The switchmode conversion minimizes heat generation during charging.

A charger using a current-limited topology requires a regulated or limited supply and simply gates the charging current.

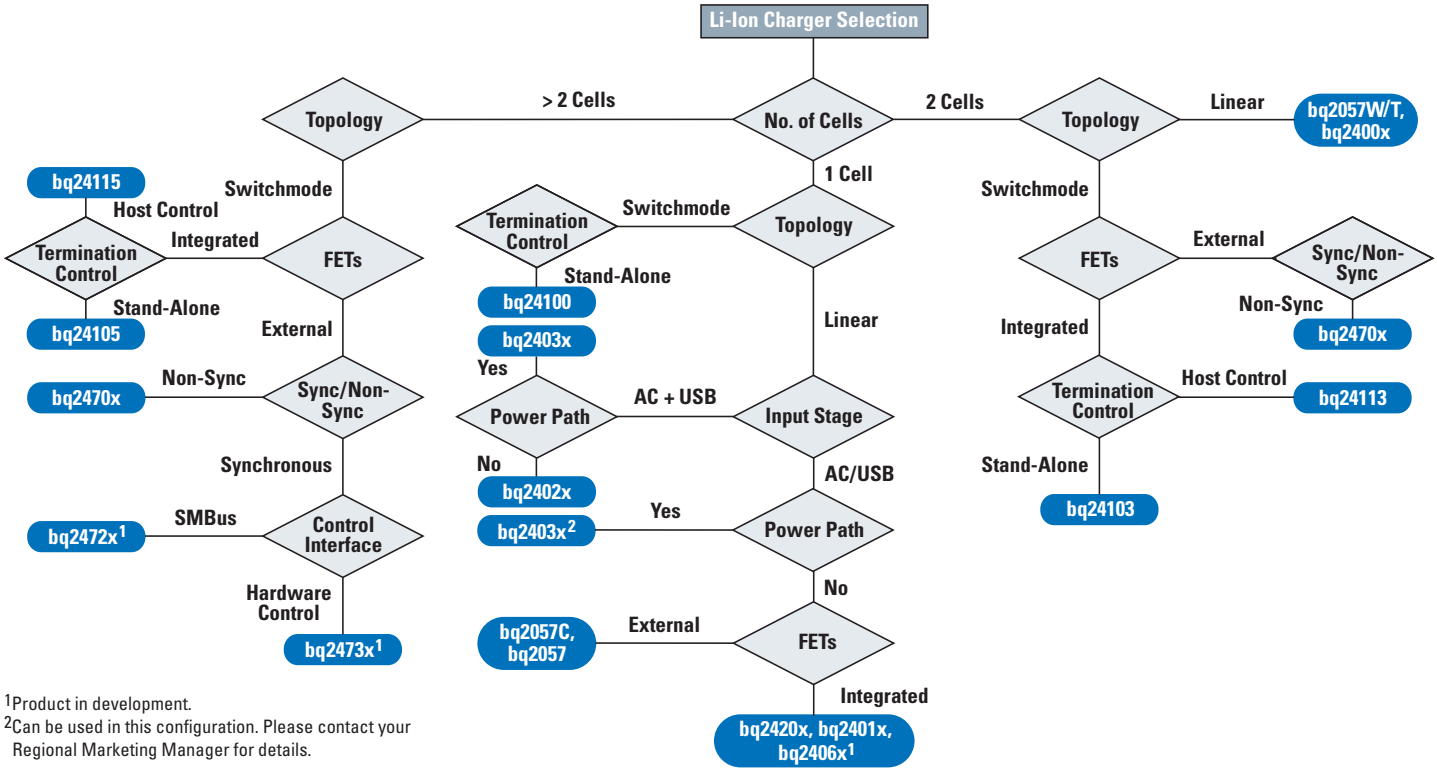
2-A Synchronous Switchmode Charger
bq2410x

Get samples, datasheets and EVMs at: **www.ti.com/sc/device/bq24100**

The bq2410x are 2-A synchronous switchmode charge management devices for 1, 2 and 3 series Li-Ion or Li-polymer battery packs.



Battery Charge Management Family of Products



[1]Product in development.
[2]Can be used in this configuration. Please contact your Regional Marketing Manager for details.

Selection Guide

Device	Number of Cells	Control Topology[1]	Integrated Power FET	Charge Current Internal FET	V_{IN} Max	Primary Charge Termination Method[2]	Safety Timer	Temp Monitor	Packaging: QFN/MLP	MSOP	TSSOP	SOIC	DIP	EVM	Price*	Comments
Multi-Chemistry (Li-Ion and NiCd/NiMH)																
bq2000	Multiple	Switching	No	—	—	PVD, min current	Yes	Yes			8	8	8	✔	1.70	Charges NiCd, NiMH, and Li-Ion
bq2000T	Multiple	Switching	No	—	—	ΔT/Δt, min current	Yes	Yes			8	8	8	✔	1.70	Charges NiCd, NiMH, and Li-Ion
bq24702/3	Multiple	Switching	No	—	30 V	Host controlled	No	No	28[3]		24			✔	3.10	Dynamic Power Management
Li-Ion Chemistry																
bq24200	1	Current-limited	Yes	500 mA	16.5 V	Min current	Yes	Yes		8				✔	0.85	Uses current-limited wall supplies, lowers power dissipation
	Parameter		bq24200		bq24201		bq24202		bq24203		bq24204		bq24205			
	Regulation Voltage (V)		4.2		4.1		4.2		4.1		4.2		4.1			
	Optional Functions[4]		STAT and TS		STAT and TS		STAT		STAT		—		—			
bq2057/C	1	Linear	No	—	18 V	Min current	No	Yes		8	8	8		✔	0.95	Low dropout, 4.1/4.2 V regulation, AutoComp™
bq2057T/W	2	Linear	No	—	18 V	Min current	No	Yes			8	8		✔	1.20	Low dropout, 8.2/8.4 V regulation, AutoComp
bq24001	1	Linear	Yes	1.2 A	13.5 V	Min current	Yes	Yes	20		20			✔	1.20	4.1-V or 4.2-V regulation, bq24007/8 has timer enable/disable pin
	Parameter			bq24001/7			bq24002		bq24003/8							
	Charge Status Configuration			Single LED			2 LEDs		Single Bicolor LED							
bq24004	2	Linear	Yes	1.2 A	13.5 V	Min current	Yes	Yes	20		20				1.60	8.2-V or 8.4-V regulation
	Parameter			bq24004			bq24005		bq24006							
	Charge Status Configuration			Single LED			2 LEDs		Single Bicolor LED							
bq24010	1	Linear	Yes	1.0 A	18 V	Min current	Yes	No	10					✔	1.05	Allows use of unregulated wall supplies with high max V_{IN}
	Parameter		bq24010		bq24012		bq24013		bq24014							
	Optional Functions[4]		PG and TS		PG and CE		CE and TTE		CE and TS							
bq24020	1	Linear	Yes	1.0 A	7 V	Min current	Yes	Yes	10					✔	1.60	Autonomous USB and AC-adapter supply management
	Parameter		bq24020		bq24022		bq24023		bq24024		bq24025		bq24026			
	Optional Functions[4]		CE and TS		PG and CE		CE and TTE		TTE and TS		CE and TS		TE and TS			
	Fast Charge Timer		5		5		5		5		5		7			
	Taper Timer		Yes		Yes		Yes		Yes		Yes		No			
bq24030	1	Linear	Yes	1.5 A	18 V	Min current	Yes	Yes	20					✔	2.30	Dynamic Power-Path Management powers the system and charges battery
	Parameter		bq24030		bq24032		bq24035		**bq24038**							
	Output for AC Input Condition		Regulated to 6 V		Regulated to 4.4 V		Cutoff at 6 V		Regulated to 4.4 V							
	Charge Regulation Voltage (V)		4.2		4.2		4.2		4.36							
bq24060	1	Linear	Yes	1 A	18 V	Min current	Yes	Yes	10					✔	1.20	Thermal regulation, 6.5-V over-voltage protection
	Parameter		**bq24060**		**bq24061**		**bq24065**		**bq24066**							
	Optional Functions[4]		TS		CE		TS		CE							
	Charge Regulation Voltage (V)		4.2		4.2		4.36		4.36							
bq24100/8	1	Switching	Yes	2.0 A	20 V	Min current	Yes	Yes	20						2.10	Synchronous PWM, different status outputs
bq24103/113	1 or 2	Switching	Yes	2.0 A	20 V	Min current/ Host controlled	Yes	Yes	20						2.20	Synchronous PWM
bq24105/115	1 to 3	Switching	Yes	2.0 A	20 V	Min current/ Host controlled	Yes	Yes	20						3.50	Synchronous PWM, prog. output voltage
bq25010/2	1	Linear	Yes	500 mA	7 V	Min current	Yes	No	20					✔	1.90	USB, integrated DC/DC converter, output adjustable or fixed 1.8 V
bq24720/1	3 or 4	Switching	No	—	30 V	SMBus	No	Yes	32					✔	4.90	Smart battery charger w/system power selector
bq24730	3 or 4	Switching	No	—	30 V	Host controlled	No	Yes	40					✔	4.90	Advanced synchronous battery charger with system power selector
bq2954	Multiple	Switching	No	—	—	Min current	Yes	Yes				16	16	✔	2.50	PWM control, low/high-side current sense
TPS65010	1	Linear	Yes	1.0 A	6 V	Min current	Yes	Yes	48					✔	3.95	Integrated battery and power management[5]
TPS65800	1	Linear	Yes	1.5 A	18 V	Min current	Yes	Yes	56					✔	6.50	Integrated battery and power management[5]
NiCd/NiMH Chemistry																
bq2002/C/E/F	Multiple	Current-limited	No	—	—	–ΔV, PVD	Yes	Yes				8	8	✔	1.05	Low-cost nickel charge ICs
bq2002D/T	Multiple	Current-limited	No	—	—	ΔT/Δt	Yes	Yes				8	8	✔	1.05	Different charge timers and status display
bq24400/1	Multiple	Switching	No	—	—	PVD, ΔT/Δt	Yes	Yes			8	8			1.55	Simple switching controller
bq2004/E/H	Multiple	Switching	No	—	—	–ΔV, PVD, ΔT/Δt	Yes	Yes				16	16	✔	2.20	Selectable timers and pulse-trickle rates
bq2005	Multiple	Switching	No	—	—	–ΔV, ΔT/Δt	Yes	Yes				20		✔	2.20	Sequential fast charge of two battery packs
Lead-Acid Chemistry																
UC3906	Multiple	Linear	No	—	40 V	Max V, min I	No	No				16	16		2.75	Temp-compensated internal reference
UC3909	Multiple	Switching	No	—	40 V	Max V, min I	No	Yes				20	20		3.05	Differential current sense input
bq2031	Multiple	Switching	No	—	—	Max V, $-\Delta^2$V, min I	Yes	Yes				16	16	✔	2.80	Three user-selectable charge algorithms to accommodate cyclic and standby applications

*[1]Current-limited = gating control of external, current-regulated/limited source. [2]PVD = peak voltage detection; ΔT/Δt = rate of temperature rise; host controlled = system processor must terminate charging; –ΔV = negative voltage change; max V = maximum voltage; min I = minimum current; Δ^2V = second difference of cell voltage. [3]Only bq24703 is available in QFN package. [4]STAT = status; TS = temperature sensing; PG = power good; CE = change enable; TTE = timer and termination enable. [5]See page 37. *Suggested resale price in U.S. dollars in quantities of 1,000.*

*New devices are listed in **bold red**.*

Battery Fuel Gauges

Design Factors

Battery Chemistry — Each battery chemistry has different operating characteristics, such as discharge profiles and self-discharge rate. TI gas gauge ICs are developed by chemistry to account for these differences to accurately display remaining energy in the battery.

Charge/Discharge Relationship — The charge and discharge rates dictate the sense resistor value.

Features

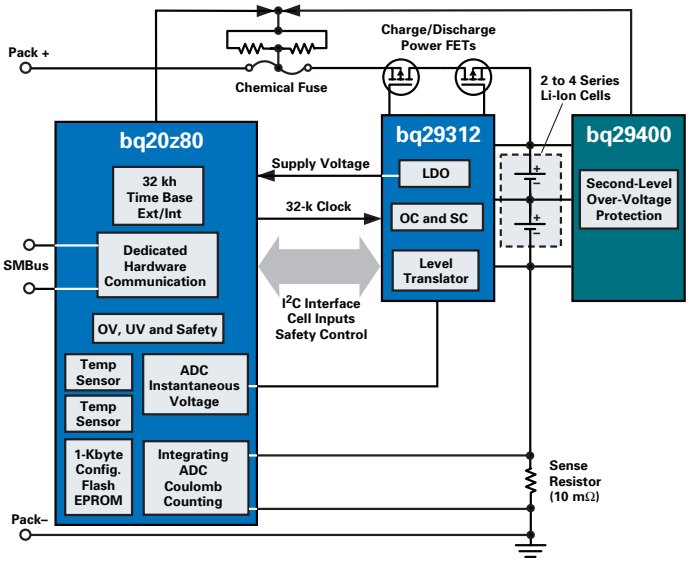
TI gas gauges and battery monitors accurately track battery activity to compute the remaining battery capacity and system run-time. They feature:

- Simple communication protocols.
- High-resolution analog-to-digital converters for accurate charge/discharge measurement.
- Integrated CPU on gas gauges to compute remaining battery capacity and run-time.

