Battery-Powered DC/DC Conversion Solutions – InfoCard 3

Linear Technology in Battery Power

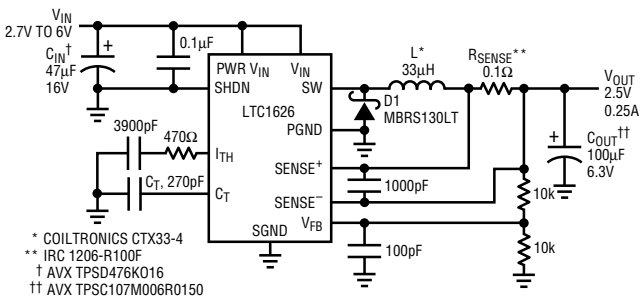
DC/DC conversion is a specialty of Linear Technology Corporation. We offer an extensive line of innovative circuits that facilitate power management and maximize battery life and system efficiency.

Feature Application: Single-Cell Li-Ion to 1.8V to 3.3V Output

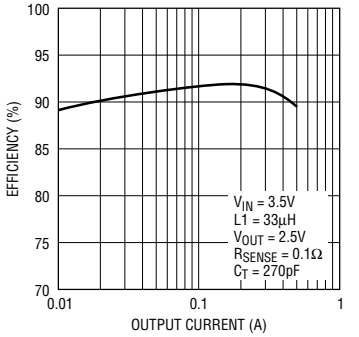
LTC1626: High Efficiency, Ultralow Shutdown Current

- 2.5V to 6V Input Range
- Efficiency to 95%
- Burst Mode™ Power Savings
- Low $R_{DS(ON)}$ Switch: 0.32Ω
- Shutdown: I_Q = 0.5µA

High Efficiency 2.5V Step-Down Converter Example



Efficiency



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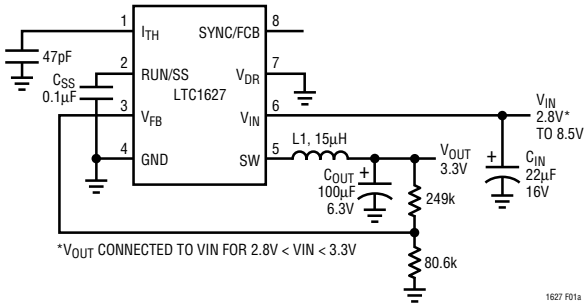
LTC1627: Synchronous Rectification, High Efficiency

- 2.65V to 8.5V Input Range
- Efficiency to 95%
- Low $R_{DS(ON)}$ Switch: 0.5Ω
- No Schottky Diode Required
- Selectable Burst Mode
- Synchronize to 525kHz

High Efficiency Step-Down Converter Example



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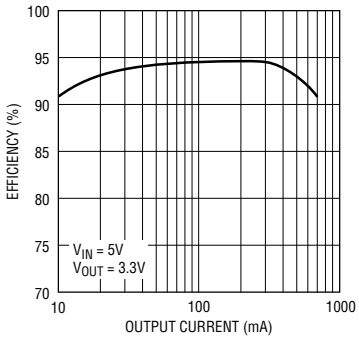
Efficiency



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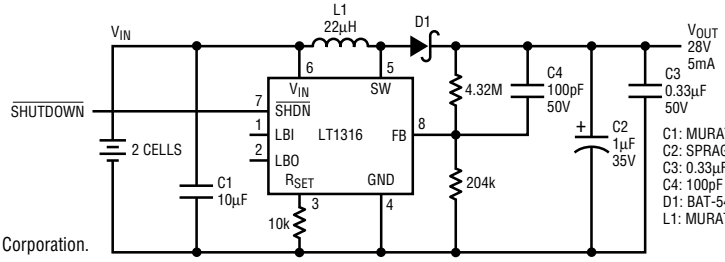
Step-Up From One Cell (1V)

