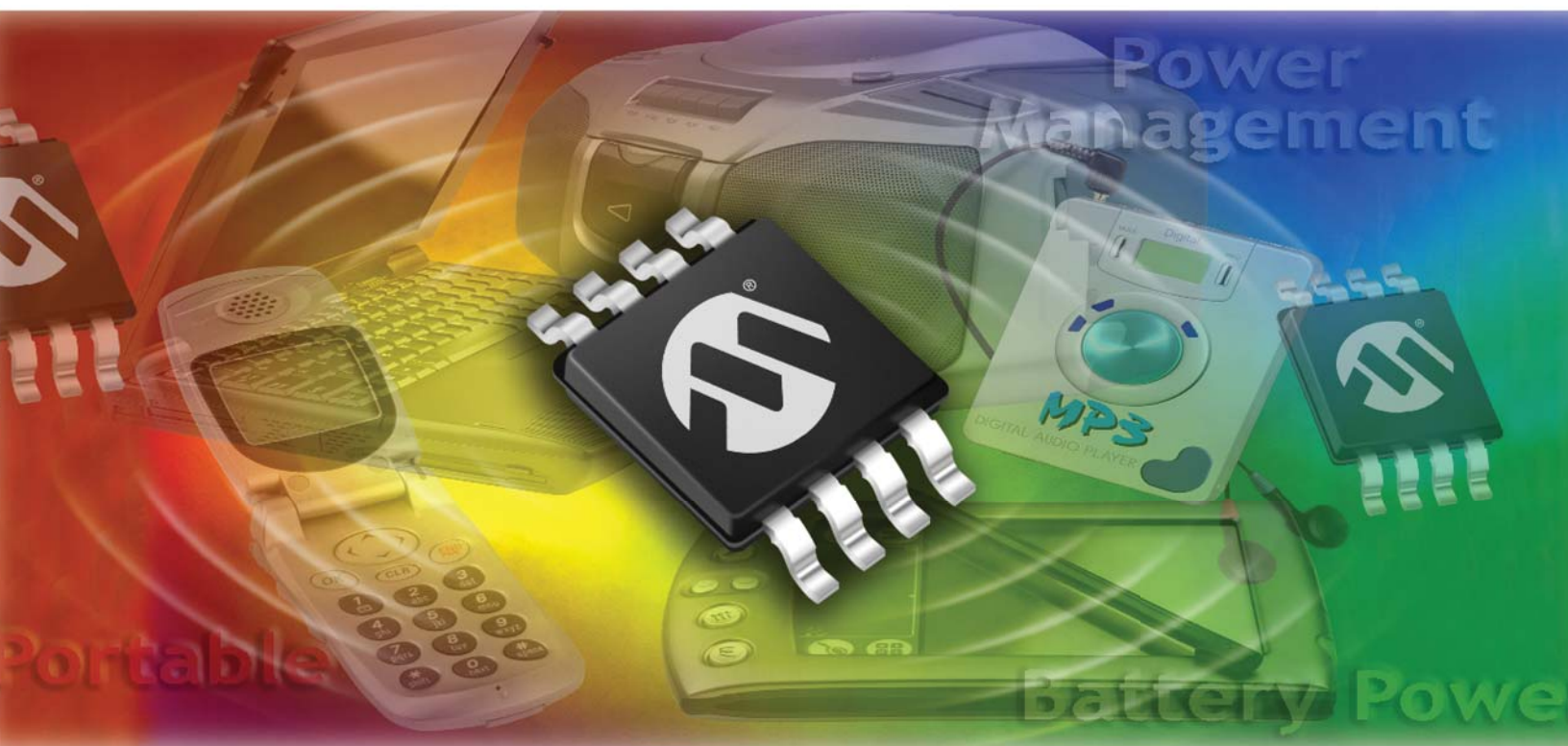# MICROCHIP

Battery Power Function Pack Design Guide

Powering Your Portable Design

Design ideas in this guide are based on many of the devices featured in Microchip Technology's Battery Management Function Pack" or "Fun Pack." A complete device list and corresponding data sheets for these products can be found at www.microchip.com/funpack

Design ideas in this guide use the following devices.

Fun Pack Kit Contents

Battery Chargers	Charge Pump DC/DC Converters	Low Dropout Linear Regulators	PICmicro® Microcontroller	PWM Controllers	Operational Amplifiers	Switching Regulators
MCP73843	MCP1252-ADJ	MCP1701	PIC12F683	MCP1630	MCP6292	MCP1601
MCP73861		TC1017				MCP1650

Powering Your Portable Design with Microchip Technology

DC/DC CONVERSION

Closed loop control with linear regulators. Often the voltage source is "incompatible" with the load. A buffer needs to be placed between the source and load to regulate or control the voltage and/or current.

Linear regulators provide closed loop control to "regulate" the voltage at the load. A basic linear regulator has three main components: an operational amplifier, a voltage reference and a pass transistor. The main purpose of a linear regulator is to produce a constant, accurate output voltage at a lower magnitude than the input voltage.

Beyond the basics, linear regulators often offer additional features: over-current protection, thermal protection and reversed polarity protection to name a few.

Microchip offers a line of CMOS, low dropout linear regulators. A low dropout regulator is a type of linear regulator designed to minimize the saturation voltage of the output transistor and to minimize the gate drive requirements. LDOs can operate with a very small input to output differential.

