7.5W Current Mode Control of Flyback Converter

11.1 Circuit Specification

This section covers a simple closed loop current mode controlled flyback converter with the following specifications.

- Input: 10V to 15V
- Output: 5V, 1.25A, 7.5W
- Topology: Non-isolated flyback Converter
- Controller: UC3843(UC3843)
- Switching Frequency: 100 kHz
- Protection: None
  Figure 11.1 and 11.2 shows the full circuit diagram of the non-isolated flyback converter operating from 15V battery (10V to 15V) providing regulated output power report at 5V (1.25 A). The controller used is UC3843 of Unitrode make.

11.2 Circuit Discription

The Circuit consists of a power circuit and a control circuit.

11.2.1 Control Circuit:

1. Controller: The controller used here is UC3843. It is 8 pin IC with maximum supply voltage is 40V.
2. C_2,C_{sh} are all used for filtering.

3. Reference voltage: IC has a internal reference Voltage of 5V.
4. Oscillator Section: Switching Frequency is determined by R_t and C_t

$$F_s = \frac{1.72}{R_t C_t} = 100KHz \tag{11.1}$$

5. Slope Compensation: Transitor Q_4 and R_v forms the Slope Compensation Circuit.The Slope Compensation circuit is required when the circuit is operating with a duty ratio more then 0.5.
6. Controller: Resistor R_f and Capacitor C_f forms the PI controller circuit.
7. Current Sense: UC3843 IC Pin 3 is the Current Sense Pin, it sense the rectified switch current from the Current Transfomer. This rectified Current gets added with the slope compensation voltage and this the Current Sensed by the IC.
8. R_b is the Bleeder resistance used, based on the value of R_b we decide the current sensed to be less then 1V threshold at pin no.3.

11.2.2 Power Circuit:

1. It Consists of the flyback converter with include a Coupled Inductor, Switch, Diode , Capacitor and Load.
2. Duty Ratio: The input voltage is in the range of 10 to 15 V. The output of the boost converter is designed for 5V. The range of duty ratio is from 0.6 to 0.33.
3. Main Inductor: The rated current is 1.25 A. The ripple current is chosen as 0.15 A. With maximum on time of 12 μs, at input voltage of 10V, this gives an inductor value of approximately 150 μH. Inductor is 150H with 33 Turns on primary and 11 Turns on seconday of 22 SWG.
4. The power MOSFET has to carry about 1A and block about 20V. The device chosen is IRFZ44.(IRFZ44) Mosfet drive is through the R_g and R_d.
5. The Diode Carries about 0.5A Average Current and Blocks about 20V and suitable for 50KHz switching. The recovery time has to be better than 50ns. Therefore MUR110 is selected.(MUR110)
6. The capacitor C1 has to limit the voltage ripple to about 1percent. This Capacitor is selected to be 220F.
7. Current Transformer: The CT is used to sense the switch current. The Core used is E 16/8/5 of SWG 28 with 1:200 Turns.
8. The Load Resistor used is 120E.[7.5W]