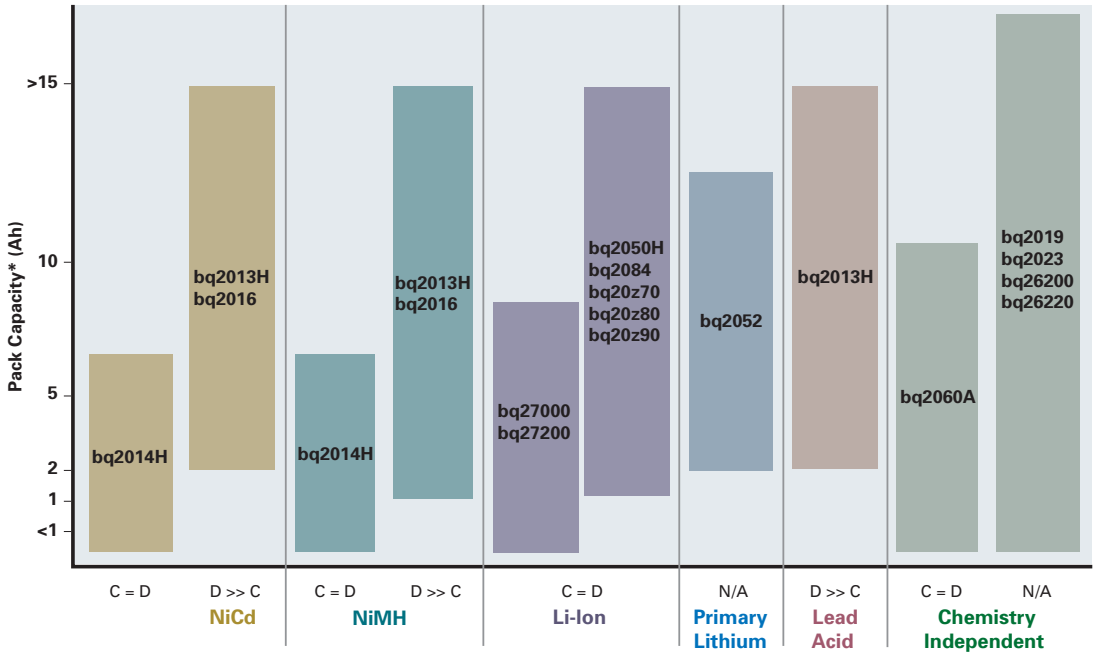
99% Accurate Gas Gauge Maximizes Run-Time
bq20z70, bq20z80, bq20z90

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/bq20z80**

The dynamic Impedance Track™ gas gauge algorithm in the bq20z80 extends battery usability, allowing use of the full chemical capacity available in a battery pack. Additional features include instant state-of-charge and real-time impedance learning. Impedance Track also enables reduction in development and production time. Remaining capacity is reported over the entire life of the battery pack with better than 99% accuracy. The bq20z80 is ideally suited for battery packs used in medical and industrial equipment, back-up batteries and laptop computers.



Battery Fuel Gauges Family of Products



C = D: Charge rate similar to discharge rate.
D>>C: Discharge rate much greater than charge rate.
N/A: Not Applicable.
*Pack capacity ratings provide an approximate range for each gas gauge.

Battery Fuel Gauges

Selection Guide

Device	Approx. Battery Capacity (mAh)	Min Max Series Cell	Number of LEDs	Communication Protocol	Other Features	Safety Enhancement	Packages	Price*
NiCd, NiMH Chemistry								
bq2013H	2000 to 15000	TBD	5	Single wire (HDQ)	Programmable offset error compensation	No	16-pin SOIC	3.70
bq2014H	500 to 6000	TBD	5	Single wire (HDQ)	Register compatible with bq2050H	No	16-pin SOIC	3.70
bq2016	1000 to 4500	TBD	5	Single wire (HDQ)	Automatic offset calibration	No	28-pin SSOP	3.00
Lithium-Ion, Lithium-Polymer Chemistry								
bq2050H	500 to 6000	TBD	5	Single wire (HDQ)	Register compatible with bq2014H	Yes	16-pin SOIC	3.70
bq2084	800 to 10000	TBD	3, 4 or 5	2 wire (SMBus)	SBS 1.1 works with bq29312 based on bq2083; includes bq2050 dataset via single wire interface	Yes	38-pin TSSOP	4.00
bq20z70	800 to 10000	2 to 4	No LED	HDQ and SMBus	Self learning, dynamic fuel gauge algorithm with bq29330	Yes	20-pin TSSOP	2.90
bq20z80	800 to 10000	2 to 4	3, 4 or 5	2 wire (SMBus)	SBS 1.1 with Impedance Track™ technology	Yes	38-pin TSSOP	4.60
bq20z90	800 to 10000	2 to 4	3, 4 or 5	2 wire (SMBus)	Self learning, dynamic fuel gauge algorithm with bq29330	Yes	30-pin TSSOP	3.30
bq27x00	300 to 6000	1 (more w/external components)	—	HDQ or I^2C	Single- and dual-cell fuel gauge with runtime to empty and charge time to full based on measured current	No	10-pin DRK	2.50
Primary Lithium Chemistry								
bq2052	1000 to 12000	1	2, 4 or 5	Single wire (HDQ)	Automatic discharge compensation	No	16-pin SOIC	4.00
Lead Acid Chemistry								
bq2013H	2000 to 15000	10	5	Single wire (HDQ)	Programmable offset error compensation	No	16-pin SOIC	3.70
Multi-Chemistry								
bq2060A	800 to 10000	0.1	4 or 5	SMBus or HDQ16	SBS 1.1 extended cold temp cell modeling and high temp safety enhancement, improved bq2060	Yes	28-pin SSOP	3.90
Battery Monitors								
bq2019	>20000	1	—	Single wire (HDQ)	64-bit ID ROM and 1 program output non-volatile memory	—	8-pin TSSOP	1.95
bq2023	>20000	0.25	—	Single wire (SDQ)	64-bit ID ROM and 1 program output automatic offset error calibration	—	8-pin TSSOP	2.00
bq26200	>20000	0.25	—	Single wire (HDQ)	High-performance battery, coulomb counter	—	8-pin TSSOP	2.00
bq26220	>20000	0.25	—	Single wire (HDQ)	64-bit ID ROM and 1 program output on-chip voltage measurement	—	8-pin TSSOP	2.05

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

*New devices are listed in **bold red**.*

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
bq2013HEVM-001	bq2013H Evaluation Kit for NiCd, 16.8 V	99
bq2014HEVM-001	bq2014H Evaluation Kit for NiMH, 10.8 V	99
bq2050HEVM-002	bq2050H Evaluation Kit for Li-Ion, 10.8 V	99
bq2060AEVM-001	bq2060A Evaluation Kit for Li-Ion	99
bq2060AEVM-002	bq2060A Evaluation Kit for NiMH	99
bq2084EVM-001	bq2084 Evaluation Kit also features the bq29312 and bq29400	99
bq20z70EVM-001	bq20z70 Evaluation kit also features the bq29330 and bq29412	99
bq20z80EVM-001	bq20z80 Evaluation kit also features the bq29312 and bq29400	99
bq20z90EVM-001	bq20z90 Evaluation kit also features the bq29330 and bq29412	99
bq26220EVM-001	bq26220 Evaluation Kit for Multi-Chemistry, 2.6 to 4.5 V	99
bq27000EVM	bq27000 Evaluation Module	99
bq27200EVM	bq27200 Evaluation Module	99

**Suggested resale price in U.S. dollars.*

Literature Number	Description
Application Notes	
SLUA324	Getting Started with the bq20z80 and EVM
SLUA325	Feature Set Comparison Between bq2084 and bq20z80
SLVA100	Advanced Gas Gauge Host Firmware Guide for the TI Battery Monitor ICs
SLVA101	HDQ Communication Basics for TI's Battery Monitor ICs
SLVA102	Gas Gauging Basics Using TI's Battery Monitor ICs
SLVA114	Advanced Gas Gauge Host Firmware Flow Chart for the TI Battery Monitor ICs
SLVA148	bq2083, bq2084, and bq2085 Calibration Procedure
SLVA149	Configuring the bq2060 and bq2060A EEPROMs
SLVA150	Avoiding Clock Jitter with the bq2085 Advanced Gas Gauge
SLVA151	Using Advance Features of the bq2060A Gas-Gauge IC
SLUA338	Configuring the bq27000/200 for Gas Gauge Applications
SLUA359	Using SHA-1 in bq20zxx Family of Gas Gauges
SLUA364	Theory and Implementation of Impedance Track Battery Fuel-Gauging Algorithm

Lithium-Ion Protection

Design Factors

Number of Series Cells — A battery is constructed from a string of series and parallel cells. Each series cell, or group of paralleled cells, requires protection from overcharge, overdischarge and short-circuit conditions.

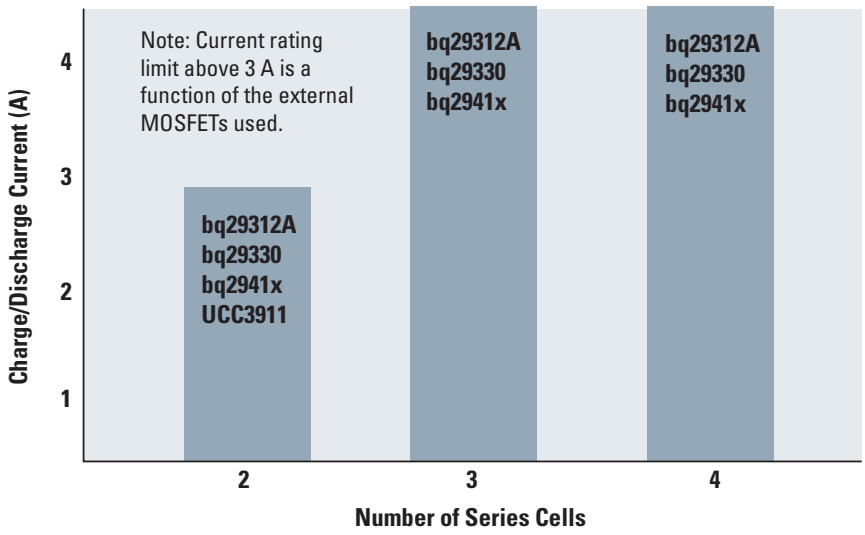
Threshold Voltage — Li-Ion and Li-polymer cells are produced by many manufacturers. Some manufacturers' technologies create cells of different maximum stress voltages, otherwise known as the "over-voltage threshold." This data is available from the cell supplier.

Threshold Tolerance — The over-voltage threshold has a tolerance that needs to be accounted for in the design for safety reasons.

Shutdown Current — In battery pack applications, constant current draw needs to be very low to preserve battery life.

Charge/Discharge Current — The pass element associated with each protection IC is rated for maximum current whether it be an internal or external FET.

Lithium-Ion Protection Family of Products



Features

- BiCMOS process results in low current consumption.
- Different over-voltage thresholds allow one design to work with several cell suppliers.
- Sleep current consumption of less than 3.5 µA enables extended battery life.
- 50 mV precision internally trimmed thresholds maximize safety.
- Short-circuit protection eliminates the need for an external fuse.

Selection Guide

Device	Number of Series Cells	Charge/Discharge Current (A)	Threshold Voltage (V_{OV})	Shutdown Current (µA)	Other Features	Available Packages	Price*
bq29312A	2, 3 or 4	External FET	bq2084[1], bq20z80[1]	1	Integrated LDO, works directly with bq2084 and bq20z80 gas gauge	24-pin TSSOP	1.30
bq29330	2, 3 or 4	External FET	bq20z90[1]	1	Integrated LDO, works directly with bq20z90 gas gauge	20-pin TSSOP	1.45
bq29412	2, 3 or 4	—	4.35	1	Second level overvoltage safety fuse blower for battery packs	8-pin TSSOP	0.42
UCC3911-x	2	3	4.2/4.25/4.3/4.35	3.5	User controllable delay for tripping short circuit current protection	16-pin SOIC	2.15

[1]Controlled by bq208x, bq20z8x or bq20z9x gas gauge.
See individual datasheets for full details.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs)		
bq2084EVM-001	bq2084 Evaluation Kit also features the bq29312 and bq29400	99
bq20z70EVM-001	bq20z70 Evaluation Kit also features the bq29330 and bq29412	99
bq20z80EVM-001	bq20z80 Evaluation Kit also features the bq29312 and bq29400	99
bq20z90EVM-001	bq20z90 Evaluation Kit also features the bq29330 and bq29412	99

**Suggested resale price in U.S. dollars.*

Authentication for Batteries and Peripherals

Design Factors

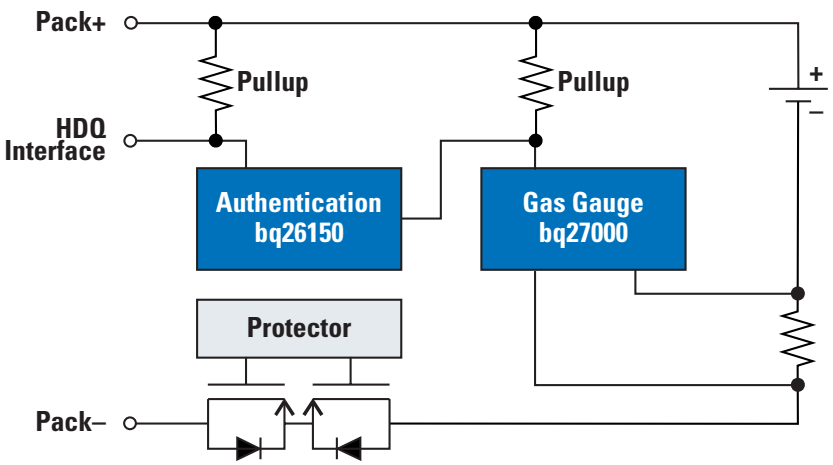
Original equipment manufacturers specify products to achieve required performance and safety goals. Authentication ensures that connected devices fulfill the established requirements and are safe for the consumer.

Features

TI authentication devices use three levels of security.

- **Identification Number** — The host controller can request an identification number that is answered with a fixed response.
- **CRC Algorithm** — The host processor sends a random challenge and reads the response that is an encoding of the challenge and a shared secret key through a CRC with a shared secret polynomial.
- **SHA-1 Encryption** — The host processor sends a random challenge and reads the response that is an encoding of the challenge and a shared secret key through the SHA-1 cryptographic primitive.