TC1017 Linear Regulator Features:

- Space-saving 5-pin SC-70 Package
- Extremely Low Operating Current for Longer Battery Life: 53 µA (typ.)
- Very Low Dropout Voltage
- Rated 150 mA Output Current
- Requires only 1 µF Ceramic Output Capacitance
- High Output Voltage Accuracy: ±0.5% (typ.)
- 10 µsec (typ.) Wake-Up Time from SHDN
- Power-Saving Shutdown Mode: 0.05 µA (typ.)
- Over-Current and Over-Temperature Protection
- Pin Compatible Upgrade for Bipolar Regulators

Low Dropout Linear Regulator Circuit
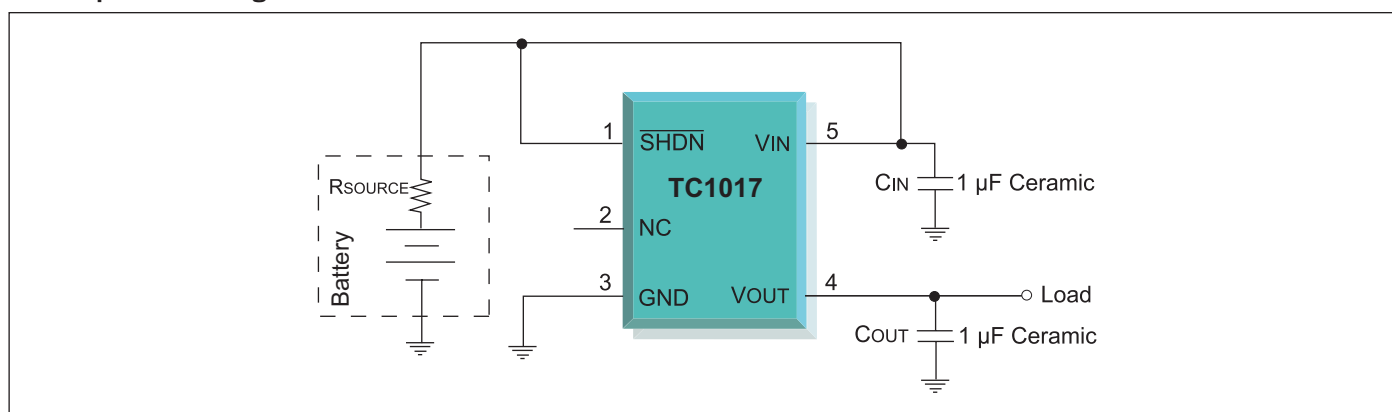
Selected Product Specifications: Linear Regulators

Device	Max. Input Voltage	Output Voltage	Output Current (mA)	Typical Active Current (µA)	Typical Dropout Voltage @ Max. I_{OUT} (mV)	Features	Packages
TC1016	6.0	1.8, 2.7, 2.8, 3.0	80	50	150	Shutdown	5-pin SC-70
TC1017	6.0	1.8, 1.85, 1.9, 2.5, 2.6, 2.7, 2.8, 2.85, 2.9, 3.0, 3.2, 3.3, 4.0	150	53	285	Shutdown	5-pin SC-70/SOT-23A
MCP1700	6.0	1.2, 1.8, 2.5, 3.0, 3.3, 5.0	250	1.6	178		3-pin SOT-23A/SOT-89, 3-pin TO-92
MCP1701	10	1.8, 2.5, 3.0, 3.3, 5.0	250	1.1	380		3-pin SOT-23A/SOT-89, 3-pin TO-92
TC2014	6.0	1.8, 2.5, 3.0, 3.3	50	55	45	Shutdown, Reference bypass input	5-pin SOT-23A
TC2015	6.0	1.8, 2.7, 2.8, 3.0, 3.3	100	55	90	Shutdown, Reference bypass input	5-pin SOT-23A
TC2185	6.0	1.8, 2.7, 2.8, 3.0, 3.3	150	55	140	Shutdown, Reference bypass input	5-pin SOT-23A
TC2186	6.0	1.8, 2.7, 2.8, 3.0, 3.3	150	55	140	Shutdown, Error output	5-pin SOT-23A
TC2117	6.0	1.8, 2.5, 3.0, 3.3	800	80	600		3-pin SOT-223, 3-pin DDPAK

Selected Product Specifications: Linear Regulator Combinations

Device	Max. Input Voltage	Output Voltage	Output Current (mA)	Typical Active Current (µA)	Typical Dropout Voltage @ Max. I_{OUT} (mV)	Features	Packages
TC1300	6.0	2.5, 2.7, 2.8, 2.85,	300	80	210	Shutdown Reference bypass input, LDO plus RESET output	8-pin MSOP
TC1301A/B	6.0	1.5-3.3 @ 100 mV increment	300/150	116	104/150	Dual LDO with RESET & Shutdown; TC1301B has individual shutdown	8-pin MSOP, 8-pin DFN

DC/DC CONVERSION (Cont.)

Employing a switch-mode power converter. Another approach to transferring the battery energy to the system load is to employ a switch-mode power converter. The primary advantage of a switch-mode power converter is that it can, ideally, accomplish power conversion and regulation at 100% efficiency. All power loss is due to non-ideal components and power loss in the control circuit.

The buck converter is an inductor based switch-mode power converter used to step-down an input source to a lower magnitude output. The buck converter goes by many names: voltage step-down converter, DC-to-DC converter, chopper converter, etc. No matter what the name, inductor based, buck derived, switch-mode converters account for 80% to 90% of all converters sold.

Microchip offers inductor based buck regulators and controllers. The distinction is whether or not the switch (MOSFET) is internal to the device (regulator) or controlled externally (controller). The schematic represented here depicts a MCP1601 buck regulator with its associated external components.

MCP1601 Synchronous Buck Regulator Features:

- Input Range of 2.7V to 5.5V
- PWM, PFM and LDO Operation
- Integrated Switches
- 750 kHz Fixed Switching Frequency
- Oscillator Synchronization to 1 MHz PWM Mode
- Auto-Switching from PWM/PFM
- 100% Duty Cycle Capable for Low Input Voltage
- 500 mA Continuous Output Current
- Under-Voltage Lock-Out Protection
- Over-Temperature Protection
- Integrated Soft Start Circuitry
- Output Voltage Capability to 0.9V
- Wide Operating Temperature Range: -40°C to +85°C
- Small 8-pin MSOP Package