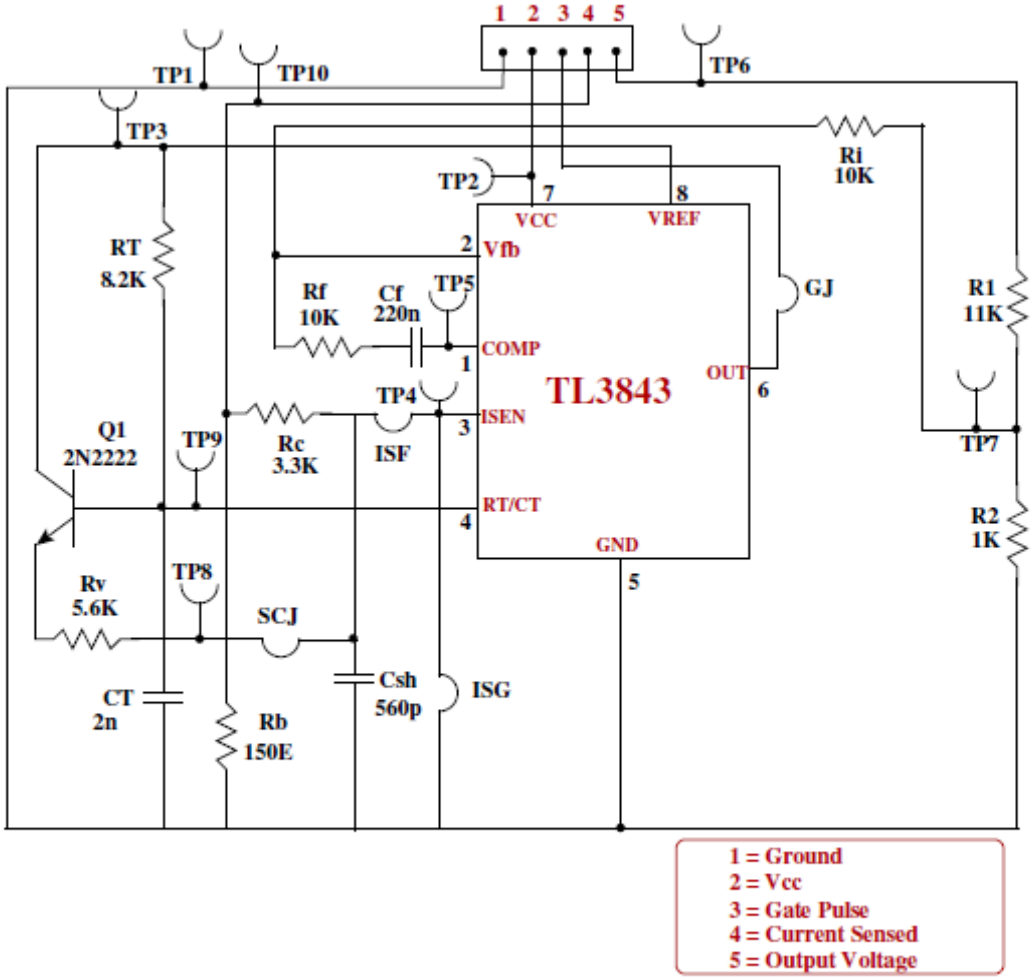


Figure 11.1: Control Circuit for Current Mode Control of Flyback Converter

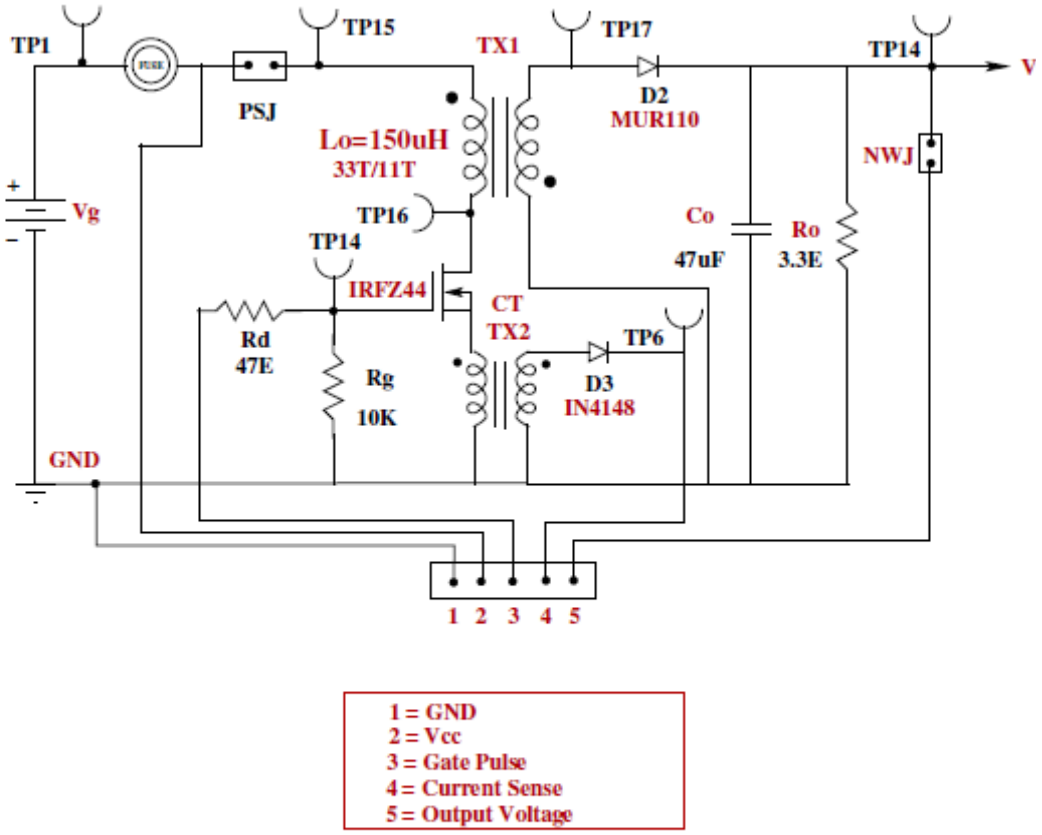


Figure 11.2: Power Circuit for Current Mode Control of Flyback Converter

11.3 Practical Bode Plot using Network Analyser

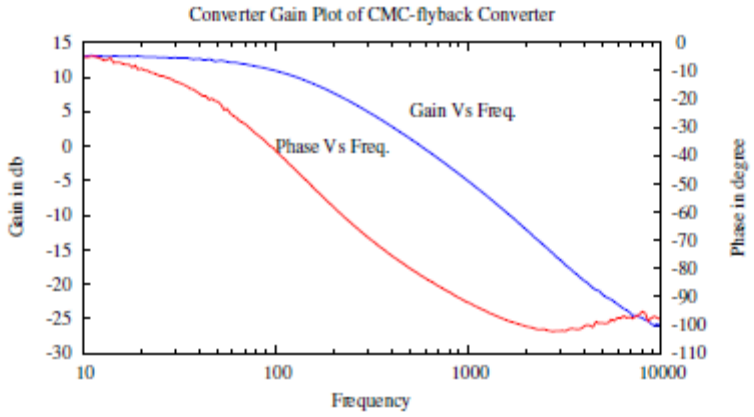


Figure 11.3: Converter Gain Bode Plot of CMC-Flyback Converter

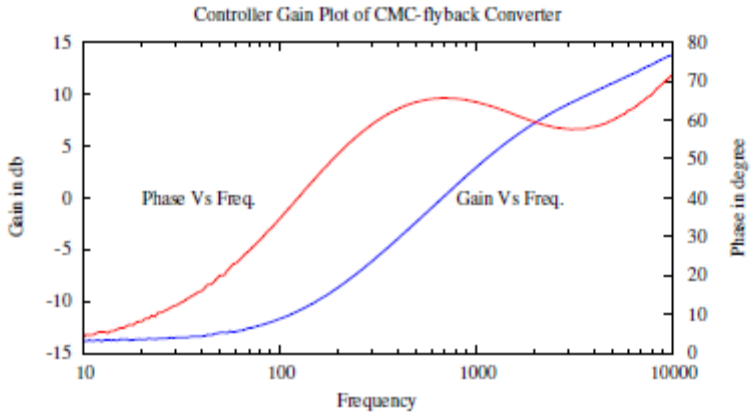


Figure 11.4: Controller Gain Bode Plot of CMC-Flyback Converter