Single-Cell Battery Pack with Gas Gauge and Authentication



Selection Guide

Device	Interface	Pins	Security	Temp (°C)	Price*
bq2022	SDQ	3	ID number	–40 to 85	1.25
bq26150	HDQ	5	CRC algorithm	–20 to 70	1.25
bq26100	SDQ	5	SHA-1 encryption	–20 to 70	1.30

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

Hot Swap and Power Distribution

Power-over-Ethernet

Design Factors

IEEE 802.3af Power-over-Ethernet — With approval of the IEEE 802.3af Power-over-Ethernet (PoE) standard, all data terminal equipment (DTE) now has the option to receive power over existing CAT-5 and CAT-3 cabling that is used for data transmission. The IEEE 802.3af standard defines the requirements associated with providing and receiving PoE cables. The Power Sourcing Equipment (PSE) provides the power on the cable and the Powered Device (PD) receives the power. As part of the IEEE 802.3af standard, the interface between the PSE and the PD is defined as it relates to the detection and classification protocol.

Power Sourcing Equipment (PSE) — The TPS2384 Quad PSE Manager independently manages power for up to four Ethernet ports, reporting system status over a standard I^2C serial interface. The TPS2384 is the most integrated PSE solution on the market today with integrated power FETs and sense resistors.

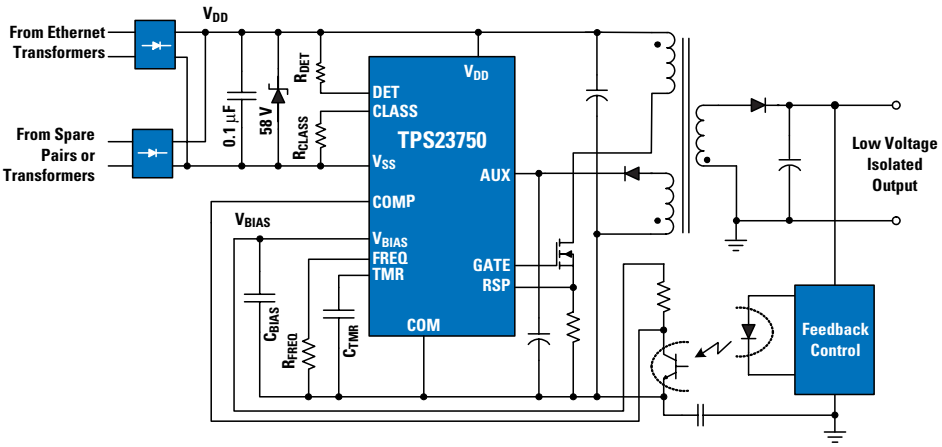
Powered Devices (PDs) — Acting as an interface between the PSE and PD, the TPS23750 performs all detection, classification, inrush current limiting and switch FET control that is necessary for compliance with the IEEE 802.3af standard.

Power-over-Ethernet

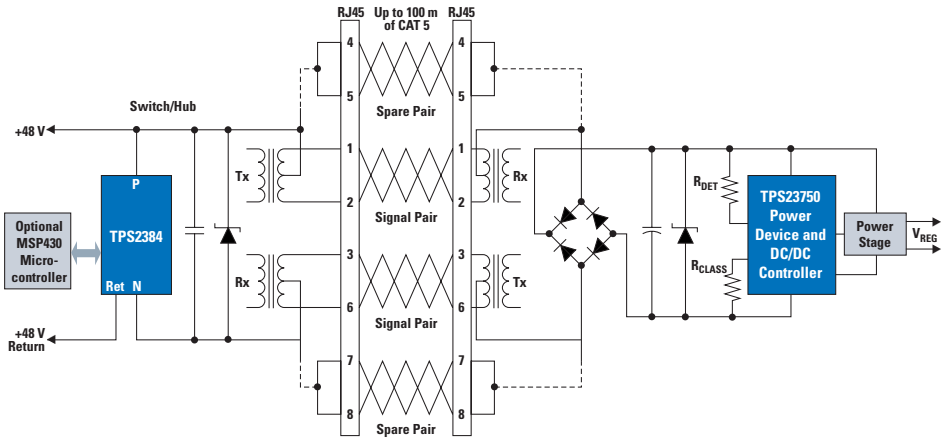
IEEE 802.3af Integrated Primary-Side PD Controller
TPS23750

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/TPS23750**

The TPS23750 is a highly integrated device that combines the functionality of the TPS2375 with a primary-side DC/DC PWM controller. Designers can create a complete front-end solution for PoE-powered devices with minimal external components.



Power-over-Ethernet (PoE) Application Diagram



The new TPS2384 and TPS2375 are IEEE 802.3af compliant power management ICs designed for managing the connection between Power Sourcing Equipment (PSE) and Powered Devices (PDs) over Ethernet cables. **www.ti.com/poe**

Selection Guide

Device	Description	Detection	Classification	Abs Max V_{IN} (V)	Operating Temp (°C)	Full Inrush Current Limiting	Current Limit (mA)	Auto Retry or Latch Off in Fault	UVLO	DC/DC Interface	Package	Price*
Power-over-Ethernet (PoE) Powered Device (PD) Interface Switches												
TPS2375	Powered Device Controller	4	Yes, Class 0-4	100	–40 to 85	Programmable	450	Latch Off	802.3af (30.6/39.4 V)	PG	SOIC-8, TSSOP-8	1.25
TPS2375-1	Powered Device Controller	4	Yes, Class 0-4	100	–40 to 85	Programmable	450	Auto Retry	802.3af (30.6/39.4 V)	PG	TSSOP-8	1.25
TPS2376	Powered Device Controller	4	Yes, Class 0-4	100	–40 to 85	Programmable	450	Latch Off	Adjustable	PG	SOIC-8, TSSOP-8	1.25
TPS2377	Powered Device Controller	4	Yes, Class 0-4	100	–40 to 85	Programmable	450	Latch Off	Legacy (30.5/35.0 V)	PG	SOIC-8, TSSOP-8	1.25
TPS2377-1	Powered Device Controller	4	Yes, Class 0-4	100	–40 to 85	Programmable	450	Auto Retry	Legacy (30.5/35.0 V)	PG	SOIC-8	1.25
TPS23750	Integrated PD with PWM Controller	4	Yes, Class 0-4	100	–40 to 85	Fixed	450	Auto Retry	802.3af (30.6/39.4 V)	N/A	TSSOP-20	1.75
TPS23770	Integrated PD with PWM Controller	4	Yes, Class 0-4	100	–40 to 85	Fixed	450	Auto Retry	Legacy (30.5/35.0 V)	N/A	TSSOP-20	1.75
PTB48540	5 V, 10-W PoE Power Module	4	Yes, Class 0-4	100	–40 to 85	Fixed	450	Latch Off	802.3af (30.6/39.4 V)	N/A	13-DIP Module	26.00

Device	Applications	Channels	Abs Max V_{IN} (V)	Operating Temp (°C)	IEEE Compliant	Interface	Disconnect	Measurements	Power FET	Package	Price*
PoE Power Sourcing Equipment (PSE) Controllers											
TPS2383B	Routers, switches, hubs, mid-spans	8	80	–40 to 85	Yes	I^2C	Both AC and DC	Current, voltage and capacitance	External	64-pin LQFP	7.35
TPS2384	Routers, switches, SOHO hubs, mid-spans	4	80	–40 to 125	Yes	I^2C	Both AC and DC	Current, voltage, capacitance and temperature	Internal	64-pin LQFP	3.90

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

*New devices are listed in **bold red**.*

For additional resources on PoE, including reference designs and evaluation modules, please see **power.ti.com/poe**

What is ATCA?

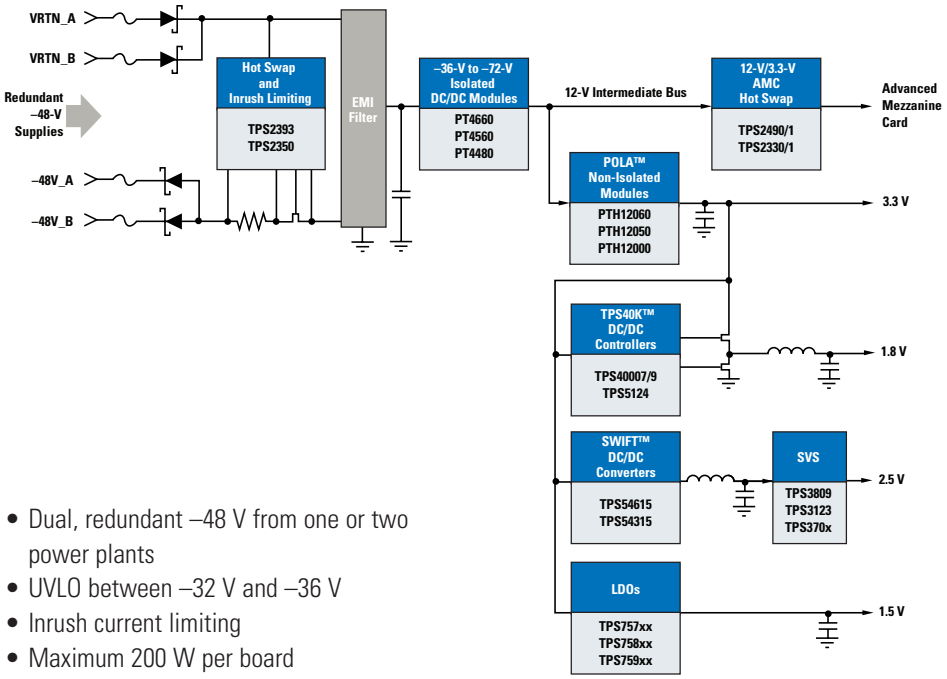
Advanced Telecommunications Computing Architecture (ATCA) is a new open standard for carrier grade communications equipment. The requirements for ATCA are defined in PICMG 3.0 specifications and include mechanical, shelf management, power distribution, data transport, thermal, regulatory guidelines and data/power connectors.

The ATCA PICMG 3.0 open standard has specific requirements for delivering dual –48-V power feeds to individual boards which may consume up to 200 W each.

ATCA Power Requirements

ATCA contains many requirements which are typical of a modern, hot swapped power system. It also contains some requirements which are particular to ATCA. Among the most challenging are the transient ride-through specifications which mandate that boards continue operation through a 5-ms short on both inputs. Boards must also continue operation through a 10-µs, 100-V transient at the input.

ATCA Power Solutions

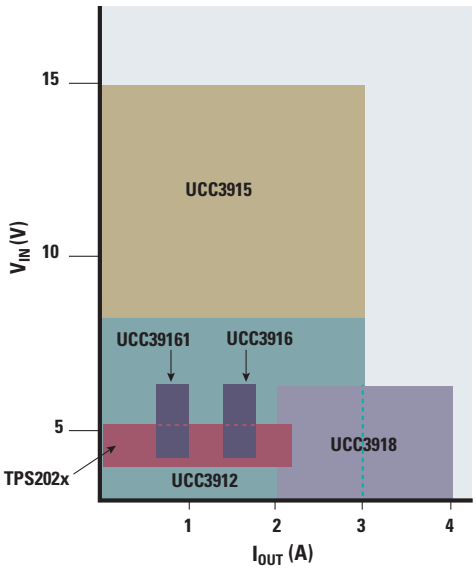


- Dual, redundant –48 V from one or two power plants
- UVLO between –32 V and –36 V
- Inrush current limiting
- Maximum 200 W per board
- Fuses on both –48-V feeds and both returns
- Isolation between A and B feeds/returns
- 5-ms holdup with input short to ground
- 60-W maximum for mezzanine cards
- 100-V transient capability

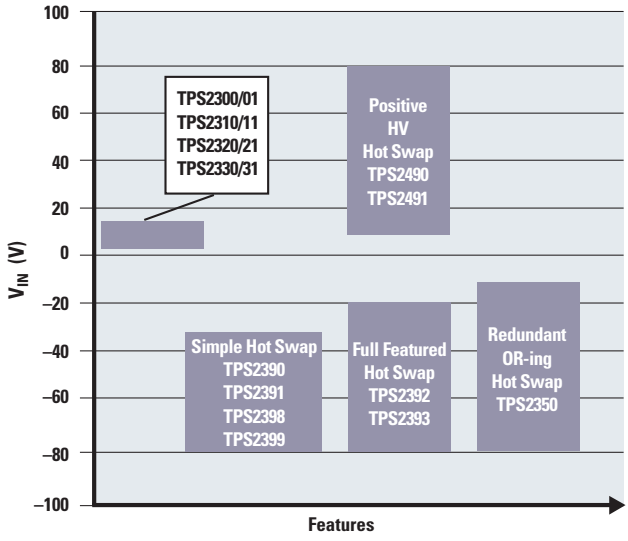
Hot Swap Power Management Family of Products

www.ti.com/atcapower

Hot Swap Power Switch ICs (Integrated Power FET)



Hot Swap Power Controller ICs (External Power FET)



Hot Swap Power Management

Hot Swap Switches (Integrated FET) Selection Guide

Device	Target Applications	Channels	V_{IN} (V)	Current Limit (A)	$r_{DS(on)}$ per FET (typ) (mΩ)	Enable/ Shutdown	Ramp	Package Options	Price*
UCC3915	Enclosure Management, General	1	7 to 15	0 to 3	150	1L	Current	SOIC-16, TSSOP-24	2.55
UCC3912	RAID, SCSI, General	1	3 to 8	0 to 3	150	1L	Current	SOIC-16, TSSOP-24	2.30
UCC3918	RAID, SCSI, General	1	3 to 6	0 to 4	75	1L	Current	SOIC-16, TSSOP-24	2.35
UCC3916	SCSI, General	1	4 to 6	1.65	220	1L	Current	SOIC-8	1.70