Step-Down Switching Regulator Circuit
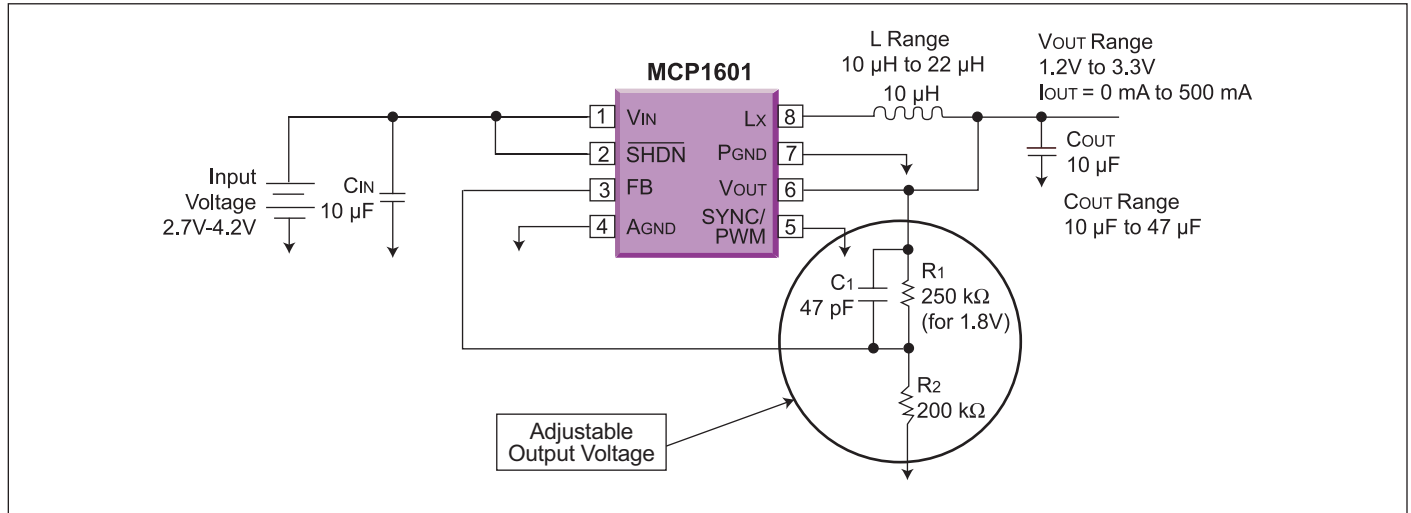
Selected Product Specifications: Switching Regulators/Controllers

Device	Output	Buck/Boost	Input Voltage Range (V)	Output Voltage (V)	Control Scheme	Features	Packages
MCP1601	Adjustable	Step-Down	2.7 to 5.5	0.9 to V_{IN}	PWM/PFM/LDO	UVLO, Auto switching, LDO	8-pin MSOP
MCP1612	Adjustable	Step-Down	2.7 to 5.5	0.8 to 5.5	PWM	UVLO, Soft-startm 1.4 MHz, 1A	8-pin MSOP/DFN
TC105	Fixed	Step-Down	2.2 to 10	3.0, 3.3, 5.0	PFM/PWM	Low-power Shutdown mode	5-pin SOT-23A
TC110	Fixed	Step-Up	2.0 to 10	3.0, 3.3, 5.0	PFM/PWM	Soft-start, Low-power Shutdown mode	5-pin SOT-23A
TC115	Fixed	Step-Up	0.9 to 10	3.0, 3.3, 5.0	PFM/PWM	Feedback voltage sensing, Low-power Shutdown mode	5-pin SOT-89
TC120	Fixed	Step-Down	1.8 to 10	3.0, 3.3, 5.0	PFM/PWM	Soft-start, Low-power Shutdown mode	8-pin SOP
TC125	Fixed	Step-Up	0.9 to 10	3.0, 3.3, 5.0	PFM	Low-power Shutdown mode	5-pin SOT-23A
TC126	Fixed	Step-Up	0.9 to 10	3.0, 3.3, 5.0	PFM	Feedback voltage sensing	5-pin SOT-23A

Powering Your Portable Design with Microchip Technology

LI-ION BATTERY MANAGEMENT

Linear charge management control. Far too often, the battery charging system is given low priority, especially in cost sensitive applications. However, the quality of the charging system plays a key role in the life and reliability of the battery.

Microchip offers a complete line of linear, Li-Ion chargers. The MCP73843 provides a reliable, low- cost battery charging solution with few external components. The MCP73843 performs constant-current, constant-voltage regulation with automatic charge termination.

In an effort to further reduce the size, cost, and complexity, many of the external components can be integrated into the charge management controller. The MCP73861 performs all the functions of the MCP73843 along with integrated charge-current sensing, pass transistor, reverse discharge protection, and cell temperature monitoring.
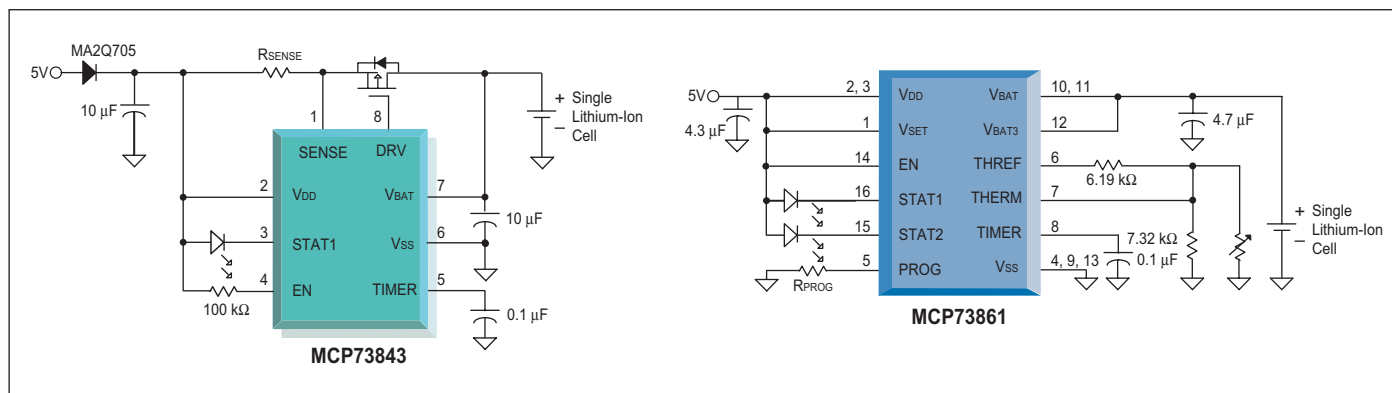
MCP73843 Battery Charger Features:
- High Accuracy Preset Voltage Regulation
- Programmable Charge Current
- Programmable Safety Timers
- Automatic Charge Termination
- Automatic Recharge
- Automatic Power-Down With No Input
- Charge Status Indicator
- Shutdown Input
- Small 8-pin MSOP Package

