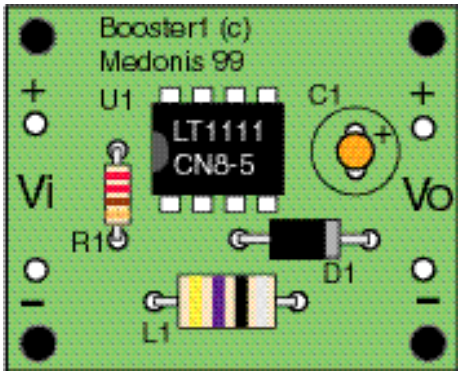
Building and Using the

Battery Booster 5



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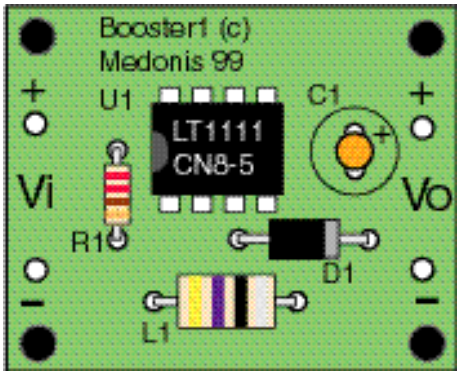

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Instructions for the Battery Booster 5

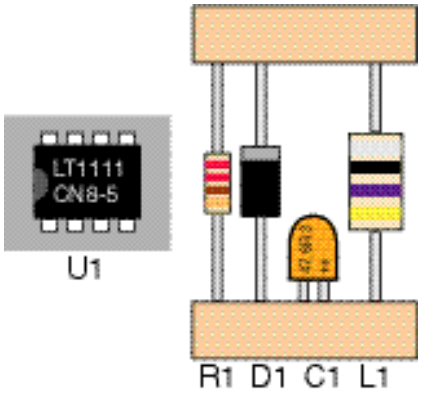
The Battery Booster 5 electronic kit outputs a regulated 5.0 volts when connected to a battery pack of 2, 3, or 4 cells[1]. Your digital circuit will continue operation even as the battery pack voltage has dropped to 2.0 volts[2]. This means much longer run times for your robot or embedded microcontroller project. No longer is it necessary to use separate battery packs for logic and motors, saving weight and money.

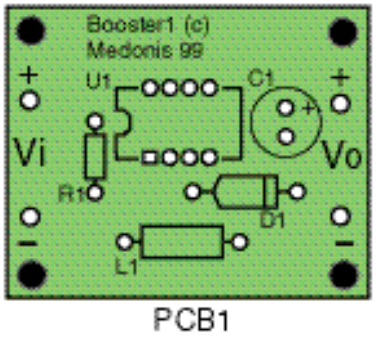
This boost circuit allows using two or three AA cells instead of a 9V battery for powering an embedded microcontroller such as the BASIC Stamp from Parallax. Two or three AA cells take up the same space and weight as a 9V battery, but AA cells can have up to 5-10 times the current capacity. For example, compare a 1000mAh NiCad AA to a 120mAh NiCad 9V battery (from Digi-Key Electronics catalog (800) 344-4539). Of course, AAA cells or C or D size cells work just fine with the boost circuit as well.

Kit Contents

The first part in the kit is the manual you are now reading, of course. There are six electronic components[3] in the kit:

U1	LT1111CN8-5, a DC-DC converter integrated circuit (IC) from Linear Technology
R1	220Ω, 5% resistor
D1	1N5818 Schottky diode
C1	47µF tantalum capacitor (note the little + sign that indicates the positive wire)
L1	47µH inductor
PCB1	Printed Circuit Board (the other components are inserted and soldered into this part)





[1] When using 4 alkaline cells, the input voltage is 6.0 volts, and the output voltage of the Battery Booster 5 circuit is 5.5 volts. Input voltages greater than 5.5 volts cause a rise in output voltage equal to input voltage minus 0.5 volts.
[2] Input voltages less than 2.5 volts cause a small drop in the Battery Booster 5 circuit's output voltage. At 2.0 volts input the output is 4.85 volts.
[3] The included components are carefully matched for maximum circuit performance, producing a circuit with the lowest ripple, smallest size, and highest efficiency. This unfortunately means that you cannot substitute, for example, a 1N4007 diode for the 1N5818 Schottky barrier diode included in the kit. The circuit would not operate. Contact Medonis Engineering if any components are missing from the kit.

