

## Simple Regulator Provides $\pm 12\text{V}$ from 5V Source

National Semiconductor  
AN-1118  
Michael Shrivathsan  
October 1998



Simple Regulator Provides  $\pm 12\text{V}$  from 5V Source

Many systems require a  $\pm 12\text{V}$  power supply. Typical examples include analog circuits or RS-232 driver power supplies. The  $\pm 12\text{V}$  typically needs to be generated from a 5V system bus. The solutions normally used involve a multiple secondary transformer or multiple switching regulators. These solutions can be complicated, may require custom transformer design and may have poor efficiency and poor regulation. The circuit shown in *Figure 1* is simple, uses only one switching regulator IC, uses a small number of components, and provides good regulation at a high efficiency. Additionally, all the components used in this circuit are off-the-shelf components.

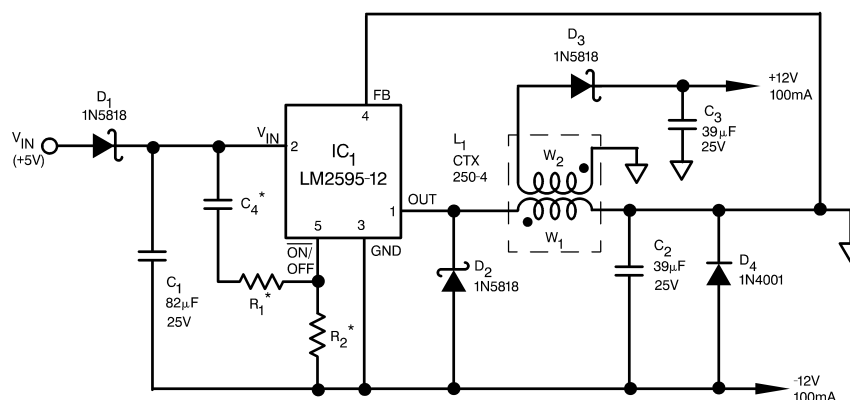
The circuit in *Figure 1* uses an LM2595-12 (buck SIMPLE SWITCHER™) based switching regulator to generate both the +12V and the -12V outputs from 5V input. The LM2595 is configured as an inverting buck-boost converter to obtain the negative output. The positive output is generated using an additional winding in the off-the-shelf inductor (CTX250-4 from Coiltronics) used in this circuit. Only one additional diode ( $D_3$ ) and a capacitor ( $C_3$ ) are needed to generate the positive output.

During the on-time of the switching cycle, the inductor ( $L_1$ ) is charged by applying the supply voltage across the inductor. During this time the output capacitors ( $C_2$  and  $C_3$ ) are supplying the load. During the off-time of the switching cycle, the energy stored in the inductor is transferred to the output capacitors and the loads. The LM2595 is regulated off of the negative output. The positive output is regulated because of

the coupling between the windings of the inductor. The diode  $D_4$  prevents the -12V output from going positive above a diode drop during the turn-on of the circuit. The diode  $D_1$  is used for providing isolation between the output and the input. LM2595 operates at a switching frequency of 150 kHz resulting in small inductor and capacitor sizes.

This circuit was built in the lab using the components shown in *Figure 1*. The -12V output varied between -11.99V and -11.97V under a load variation between 50 mA and 100 mA and a line variation between 4.5V and 5.5V. The +12V output varied between 11.15V and 11.45V under the same conditions. The +12V output is lower than the -12V output because of the voltage divider effect of the leakage inductance and a mismatch in the forward voltage drops of  $D_2$  and  $D_3$ . The efficiency of this circuit varied between 76% and 83% over the line and load variation. The ripple voltage on the +12V and the -12V outputs is less than 1%. A majority of this ripple voltage is due to the ESR (Equivalent Series Resistance) of the output capacitors  $C_2$  and  $C_3$ . The capacitors used in this circuit have an ESR of 0.65Ω. A smaller ripple voltage can be obtained by using lower ESR, higher value output capacitors.

If higher load currents are desired, the LM2596 SIMPLE SWITCHER should be used in the place of LM2595. This will provide up to 275 mA of load current each from the +12V and -12V outputs. Other output voltages are also achievable using LM2596-ADJ versions.



\* Components needed if the 5V supply is current-limited during start-up.

C4: 0.1µF, ceramic  
R1, R2: 47kΩ, 1/4W, 10%

FIGURE 1.

AN100992-1

AN-1118

#### LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

www.national.com

**National Semiconductor Europe**

Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
Italiano Tel: +49 (0) 1 80-534 16 80

**National Semiconductor Asia Pacific Customer Response Group**

Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

**National Semiconductor Japan Ltd.**

Tel: 81-3-5620-6175  
Fax: 81-3-5620-6179