Additional MCP73861 Features:
- Integrated Charge Current Sense
- Integrated Pass Transistor
- Integrated Reverse Discharge Protection
- Fault Indicator
- Continuous Cell Temperature Monitor
- Small 16-Lead, 4mm x 4mm QFN Package

Linear, Li-Ion Battery Charger Circuits

MCP73843

MCP73861

Selected Product Specifications: Battery Charger Family

Device	Mode	# of Cells	Vcc Range (V)	Max. Voltage Regulation	Int/Ext FET	Features
MCP73826	Linear	1	4.5-5.5	±1.0%	Ext	Small size
MCP73827	Linear	1	4.5-5.5	±1.0%	Ext	Mode indicator, charge current monitor
MCP73828	Linear	1	4.5-5.5	±1.0%	Ext	Temperature monitor
MCP73841	Linear	1	4.5-12	±0.5%	Ext	Safety charge timers, temperature monitor
MCP73842	Linear	2	8.7-12	±0.5%	Ext	Safety charge timers, temperature monitor
MCP73843	Linear	1	4.5-12	±0.5%	Ext	Safety charge timers
MCP73844	Linear	2	8.7-12	±0.5%	Ext	Safety charge timers
MCP73853	Linear	1	4.5-5.5	±0.5%	Int	USB control, safety charge timers, temperature monitor, thermal regulation
MCP73855	Linear	1	4.5-5.5	±0.5%	Int	USB control, safety charge timers, thermal regulation
MCP73861	Linear	1	4.5-12	±0.5%	Int	Safety charge timers, temperature monitor, thermal regulation
MCP73862	Linear	2	8.7-12	±0.5%	Int	Safety charge timers, temperature monitor, thermal regulation

BATTERY MANAGEMENT

**Intelligent, switch-mode charge management control.**
The MCP1630 is a high-speed, microcontroller-adaptable, Pulse-Width Modulator (PWM) used to develop intelligent power control systems. Combined with a microcontroller, the MCP1630 regulates output voltage or current by controlling the power-system duty cycle. In the power control system, the microcontroller can be used to digitally adjust the output voltage or current by controlling the voltage reference applied to the MCP1630; thereby bringing digital control to the analog PWM function.

The fast comparator of the MCP1630 enables this device to be used as an excellent current mode controller. With a typical response time of 12 ns, the MCP1630 comparator provides a very tight limit to the maximum switch current over a wide range of input voltages.

MCP1630 PWM Features:

- High-Speed PWM Operation:
  – 12 ns Current Sense to Output Delay
- Operating Temperature Range: -40°C - +125°C
- Precise Peak Current Limit: ±5%
- CMOS Output Driver (Drives MOSFET Driver or Low-Side N-channel MOSFET Directly)
- External Oscillator Input (from PICmicro® Microcontroller)
- External Voltage Reference Input (for Adjustable Voltage or Current Output Application)
- Peak Current Mode Operation to 1 MHz
- Low Operating Current: 2.8 mA, typical
- Fast Output Rise and Fall Times: 5.9 ns, 6.2 ns
- Under-voltage Lockout
- Output Short Circuit Protection
- Over-temperature Protection

Switch-mode, Li-Ion Battery Charger Circuits
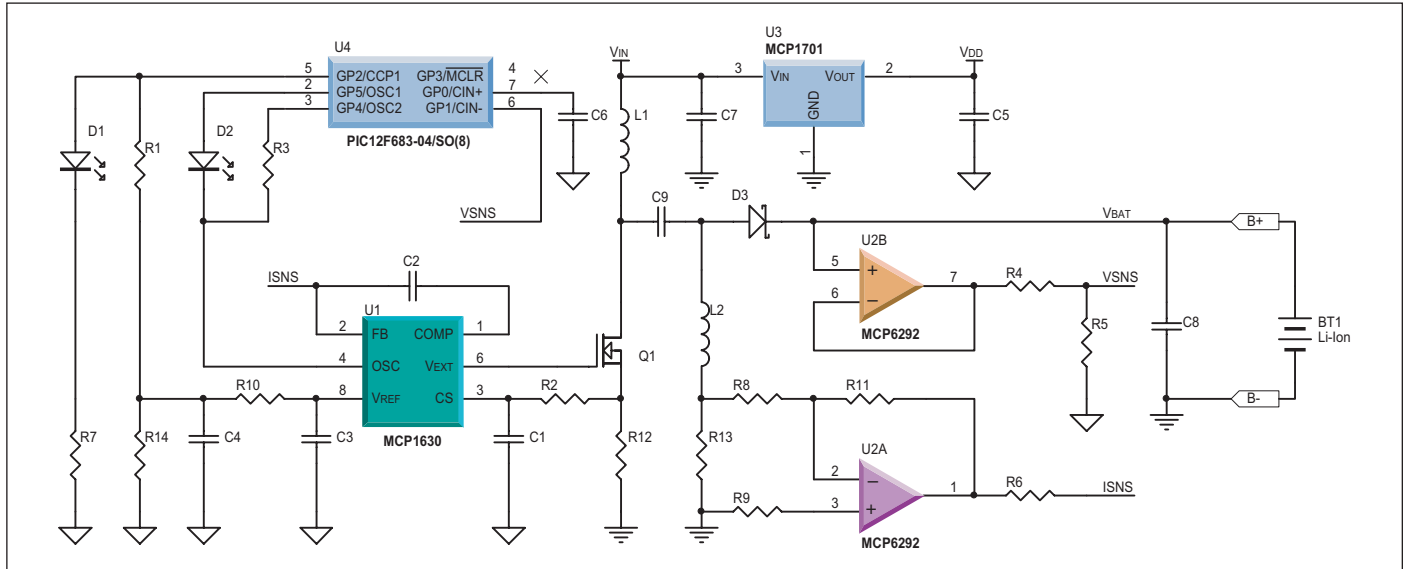
Selected Product Specifications: MCP1630 PWM Controller