V_{OUT} Example	I_{OUT} (mA)	V_{IN} Min (V)	Device	I_Q (µA)	I_{SD} (µA)	Low Batt	Burst Mode	Package	Applications and Features
3.3V	30	1	LT1610	30	1		x	MS8, S8	Fixed 1.7MHz, Tiny Inductors and Capacitors
	75	1	LT1307	50	3	x	x	MS8, S8	600kHz, True Current Mode PWM from One Cell
	300	1	LT1308	100	3	x	x	S8	600kHz Fixed Frequency, Low V_{CESAT} Switch
5V	50	1	LT1307	50	3	x	x	MS8, S8	600kHz, Tiny Ceramic MLC Capacitors
	200	1	LT1308	100	3	x	x	S8	High Efficiency over Broad Load Range
CCFL		1	LT1307B	50	3	x		MS8, S8	Single Cell CCFL Power Supply

LCD Bias from One and Two Cells

- Boosted Voltage up to ±30V for Contrast Control of LCDs
- Designs for Positive or Negative Bias, for Split Supply Bias and for Selectable Positive or Negative Bias

Low Profile 2 Cell-to-28V Converter for LCD Bias



C1: MURATA GRM235Y5V106Z010
C2: SPRAGUE 293D105X9035B2T
C3: 0.33µF CERAMIC, 50V
C4: 100pF CERAMIC, 50V
D1: BAT-54
L1: MURATA LQH3C220K04

Rev I 0798

LCD Bias from One and Two Cells

Device	V_{OUT} Range (V)	V_{IN} Range (V)	I_Q (µA)	I_{SD} (µA)	Low Batt	Burst Mode	Package	Applications Example
LT1107	1.2 to 50	2 to 30	300		x		N8, S8	Dual Positive-to-Negative Converter, Low Power Shutdown
LT1111	1.2 to 50	2 to 30	300		x		N8, S8	72kHz, 3V to –22V, 7mA Output at 2V Input
LT1173	1.2 to 50	2 to 30	110		x		N8, S8	2-Cell to ±12V to ±24V, Line Regulation of 0.2%
LT1300	4 to 29	1.8 to 10	120	10	x	x	N8, S8	155kHz, –4V to –29V, 20mA from 3.3V, 83% Efficiency
LT1304	1.2 to 22	1.5 to 8	120	10	x		S8	70% to 75% Efficiency, –14V to –22V, 1mA to 10mA
LT1307	1.2 to 26	1 to 5	50	3	x	x	MS8, S8	600kHz, Tiny Surface Mount Components, 16V to 24V at 5mA to 35mA with 1- to 3-Cell Supply
LT1316	1.2 to 28	1.5 to 12	33	3	x		MS8, S8	Low Profile 2 Cell-to-28V; Bipolar Bias (13V, –15V); Dual Output Positive or Negative Converter; Disconnect in Shutdown
LT1614	–1.2 to –24	1 to 6	1mA	10	x		MS8, S8	600kHz Fixed Frequency, Ceramic Capacitors

Step-Up from Two Cells or 1-Cell Li-Ion

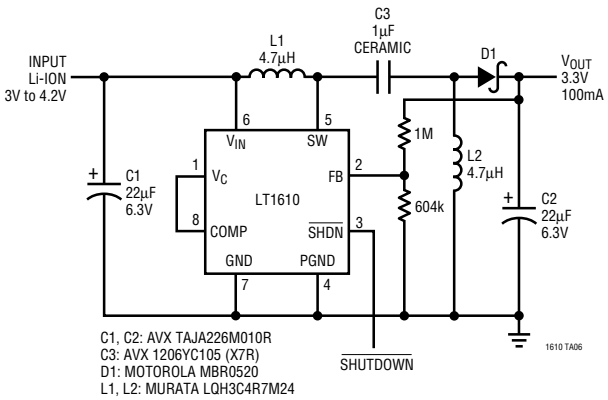
I_{OUT} (mA)	V_{OUT}* Range (V)	V_{IN} Min (V)	Device	I_Q (µA)	I_{SD} (µA)	Low Batt	Burst Mode	Package	Applications and Features
100	3 to 26	1.5	LT1316	33	3	x		MS8, S8	Li-Ion to Cell Phone Power Amp, LCD Bias
100	2 to 28	1	LT1610	30	1		x	MS8, S8	Fixed 1.7MHz, SEPIC from 1-Cell Li-Ion
150	3 to 30	2	LT1107	300		x		N8, S8	Only 3 External Parts, Auxiliary Gain Block
200	3 to 26	1	LT1307	50	3	x	x	MS8, S8	600kHz, Tiny Surface Mount Components
200	3 to 26	1.5	LT1317	100	30	x	x	MS8, S8	600kHz Fixed Frequency, Low Ripple
200	3 to 26	1.8	LT1500/01	200	8	x	x	S8, S(14)	Low Spectral Noise, Synchronize to 500kHz
300	3 to 22	1.5	LT1304	120	10	x		S8	1-Cell Li-Ion Supply for Cell Phone Power Amp
400	3.3 to 5	1.8	LT1300	120	10	x	x	N8, S8	155kHz, Selectable 3.3V/5V
500	3 to 26	1	LT1308	100	3	x	x	S8	600kHz, 1-Cell Li-Ion to Cell Phone Power Amp
600	3 to 12	2	LT1302	200	15		x	N8, S8	220kHz, 2A Switch Current for Cell Phone Power Amp
1A	3 to 26	2.5	LT1308	100	3	x	x	S8	Single Li-Ion to 3.3V or 5V/1A

