POWER SUPPLIES ANALOG DESIGN GUIDE »»

4

Data Sheets • Applications Notes • Free Samples

Introducing the World's Smallest Integrated Power ICs for CDMA Handsets

INPUT
+2.5V
TO +5.5V

IN1
IN2/3
IN4/5

MAXIM
MAX1798
(MAX1799)

ON

SPI™
OR
I²C™

CS (AS)
SCLK (SCK)
DIN (SDA)
BP

0.01µF

GND   PGND

ONO
OFF
OUT1
RSO

OUT2
OUT3
OUT4
OUT5

DR1
DR2

IRQ
WDOUT
VCC
RESET

MSM CONTROLLER

TX
RX
BBA
AUDIO OR
PLL + VCO

VIN1

VIBRATOR

BACKLIGHT

20-PIN TSSOP
6.2mm x 6.4mm

( ) ARE FOR MAX1799.

Also in this Issue:

FUTURE PRODUCT — **Simple 36V Step-Down DC-DCs in µMAX**

NEW — **World's Smallest SIM/Smart-Card Solutions**

NEW — **High-Efficiency Step-Down Charge Pump**

NEW — **Smallest 100mA Step-Up/Down Solution**

NEW — **World's Smallest Complete Li+ Battery Chargers**

NEW — **Low-Cost, High-Accuracy USB Power Switches**

NEW — **Industry's First SpeedStep™ Converter for CPU Core Supplies**

Industry's Largest Selection of SOT23 Charge Pumps

And Much More!

ANALOG DESIGN GUIDE

|	
1	Multiplexers, Switches
2	Interface Products
3	Op Amps, Comparators
4	DC-DC Converters, Power Supplies
5	µP Supervisory
6	Analog Filters
7	A/D Converters
8	Video/High-Speed Amps
9	D/A Converters
10	Analog Functions
11	Voltage References
12	Temperature Sensors
13	High-Speed ADCs & DACs
14	Signal Conditioners

»» MAXIM

Introducing the World's Smallest Integrated Power ICs for CDMA Handsets

The MAX1798/MAX1799* system power supplies are designed specifically for W-CDMA cellular/PCS handsets using a variety of available CDMA chipsets. Each IC contains five low-noise, low-dropout linear regulators (LDOs); a 140ms min reset timer; a watchdog timer input; two undedicated high-current, open-drain drivers; optional push-on/push-off power control; and a serial interface. The two devices differ only in their serial interface: the MAX1798 features a 3-wire SPI-compatible interface, while the MAX1799 features an I^{2}C-compatible interface.

Each linear regulator offers extremely low dropout voltage of 100mV. LDO1 is rated for 300mA, while LDO2–LDO5 are each rated for 150mA. All LDOs are optimized for high accuracy, low noise, high 70dB PSRR, and high 60dB channel-to-channel isolation. For added flexibility, each LDO's output voltage is independently programmable to any of 32 voltages in the 1.8V to 3.3V range via the serial interface. For added system protection, each LDO has independent current limiting and thermal-overload protection.

In addition to their high functionality, these devices are packaged in small 20-pin TSSOP packages, making them the most compact solutions available for CDMA handset system power.

*Future product—contact factory for availability.

20-PIN TSSOP
6.2mm x 6.4mm
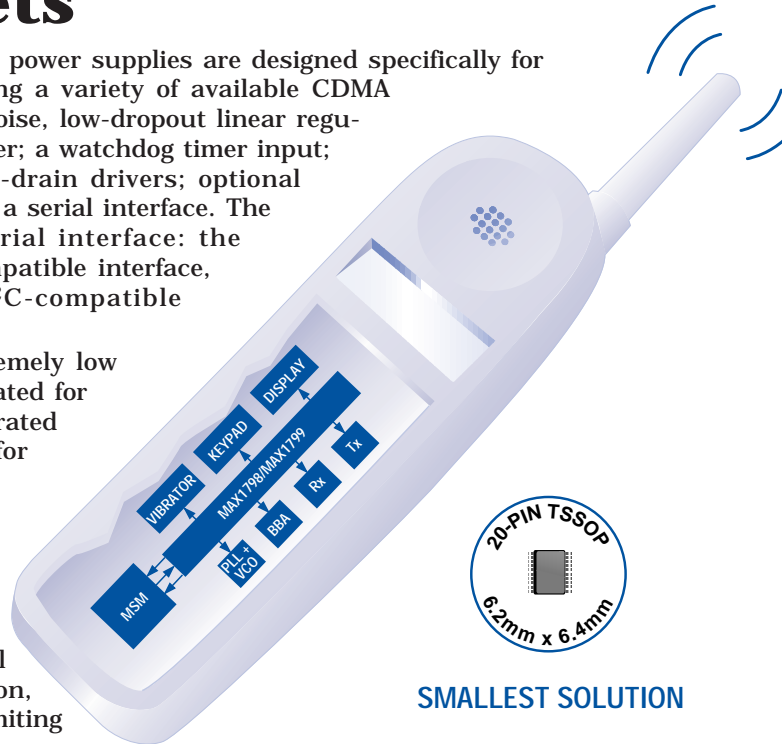
SMALLEST SOLUTION

- **Low-Noise, Low-Dropout Linear Regulators:**
  - **One 300mA LDO**
  - **Four 150mA LDOs**
  - **Low 100mV max Dropout**
  - **Excellent AC Specs:**
    <45µV$_{RMS}$ Output Voltage Noise
    >60dB Channel-to-Channel Isolation
    70dB PSRR
  - **Independent Current and Thermal-Overload Protection (each LDO)**
- **140ms min Reset Timer**
- **Watchdog Input**
- **Two Independent, High-Current, Open-Drain Driver Outputs**

- **Optional Push-On/Push-Off Power Control**
- **Serial Interface:**
  - **Independently Programs LDO Output Voltage from 1.8V to 3.3V**
  - **Independently Enables/Disables LDOs**
  - **Independently Enables/Disables High-Current Drivers**
  - **3-Wire SPI-Compatible Serial Interface (MAX1798)**
  - **2-Wire I^{2}C-Compatible Serial Interface (MAX1799)**
- **+2.5V to +5.5V Input Voltage Range**
- **Compact 20-Pin TSSOP Package**

MAXIM

Simple 36V Step-Down DC-DCs in Tiny µMAX Packages

The MAX1744/MAX1745 are simple step-down DC-DC controllers capable of operating with input voltages of up to 36V. Using a proprietary current-limited control scheme, these devices consume just 90mA of quiescent supply current and maintain excellent efficiency at all loads.

These step-down controllers drive an external P-channel MOSFET, allowing design flexibility for applications with power requirements exceeding 15W. Their high 450kHz maximum switching frequency permits small external components for space-critical applications; 100% duty-cycle operation ensures the lowest possible dropout voltage.

The MAX1744 is preset for output voltages of either 3.3V or 5V, while the MAX1745 has adjustable output voltages over a 1.25V to 18V range.

The MAX1744/MAX1745 are available in space-saving 10-pin µMAX packages, which are just $1/2$ the size of standard 8-pin SO packages.
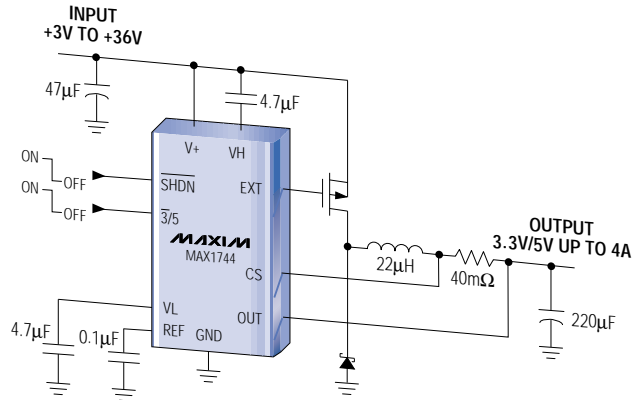
• **High-Voltage Operation (up to 36V in)**

• **10-Pin µMAX Package**

• **Efficiency >90%**

• **Output Power >15W**

• **90µA Quiescent Supply Current**

• **Up to 450kHz Switching Frequency**

• **4µA Shutdown Current**

• **Output Voltage**
   3.3V/5V (MAX1744)
   Adj (1.25V to 18V) (MAX1745)

• **Current-Limited Control Scheme**

• **100% Maximum Duty Cycle for Low Dropout**

World's Smallest SIM/ Smart-Card Level Translators

The MAX1740/MAX1741 SIM/smart-card level translators provide level shifting and ESD protection for subscriber identification module (SIM) and smart-card ports. These devices integrate two unidirectional level shifters for the reset and clock signals, a bidirectional level shifter for the serial data stream, and ±10kV ESD protection on all card contacts.

The MAX1740 includes a $\overline{\text{SHDN}}$ control input to aid card insertion and removal, while the MAX1741 includes a system-side data driver to support system controllers without open-drain drivers. Both devices simplify power management by automatically shutting down when either supply is removed, and either device may be combined with the MAX1686H to provide a complete level-translation and card-power solution for SIMs and smart cards.

The MAX1740/MAX1741 are available in ultra-small 10-pin µMAX packages, which occupy half the area of an 8-pin SO and are only 1.09mm high.