Device	Input Voltage Range (V)	Current Sense-to-Output Delay	Control Scheme	Ext. Oscillator Range	Operating Temperature Range	Packages
MCP1630	3.0-5.5	12 nS typ.	Cycle-by-Cycle DC Control	1.0 MHz	-40°C to +125°C	8-pin MSOP

Selected Product Specifications: PIC12F683 Microcontroller

Device	Bytes	OTP/Flash Words	RAM Bytes	I/O Pins	Packages	8-bit ADC Channels	Comparators	Timers/ WDT	Max. Speed MHz	Other Features
PIC12F683	3584	2048	128	6	8-pin PDIP/SOIC/DFN	4 x 10-bit	1	1 16-bit, 2 8-bit, 1 WDT	20	Internal 8 MHz oscillator

Selected Product Specifications: MCP6292 Op Amp

Device	# Per Package	GBWP	IQ Typ. (µA)	Vos Max. (mV)	Operating Voltage (V)	Packages
MCP6292	2	10 MHz	1000	3	2.4 to 5.5	8-pin PDIP/SOIC/MSOP

Selected Product Specifications: MCP1701 Low Dropout Positive Voltage Regulator

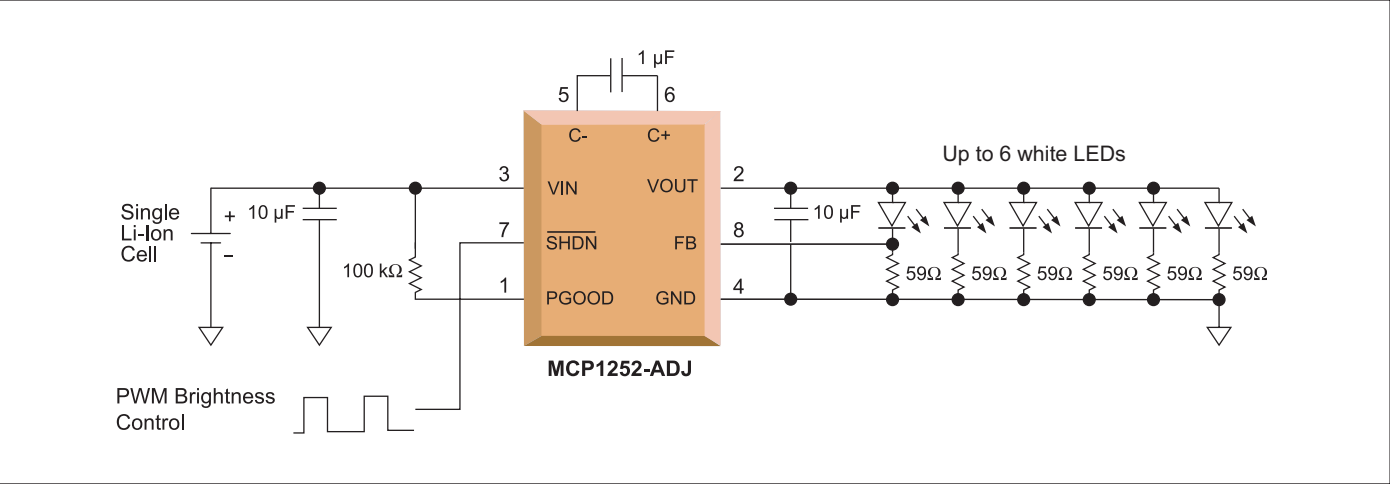| Device	Max. Input Voltage (V)	Output Voltage (V)	Typ. Dropout Voltage @ 200 mV	Typ. Output Voltage Accuracy (%)	Packages
MCP1701	10	1.8, 2.5, 3.0, 3.3, 5.0	380 mV	± 0.5	3-pin SOT-23A, 3-pin SOT-89 3-pin TO-92

BACKLIGHTING

Biasing the backlighting. The MCP1252-ADJ is an inductorless, positive-regulated charge pump DC/DC converter. The device generates an adjustable output voltage. It is specifically designed for applications requiring low noise and high efficiency and is able to deliver up to 120 mA output current. The device allows the input voltage to be lower or higher than the output voltage, by automatically switching between buck/ boost operation.

Today's new color displays require a pure white light for back lighting. White light emitting diodes have become the component of choice. The MCP1252-ADJ is an excellent choice for biasing the back lighting. Light intensity is controlled uniformly through the use of ballast resistors. The peak intensity is set by the feedback to the MCP1252-ADJ. Dimming is accomplished by pulse-width modulating the shutdown pin of the device.

MCP1252 Charge Pump Features:

- Inductorless, Buck/Boost, DC/DC Converter
- Low Power: 80 µA (Typical)
- 120 mA Output Current
- Wide Operating Temperature Range: -40°C to +85°C
- Thermal Shutdown and Short-Circuit Protection
- Uses Small Ceramic Capacitors
- Low Power Shutdown Mode: 0.1 µA (Typical)
- Shutdown Input Compatible with 1.8V Logic
- V_{IN} Range: 2.0V to 5.5V

White LED Backlighting Circuit with Regulated Charge Pump

Selected Product Specifications: Regulated Charge Pump DC/DC Converters

Device	Input Voltage Range (V)	Output Voltage (V)	Max. Input Current[1] (µA)	Typical Active Output Current (mA)	Features	Packages
MCP1252-33X50	2.7-5.5	Selectable 3.3 or 5.0V	120	120 mA for V_{IN}>3.0V	Power-Good output, 650 kHz oscillator	8-pin MSOP
MCP1252-ADJ	2.0-5.5	Adjustable 1.5V to 5.5V	120	120 mA for V_{IN}>3.0V	Power-Good output, 650 kHz oscillator	8-pin MSOP
MCP1253-33X50	2.7-5.5	Selectable 3.3 or 5.0V	120	120 mA for V_{IN}>3.0V	Power-Good output, 1 MHz oscillator	8-pin MSOP
MCP1253-ADJ	2.0-5.5	Adjustable 1.5V to 5.5V	120	120 mA for V_{IN}>3.0V	Power-Good output, 1 MHz oscillator	8-pin MSOP

Microchip also offers Inverting or Doubling Charge Pumps, Multi-Function Charge Pumps and Inverting and Doubling Charge Pumps. See the Microchip web site for complete specifications www.microchip.com.

