MIC2171 SLIC Evaluation Board

100kHz Switching Regulator

Advance Information

General Description

This evaluation board is designed to supply the required ringer and interface voltages used in a Subscriber Line Interface Circuit. The MIC2171 switching regulator IC is used in a flyback topology to generate –24V and –70V from an input voltage of +8V to +20V. The –24V output is rated at 50mA and the –70V output is rated at 60mA. The power supply regulates the outputs from no load to the full rated load. The MIC2171 provides short circuit protection of the outputs.

The entire circuit takes up less than 3 in^2 of board space while producing up to 5.5W of output power. Its efficiency at full load is better than 75%. The MIC2171 features a switching frequency of 100kHz. The circuit includes an undervoltage lockout, which turns the power supply off when V_{IN} is typically less than 7.0V.

Requirements

The SLIC evaluation board requires an input power source with a voltage capability of 20V and should be able to source at least 1A. The evaluation board's outputs may be loaded with a resistive or active load. The active load may be set for constant current or constant resistance mode. The loads must be rated for the relatively high output voltage of –70V.

Precautions

The evaluation board does not have input reverse polarity protection. Applying a negative voltage at the V_{IN} terminal (with respect to ground) may permanently damage the components on the board.

The maximum input voltage of the board is 35V, limited by the voltage rating of the input capacitors. Exceeding this voltage will damage the capacitors.

The first time the evaluation board is powered up, or after any modifications, the input voltage should be slowly increased from 0V. The input current should be monitored while increasing the input voltage. If the circuit draws excessive current, shut off the input power supply and check for proper circuit connections. Using a current limited input source will help to decrease the chance of catastrophic failure.

Circuit Description

The evaluation board schematic is shown in Figure 1. A two-output flyback converter topology is used to generate the two negative output voltages. The MIC2171 switching regulator IC, U1, is used to control the switching waveform and regulate the output voltages. When the switching transistor turns on, current flows in the transformer primary. The output diodes, D3 and D4, are reversed biased, so no current flows in the secondary during the on-time. When the switching transistor turns off, the voltages across the transformer primary and