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

Hot Swap Controllers (External FET) Selection Guide

Device	Target Applications	Channels	V_{IN} Range (V)	Enable/ Shutdown	UV	OV	Fault	PG	Latch	Auto Retry	Ramp	Power Limiting	Package	Price*
TPS2300/01	CompactPCI, General	2	3 to 13/3 to 5.5	1L/1H	✔		✔	✔	✔		Voltage	No	20-pin TSSOP	1.60
TPS2310/11	CompactPCI, General	2	3 to 13/3 to 5.5	1L/1H	✔		✔	✔	✔		Voltage	No	20-pin TSSOP	1.60
TPS2320/21	CompactPCI, General	2	3 to 13/3 to 5.5	1L/1H	✔		✔	✔	✔		Voltage	No	16-pin SOIC/TSSOP	1.35
TPS2330/31	CompactPCI, General	1	3 to 13	1L/1H	✔		✔	✔	✔		Voltage	No	14-pin SOIC/TSSOP	1.25
TPS2342	CompactPCI, PCI-X, PC-X2.0	12	3.3, V_{aux}, V_{IO}, 5, +12, –12	1L	✔			✔	✔		Voltage	No	80-pin HTQFP	7.00
TPS2343	CompactPCI, PCI-X, PC-X2.0	12	3.3, V_{aux}, V_{IO}, 5, +12, –12	1L	✔			✔	✔		Voltage	No	80-pin SSOP	7.50
TPS2350	Replace –48-V OR-ing Diodes	2	–12 to –80	1H	✔	✔	✔	✔		✔	Current	No	14-pin SOIC/TSSOP	1.90
TPS2363	PCI Express	6	3.3 V_{aux}, 3.3, +12	1L	✔		✔	✔	✔		Voltage	No	48-pin QFP	2.50
TPS2390	Simple –48-V Telecom	1	–36 to –80	1H			✔		✔		Current	No	8-pin MSOP	1.00
TPS2391	Simple –48-V Telecom	1	–36 to –80	1H			✔			✔	Current	No	8-pin MSOP	1.00
TPS2392	Full Featured –48-V Telecom	1	–20 to –80	1H	✔	✔	✔	✔	✔		Current	No	14-pin TSSOP	1.80
TPS2393	Full Featured –48-V Telecom	1	–20 to –80	1H	✔	✔	✔	✔		✔	Current	No	14-pin TSSOP, 44-pin TSSOP	1.80
TPS2393A	Full Featured –48-V Telecom	1	–20 to –80	1H	✔	✔	✔	✔		✔	Current	No	14-pin TSSOP	1.80
TPS2398	Simple –48-V Telecom with PG	1	–36 to –80	1H				✔	✔		Current	No	8-pin MSOP	1.25
TPS2399	Simple –48-V Telecom with PG	1	–36 to –80	1H				✔		✔	Current	No	8-pin MSOP	1.25
TPS2400	Overvoltage/Undervoltage Protection IC	1	2 to 100	1H	✔	✔			✔		—	No	SOT-23-5	0.80
TPS2490	Servers, Basestations, +48 V	1	9 to 80	1H	✔			✔	✔		Current	Yes	10-pin MSOP	1.70
TPS2491	Servers, Basestations, +48 V	1	9 to 80	1H	✔			✔		✔	Current	Yes	10-pin MSOP	1.70

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

Resources *For a complete list of Resources, visit power.ti.com*

Part Number	Description	Price*
Evaluation Modules (EVMs) and Tools		
TPS2375EVM	Power-over-Ethernet Powered Device Controller Evaluation Module	49
TPS2384EVM	Power-over-Ethernet Power Sourcing Equipment Controller Evaluation Module	149

Suggested resale price in U.S. dollars. *New devices are listed in **bold red**.*

Literature Number	Part Number	Description
Application Notes		
SLUA331	UC2572	ATCA High Voltage Energy Storage Technique to Reduce Size and Cost of Transient Holdup Circuitry
SLVR248	TPS2490/TPS2231	ATCA AMC Hot Swap Reference Design
SLUU206	TPS2375/TPS2376/TPS2377	Estimating Available Application Power for Power-over-Ethernet Applications
SLUA318	TPS2393	–48-V ATCA Module Hot Swap Using the TPS2393
SLVA158	TPS2490/TPS2491	Hot Swap Design Using the TPS2490/91 and MOSFET Transient Thermal Response
SLUA313	TPS2392/TPS2393	Protecting the TPS2392/TPS2393 Insertion Detection Inputs in Fused Applications
SLVA163	TPS2400	Overvoltage Protector for High Voltage Loads
SLVS368	—	Comparing Performance of Current Ramp and Voltage Ramp Hot Swap Controller ICs
SLUA187	UCC3912/15	Programmable Hot Swap Power Manager
SLUA198	UCC3912	Electronic Circuit Breaker ICs
SLUA131	UCC3912	Integrated Electronic Circuit Breaker IC for Hot Swap
SLUA211	UCC3918	Hot Swap Power Manager Evaluation Board and Schematic
SLUA283	TPS239x	A Universal Telecommunications Hot Swap Device Family
SLUA302	TPS2398/99, TPS2390/91	A Comparison of Telecom Hot Swap Managers TPS2398/99 vs TPS2390/91
SLUA291	TPS239x	–48-V Hot Swap Performance Competitive Comparison
SLUA306	TPS2398/99	Using the TPS2398/99 Hot Swap Controller with Power Trends PT4485
SLUA297	TPS2350	Boosting Supply Select Hysteresis on the TPS2350

Design Factors

PCMCIA/CardBus Power Switches

Standard PC cards require that V_{CC} be switched between ground, 3.3 V and 5 V, while V_{PP} is switched between ground, 3.3 V, 5 V and 12 V. CardBay sockets have the standard requirements for V_{CC}, but require ground, 3.3 V and 5 V to V_{PP}, and ground, 1.8 V or 3.3 V to V_{CORE}. Other PC card applications may simply not need 12 V or V_{PP} while still having the standard requirements for V_{CC}. Therefore, consider the voltage requirements of the application when selecting a PCMCIA power switch.

USB High-Power Peripheral Switch With Dual Current Limit + LDO

TPS2140/41/50/51 — The TPS2140/41/50/51 target high-power USB peripherals such as ADSL modems. The devices contain a power switch and an LDO. The dual-current-limiting switch allows the use of high-value capacitance to stabilize the voltage from the USB bus.

Dual Power Switch + LDO for USB Bus-Powered Peripherals and Hubs

TPS2148/49 — TPS2148 is a complete power management solution for USB bus-powered peripherals such as zip drives, while TPS2149 is for USB bus-powered hubs, such as keyboards with integrated hubs. TPS2148/9 each combine a 3.3-V LDO and dual power switch in a single MSOP. The TPS2148 switch configuration allows power and board capacitance segmentation to meet USB system current requirements. The TPS2149 switches manage two independent or four ganged USB ports.

4-Port USB Hub Power Controllers

TPS207x — The TPS207x family provides the complete power solution for 4-port self-powered, bus-powered or hybrid USB hubs by incorporating current-limited switches for four ports, a 3.3-V 100-mA LDO, a 5-V LDO controller for self power (TPS2070, TPS2071) and a DP0 line control to signal an attach to the host.

PCMCIA Devices Family of Products

PCMCIA/CardBus Power Switch Matrix ICs

	Current Limit (min) (A)			
	0.3	0.7	1.0	2.5
3.3 V, 5 V, 12 V, V_{PP}				
Dual	—	—	TPS2224A, TPS2226A, TPS2204A, TPS2206A, TPS2205,	—
Single	TPS2212	—	TPS2204A, TPS2210A, TPS2211A, TPS2220A, TPS2220B	TPS2231
No 12 V				
Dual	—	—	TPS2223A	TPS2236
Single	—	TPS2044B/54B[1]	—	—
No V_{PP}				
Dual	—	TPS2044B/54B[1]	—	—

[1]UL products.

USB Devices Family of Products

USB Power Distribution Switches

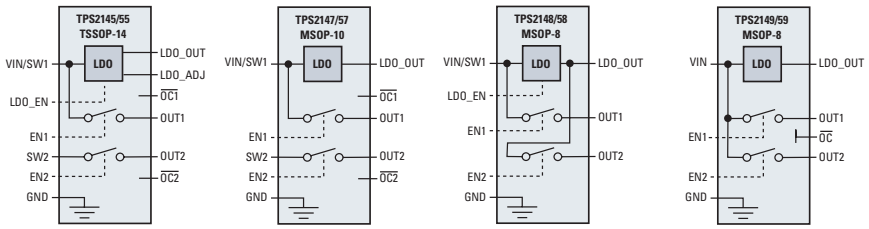
	Current Limit (min) (A)							
	0.22	0.3	0.66	0.7	1.1	1.5	1.65	2.2
Quad	—	TPS2048A/58A[1]	—	TPS2044B/54B[1]	—	—	—	—
Triple	—	TPS2047B/57A[1]	—	TPS2043B/53B[1]	TPS2063/67[1]	—	—	—
Dual	—	TPS2046B/56A	—	TPS2042B/52B[1]	TPS2062/66	TPS2060/64[1]	—	—
Single	TPS2020/30	TPS2045A/55A[1]	TPS2021/31	TPS2041B/51B[1]	TPS2022/32 TPS2061/65[1]	—	TPS2023/33	TPS2024/34

[1]UL products.

4-Port USB Hub Power Controllers

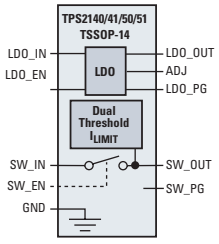
Device	5-V LDO Controller	Bus Power Mode Indicator	Pins	Package
TPS2070	Yes	Active Low	32	HTSSOP
TPS2071	Yes	Active High	32	HTSSOP
TPS2074	No	Active Low	24	SSOP
TPS2075	No	Active High	24	SSOP

Dual Power Switch + LDO for USB Bus-Powered Peripherals and Hubs



USB High-Power Peripheral Bus Switch + LDO

Device	Switch Voltage	Description
TPS2140	3.3 V	3.3-V, 500-mA switch with active-low enable, 250-mA LDO
TPS2141	5.0 V	5.0-V, 500-mA switch with active-low enable, 250-mA LDO
TPS2150	3.3 V	3.3-V, 500-mA switch with active-high enable, 250-mA LDO
TPS2151	5.0 V	5.0-V, 500-mA switch with active-high enable, 250-mA LDO



PCMCIA and USB Devices

Design Factors (Continued)

Ease of Use — USB allows simplified installation and improved performance for peripheral devices by eliminating the need to repeatedly load new drivers and establish individual settings. USB combines a multitude of existing interfaces into a single easy-to-use connector, greatly reducing system complexity and offering manufacturers the ability to develop highly integrated products.

Power Distribution Switches

TPS204xB/5xB — The TPS204xB/5xB families of 80-mΩ current-limiting power switches meet all the USB power management requirements for controlling downstream ports, and include additional features to improve the design reliability. For example, when an over-current condition exists, the device intelligently shuts down only the port that sees the fault.

TPS202x/3x/6x — The TPS202x/3x/6x families of low on-resistance current-limiting power switches allow ganging of multiple ports to a single switch, as described in Application Note SLVA049. Though ganging can be cost effective, all ports are affected by a fault.

For detailed information regarding USB solutions, visit:

www.ti.com/sc/usbsolutions

Selection Guide

Device	Interface	Number of Ports	3.3-V $r_{DS(on)}$ (typ) (mΩ)	5.0-V $r_{DS(on)}$ (typ) (mΩ)	I_{OS} (min) (A)	Predecessor	Price*
PCMCIA/CardBus Switch Matrix ICs							
TPS2210A	3-line Serial	1	85	95	1	—	0.85
TPS2204A	3-line Serial	2	85	95	1	TPS2214/14A	1.95
TPS2220B	3-line Serial	1	85	95	1	TPS2220A	0.85
TPS2223A	3-line Serial	2	85	95	1	—	1.80
TPS2224A	3-line Serial	2	85	95	1	TPS2214/14A	1.95
TPS2226A	3-line Serial	2	85	95	1	TPS2206, TPS2216/16A	2.10
TPS2206A	3-line Serial	2	85	95	1	TPS2206, TPS2216/16A	2.10
TPS2205	8-line Parallel	2	70	100	1	TPS2201	2.90
TPS2211A	4-line Parallel	1	70	57	1	TPS2211	0.75
TPS2212	4-line Parallel	1	160	160	0.3	—	1.45
TPS2231	4-line Parallel	1	68	—	2.5	—	1.00
TPS2044B or 54B	Parallel	1 or 2	80	80	0.7	TPS2044/44A, TPS2054/54A	1.00
TPS2221	Interface Parallel	1	72	97	1	—	1.85
TPS2228	Interface Serial	2	72	97	1	—	3.10

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

*New devices are listed in **bold red**.*

Selection Guide (Continued)

Device	Number of FETs	I_{OS} (min) (A)	$r_{DS(on)}$ (mΩ)	V_{IN} Range (V)	Supply Current (µA)	OC Logic Output	OT Logic Output	Enable	Predecessor	Price*
USB Power Distribution Switches										
TPS2020/30	1	0.22	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2021/31	1	0.66	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2014	1.05
TPS2022/32	1	1.1	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2015	1.05
TPS2023/33	1	1.65	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2024/34	1	2.2	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2041B/51B	1	0.7	70	2.7 to 5.5	40	Each	Yes	L/H	TPS2041/51/41A/51A	0.50
TPS2042B/52B	2	0.7	70	2.7 to 5.5	53	Each	Yes	L/H	TPS2042/52/42A/52A	0.70
TPS2043B/53B	3	0.7	70	2.7 to 5.5	65	Each	Yes	L/H	TPS2043/53/43A/53A	0.90
TPS2044B/54B	4	0.7	70	2.7 to 5.5	75	Each	Yes	L/H	TPS2044/54/44A/54A	1.00
TPS2045A/55A	1	0.3	80	2.7 to 5.5	80	Each	Yes	L/H	TPS2045/55	0.60
TPS2046B/56A	2	0.3	80	2.7 to 5.5	80	Each	Yes	L/H	TPS2046/46A/56	0.65
TPS2047B/57A	3	0.3	80	2.7 to 5.5	160	Each	Yes	L/H	TPS2047/47A/57	0.90
TPS2048A/58A	4	0.3	80	2.7 to 5.5	160	Each	Yes	L/H	TPS2048/58	1.20
TPS2060/4	2	1.5	70	2.7 to 5.5	50	Each	Yes	L/H	—	1.20
TPS2061/5	1	1.1	70	2.7 to 5.5	43	Each	Yes	L/H	—	0.60
TPS2062/6	2	1.1	70	2.7 to 5.5	50	Each	Yes	L/H	—	0.75
TPS2063/7	3	1.1	70	2.7 to 5.5	65	Each	Yes	L/H	—	0.90