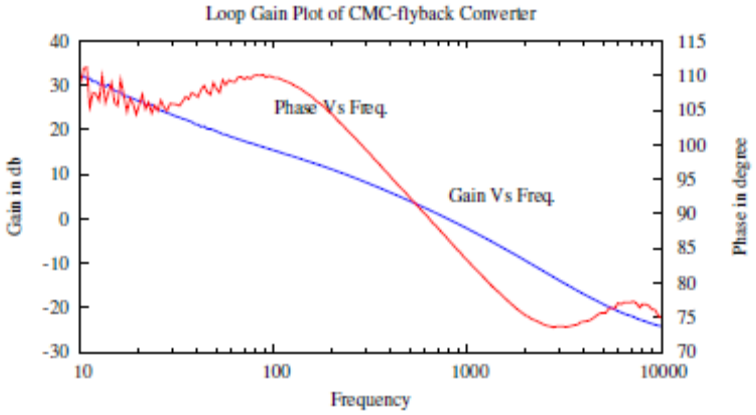
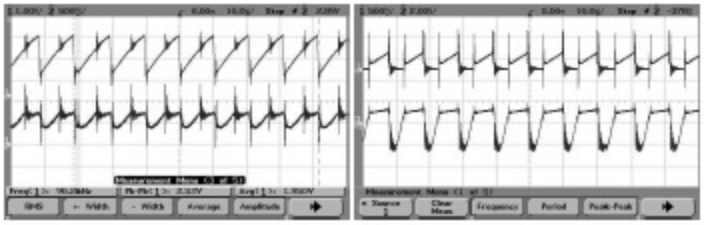


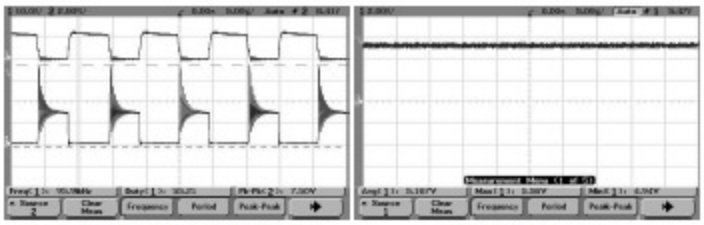
Figure 11.5: Loop Gain Bode Plot of CMC-Flyback Converter

11.4 Pratical Waveform of the CMC-flyback Converter



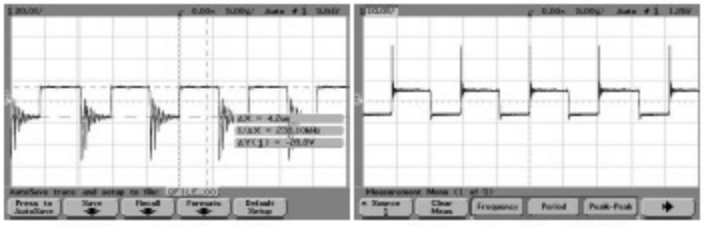
(a) Ramp Voltage and Current sensed with Ramp Compensation

(b) Rectified and Unrectified Switch Current



(c) Gate Voltage and Switch Voltage

(d) Output Voltage



(e) Primary Inductor Voltage

(f) Secondary Inductor Voltage