• **No External Components Required**

• **±10kV ESD Protection on All Card Contacts**

• **1µA Quiescent Supply Current**
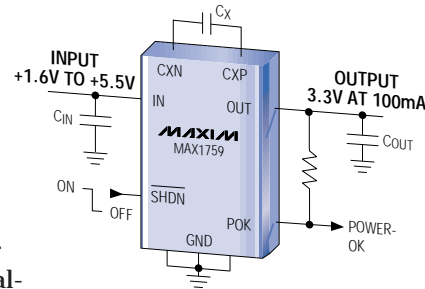
• **0.01µA Shutdown Supply Current**

NEW
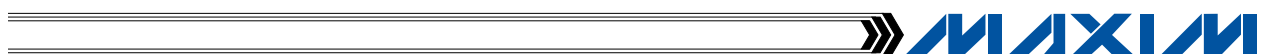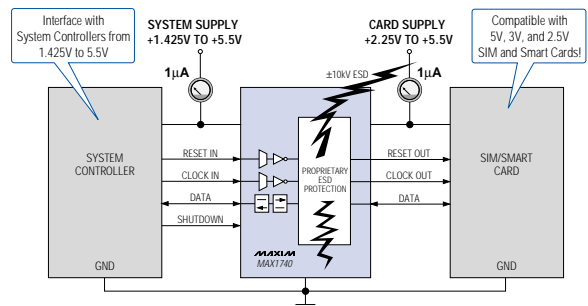
Regulated Charge Pumps Replace Switchers and Linears in Compact Designs

The MAX1730 and MAX1759 are new additions to Maxim's extensive line of regulated charge pumps. Both devices are available in tiny µMAX packages and require just a few small external capacitors to implement complete DC-DC solutions.

The MAX1730 is a regulated step-down charge pump that generates up to 50mA at fixed voltages of either 1.8V or 1.9V. Specifically designed as a high-efficiency linear-regulator replacement for logic supplies, this converter employs fractional-conversion techniques to greatly exceed the efficiency of a linear regulator. A high 2MHz max operating frequency permits the use of 0.22µF flying capacitors, ensuring the smallest solution possible. Proprietary soft-start prevents excessive current draw from the supply at startup, making the MAX1730 compatible with higher impedance sources such as alkaline and Li+ cells.

The MAX1759 is a buck/boost regulating charge pump that generates a regulated 3.3V (or 2.5V to 5.5V adjustable) output voltage from a single Li+ cell, or from two or three NiMH or alkaline cells for small hand-held portable equipment. Designed to be an extremely compact buck/boost converter, this device requires only three small ceramic capacitors to build a complete DC-DC converter capable of generating a guaranteed 100mA min output current. Despite its high 1.5MHz operating frequency, the MAX1759 maintains low 50µA quiescent supply current. For added flexibility, the MAX1759 also includes an open-drain power-OK (POK) output that signals when the output voltage is in regulation.

MAX1730:
- \> 85% Peak Efficiency
- 50mA Guaranteed Output Current
- Fixed 1.8V/1.9V Output Voltages
- Up to 2MHz Operating Frequency
- Small 0.22µF Capacitors
- No Inductor Required
- Low 75µA Quiescent Supply Current
- 1µA Shutdown Mode
- +2.7V to +5.5V Input Voltage Range
- Output Disconnects from Input in Shutdown
- Small 10-Pin µMAX Package

MAX1759:
- Regulated Output Voltage (fixed 3.3V or adj 2.5V to 5.5V)
- 100mA Guaranteed Output Current
- +1.6V to +5.5V Input Voltage Range
- Low 50µA Quiescent Supply Current
- 1µA Shutdown Mode
- Load Disconnects from Input in Shutdown
- High 1.5MHz Operating Frequency
- Uses Small Ceramic Capacitors
- Short-Circuit Protection and Thermal Shutdown
- Small 10-Pin µMAX Package

MAXIM

NEW

Chargers Dissipate Virtually No Power in the Handset

The MAX1679 and MAX1736 are single-cell Li+ battery chargers suitable for cellular/PCS phones and low-power hand-held equipment such as PDAs and portable digital audio players. Unlike heat-dissipating linear-mode chargers, their low-dissipation control scheme works in conjunction with a low-cost, current-limited wall cube to dissipate virtually no heat—even over extended periods of fast charging. Both devices feature overall system accuracy of 0.75%, ensuring that the cell capacity is fully utilized without degrading the life of the cell.

The MAX1679, packaged in an 8-pin μMAX, is a flexible device that provides all of the intelligence required of a complete charging solution for Li+ cells. It includes three safety timer settings to automatically terminate the charge cycle under fault conditions, an LED driver to communicate the current charge state, continuous thermal and under/overvoltage protection, and an output voltage that can be adjusted using a single low-cost resistor.

The MAX1736 comes in a 6-pin SOT23 package and provides the high-accuracy voltage regulation required to charge Li+ cells. Its single control pin permits an optional microcontroller to easily implement a wide range of algorithms to control charge, allowing this device to be easily integrated into new and existing designs.

Both the MAX1679 and MAX1736 detect the presence of their power source and automatically power down when the source is removed to minimize battery drain. Both devices automatically initiate a charge cycle when the power source is applied or when the battery is inserted, and the charging cycle automatically terminates when the average charging current falls below a preset threshold.
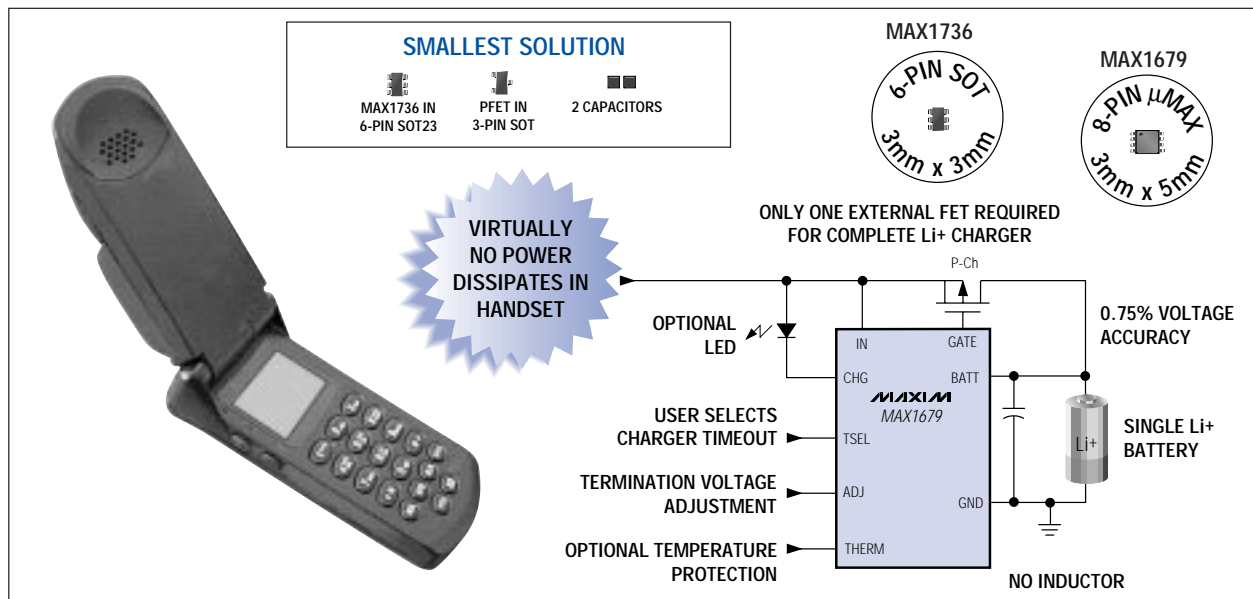
- **Simple Stand-Alone Application Circuits**
- **Lowest Power-Dissipation Control Scheme**
- **Tiny Packages Minimize Space Requirements**
- **0.75% Overall System Accuracy**
- **No Inductor Required**

- **Safely Conditions Near-Dead Cells**
- **Continuous Thermal Protection (MAX1679)**
- **Programmable Safety Timeout (MAX1679)**
- **Automatic Power-Down when the Power Source Is Removed**

MAXIM

Maxim Has the Industry's Widest Selection of SOT23 Charge Pumps

Maxim offers the broadest array of charge pumps in the ultra-small SOT23 package for use as GaAsFET biases, LCD supplies, and analog measurement supplies. These charge pumps invert or double an input voltage (1.5V to 5.5V) using two small external capacitors. No inductors are required. Switching frequencies are available from 12kHz to 500kHz to allow trade-offs between lowest quiescent current and smallest external capacitors.

Highest Guaranteed Output Current: 60mA (MAX1697)

Lowest Output Resistance: 12Ω (MAX1697)

Lowest Quiescent Current: 50µA (MAX1720)

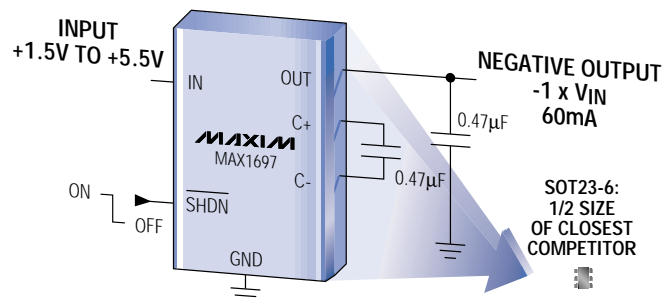|	Part	Pin-Package	Description	Output Current (mA)	Switching Frequency (kHz)	Capacitors (µF)
NEW	MAX1697	6-SOT23	Inverter	60	12 to 250	0.47
NEW	MAX1719	6-SOT23	Inverter	25	125	0.33
	MAX1720	6-SOT23	Inverter	25	12	0.33
	MAX1721	6-SOT23	Inverter	25	125	0.33
	MAX870	5-SOT23	Inverter	25	125	0.10
	MAX871	5-SOT23	Inverter	25	500	0.10
	MAX828	5-SOT23	Inverter	25	12	3.30
	MAX829	5-SOT23	Inverter	25	35	3.30
	MAX1682	5-SOT23	Doubler	25	12	3.30
	MAX1683	5-SOT23	Doubler	25	35	3.30

Smallest External Capacitors: 0.1µF (MAX871)

Most Switching Frequency Options: 12, 35, 125, 250, or 500kHz

0.1µA Logic-Controlled Shutdown (all 6-pin SOT23 devices)

Industry Standard (MAX828)

SMALLEST 60mA CHARGE-PUMP INVERTER

INPUT +1.5V TO +5.5V

IN

OUT

C+

C-

MAX1697

ON

OFF

SHDN

GND

NEGATIVE OUTPUT -1 x V_{IN} 60mA

0.47µF

0.47µF

SOT23-6: 1/2 SIZE OF CLOSEST COMPETITOR

Maxim's Low-Dropout Linears Provide Low Supply Current, Small Packaging

Industry's Lowest Dropout SOT23 LDOs with Voltage Monitor

The MAX8875 linear regulator comes in an ultra-small 5-pin SOT23 package and provides the best combination of low dropout voltage and low full-load supply current. It extends battery life in cell phones, PCMCIA cards, modems, and other hand-held portables. The power-OK output signals when the output voltage drops out of regulation by 5%.