Device	Application	Number of FETs	Switch Enable	Bus Power Indicator (BPMODE)	V_{IN} (min) (V)	V_{IN} (max) (V)	Bus Powered $r_{DS(on)}$ per FET (typ) (mΩ)	Bus Powered Current Limit (min) (A)	Self Powered $r_{DS(on)}$ per FET (typ) (mΩ)	Self Powered Current Limit (min) (A)	LDO Controller (A)	LDO	Price*
USB Power Controllers													
TPS2070	USB 4-port hub	8	L	1L	4.5	5.5	560	0.12	107	0.6	5 V, 3 A	3.3 V, 100 mA	2.55
TPS2071	USB 4-port hub	8	L	1H	4.5	5.5	560	0.12	107	0.6	5 V, 3 A	3.3 V, 100 mA	2.55
TPS2074	USB 4-port hub	8	L	1L	4.5	5.5	500	0.12	100	0.6	—	3.3 V, 100 mA	2.55
TPS2075	USB 4-port hub	8	L	1H	4.5	5.5	500	0.12	100	0.6	—	3.3 V, 100 mA	2.55
TPS2140	USB peripheral	1	L	—	2.7	5.5	70	0.1 and 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2141	USB peripheral	1	L	—	4	5.5	70	0.1 and 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2150	USB peripheral	1	H	—	2.7	5.5	70	0.1 and 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2151	USB peripheral	1	H	—	4	5.5	70	0.1 and 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2145	DSP, PDA	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.15
TPS2147	DSP, PDA	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.10
TPS2148	USB peripheral	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.99
TPS2149	USB 2-port hub	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.95
TPS2155	DSP, PDA	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.15
TPS2157	DSP, PDA	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.10
TPS2158	USB peripheral	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.99
TPS2159	USB 2-port hub	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.95

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

Power Multiplexers and Current-Limiting Switches

Design Factors

Power MUX ICs

Power MUX ICs are designed to transition from a main power supply to an auxiliary source when the main supply shuts down (e.g., switching from battery operation to a wall adapter).

Current-Limiting Power Switches

Power switches are used to intelligently turn power on and off, while providing fault protection. They are useful anywhere controlled allocation of power is needed to circuit blocks, modules, add-in cards or cabled connections. They are ideal for power sequencing or segmentation.

To minimize voltage drop, select devices with the lowest $r_{DS(on)}$ or Drain-to-Source on-resistance.

Universal Serial Bus (USB) Power Switches and LDO+ Power Switch Combination ICs are covered on pages 51–53.

ExpressCard™ Power Switches

The TPS2231 and TPS2236 ExpressCard power interface switches provide the total power management solution required by the ExpressCard specification. The TPS2231 and TPS2236 ExpressCard power interface switches distribute 3.3 V, AUX, and 1.5 V to the ExpressCard socket. Each voltage rail is protected with integrated current-limiting circuitry. The TPS2231 supports systems with single-slot ExpressCard/34 or ExpressCard/54 sockets. The TPS2236 supports systems with dual-slot ExpressCard sockets.

Power Multiplexers Family of Products

Power MUX ICs

Configuration	Device	I_{OUT} (mA)	Transition	Comments
	TPS2100/1	IN1: 500, IN2: 10	Manual	SOT-23, 0 to 70°C
	TPS2102/3	IN1: 500, IN2: 100	Manual	SOT-23, 0 to 70°C
	TPS2104/5	IN1: 500, IN2: 100	Manual	SOT-23, –40 to 85°C
IN1 IN2	TPS2110A	Adj. 310 to 750	Auto/Manual	TSSOP
	TPS2111A	Adj. 630 to 1250	Auto/Manual	TSSOP
	TPS2112A	Adj. 310 to 750	Auto	TSSOP, Status pin
	TPS2113A	Adj. 630 to 1250	Auto	TSSOP, Status pin
	TPS2114A	Adj. 310 to 750	Auto/Manual	TSSOP, Status pin
	TPS2115A	Adj. 630 to 1250	Auto/Manual	TSSOP, Status pin

See also TPPM0301/2/3 (for NIC cards) in this selection guide on page 55.

Current-Limiting Switches Family of Products

Current-Limiting Power Switch ICs

	Current Limit (min) (A)							
	0.22	0.3	0.345	0.66	0.7	1.1	1.65	2.2
Fault Reporting								
Quad	—	TPS2048A/58A[2] TPS2095/6/7	TPS2048/58[2]	—	TPS2044/54[2] TPS2044A/54A[2] TPS2044B/54B[2] TPS2085/6/7	—	—	—
Triple	—	TPS2047B/57A	TPS2047/57[2]	—	TPS2043/53[2] TPS2043A/53A[2] TPS2043B/53B[2]	TPS2063/7	—	—
Dual	—	TPS2046B/56A TPS2090/1/2	TPS2046/56[2]	—	TPS2042/52[2] TPS2042A/52A[2] TPS2042B/52B[2] TPS2080/1/2	TPS2062/6	—	—
Single	TPS2020/30[1]	TPS2045A/55A[2]	TPS2045/55[2]	TPS2021/31[1]	TPS2041/51[2] TPS2041A/51A[2] TPS2041B/51B[2]	TPS2022/32 TPS2061/5	TPS2023/33	TPS2024/34
No Fault Reporting								
Single	TPS2010A	—	—	TPS2011A	—	TPS2012A	TPS2013A	—

[1]*Nemko recognized.* [2]*UL and Nemko recognized.*

ExpressCard Power Switch ICs

Device	Ports	3-V $r_{DS(on)}$ (typ) (mΩ)	Interface	Current Limit (min) (A)
TPS2231	1	45	Parallel	2.5
TPS2236	2	45	Parallel	2.5

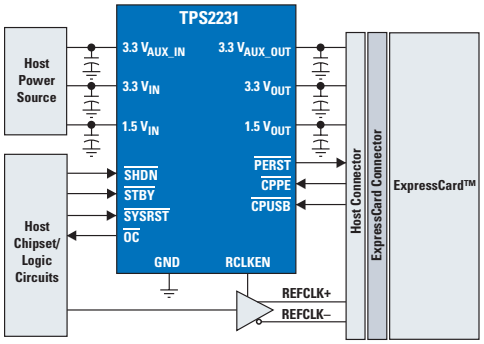
Integrated ExpressCard™ Power Interface Switch

TPS2231

Get samples, datasheets, EVMs and app reports at: **www.ti.com/sc/device/TPS2231**

Key Features

- Meets PC card standard for ExpressCard™ technology
- TTL-logic compatible inputs
- Short-circuit and thermal protection
- 50-µA (typ) quiescent current on 3.3-V auxiliary input (single)



Typical ExpressCard™ power-distribution application.

Power Multiplexers and Current-Limiting Switches

Selection Guide

Device	Number of Inputs	IN1 $r_{DS(on)}$ (mΩ)	IN2 $r_{DS(on)}$ (mΩ)	IN1 Output Current (mA)	IN2 Output Current (mA)	IN1 Supply Current (µA)	IN2 Supply Current (µA)	Input Voltage Range (V)	Transition Time IN1 to IN2 (µs)	Transition Time IN2 to IN1 (µs)	Transition	Price*
Power MUX ICs												
TPPM0301/2	3	—	—	400	400	2500	250	3 to 5.5	—	—	Autoswitch	1.60
TPPM0303	3	—	—	250	250	2500	250	3 to 5.5	—	—	Autoswitch	1.07
TPS2100/1	2	250	1300	500	10	10	0.75	2.7 to 4.0	4	900	L/H enable	0.59
TPS2102/3	2	250	1300	500	100	14	0.75	2.7 to 4.0	3	700	L/H enable	0.69
TPS2104/5	2	250	1300	500	100	18	0.75	2.7 to 5.5	3	700	L/H enable	0.85
TPS2110A/2A/4A	2	120	120	312 to 750	312 to 750	85	85	2.8 to 5.5	40	40	Autoswitch	0.70
TPS2111A/3A/5A	2	84	84	625 to 1250	625 to 1250	85	85	2.8 to 5.5	40	40	Autoswitch	0.70

Device	Number of FETs	I_{OS} (min) (A)	$r_{DS(on)}$ (mΩ)	V_{IN} Range (V)	Supply Current (µA)	OC Logic Output	OT Logic Output	Enable	Predecessor	Price*
Current-Limiting Power Switch ICs										
TPS2010A	1	0.22	30	2.7 to 5.5	73	No	No	L	TPS2010	0.75
TPS2011A	1	0.66	30	2.7 to 5.5	73	No	No	L	TPS2011	0.75
TPS2012A	1	1.1	30	2.7 to 5.5	73	No	No	L	TPS2012	0.75
TPS2013A	1	1.65	30	2.7 to 5.5	73	No	No	L	TPS2013	0.75
TPS2020/30	1	0.22	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2021/31	1	0.66	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2014	1.05
TPS2022/32	1	1.1	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2015	1.05
TPS2023/33	1	1.65	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2024/34	1	2.2	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2041B/51B	1	0.7	70	2.7 to 5.5	43	Each	Yes	L/H	TPS2041/51/41A/51A	0.50
TPS2042B/52B	2	0.7 ea	70	2.7 to 5.5	50	Each	Yes	L/H	TPS2042/52/42A/52A	0.70
TPS2043B/53B	3	0.7 ea	70	2.7 to 5.5	65	Each	Yes	L/H	TPS2043/53/43A/53A	0.90
TPS2044B/54B	4	0.7 ea	70	2.7 to 5.5	75	Each	Yes	L/H	TPS2044/54/44A/54A	1.00
TPS2045A/55A	1	0.3	80	2.7 to 5.5	80	Each	Yes	L/H	TPS2045/55	0.60
TPS2046B/56A	2	0.3 ea	80	2.7 to 5.5	80	Each	Yes	L/H	TPS2046/46A/56	0.65
TPS2047B/57A	3	0.3 ea	80	2.7 to 5.5	160	Each	Yes	L/H	TPS2047/47A/57	0.90
TPS2048A/58A	4	0.3 ea	80	2.7 to 5.5	160	Each	Yes	L/H	TPS2048/58	1.20
TPS2060/4	2	1.5 ea	70	2.7 to 5.5	50	Each	Yes	L/H	—	1.20
TPS2061/5	1	1.1	70	2.7 to 5.5	43	Each	Yes	L/H	—	0.60
TPS2062/6	2	1.1 ea	70	2.7 to 5.5	50	Each	Yes	L/H	—	0.75
TPS2063/7	3	1.1 ea	70	2.7 to 5.5	65	Each	Yes	L/H	—	0.90
TPS2080/1/2[1]	2	0.7 ea	80	2.7 to 5.5	85	Yes	Yes	2H, 1L/1H, 2L	—	0.65
TPS2085/6/7[1]	4	0.7 ea	80	2.7 to 5.5	85	Yes	Yes	4H, 2L/2H, 4L	—	1.05
TPS2090/1/2[1]	2	0.3 ea	80	2.7 to 5.5	85	Yes	Yes	2H, 1L/1H, 2L	—	0.65
TPS2095/6/7[1]	4	0.3 ea	80	2.7 to 5.5	85	Yes	Yes	4H, 2L/2H, 4L	—	1.05

[1]Can be configured as power MUX ICs.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Design Factors

System Voltages — The version of supervisor you require is dependent on the voltage rail(s) within the system. For example, supervisors designed to support a processor need to be selected according to the voltage driving the processor.

Number of Channels — Typically the number of supervisor functions required in a system is dependent on the processor and peripheral(s) voltages. For example, split-voltage processors may require supervision of both rails, while the memory in the system may also require supervision and be operating on a third (different) voltage rail.

Manual Reset (MR) — This feature allows the user to manually reset the circuit or control the supervisory circuit by another device of the application.

Watchdog Input (WDI) — In situations where the system processor may not be functioning properly, its onboard watchdog feature may fail to reset. Supervisors with integrated watchdog functionality increase system reliability by being able to trigger a reset.