*Fixed and Adjustable Versions

SEPIC and Buck/Boost Conversion, 3.3V from Three Cells, etc.

- "Single-Ended Primary Inductance Converter"
- Works with Boost Switching Regulators
- 2 Cells-to-2V, 4 Cells-to-5V, etc.
- 75% Typical Efficiency, to 90% with MOSFET Post Regulator (*Design Notes 109 and 110*)
- Uses Off-the-Shelf, Small Dual-Wound Inductors

Li-Ion to 3.3V SEPIC DC/DC Converter



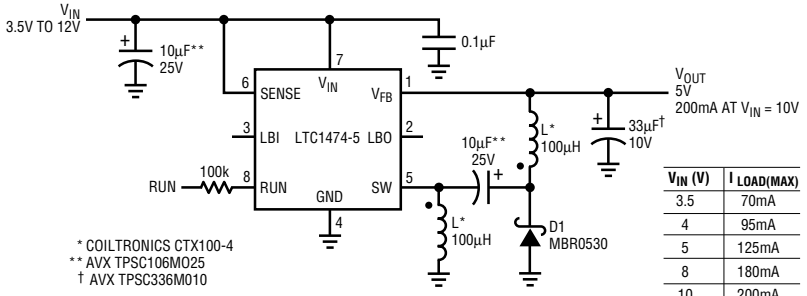
C1, C2: AVX TAJA226M010R
C3: AVX 1206YC105 (X7R)
D1: MOTOROLA MBR0520
L1, L2: MURATA LQH3C4R7M24

High Efficiency Step-Down Switching Regulators (Internal Switch)

LTC1474/LTC1475: High Efficiency, 10μA Supply Current

- Very Low Standby Current: 10μA Typical (No Load While Maintaining Output Voltage)
- On-Chip 1.4Ω MOSFET Power Switch
- 3V to 18V V_{IN} Range, to 300mA Output
- Programmable Peak Inductor Current
- Burst Mode Operation for Light Loads
- Logic-Controlled or Push-Button Shutdown
- Tiny 8-Lead MSOP and SO Packages

