RC5010

Step-up Regulator for Notebook PCs

Features

- High efficiency – 85% typical
- Low quiescent current – 215 µA
- Adjustable output – 1.3V to 30V
- High switch current – 200 mA
- Bandgap reference – 1.31V
- Accurate oscillator frequency – ±10%
- Remote shutdown capability
- Low battery detection circuitry
- Low component count
- 8 pin SOIC

Applications

- Notebooks, sub-notebooks & PDAs
- LCD panels

Functional Description

The RC5010 monolithic IC is a low power switch mode regulator designed for notebook and sub notebook power supply applications. This DC-to-DC converter IC provides all of the active components needed to create supplies for portable computers (load power up to 400 mW, or up to 10W with an external power transistor). Contained internally are an oscillator, switch, reference, comparator, and logic, plus a discharged battery detection circuit.

The RC5010 can be used in PCMCIA Flash Memory cards, RF LAN cards, etc. where a non-standard voltage supply is needed.

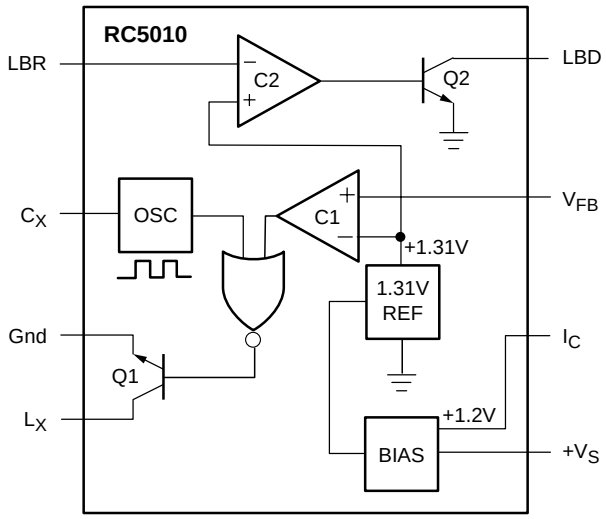
The regulator can achieve 85% efficiency in most applications while operating over a wide supply voltage range, 2.2V to 30V, at a very low quiescent current drain of 0.2mA, and 2µA in shutdown mode.

The standard application circuit requires seven external components for step-up operation: an inductor, a steering diode, three resistors, a low value timing capacitor, and an electrolytic filter capacitor. The combination of low supply current, small package, and ease of application makes the RC5010 adaptable to a wide range of battery operated notebook computers and PDAs.

The RC5010 is most suited for single ended step-up ($V_{OUT} > V_{IN}$) circuits because the NPN internal switch transistor is referenced to ground.

With some optional external components the application circuit can be designed to display when the battery voltage falls below a predetermined level; the application can flag low at one level and then shut itself off after the battery decays to a second level. See the applications section for these and other applications.

Block Diagram



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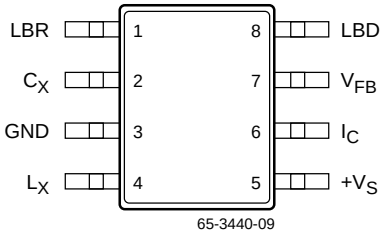
Pin Assignments



Pin Descriptions

Pin Name	Pin Number	Function
LBR	1	Low Battery (Set) Resistor
C_X	2	Timing Capacitor
GND	3	Ground
L_X	4	External Inductor
$+V_S$	5	+Supply Voltage
I_C	6	Reference Set Current
V_{FB}	7	Feedback Voltage
LBD	8	Low Battery Detector Output

Absolute Maximum Ratings

beyond which the device may be damaged[1]

Parameter	Min.	Typ.	Max.	Units
Supply Voltage (without external transistor)			30	V
$P_D T_A$ < 50°C			300	mW
Operating Temperature	0		70	°C
Storage Temperature	-65		150	°C
Junction Temperature			125	°C
Switch Current (peak)			200	mA
For T_A > 50°C Derate at 4.2mW/°C				

Note:

1. Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if Operating Conditions are not exceeded.