For a pin-compatible, functionally equivalent LDO that is compatible with low-cost, high-ESR output capacitors, refer to the MAX8885. Maxim offers the widest selection of low-dropout linear regulators in proprietary and second-source pinouts.
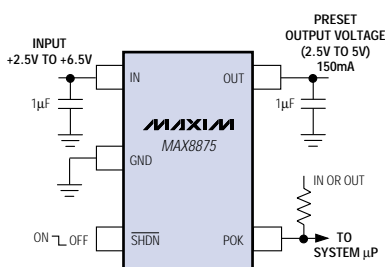
Parameter	Typical	Units
Input Voltage Range	2.5 to 6.5	V
Supply Current	85	µA
Shutdown Current	0.01	µA
Output Voltage	2.5 to 5.0	V
Output Current	150	mA

- Power-OK Output Flags 5% Out of Regulation
- High Guaranteed Output Current: 150mA
- Longest Battery Life
- Smallest Output Capacitor: 1µF Ceramic (stable for 0mA to 150mA loads)
- 1% Fixed-Output Voltages Available: 2.5V, 2.7V, 3.0V, 3.3V, 5.0V

Available in Second-Source† Pinouts!

Maxim's SOT23 linear regulators are available with the same pinouts as the '2980/'2981 and '2982, so you can replace your SOT23 linears with lower dropout equivalents and get longer battery life.

SEE ALSO:
MAX8877/78
MAX8863/64

Maxim Second Source	Same Specs as	Competitors' Equivalent
MAX8873/MAX8874	MAX8863/MAX8864	'2980/'2981
MAX8877/MAX8878	MAX8867/MAX8868	'2982
MAX8875/MAX8885	MAX8877/MAX8878*	'5206

† Maxim's maximum input voltage range is +6.5V operating, +7.0V absolute maximum.
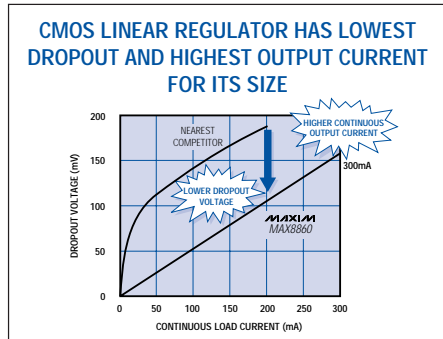*MAX8875/MAX8885 have 170µV$_{RMS}$ output voltage noise.

Maxim's Lowest Dropout 300mA Regulator in µMAX

The MAX8860 is a low-dropout linear regulator that guarantees 300mA continuous output current and comes in a thin, ultra-small µMAX package. Output voltage is preset at 3.3V, 3.0V, 2.82V, 2.77V, 2.5V, and 1.8V or is adjustable from 1.25V to 6.5V. The $\overline{FAULT}$ output indicates when the device is out of regulation due to dropout, current overload, or thermal shutdown. The dropout voltage detector threshold tracks load current and extends battery life. Other features include reverse battery protection, 0.01µA shutdown current, and a low 120µA no-load operating current.
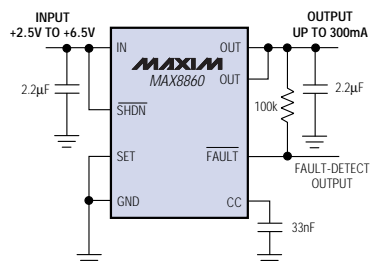
Parameter	Specification	Units
Input Voltage Range	+2.5 to +6.5	V
Supply Current	120	µA
Shutdown	0.01	µA
Output Voltage	3.3, 3.0, 2.82, 2.77, 2.5, 1.8 1.25 to 6.5	V
Output Current	300	mA

Now Available! 1.8V, 2.5V, and 3.0V fixed outputs.

CMOS LINEAR REGULATOR HAS LOWEST DROPOUT AND HIGHEST OUTPUT CURRENT FOR ITS SIZE

Complete Power-Management Solutions for Wireless Handsets (continued on next page)

Maxim's extensive line of power-management ICs provides the industry's best combination of high efficiency, low noise, and small size for your wireless applications. Whether you use one Li+ cell or two to three NiCd cells, our products extend battery life and provide the flexibility and performance you demand.

Low-Noise, Low-Dropout Linear Regulators

|	Part	Output Current (mA)	$R_{DS(ON)}$ (Ω)	Features
NEW	MAX1798/9	300 x 1, 150 x 4	0.33	Complete system supply for CDMA handsets
	MAX8860	300	0.5	$\overline{FAULT}$ output, excellent output accuracy, low noise, lowest dropout
	MAX8863/4	100	1.1	Low cost, low dropout
	MAX8865/6	2 x 100	1.1	Dual MAX8863/4 in µMAX package
	MAX8867/8	150	1.1	30µVRMS output noise
	MAX8873/4	120	1.1	MAX8863/4 in '2982 pinout
	MAX8875	150	1.1	Low-dropout '5206 replacement, low-ESR capacitors
NEW	MAX8885	150	1.1	Low-dropout '5206 replacement, high-ESR capacitors
NEW	MAX8877/8	150	1.1	MAX8867/8 in '2982 pinout

High-Efficiency, Low-Noise Buck Converters

Part	Input Voltage Range (V)	Output Current (mA)	Features
MAX887H	3.5 to 11	600	100% duty cycle, synchronizable, output down to 1.25V
MAX1692	2.7 to 5.5	600 (min)	100% duty cycle, output down to 1.25V, no Schottky diode required, small inductor, 10-pin µMAX
MAX886*/8	3 to 12	500	Four DAC-controlled LDO outputs, 3V/5V SIM output, POR output, serial interface
MAX1684/5	2.7 to 14	1000 (min)	100% duty cycle, output down to 1.25V, small inductor, high accuracy

* Future product—contact factory for availability.

High-Efficiency, Low-Noise Boost Converters

Part	3.6V$_{IN}$, 5V$_{OUT}$ Output Current (mA)	1.2V$_{IN}$, 3.3V$_{OUT}$ Output Current (mA)	Features
MAX1687	2000**	3000**	Ideal for GSM, constant charge rate
MAX1688	2000**	3000**	Ideal for GSM, constant charge time
MAX1703	1500	500	Configurable as 1.5A efficient buck/boost
MAX1700	1000	300	Simplest device
MAX1701	1000	300	Configurable as 1A efficient buck/boost
MAX1705	1000	300	Includes 200mA linear regulator
MAX849	1000	300	Includes 2-channel A/D converter
MAX1674	600	200	16µA supply current, µMAX package
MAX1676	600	200	EMI suppression, 16µA supply current, µMAX package
MAX1706	500	200	Includes 200mA linear regulator
MAX848	500	200	Includes 2-channel A/D converter
MAX1677	350	200	Secondary ±28V output for LCD bias
MAX1675	350	100	16µA supply current, µMAX package

**GSM Burst Current
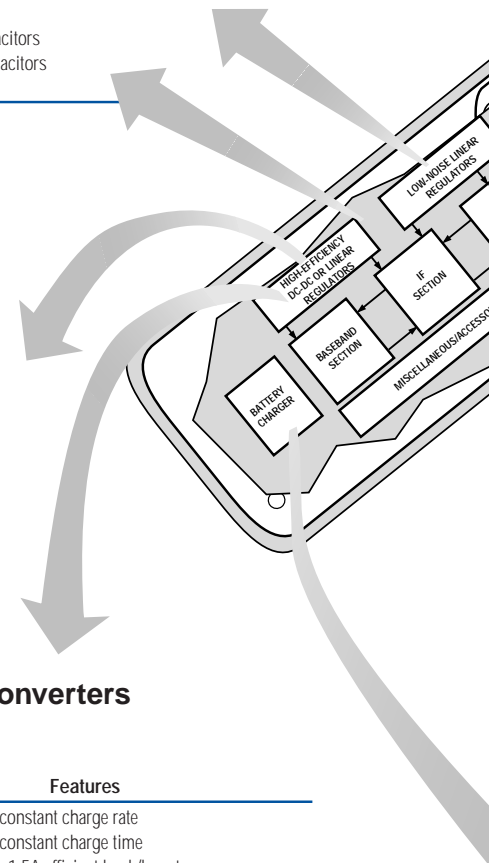
MAXIM

Complete Power-Management Solutions for Wireless Handsets (continued from previous page)

