Application Report
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AN-777 LM2577 Three Output, Isolated Flyback Regulator

ABSTRACT

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 these 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.

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1 Overview

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 µH) 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. Interlaying the primary winding between the secondary windings improves the transformers coupling.

The zener diode circuit (V_Z, R_Z, R_I) 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 a voltage that is too large, turning the power switch 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. Because 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.

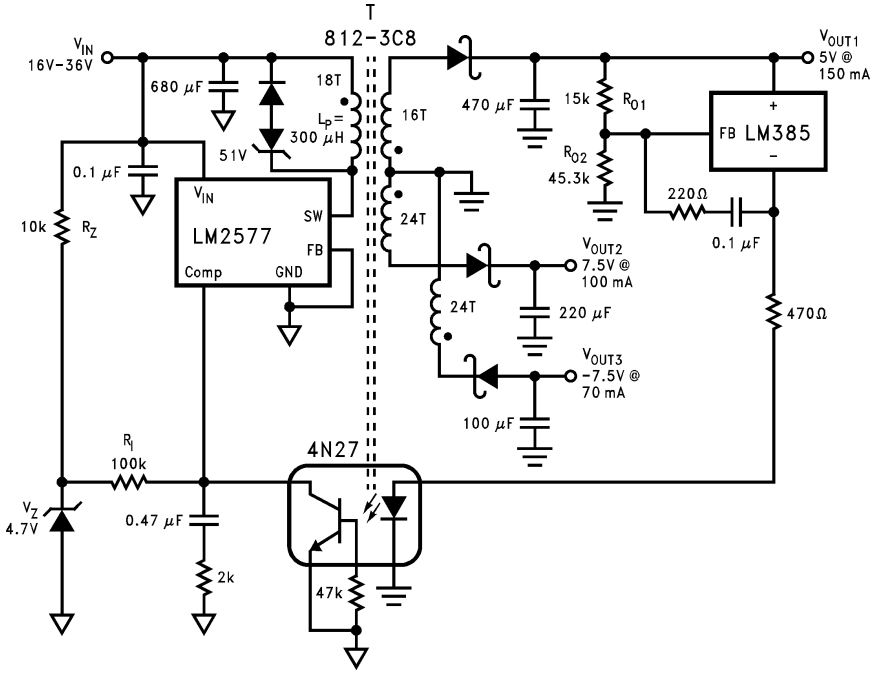
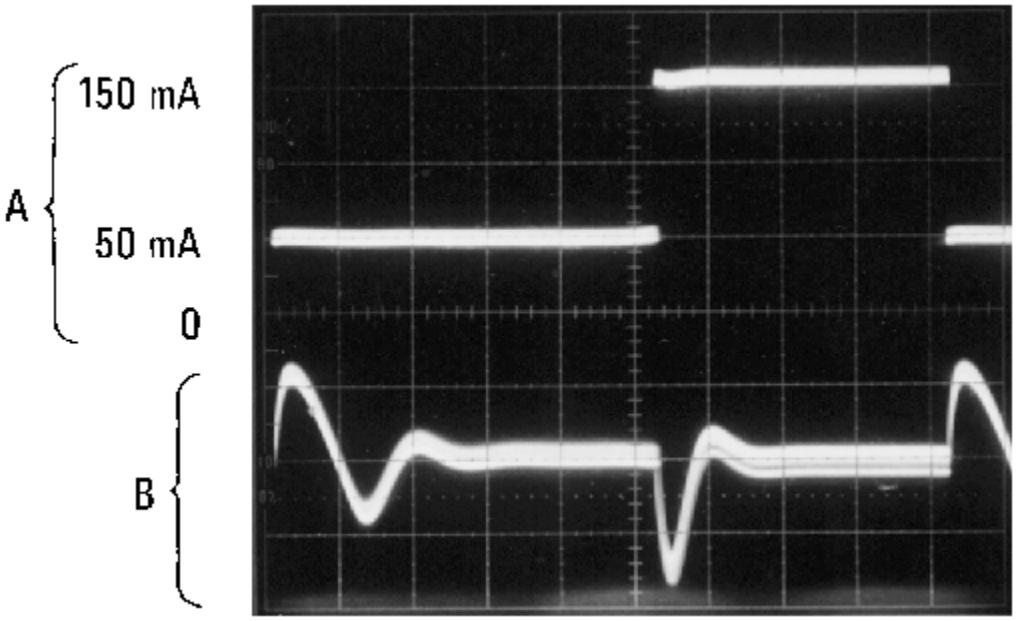


Figure 1. LM2577 Three Output, Isolated Flyback Regulator

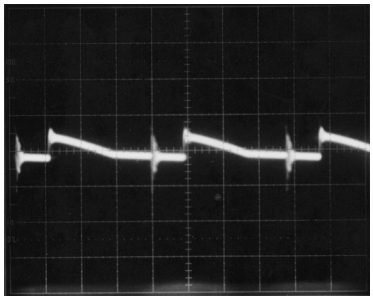
Table 1. Electrical Test Test Data V_I = 16V–36V

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



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

Figure 2. Load Transient Response



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

Figure 3. Output Ripple Voltage

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