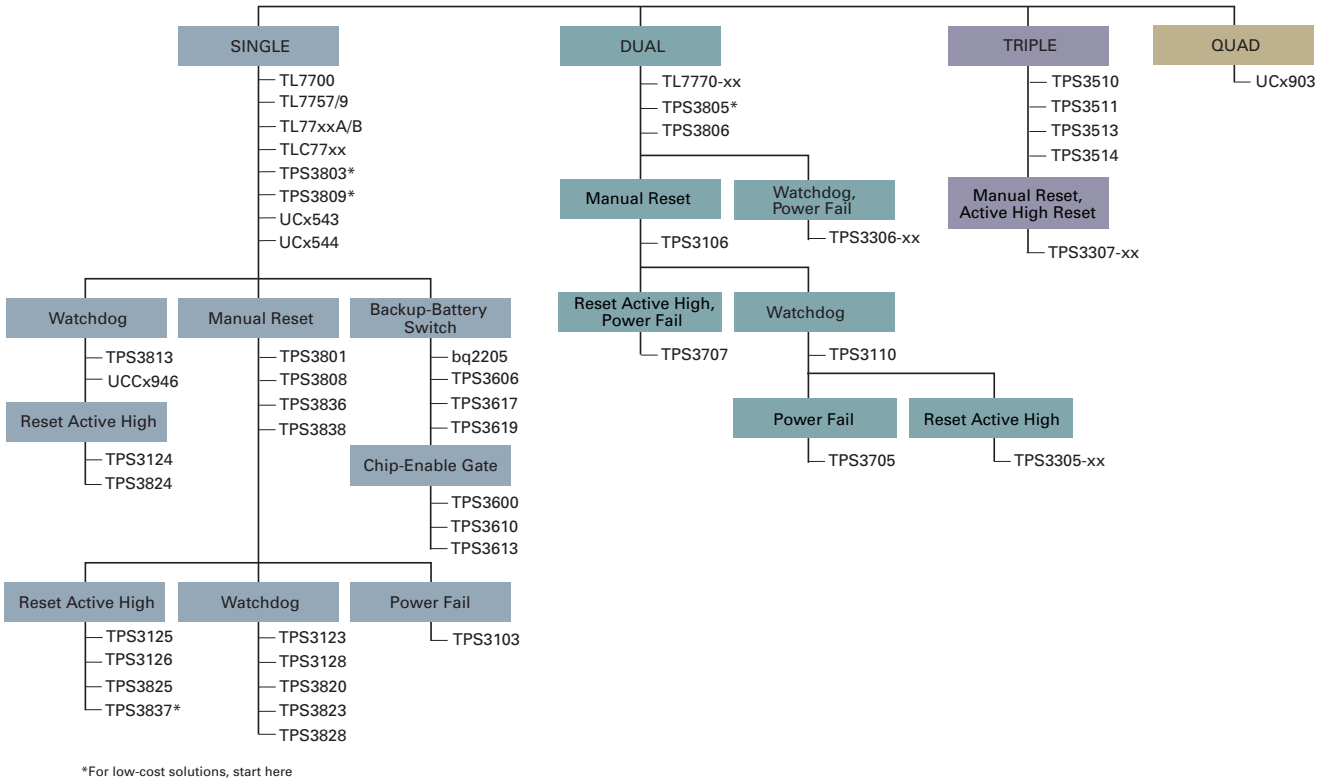
Active High Output — Allows the use of processors with active high reset input without additional components.

Power Fail Input/Output (PFI/PFO) — Allows for more flexibility by using this comparator, e.g., for long-term battery observation and pre-warning.

Delay Time — Allows the voltage and other components in the circuit to stabilize first before the normal operation starts again.

Chip-Enable Gating — Chip-enable gating prevents erroneous data from corrupting CMOS RAM during an undervoltage condition.

Supervisory Circuits (Voltage Supervisors) Family of Products



*For low-cost solutions, start here

Selection Guide

Device	Number of Supervisors	Supervised Voltages	Packages	V_{DD} Range (V)	I_{DD} (typ) (µA)	Time Delay (ms)	Watchdog Timer WDI (sec)	Reset Threshold Accuracy (%)	Manual Reset Input/MR	Active-Low Reset Output	Active-High Reset Output	Reset Output Topology[1]	Power-Fail PFI/PFO	Over-Voltage Detection	Over-Current Detection	Backup-Battery Switchover	Chip-Enabled Gating	Price*	Comments
General Purpose Supply Supervisors																			
TPS3808	1	Adj./0.9/1.2/1.5/1.8/2.5/3.0/3.3/5.0/EEPROM	SOT-23	1.8 to 6.5	2.4	Prog	—	0.5	✔	✔		OD						0.70	
TPS3103	1	1.2/1.5/2.0/3.3	SOT-23	0.4 to 3.3	1.2	130	—	0.75	✔	✔		OD	✔					0.90	
TPS3123	1	1.2/1.5/1.8	SOT-23	0.75 to 3.3	14	180	1.4	3.6	✔	✔		PP						0.85	
TPS3124	1	1.2/1.5/1.8	SOT-23	0.75 to 3.3	14	180	1.4	3.6		✔	✔	PP						0.85	
TPS3125	1	1.2/1.5/1.8/3.0	SOT-23	0.75 to 3.3	14	180	—	3.6	✔	✔	✔	PP						0.80	
TPS3126	1	1.2/1.5/1.8	SOT-23	0.75 to 3.3	14	180	—	3.5	✔	✔	✔	OD						0.80	
TPS3128	1	1.2/1.5/1.8	SOT-23	0.75 to 3.3	14	180	1.4	3.5	✔	✔		OD						0.85	
TPS3800	1	2.7	SC-70	1.6 to 6.0	9	100	—	2	✔	✔		PP						0.49	
TPS3801	1	Adj./1.8/2.5/3.0/3.3/5.0	SC-70	1.6 to 6.0	9	200	—	2	✔	✔		PP						0.49	
TPS3802	1	3.0/3.3	SC-70	1.6 to 6.0	9	400	—	2	✔	✔		PP						0.49	
TPS3803	1	Adj./1.5	SC-70	1.3 to 6.0	3	5 µs	—	1.5		✔		OD						0.29	
TPS3809	1	2.5/3.0/3.3/5.0	SOT-23	2.0 to 6.0	9	200	—	2.2		✔		PP						0.29	
TPS3813	1	2.5/3.0/3.3/5.0	SOT-23	2.0 to 6.0	9	25	Window	2.2		✔		OD						0.90	Window Watchdog
TPS3820/8-xx	1	3.3/5.0	SOT-23	1.1 to 5.5	15	25/200	0.2/1.6	2.4	✔	✔		PP/OD						0.65	
TPS3823	1	2.5/3.0/3.3/5.0	SOT-23	1.1 to 5.5	15	200	1.6	2.4	✔	✔		PP						0.65	
TPS3824-xx	1	2.5/3.0/3.3/5.0	SOT-23	1.1 to 5.5	15	200	1.6	2.2		✔	✔	PP						0.65	
TPS3825-xx	1	3.3/5.0	SOT-23	1.1 to 5.5	15	200	—	2.2	✔	✔	✔	PP						0.55	
TPS3836/8	1	1.8/2.5/3.0/3.3	SOT-23	1.6 to 6.0	0.22	10/200	—	2.5	✔	✔		PP/OD						0.85	
TPS3837	1	1.8/2.5/3.0/3.3	SOT-23	1.6 to 6.0	0.22	10/200	—	2.4	✔		✔	PP						0.85	
TL7700	1	Adjustable	DIP-8, SOP-8	1.8 to 40	0.6 mA	Prog	—	1		✔		OC						2.25	
TL7757	1	5	SO-8, SOT-89, TO-92	1.0 to 7.0	1.4 mA	5 µs	—	2.6		✔		OC						0.32	
TL7759	1	5	SO-8	1.0 to 7.0	1.4 mA	5 µs	—	2.6		✔	✔	OC						0.88	
TL77xxA	1	2.7/5/9/12/15	SO-8, DIP-8, SOP-8	3.5 to 18	1.8 mA	Prog	—	2	✔	✔	✔	OC						0.25	
TL77xxB	1	2.7/3.3/5	SO-8, DIP-8	3.6 to 18	1.8 mA	Prog	—	2	✔	✔	✔	OC						0.27	
TLC77xx	1	Adj./2.5/3.3/3.0/5.0	SO-8, DIP-8, TSSOP-8	2.0 to 6.0	9	Prog	—	5.5		✔	✔	PP						0.65	
UCCx946	1	Adjustable	SO-8, DIL-8, TSSOP-8	2.0 to 5.5	10	Prog	Prog	2		✔		PP						1.40	
TPS3807	2	3/3.5	SC-70	1.8 to 6.5	3.5	20	—	1		✔		OD						0.95	
TPS3106	2	Adj./0.9/1.6/3.3	SOT-23	0.4 to 3.3	1.2	130	—	0.75	✔	✔		OD						0.90	
TPS3110	2	Adj./0.9/1.2/1.5/3.3	SOT-23	0.4 to 3.3	1.2	130	1.1	0.75	✔	✔		PP						0.99	
TPS3305-xx	2	1.8/2.5/3.3/5.0	SO-8, MSOP-8	2.7 to 6.0	15	200	1.6	2.7	✔	✔	✔	PP						1.00	
TPS3306-xx	2	1.5/1.8/2.0/2.5/3.3/5.0	SO-8, MSOP-8	2.7 to 6.0	15	100	0.8	2.7		✔		OD	✔	✔				1.05	
TPS3705-xx	2	3.0/3.3/5.0	SO-8, MSOP-8	2.0 to 6.0	30	200	1.6	2.1	✔	✔		PP	✔					0.80	
TPS3707-xx	2	2.5/3.0/3.3/5.0	SO-8, MSOP-8	2.0 to 6.0	20	200	—	2.2	✔	✔	✔	PP	✔					0.75	
TPS3805	2	Adj./3.3	SC-70	1.3 to 6.0	3	5 µs	—	1.5		✔		PP						0.34	
TPS3806	2	Adj./2.0/3.3	SOT-23	1.3 to 6.0	3	5 µs	—	2		✔		OD						0.60	
TL7770-xx	2	5.0/12.0 & Adj.	SO-16, DIP-16	3.5 to 18	5 mA	Prog	—	2	✔	✔	✔	OC		✔				1.55	
TPS3307-xx	3	Adj./1.8/2.5/3.3/5.0	SO-8, MSOP-8	2.0 to 6.0	15	200	—	2.7	✔	✔	✔	PP						1.05	
UCx903	4	Adjustable	DIP-18, PLCC-20	—	7 mA	Prog	—	5		✔	✔	OC	✔	✔				2.45	
Battery Backup Switchover Supply Supervisors																			
TPS3600	1	2.0/2.5/3.3/5.0	TSSOP-14	—	20	100	0.8	2.3	✔	✔		PP	✔			✔	✔	2.30	
TPS3606-33	1	3.3	MSOP-10	—	20	100	0.8	2	✔	✔		PP	✔			✔		1.80	
TPS3610	1	1.8/5.0	TSSOP-14	—	20	100	0.8	2		✔		PP	✔			✔	✔	2.10	
TPS3613-01	1	Adjustable	MSOP-10	—	20	100	—	1.7	✔	✔	✔	PP				✔	✔	1.60	
TPS3617-50	1	5	MSOP-8	—	20	100	0.8	2		✔		PP	✔			✔		1.35	
TPS3619	1	3.3/5.0	MSOP-8	—	15	100	—	2	✔	✔		PP	✔			✔		1.10	
bq2205LY	1	3.3	TSSOP-16	—	0.2 mA	55	—	1.7		✔		OD				✔	Two	1.75	3.3-V SRAM Controller with Battery Backup
Special Function Supply Supervisors																			
bq2205LY	1	3.3	TSSOP-16	—	0.2 mA	55	—	1.7		✔		OD				✔	Two	1.75	3.3-V SRAM Controller with Battery Backup
TPS3510	3	3.3/5.0/12.0	SO-8, DIP-8	—	1 mA	300	—	9.1		✔		OD	✔	✔				0.55	PC Power Supplies
TPS3511	3	3.3/5.0/12.0	SO-8, DIP-8	—	1 mA	150	—	5.7		✔		OD	✔	✔				0.55	PC Power Supplies
TPS3513	3	3.3/5.0/12.0	SO-14, DIP-14	—	1 mA	300	—	9.1		✔		OD	✔	✔	✔			0.85	PC Power Supplies
TPS3514	3	3.3/5.0/12.0	SO-14, DIP-14	—	1 mA	300	—	5.2		✔		OD	✔	✔	✔			0.85	PC Power Supplies

[1]*PP = push-pull, OD = open drain, OC = open collector.* **Suggested resale price in U.S. dollars in quantities of 1,000.* *New devices are listed in **bold red**.*

Note: Custom voltages can be provided. Minimum order quantities may apply. Contact TI for details and availability.

Design Factors

Topology — Shunt (two-terminal) vs. series (three-terminal). Shunt references are very similar to Zener diodes in operation as both require an external resistor for biasing. The external resistor determines the maximum current that can be supplied to the load as well as provide the minimum biasing current to maintain regulation. Shunt references should be considered when the load is nearly constant and power supply variations are minimal. Series references do not require any external components and they should be considered when the load is variable and lower voltage overhead is of the importance. They are also more immune to the power supply changes than shunt references.

Initial Accuracy — This parameter is of primary concern in systems where calibration is impossible or inconvenient. Usually, it is accomplished by the calibration of the overall system. Initial accuracy is specified with fixed input voltage and no load current (for series type) or fixed bias current (for shunt type).

Temperature Drift — Temperature drift is the change in output voltage due to the temperature change, expressed in ppm/°C. Buried Zener type references (e.g., REF02, REF102) typically have a lower temperature drift than bandgap type voltage references. Temperature drift can be specified in several ways (slope, butterfly and box), but the most common way is the box method calculated as:

$$TC\left(\frac{ppm}{°C}\right) = \frac{(V_{max} - V_{min}) \times 10^6}{(T_{max} - T_{min}) \times V_{nom}}$$

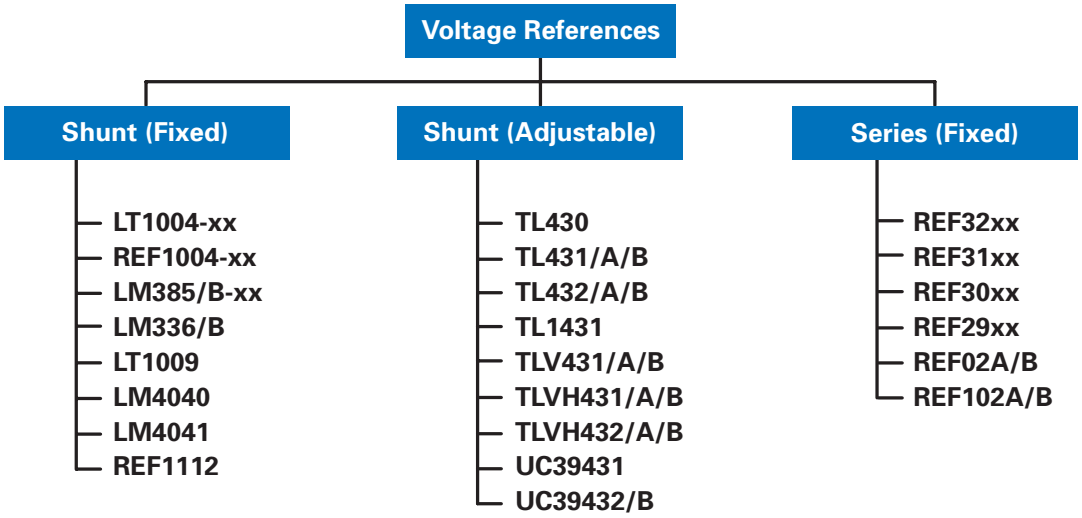
Long-Term Stability — The output of a voltage reference changes very gradually as time goes by. The greatest change occurs in the first 500 hours. This parameter can be important in high-performance applications or in applications where periodic calibration is not acceptable. TI specifies long-term stability data based on the observation over 1000 hours at room temperature.