Maxim's state-of-the-art 1.2µm BiCMOS process is the industry's best process for power management. With our high gate density and a wide range of high-voltage/high-current devices, we continue to lead the industry with the low-power/high-integration devices required for tomorrow's wireless applications. When your application requires higher integration, many of our products double as proven building blocks for custom and semicustom designs. For more information on Maxim's custom IC capabilities, contact your local Maxim sales office.
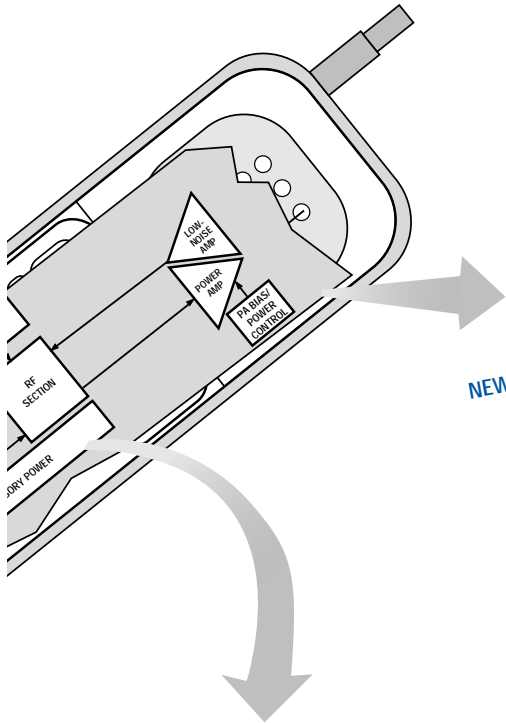
Low-Noise GaAsFET Bias

Part	Description	Features
MAX768	Low-Noise Doubler/Inverter	Dual, low-noise outputs up to $\pm 2 \times V_{IN}$
MAX828/9	Inverter	SOT23-5 package
MAX840/3/4	Low-Noise Inverter	Wide input voltage range
MAX850/1/2/3	Low-Noise Inverter	Wide input voltage range
MAX868	Inverting Voltage Doubler	10-pin µMAX package, shutdown, 30µA I_Q, regulated output
MAX870/1	Inverter	SOT23-5 package
MAX881R	Low-Noise Inverter	Power-OK signal, small µMAX package
MAX1697	Inverter with Shutdown	Lowest R_{OUT} inverter in SOT23, 60mA output
MAX1719/20/21	Inverter with Shutdown	SOT23-6 package

NEW

Miscellaneous/Accessory Power

Application	Part	Description	Features
Card Slots	MAX619	5V Regulated Charge Pump	500kHz operation, µMAX package
	MAX679	3.3V Regulated Charge Pump	µMAX package
	MAX682/3/4	250/100/50mA, 5V Regulated Charge Pump	Low-noise, fixed-frequency operation
	MAX1686H	3V/5V Regulated Charge Pump	Ideal for dual-voltage SIM card slots
VCOs	MAX768	Dual, Low-Noise Regulated Charge Pump	Dual, low-noise outputs up to $\pm 2 \times V_{IN}$
LCDs	MAX865	Dual-Output Charge Pump	Dual outputs ($\pm 2 \times V_{IN}$), µMAX package
	MAX868	Inverting Voltage Doubler	30mA at up to $-2 \times V_{IN}$, µMAX package
	MAX1677	500mA Boost and ± 28V LCD Bias	Dual outputs, 16-pin QSOP package, no external FETs
	MAX1682/3	30mA Doubling Charge Pump	SOT23-5 package
	MAX1729	ECB Color LCD Bias	Temperature-compensated output
Annunciator	MAX1749	Vibrator Motor Driver	Constant vibration strength over battery life
PA Bias Control	MAX4473	PA Bias-Control Amplifier	Small µMAX package, guaranteed 1.5µs enable/disable times
Li+ Charger	MAX1679	Complete Single-Cell Li+ Charger in µMAX	Charges fast, phone stays cool
Li+ Charger	MAX1736	Simple Single-Cell Li+ Charger in SOT23	Simple 1-pin control interface

NEW
NEW

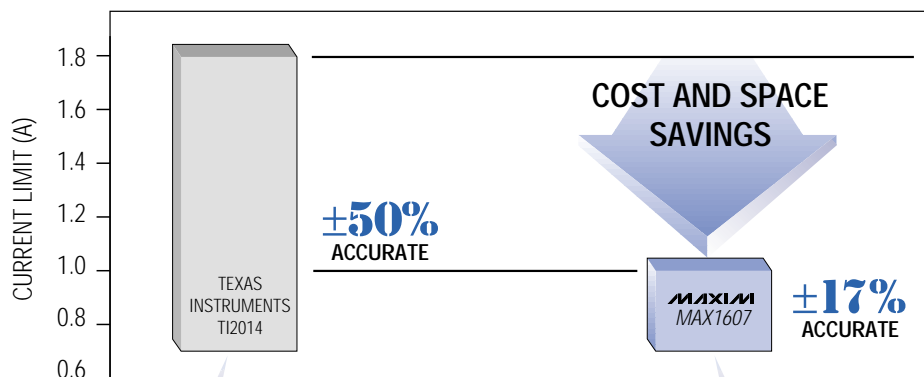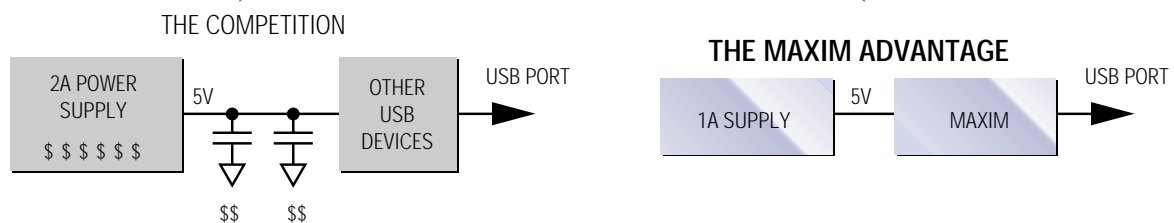$\bowtie\!\!\bowtie\!\!\bowtie$ **MAXIM**

Lowest Cost, Highest Accuracy
USB Switches Have Best Performance

## Three Choices for Cost Reduction and Performance Upgrade

Save 20% Without New Board Layout

MAX893L 8-Pin SO

- ±20% Accuracy
- Maximum Current Programmable up to 1.2A
- Pin Compatible with MAX890L

World's Smallest USB Power Switches

MAX1693
MAX1694 10-Pin µMAX

- 10ms Fault Blanking Prevents False Resets
- Latched Output Protects Supply in Continuous Short-Circuit Conditions

Reduce Cost and Improve Performance

MAX1607 8-Pin SO

- 10ms Fault Blanking Prevents False Resets
- Pin-Compatible Upgrade to TI2014/5 and TI2041

CURRENT LIMIT (A)

1.8
1.6
1.4
1.2
1.0
0.8
0.6

TEXAS INSTRUMENTS TI2014

COST AND SPACE SAVINGS

±50% ACCURATE

MAX1607 ±17% ACCURATE

Tighter Accuracy Is Cheaper!

THE COMPETITION

2A POWER SUPPLY
$ $ $ $ $ $

5V

$$ $$

OTHER USB DEVICES

USB PORT

THE MAXIM ADVANTAGE

1A SUPPLY

5V

MAXIM

USB PORT

*Guaranteed maximum current limit defines the highest current that can be drawn from a protected USB port when an overcurrent or short-circuit condition occurs. If the system power supply cannot deliver this maximum current, the system voltage will be dragged down before the current limit kicks in, causing a system glitch. Maxim's tight current-limit accuracy permits a smaller, less-expensive power supply.*

MAXIM
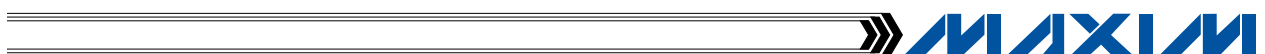
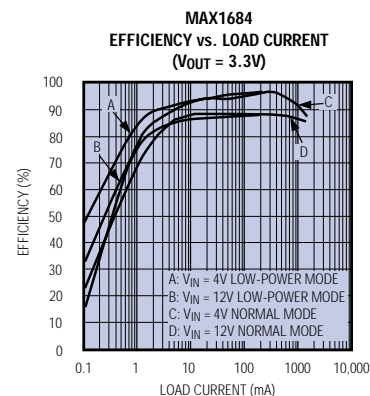# Smallest 1.5A Step-Down DC-DCs for Hand-Held PCs Are 96% Efficient

The MAX1684/MAX1685 are the smallest, highest efficiency step-down DC-DC converters available for hand-held PCs. Their 14V input range and 1.5A output current make them ideal for applications powered by two to three Li+ cells and wall adapters. The MAX1684/MAX1685 have 1% accurate preset 3.3V output voltages, or may be externally adjusted to provide outputs from 1.25V to V_{IN}; 100% duty-cycle operation ensures the lowest dropout voltages and permits the longest possible battery life. These devices feature internal 0.24Ω switches and synchronous rectifiers. They are packaged in a small 16-pin QSOP.
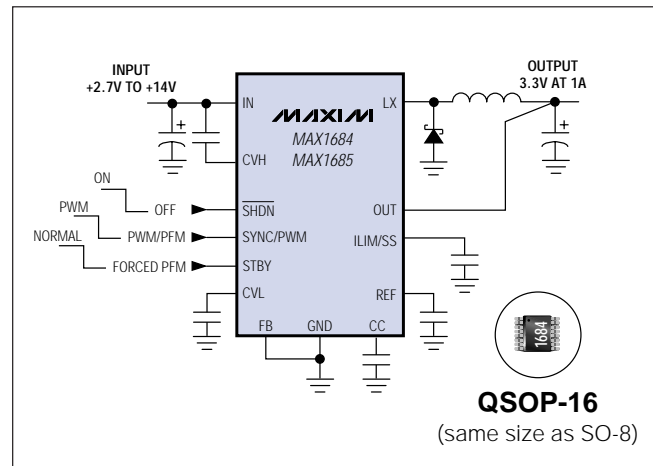
For maximum versatility, the MAX1684/MAX1685 provide four modes of operation. In normal mode, these devices use Maxim's Idle Mode™ control scheme to maintain the highest possible efficiency at all loads. Fixed-frequency PWM mode provides the lowest noise operation and is ideal for devices with wireless capability. Low-power mode provides the lowest supply current (25µA) when a full load is not required. Finally, shutdown mode reduces the supply current to just 2µA.