BACKLIGHTING

Driving white light emitting diodes in series. An alternative to the MCP1252 back lighting approach is to drive the white light emitting diodes in series. The series connection provides improved brightness matching between the diodes since they all operate with the same current. Light intensity is adjusted by controlling the current through the diodes.

The MCP1650 is a boost controller that can be used to bias the diodes in series as depicted.

MCP1650 Features:

- Output Power Capability Over 5 Watts
- Output Voltage Capability From 3.3V to Over 100V
- 750 kHz Gated Oscillator Switching Frequency
- Adaptable Duty Cycle for Battery or Wide-Input, Voltage-Range Applications
- Input Voltage Range: 2.0V to 5.5V
- Capable of SEPIC and Flyback Topologies
- Shutdown Control with I_Q < 0.1 µA (Typical)
- Low Operating Quiescent Current: I_Q = 120 µA
- Voltage Feedback Tolerance (0.6%, Typical)
- Popular MSOP-8 Package
- Peak Current Limit Feature
- Two Undervoltage Lockout (UVLO) Options: 2.0V or 2.55V
- Operating Temperature Range: -40°C to +125°C

White LED Backlighting Circuit with Boost Controller
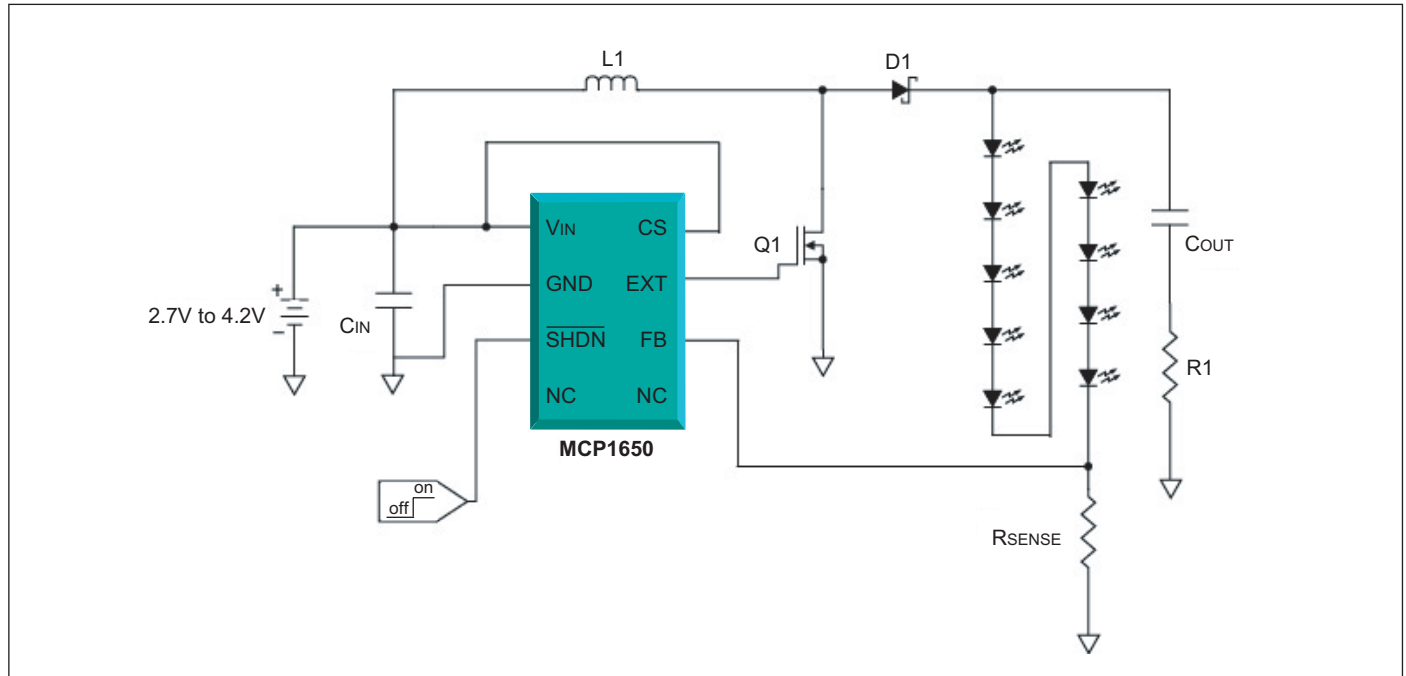
Selected Product Specifications: Boost Controllers

Device	Output	Buck/Boost	Input Voltage Range (V)	Output Voltage (V)	Control Scheme	Features	Packages
MCP1650	Adjustable	Step-Up	2.7 to 5.5	2.5 to Ext. Tx. Limited	Constant Frequency, 2 Fixed DC	2 duty cycles for min. and max. loads, Shutdown, UVLO, Soft-start	8-pin MSOP
MCP1651	Adjustable	Step-Up	2.7 to 5.5	2.5 to Ext. Tx. Limited	Constant Frequency, 2 Fixed DC	2 duty cycles for min. and max. loads, Shutdown, Low battery detect, UVLO, Soft-start	8-pin MSOP
MCP1652	Adjustable	Step-Up	2.7 to 5.5	2.5 to Ext. Tx. Limited	Constant Frequency, 2 Fixed DC	2 duty cycles for min. and max. loads, Shutdown, Power good indicator, UVLO, Soft-start	8-pin MSOP
MCP1653	Adjustable	Step-Up	2.7 to 5.5	2.5 to Ext. Tx. Limited	Constant Frequency, 2 Fixed DC	2 duty cycles for min. and max. loads, Shutdown, Low battery detect, Power good indicator, UVLO, Soft-start	10-pin MSOP