5V Buck-Boost Converter

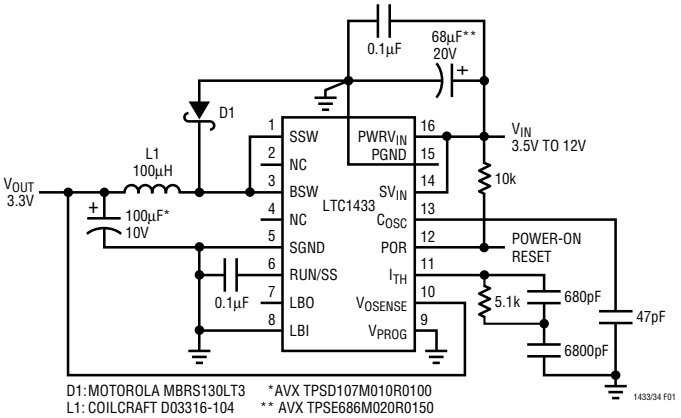


V_{IN} (V)	$I_{LOAD(MAX)}$
3.5	70mA
4	95mA
5	125mA
8	180mA
10	200mA
12	225mA

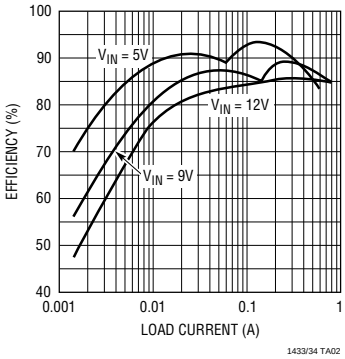
LTC1433/LTC1434: High Efficiency, Low Spectral Noise

- Fixed Frequency PWM Operation with Adaptive Power™ Mode
- High Efficiency to 93%, >80% from 3mA to 450mA
- Synchronize to 700kHz
- Up to 450mA Output
- Power-On Reset
- Shutdown Current: 15μA

High Efficiency Step-Down Converter



LTC1433 Efficiency for V_{OUT} = 3.3V



High Efficiency Step-Down Switching Regulators

I_{OUT} (mA)	V_{OUT} (V)	V_{IN} (V)	Device	I_Q (μA)	I_{SD} (μA)	Low Batt	Burst Mode	Peak Efficiency	Package	Comments
300	3.3, 5, Adj	3 to 18	LTC1474	100	6	x	x	92%	MS8, S8	High Efficiency over Wide Load Range
300	3.3, 5, Adj	3 to 18	LTC1475	100	6	x	x	92%	MS8, S8	As LTC1474, with Push-Button On/Off
400	3.3, 5, Adj	4 to 18.5	LTC1174	130	1	x	x	94%	N8, S8	Few External Parts, Low Dropout
425	3.3, 5, Adj	4 to 18.5	LTC1574	130	2	x	x	94%	S(16)	Minimum Parts Count, Internal Shottky
450	3.3, 5, Adj	3 to 13.5	LTC1433	470	15	x		93%	GN(16)	Current Mode, Constant 700kHz
450	3.3, 5, Adj	3 to 13.5	LTC1434	470	15	x		93%	GN(16)	As LTC1433, Phase-Lockable
500	Adj	2.5 to 6	LTC1626	165	0.5	x	x	95%	S(14)	Low $R_{DS(ON)}$ Switch, Single-Cell Li-Ion
700	Adj	2.65 to 8.5	LTC1627	250	15		x	95%	S8	Fixed 350kHz, Synchronous, Undervoltage Lockout

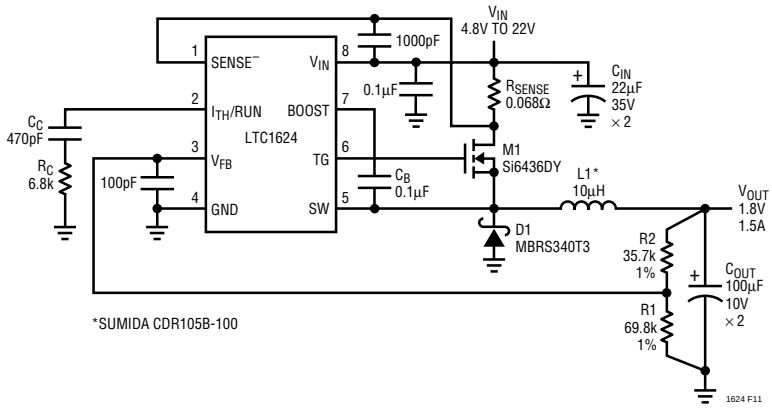
Package Codes: G = SSOP (0.209" Wide), GN = Narrow SSOP (0.150"), GW = Wide SSOP (0.300"), MS = MSOP, N = Plastic DIP, R = Plastic DD, S = Narrow Small Outline (SO), T = Plastic TO-220

High Efficiency Step-Down Switching Regulator Controllers

LTC1624:
High Efficiency SO-8 N-Channel Controller

- N-Channel MOSFET Drive
- Boost, Step-Down, SEPIC and Inverting Configurations
- Wide Input and Output Range
- Fixed Frequency, Current Mode Operation
- Burst Mode Operation for Light Load Currents
- Low Dropout Operation: 95% Duty Cycle