The MAX1684 operates at a 300kHz frequency, while the MAX1685 operates at 600kHz to permit the smallest external components. Both devices can be synchronized to an external clock and include an adjustable current limit as well as a soft-start function.

QSOP-16
(same size as SO-8)

- **+2.7V to +14V Input Voltage Range**
- **1A Guaranteed Output Current**
- **Fixed 3.3V (or adjustable) Output Voltage**
- **> 95% Efficiency**
- **100% Duty-Cycle Operation**
- **Fixed-Frequency PWM Operation**
    300kHz (MAX1684)
    600kHz (MAX1685)
- **30µA Operating Quiescent Current (MAX1684)**
- **Programmable Current Limit/Soft-Start**
- **Small 16-Pin QSOP Package**

Idle Mode is a trademark of Maxim Integrated Products.

MAX1684
EFFICIENCY vs. LOAD CURRENT
(V_{OUT} = 3.3V)

A: V_{IN} = 4V LOW-POWER MODE
B: V_{IN} = 12V LOW-POWER MODE
C: V_{IN} = 4V NORMAL MODE
D: V_{IN} = 12V NORMAL MODE

Flexible, Efficient Power for Your PDA and Subnotebook Designs (continued on next page)

Maxim's broad range of power-management products contains all of the components you need to provide flexible, efficient power to your PDA or subnotebook design. Featured components include battery chargers for all chemistries, card-slot protection, core and accessory power, and LCD-panel bias supplies.

LCD Bias and CCFL Backlight Supplies

Part	Description	Features
MAX629	LCD Bias Supply	±28V with internal switch
MAX686	LCD Bias Supply	MAX629 functions + digital output control
MAX868	Regulated Charge Pump	Output up to -2V_{IN}
MAX1610	CCFL Supply	Digital output control
MAX1611	CCFL Supply	SMBus™-controlled output
MAX1664	AMLCD Supply	Internal boost + LCD bias and backplane drive
MAX1677	Logic and LCD Supplies	350mA boost and ±28V LCD
NEW MAX1790	LCD Bias Supply	12V internal switch, constant frequency
FUTURE MAX1748*	Triple-Output TFT LCD Supply	Low-profile TSSOP package
FUTURE MAX1739*	High-Power CCFL Supply	Wide intensity range

* Future product—contact factory for availability.
SMBus is a trademark of Intel Corp.
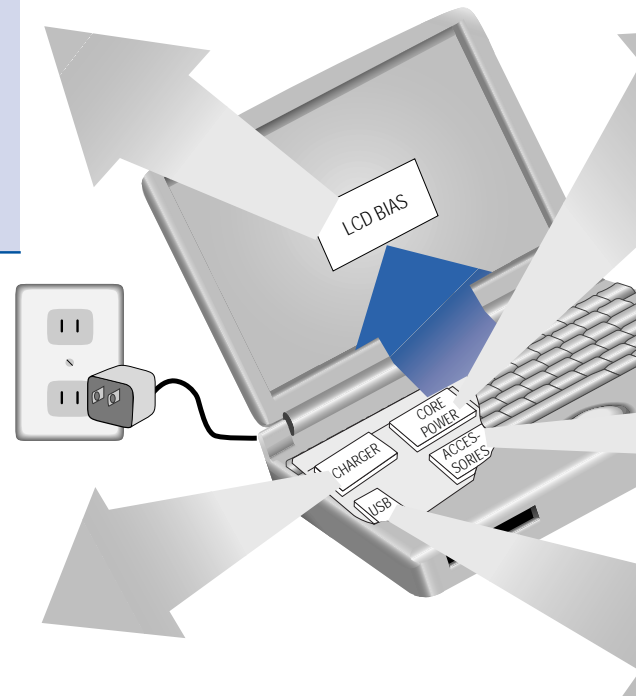
Battery Management

Application	Part	Battery Chemistry	Description
Battery Chargers	MAX712/13	NiMH, NiCd	High-Efficiency Stand-Alone Battery Charger
	MAX745	Li+	High-Efficiency Stand-Alone Battery Charger
	MAX846	Li+, NiMH, NiCd, Lead Acid	Compact, Low-Cost, Multichemistry Battery Charger
	MAX1640/1	NiMH, NiCd, Lead Acid	High-Efficiency Battery Charger
	MAX1647/8	Li+, NiMH, NiCd, Lead Acid	SMBus Smart Battery Charger
	NEW MAX1667	Li+, NiMH, NiCd, Lead Acid	SMBus Smart Battery Charger
	NEW MAX1679	Li+	Compact Complete Li+ Charger, Keeps PDA Cool During Charge
	NEW MAX1736	Li+	Simple Li+ Charger
Fuel Gauges	MAX1660	Any	High-Accuracy Fuel Gauge
	MAX4173T/F/H	Any	High-Accuracy Current Sense
Pack Protector	**NEW** MAX1665	Li+	2-, 3-, and 4-Cell Li+ Pack Protector
	NEW MAX1666	Li+	Pack Protection Plus LDO, Serial Interface, and Adjustable Thresholds

Flexible, Efficient Power for Your PDA and Subnotebook Designs (continued from previous page)

In addition to the products shown in the following tables, Maxim offers a complete portfolio of notebook computer power products. For more information on our line of notebook power products, phone Maxim at 1-800-998-8800, ask for the Literature Department, and request the latest edition of the Low-Power Notebook ICs Analog Design Guide.

CPU Core and I/O Power

Part	Description	Features
MAX887H	High-Efficiency, PWM Step-Down Converter	Internal synchronous switch
MAX1626	High-Efficiency Step-Down Controller	3.3V/5V fixed output
MAX1627	High-Efficiency Step-Down Controller	Adjustable output
MAX1652	High-Efficiency, PWM Step-Down Controller	Regulates secondary positive output
MAX1653	High-Efficiency, PWM Step-Down Controller	MAX797 upgrade in small 16-pin QSOP
MAX1654	High-Efficiency, PWM Step-Down Controller	Regulates secondary negative output
MAX1655	High-Efficiency, PWM Step-Down Controller	Output as low as 1V
MAX1684/5	High-Efficiency, PWM Step-Down Converter	Output as low as 1.25V, 1A guaranteed output current
MAX1692	High-Efficiency, PWM Step-Down Converter	µMAX package, output as low as 1.25V
MAX1700 family	High-Efficiency Step-Up Converters	Small size, small packages

Accessory Power

	Part	Description	Output Current (mA)	Features
	MAX603/4	Low-Dropout Linear Regulator	500	Low supply current
	MAX682/3/4	5V Regulated Charge Pump	250/100/50	Compact 5V load supply
	MAX882/3/4	Low-Dropout Linear Regulator	200	Low supply current
NEW	MAX8860	Low-Dropout Linear Regulator	300	High accuracy
	MAX8867/8	Low-Dropout Linear Regulator	150	Low-noise output
NEW	MAX8875	Low-Dropout Linear Regulator	150	Power-OK output
NEW	MAX8885	Low-Dropout Linear Regulator	150	Power-OK output
	MAX8877/8	Low-Dropout Linear Regulator	150	Low-noise output

Card-Slot/Load-Switch Control

	Part	Description	Features
	MAX869	2A (adj), High-Accuracy Current-Limited Switch	USB compatible
	MAX890	1A (adj), High-Accuracy Current-Limited Switch	USB compatible
	MAX891/2	500mA/250mA (adj), High-Accuracy Current-Limited Switch	USB compatible, µMAX package
NEW	MAX893L	1A (adj), High-Accuracy Current-Limited Switch	USB compatible
	MAX894/5	Dual, 500mA/250mA (adj), High-Accuracy Current-Limited Switch	Dual switches in 8-pin SO
NEW	MAX1607	750mA High-Accuracy Current-Limited Switch	High-performance TI2014/5 upgrade
	MAX1661/2/3	SMBus Serial Bus Expansion and Load-Switch Control	Three SMBus GPIOs in 10-pin µMAX
NEW	MAX1693/4	750mA High-Accuracy Current-Limited Switch	USB compatible, µMAX package, latched output (MAX1694)

High-Efficiency, Low-Noise Step-Up Converters Power Wireless Handsets

Maxim's MAX1700 family of PWM boost converters offers the best combination of small size, low noise, and high efficiency for wireless handsets and PDAs. Their wide input voltage range, extending as low as 0.7V, is ideal for a range of battery sources from one to three NiCd/NiMH cells or one Li+ cell. Efficiency exceeds 95%, with pin-selectable low-power and micropower shutdown modes to ensure the longest standby times. Their fixed-frequency, synchronizable PWM operation ensures that the switching frequency (and its harmonics) does not interfere with noise-sensitive circuitry within your system.


OPERATES FROM A SINGLE AA CELL!

