

UNIQUE "CHEAP AND DIRTY" CONVERTER
FOR LOW POWER BIAS SUPPLIES
Bill Andreycak

Regulated output voltage is obtained - regardless of input voltage

Most power supply designs use PWM controller ICs and MOSFET switches which require 10 to 15 volt bias supplies for proper operation. A common application problem is to first generate an auxiliary supply within this range. Although simple in many applications, developing this supply with a variable low voltage input can be challenging especially when the input amplitude goes both below and above the desired output voltage. The circuit shown below is a unique, inexpensive solution to this problem.

Basically, the topology is a two transistor flyback (buck-boost) converter which provides a noninverting output polarity. By varying the duty cycle, the output voltage can be either higher or lower than the input amplitude. This attribute makes this approach ideally suited for many widerange input or automotive applications. Likewise, this technique is equally applicable to power factor correction applications. Additionally, the inductor can be operated in either the continuous or discontinuous current modes.

BUCK-BOOST CONVERTER (2 XTOR)

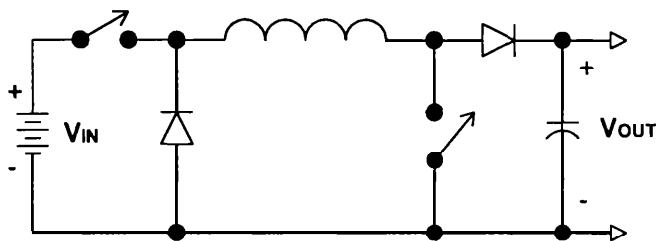


Figure 1.

Implementation of this technique will require a "high side" switch connected to the input voltage (V_{IN}) and a low side switch to ground. Both of these are activated together, placing the inductor across the input supply while the switches are on. At turn off, the inductor is placed across the output capacitor

and the two diodes conduct until the current reaches zero (discontinuous mode) or the next switching cycle is initiated (continuous mode). Inductor voltage and current waveforms are shown at maximum duty cycle for clarity.

INDUCTOR VOLTAGE AND CURRENT

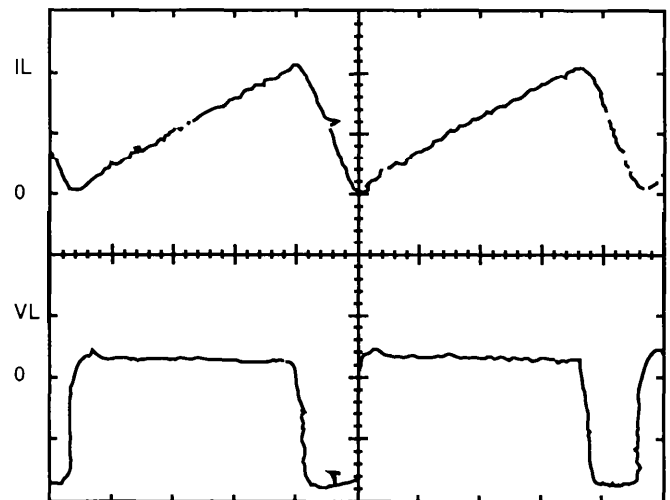


Figure 2.

At first, most PWM controllers may seem to be likely candidates for implementation of this technique. However, only one PWM features the ability to simultaneously switch both outputs together. The UC494A provides this operational mode by grounding its output control (O/C) input. Also limiting the IC selection is the fact that one IC output must go high and the other low each cycle. This is accomplished by connecting each of the UC494A's output collectors and emitters as required.

Switching at 200kHz in this application, the UC494A is programmed by a 9.1 K timing resistor (R_T) and 470 pF capacitor (C_T). High frequency conversion facilitates the use of a small (surface mount) inductor and output storage capacitor. Output voltage is regulated by using the ICs "A" amplifier as the voltage error amplifier. The 15 volt output is divided

down to 5 volts across the 15 K ohm resistor at pin 1 and compared to the reference voltage at pin 14. The 30K ohm resistor to V_{out} can be changed to provide different output voltages if required. Amplifier "B" is not used, but can be configured to provide overcurrent or overvoltage protection if desired. Schottky (1N5820) diodes are used in the

power stage to maximize efficiency. Standard silicon diodes can be substituted in cost sensitive applications with some performance degradation. Efficiency for the 400 mW converter shown in figure 3 is approximately 50% for inputs between 7 and 16 volts and decreases slightly at higher and lower inputs. Consult Unitrode Design Note DN-37 for further information about 5 volt PWM operation.