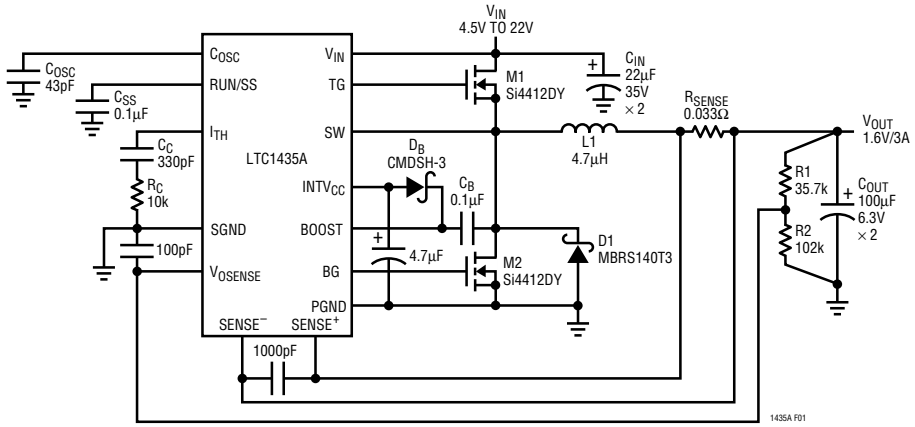
Wide Input Range 1.8V/1.5A Converter



LTC1435 Series:
Fixed Frequency Synchronous

- Low Loss N-Channel MOSFET Drive
- 50kHz to 400kHz Fixed Frequency
- Tight Regulation with Fast Load Transitions
- Single- and Dual-Output Versions
- Up to Four Outputs Possible
- Wide V_{IN} Range: 3.5V to 36V
- Burst Mode Operation at Light Loads