INPUT +0.7V TO +5.5V

OUTPUT 5V OR ADJ UP TO 1.5A
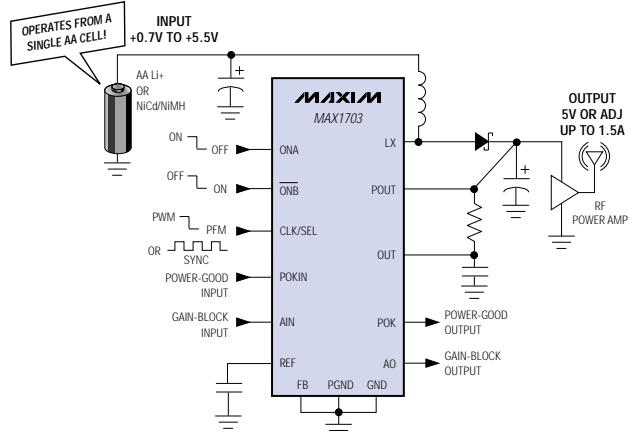
- **> 95% Efficiency**
- **Low-Noise, Synchronizable PWM Operation**
- **+0.7V to +5.5V Input Range**
- **3.3V/5V/Adj (2.5V to 5V) Output Range**
- **Up to 1.5A Output Current**
- **Small QSOP Packages (same size as SO-8)**
- **1µA Shutdown Mode**

Coming Soon!
MAX1760, MAX1763, MAX1765
Enhanced Versions of the Industry-Leading MAX1700 Family of Step-Up Converters!

500mA from a Single AA or NiCd/NiMH Cell!

MAX1703 EFFICIENCY vs. LOAD CURRENT

Part	Output Current (mA)		Pin-Package	Features
	3.6V$_{IN}$, 5V$_{OUT}$	1.2V$_{IN}$, 3.3V$_{OUT}$		
MAX1703	1500	500	16-NSO	With battery monitor and linear-regulator controller
MAX1700	1000	300	16-QSOP	Simplest device
MAX1701	1000	300	16-QSOP	With battery monitor and linear-regulator controller
MAX1705	1000	300	16-QSOP	Includes 200mA linear regulator
MAX1706	500	200	16-QSOP	Includes 200mA linear regulator
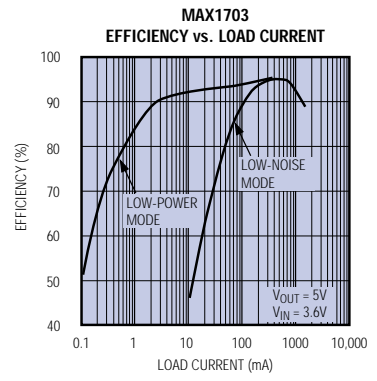
PWM Step-Up Converters

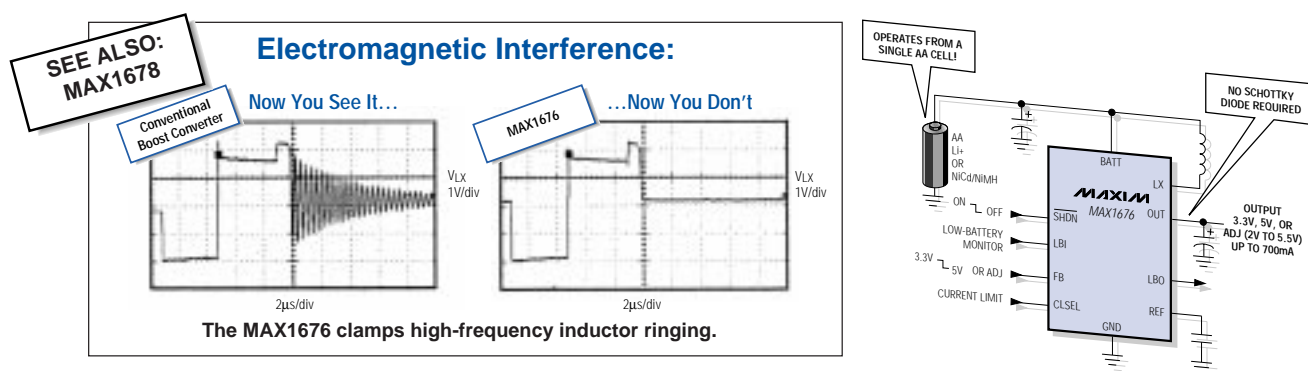|	Part	Input Voltage Range (V)	Output Voltage (V)	Output Current (mA)	Control Scheme	Pin-Package	Features
	MAX1700	0.7 to 5.5	3.3/adj	1A	PWM/PFM	16-QSOP	1- to 3-cell step-up
	MAX1701	0.7 to 5.5	3.3/adj	1A	PWM/PFM	16-QSOP	1- to 3-cell step-up, includes 2 battery monitors and a gain-block output for external LDO controller
	MAX1703	0.7 to 5.5	5/adj	1.5A	PWM/PFM	16-NSO	1- to 3-cell step-up, includes 2 battery monitors and a gain-block output for external LDO controller
	MAX1705/6	0.7 to 5.5	Adj	1A/500	PWM/PFM	16-QSOP	1- to 3-cell step-up, includes 200mA LDOs
NEW	MAX1790	2.6 to 5.5	Adj	600	PWM/PFM	8-µMAX	High 1.2MHz operation, output up to 12V
	MAX618	3 to 28	Adj	500	PWM	16-QSOP	28V/2A internal switch; ideal for boost, SEPIC, or flyback configurations
	MAX731	1.4 to 5.25	5	200	PWM	8-DIP, 16-WSO	Upgraded by MAX1700
	MAX732	4 to 9.3	12	200	PWM	8-DIP, 16-WSO	Upgraded by MAX618
	MAX733	4 to 11	15	125	PWM	8-DIP, 16-WSO	Upgraded by MAX618
	MAX734	1.9 to 12	12	120	PWM	8-DIP/SO	12V flash-memory supply
	MAX752	1.8 to 14	Adj	200	PWM	8-DIP/SO	Upgraded by MAX618
	MAX848/9	0.7 to 5.5	3.3/adj	1A	PWM/PFM	16-NSO	1- to 3-cell step-up, includes ADC output
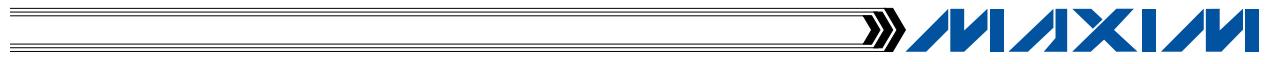
Low-Cost, Low-Noise Step-Ups Reduce EMI in Noise-Sensitive Apps

16µA, 95% Efficient Regulators Fit 1A Switch in µMAX

The MAX1674/MAX1675/MAX1676 are ideal for one-cell and two-cell step-up applications. Their internal switches and synchronous rectifier eliminate the need for an external MOSFET switch and Schottky diode, improving efficiency and reducing solution size and cost.

These step-up converters have preset (pin-selectable) outputs of 3.3V or 5V, or are adjustable from 2V to 5.5V using a resistor-divider. The MAX1674 and MAX1675 feature 1A and 500mA switches, respectively, allowing optimization of external component size. The MAX1676 features a pin-selectable current limit (1A or 500mA), as well as circuitry to damp inductor ringing, eliminating a source of EMI in noise-sensitive applications. All three parts are packaged in an ultra-small, 1.1mm-high µMAX.

SEE ALSO: MAX1678

Electromagnetic Interference:

Now You See It…   …Now You Don't

Conventional Boost Converter   MAX1676

The MAX1676 clamps high-frequency inductor ringing.

OPERATES FROM A SINGLE AA CELL!