Operating Conditions

Parameter		Min.	Typ.	Max.	Units
θ_{JA}	SO8 thermal resistance		240		°C/W

DC Electrical Characteristics

$+V_S$ = +6.0V, I_C = 5.0 µA and T_A = +25°C unless otherwise noted.

Parameter		Conditions	Min.	Typ.	Max.	Units
$+V_S$	Supply Voltage		2.2		30	V
V_{REF}	Reference Voltage (internal)		1.24	1.31	1.38	V
I_{SY}	Supply Current	Measured at Pin 5 I_4 = 0		215	300	µA
I_{LBD}	Low Battery Detect Output Current Drive	V_8 = 0.4V, V_1 = 1.1V	500	1500		µA
T_C	Reference Set Current		1.0	5.0	50	µA
I_{CO}	Switch Leakage Current	V_4 = 30V		0.01	5.0	µA
I_{SO}	Supply Current (disabled)	$V_C \leq$ 200mV		0.1	5.0	µA
I_1	Low Battery Detect Bias Current	V1 = 1.2V		0.7		µA
I_{CX}	Capacitor Charging Current			8.6		µA
$+V_{THX}$	Capacitor Threshold Voltage +			1.4		V
$–V_{THX}$	Capacitor Threshold Voltage –			0.5		V
I_{FB}	Feedback Input Current	V7 = 1.3V		0.1		µA

$+V_S$ = +6.0V, I_C = 5.0 µA over the full operating temperature range unless otherwise noted.

Parameter		Conditions	Min.	Typ.	Max.	Units
$+V_S$	Supply Voltage		2.6		30	V
V_{REF}	Reference Voltage (internal)		1.20	1.31	1.42	V
I_{SY}	Supply Current	Measured at Pin 5 I_4 = 0		235	350	µA
I_C	Reference Set Current		1.0	5.0	50	µA
I_{CO}	Switch Leakage Current	V_4 = 30V		1.0	30	µA
I_{SO}	Supply Current (Disabled)	V_C = ≤ 200 mV		1.0	30	µA
I_{LBD}	Low Battery Detect Output Current Drive	V_8 = 0.4V, V_1 = 1.1V	500	1200		µA

AC Electrical Characteristics

$+V_S$ = +6.0V, I_C = 5.0 µA and T_A = +25°C unless otherwise noted.

Parameter		Conditions	Min.	Typ.	Max.	Units
I_{SW}	Switch Current	V4 = 400mV	100	200		mA
eff	Efficiency			85		%
	Line Regulation	0.5 V_{OUT} < V_S < V_{OUT}		0.04	0.5	%V_O
L_1	Load Regulation	V_S = 0.5 V_{OUT} P_L = 150mW		0.2	0.5	%V_O
F_O	Operating Frequency Range[1]		1.0	25	75	kHz
	Oscillator Frequency Tolerance			±10		%

Note:

1. Guaranteed by design.

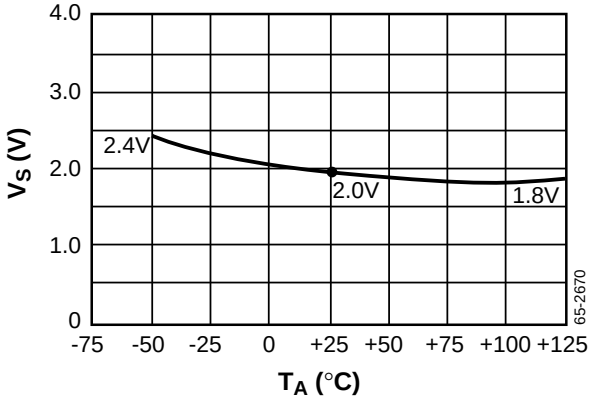
AC Electrical Characteristics (continued)

$+V_S$ = +6.0V, I_C = 5.0 μA and over the full operating temperature range unless otherwise noted.