Output Noise — Output noise is usually specified over two frequency ranges: 0.1 Hz to 10 Hz (peak-to-peak noise) and 10 Hz to 1 kHz (RMS noise). Noise can be important because it can reduce dynamic range of the acquisition system. High-resolution data acquisition systems may experience "dither" in the LSBs solely due to reference noise. Noise can be reduced by external filtering (REF102 has noise reduction pin).

Adjustable Output — Both fixed and adjustable outputs are available. The adjustable output can be set via a resistor divider connected to a reference pin.

Packaging — Through-holes (PDIP and TO-92) and surface mount (SOIC, TSSOP, SOT-89 and SOT23) packages are available.

Voltage References Family of Products



Selection Guide

Device	V_{OUT} (V)	Initial Tolerance @ 25°C (%)	Temp. Coefficient (typ) (ppm/°C)	Temp. Coefficient (max) (ppm/°C)	I_{OUT} (max) (mA)	I_q (max) (mA)	V_{IN} (min) (V)	V_{IN} (max) (V)	Package	Price*
Series Voltage References										
REF32xx	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	0.2	4	7	±10	0.12	1.8	3.5	SOT23	1.70
REF31xx	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	0.2	5	15	±10	0.115	1.8	5.5	SOT23	1.10
REF30xx	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	0.2	20	50	25	0.05	1.8	5.5	SOT23	0.59
REF29xx	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	2	35	100	25	0.05	1.8	5.5	SOT23	0.49
REF02A/B	5	0.2, 0.3	4	10, 15	21	1.4	8	40	SOIC, PDIP	1.75
REF102A/B	10	0.05, 0.1	—	5, 10	10	1.4	11.4	36	SOIC, PDIP	1.75
REF102C	10	0.025	—	2.5	10	1.4	11.4	36	SOIC, PDIP	4.85

Device	V_{OUT} (V)	Initial Tolerance @ 25°C (%)	Adj. V_{OUT} (min) (V)	Adj. V_{OUT} (max) (V)	Min I_Z for Reg. (µA)	I_q (max) (mA)	I_{OUT}/I_Z (max) (mA)	V_{IN} (min) (V)	V_{IN} (max) (V)	Temp. Coefficient (typ) (ppm/°C)	Temp. Coefficient (max) (ppm/°C)	Package	Price*
Shunt Voltage References													
LM236-2.5, LM336/B-2.5	2.5	2, 4	—	—	400	—	10	—	—	10, 13	33	SOIC, TSSOP, TO92	0.40
LM285-xx, LM385/B-xx	1.235, 2.5	1, 1.5, 2, 3	—	—	10, 20	—	20	—	—	20	—	SOIC, TSSOP, TO92	0.18
LM4040	2.048, 2.5, 3, 4.096, 5, 10	0.1, 0.2, 0.5, 1	—	—	75	—	20	—	—	15	100, 150	SOT23, SC70, **TO92**	0.27
LM4041	Adj., 1.225	0.1, 0.2, 0.5, 1	1.225	10	75	—	12	—	—	15	100, 150	SOT23, SC70, **TO92**	0.27
LT1004-xx	1.235, 2.5	0.3, 0.8	—	—	10, 20	—	20	—	—	20	—	SOIC, TSSOP, TO92	0.40
LT1009	2.5	0.2	—	—	400	—	10	—	—	—	25	SOIC, TSSOP, TO92	0.41
REF1004-xx	1.235, 2.5	0.3, 0.4	—	—	10, 20	—	20	—	—	20	—	SOIC, PDIP	1.23
REF1112	1.25	0.2	—	—	1	0.005	5	—	—	10	30	SOT23	0.79
TL1431	Adj.	0.4	2.5	36	1000	—	100	—	—	23	114	SOIC, TSSOP, TO92	0.32
TL430	Adj.	5	2.75	30	2000	—	100	—	—	120	—	TO92	0.58
TL431/A/B, TL432/A/B	Adj.	0.5, 1, 2	2.495	36	600, 1000	—	100	—	—	34	83	SOIC, PDIP, TSSOP, SOT89, SOT23	0.14
TLV431/A/B	Adj.	0.5, 1, 1.5	1.24	6	80	—	15	—	—	39	129	SOIC, SOT23, SC70, TO92	0.23
TLVH431/A/B, TLVH432/A/B	Adj.	0.5, 1, 1.5	1.24	18	100	—	80	—	—	39	129	SOT23, SC70, SOT89, TO92	0.27
UC39431	Adj., 2.82, 3.12, 5.1, 7.8, 10.42, 12.24	0.4	2.3	36	800	0.5	100	2.2	36	—	—	SOIC, PDIP	2.33
UC39432/B	Adj., 1.3	0.4, 0.8	2.2	36	800	0.5	100	2.2	36	—	—	SOIC, PDIP	2.09

Device	No. of Outputs	I_{OUT} (µA)	Current Tolerance (max) (%)	Current Match Tolerance (max) (%)	Temp Drift (typ) (ppm/°C)	Voltage Compliance, 1% (V)	Current Mirror Tolerance (max) (%)	Price*
Current References								
REF200	2	100	1	1	25	2.5 to 40	0.5	2.60

Device	Number of Channels	V_S (min) (V)	V_S (max) (V)	I_q per Channel (max) (mA)	V_{IO} (25°C) (max) (mV)	GBW (typ) (MHz)	Single Supply	V_{ref} Fixed (V)	V_{ref} Adj. (min) (V)	V_{ref} Adj. (max) (V)	V_{ref} 25°C Tolerance (%)	I_{ref} (max) (mA)	Package	Price*
Op Amp with Voltage Reference														
TL103W/A	2	3	36	0.6	4, 3	0.9	Yes	2.5	—	—	0.7, 0.4	100	SOIC8	0.32
TSM104W/A	4	3	36	0.6	5, 3	0.9	Yes	—	2.5	36	0.7, 0.4	100	SOIC, TSSOP	0.32

Device	Number of Channels	V_S (min) (V)	V_S (max) (V)	I_q per Channel (max) (mA)	t_{RESP} Low-to-High (µs)	Output Type	V_{IO} (25°C) (max) (mV)	Rail-to-Rail	V_{ref} Fixed (V)	V_{ref} 25°C Tolerance (%)	V_{ref} Temp Co. (typ) (ppm/°C)	Package	Price*
Comparator with Voltage Reference													
TLV3011	1	1.8	5.5	0.005	6	Open-Drain	12	In, Out	1.242	1	40	SOT23, SC70	0.75
TLV3012	1	1.8	5.5	0.005	6	Push-Pull	12	In, Out	1.242	1	40	SOT23, SC70	0.75

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

*Preview devices are listed in **bold blue**.*

Real-Time Clocks

Design Factors

Data Bus Type — There are two data bus types available: (1) address/data multiplexed and (2) parallel. With (1), the memory address lines and data lines share the same pins. With (2), the address lines and data lines are separate and the interface is the same as a static RAM. The address/data multiplexed devices have fewer pins but may require more logic to interface.

3- or 5-V Operation — The RTCs can run from a 5-V or 3-V rail.

CPU Supervisor — Some parts include a full CPU supervisor that provides:

- CPU reset (power-on and push-button).
- Power-fail interrupt.
- Watchdog timer.
- Non-volatile control for additional NVSRAM.

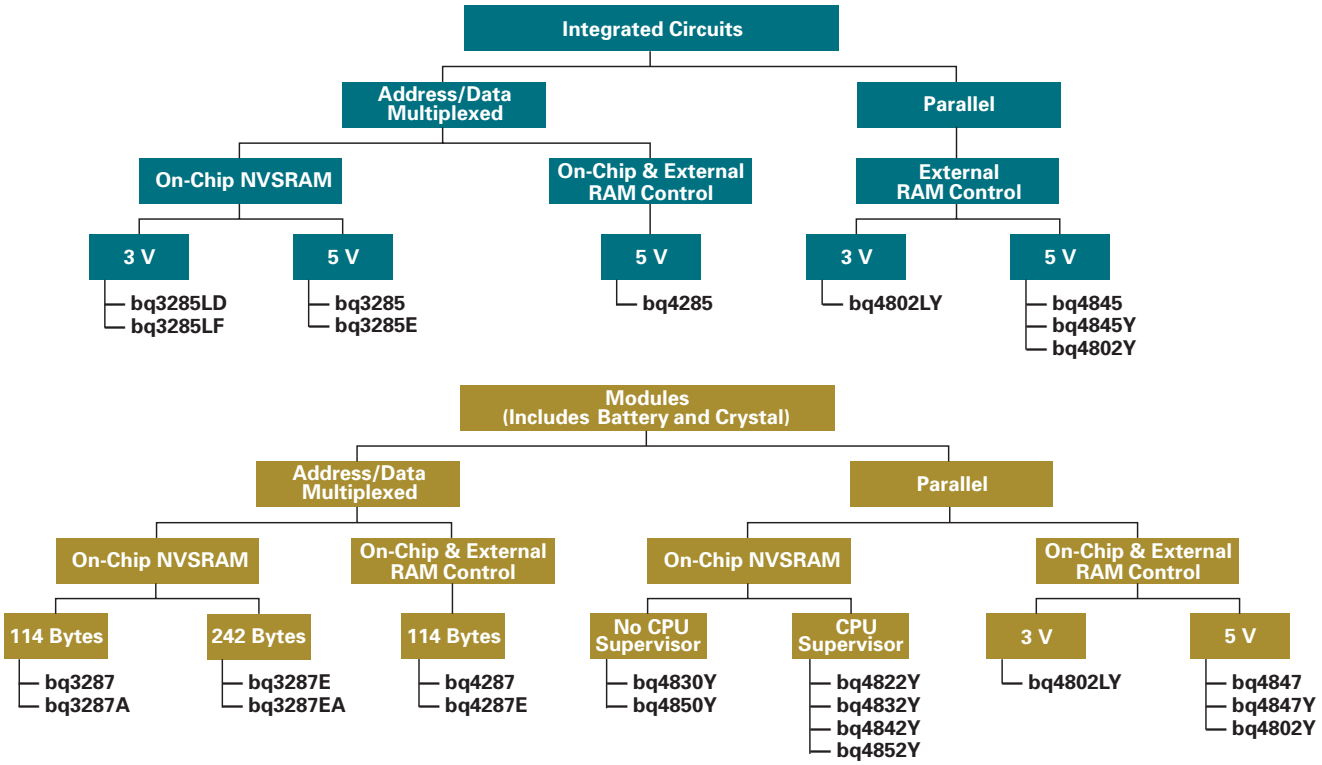
The integration of the supervisor on the RTC can reduce the component count in a design.

- Onboard NVSRAM.
- V_{CC} tolerance.
- Package type.

Features

- Real-time clock counts seconds through centuries in BCD format.
- Complete surface-mount solution with SNAPHAT® package.
- Less than 500 nA of current consumption in battery backup mode.
- Clock accuracy (modules) better than 1 minute per month.
- Up to 512K x 8 of onboard NVSRAM.
- 3- or 5-V operation.
- Fully integrated CPU supervisor.

Real-Time Clocks Family of Products



Integrated RTC and CPU Supervisor in Space-Saving SNAPHAT® Package
bq4802Y

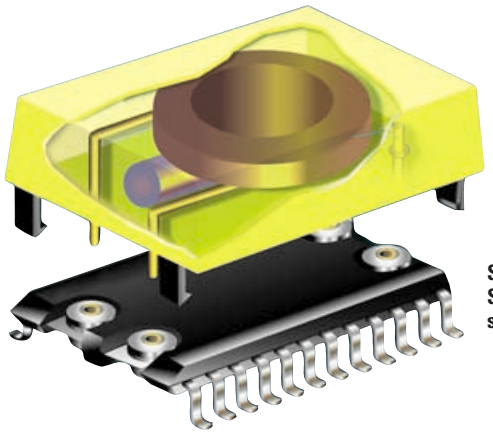
Get samples and datasheets at: **www.ti.com/sc/device/bq4802Y**

Key Features

- Real-time clock counts seconds through centuries in BCD format
- SNAPHAT package allows small, compact surface-mount solution
- Automatic battery backup in the absence of main power
- Nonvolatile control for external SRAM
- Full CPU supervisor:
  - Microprocessor reset with push-button override
  - Watchdog timer
  - Power-fail interrupt warning
  - Programmable periodic interrupt

Applications

- Portable instrumentation
- Fax/copy machines
- Point-of-sale terminals
- Network hubs/routers
- Set-top boxes
- Test and medical equipment



bq4802Y RTC and CPU supervisor.

