

LM2577 Three Output, Isolated Flyback Regulator

National Semiconductor
 Application Note 777
 Tom Gross
 April 1998



Many voltage regulator applications require multiple outputs, such as a computer's power supply or a regulator used to meet the voltage requirements inside an automobile. Some of these applications require isolation between the regulator's input and output for protection and separate ground specifications. Using this criteria, a LM2577 simple switcher flyback regulator has been designed with multiple (3) outputs and input-to-output isolation. The three outputs are: 1) 5V @ 150 mA, 2) 7.5V @ 100 mA, and 3) -7.5V @ 70 mA. The table below gives the electrical specifications.

The LM2577 flyback regulator uses a 4N27 optocoupler to provide a galvanic isolation. The base resistor of the optocoupler is chosen so that it is large enough (47 kΩ) to supply a minimum base current—which in turn, demands a lower drive current to the optocoupler's diode—but not so large as to produce a pole in the regulator's frequency response. If the pole's frequency is below the regulator loop's crossover frequency, stability problems will occur. Thus, a zero must be developed, requiring extra circuitry, to compensate for the extra pole in the loop.

An LM385 Adjustable Voltage Reference, along with resistors R_{O1} and R_{O2} , set the main output voltage to 5V ±4% by the equation: $V_O = 1.24V (1 + R_{O2}/R_{O1})$. The LM385 supplies a drive current to the optocoupler (about 10 mA) proportional to the output voltage. Due to the high gain of the LM385, the LM2577's error amplifier is bypassed, and the feedback signal is fed directly to the compensation pin. Employing the error amplifier's gain block in the loop would add with the LM385 gain (the optocoupler's gain is around unity) to produce a very large overall loop gain. Such a large loop gain makes the loop too difficult to stabilize—thus the

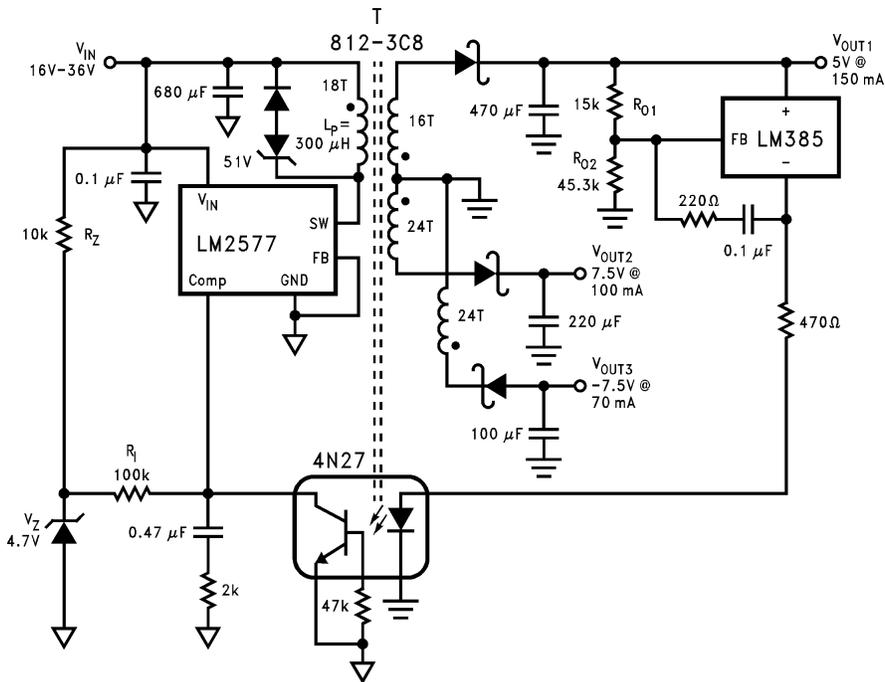
bypassed error amplifier. With the regulator input voltage of 26V and full load on all outputs, the frequency response has a crossover frequency at 1 kHz and phase margin of 90°.