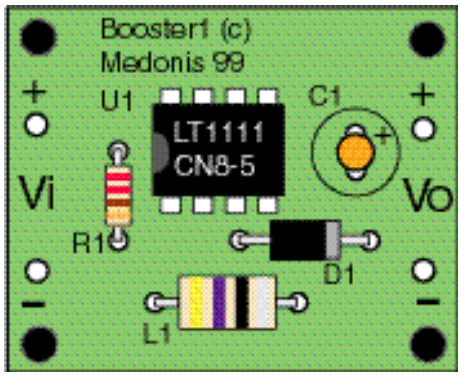
Construction

Construction of the Battery Booster 5 kit is very simple. The circuit needs no adjustment, and there are only five components to solder onto the included printed circuit board (PCB). If you are new to soldering, you might want to review some beginning electronics books that discuss soldering technique or explore some of the online tutorials on soldering such as the one found on the Robot Store's website at www.robotstore.com. In this circuit, make sure not to overheat the integrated circuit when you solder its pins.

SAFETY FIRST! Wear Eye Protection When:
Cutting the excess wire from components. Those wire bits can fly pretty far!
Powering up the circuit for the first time. Capacitor C1 will burn up or explode if installed backwards!

Keeping safety in mind, solder the components to the circuit board following these points:

1. Integrated circuit U1, the LT1111CN8-5, should be inserted as shown in the drawing below.
2. Resistor R1 looks similar to inductor L1. The resistor is the narrower component, and has a color pattern indicating its value: Red Red Brown Gold. R1 can be inserted in either direction.
3. Diode D1 has a gray stripe on it that indicates polarity, and is inserted so the stripe matches with the symbol on the PCB. The correct direction is shown in the drawing below.
4. Capacitor C1 has a small + sign on it that indicates the positive wire, and is inserted to match with the small + sign on the PCB. This would place the printed side of the capacitor AWAY from the integrated circuit U1.
5. Inductor L1 looks like resistor R1, except L1 is thicker in diameter than R1. Like R1, L1 also has a color code: Yellow Purple Black Silver. The inductor L1 is not polarized, you can insert it in either direction.



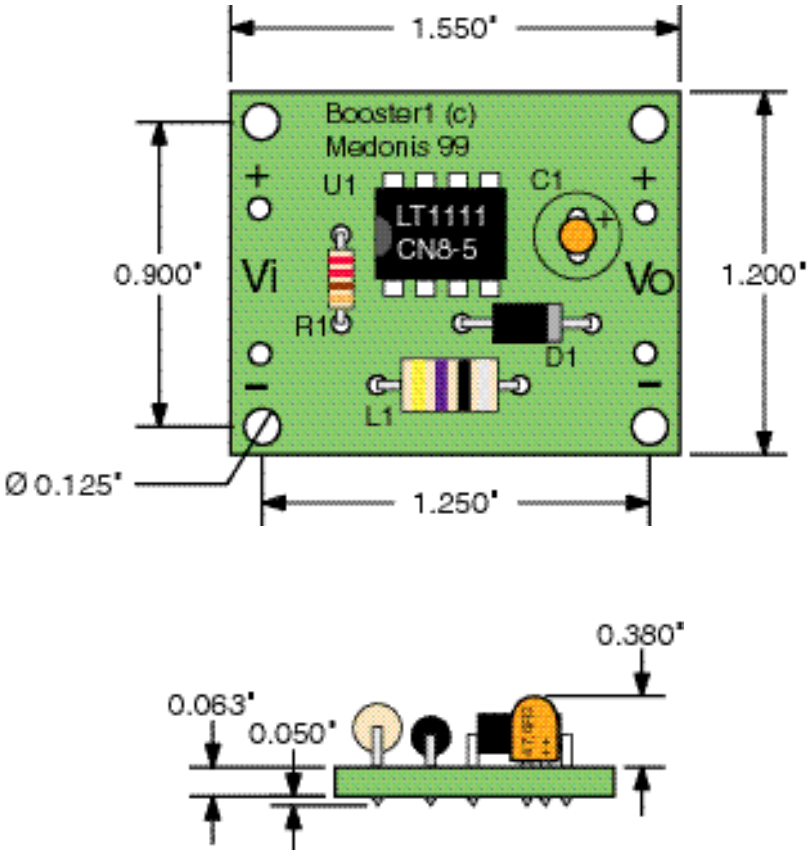
Once you have soldered all of the electronic components to the PCB, double check that the capacitor's + sign matches the + sign on the PCB. The printing on the capacitor will be on the side away from the IC.