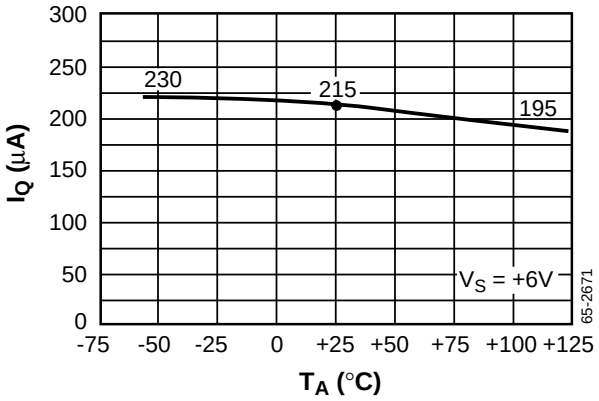
Parameter		Conditions	Min.	Typ.	Max.	Units
	Oscillator Frequency Temperature Drift			±200		ppm/°C
	Line Regulation	0.5 V_{OUT} < V_S < V_{OUT}		0.5	1.0	%V_O
L_1	Load Regulation	V_S = 0.5 V_{OUT} P_L = 150mW		0.5	1.0	%V_O

Typical Performance Characteristics

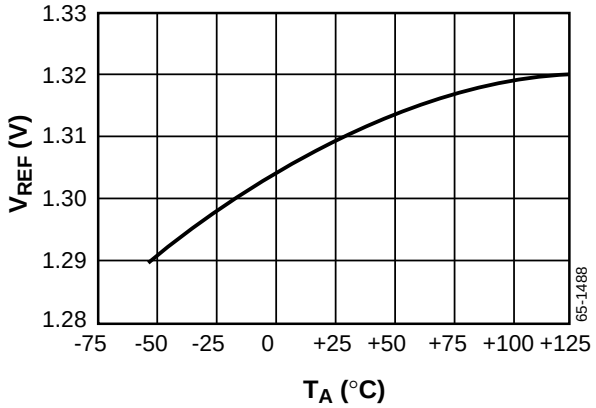
Minimum Supply Voltage vs. Temperature



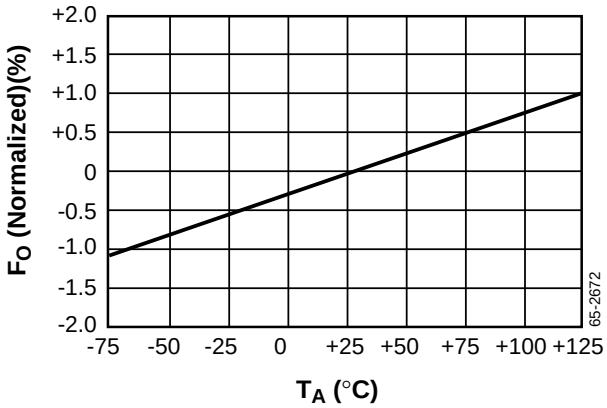
Quiescent Current vs. Temperature



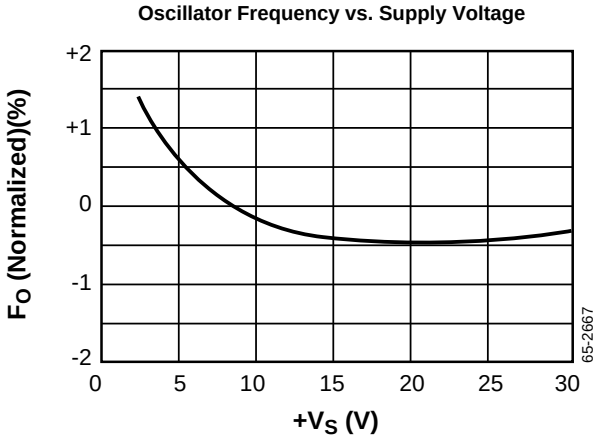
Reference Voltage vs. Temperature



Oscillator Frequency vs. Temperature



Typical Performance Characteristics (continued)