Powering Your Portable Design with Microchip Technology

RELATED SUPPORT MATERIAL

The following Application Notes are available on the Microchip web site: **www.microchip.com.**

Application Notes

AN246: *Driving the Analog Inputs of a SAR A/D Converter*

Driving any A/D Converter (ADC) can be challenging if all issues and trade-offs are not well understood from the beginning. With Successive Approximation Register (SAR) ADCs, the sampling speed and source impedance should be taken into consideration if the device is to be fully utilized. In this application note we will delve into the issues surrounding the SAR Converter's input and conversion nuances to insure that the converter is handled properly from the beginning of the design phase. We will also review the specifications available in most A/D Converter data sheets and identify the important specifications for driving your SAR. From this discussion, techniques will be explored which can be used to successfully drive the input of the SAR A/D Converter. Since most SAR applications require an active driving device at the converter's input, the final subject will be to explore the impact of an operational amplifier on the analog-to-digital conversion in terms of DC as well as AC responses.

AN693: *Understanding A/D Converter Performance Specifications*

The purpose of this application note is to describe the specifications used to quantify the performance of A/D converters and give the reader a better understanding of the significance of those specifications in an application. Although the information presented here is applicable to all A/D converters, specific attention is given to features of the standalone and PICmicro® A/D converters produced by Microchip Technology.

AN793: *Power Management in Portable Applications: Understanding the Buck Switchmode Power Converter*

Powering today's portable world poses many challenges for system designers. The use of batteries as a prime power source is on the rise. As a result, a burden has been placed on the system designer to create sophisticated systems utilizing the batteries full potential.

Each application is unique, but one common theme rings through: **maximize battery capacity usage**. This theme directly relates to how efficiently the energy from the batteries is converted and transferred to the system load. No single method is ideal for all applications. Linear regulators, switched capacitor charge pumps and inductor based switchmode power converters are all employed. Each method has its associated advantages and disadvantages. It is the particular application with its individual requirements that determines which method will be the best to use.

This application note focuses on the fundamentals of inductor based switchmode power converters. This is a "grass roots" approach to understanding switchmode power converters. Specifically, the basic buck circuit topology and its associated waveforms will be examined both empirically and mathematically.

AN947: *Power Management in Portable Applications: Charging Lithium-Ion/Lithium-Polymer Batteries*

This application note focuses on the fundamentals of charging Lithium-Ion/Lithium-Polymer batteries. In particular, a linear, stand-alone solution utilizing Microchip's MCP73841 will be explored.

AN948: *Efficiently Powering Nine White LEDs with the MCP1650*

The number of applications that utilize white LEDs has steadily increased due to the increased usage of Liquid Crystal Displays (LCDs) in automotive and cellular telephone displays, PDAs, handheld electronic games and computer monitors. In order to view the information on these displays, a light source is needed. Typically, this light source has been provided by Cold Cathode Florescent Tubes (CCFT). However, since designers are tasked with improving efficiency, lowering cost and decreasing size, white LEDs are now being used. Powering white LEDs, which have a forward drop (VF) of 3.6V, typically, becomes more difficult when the application requires multiple LEDs. In this Application Note, a solution using the MCP1650 is discussed and shown to be greater than 85% efficient.

AN960: *New Components and Design Methods Bring Intelligence to Battery Charger Applications*

This application note will describe a typical intelligent battery charger power system application. As with most real life applications, there are many demands made on the power system designer to protect the system in the case of battery removal, plugging the battery in backwards, reverse polarity at the input, a battery shorting and even more unimaginable situations. A complete battery charger, fuel gauge system design will be presented as an example of the mixed signal design method. Battery reference material and basic switchmode power supply converter trade-offs are covered in the beginning of this application note.

AN968: *Simple Sychronous Buck Regulator – MCP1612*

This application note contains all of the information needed to design a synchronous buck converter using the MCP1612. It also contains a real-world design example with measured laboratory data.

AN971: *USB Port-Powered Li-Ion/Li-Polymer Battery Charging*

The Universal Serial Bus, USB, allows many computer peripherals to be easily swapped for another without having to turn off the computer. Today, a variety of handheld, battery-operated peripherals provide USB ports to facilitate data transfer to and from a host computer. With the introduction of the new USB 2.0 specification, CD/DVD players, MP3 players, cameras, personal data assistants, and even cell phones can transfer data at rates up to 480 Mbps.

These peripherals are, in some instances, self-powered. As a result, many of these peripherals do not take full advantage of the USB port. Often overshadowed by the data interface of the USB port, a power port is provided. Microchip's MCP73853/55 and MCP73861 advanced, fully integrated, single cell Li-Ion charge management devices allow these peripherals to utilize the full "power" of the USB port.

RELATED SUPPORT MATERIAL

Microchip offers a number of boards to help evaluate device families. Contact your local Microchip sales office for a demonstration. Evaluation boards are available for the following devices featured in this guide.

Evaluation Boards

MCP1252DM-BKLT: *MCP1252 Charge Pump Backlight Demonstration Board*

The MCP1252 Charge Pump Backlight LED Demo Board demonstrates the use of a Charge Pump device in an LED application. The board also serves as a platform to evaluate the MCP1252 device in general. The MCP1252-ADJ is an excellent choice for biasing the back lighting or driving other LED applications. Light intensity is controlled uniformly through the use of ballast resistors. The peak intensity is set by the feedback to the MCP1252-ADJ. Dimming is accomplished by pulse-width modulating the shutdown pin of the device.

The board also features a PIC10F206 microcontroller in a SOT23 package, which is used to provide an enable signal to the MCP1252. The PICmicro microcontroller also accepts a push-button input that allows the user to adjust the white LEDs to five different light intensities, in addition to placing the system in a standby mode that consumes less than 1 μA of current (typical).