BUCK BOOST CONVERTER USING THE UC 494A PWM CONTROLLER

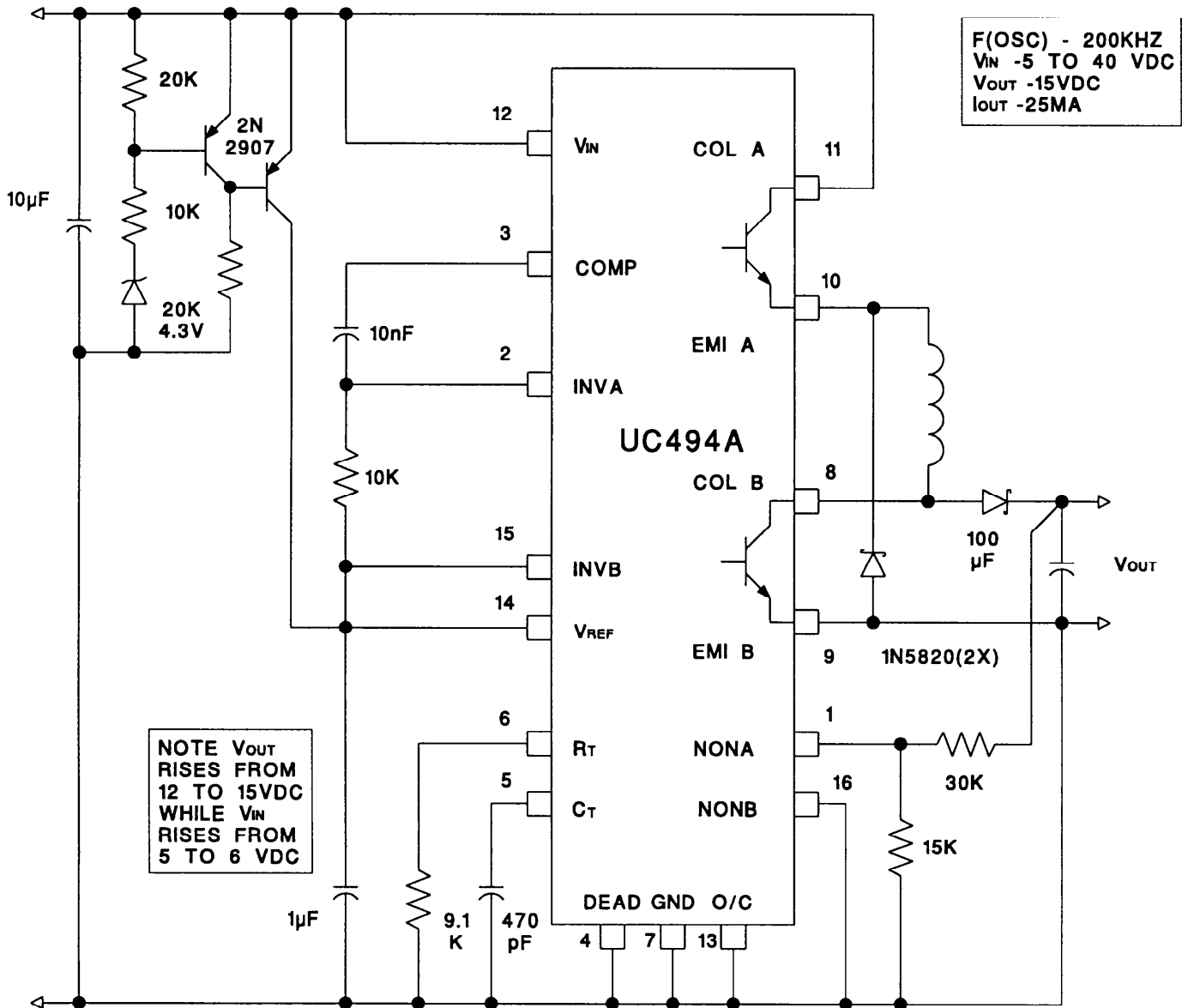


Figure 3.

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.