High Efficiency Step-Down Converter

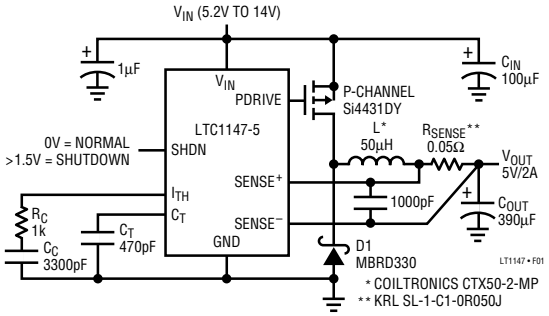


Device	V_{IN} Range (V)	Sync/ Nonsync	Outputs	Burst Mode	Low Batt	I_Q (µA)	I_{SD} (µA)	Peak Efficiency	Package	Features and Applications
LTC1435 Family (Constant Frequency Synchronous, Ultrahigh Efficiency, Wide Input Voltage)										
Single Converter										
LTC1435	3.5 to 36	Sync	1.19V to 9V	x		260	16	97%	G, S(16)	Ultrahigh Efficiency, to 99% Duty Cycle
LTC1436	3.5 to 36	Sync	1.19V to 9V	x	x	260	16	97%	GN(24)	2.9V/5A with 5V Auxiliary Output
LTC1437	3.5 to 36	Sync	1.19V to 9V	x	x	260	16	97%	G(28)	2.5V/5A Adjustable Output with 5V Auxiliary Output
LTC1624	3.5 to 36	Nonsync	1.19V to 30V	x		550	16	93%	S8	Boost, SEPIC, Step-Down and Inverting Regulator
LTC1625	3.7 to 36	Sync	1.19V to V_{IN}	x		500	15	98%	G, N, S(16)	No Sense Resistor, Highest Efficiency, Few Externals
Dual Converters										
LTC1438	3.5 to 36	Sync	1.19V to 9V	x	x	320	16	97%	G(28)	Dual 5V/3V, 400kHz, Low Dropout
LTC1439	3.5 to 36	Sync	1.19V to 9V	x	x	320	16	97%	G, GW(36)	5V/3A, 3.3V/3.5A and 12V/200mA Regulator
LTC1538	3.5 to 36	Sync	1.19V to 9V	x		320	70	97%	G, GW	Like LTC1438/LTC1439 Except with 5V Linear Regulator
LTC1539	3.5 to 36	Sync	1.19V to 9V	x	x	320	70	97%	G, GW	Active in Shutdown Mode
LTC1148 Family (Very High Efficiency, Burst Mode, Very Low Power)										
Single Converter										
LTC1147	3.5 to 16	Nonsync	3.3V, 5V, Adj	x		160	10	93%	N, S8	Very High Efficiency over Three Decades of Output
LTC1148	3.5 to 20	Sync	3.3V, 5V, Adj	x		160	10	95%	N, S(14)	To 250kHz, Programmable Current
LTC1149	4 to 60	Sync	3.3V, 5V, Adj	x		600	135	95%	N, S(16)	Wide Input Voltage Range, 48V Operation
LTC1159	4 to 60	Sync	3.3V, 5V, Adj	x		200	15	95%	G(20), S(16)	Good Transient Response, Drives Logic Level MOSFETs
LTC1266	3.5 to 20	Sync	3.3V, 5V, Adj	x	x	170	25	95%	S(16)	To 400kHz, N-Channel or P-Channel Drive
Dual Converters										
LTC1142	4 to 20	Sync	3.3V/5V, Adj	x		320	20	95%	G(28)	Low Dropout, Programmable Operating Current
LTC1143	3.5 to 16	Nonsync	3.3V/5V, Adj	x		320	20	93%	S(16)	Dual 5V/3.3V Step-Down Converter
LTC1267	4 to 40	Sync	3.3V/5V, Adj	x		320	15	95%	G(28)	Drives Complementary Power MOSFETs

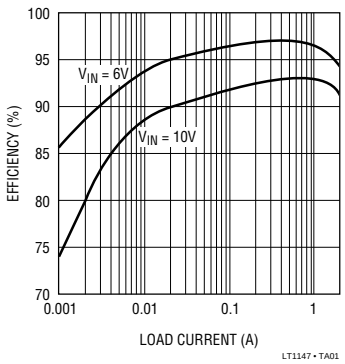
LTC1148 Series: Ultrahigh Efficiency with Burst Mode

- >95% Efficiency Possible, 90% over Three Decades of Output Current
- Current Mode for Good Line Rejection
- Single- and Dual-Output Versions (See Table)
- Synchronous and Nonsynchronous Versions
- Adaptive Nonoverlap Gate Drives
- 160µA Standby Current at Light Loads

High Efficiency Step-Down Converter



LTC1147-5 Efficiency



Positive-to-Negative Voltage Converters

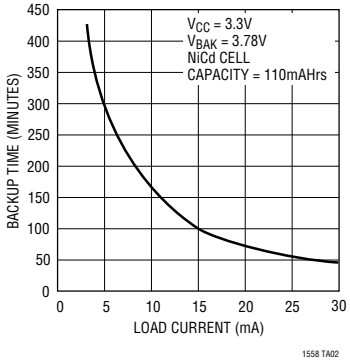
I_{OUT} (mA)	$-V_{OUT}$ Range (V)	V_{IN} (V)	Device	I_Q (µA)	I_{SD} (µA)	Package	Comments
75	3 to 30	2 to 30	LT1107-5	300		S8	Only 3 External Parts, Auxiliary Gain Block
100	3 to 26	1.5 to 12	LT1316	33	3	MS8, S8	LCD Bias from Two Cells
200	3 to 24	1 to 6	LT1614	1mA	10	MS8, S8	600kHz Fixed, Ceramic Capacitors
235	3 to 12	4 to 12.5	LTC1574	130	2	S(16)	Minimum Parts Count, to 200kHz, Internal Schottky
240	3 to 12	3.5 to 12	LTC1474	100	6	MS8, S8	High Efficiency over Wide Load Range
250	3 to 26	2 to 30	LT1111	300		S8	With Multipurpose Auxiliary Gain Block
255	3 to 12	4 to 13.5	LTC1174	130	2	S8	Fixed 5V, 3.3V Versions, to 600mA
420	2 to 12	3.5 to 7.5	LTC1433	470	15	G(20)	Current Mode, Constant 700kHz
500	2.5 to 35	2.7 to 30	LT1373	1mA	12	S8	250kHz Fixed Frequency, Regulates Positive or Negative
500	3 to 20	5.5 to 25	LT1376	2.5mA	20	N, S8, S(16)	Use LT1507 for 4V to 15V Inputs, 500kHz, Synchronizes to 1MHz
1A	4 to 10	3.5 to 20	LTC1148	160	10	S(14)	External MOSFETs, High Efficiency, Synchronous
1.8A	3 to 20	5.5 to 25	LT1374	2.5mA	20	R7, S8, T7	Use LT1506 for 4V to 15V Inputs, 500kHz, Synchronizes to 1MHz
2A	5 to 22	3.5 to 36	LTC1624	550	16	S8	200kHz, Wide Input and Output Range