The flyback regulator's mode of operation is continuous, so a large primary inductance ($L_P = 300 \mu H$) is needed for the transformer. Using a Ferroxcube 812E250-3C8 E core, the primary winding requires about 50 turns. With the turns ratios as they are shown on the schematic and the small core size, the transformer windings must be wound tightly so that they fit the core windows. Interlayering the primary winding between the secondary windings improves the transformers coupling.

The zener diode circuit (V_Z, R_Z, R_1) is added to provide the optocoupler transistor with about 20 μA of bias current, on top of the current sourced from the compensation pin (about 7 μA). The isolation resistor, between the compensation pin and the zener diode, needs to be as large as 100 kΩ, or at start-up, the compensation pin will see too large a voltage, turning the power switcher fully on—thus forcing the LM2577 into current limit. Also, to ensure good line regulation, the dynamic impedance of the zener diode must be very good.

Test data for this regulator follows the schematic. Since feedback is taken from Output 1, its load and line regulation are better than that of the other two outputs, which rely on feedback through the transformer coupling. The output ripple voltage of all three outputs is largely dependent on the filter capacitors used, and could be reduced by the use of additional high-quality filter capacitors or an additional L-C filter section.

LM2577 Three Output, Isolated Flyback Regulator

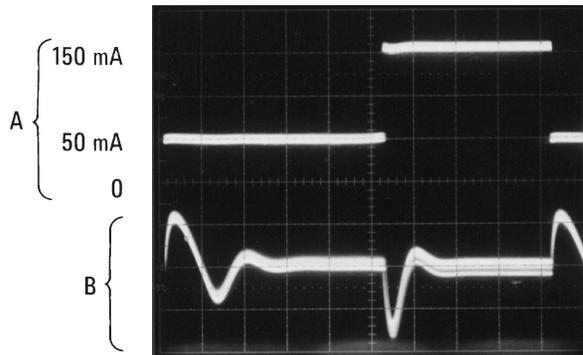


01121701

ELECTRICAL TEST DATA

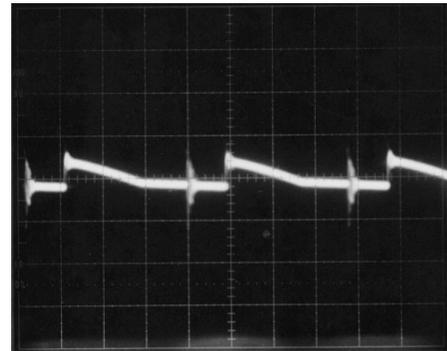
$V_I = 16V-36V$

Output Voltages	Line Regulation ($I_O = \text{Full Load}$)	Load Regulation ($V_I = 26V$)	Output Ripple Voltage ($T_A = 25^\circ C$)
$V_{O1} = 5V$	0.2%	0.04% 30 mA–150 mA	50 mV
$V_{O2} = 7.5V$	0.3%	3% 20 mA–100 mA	50 mV
$V_{O3} = 7.5V$	0.3%	2% 12 mA–70 mA	50 mV



01121702

Load Transient Response
A. Load Current, 50 mA/div
B. Output Voltage Change 50 mV/div (AC-Coupled)
Horizontal: 5 ms/div



01121703

Output Ripple Voltage
20 mV/div (AC-Coupled)
Horizontal: 5 ms/div

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL 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 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 is 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
 Email: support@nsc.com

www.national.com

National Semiconductor Europe
 Fax: +49 (0) 180-530 85 86
 Email: europe.support@nsc.com
 Deutsch Tel: +49 (0) 69 9508 6208
 English Tel: +44 (0) 870 24 0 2171
 Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Response Group
 Tel: 65-2544466
 Fax: 65-2504466
 Email: ap.support@nsc.com

National Semiconductor Japan Ltd.
 Tel: 81-3-5639-7560
 Fax: 81-3-5639-7507