NO SCHOTTKY DIODE REQUIRED

OUTPUT 3.3V, 5V, OR ADJ (2V TO 5.5V) UP TO 700mA

PFM Step-Up Converters

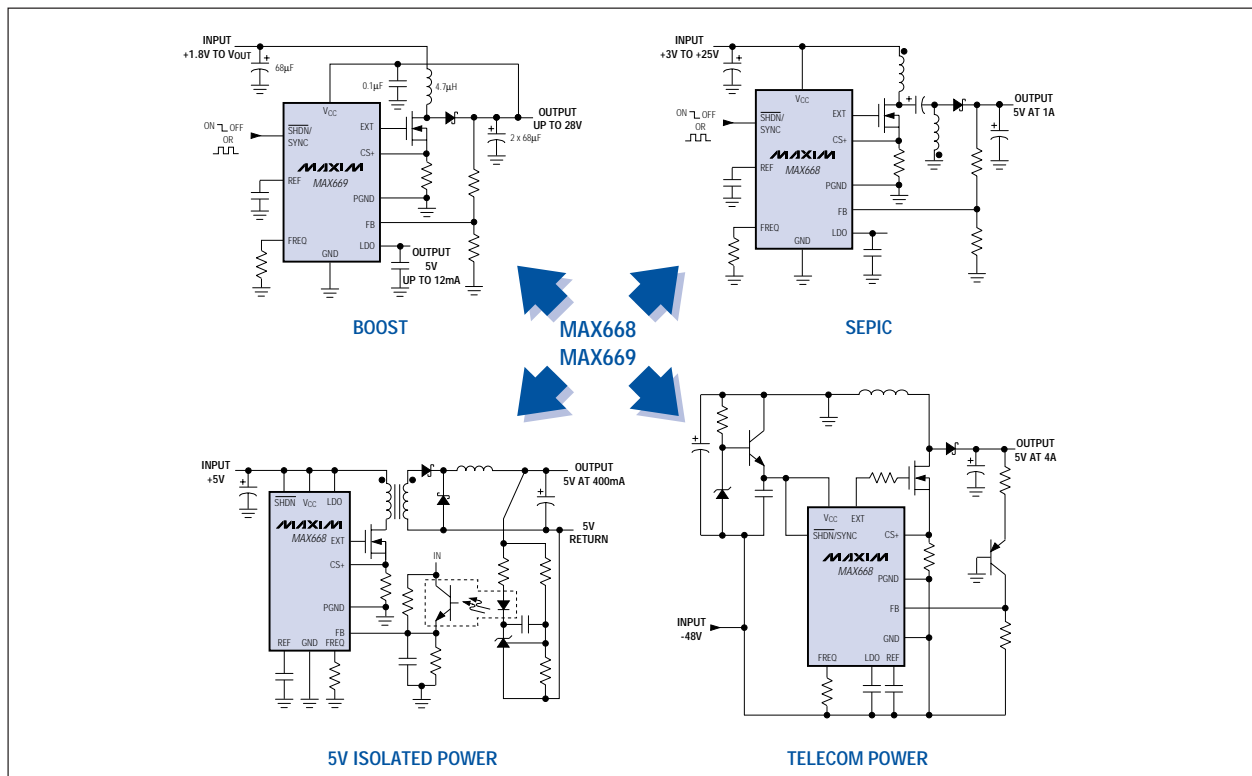| Part	Input Voltage Range (V)	Output Voltage (V)	Output Current (mA)	Pin-Package	Features
MAX1674	0.7 to 5.5	3.3/5/adj	700	8-µMAX	Low I_Q, internal synchronous rectifier
MAX1676	0.7 to 5.5	3.3/5/adj	700	10-µMAX	Low I_Q, internal synchronous rectifier, EMI-suppression circuitry
MAX1675	0.7 to 5.5	3.3/5/adj	300	8-µMAX	Low I_Q, internal synchronous rectifier
MAX606/7	3 to 5.5	5/12/adj	350	8-µMAX/SO	1MHz switching frequency, fits Type 1 PC cards
MAX756/7	1.1 to 5.5	3.3/5/adj	250	8-DIP/SO	Upgraded by MAX1674/5/6
MAX761/2	2 to 16.5	12/15/adj	150	8-DIP/SO	
MAX629	2.7 to 5.5	V_{IN} to 28 or 0 to -28	100	8-SO	28V/500mA internal switch
MAX686	2.7 to 5.5	V_{IN} to 28 or 0 to -28	100	16-QSOP	28V/500mA internal switch, internal DAC-controlled output voltage
MAX856/7/8/9	0.8 to 6	3.3/5/adj	100	8-SO/µMAX	Upgraded by MAX1674/5/6
MAX1678	0.7 to 5.5	3.3/adj	100	8-µMAX	1- to 2-cell step-up, EMI-suppression circuitry
MAX866/7	0.8 to 6	3.3/5/adj	50	8-µMAX	Upgraded by MAX1678
MAX630	2 to 16.5	Adj	30	8-DIP/SO	Improved RC4123 second source
MAX631	2 to 16.5	5/adj	30	8-DIP/SO	Only two external components
MAX632	2 to 16.5	12/adj	30	8-DIP/SO	Only two external components
MAX633	2 to 16.5	15/adj	30	8-DIP/SO	Only two external components
MAX1642/3	0.7 to 1.65	3.3/adj	30	8-µMAX	Upgraded by MAX1678

Step-Up/Step-Down Converters

Part	Input Voltage Range (V)	Output Voltage (V)	Output Current (mA)	Pin-Package	Features
MAX710	1.8 to 11	3.3/5	500	16-NSO	Buck/boost requires only one inductor, true shutdown
MAX711	1.8 to 11	Adj	500	16-NSO	Buck/boost requires only one inductor, true shutdown
MAX1672	1.8 to 11	3.3/5/adj	300	16-QSOP	Buck/boost requires only one inductor, true shutdown

MAXIM

High-Power, Flexible PWM Controllers in µMAX

The MAX668/MAX669 are constant-frequency PWM controllers, configurable in step-up, SEPIC, flyback, and isolated topologies at power levels exceeding 20W. Their wide input voltage range permits a variety of input sources. The adjustable (100kHz to 500kHz) or synchronizable operating frequency allows optimization of external component size and cost, and isolates switching harmonics from critical frequencies in noise-sensitive applications. This combination of wide input range and programmable frequency makes the MAX668/MAX669 an excellent choice for many applications.

The MAX668 operates with inputs as low as +3V and puts no restriction on the output voltage generated. The MAX669 is identical to the MAX668, except its internal "bootstrap" connection allows operation at voltages down to 1.8V while restricting the output voltage to a maximum of 28V. Both parts offer a digital soft-start function, a logic-controlled shutdown mode, a user-programmable current limit, and a 5V linear-regulator output capable or sourcing up to 12mA—all in an extremely compact 10-pin µMAX package. A preassembled evaluation kit is available.

BOOST

SEPIC

MAX668 MAX669

5V ISOLATED POWER

TELECOM POWER

Step-Up Controllers

Part	Input Voltage Range (V)	Output Voltage (V)	Output Power* (W)	Control Scheme	Pin-Package	Features
MAX668	3 to 28	Adj	25	PWM	10-µMAX	Ideal for boost and flyback configurations
MAX669	1.8 to 28	Adj	25	PWM	10-µMAX	Ideal for boost and flyback configurations
MAX608	1.8 to 16.5	5/adj	24	PFM	8-SO	Flexible, simple device
MAX1771	2 to 16.5	12/adj	24	PFM	8-SO	Flexible, simple device
MAX863	1.5 to 11	3.3/adj & 5/adj	20	PFM	16-QSOP	Ideal for dual-supply systems (ex: SEPIC and boost)
MAX770/1/2	2 to 16.5	5/12/15/adj	15	PFM	8-SO	Upgraded by MAX1771/MAX608
MAX773	Unlimited	5/12/15/adj	15	PFM	14-SO	On-board shunt regulator for unlimited input voltages
MAX641/2/3	2 to 16.5	5/12/15/adj	10	PFM	8-DIP/SO	Upgraded by MAX1771

*Output power represents a typical application and is provided for product selection guidance only. The output power capability is dominated by external component selection.
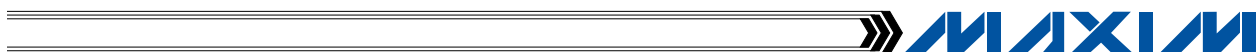
Industry's First SpeedStep Step-Down Converter for CPU Core Supplies

Allows Dynamic Adjustment of Output Voltage While Minimizing Inrush Current*

The MAX1717 is a highly integrated step-down controller that's optimized for use in core supplies for Intel's SpeedStep mobile processors. It features Maxim's proprietary, dynamically adjustable output voltage technology, which provides precision slew-rate control to minimize inrush currents. Quick-PWM™ operation combines with high output accuracy to deliver a ±1% accurate output voltage over line and load variations, as well as a 100ns "instant-on" response to load transients. The MAX1717 is highly flexible, allowing operation with or without "voltage positioning" at frequencies ranging from 200kHz to 1MHz. An integrated multiplexer allows selection between two 5-bit DAC settings with five digital input pins. The MAX1717 is offered in a small, 24-pin QSOP package.

- **0.925V to 2V Dynamic V$_{OUT}$ Adjust Range**
- **Integrates 2-Channel VID Multiplexer**
- **200kHz/300kHz/550kHz/1000kHz Switching Frequency Options**
- **2V to 28V Battery Input Voltage Range**
- **500µA typ I$_{CC}$ Supply Current**
- **10µA Shutdown Current**

MAX1717
SpeedStep OUTPUT VOLTAGE TRANSITION
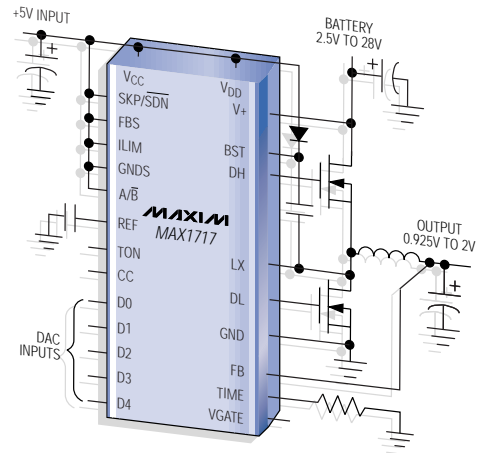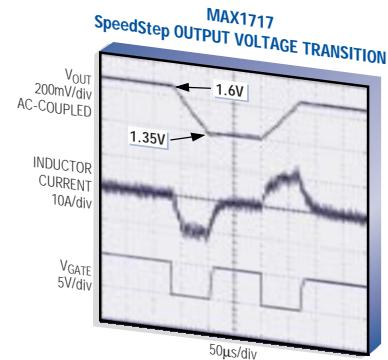
*Patent pending

High-Power Step-Down Controllers

Part	Input Voltage Range (V)	Output Voltage (V)	Output Current** (A)	Pin-Package	Features
MAX1624	4.5 to 5.5	Adj	25	24-SSOP	VRM supply for desktops
MAX1625	4.5 to 5.5	Adj	25	16-SO	VRM supply for desktops
MAX1638	4.5 to 5.5	Adj	25	24-SSOP	VRM supply for desktops
MAX1639	4.5 to 5.5	Adj	25	16-SO	VRM supply for desktops
MAX1717	2.5V to 28V	Adj	25	24-QSOP	CPU core supply for SpeedStep
MAX1710	4.5 to 28	Adj	20	24-QSOP	Mobile Pentium® II compliant
MAX1711	4.5 to 28	Adj	20	24-QSOP	Mobile Pentium® II compliant
MAX796	4.5 to 30	5/3.3/adj	15	16-NSO	Upgraded by MAX1652
MAX797	4.5 to 30	5/3.3/adj	15	16-NSO	Upgraded by MAX1653/MAX1655
MAX798	4.5 to 30	Adj	15	16-NSO	MAX797 with output to 1.6V
MAX799	4.5 to 30	5/3.3/adj	15	16-NSO	Upgraded by MAX1654
MAX1652	4.5 to 28	5/3.3/adj	10	16-QSOP	MAX796 in 16-pin QSOP
MAX1653	4.5 to 28	5/3.3/adj	10	16-QSOP/SO	Pin-compatible MAX797 upgrade
MAX1654	4.5 to 28	5/3.3/adj	10	16-QSOP	MAX799 in 16-pin QSOP
MAX1655	4.5 to 28	Adj	10	16-QSOP/SO	MAX1653 with output to 1V
MAX1714A/B	4.5 to 28	2.5/3.3/adj	15	20-QSOP, 16-QSOP	Low cost, high efficiency
MAX1715	4.5 to 28	1.8/2.5 and 2.5/3.3	15 x 2	28-QSOP	Low cost, dual, high efficiency
MAX1636	4.5 to 30	Adj	10	20-SSOP	High-accuracy outputs
MAX1637	3.15 to 5.5	Adj	10	16-QSOP	Low-cost notebook supply

NEW (MAX1714A/B)
NEW (MAX1715)

Pentium is a registered trademark of Intel Corp.
Quick-PWM and Dual Mode are trademarks of Maxim Integrated Products.