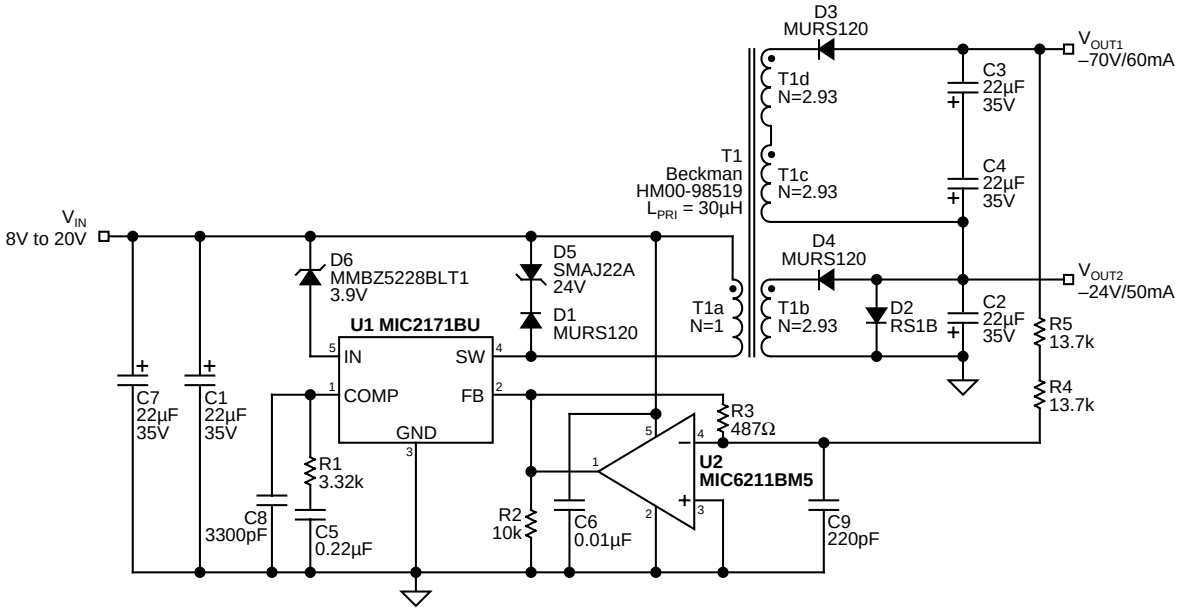


Figure 1. Subscriber Line Interface Circuit Power Supply

secondary reverse, allowing diodes D3 and D4 to conduct. The energy stored in the transformer during the on-time is transferred to the output during the transistor off-time.

The MIC6211 op amp, U2, is needed to invert and attenuate the negative output voltage before it can be connected to the feedback pin of U1. Resistors R4 and R5 serve a dual purpose. They are part of the output voltage setting network and provide a minimum load to the –70V output. Two resistors (R4 and R5)) share the power dissipation. Resistors R3, R4 and R5 set the output voltage according to the formula below.

$$(1) \quad V_{OUT} = -1.24V\left(\frac{R4+R5}{R3}\right)$$

The power dissipated in resistor R4 or R5 is calculated in Equation 2.

$$(2) \quad P_{DISS} = \frac{\left(\frac{1}{2}V_{OUT}\right)^2}{R4}$$

For the evaluation circuit R4 and R5 each dissipate 90mW.

Zener diode D6 increases the input undervoltage lockout threshold of the MIC2171. The turn on threshold of the MIC2171 is typically 2.7V at 25°C. The 3.9V Zener will prevent the IC from starting up until the input voltage reaches a minimum of 6.7V. Diode D2 is used to prevent the –24V output from temporarily going positive when the –70V output is short-circuited. The diode protects the tantalum capacitors from reverse voltage damage.

Referencing Figure 1, there are three secondary windings, each having an equal number of turns. The sum of the three windings plus two diode drops is equal to the regulated output voltage of –70V (ignoring resistive losses). Therefore, 23.7V is developed across each winding, assuming a 0.6V diode drop. The output voltage on the –24V section is closer to –23.1V. The –70V output is achieved by stacking a –47V section (two windings in series) on top of the –24V output. This technique improves the cross regulation over using individual –24V and –70V output sections. Other advantages of this technique are lower voltage stresses on the output capacitors and fewer windings on the power transformer.

The coupling between the primary and secondary is not ideal and therefore, not all of the energy stored in the inductor is transferred to the secondary. This non-ideal coupling appears as a leakage inductance, which forces current to flow in the primary for a short time after the transistor turns off. Diodes D1 and D5 form a clamping circuit which provides a path for this leakage current to flow and limits the maximum voltage on the switching transistor to 24V. The clamp voltage must be greater than the maximum flyback voltage, which appears across the primary winding during the “off time”. The flyback voltage across the primary winding is equal to the voltage across the secondary winding times the transformer turns ratio.

$$V_{flyback} = V_{secondary}\left(\frac{N_{primary}}{N_{secondary}}\right) = 23.3V\frac{1}{2.93}$$

$$V_{flyback} = 8V$$

The peak primary current is calculated from Equation 3.