MCP1252EV: *MCP1252/53 Evaluation Kit*

The MCP1252/3 Evaluation Board is an evaluation kit designed to support Microchip's MCP1252-33X50, MCP1252-ADJ, MCP1253-33X50 and MCP1253-ADJ low noise, positive-regulated charge pump devices. The evaluation kit is fully assembled and tested. The kit is useful for evaluating simple stand-alone operation or for evaluating applications interfaced with a microcontroller.

MCP1601EV: *MCP1601 Buck Regulator Evaluation Board*

The MCP1601 Buck Regulator Evaluation Board demonstrates Microchip's MCP1601 Synchronous Buck Regulator, developed for battery powered applications as well as distributed power applications. The MCP1601 Evaluation Board is capable of operation over the entire 2.7V to 5.5V input range of the MCP1601 device. Two 2-position DIP switches are used, one to select the output voltage (1.8V, 2.05V, 2.45V or 3.28V) and one that turns the MCP1601 on and off with the other position selecting the mode of operation (PWM-pulse width modulation or PFM-pulse frequency modulation). Surface mount test points are used to apply power and load in addition to probing several points in the test circuit.

MCP1612EV: *MCP1612 Synchronous Buck Regulator Evaluation Board*

The MCP1612 Synchronous Buck Regulator Evaluation Board features Microchip Technology's 1A 1.4 MHz synchronous buck regulator in two buck converter applications. The first application uses the MCP1612 in the 8-leaded MSOP package. This converter has four (0.8V, 1.0V, 1.2V and 1.4V) selectable output voltages available. The second application features the MCP1612 in the 8-leaded DFN package. This converter also has four (0.8V, 1.7V, 2.4V and 3.3V) selectable output voltages. A shutdown terminal is also provided for each converter.

MCP1650EV: *MCP1650 Boost Controller Evaluation Board*

The MCP1650 Boost Controller Evaluation Board demonstrates Microchip Technology's MCP165X Boost Controller product family in two high-power, boost-converter applications. The first application features the MCP1651 (8-pin MSOP) with the low battery detect feature and provides a regulated 5V output with an input voltage range of 2.8V to 4.8V. The second application uses the MCP1653 (10-pin MSOP), with both low battery detect and power good features. The input voltage for this application is 3.3V, with the output boosted to 12V.

MCP1630DM-NMC1: *MCP1630 NiMH Battery Charger Demonstration Board*

The MCP1630 High Speed PWM is interfaced to the PIC16LF818 to develop a complete NiMH battery charger with fuel gauge capability. The MCP1630 is used to regulate the battery charge current and protect the SEPIC power train against an open circuit (removed battery) or a shorted battery. The high speed (12ns current sense to output) capability of the MCP1630 is used to switch the SEPIC converter at 1 MHz, minimizing external inductor and capacitor cost, while the PIC16LF818 performs the complex NiMH battery charger timing functions. Both the MCP1630 and PICLF818 protect the battery and circuit in the event of a fault.

MCP1630RD-LIC1: *MCP1630 Li-Ion Multi Bay Battery Charger Reference Design*

The MCP1630 Multi-Bay Li-Ion Charger is used to evaluate Microchip's MCP1630 used in a SEPIC power converter application. The MCP1630 Multi-Bay Li-Ion Charger is capable of charging two single-cell, Li-Ion battery packs in parallel utilizing an input voltage of 10V to 30V (battery packs are not included). Multiple boards can be daisy-chained for additional charger bays. The MCP1630 Multi-Bay Li-Ion Charger is intended for use in pseudo-smart battery charger applications utilizing battery packs containing Microchip's PS700 Battery Monitor. Standard battery packs can be utilized as well. The MCP1630 Multi-Bay Li-Ion Charger provides a constant current – constant voltage charge with preconditioning, cell temperature monitoring and battery pack fault monitoring. Each charger bay provides a status and fault indication. The MCP1630 Multi-Bay Li-Ion Charger automatically detects the insertion or removal of a battery pack.

MCP1650DM-LED1: *MCP165X 3W White LED Demo Board*

The MCP165X 3W White LED Demo Board demonstrates Microchip's MCP165X Boost Controller product family in a battery powered white LED application. The MCP1651 (8-pin MSOP) with low battery detect is featured in a SEPIC converter topology with an input voltage range of 2.0V to 4.5V.

MCP7382XEV: *MCP7382X Li-Ion Battery Charger Evaluation Board*

The MCP7382X Li-Ion Battery Charger Evaluation Board features three circuits utilizing the MCP73826, MCP73827 and MCP73828 devices to demonstrate simple, stand-alone, linear charging of single cell Lithium-Ion/Lithium-Polymer battery packs (the battery packs are not included).

MCP7384XEV: *MCP7384X Li-Ion Battery Charger Evaluation Board*

The MCP7384X Li-Ion Battery Charger Evaluation Board features three circuits utilizing the MCP73841, MCP73842 and MCP73843 devices to demonstrate simple, stand-alone, linear charging of single or dual cell Lithium-Ion/ Lithium-Polymer battery packs (the battery packs are not included).

MCP7386XEV: *MCP7386X Li-Ion Battery Charger Evaluation Board*

The MCP7386X Evaluation Board is set up to evaluate simple, stand-alone, linear charging of single/dual cell Lithium-Ion/Lithium-Polymer battery packs (the battery packs are not included). The board design provides constant current charging followed by constant voltage charging with automatic charge termination. As provided, the MCP7386X Evaluation Board is set for a fast charge current level of 1.1A for single cell applications. The MCP73861 is equipped with shutdown control, status indicator, fault indicator, safety timer, and continuous cell temperature monitor. For dual cell applications, the MCP73862 can be substituted for the MCP73861. Refer to the appropriate data sheets for details on the individual device features.

MCP73855EV: *MCP73855 Li-Ion Battery Charger Evaluation Board*

The MCP73855 Evaluation Board is set up to evaluate simple, stand-alone, linear charging of single cell Li-Ion/Li-Polymer battery packs (the battery packs are not included). The board design provides constant current charging followed by constant voltage charging with automatic charge termination. As provided, the MCP73855 Evaluation Board is set for a fast charge current level of 85 mA. The MCP73855 is equipped with shutdown control, status indicator, and safety timers. Refer to the data sheet for details on the device features.

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