** Output power represents a typical application, and is provided for product selection guidance only. True output power capability is dominated by external component selection.

Tiny Switcher is 10x Better than LDOs for 1.8V Logic Supply

600mA min Output Current, Up to 95% Efficiency, 10x Power Savings

The MAX1692 step-down DC-DC converter allows PDAs and cell phones to take full advantage of the power savings associated with low-voltage (<1.8V) core logic supplies. Many systems now use linear regulators, which typically dissipate 900mW. The MAX1692 dissipates only 90mW, reducing heat and saving battery life, and delivers a minimum of 600mA at outputs down to 1.25V. Its synchronous rectifier provides up to 95% efficiency. This device requires no external FETs and comes in a tiny 10-pin µMAX package.
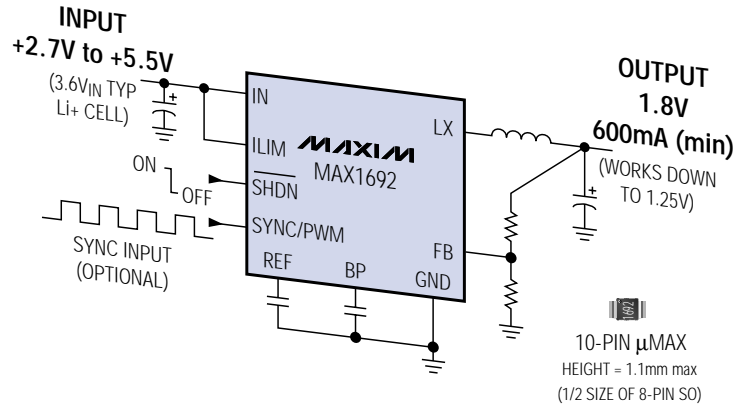
- **No External FETs or Schottky Diode Required**
- **Synchronous Rectification Provides up to 95% Efficiency**
- **Low-Dropout Voltage: 150mV at 500mA (vs. 500mV for linear regulator)**
- **Adjustable Output: 1.25V to V_{IN}**
- **Guaranteed 600mA Output Current**
- **Low-Noise, Fixed-Frequency PWM Operation at 750kHz (or sync at 450kHz to 900kHz)**
- **85µA Quiescent Supply Current**
- **EV Kit Available (MAX1692EVKIT)**

MAX1692 Saves 10x More Power
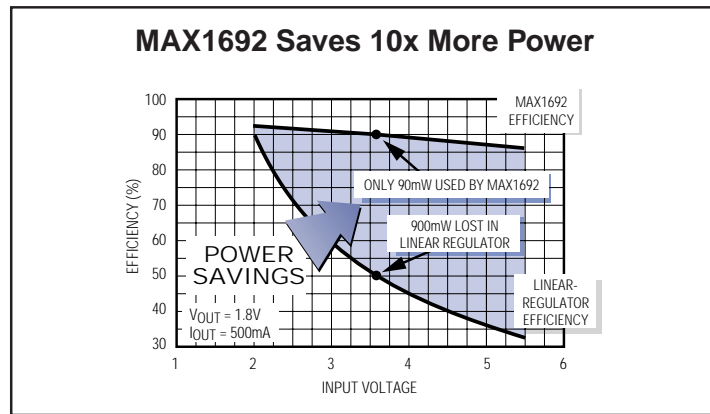
The MAX1692 provides step-down conversion for 1.8V cell-phone baseband logic, PDAs, and other handhelds. Its high efficiency and low dropout save the heat and power otherwise dissipated in a linear regulator.

PWM Step-Down Converters

	Part	Input Voltage Range (V)	Output Voltage (V)	Output Current (mA)	Pin-Package	Features
NEW	MAX1623	4.5 to 5.5	3.3/2.5/adj	3A	20-SSOP	1% accurate output voltage
	MAX1644	3 to 5.5	3.3/2.5/adj	2A	16-SSOP	1% accurate output voltage
	MAX730A	5.2 to 11	5	1A	8-SO	Upgraded by MAX1684/MAX1685
	MAX1684/5	2.7 to 14	3.3/adj	1A (min)	16-QSOP	High-frequency operation
	MAX738A	6 to 16	5	750	16-WSO	Upgraded by MAX1684/MAX1685
	MAX744A	6 to 16	5	750	16-WSO	Upgraded by MAX1684/MAX1685
	MAX758A	3.3 to 16	Adj	750	16-WSO	Upgraded by MAX1684/MAX1685
	MAX887	3.5 to 11	Adj	600	8-SO	Few external components
	MAX1692	2.7 to 5.5	Adj	600 (min)	10-µMAX	High-frequency operation
	MAX750A	4 to 11	Adj	450	8-SO	Upgraded by MAX887
	MAX748A	3.3 to 16	3.3	500	16-WSO	Upgraded by MAX1684/MAX1685
	MAX763A	3.3 to 11	3.3	500	8-SO	Upgraded by MAX887
FUTURE	MAX886*	2.7 to 12	Adj	500	32-TQFP	Highly integrated system IC
	MAX888	2.7 to 12	Adj	500	32-TQFP	Highly integrated system IC

*Future product—contact factory for availability.

Triple-Output DC-DC Converter for TFT LCD Comes in Low-Profile TSSOP

The MAX1748* offers three regulators in one low-profile (1.1mm max) TSSOP package for TFT LCD applications. It includes a 1MHz boost regulator with built-in MOSFET and two regulated charge-pump controllers (+30V and -15V), resulting in a highly integrated solution that can use minimum-size storage components (inductors, capacitors). The MAX1748 is highly versatile, with its selectable output voltage, customizable internal supply sequencing, and wide input voltage range. It also provides high output accuracy, fast transient response, and high efficiency.

- **Low Profile: Total Solution < 1.1mm High**
- **Customizable Internal Supply Sequencing**
- **Main Output Voltage Adjustable up to 12V (or higher with external MOSFET) and Regulated to ±1%**
- **Built-In 1.3A Power MOSFET**
- **+2.7V to +5.5V Input Supply Range**
- **1MHz Current-Mode PWM Control**
- **> 85% Efficiency**
- **3mA Quiescent Current 1µA Shutdown Current**
- **Power-Ready Output**

* Future product—contact factory for availability.
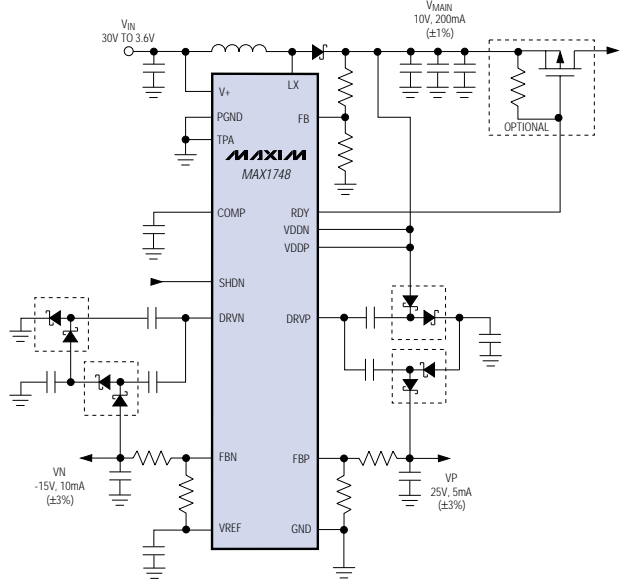
High-Power CCFL Backlight Supply Has Wide Intensity Range

The MAX1739* uses the industry-proven Royer oscillator inverter architecture to drive up to two 4W CCFLs and allow the widest intensity range possible. The CCFL brightness remains constant over changing input voltages and protects against lamp open and short-circuited conditions.

CCFL brightness can be voltage controlled or set with an Intel SMBus-compatible 2-wire interface, with over 30:1 range. Minimum CCFL intensity is independently adjustable from the maximum setting.

- **Wide Input Range (+6V to +24V)**
- **Drives External Low-Side N-Channel MOSFETs in Royer Oscillator for Higher Efficiency and Control**
- **Open Lamp Protection with 2s Timeout**
- **256ms Lamp Turn-On Delay**
- **Meets UL950 Safety Requirements**
- **Floating or Grounded Lamp**
- **No Flicker at Low Brightness**
- **No External Logic Supply Necessary**

*Future product—contact factory for availibility.

LOW-PROFILE 20-PIN TSSOP

MAXIM