Selection Guide

Device	V_{CC} Level (V)	V_{CC} Tolerance (%)	CPU Supervisor	Onboard NVSRAM	External NVSRAM Control	Packages	Price*
Parallel Interface							
bq4802Y	5	10	Yes	No	Yes	28-pin SOIC, TSSOP or DHS for SNAPHAT®	2.50
bq4802LY	3	10	Yes	No	Yes	28-pin SOIC, TSSOP or DHS for SNAPHAT	2.50
bq48SH-28X6NSH	—	—	—	—	—	SNAPHAT for Use with bq4802 DSH	3.60
bq4845	5	5	Yes	No	Yes	28-pin SOIC	2.50
bq4845Y	5	10	Yes	No	Yes	28-pin SOIC	2.50
bq4830Y	5	10	No	32K x 8	No	28-pin DIP Module	10.50
bq4822Y	5	10	No	8K x 8	No	28-pin DIP Module	9.50
bq4832Y	5	10	No	32K x 8	No	32-pin DIP Module	12.50
bq4842Y	5	10	No	128K x 8	No	32-pin DIP Module	14.50
bq4852Y	5	10	No	512K x 8	No	36-pin DIP Module	29.00
bq4847	5	5	Yes	No	Yes	28-pin DIP Module	4.95
bq4847Y	5	10	Yes	No	Yes	28-pin DIP Module	4.95
bq4850Y	5	10	No	512K x 8	No	32-pin DIP Module	25.00
Address/Data Multiplexed							
bq3285	5	10	No	114 bytes	No	24-pin SOIC	2.10
bq3285E	5	10	No	242 bytes	No	24-pin SOIC or SSOP	2.10
bq3285LD	3	10	No	242 bytes	No	24-pin SSOP	2.10
bq3285LF	3	10	No	240 bytes	No	24-pin SSOP	2.10
bq3287	5	10	No	114 bytes	No	24-pin DIP Module	3.80
bq3287A[1]	5	10	No	114 bytes	No	24-pin DIP Module	3.80
bq3287E	5	10	No	242 bytes	No	24-pin DIP Module	3.80
bq3287EA[1]	5	10	No	242 bytes	No	24-pin DIP Module	3.80
bq4285	5	10	No	114 bytes	Yes	24-pin SOIC	2.35
bq4285E	5	10	No	114 bytes	Yes	24-pin SOIC	2.35
bq4287	5	10	No	114 bytes	Yes	24-pin DIP Module	4.30

[1]The "A" versions have a RAM clear input pin.

*New devices are listed in **bold red**.*

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

Non-Volatile SRAM (NVSRAM)

Design Factors

Memory Density

The densities range from 64 Kbit to 16 Mbit organized x 8.

V_{CC} Tolerance

To protect data during power-up/-down sequences, the NVSRAM automatically deselects the SRAM when its supply voltage is 5 or 10% below the nominal 5 V. The tolerance should match the characteristics of the 5-V supply.

Features

- 10-year data retention in the absence of power.
- Standard SRAM pinout and interface.
- Unlimited write cycles.
- Access times of 70 ns.
- Automatic write protection during power cycles.
- Internal battery isolated until initial power-up.
- 28- to 36-pin DIP.

Non-Volatile SRAM (NVSRAM) Family of Products

Device	Description	Price*
5% V_{CC} Tolerance		
bq4010	8K x 8 (64 Kbit)	6.50
bq4011	32K x 8 (256 Kbit)	7.50
bq4013	128K x 8 (1 Mbit)	9.50
bq4014	256K x 8 (2 Mbit)	20.00
bq4015	512K x 8 (4 Mbit)	22.00
bq4016	1024K x 8 (8 Mbit)	26.00
bq4017	2048K x 8 (16 Mbit)	50.00
10% V_{CC} Tolerance		
bq4010Y	8K x 8 (64 Kbit)	6.50
bq4011Y	32K x 8 (256 Kbit)	7.50
bq4013Y	128K x 8 (1 Mbit)	9.50
bq4014Y	256K x 8 (2 Mbit)	20.00
bq4015Y	512K x 8 (4 Mbit)	22.00
bq4016Y	1024K x 8 (8 Mbit)	26.00
bq4017Y	2048K x 8 (16 Mbit)	50.00

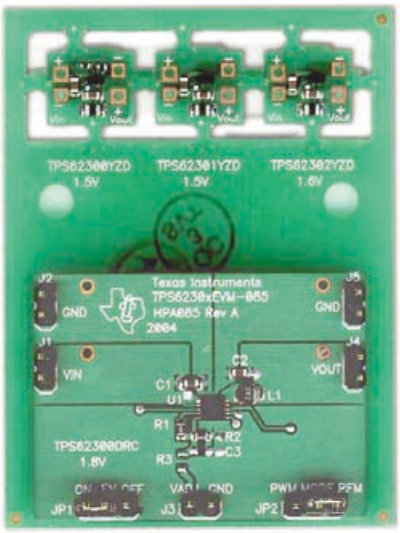
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Power Management Design Tools

From data sheets and application notes to software tools and evaluation modules, TI has a variety of tools available to maximize your design and speed your time to market. Below is a partial list of resources.

Evaluation Modules (EVMs)

EVMs provide development and evaluation environments to help speed time to market. To find a list of available EVMs, go to **power.ti.com**, select "Design Resources," then "Development Tools." EVMs can be purchased through the TI eStore, where you can search for EVMs by product number, type or application. In most cases, EVMs are shipped within 24 hours.



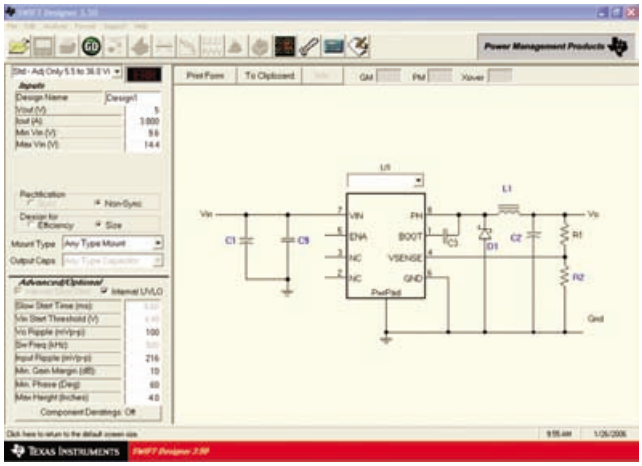
Reference Design Resources

Our reference design home page features solutions including schematics and detailed bills of material. For a complete list of available reference designs, go to: **www.ti.com/powerreferencedesigns**

Design Software

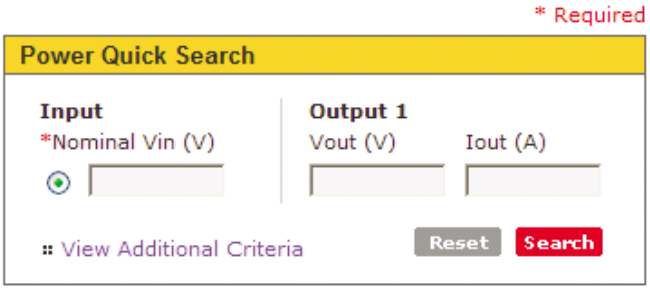
Go to **power.ti.com** to download these software tools:

- SWIFT™ Designer Software Tool: Design software for TPS54000 DC/DC converters
- TPS40K™: DC/DC Controller Products Designer Software: Design software for TPS40000 DC/DC controllers
- TPS62K: Low-Power DC/DC Designer Software: Design software for TPS60000 DC/DC converters



Power Quick Search Tool

Looking to find an appropriate device quickly? Go to **power.ti.com** and enter the desired input and output voltage(s) in the Power Quick Search box.



Power Management Literature

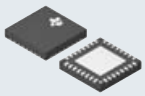
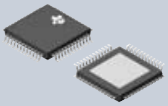
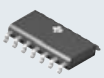
You can download the following literature from **www.ti.com/analoglit**

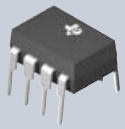
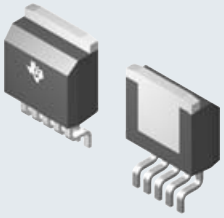
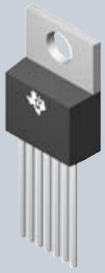
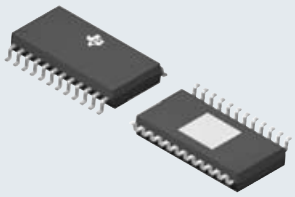
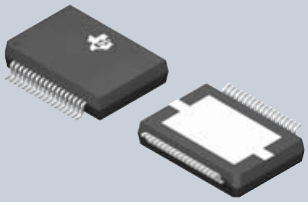
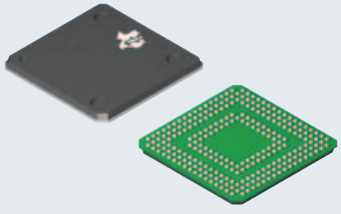
- Power Management Reference Design Cookbook
- T2 Power Modules with *TurboTrans*™ Technology Brochure
- Lighting and Display Power Selection Guide
- MSP430 MCU Power Management Reference Guide
- Fusion Digital Power™ Control Solutions Guide
- Power Management Reference Guide for Altera® FPGAs and CPLDs
- Power Management Reference Guide for Xilinx® FPGAs
- DSP Power Management Reference Guide

Get started quickly with 20 popular reference designs from which to choose. Schematics, bill of materials and in-depth technical information are available.

Packaging

High-Performance Analog Packages

	Package Type	Package Designator
	Wafer Scale Package (WSP)	YEG, YEK, YEJ, YEA, YZA, YED, YNA
	Small Outline Transistor Package (SOT23)	DBY, DCN, Thin SOT, DDC
	Transistor Outline (TO236)	DBZ
	Mini Small Outline Package (MSOP)	DGK, DGS
	Small Outline No Leads (SON)	DRD, DRB, DRC
	Shrink Small Outline Package (SSOP)	DBQ, DB, DL
	Quad Flatpack No Leads (QFN)	RGS, RGY, RGT, RGV, RGY, RHC, RGA, RGP, RGW, RGY, RGE, RGU, RHD, RGL, RGD, RHB, RGF, RHA, RTA, RGN, RGZ, RGQ, RGC, RHE, RHF
	Thin Quad Flatpack (TQFP)	PBS, PJT, PFB, PAG
	Small Outline Transistor (SOT223)	DCY, DCQ
	Heat Sink Thin Quad Flatpack (HTQFP)	PHP, PAP
	Small Outline Integrated Circuit (SOIC)	D, DTH, DTC, DW, DWU

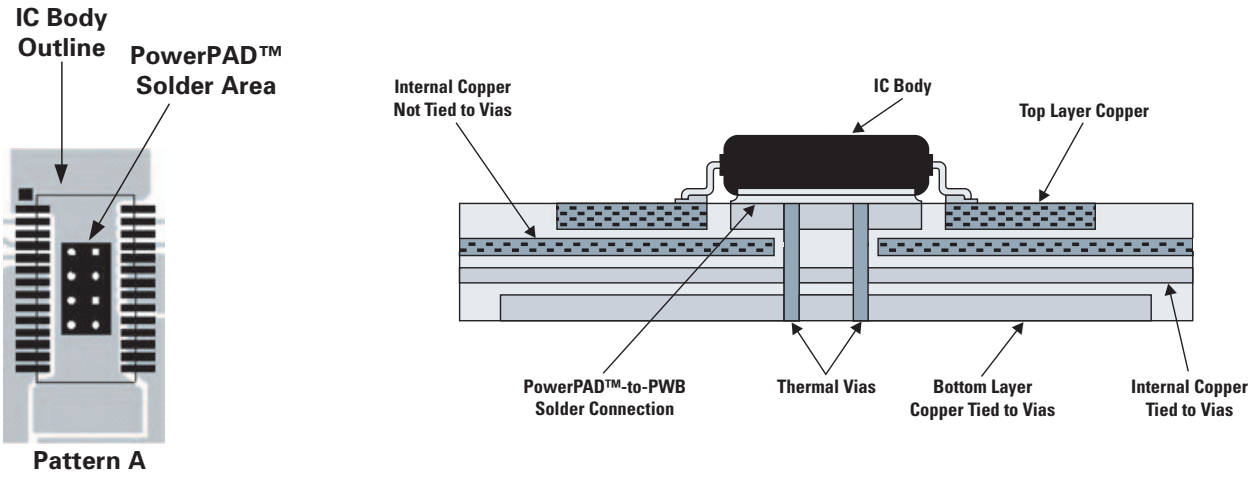
	Package Type	Package Designator
	Thin Shrink Small Outline Package (TSSOP)	PW
	Plastic Dual-In-Line Package (PDIP)	P, N, NT, NTD
	Surface Mount Header (DDPak)	KTT, KTW
	Transistor Outline (TO220)	KC
	Heat Sink Small Outline Package (HSOP)	DWP, DWD
	Power Small Outline Package (PSOP3)	DKP (slug down), DKD (slug up)
	Ball Grid Array (BGA)	

How to Connect the PowerPAD™

The PowerPAD™ should be connected to the appropriate internal signal plane as specified in the product datasheet. Depending on the electrical properties of the thermally conductive epoxy used to connect the Integrated Circuit (IC) to the lead frame, the PowerPAD may have a low impedance connection to the internal signal plane as specified in the product datasheet. Even though the PowerPAD should not be used as your primary signal connection for the IC (use the designated signal pins as specified in the product data sheet), the copper area under the pad can be connected to the specified signal plane per the product data sheet without affecting the device. Since the PowerPAD is intended to remove heat from the part, the size of the signal plane to which the thermal pad is attached within the board should be as large as needed to dissipate the heat. The via array recommendations in the documents below may vary based on layout constraints and recommendations presented in the product datasheet. The documents below should be used as a general guideline for board design while referring to the product datasheet for application specific via and land pattern requirements.

You can find additional information in the following resources. Technical literature can be accessed online with **www-s.ti.com/sc/techlit/*litnumber*** by replacing ***litnumber*** with one of the literature numbers shown below in parentheses.

- Remember to check the CAD format for your package under "Symbols/Footprints," available in all TI Product Folders
- Download the "PowerPAD Made Easy" application brief (SLMA004) in conjunction with the "PowerPAD Thermally Enhanced Package" technical brief (SLMA002)
- Specific information on QFN/SON packages is available in application reports (SLUA271 and SCBA017)
- Visit TI's Analog & Mixed-Signal KnowledgeBase at **support.ti.com/sc/knowledgebase**
- Ask our experts your specific design questions via email by selecting Analog & Mixed-Signal email support in the Contact Tech Support frame at **support.ti.com**



PowerPAD™ package as used by the SWIFT™ product family.

Device Index

Device Index (Continued)

Device Index (Continued)

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