Battery Backup Controllers and Regulators

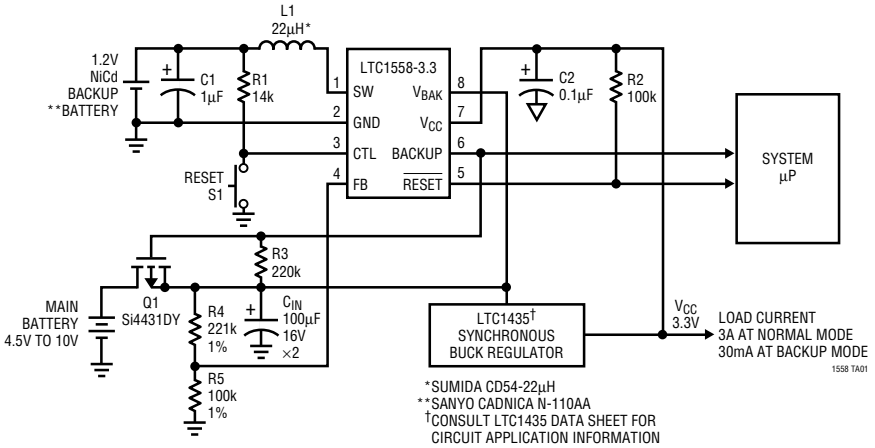
LTC1558: Battery Backup Controller

- Complete Backup Battery System
- Generates Adjustable Backup Voltage from a Single 1.2V Button Cell
- Smart NiCd Charger Minimizes Recharge Time and Maximizes System Efficiency
- Short-Circuit and Thermal Limiting Protection
- SSOP and SO Packages

Backup Time vs 3.3V Output Load Current



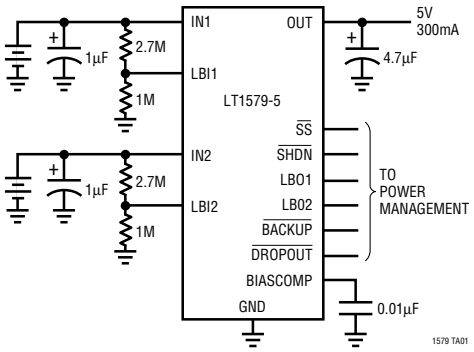
Battery Backup System from a Single Button Cell



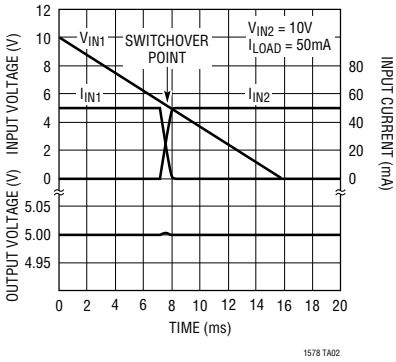
LTC1579:
Dual Input Battery Backup Regulator

- Uninterruptible Output from Two Inputs
- Fixed or Adjustable Output from 1.5V to 20V
- Low Dropout Voltage: 0.4V
- Two Low-Battery Comparators
- Remove, Recharge and Replace Batteries Without Loss of Regulation
- Shutdown Mode: 7μA