Applications Discussion

LCD Driver Application

Many hand-held electronic devices require a regulated output voltage from a battery supply source. In today's notebook computers, the battery voltage is a function of load, charge conditions, and battery age, and can vary from 6 Volts to 18 Volts. The standard voltages found in a notebook computer are 3.3V, 5V, and 12V. LCD displays require a higher voltage which is adjustable under light conditions, temperature and LCD aging effects. A user may adjust the LCD voltage conditions for better readability and screen perception of the display. This adjustment takes places from 18V to 30V. Figure 1 is a schematic based on the RC5010 step-up converter. The switching frequency of 20 kHz allows to transfer the energy on the output by stepping up the voltage from 7V (or any higher voltage) to a regulated output voltage. LCDs use current from few mA to 30mA. The Power FET isolates the output stage from leaking current when the circuit is switched in power down mode. Under power down mode, the only current used by this application is the leakage current flowing through 1M Ohm resistor connected to the switch or open collector gate. When "ON," the voltage present at pin 6 is 1.4V and will not pull the open collector (drain) to any dangerous breakdown voltage for the logic driver. Figures 2 and 3 represent the efficiency versus the output voltage, load and input voltage. This application can be used also in a PDA hand held device.

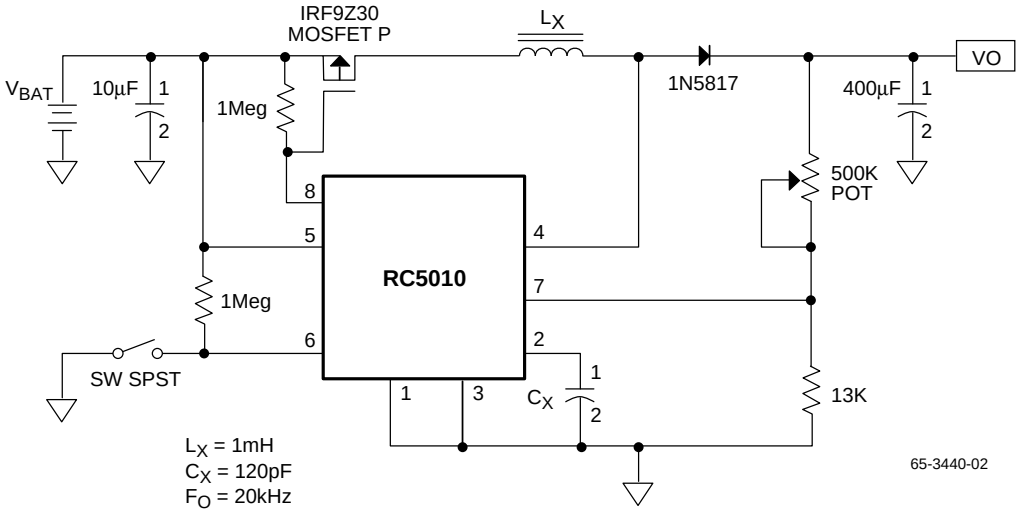


Figure 1. Adjustable Converter for Positive LCD Display Applications

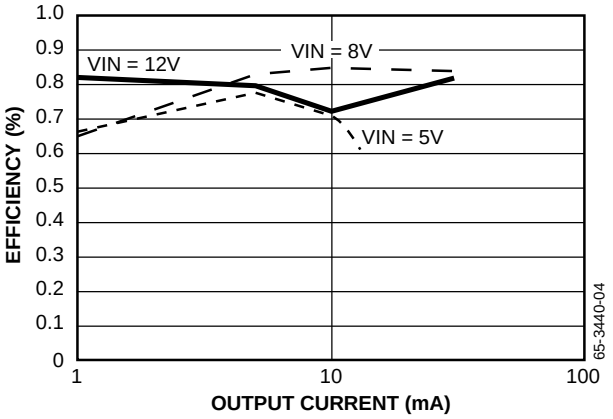


Figure 2. Efficiency vs. Output Current, V_{OUT} = 18V

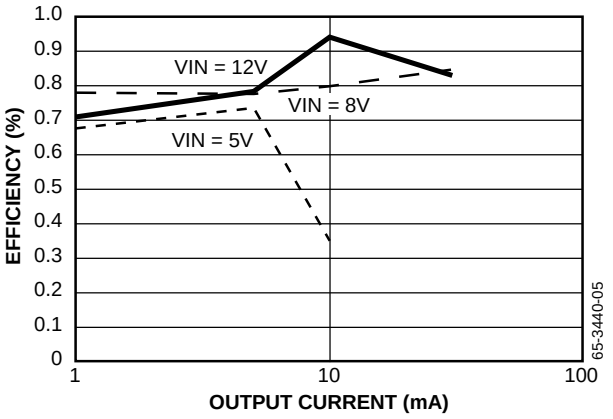


Figure 3. Efficiency vs. Output Current, V_{OUT} = 30V

5V to 12V Step-up Converter for Flash Memory Cards and PCMCIA Applications

Figure 4 is a fixed voltage regulator capable of transfering power from a 5V input voltage (or any other 3.3 to 9V battery operated device) to 12V precise voltage. A 12V regulated supply is required by notebooks on board subsystems, PCMCIA flash memory cards, and other applications found in portable equipment. RF LANs, modem-fax cards, etc. may use this device to set the proper voltage from an unregulated battery. Figures 5, 6, and 7 represent the efficiency versus the output voltage, load and input voltage.

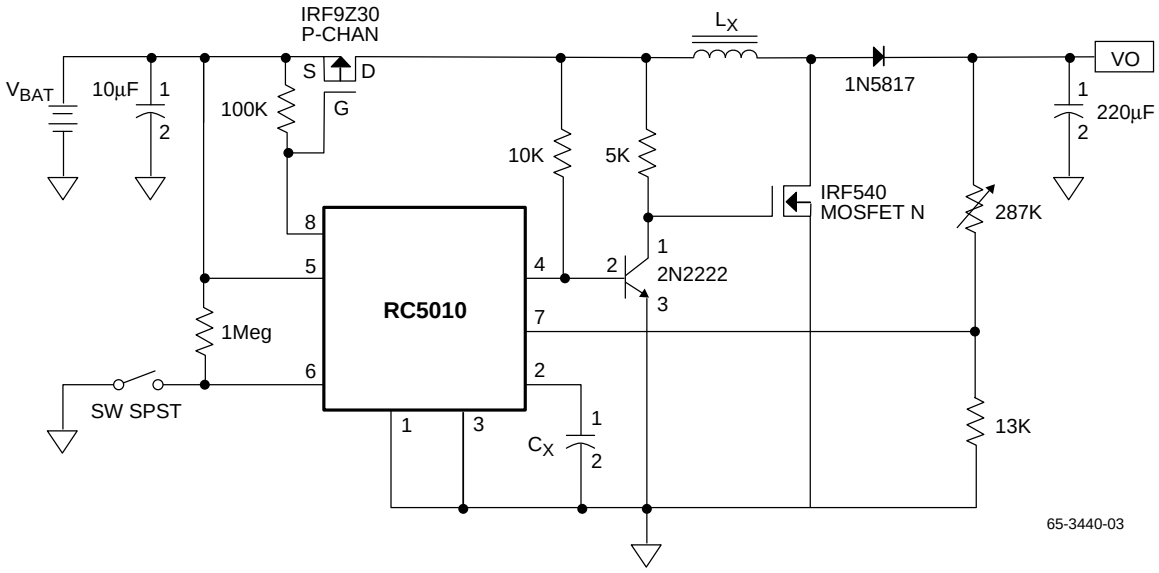


Figure 4. Fixed 12V Converter for Notebook and PDA Applications

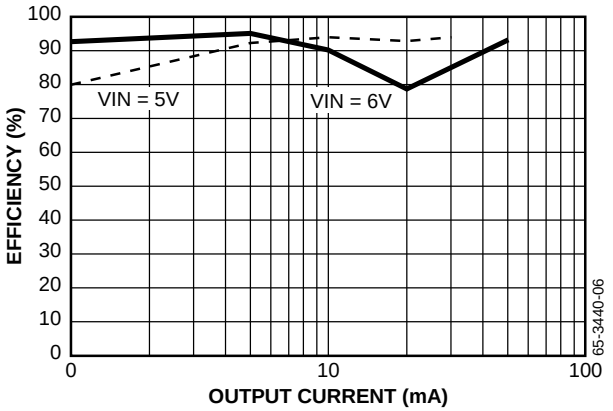


Figure 5. PCMCIA Application V_{OUT} = 12V, Efficiency vs. Output Current (No External Components)