Connect a 2, 3, or 4 cell battery pack to the Volts In terminals, Vi, and if you have a voltmeter measure the output voltage at the Volts Out terminals Vo. You should measure about 5 volts, but a measurement as low as 4.85 volts or as high as 5.15 volts is still OK. If the output voltage is correct, then you can connect the Battery Booster 5 to your BASIC Stamp or any circuit that needs 5 volt DC power.

If you have any questions, or a component is missing from the kit, please contact Medonis Engineering at (503) 605-1470 or email at info@medonis.com.

Mechanical Specifications

The Battery Booster 5 PCB has four mounting holes, one at each corner of the board, and these are insulated from the circuit so metal mounting hardware can be used.



Electrical Specifications

Minimum Input Voltage: 2.0 Volts
Maximum Input Voltage: 6.0 Volts
Minimum Output Current: 0.000 Amps
Maximum Output Current: 0.100 Amps

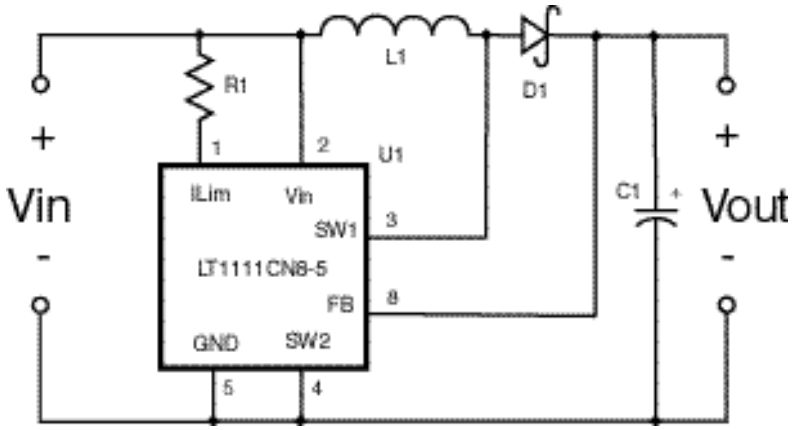
Maximum Output Ripple: 0.150 Volts
Maximum Conversion Efficiency: 85%

Minimum Operating Temperature: 0 degrees Celsius (32 degrees F)
Maximum Operating Temperature: 70 degrees Celsius (158 degrees F)

Circuit Description

The electronic term for the Battery Booster 5 circuit is *DC-DC Converter*. The circuit is built around an integrated circuit from Linear Technology that switches current flow through an inductor to achieve the step up in voltage. Conversion of AC voltage is much easier, of course, but that device is not called *AC-AC converter*, instead is known by the name *Transformer*.

In order to convert DC voltage to a higher value, the circuit uses the electronic characteristics of an inductor. The same characteristics are used in a transformer. The complete Battery Booster 5 circuit is shown in the schematic below. This circuit converts input voltages between 2.0 and 6.0 volts into a regulated 5.0 volt output. This output is capable of supplying up to 100mA of output current[4].



Note that it is the entire circuit that is the DC-DC converter, not the LT1111 by itself. A DC-DC converter, such as the Battery Booster 5, is able to boost voltage mainly because of the nature of an inductor. An inductor is defined as a device that generates a voltage across itself when a change in current flow occurs.

Here is the sequence of events that make the conversion: The LT1111 has an internal 72kHz oscillator switches the SW1 pin to ground and then open again, and this cycling current flow in inductor L1 causes the output voltage to rise. The voltage charges up capacitor C1, and once that voltage reaches 5.0 volts, read at the feedback pin FB on the LT1111, then the LT1111 shuts down the internal oscillator.

As the load connected to Vout draws current, fed from C1, the output voltage drops, and the LT1111 starts up the internal oscillator again to raise the output voltage. This constant process of turning on the oscillator to raise the voltage, and then turning the oscillator off, causes a ripple in the output voltage of up to 150mV. The amount of ripple depends on the load current and the input voltage. The ripple voltage gets higher as the input voltage gets higher, and as the load current gets higher. At lower input voltages, and lower load currents, the ripple voltage is reduced. For example, at an input voltage of 3.0 volts and a load current of 25mA the ripple voltage is 80mV.

Go to the Medonis Engineering web site at www.medonis.com for further information on DC-DC converters and battery technologies. Also, see the Linear Technology web site at www.linear-tech.com for more information on the LT1111 integrated circuit and DC-DC converter circuits.

[4] The maximum output current is limited by the 250mW maximum heat dissipation of the inductor L1. At 100mA of supply current, power dissipated in L1 is 150mW. Currents above 170mA will destroy inductor L1.