5V Dual Battery Supply



Automatic Input Switching

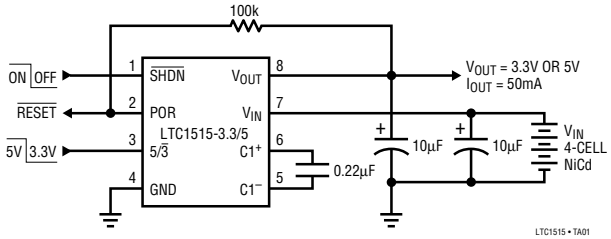


Inductorless DC/DC Converters

Innovation in switched-capacitor converter design has created very useful circuits for space constrained, low power applications. New circuits:

- **LTC1514/LTC1515:** Step-Up/Step-Down with Only Three Small Capacitors and One SO-8 IC
- **LTC1517/LTC1522:** Ultralow Power, Fixed Outputs in SOT-23, MSOP-8 and SO-8

Programmable 5V/3.3V Power Supply with Power-On Reset



Switched-Capacitor DC/DC Converters (No Inductors)

Device	V_{IN} Range (V)	Outputs	I_{OUT}* (mA)	Step Up	Step Down	Pos-Neg	Burst Mode	I_Q** (μA)	I_{SD}** (μA)	Package	Application Examples or Features
Regulated											
LTC1517	2.7 to 5	3.3V, 5V	20	x	x		x	6		SOT23-5	800kHz, SOT-23, Short-Circuit/Thermal Protected
LTC1522	2.7 to 5	5V	20	x				6	1	MS8, S8	Micropower Regulated 5V Charge Pump
LTC1516	2 to 5	5V	50	x				12	1	S8	2 Cell-to-5V, Doubler or Tripler, 600kHz
LTC1515	2 to 10	3V, 3.3V, 5V, Adj	50	x	x	x		60	1	S8	650kHz, Power-On Reset, Fault Protected
LTC1514	2 to 10	3.3V, 5V	50	x	x			60	10	S8	650kHz, Soft Start, Fault Protected, Low Battery
LT1054	3.5 to 15	Adj	100	x		x		2.5mA		S8, S(16)	Inverter/Doubler, Low Dropout, Synchronizable
LTC1555	2.7 to 10	3V, 5V, V_{IN}	20	x	x			60	1	G(16)	SIM Power Supply and Level Translator
LTC1556	2.7 to 10	3V, 5V, V_{IN}	20	x	x			60	1	GN(20)	LTC1555 with Auxiliary LDO Regulator/Switch
LTC1262	4.75 to 5.5	12V	30	x				500	0.5	N8, S8	Byte-Wide Flash Memory
LTC1263	4.75 to 5.5	12V	60	x		x		300	0.5	S8	Double Byte-Wide Flash Memory
Positive-to-Negative Inverters											
LTC1261	3 to 8	–1.25V to –8V	15			x		600	5	S8, S(14)	Adj or Fixed –3.5V, –4V, –4.5V, –5V; Power Valid Output
LTC1429	3 to 8	–1.25V to –8V	12			x		600	0.2	S8, S(14)	Clock Sync, Fixed –3.5V, –4V, –4.5V, –5V, Power Valid
LTC1550	4.5 to 6.5	–4.1V	10			x		4mA	1	S8	900kHz, GaAs Transmitter FET Bias
LTC1551	4.5 to 6.5	–4.1V	10			x		4mA	1	S8	LTC1550 with Active High Shutdown Pin
Unregulated											
LTC1044A	1.5 to 12	1.5V to 12V	20	x	x	x		60	1.5	S8	Invert, Double, Divide, Multiply, Split; 98% Efficiency
LTC1144	2 to 18	–2V to –18V, ±15V	20	x		x		1.6mA	8	S8	Wide Input Range with Shutdown, 93% Efficiency Typ
LTC1046	1.5 to 6	–5V, ±5V	50	x	x	x		165		S8	Invert, Double, Divide, Split; 95% Minimum Efficiency
LTC660	1.5 to 5.5	5V to 11V, –1.5V to –5V	100	x		x		80		S8	88% Efficiency at 100mA, 6.5Ω R_{OUT}

*Guaranteed values, higher under some conditions **Typical Values