$$(3) \quad I_P = \sqrt{\frac{2P_{OUT}\,t}{\eta L_{PRI}}}$$

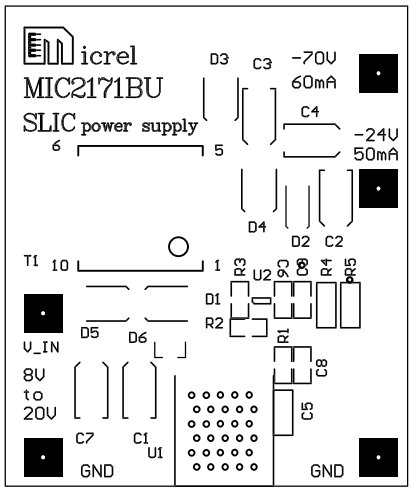
$$I_P = \sqrt{\frac{2 \times 5.5W \times 10\mu s}{0.75 \times 30\mu H}}$$

$$I_P = 2.21A$$

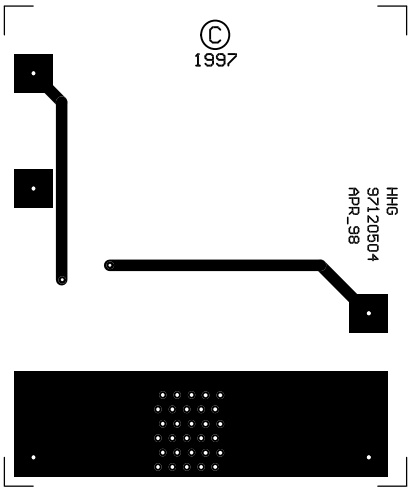
Parts List

Reference	Vendor	Part Number	Description	Quantity
U1	Micrel	MIC2171BU	100kHz switching regulator	1
U2	Micrel	MIC6211BM5	IttyBitty™ operational amplifier	1
C1, C2–4, C7	AVX	TPSE226M035R0300	22µF,35V, tant.	5
C5	AVX	12063C224MATMA	0.22µF, ceramic	1
C6	AVX	08055C103MATMA	0.01µF, ceramic	1
C8	AVX	08055C332MATMA	3300pF, ceramic	1
C9	AVX	08055C221MATMA	220pF, ceramic	1
D1, D3, D4	Motorola	MURS120T3	1A, 200V ultrafast	3
D2	G.I.	RS1B	1A, 100V diode	1
D5	G.I.	SMAJ22A	22V TVS	1
D6	Motorola	MMB25228BLT1	3.9V Zener, 1/4W	1
R1		0805-size resistor	3.32k 1% metal film	1
R2		0805-size resistor	10k 1% metal film	1
R3		0805-size resistor	487Ω 1% metal film	1
R4		1206-size resistor	13.7k 1% metal film	1
R5		1206-size resistor	13.7k 1% metal film	1
T1	Beckman	HM00-98519	flyback transformer	1

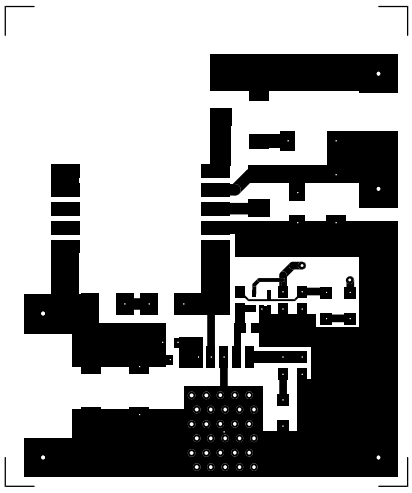
PCB Layouts



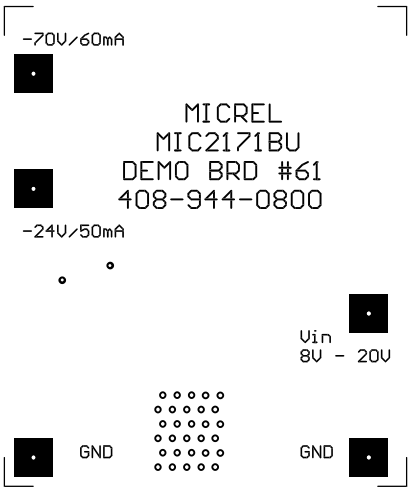
Component-Side Silk Screen



Solder-Side Copper



Component-Side Copper



Solder-Side Silk Screen

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