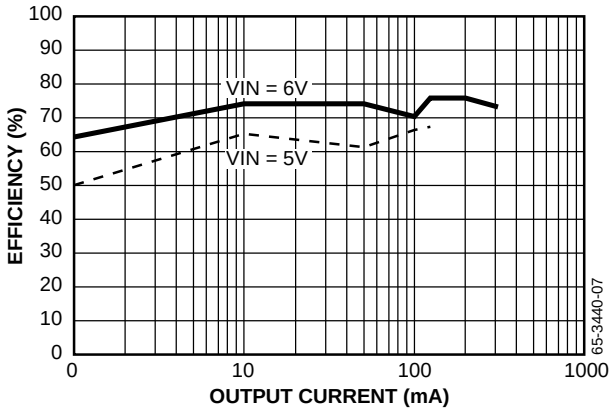


Figure 6. PCMCIA Application (External Components) V_{OUT} = 12V, Efficiency vs. Output Current

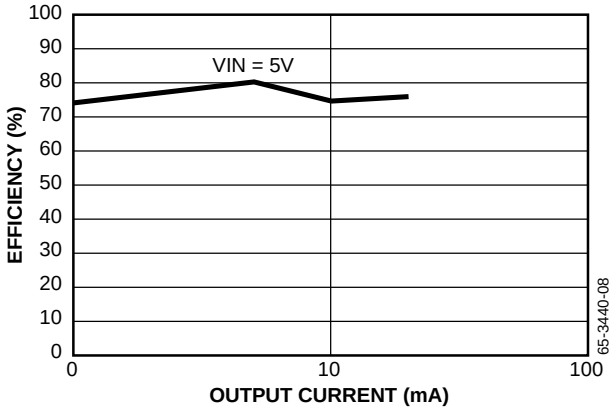


Figure 7. Efficiency vs. Output Current, VOUT = 12V

Notes:

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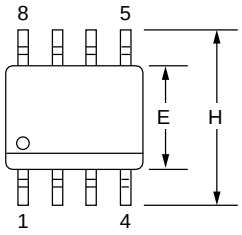
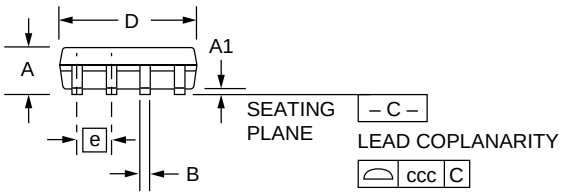
Mechanical Dimensions – 8-Lead SOIC Package

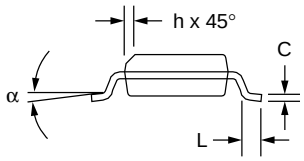
Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.053	.069	1.35	1.75	
A1	.004	.010	0.10	0.25	
B	.013	.020	0.33	0.51	
C	.008	.010	0.20	0.25	5
D	.189	.197	4.80	5.00	2
E	.150	.158	3.81	4.01	2
e	.050 BSC		1.27 BSC		
H	.228	.244	5.79	6.20	
h	.010	.020	0.25	0.50	
L	.016	.050	0.40	1.27	3
N	8		8		6
α	0°	8°	0°	8°	
ccc	—	.004	—	0.10	

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. "D" and "E" do not include mold flash. Mold flash or protrusions shall not exceed .010 inch (0.25mm).
3. "L" is the length of terminal for soldering to a substrate.
4. Terminal numbers are shown for reference only.
5. "C" dimension does not include solder finish thickness.
6. Symbol "N" is the maximum number of terminals.







Ordering Information

Product Number	Temperature Range	Screening	Package	Package Marking
RC5010M	0° to 70°C	Commercial	8-pin Wide SOIC	RC5010M

Raytheon Electronics
Semiconductor Division
350 Ellis Street
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